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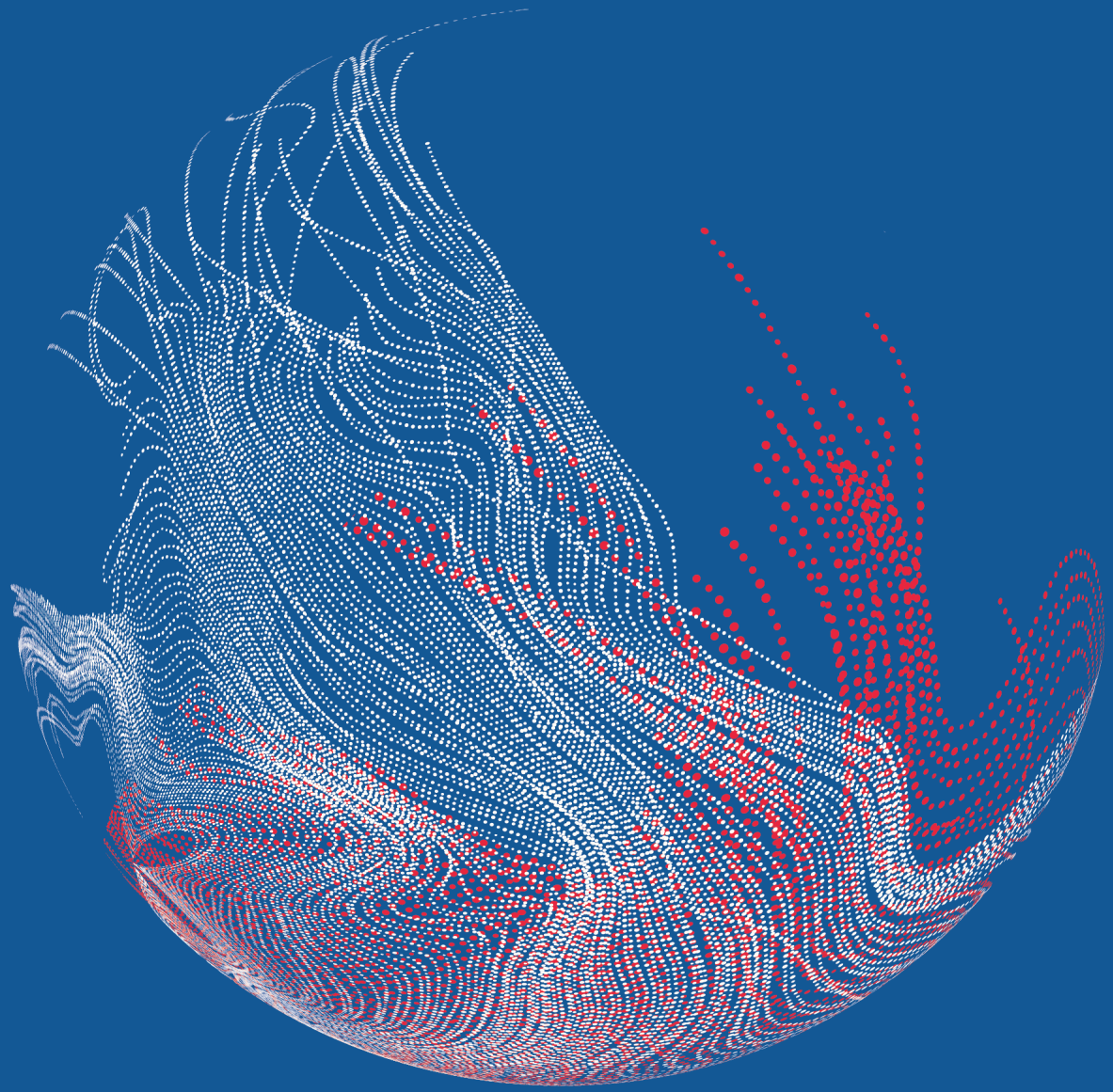
Business Case for Natural Refrigerants



June 12-13, 2023
Washington D.C.

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Efficiency Optimization in a Robotized Logistic Center in Santiago (Chile) Using CO2 Refrigeration System

SCM FRIGO

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Introduction

The project involve the following company:

FRIOSAN, the first sustainable, automated and continuously operating logistics operator in the frozen storage area for internal consumption and export based in Santiago, Chile.

CALTRONICS, Chile, specialized in the production and installation of robotized warehouse with more than 25 year of experience.

Portan - Nuova Service, installation company based in Santiago with more than 30 years of experience in commercial and industrial refrigeration installations.

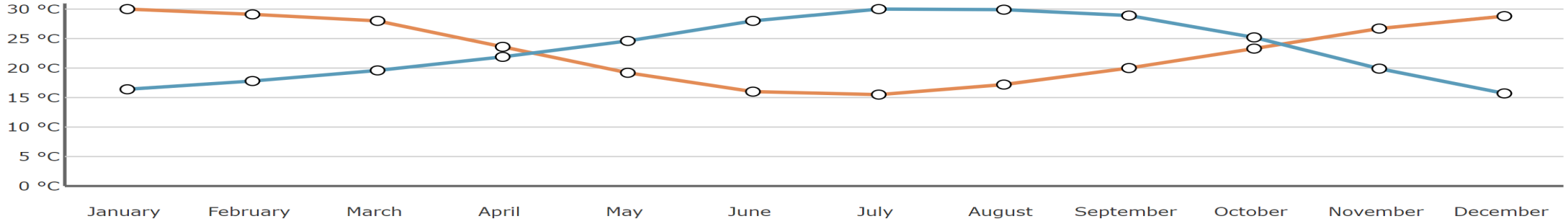
SCM FRIGO, leading manufacturer of refrigeration equipment using natural refrigerants based in Padova, Italy and part of the international Swedish group Beijer Ref.

Los Angeles, California, and Santiago, Chile The Köppen Classification data revealed that the mild conditions and warm, dry summers in Los Angeles are a perfect match for the weather conditions in Santiago, Chile.

Colors of the following climate diagrams:
California
Santiago Metropolitan

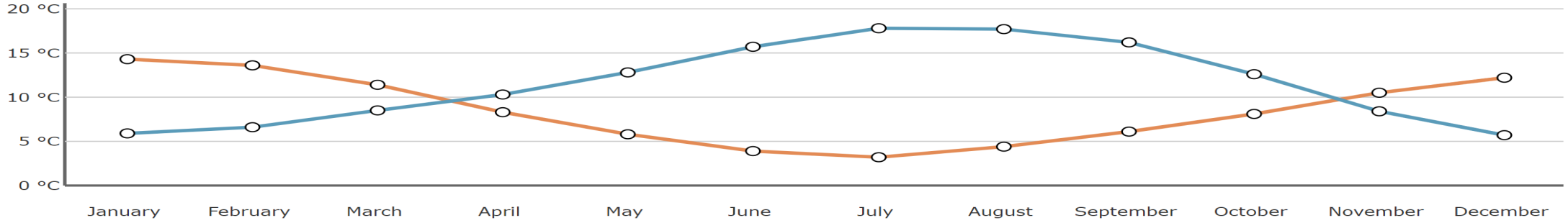
Daily maximum temperatures

The highest daytime temperatures in Santiago Metropolitan are reached in January with an average of 30.0 °C. The coldest month, on the other hand, is July, with an average of just 15.5 °C. In California, July is the warmest month, with 30.0 °C. There, it is coolest in December with an average of 15.7 °C.



Night time lows

At night, it cools down to varying degrees depending on the country and altitude. In Santiago Metropolitan, temperatures drop as low as 3.2 °C in July. The warmest nights are in January at 14.3 °C. In California, it is coolest at night in December at 5.7 °C and warmest in July at 17.8 °C. This corresponds to a cooling of 12.1 to 16.6 °C in Santiago Metropolitan and 10.0 to 12.7 °C in California.



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Wharehouse definitions and major challenges:

1- Frozen logistic storage in Chile has currently a **deficit of 100.000 pallet positions**

2- the Friosan project will **cover 16.000 pallets positions, or 16% of the deficit**, it has the objective to be the lowest cost Operator in the short and long run by using robotized and automated systems operation

3- the **Warehouse is in a premium logistic area** of Pudahuel area, 5 minutes from the Santiago airport, 2 minutes from the main highways to the San Antonio / Valapraiso Port, and the main South / North Highways where the major food processing and production facilities are based

4- **Seismic construction standard up to 9 degree magnitude earthquake**

5- **FRIOSAN board members commitments** with the sustainability of the operation and the environment are:

- **Use of 100% Certified Renewable Energy**
- When fully operational all the energy used in our comes from renewable energy electric generators.

Rationalization in the use of Energy
Our operation allows us to optimize the use of electricity through sectioned cold rooms with robotic opening. LEED certified

Minimize use of Water & Reuse of Greywater
All our gray water goes through a treatment process, and is reused to irrigate our gardens. Cooling and condensing systems by air and adiabatic cooling via micro-spray with tap water

Sustainable Green Areas
All our green areas are designed with native flora, corresponding to the climate of the place of our facilities, thus helping to maintain the ecosystem and the biological balance of the area.

Use of CO2 as Refrigerant Gas
All our cfuture refrigerated warehouses will use CO2 as a refrigerant, 100% natural gas, friendly to the environment, which serves to maintain the cold hain in a clean, safe, efficient way with excellent refrigeration properties.

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Robotized low temperature warehouse

LT warehouse: 263 ft x 193 ft x H 79 ft

LT refrigeration load: 247 TR @ -0,5 °F room T

MT loading bay: 265 ft x 43 ft x H 23 ft

MT refrigeration load: 76 TR @ 32°F room T

Installation site: Santiago (Chile)

Design ambient temperature: 95°F

Relative humidity avg. (summer): 54%

Friosan Targets:

- **Technology Advance Solution**
- **High Operational Efficiency**
- **Sustainable**

Solution adopted:

Refrigerant CO2 (R744)

5 LT coldroom with refrigeration capacity of 50 TR @- 13°F SST

8 LT cubic evaporators dry expansions with 2 fans for each LT coldroom

1 MT loading bay with refrigeration capacity of 76 TR @ 17,6°F SST

8 MT cubic evaporator dry expansions with 3 fans for the loading bay

2 booster units with triple temperature LT / MT / HT to optimize the efficiency of the system

Vapour Multi Ejector

Stepless compressor capacity modulation (CRII) on MT and HT

LT compressor capacity modulation with Frequency inverter

Adiabatic gas cooler to improve efficiency during summer period.

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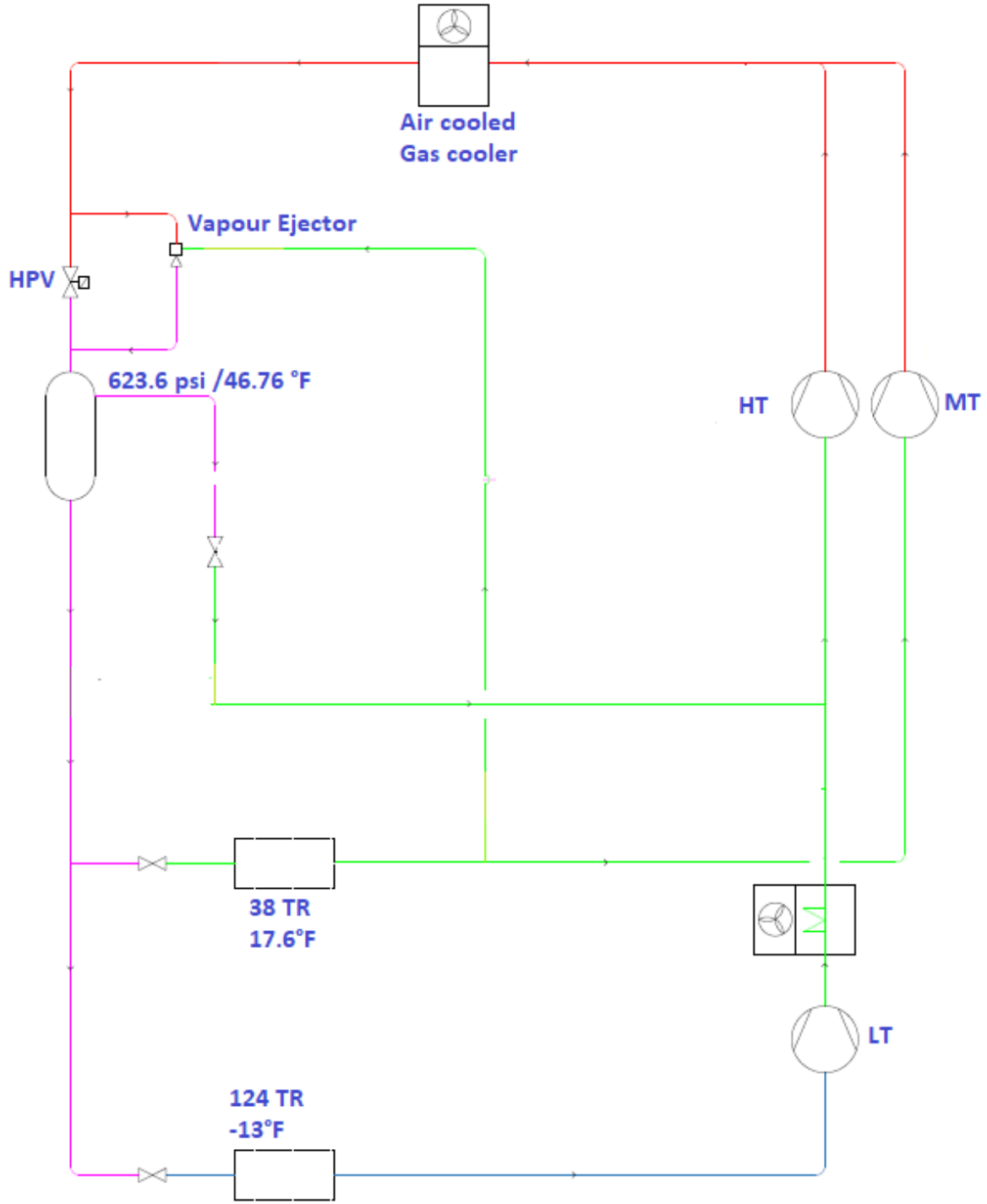

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The solution adopted is combining:

- Pure LT booster with optimized compression ration between high and low stage
- Satellite MT compressor
- Vapour ejector connected to the MT suction
- Flash gas generated from MT is managed from the HT compressors @ 46,76°F
- The **efficiency improvement of this configuration compared with configuration with dedicated parallel compressor is +8%** at the design conditions with less complexity.
- The **Vapour Ejector gives other average 12% of efficency improvement to the system.**

Installation & operational requirements from the customers request matched

- Minimum, maximum & mean outside temperatures
- refrigeration rack evaporation temperature
- Expansion valve expansion temperature,
- In evaporator temperature
- Out evaporator temperature
- Temperature in farthest points from evaporator at eighth of 2 mts.
- Energy consumption (considering that cold rooms are at full at 50% capacity or less)

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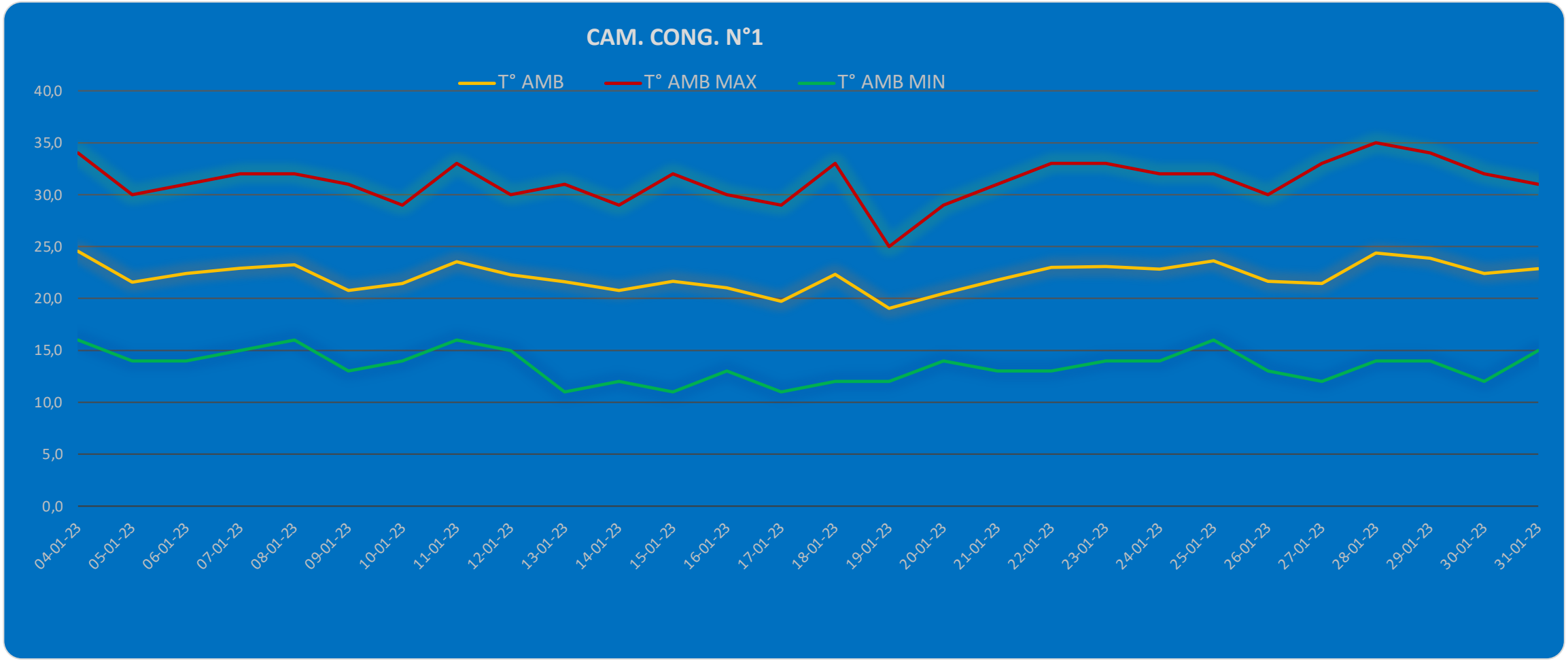

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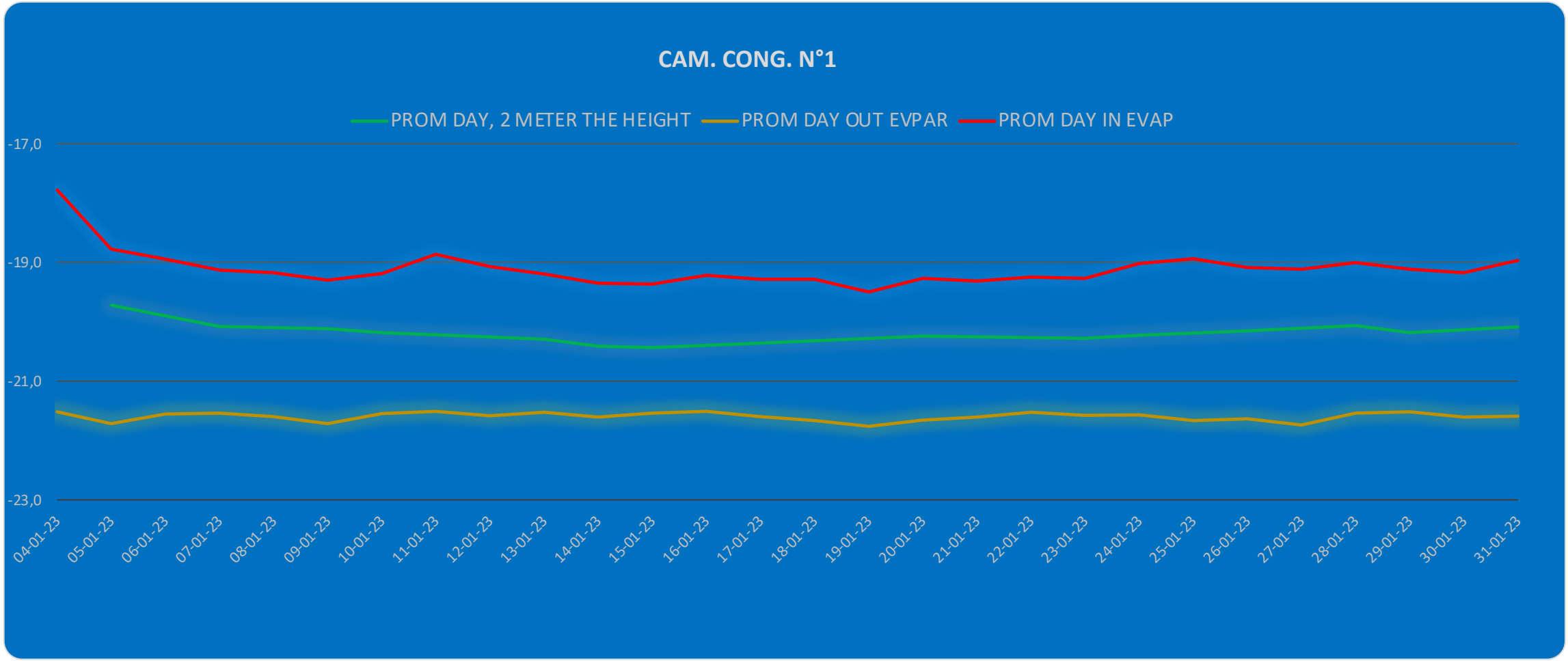

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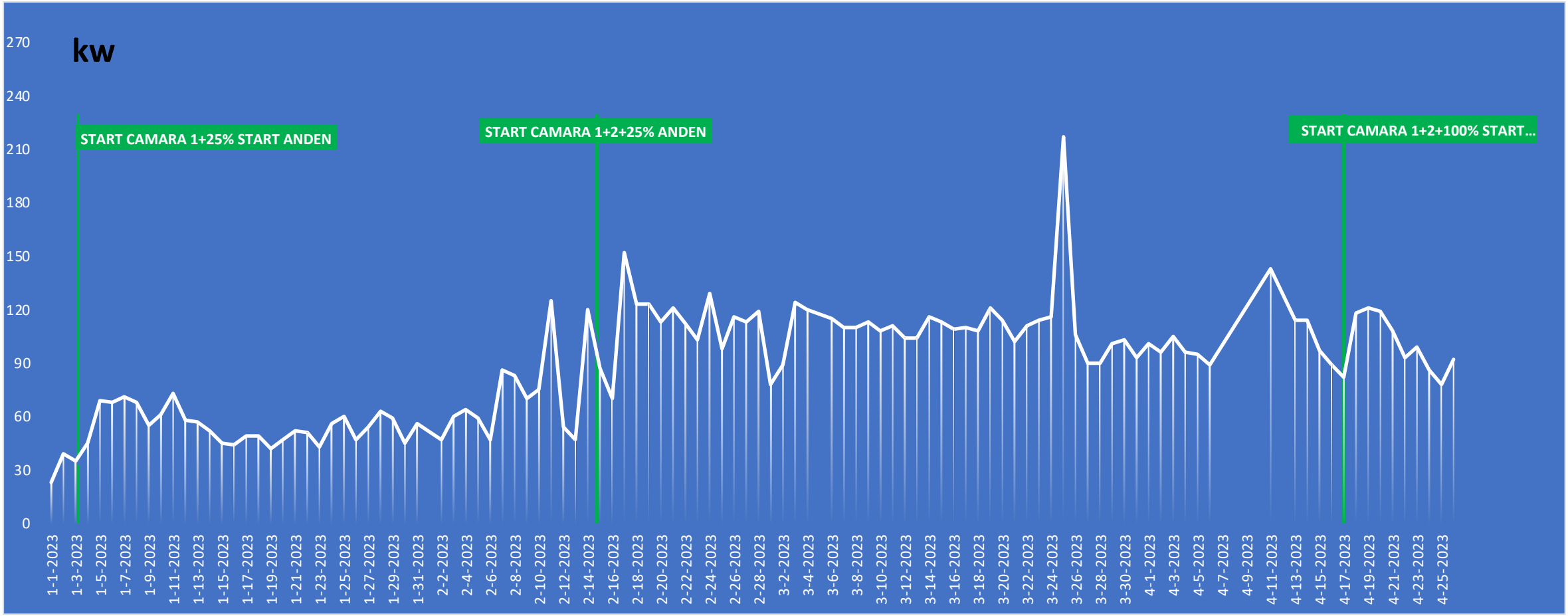
ENEGY CONSUPTION PER CUBIC YARD OF LT WAREHOUSE 2.2 WATTS (RACK + GAS COOLER) EVAPORATORS FANS AND DEFROST HEATERS)



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- Minimum distance between drains and Robot beam guidance system 4” to 5”
- Double drain defrost heaters with alarm system into monitoring when one of them breaks down, easy removing and replacement system. System to maintain 68 F and 86 F inside copper pipe drain, each one of the 5 cold rooms has 8 evaporators and each evaporator has a 9 yards part copper drain inside the cold room.
- All the piping in the inside of the cold rooms since was not possible to run on the outside of wall or roof
- Distances between some EVV and the cold rooms electric boards, required to use IP 67 ELECTRONIC DRIVER control system inside the cold room. NO technical room between cold room and roof (cold room ceiling ids the roof
- The cold room ceiling is slanted and the largest vertical space for the evaporator to be placed is 4 ‘, a tubular Meccano system was developed to either place a evaporator totally vertical and also to mount 4 units per day

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Barriers and solutions

- Technological barriers: the technology applied in the system are well known from installer and already tested in the other installations
- Seismic area: divided the LT volume in 5 cold rooms to reduce the heart quake wave impact on the structure and on the operations of the robots.
  Limit the weigh of the evaporators installed on top by dividing the load in 8 evaporator for each cold room.
- Reliability: the system cooling capacity is provided by 2 unit with same configuration connected both on all the cold rooms to ensure a safe operation.
- Remote control: Full monitoring system has been installed to monitor the operation of the plant and the units.

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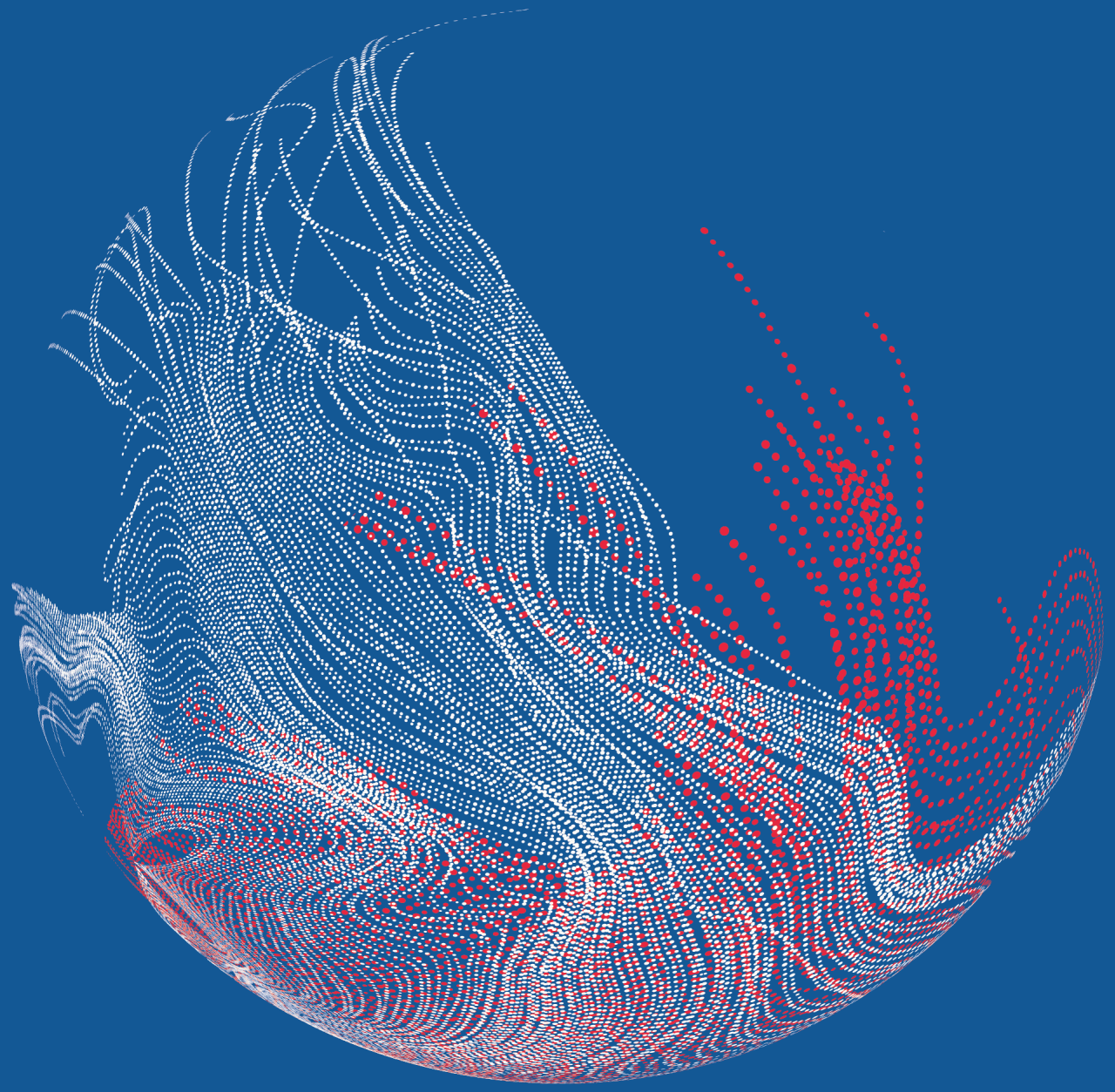

Thank you for listening!