IMPROVING COLD STORAGE EQUIPMENT IN EUROPE

Energy consumption storage facilities examined in ICE-E

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Contents

Executive summary

This report covers the overall results and conclusions from the 28 audits conducted during the ICE-E project.

The 28 plants audited were situated at 13 different sites in 4 countries.

The cold store facilities were examined in details in order to determine the potential for energy saving. No financial consideration (like investment cost etc.) has been included in this analysis.

Based on this some general conclusions can be drawn:

- In total 130 interventions were identified which can be grouped is 20 different issue-groups.

  Of these:

- 28% can be handled by the owner / operator not having specialized technical knowledge.
- 51% needed assistance by a refrigeration specialist
- 22% need assistance by a consultant, specialized in refrigeration technology and/or cold storage

The saving potential found was between 0 and 72% of the power consumption related to the operation of the cold store.

Introduction

During the ICE-E project 28 cold store facilities were examined in detail in order to determine the potential for energy saving.

Some of the sites also include production and/or processing, but as the ICE-E project covers only cold storage the energy consumption related to the cold storage only was examined.

This document draws together the major findings in relation to potential savings from the energetic point of view. This means that the economics involved in realizing the saving potential are not considered. These issues are covered in another deliverable. The document shall be seen as a source of inspiration in order to investigate your own cold store and the way you operate it. It is not only the different issues that can be handled by the cold store owner / operator but it can be used to challenge the subcontractor / service company in order to identify and realize more specialized issues.

The issues for saving

When looking at savings often only the refrigeration system is analyzed as it is by far the most energy consuming system in a cold store.

But one has to remember that the "only" job for the refrigeration system is to remove all the heat and energy (electrical, truck/lift fuel, human activity, respiration etc.) entering the cold store. In other words savings on the refrigeration system can be obtained "just" by removing load. When reducing electrical load (light, fan motors, lifts etc.) the saving is two-fold: First the direct saving and second the saving on the refrigeration system as the load goes down.

The methodology used in the audits is divided into

- Estimating the heat load including electrical load
- Investigating the electrical consumption
- Analyzing the refrigeration system
- Identifying and quantifying potential savings

In Table 1 the results of the audits are listed as "issues" along some general information on the cold store audited.

Site no.	1	2	2	3	3	3	3	4	4	4	5	6	6	6	7	7	7	7	7	7	8	8	9	10	11	12	13	13
Plant no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Refrigerant	R717	R22	R507	R22	R422D	R422D	R422D	R404A	R404A	R404A	R717	R404A	R404A	R404A	R404A	R404A	R404A	R404A	R404A	R404A	R717	R717	R404A	R717	R717 / secon	R22 / R134a	R717	R717
Heat load (kW)	950	55/25	30	115/45	105/40	45/20	215/80	150	105	270	-	35	15	30	3	3	1,5	0,5	1	1,5	10	130	3	250	45	10	140	55
air temp > 0 °C	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x		x		x	x		
air temp < -18°C	x										x	x										x		x			x	x
Total saving %	20	20	10	20	20	20	20	72	68	57	8	28	0	15	9	10	19	22	8	6	6	7	20	26	19	36	24	31
Issue																												
Infiltration/door protection	x							x		x	x	x	x								x				x	x	x	
Lighting	x							x	x	x														x	x	x	x	x
Insulation				x	x	x	x														x	x	x	x				
Reduce condensing pressure	x	x		x	x	x						x	x	x											x	x	x	
Control of condenser fans							x																					
Subcooling								x	x	x																		
Defrost control	x		x					x	x	x				x										x	x		x	x
Room temp settings								x	x	x		x	x	x													x	x
Superheat control						x		x	x	x																		
Control of evaporator fans			x												x	x	x	x	x	x				x	x	x	x	x
EC fans								x	x	x																		
Control of compressors	x		x					x	x	x											x	x		x	x		x	x
Other refrig system issues							x					x	x	x														
Other controls							x														x	x	x		x			
Expansion device		x										x	x	x														
System design								x	x	x	x				x	x	x	x	x	x			x	x				
Battery charging								x		x																		
Service/maint./monitoring																							x	x			x	
Product temperature											x													x				
Restoring of control settings								x	x	x		x	x	x														

Owner /operator (green) **Consultant** (yellow) **Refrigeration specialist** (blue)

Table 1 Results from the 28 audits and identified issues impacting the energy consumption. The skills needed for the different issues are indicated.

In total 130 instances were identified which can be grouped is 20 different issue-groups as shown in Table 1 and Figure 2 to 4.

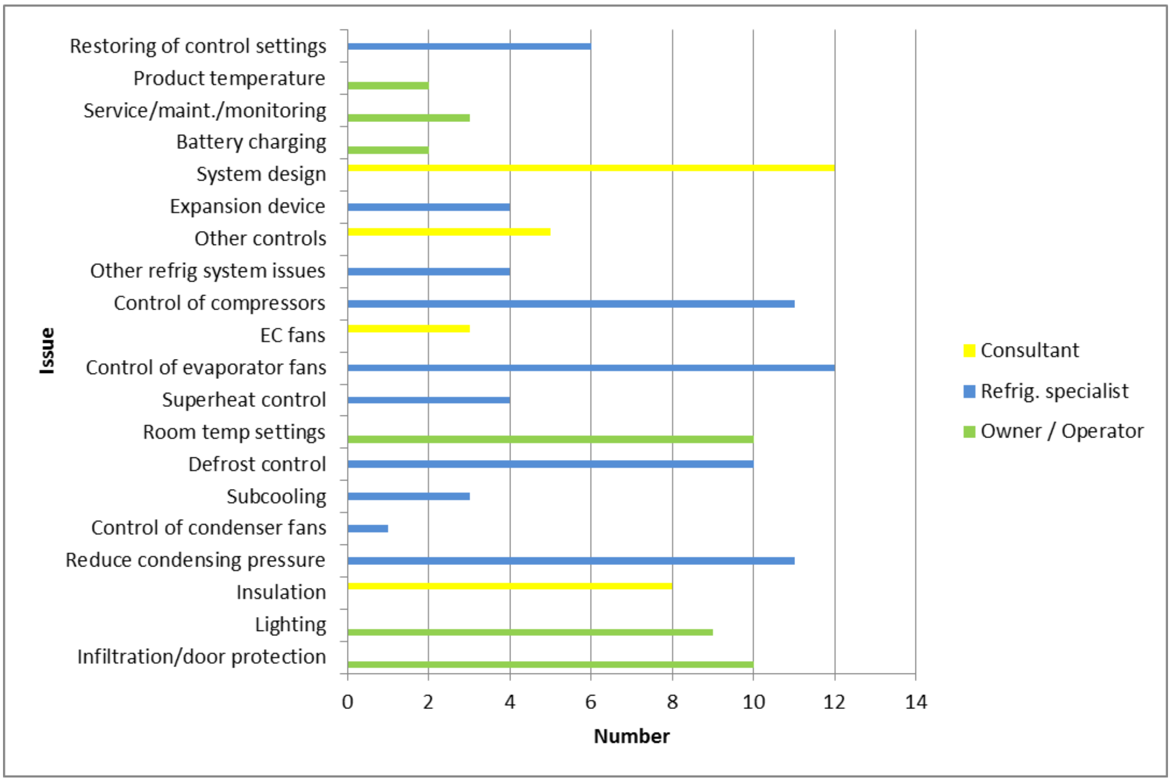

Figure 2 The number of instances of the individual issues and the skills needed.

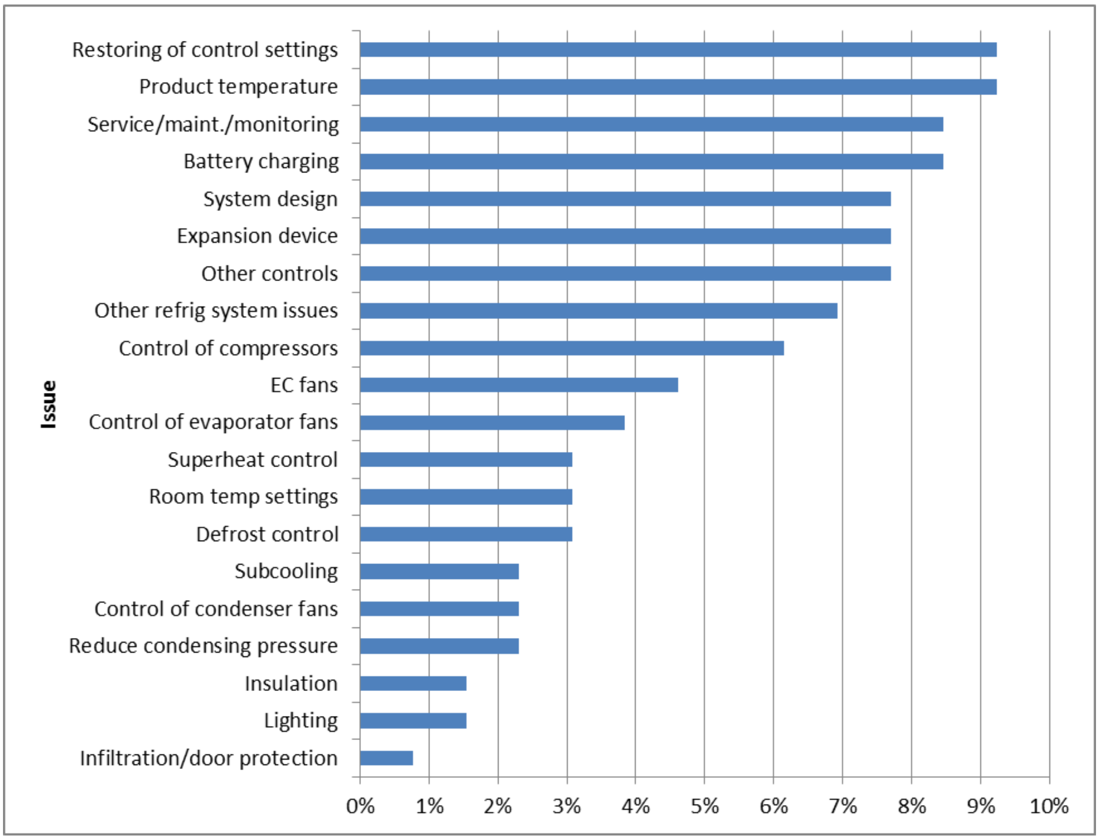

Figure 3 Individual issues as percentage of total number

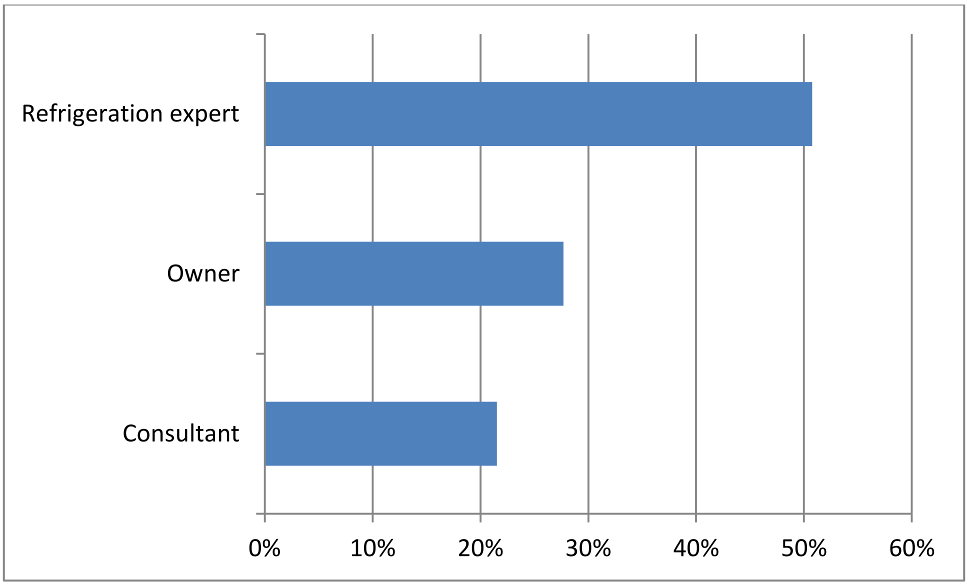

Figure 4 Distribution of issues divided on the different participants

As it can be seen form Figure 4 about 28% of the identified issues could be handled by the Owner /operator of the cold store.

The figures only show the number of issues and not the amount of impact on the energy efficiency.

The impact of minimizing the "issues" can be analyzed using both the "simple" and "complex" calculation model provided on the ICE-E home page www.ice-e.eu.

Also the relevant Info Packs and Case studies can be consulted for information and the e-learning tools for more in depth information and training.

Issues impacting the energy efficiency

The following issues impacting the energy consumption were identified

Infiltration/door protection

Significant infiltration of warm and moist air was found in 10 audits including all the low temperature stores.

Investigation into energy saving can be done by the owner /operator without special skills.

Lighting

An issue in 9 audits.

The heat load from lighting can quite easily be investigated by the owner /operator without special skills.

The saving potential is both direct and indirect (the COP of the refrigeration system).

Insulation

An issue in 8 audits.

Insulation can both be too thin, too low quality and damaged/old.

The condition of the vapor retarded has to be checked in order to keep both the performance of the insulation and the building components (moisture in the construction).

The ICE-E calculation models can be used to analyze the impact both the quality of the insulation and the thickness.

A detailed analysis including infra-red measurements is a job for a consultant.

Reduce condensing pressure

An issue in 11 audits.

The daily/automatic checking of the condensing pressure compared to the temperature of the ambient (or cooling water etc.) can be done by the owner / operator. But the actual work of reducing the pressure is a job for a refrigeration specialist.

The ICE-E Complex model is an effective tool for analyzing the impact but as a rule of thumb 1°C too high condensing temperature equals 2-3% extra power consumption.

Control of condenser fans

This is only registered as an issue in 1 audit, but quite simple controllers are available optimizing the condenser fan speed and condensing pressure.

Reducing speed of pumps and fans has an enormous impact on the energy consumption.

The analysis is a job for a refrigeration specialist or consultant experienced in refrigeration.

Subcooling

An issue in 3 audits.

This is especially a problem for DX systems: loosing the sub cooling of the liquid refrigerant supplied to the expansion valves can cause too little liquid supply.

The analysis is a job for a refrigeration specialist or consultant experienced into refrigeration.

Defrost control

An issue in 10 audits.

Correct timing and length of defrost has a direct impact on both the heat dissipated into the cold store and the performance of the air cooler/evaporator.

Daily checking of the status can be done by the owner/operator but it is recommended to consult a refrigeration specialist before starting to optimizing the defrost process.

At air temperatures above 0°C the use of the air flow through evaporator instead of electrical or hot gas defrost should be considered (of-cycle or passive defrosting).

Room temp settings

An issue in 10 audits.

Too low set point for the cold store air temperature wastes energy and it can raise the weight loss of the stored products due to drying out.

As a rule of thumb 1°C too low cold store air temperature equals 2-3% extra power consumption.

The daily checking of the status and adjustment can be done by the owner/operator.

Superheat control

An issue in 4 audits.

Too high superheat out of the evaporator on DX systems indicates a possibility of raising the evaporation temperature as the refrigeration system often will compensate for bad evaporator efficiency by lowering the evaporation temperature (suction pressure).

The cause of the problem is often one of the following

- lack refrigerant charge on the system
- lack of refrigerant supply to the valve
- lack of sub cooling

- poor expansion valve control
- wrong valve size (or nozzle)

As a rule of thumb 1°C too low evaporation temperature equals 2-3% extra power consumption.

The analysis and solving of the problem is a job for a refrigeration specialist.

Control of evaporator fans

An issue in 10 audits.

Reducing speed of pumps and fans has an enormous impact on the energy consumption and running evaporator fans at lower speed instead of on/off regulation can provide quite high saving if the off-time is significant (low duty factor). But also cascading of multiple fans or pulsing fans so only the required fan capacity is running can save power as well as controlling the optimum condensing pressure.

The analysis of duty factor can quite easily be investigated by the owner /operator without special skills.

Please be aware the low duty factor can imply that the evaporation temperature is too low and should be raised.

EC fans

An issue in 3 audits.

EC fans are more efficient than ordinary fan motors and should be considered when changing fan motors. EC motors have built-in variable speed drive so a control signal is needed in order to get the full benefit of the investment in EC fans.

The analysis of the benefit of using EC fans is a job for a consultant.

Control of compressors

An issue in 11 audits.

Optimal operation of the refrigeration compressors can have a high impact on the power consumption. Especially fixed speed screw compressors have very bad part load efficiency and should be operating at 100% load as much as possible. In case of a mix of screws and reciprocating compressors it is highly recommended to do the part load operation on the reciprocating compressors.

The detailed analysis is a job for a refrigeration specialist or consultant experienced into refrigeration.

Other refrigeration system issues

This is an issue in 4 audits and covers a lot of other possible issues and problems.

The daily check of running condition etc. can reveal problems but the detailed analysis is a job for a refrigeration specialist or consultant experienced into refrigeration.

Other controls

This is an issue in 4 audits and covers other possible issues and problems.

The daily check of running condition etc. can reveal problems but the detailed analysis is a job for a refrigeration specialist or consultant experienced into refrigeration.

Expansion device

An issue in 4 audits.

The size and function of the expansion valve in DX systems has an enormous impact on the performance of the evaporator and the evaporations temperature.'

The daily check of running condition etc. can reveal problems but the detailed analysis is a job for a refrigeration specialist.

System design

An issue in 12 audits.

A change of systems design (e.g. the inter connection of different compressors or piping) will some time make savings possible.

The detailed analysis is a job for a refrigeration specialist or consultant experienced into refrigeration.

Battery charging

An issue in 2 audits.

When charging batteries for lifts etc. quite some heat is dissipated into the surrounding air. Therefor charging shall not be done in refrigerated areas as it is a source of heat load.

Service/maintenance/monitoring

An issue in 3 audits.

Daily monitoring of the running condition of the refrigeration system is highly recommended. Scheduled service and maintenance is also recommended in order to have a safe and stable refrigeration system.

The daily monitoring should be do by the owner/operator in order to have updates knowledge of the system performance.

Most of the service and maintenance on the refrigeration system have to be done by refrigeration specialist.

Product temperature

This was only an issue in 2 audits but the heat load from products not having the right temperature when loaded to the store or different temperatures in different stores/rooms impacting the product temperature is wasted energy.

The ICE-E simple calculation tool is efficient in order to analysis the impact from product temperature.

The analysis and daily monitoring should be done by the owner/operator.

Restoring of control settings

An issue in 6 audits.

Often the set points for the room temperature and/or settings for the refrigerations system are “slipping”: It is changed due to some event (e.g. a blocked door) but never changed back.

The daily monitoring do by the owner/operator is capable of catching this “slipping” which also can be caused by some malfunctioning component in the system.

General conclusions

The 28 plants audited were situated at 13 different sites in 4 countries.

The cold store facilities were examined in details in order to determine the potential for energy saving. No financial consideration (like investment cost etc.) has been included in this analysis.

Based on this (Table 1 and Figure 2) some general conclusions can be drawn:

- In total 130 instances were identified which can be grouped is 20 different issue-groups.

Of these

- 28% can be handled by the owner / operator not having specialized technical knowledge.
- 51% needs assistance by a refrigeration specialist
- 22% need assistance by a consultant, specialized in refrigeration technology and/or cold storage

The saving potential found is between 0 and 72% of the power consumption related to the operation of the cold store.

The sites

In the following a short description of the individual sites can be found.

For the more detailed description and documentation please refer the site specific reports mentioned.

Site 1

Site description:

The site has one plant consisting of 7 frozen stores and 1 chilled store, all served by a common R717 based pump circulated over feed refrigeration system. The chilled store is connected to the intermediate surge drum.

Executive summary:

A survey was carried out during May 2012. During the survey data was collected on the operation of the 8 refrigeration store rooms on site (7 freezers and 1 chiller that all operated from a single refrigeration plant). From the data collected heat loads on each cold store and the efficiency of the refrigeration plant supplying all the rooms was calculated.

Making changes to the way in which the refrigeration plant operates would provide substantial savings. The current plant is efficient but energy consumption could be reduced. In addition heat loads in the stores could be reduced.

The following are recommended to reduce the energy consumption:

1. Infiltration in the frozen stores can be reduced by replacing damaged strip curtains and reinstalling door operation. At the same time the interlock between the open doors and the lighting needs to be removed so that lighting remains on within each chamber when forklifts are operating.
2. Infiltration in the chilled store can be reduced by repairing gaps under the docking doors, closing doors to ambient and operating the battery charging area correctly.
3. Changing lighting to LED lights should be considered, particularly if lights with sensors are used. The economics of LED lights are marginal on energy alone but they may save money if maintenance and life of lamps is taken into account.
4. The reciprocating compressors should be used as the lead compressors for the ip (intermediate pressure) load.
5. Condensing pressure should be reduced.
6. Defrosts should terminate on temperature and not time. Reducing infiltration will reduce defrost demand. Defrosts should be re commissioned.
7. The capacity algorithm for the 3 screw compressors should be improved so that the compressors operate at full load where they are more efficient.
8. If heat loads are reduced it would be advisable to fully utilise the excess ‘free’ solar energy and to use the frozen stores as a thermal store. This would reduce the energy that needs to be purchased.

If the above were implemented saving of at least 20% should be achievable (without including the items where it was impossible to provide accurate estimates of the energy saved).

Site 2

Site description:

The site has 2 plants serving in total 5 chilled stores. Both plants are DX type operating on R22 and R507 respectively.

Executive summary:

Surveys were carried out during October and November 2011. During the first survey stores 6, 7 and 8 were audited and potatoes were being chilled after harvest or onions were being stored at ambient temperatures. During the second visit stores 6, 7 and 8 and stores 9 and 10 were audited and potatoes and celeriac were being stored and were already cooled to the store temperature. During the survey data was collected on the operation of the following stores/store groups:

- Stores 6, 7 and 8
- Stored 9 and 10

From the data collected heat loads on each cold store and the efficiency of the refrigeration plant supplying all the rooms was calculated.

Making changes to the way in which the refrigeration plant operates would provide reasonable savings. In addition heat loads on the stores could be reduced by increasing insulation thickness.

The following are recommended to reduce the energy consumption:

<u>Stores 6, 7 and 8:</u>

Reduce condensing temperature to 20°C during winter and to 10°C warmer than the ambient during the rest of the year. This would save approximately 20% of the energy used (change expansion valves at same time; it may be necessary to have 2 expansion valves fitted, one for summer use and one for winter use).

<u>Stores 9 and 10:</u>

Investigate control setting to prevent inverter compressor hunting. This should save 5-10% of the energy.

Run fans to stir air (not run compressors). Run minimal number of fans. Savings of approximately 10% could be achieved.

Investigate using off-cycle defrosting. Removing the need for hot gas defrosting would decrease the energy consumption during storage (as opposed to removing field heat from the product) by approximately 30%.

Site 3

Site description:

The site has 4 plants serving in total 8 chilled stores. The plants are all DX type, three operating on R422D and 1 one R22.

Executive summary:

Surveys were carried out during October and November2011. During the first survey potatoes were being chilled after harvest whereas during the second visit the potatoes had been cooled to the store temperature. During the survey data was collected on the operation of the following stores/store groups:

- Stores 1 and 2
- Stores 3 and 4
- Store 9
- Stores 10, 11 and 12

From the data collected heat loads on each cold store and the efficiency of the refrigeration plant supplying all the rooms was calculated.

Making changes to the way in which the refrigeration plant operates would provide reasonable savings. In addition heat loads on the stores could be reduced by increasing insulation thickness.

The following are recommended to reduce the energy consumption:

1. Increase insulation thickness on all outside walls to 200 mm.
2. Reduce condensing pressure on all plants to 12.5 BarG.
3. Optimise operation of condenser fans on plant operating stores 11, 11 and 12.
4. Move receiver for plant operating stores 10, 11 and 12 to outside plant room.

In addition it is recommended planning to change the refrigerant on plant 1 and 2 from R22 to R422D (this is a legislative issue rather than a means to save energy).

The above initiatives would save approximately 20% of the energy used during stable operation.

As 2-3 times the energy is used during the pull down period energy savings would be expected to be slightly greater than those outlined above.

Options to save energy through replacing plant were also explored. The inverter compressor unit (rooms 3 and 4) was shown to be the most efficient of the plants examined during stable operation but was not as efficient as the multi-compressor pack (rooms 10, 11 and 12) during pull down. Using inverters on compressors is a possibility but needs care to ensure that plant is not compromised by poor oil return. The financial benefits of using inverters are probably marginal unless new plant is being installed. Other options are available if plant is being replaced but the financial investment could only be justified if plant needs to be replaced.

Site 4

Site description:

The site has 3 plants each serving 1 chilled store. All the plants are DX type operating on R404A.

Executive summary:

A survey was carried out during July 2011. During the survey data was collected on the operation of the 3 refrigeration store rooms on site (IP1, IP2 and IP3). From the data collected heat loads on each cold store and the relative efficiency of each cold store were calculated.

Making changes to the way in which the refrigeration plants operate would provide substantial savings. The current plants are not operated efficiently and the following are recommended to reduce the energy consumption:

1. Install a liquid subcooler on all systems.
2. Re commission expansion valves to provide 3-4°C of superheat at exit to evaporator.
3. Restore all plant to original design operation (-4°C evaporating, 25°C condensing).
4. Ensure all stores operate at 4°C (not lower as current).
5. Operate IP1 and IP2 on 1 system (with backup compressor available to cut in automatically). Operate IP3 on 2 systems.
6. Investigate use of off-cycle defrosts (or if unsuccessful 1 electric defrost per day).
7. Eliminate infiltration in battery charging areas.
8. Investigate LED lights in all stores, especially IP3.
9. Investigate use of EC fans in all stores.

If the above heat loads are reduced it would be possible to operate IP3 throughout the year on a single system. A staged control where 1 system is operated with the compressor at full loading rather than all 3 systems with compressors at 33% loading should be implemented.

Combining the energy savings achievable from refrigeration system optimisation and heat load reduction the potential savings are IP1: 72%, IP2: 68% and IP3: 57%.

Site 5

Site description:

The site consists of 3 frozen stores served by a common R717 based pump circulated over feed refrigeration system.

Executive summary:

A survey was carried out during June – July 2012.

During the survey data was collected for the operation of ammonia refrigeration plant, which powers three low-temperature cold rooms - Chamber 1, Chamber 2 and Chamber 3 forming the refrigeration storage of the factory's finished products.

Into consideration is taken that this is a production cold store and the resulting characteristics of this fact in its operation.

Changing the way the chambers are being utilized will provide substantial savings in terms of electrical energy consumed by the ammonia refrigeration plant which is the biggest energy consumer in the whole plant.

The investigation that was conducted, it was concluded that the reduction of the heat load infiltration through cold room doors is the most important factor in reducing energy consumption of the ammonia system.

Reducing the heat load of opening the cold room doors can be achieved by:

1. Installing air curtains over cold room doors;
2. Cooling the air in the hallway outside the doors of cold rooms to around 5°C;
3. Optimizing the operations of loading and export of products from cold rooms and thereby reducing the time during which the three cold room doors remain open.

The first two ways involve considerable investment and given the strong seasonal nature of ice cream production, the third way is the cheapest and the most appropriate.

Reducing the time the three cold room doors remain open by 25% (from average 80 min/24 h to about 60 min/24 h), theoretically the factory will achieve energy consumption savings of 8,3%.

73% of the total annual production of ice cream is produced and in May, June, July and August. For this months production program is almost identical.

Energy consumption saving of 40 000 kWh is theoretically possible for these four months based on the above-mentioned time reduction during which the three cold rooms remain open.

Site 6

Site description:

The site consists of 3 plants: 1 frozen store, 1 chilled store and a cooled dock area all served by individual DX refrigeration plants all operating on R404A.

Executive summary:

A survey was carried out in Bulgaria during May-June 2012.

During the survey, data was collected on the operation of the two refrigerated rooms (Store A) and (Store B) and one refrigerated corridor (Store C) on site. From the data collected on heat loads, for the two cold stores and the cooled dock, the relative efficiency of each cold room was calculated.

Making changes to the way in which the refrigeration plants operate would provide substantial savings. The current plants are not operated efficiently and the following are recommended to reduce the energy consumption:

1. 1.To restore normal operation of the air-cooled compressor-condenser refrigeration units (Reducing the excessive condensing temperature)
2. Recommission expansion valves to provide 5-7 °C of superheat at exit to evaporator.
3. Restore all cold rooms to original design operating parameters (condensing and evaporator temperatures, refuelling installations with liquid refrigerant etc.)
4. Ensure all rooms operate at set temperatures (-20; 2 ; 8 °C not lower as current).
5. Investigate reducing of defrosting in Store A and replacement of electrical with air defrosting in Store C.
6. Reducing the infiltration of air from the doors of cold rooms (Store A and Store B).

If the above actions are implemented, substantial energy saving are achievable: Store A 28%, Store B 0% and Store C 15%.

Site 7

Site description:

The site consists of 6 chilled stores plants each served by an individual DX refrigeration plants all operating on R404A.

Executive summary:

A survey was carried out during August 2012. During the survey data was collected on the operation of the refrigeration store and plant site. From the data collected heat loads on each cold store and the relative efficiency of each cold store were calculated.

The cold stores are well constructed and operated (insulation, doors protection, loading/unloading, lighting) so no major possibility of energy saving through the reduction of non refrigeration system heat loads is foreseen.

For all of the six investigated cold stores the following are recommended to reduce the energy consumption:

Install evaporator fans switches for on/off control of fans during compressor off periods.

For stores 3, 4, 5, 6, installing larger heat transfer surface evaporators would be beneficial both in terms of energy consumption (higher evaporation temperature, all the other working conditions being the same) and in reducing meat weight loss because of water evaporation.

The overall energy saving potential found was:

Store 1: 9%

Store 2: 10%

Store 3: 19%

Store 4: 22%

Store 5: 8%

Store 6: 6%

Site 8

Site description:

The site consists of 2 plants: 1 plant serving a chilled store and 1 plant serving 4 frozen stores. Both plants are R717 based pump circulated over feed refrigeration system.

Executive summary:

A survey was carried out during February 2012. During the survey data was collected on the operation of the refrigeration store and plant site. From the data collected heat loads on each cold store and the relative efficiency of each cold store were calculated.

Making changes to the way in which the refrigeration plants operate would provide substantial savings. The current plants are not operated efficiently and the following are recommended to reduce the energy consumption:

1. Improve insulations of positive temperature stores. Saving potential 18%.
2. Install doors protection in positive temperature stores. Saving potential 6%.
3. Improve insulation of low temperature stores. Saving potential 7%.

Site 9

Site description:

The site consists of 1 plant serving a chilled store. The plant is of the DX type operated on R404A.

Executive summary:

A survey was carried out during February and March 2012. During the survey data was collected on the operation of the refrigeration store and plant site.

From the data collected heat loads on the cold store and the relative efficiency of the cold store were calculated.

The current plant is operated efficiently, still modifications are advisable to reduce the energy consumption:

1. Improving the insulation of the store (floor) would be beneficial.
2. Modify electrical wiring of compressor oil heater cartridge (done).
3. Improve the existing monitoring and control system with amemory card to register operating conditions.
4. Install an electronic energy meter.
5. Move the condenser in the North or East side of the building / promote shadowing of condenser (trees, other).
6. Set up a permanent maintenance schedule.

The above initiatives would save approximately 20% of the energy used during stable operation.

Site 10

Site description:

The site consists of 1 common R717 based pump circulated over feed refrigeration plant serving the two frozen stores, the unloading dock area and the loading dock area.

Executive summary:

The facility consists of 4 frozen stores. The stores are operated at -19 to -21°C.

The following are recommended to reduce the energy consumption:

1. General service and recommissioning of the refrigeration system: 6,3 % saving
2. Change of operating conditions for the refrigeration system: 6,0 % saving
3. 280mm extra insulation at roof: 1,5 % saving
4. 150mm extra insulation in walls: 4,6 % saving
5. Pressurized buffer tank for evaporative condenser: 1,1 % saving
6. Minimizing temperature difference between rooms: 0,7 % saving
7. LED lighting: 2,0 % saving
8. VSD drive on evaporator fans in loading and unloading area: 1,8 % saving
9. VSD on one screw compressor: 2,0 % saving

These saving potentials add up to 26% but in reality it can be a little lower as some of these savings are dependent to some degree.

Site 11

Site description:

The site consists of two chilled storage rooms served by a secondary glycol cooling system cooled by cooled by a R717 based refrigeration system having a self-circulating flooded plate heat exchanger.

Executive summary:

Two chilled stores have been audited: “Store 1” operated at a set point of +2 °C storage and “store 2” operated at a set point of +5 °C. The use of the stores is very dependent on the season. The average heat load on the stores is estimated to 43kW when harvesting vegetables in the summer period.

Both the stores as well as production facilities and vacuum coolers are cooled by a secondary glycol based system cooled by a R717 based refrigeration system having a self-circulating flooded plate heat exchanger.

The following are recommended to reduce the energy consumption:

1. VSD on oil comer for screw compressors 1.5 % saving
2. VSD drive on air cooler fans 6.6 % saving
3. Raising evaporating temperature when vacuum coolers are off 3.0 % saving
4. LED lighting 0.5 % saving
5. Lowering of condensing pressure 7.4 % saving

These saving potentials add up to 19% but in reality it can be a little lower as some of these savings are dependent to some degree.

Site 12

Site description:

The site consists of two chilled storage rooms served by an individual DX type refrigeration system having a condensing unit on the roof.

Executive summary:

Two stores were audited both operated at a set point of +4 °C.

Each room has a dedicated DX type refrigeration plant having a condensing unit on the roof.

The total average heat load is calculated to be 10.9 kW. This figure is very dependent on the use of the room.

The following are recommended to reduce the energy consumption:

1. Awareness of the operation of doors 3.0 % saving
2. LED lighting 1.8 % saving
3. VSD drive on evaporator fans 13.1 % saving
4. Lowering of condensing pressure 18.0 % saving

These saving potentials add up to 36% but in reality it can be a little lower as some of these savings are dependent to some degree.

Site 13

Site description:

The site consists of 2 plants both R717 based pump circulated over feed refrigeration plant serving the 2 frozen storages and 1 frozen storage respectively.

Executive summary:

The facility has been expanded several times and now consist of 2 R717 based pump circulated over feed refrigeration plant serving the total of 3 frozen stores: “Storage 1” and “Storage 2” served by “Plant room A” and “Storage 3” served by “Plant room B”. Both plant rooms also serve blast freezers.

The following are recommended to reduce the energy consumption in “Plant room A”:

10. VSD drive on evaporator fans in “Storage 1”: 2.4 % saving
11. VSD drive on evaporator fans in “Storage 2”: 5.2 % saving
12. Automtic doors installed at “Storage 2”: 4 % saving
13. Raising of the evaporation temperature in “Plant room A”: 1.1 % saving
14. New evaporative condenser for “Plant room A”: 4.9 % saving
15. LED lighting in “Storage 1”: 2.5 % saving
16. LED lighting in “Storage 2”: 1.6 % saving
17. Raising air temperature in “Storage 1”: 1.3 % saving
18. Raising air temperature in “Storage 2”: 0.9 % saving

These saving potentials for “Plant room A” add up to 24% but in reality it can be a little lower as some of these savings are dependent to some degree.

The following are recommended to reduce the energy consumption in “Plant room B”:

1. VSD drive on evaporator fans in “Storage 3”: 10.6 % saving
2. Raising of the evaporation temperature in “Plant room B”: 0.6 % saving
3. Minimizing part load on screw compressors in “plant room B” 9.0 % saving
4. LED lighting in “Storage 3”: 7.7 % saving
5. Raising air temperature in “Storage 3”: 3.3 % saving

These saving potentials for “Plant room B” add up to 31% but in reality also here it can be a little lower as some of these savings are dependent to some degree.