

VOETS & DONKERS
KOELTECHNIEK EN LUCHTBEHANDELING

Simon Beheer BV Cold Storage Facility
Ruiting 15, 5076 RA Haaren, Netherlands

Proven Energy Efficiency Increase

Simon Beheer BV operates Cold Storage units that are continuously maintained at subzero degrees to keep fruits and flowers fresh. Electricity cost being the main expense of the facility, the opportunity to save energy is welcomed by Simon Beheer BV through a "Try & Buy" proposal.

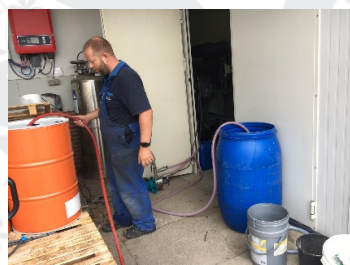
In this project, a minimum of 20% increase in COP was committed by Hydromx Inc via detailed Energy Performance Contract (EPC) signed by both parties. Close to 2 years of baseline data was gathered for a comprehensive analysis.

System comprises 12 cold storage cells with different capacities. All the cells thermally isolated by the highest standards and under the same roof. The plant was constructed and is maintained by Voets & Donkers BV, HVAC contracting company. The cells are thermostatically controlled and steadied at 0,3°C by a PLC software and BMS system.

A custom designed refrigeration system has an air-cooled type Chiller. Bitzer semi-hermetic tandem compressors are chosen, which uses R134A type condenser refrigerant and runs in 4 stages; 25/50/75/100.

Application of Hydromx®

Since the system chilled water already had 35% Propylene Glycol, Hydromx custom manufactured Nano-Techno package was directly applied by injection method without interrupting the chiller plant operation. The system total volume was 3,5 m³. The nano-techno package was dozed into the chilled water loop by Voets & Donkers.





Method of Comparison

The performance of Hydromx was compared for the months from July to December of 2019 & 2020 baseline data. Simon Beheer management had requested that the comparison analysis to be performed particularly for the months of July through December as the harvesting season starts in August & ends in October. The November and December months are relatively stable. In the EPC Contract both Simon Beheer and Hydromx agreed on the performance comparison methodology. The coefficient of performance (CoP) of before and after data was compared. The performance difference calculated by the change in the CoP of the system according to the below methodology as mutually agreed by both parties.

$$CoP = \frac{TOTAL\ HEAT\ LOAD}{TOTAL\ ENERGY\ CONSUMPTIONS}$$

$$\text{The efficiency ratio} = \frac{CoP_{after}}{CoP_{before}}$$

Calculation of Total Heat Load (Q_{total})

The main heat load is due to fruit cooling in the cells. It is calculated by the formula below.

$$Q = M_{fruit} * C_{p,fruit} * \Delta T_{fruit}$$

The temperature changes of the products was logged by the A&C software as seen on Figure1. The raw data then was exported to Excel where the calculations are completed. The product movement in the cells was also recorded by the Simon Beheers BV with complete details. The calculation tables were prepared by identical methodologies for both periods with the records of each cell provided by Simon Beheer.

Temperatures	2019	2020	Difference
July	19,3	17,5	1,8
August	19,1	20,8	-1,7
September	14,9	15,8	-0,9
October	12	11,4	0,6
November	6,3	8,7	-2,4

Weather Impact

The overall impact of Outside Air Temperatures was determined to be negligible as monthly temperature and humidity averages had not recorded any significant difference.

	Cells & Time Frames	Material Mass (kg)	$\Sigma \Delta T$ Product 1 (0°C)	$\Sigma \Delta T$ Product 2 (0°C)	Qmaterial Change (KJ)
	CELL 1 28.08-31.08	18.222,00	10,90	70,80	2.709.502,07
CELL1	Aug 2018	18.222,00	10,90	70,80	2.709.502,07
CELL1	CELL 1 01.09-30.09	18.222,00	257,00	467,00	24.010.764,96
CELL1	Sep 2018	18.222,00	257,00	467,00	24.010.764,96
CELL1	CELL 1 01.10-05.10	18.222,00	66,90	57,40	4.122.290,17
CELL1	CELL 1 06.10-31.10	13.022,00	285,40	353,20	15.134.845,54
CELL1	Oct 2018		352,30	410,60	19.257.135,72
CELL1	CELL 1 1.11-11.11	13.022,00	150,90	172,10	7.655.112,92
CELL1	CELL 1 12.11-22.11	0,00	48,10	23,20	0,00
CELL1	CELL 1 23.11-30.11	9.200,00	59,20	39,70	523.181,00
CELL1	Nov 2018		258,20	235,00	8.178.293,92
CELL1	CELL 1 01.12-31.12	9.200,00	263,80	172,00	2.305.382,00
CELL1	Dec 2018	9.200,00	263,80	172,00	2.305.382,00
CELL1	Jan 2019	9.200,00	393,70	274,40	3.216.849,00
CELL1	Feb 2019	9.200,00	62,30	257,30	1.690.684,00

SAMPLE CALCULATION TABLE

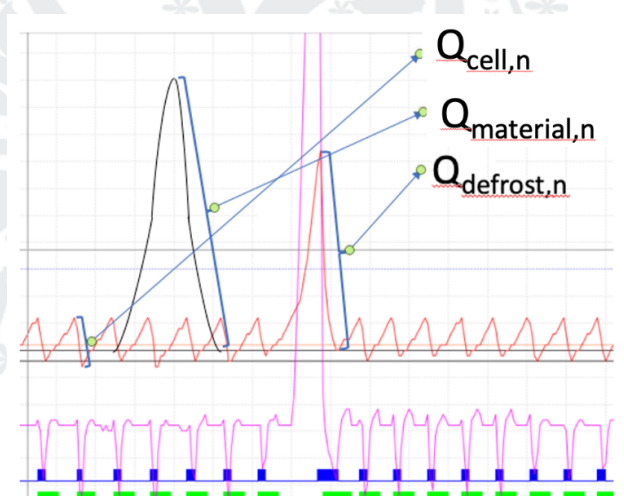
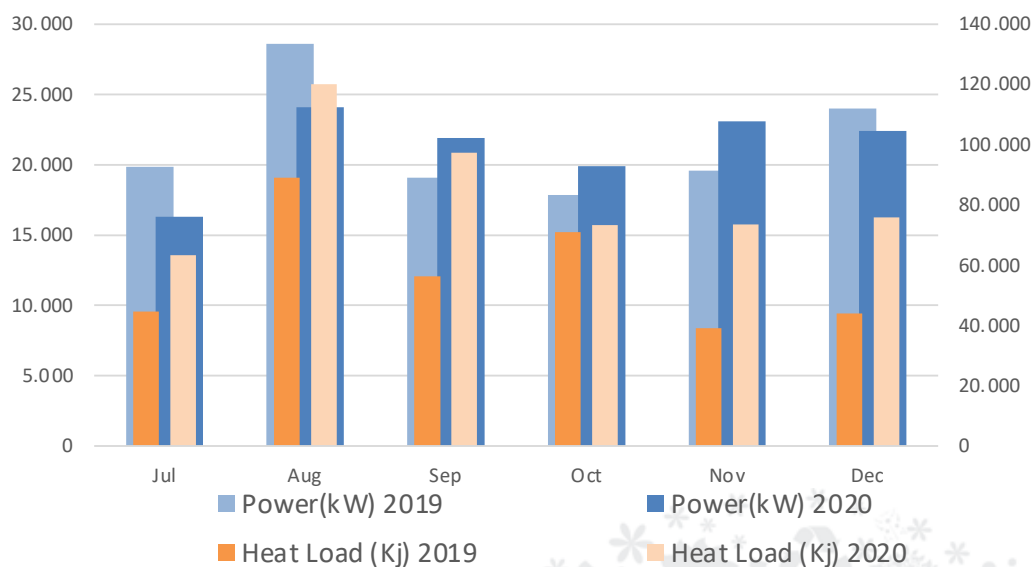


Figure1. Sample of Trends records



Results

Hydromx increased the COP by 54%



The comparison was completed for the months from July to December, for the years 2019 and 2020. Post Hydromx® installation, the CoP of the system increased by 54% on the average for the months required by Simon Beheer. Except the month of October, Hydromx increased the CoP of the system significantly.

Water Period	HEAT LOAD (Kj)	Power(kW)	COP(kW)	Amb Temp Δ
Dec 2019	44.028.013	24.025	1.833	0,28
Nov 2019	39.014.787	19.589	1.992	-2,4
Oct 2019	70.479.642	17.851	3.948	0,6
Sep 2019	55.550.445	19.092	2.910	0,83
Aug 2019	86.061.231	28626	3.006	1,60
Jul 2019	44.162.346	19.851	2.225	-1,80

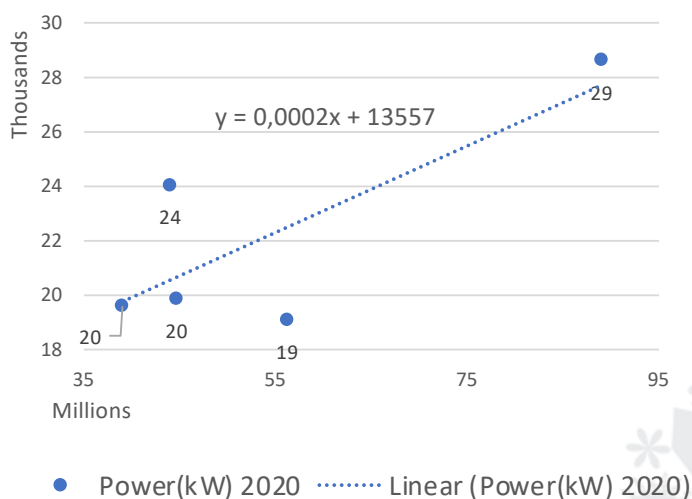
Hydromx Period	HEAT LOAD (Kj)	Power(kW)	COP(kW)	COP Change
Dec 2020	75.903.798	22.434	3.383	84,60%
Nov 2020	73.606.994	23.078	3.189	60,10%
Oct 2020	72.742.996	19.895	3.656	-7,40%
Sep 2020	95.619.230	21.919	4.362	49,90%
Aug 2020	118.941.397	24.077	4.940	64,30%
Jul 2020	62.993.854	17.135	3.866	73,80%
Average COP Change				54%



2-Year ROI

ROI Calculation

Power(kW) VS Heat Load 2019



Besides the CoP enhancement, the feasibility of the project was equally taken into consideration.

For the ROI calculation of this project the Linear Regression analysis was used. By means of the best fitted line, the amount of power saved in the Hydromx® period was calculated based on the behavior of the system with water period.

Consumption during Hydromx period was adjusted to the baseline data.

The difference between the actual consumption and the regressed period result is the actual saving amount.

October 2019 vs 2020 comparison excluded from the calculations due to the "anomalies detected in the data", which was acknowledged by Simon Beheer BV.

The amount of energy saving for the 5 months was cumulated for **46.070 kW** which corresponds to **4.600 EUR** and **38,4%**.

If we extrapolate the saving amount for the rest of 7 months more, with the worst-case scenario, savings would be **9.000 EUR**.

The project cost would be 25.500 EUR based on the Suggested Retail Price, which corresponds to **2,8 years of ROI**.

This result is highly anticipated in such energy use dense applications based on retail price.

Simon Beheer has confirmed the performance increase as a paying customer.

