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CRISTO CONTROL 2

Installation
Operation
Commissioning
Maintenance



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1 Introduction

A centralised refrigeration system is complex and depends on numerous components functioning together.

Beyond the individual performance of each one of these components, the performance of the system as a whole relies on control strategies and its dynamic regulation.

Among the components of a high-energy performance refrigeration system, we find in particular chillers, cold storage, drycoolers with free cooling, heat exchangers, circulation pumps, motorised valves, different types of sensors, variable speed drives, etc.

All these components, interacting constantly with each other, must meet the demands of the networks being served, with the best overall energy output and at the lowest cost. This demand varies according to the weather and seasons. Energy costs are also variable (peak times/off-peak times, periods of high demand, annual variations, variations according to primary energy type, etc.).

Therefore a refrigeration system's running needs are not always the same. For such a system to function at peak efficiency over time, it is helpful to include intelligent and dynamic controls, a measure of performance, a monitoring system and a preventative and corrective maintenance tool that works both locally and remotely.

This is the goal of the Cristo'Control2, which was developed by our company. It combines the benefits of the CIAT group's experience in refrigeration and heat exchange that has been the basis of its business for over 70 years, with CRISTOPIA's more than 25 years' experience in thermal energy storage systems.

This document gives an overview of the Cristo'Control2 and all its features, including the usage instructions that will guarantee the optimum benefit from its use.

2 Overview of the Cristo'Control2

2.1 Cristo'Control2 general structure

This is the general structure of the Cristo'Control2 with its primary connections (local and remote) that allow it to communicate with the essential control devices (chiller, etc.) and system monitoring (Web server):

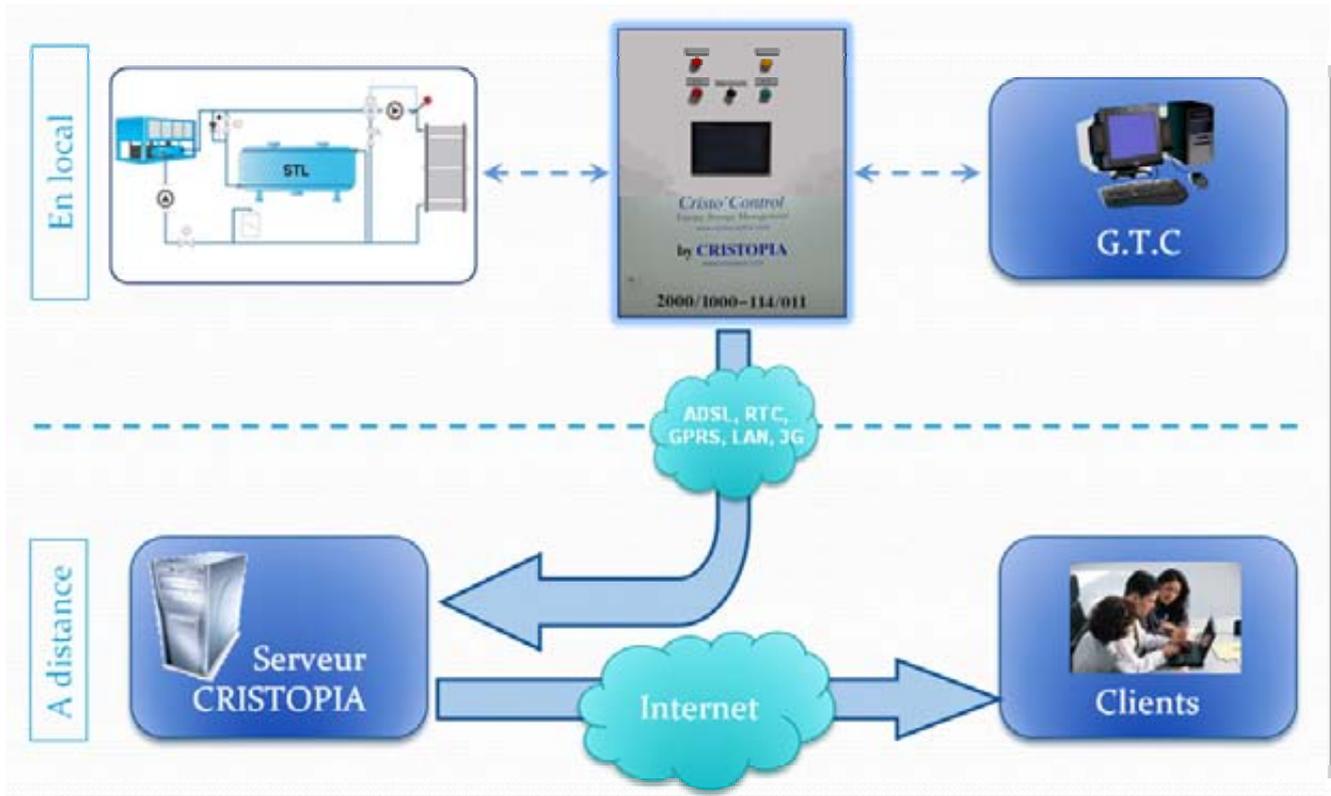


Figure 1: Cristo'Control2 general structure

2.2 Role of the Cristo'Control2

This control system enables optimal performance to be achieved based on refrigeration needs from the time it is installed throughout the operating life of the system.

To accomplish this, Cristo'Control2 enables the following tasks to be carried out:

- **Automatic management of authorised operating modes**

The Cristo'Control2 selects the appropriate operating mode according to predefined parameters and user-adjustable values (schedules, tariff bands, capacity demands, energy available, etc.). In case of a fault or alarm on a component, it also controls the best possible withdrawal strategies (example: operation in degraded mode) while waiting for a maintenance technician to work on the system. Several strategies can also be selected according to defined seasons, at the user's convenience.

- **Refrigeration network control**

The Cristo'Control2 manages all the primary refrigeration circuit's devices up to the exchanger, including the chiller(s) (running or stopped), setpoint changes, V3V regulation, variable flow, the opening and closing of the valves, balancing uptime for dual pumps, etc. The Cristo'Control2 can also control the system's secondary equipment (basic units, secondary distribution pumps, etc.) and run a series of chillers according to system needs.

- **The alarms and faults report**

Sending alarm and fault messages to the entity in charge of system maintenance (email, put FTP, trap SNMP, fax (*1), SMS (*1), etc.).

In the same way, when possible and if a fault occurs, the Cristo'Control2 implements the best strategy to ensure that needs continue to be met (while waiting for the component at fault to be repaired (changeover to back-up pump, energy source, mode selection, etc.).

- **Remote monitoring in real time**

Viewing the system, the statuses of the devices and the operating parameters in real time, using a report on the BMS (via RS422 / 485 - Modbus RTU as standard) and through access via Web browser to the Cristo'Control2 management, including curves, events, real-time measurements and operations reports* (2).

The CRISTOPIA Web server returns this data periodically to build a history of all the information gathered since the system was switched on for the first time. This history is then accessible remotely via the website www.cristocontrol.com.

Note:

(*1): If this option is selected when ordering.

(*2): Free for 3 months after the system is switched on for the first time, with subscription to the service contract.

2.3 Access to the Cristo'Control2

The system may be accessed in two ways:

- **locally** via the display on the front of the electrics box,
- **remotely** from any workstation with Internet access, via the Cristo'Control2 website.

These two methods for accessing the system enable configuration, operation and maintenance of the system. They provide an overall view of its operation, to monitor and analyse performance, to implement diagnostics and to adapt the strategies in case needs change.

Access to the different functional areas of the system can be granted according to the user's status.

Note: Remote access via the www.cristocontrol.com website only gives access to the monitoring section of the Cristo'Control2; therefore, it is very important to be physically present to work on the system.

3 Local access to the system

3.1 Front of the unit

This is the front of the Cristo'Control2 control unit.



Figure 2: Cristo'Control2 unit

Several machine interfaces are available on the front of the unit, which allow the user to carry out actions or check the status of the system at a glance.

Indicators:

- **Alarm (red)** indicator: indicates one or more active alarms
- **Fault (orange)** indicator: indicates one or more active faults
- **Emergency (red)** indicator: Emergency mode activated
- **Running (green)** indicator: indicates unit is operating normally

Switch:

- 3 position key-operated switch:
 - Centre position "**Stop**": the unit is in standby mode, no production or storage mode can be forced.
 - Left position "**Emergency**": System changeover in Emergency mode (see chapter 3.1.2)
 - Right position "**Running**": system is running automatically

Display:

- 8-inch colour display: allows the system to be run locally (see chapter 3.2)

3.1.1 Emergency mode

The Emergency mode is a degraded mode, which must be used with caution.

This mode is usually used during:

- **pre-commissioning:** before CRISTOPIA sets up the unit,
- **a major problem with the control system:** lightning, short-circuit, etc.,
- **a replacement of the control system following a major fault.**

Emergency mode allows the control unit to be bypassed for the purpose of system changeover in direct production mode (chiller only) or direct production + discharge (chiller + STL) according to the system's hydraulic diagram.

During a changeover in this mode, no safety chain is being respected given that the system is forced electrically, the control system is no longer able to manage sequencing when the devices are started. Also, since the control system is being bypassed, the equipment run by protocol is no longer being managed.

To changeover in Emergency:

- **set the switch to the Emergency position (it is necessary to have the key),**
- **change over the locally-controlled chiller(s),**
- **force the running chiller(s) via their console.**

To exit Emergency mode, simply follow the above steps in reverse order.

Note: Switching to Emergency mode is done at the operator's risk. In this mode, we cannot be held responsible in case of a fault due to a sequencing problem or due to the safety chains not being respected when the unit is being controlled manually by the operator.

3.2 Touch screen

The Cristo'Control2 features an 8-inch touch screen HMI located on the front of the control unit (see *Figure 2: Cristo'Control2 unit*). This interface allows the user to interact with the control system, thereby allowing:

- the system to be viewed in real time,
- the operating parameters to be regulated,
- production to be configured,
- performance analysis using curves,
- diagnostics of the origin of a fault,
- preventative and corrective maintenance tools.

The following chapters describe all of the functions available in the Cristo'Control2 as well as the methods that allow them to be used.

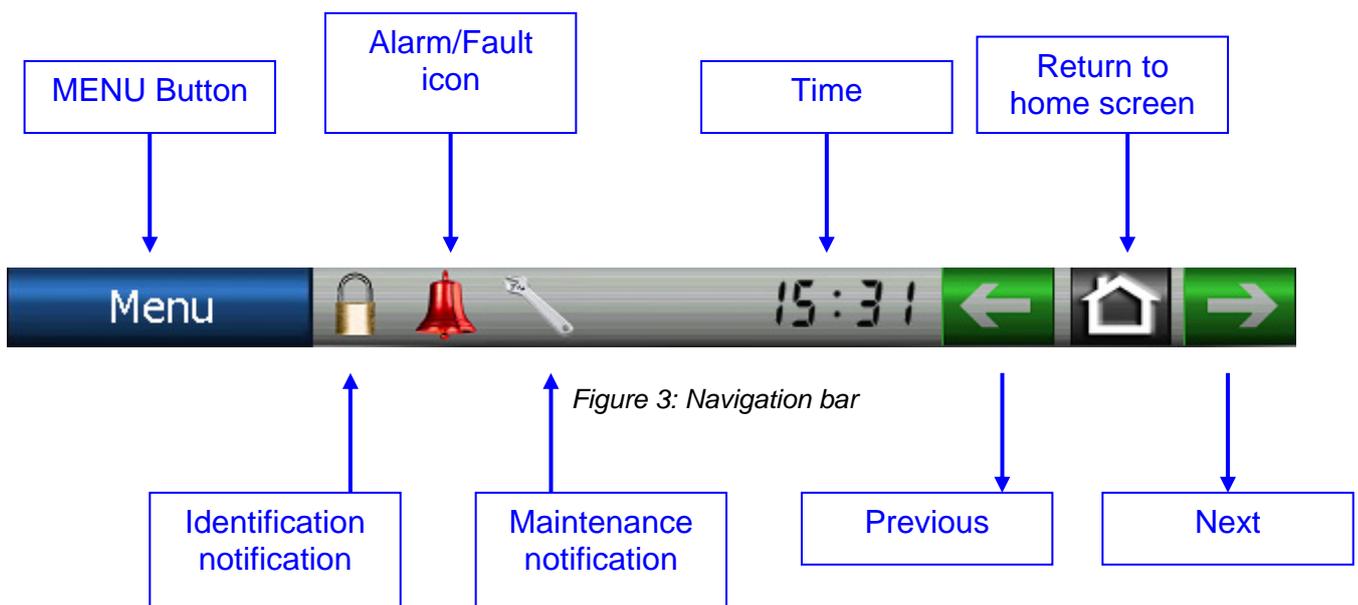
3.2.1 Tools and rights

This section describes the tools available to facilitate use of the Cristo'Control2. It also describes the different levels of access to the available data.

3.2.1.1 Navigation bar

Present in the lower part of all of the interface screens, this navigation bar allows quick access to several essential functions, as shown in the figure below.

It is made up of several icons and buttons:



-  : access to the different sections of the Cristo'Control2 interface:
 - Overview screen,
 - System operation,
 - Production management,
 - Strategy management,
 - Events,
 - Maintenance,
 - HMI options.

-  : Identification notification icon (see 3.2.1.2 Access and modification rights)
 -  indicates that there is no verification in progress
 -  indicates that the user has been verified

-  : Alarm/Fault icon (see 3.2.7 Events) : touching this icon gives access to the list of events in progress
 -  : indicates that there is at least one current alarm on the system
 -  : indicates that there is at least one current fault on the system

-  : maintenance notification icon: the symbol informs the user that at least one device is due for maintenance, touching this icon gives access to the list of current maintenance tasks.

-  : indicates the system time, touching this area gives access to the time adjustment screen.

-  and  : Previous and Next buttons: return the user to the previous screen, and in some cases give access to the next screen.

3.2.1.2 Access and modification rights

To ensure that data modification is kept secure, there are two types of access to the Cristo'Control2 interface:

- **Guest access** (Read only): This type of access does not require any type of identification, and allows the user to see a large amount of the data present on the Cristo'Control2 interface. However, this type of access does not allow the user to modify any of the data in any way.
- **User access** (Read/Write): After password identification, this type of access allows the user to view all the data on the interface, and authorises him or her to modify the data necessary for the operation of the unit (setpoints, production periods, event management, etc.). The user can identify himself or herself using the icon on the navigation bar.

If a user who has not been verified attempts to modify data, a window pops up requesting the user's password.

Additionally, if a session has been inactive for a certain period of time, (default: 10 min), the interface automatically returns to the home screen and disconnects the user, so that data access is kept secure.

3.2.2 Navigation on the display screen

Here is the overview of the Cristo'Control2 display screen navigation.

Seven menus are accessed directly by clicking on the pop-up menu,  allowing access to a multitude of data in read-only or read/write format.

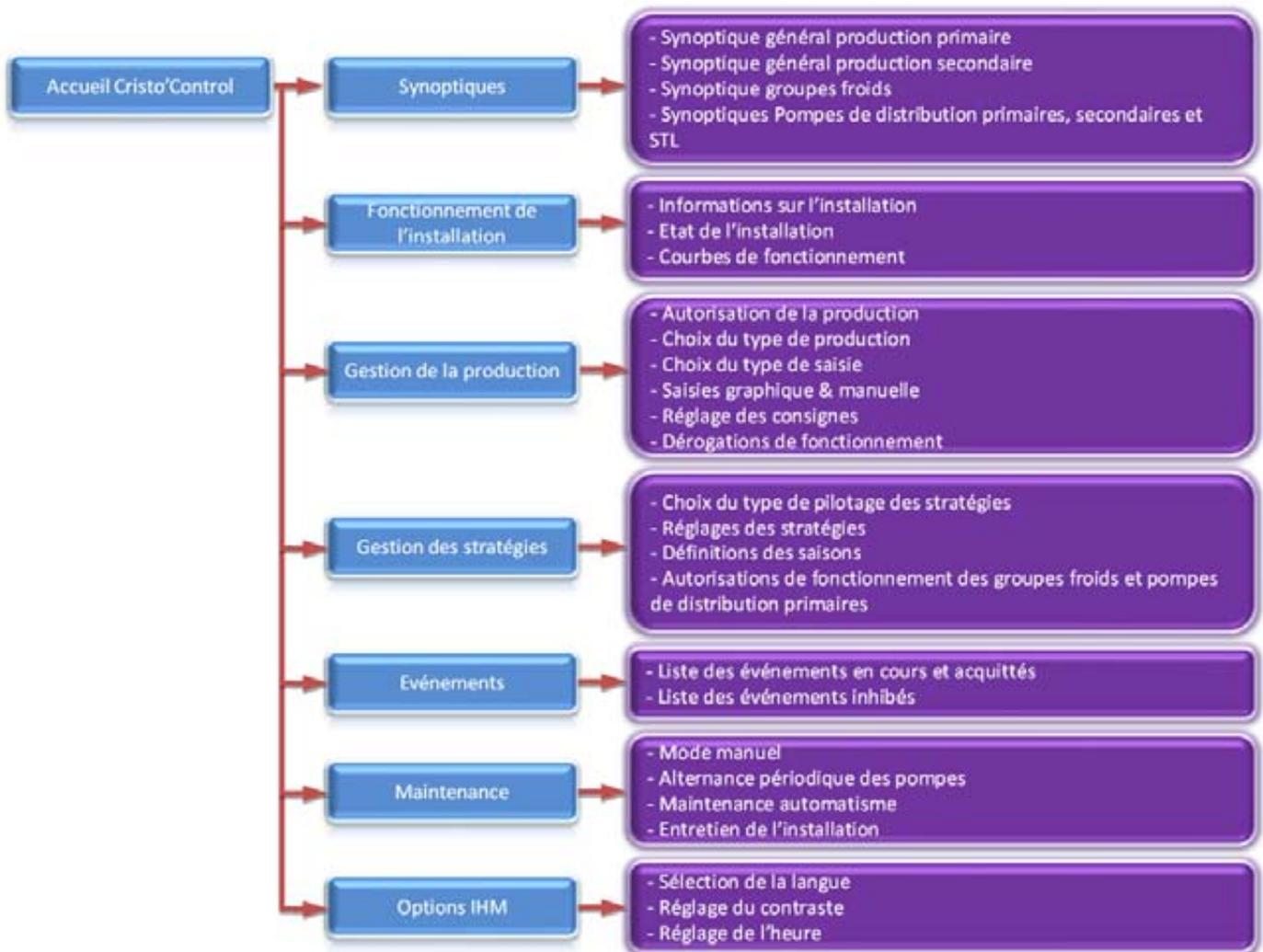


Figure 4: Overview of the display screen navigation

3.2.3 Overview screens

This menu gives access to all the available overview screens:

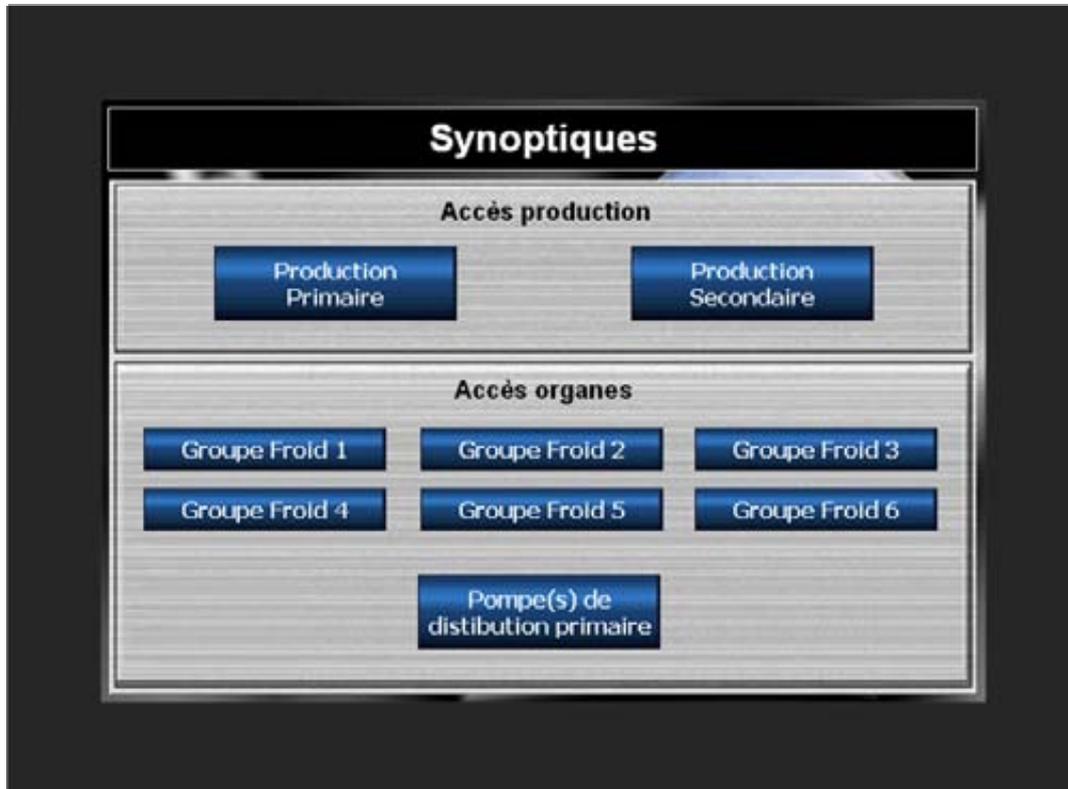


Figure 5: Access to the overview screens

Access to the overview screens is divided in two parts: access to the general overview for the device, and access to the overviews of the various devices that are present.

Note: the number of overview screens available depends on the number of devices present in the system

3.2.3.1 System overview screen (Production access)

This overview allows the operation of the whole system to be viewed in real time, therefore we see all the devices (or groups of devices if it is not possible to show them all individually) present in the system. The operating phase is indicated by a section of text stating the current operating mode and by the blue colour of the pipes when the fluid is circulating.

The instant measurements of temperature, flow rate, or pressure recorded by the Cristo'Control2 are displayed in the overview; they allow the user to control the system's operation and are valuable resources for system analysis.

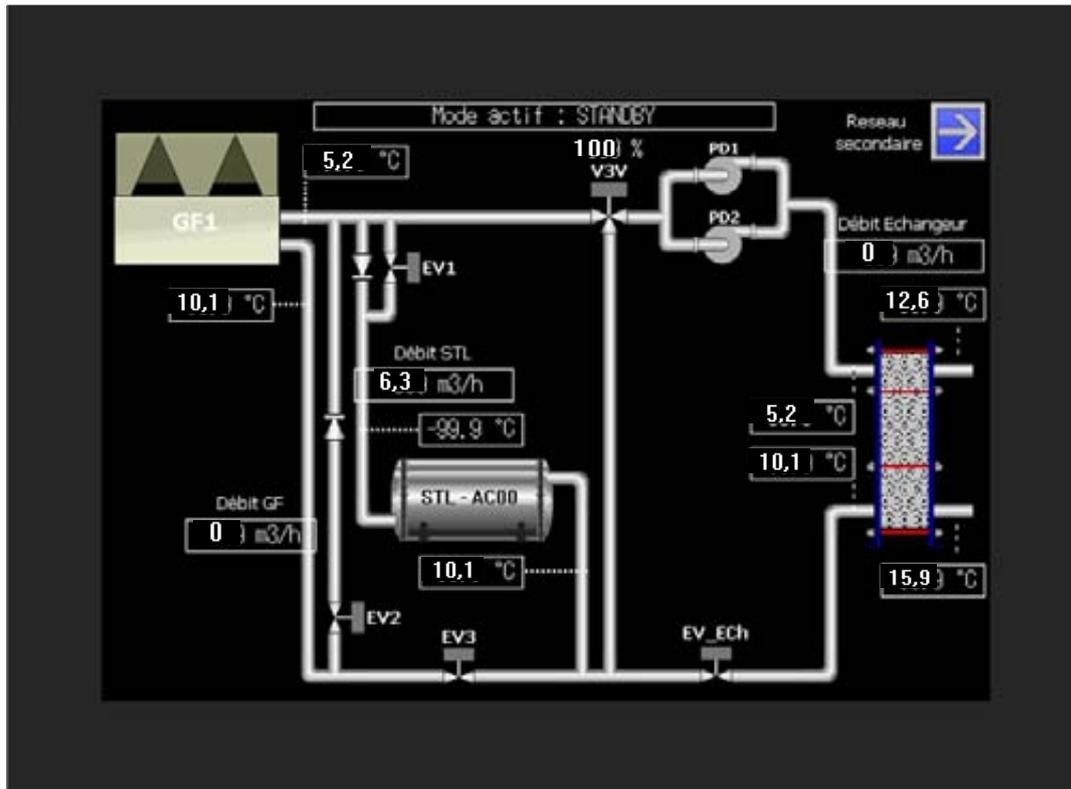


Figure 6: System overview screen – main side

In cases where the Cristo'Control2 controls the exchanger's secondary equipment, a button in the top right of the screen gives access to the overview screen for the secondary network; also, a button in the top left of the screen showing the overview screen for the secondary equipment allows the user to return to the overview screen for the exchanger's primary network.

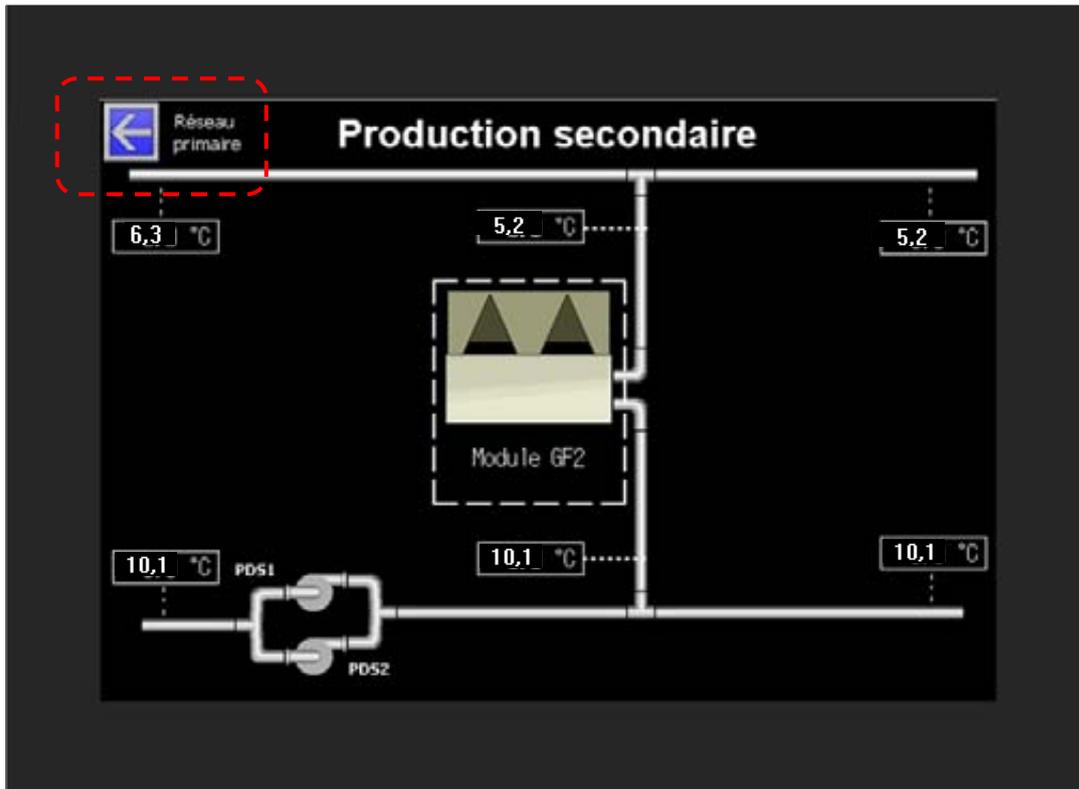


Figure 7: System overview screen – secondary side

To facilitate access to the data, touching each active device group gives access to a screen that describes its function.

3.2.3.2 Device overview screens (Device access)

These overviews, which are present for the pumps, the chillers, the exchangers and the STL storage tanks, drycoolers, etc., allow the user to view a device's operation as it happens and also to access data on the device's operating status and its technical specifications.

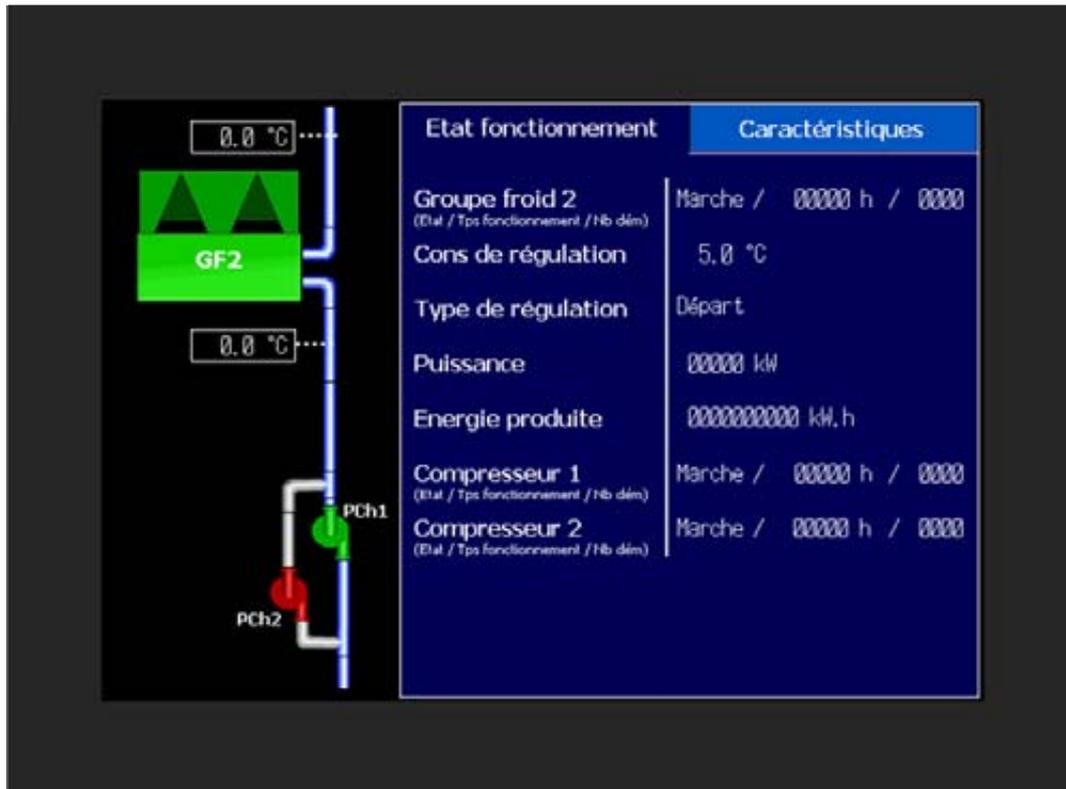


Figure 8: Device overview screens

This data is separated into two categories. The first concerns the component's instant operation status, and the second its technical specifications. Changing from one category to another is done by touching the corresponding tab.



Figure 9: Device navigation tabs

3.2.3.2.1 water chillers

Here is the list of information available from the "Chiller X" overview screen:

- **Operation :**

- Chiller X: indicates if the chiller X is stopped, running, has a fault or has an activated alarm,
- Control setpoint: Value of the water chiller temperature setpoint,
- Control type: Indicates if the chiller regulates based on supply temperature or return temperature,
- Capacity: Instant cooling capacity of the group as a percentage,
- Energy produced: Total energy produced by the chiller.
- Operating time: Chiller operating time, this value can be reset by a verified user*
- Number of starts: Number of chiller starts, this value can be reset by a verified user*

- **Specifications:**

- Position of the chiller: Indicates whether the chiller is in the exchanger's primary or secondary,
- Capacity (direct): Nominal capacity for the chiller in production, no storage,
- Capacity (charge): Nominal capacity for the chiller during storage,
- Manufacturer: Inform the manufacturer of the chiller,
- Type of order: Indicates whether the chiller is controlled by dry contact or by communication bus,
- Comm board model: In the case of communication by bus, indicates the model of the communication board used by the chiller,
- MODBUS address: In the case of communication by bus, indicates the MODBUS address used by the chiller,
- Comm speed: In the case of communication by bus, indicates the speed of communication with the chiller during data transmission,

Note: Free for 3 months after the system is switched on for the first time, with subscription to the service contract.

3.2.3.2.2 Pumps

Here is the list of information available from the "Pump X" overview screen:

- **Operation :**
 - Pump X: indicates whether pump X is stopped, running, has a fault or has an activated alarm,
 - Operating time: Pump operating time, this value can be reset by a verified user*
 - Number of starts: Number of pump starts, this value can be reset by a verified user*
- **Specifications:**
 - Nominal flow rate: Present only for primary distribution pumps, this indicates the nominal flow rate that must circulate in the primary unit in the exchanger during the production phase,
 - Pump Y type: In the case of a group of pumps, describes the function of pump Y, normal (must be running to guarantee the nominal flow rate), emergency (emergency pump), series (used to vary the flow rate according to demand).

Note: Free for 3 months after the system is switched on for the first time, with subscription to the service contract.

3.2.3.2.3 Exchangers

This screen is accessible from the general system overview screen by simply clicking on the exchanger; here is a list of the information available from the "Exchangers" overview screen:

- **Operation :**
 - Capacity: Instant capacity supplied to the primary from the exchanger,
 - Energy: Total energy provided to the primary from the exchanger,
 - Flow rate: Instant flow rate to the primary from the exchanger.
- **Specifications:**
 - Theoretical delta T°C in the primary: Theoretical temperature difference between the inlet and the outlet from the exchanger to the primary,
 - Theoretical delta T°C in the secondary: Theoretical temperature difference between the inlet and the outlet from the exchanger to the secondary,
 - Pinch-point T°C : Theoretical temperature difference between the inlet into the primary and the outlet into the secondary from the exchanger.

3.2.3.2.4 STL tanks

This screen is accessible from the general system overview by simply clicking on the tank; here is the list of information available from the "STL tank" overview screen:

- **Operation :**
 - Capacity: Instant capacity provided or received by the storage tanks,
 - Remaining energy: Amount of energy available in the tank in real time,
 - Remaining energy (%): Percentage of energy available in the tank in real time,
 - Flow rate: Instant flow rate in the tank.

- **Specifications:**
 - Discharge capacity : Maximum energy that can be discharged daily,
 - Number of tanks: Number of storage tanks present in the system,
 - Storage volume: Total storage volume,
 - Type of nodules: Type of nodules used by the storage system.

3.2.4 System operation

This section is dedicated to the system's general operation; it contains information allowing the first diagnostics to be carried out in case a device suffers a partial fault.

3.2.4.1 General information

This screen contains the following information:

- **Initial date of service**, this refers to the Cristo'Control2's initial date of service,
- **Operating time of the system**, indicates the time that has passed since the beginning of service (unit being switched on),
- **Total energy supplied**, this refers to the total energy provided by the refrigeration system since it was initially switched on,
- **Total chiller energy in direct production**, this refers to the total amount of energy provided by the chillers since they were initially switched on.

3.2.4.2 System status

The "System status" screen allows the overall operation of the system to be understood at once.

This page contains:

- **Current operating mode:** Shows which of the following modes the system is in currently
 - *Storage,*
 - *Storage + demand,*
 - *Production without discharge,*
 - *Production with discharge alone,*
 - *Chiller production + discharge.*

- **Active season:** Indicates the current season, out of the three possible seasons,

- **Active strategy:** Indicates the current strategy being used, out of those available in the system:
 - *Off*
 - *Peak shaving,*
 - *Time of day,*
 - *Peak shaving + time of day,*
 - *Full storage.*

3.2.4.3 Curves

Several curves are available on the Cristo'Control2 interface and can be selected from the "curves" submenu.

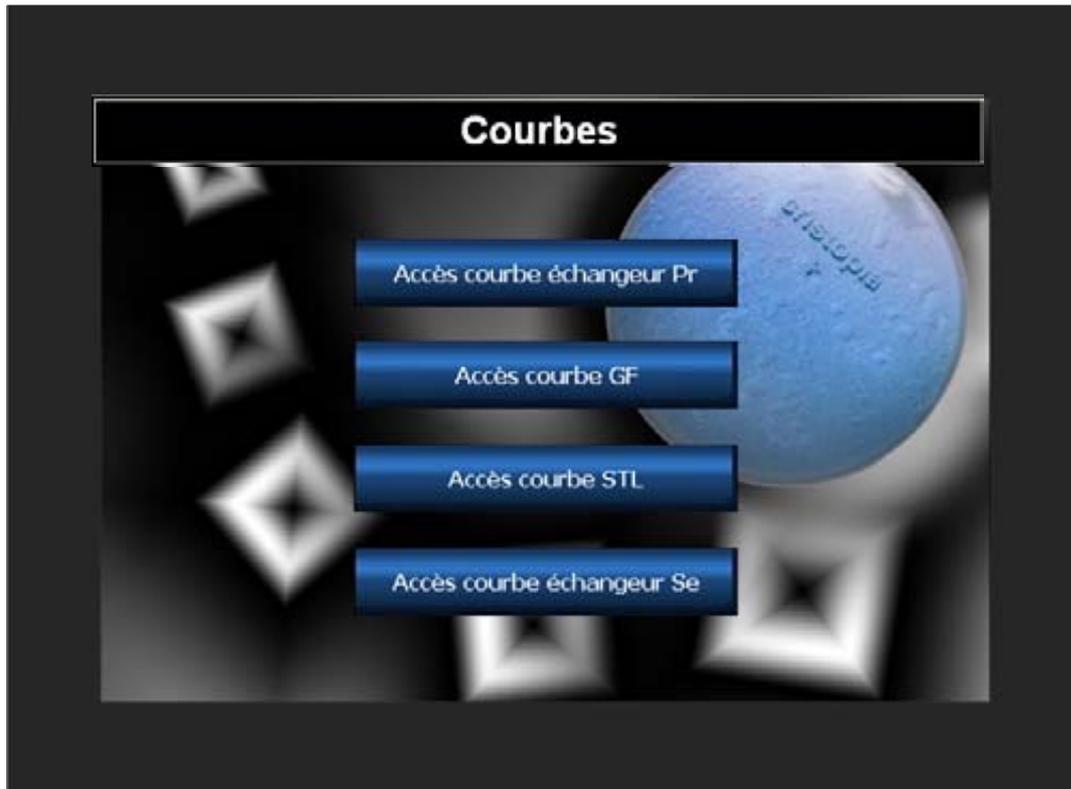


Figure 10: Curve selection

They display the information, using the colour-coding system below:

- **Water chiller temperature:**
 - *Active mode (red)*
 - *Standard inlet temperature for chillers (dark blue),*
 - *Standard outlet temperature for chillers (light blue),*
- **STL tank temperature:**
 - *Active mode (red)*
 - *STL tank bottom temperature (dark blue),*
 - *STL tank top temperature (light blue),*
- **Primary exchanger temperature:**
 - *Active mode (red)*
 - *Primary exchanger outlet temperature (dark blue),*
 - *Primary exchanger inlet temperature (light blue),*
- **Secondary exchanger temperature**
 - *Active mode (red)*
 - *Secondary exchanger outlet temperature (dark blue),*
 - *Secondary exchanger inlet temperature (light blue),*

Note: curves can be viewed on the Cristo'Control2 local interface for up to 7 days, and this is only possible if the necessary devices (temperature sensors, etc.) are present in the system and are connected to the Cristo'Control2 unit.

It is possible to modify the time base for the diagrams using the tool at the bottom right of the graph.

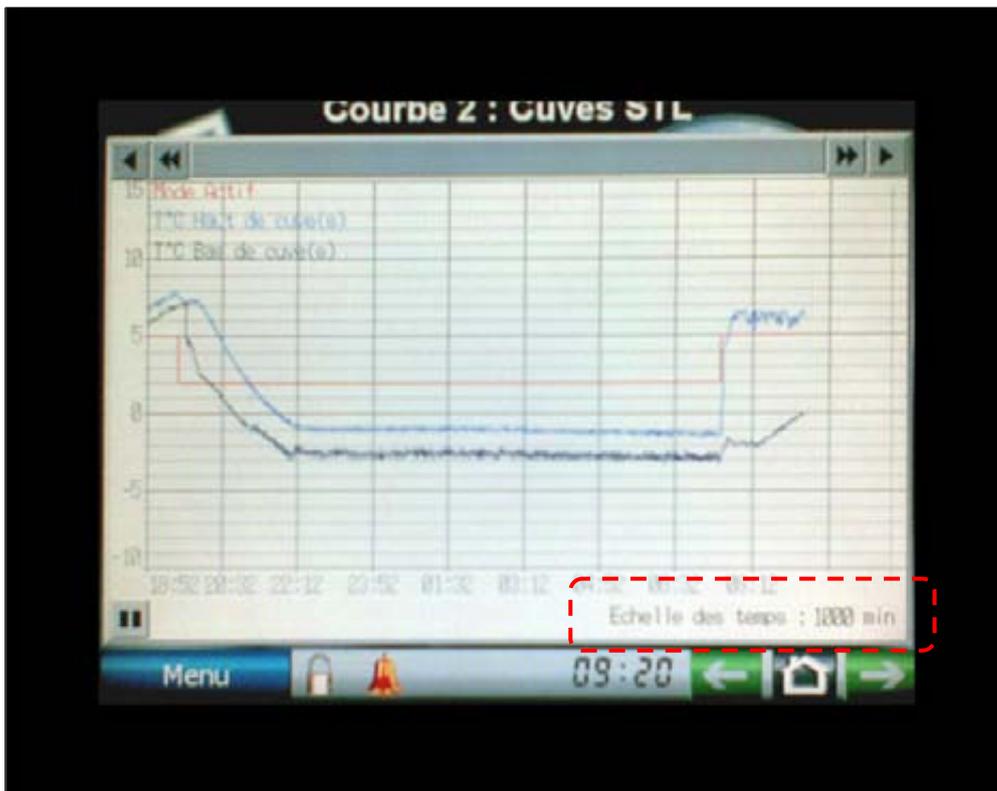


Figure 11: Curve example

3.2.5 Production management,

The production management section allows the initial conditions for chilled water production to be configured. The first adjustments can be carried out from the home screen (see *Figure 12: Production management*):

- **Production authorisation:** allows the chilled water production to be authorised or not authorised,
- **Choice of production type:** choice of production activation method:
 - **Production according to a schedule entered:** Production starts based on a weekly schedule,
 - **Production by contact:** Production starts when authorised by a dry contact in the PLC inlet (ex: coming from a BMS),

- **Threshold-based production:** Production starts when a temperature threshold is reached, according to a selected sensor,
- **Choice of entry method:** In cases of production according to a schedule entered, this button allows the user to choose the method for entering production schedules. Depending on the method selected, an access button appears that gives access to the adjustment screen:
 - **Graphical entry:** this solution allows the user to define the production, storage and production + storage periods graphically, and also the schedule bands (peak times, off-peak times, periods of high demand). In cases where an EDF meter is connected to the Cristo'Control2, it can include the electric pips if necessary. This intuitive and user-friendly input method can be done in 30 min. time slots.
 - **Manual entry:** this solution allows production periods, storage periods, tariff bands, etc. to be defined as above, but with a higher degree of precision, nearly to the minute.
- **Setpoint adjustment:** This button gives access to the control setpoint adjustment for the system and the chillers (see paragraph 3.2.5.3 Setpoint adjustment),
- **Operation overrides:** This button gives access to the operation overrides authorisation screen (see paragraph 3.2.5.4 Operation overrides).



Figure 12: Production management

3.2.5.1 Production according to schedules entered

Choosing this type of production allows the user to configure the production period on a weekly basis. It is therefore possible to define a week's production periods either day by day or by choosing a day type to be used for all the days in the week.

3.2.5.1.1 If schedules are entered manually

Entering the production schedules manually gives the user the opportunity to configure with great precision (nearly to the minute) the different production periods and tariff bands (in cases where tariff band management is needed).

This adjustment is done by defining start and end times for each period entered. However, if the start and end times of a period are similar, this period will not be applied by the Cristo'Control2.

A "Day selection" pop-up menu allows the user to select the day to be configured, or to use a day type. If a day type is used, the Cristo'Control2 will apply that day type configuration to all the days in the week.

- **Production periods:** It is possible to define up to three different production periods per day,
- **Storage period:** Defines the period dedicated to storage,
- **Storage + demand period:** To be used when needs must be met during the storage period,
- **Tariff bands:** In cases where tariff bands are being used, this allows the user to define two peak time periods and one off-peak time period.

Figure 13: Manual entry of production schedules

The  icon allows all the values to be reset to zero.

Important: The periods entered will not be applied by the Cristo'Control2 until after the entered data is confirmed by touching the button



3.2.5.1.2 If schedules are entered graphically

This solution allows the user to define the production, storage and production + storage periods graphically, and also the schedule bands (peak times, off-peak times, periods of high demand) in cases where tariff bands are being used. This intuitive and user-friendly input method can be done in 30 min time slots.

The various buttons located in the lower section allow the user to select the period for which data is to be entered; the period for which data is currently being entered is indicated by a flashing button. To enter data for a period, touch the starting time slot and then the ending time slot. Then all the time slots in between the two will be part of this period.

A "Day selection" pop-up menu allows the user to select the day to be configured, or to use a day type. If a day type is used, the Cristo'Control2 will apply that day type configuration to all the days in the week.

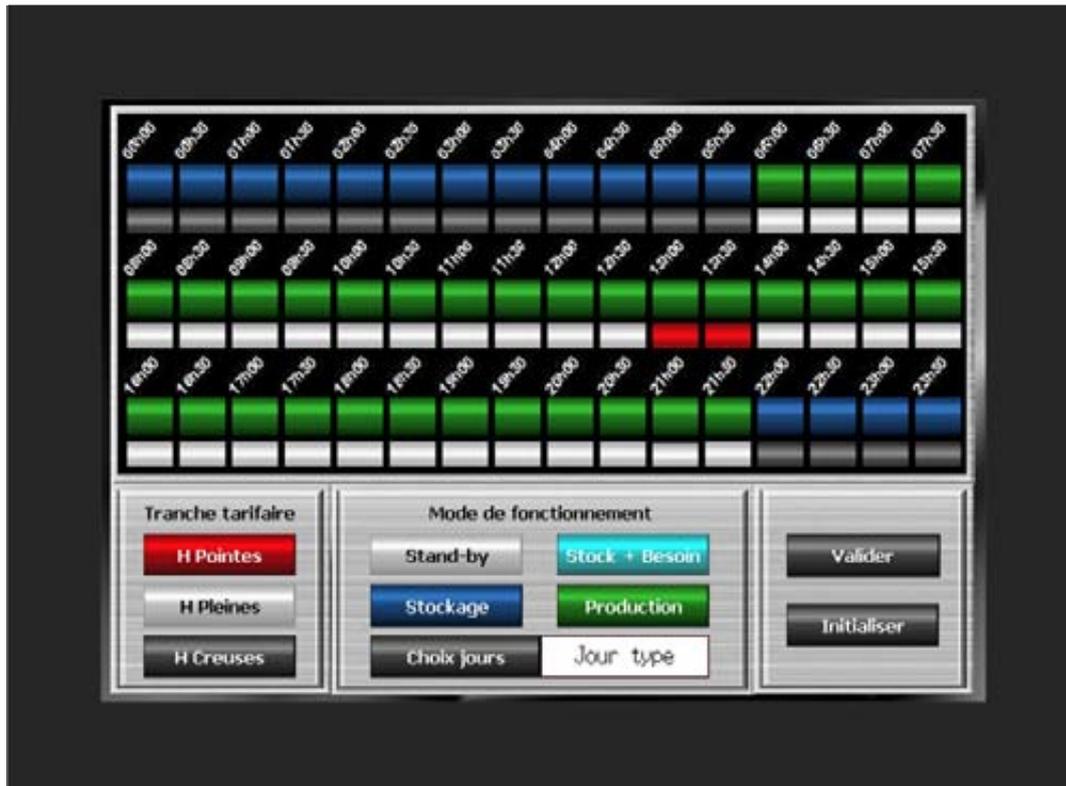


Figure 14: Graphical entry of production schedules

The **Initialiser** button restores the default entry (standby and peak times).

Important: The periods entered will not be applied by the Cristo'Control2 until after the entered data is confirmed by touching the button



3.2.5.2 Threshold-based production

The user can select a temperature sensor so that the Cristo'Control2 can continually read the value. The Cristo'Control2 can authorise or not authorise the start of production based on a user-defined temperature level:

- **Control sensor selection:** allows the user to select the control sensor to be monitored
 - Secondary exchanger outlet
 - Secondary distribution outlet (if sensor is present)
 - Outdoor sensor (if sensor is present)
- **Production activation temperature level:** sets the temperature level above which production will be started.



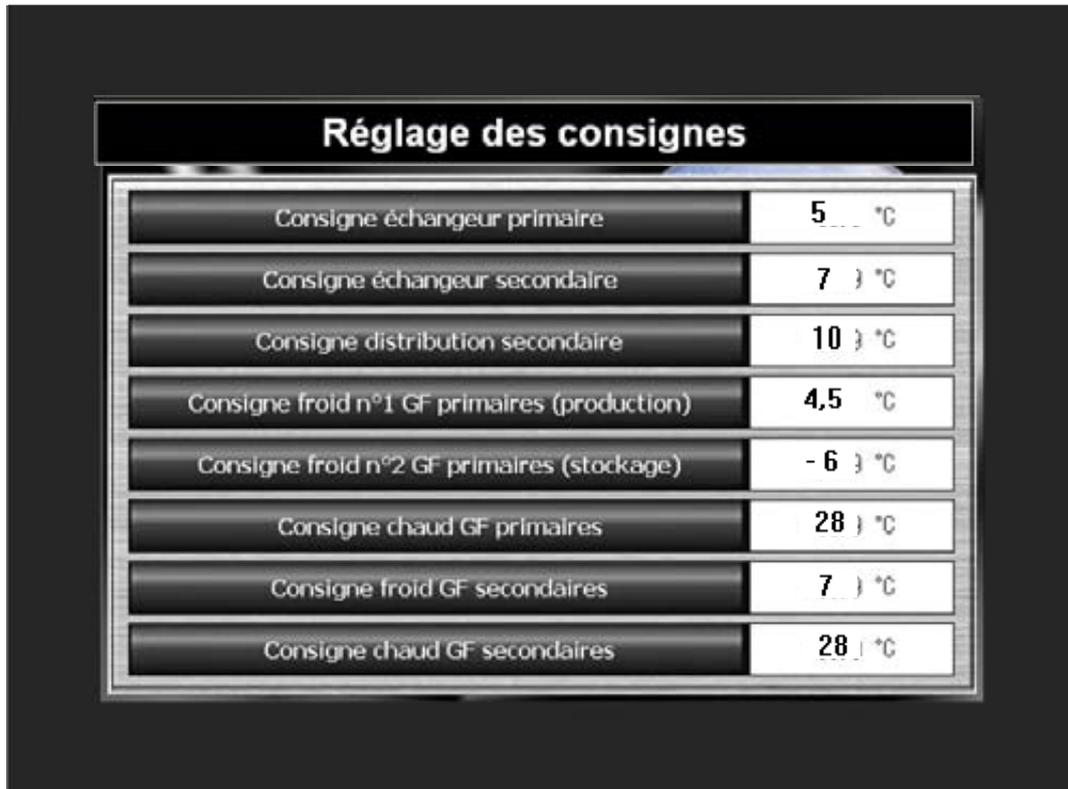
Figure 15: Threshold-based production

3.2.5.3 Setpoint adjustment

The regulation and dynamic behaviour of the system directly depend on the adjustment of the temperature setpoints.

- **Primary exchanger setpoint:** Establishes the setpoint temperature in case the primary exchanger inlet temperature is changed or if the secondary exchanger outlet sensor is not in service.
- **Secondary exchanger setpoint:** Establishes the setpoint temperature in case the secondary exchanger outlet temperature is changed or if the primary exchanger inlet sensor is not in service.
- **Secondary distribution setpoint:** Establishes the setpoint temperature in case the secondary main distribution starting temperature is changed,
- **Cold setpoint no.1 for primary chiller (production):** Establishes the setpoint temperature for chillers located in the exchanger's primary unit in direct production mode,
- **Cold setpoint no.2 for primary chiller (storage):** Establishes the setpoint temperature for chillers located in the exchanger's primary unit in storage mode,

- **Hot setpoint for primary chillers:** Establishes the setpoint temperature for chillers located in the exchanger's primary unit in heat production mode, (in the case of heat pumps),
- **Cold setpoint for secondary chillers:** Establishes the setpoint temperature for chillers located in the exchanger's secondary unit in direct production mode,
- **Hot setpoint for secondary chillers:** Establishes the setpoint temperature for chillers located in the exchanger's secondary unit in heat production mode, (in the case of heat pumps),



| Réglage des consignes | |
|--|--------|
| Consigne échangeur primaire | 5 °C |
| Consigne échangeur secondaire | 7 °C |
| Consigne distribution secondaire | 10 °C |
| Consigne froid n°1 GF primaires (production) | 4,5 °C |
| Consigne froid n°2 GF primaires (stockage) | - 6 °C |
| Consigne chaud GF primaires | 28 °C |
| Consigne froid GF secondaires | 7 °C |
| Consigne chaud GF secondaires | 28 °C |

Figure 16: Setpoint adjustment

The setpoint values are deliberately kept narrow to avoid any input error. A pop-up will appear if the value entered is not within the limit, and it will also mention what the lower and upper limits are.

3.2.5.4 Operation overrides

The operation overrides allow the user to initiate operations that fall outside normal use of the system. These overrides are therefore to be used only after studying the risks they may lead to.

- **Authorisation for starting chillers during peak time periods:** during a time of day strategy or when peak shaving + time of day strategy is activated, if the discharge does not allow the setpoint to be maintained because demand is too high or storage has not been fully completed, etc., the operator can choose whether or not to authorise the refrigeration

equipment to start again during these peak time periods or to let the temperature drift if this is deemed acceptable.

- **Degraded operating mode:** in case of an alarm on the system (normally causing it to stop), this operating mode allows the user to authorise the system to continue to function in degraded mode. Example: in case of an alarm on a charge pump, the Cristo'Control2 will automatically change over to discharge mode alone as long as the alarm is not released by the maintenance operator.
- **Maximum daily discharge:** this override makes it possible, from a set starting time (eg: 16:00) to discharge all the energy still available in the tanks while maintaining a minimum energy level necessary to clear the evening peak time periods if there are any. The refrigeration equipment will also be stopped and restarted when the energy in the tank reaches its minimum level and the setpoint can no longer be maintained solely by the storage.



Figure 17: Operation overrides

3.2.6 Strategy management,

"Strategy" refers to the way the stored energy in the STL system will be used.

For this, the Cristo'Control2 offers several control options and several usage strategies for the various seasons.

3.2.6.1 The various strategies

Four strategies are included as standard in the Cristo'Control2 and can be selected by the user at any time.*

The four strategies are included in the Cristo'Control2 are:

- **Peak shaving:** Priority is given to the operation of the chillers that are sized according to maximum capacity. The chiller charges the STL overnight. From the time demand for capacity becomes higher than the capacity of the chiller, the STL works together with the chiller to restore its cold energy.

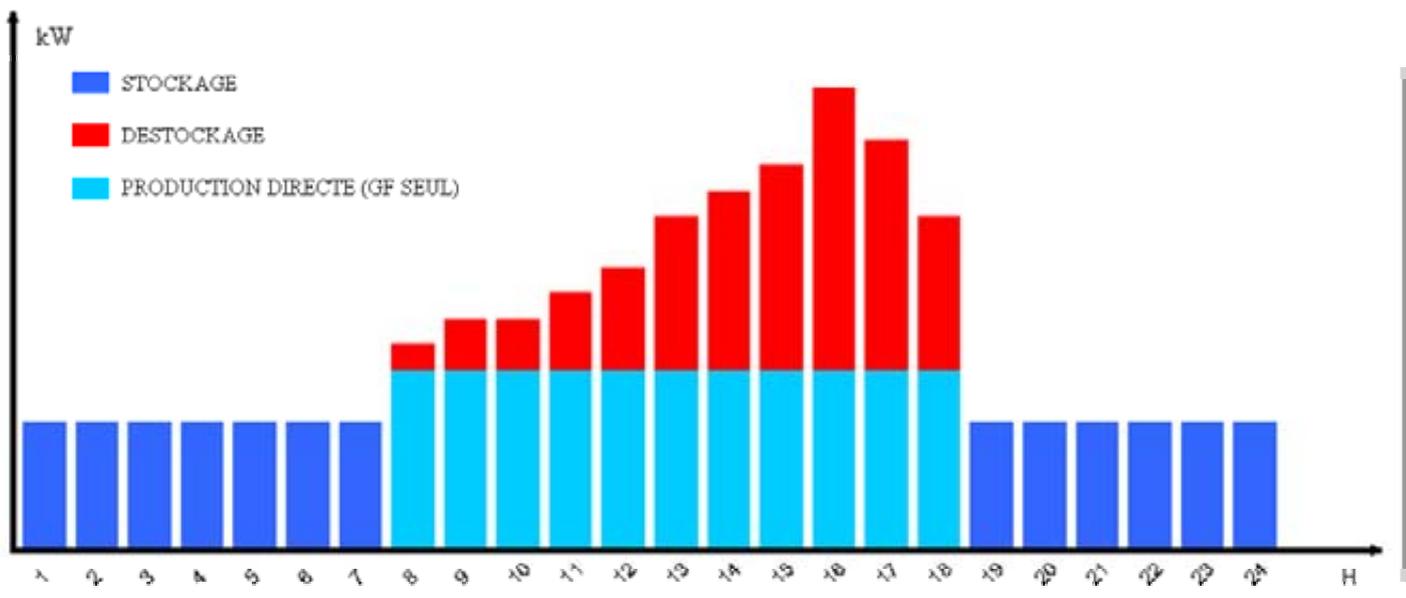


Figure 18: Peak shaving strategy

- **Time of day:** During peak hours, for example as recovered by a green EDF meter or as entered directly via the HMI, the chillers are stopped and demand is met by storage. The chiller charges the STL overnight.

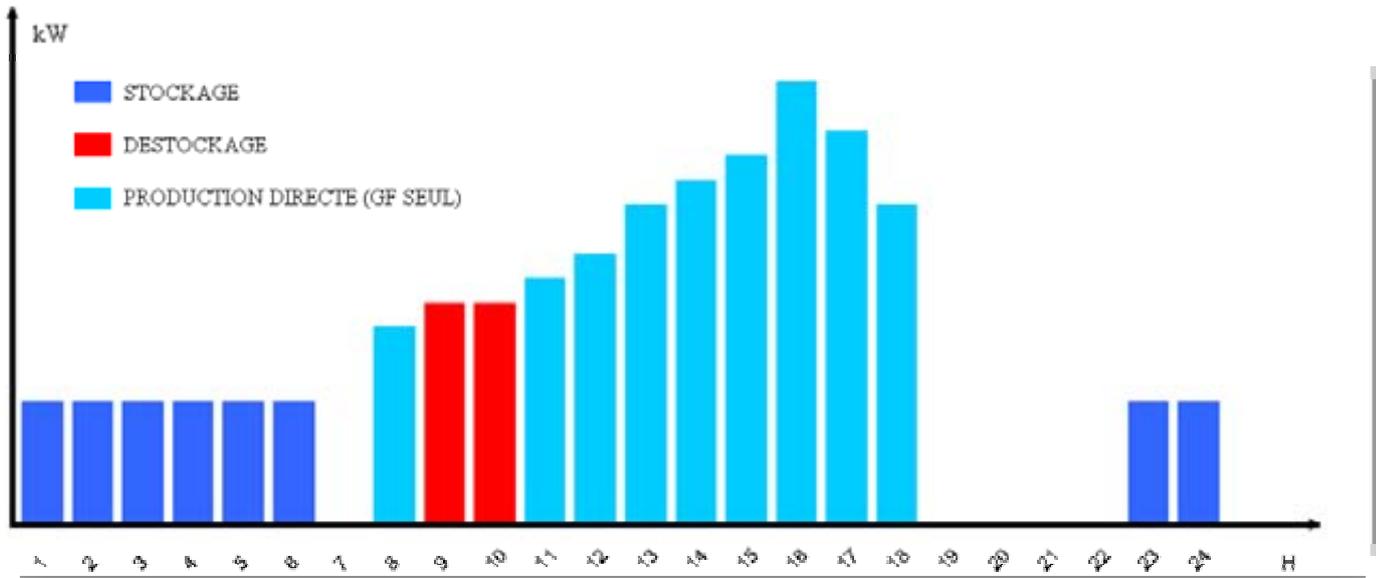


Figure 19: Time-of-day strategy

- **Full storage:** The chillers are stopped for the whole day and storage is used up to the maximum available energy. This strategy is used in low season, for example.

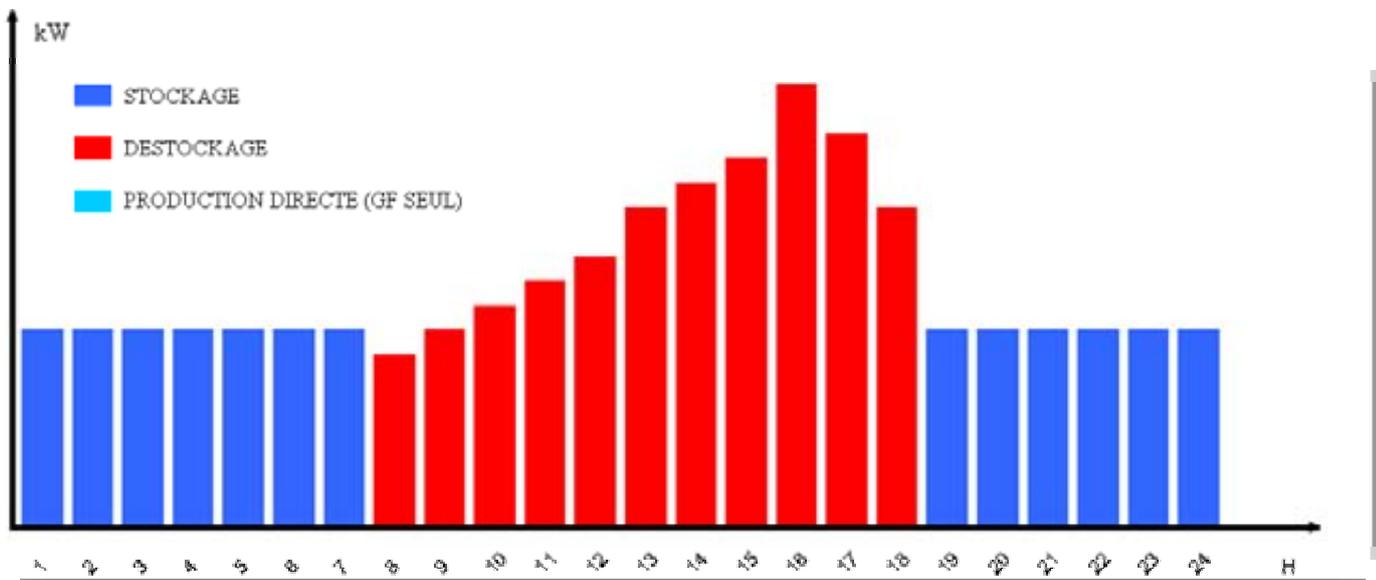


Figure 20: Full storage strategy

Peak shaving + time-of-day: combination of the two strategies

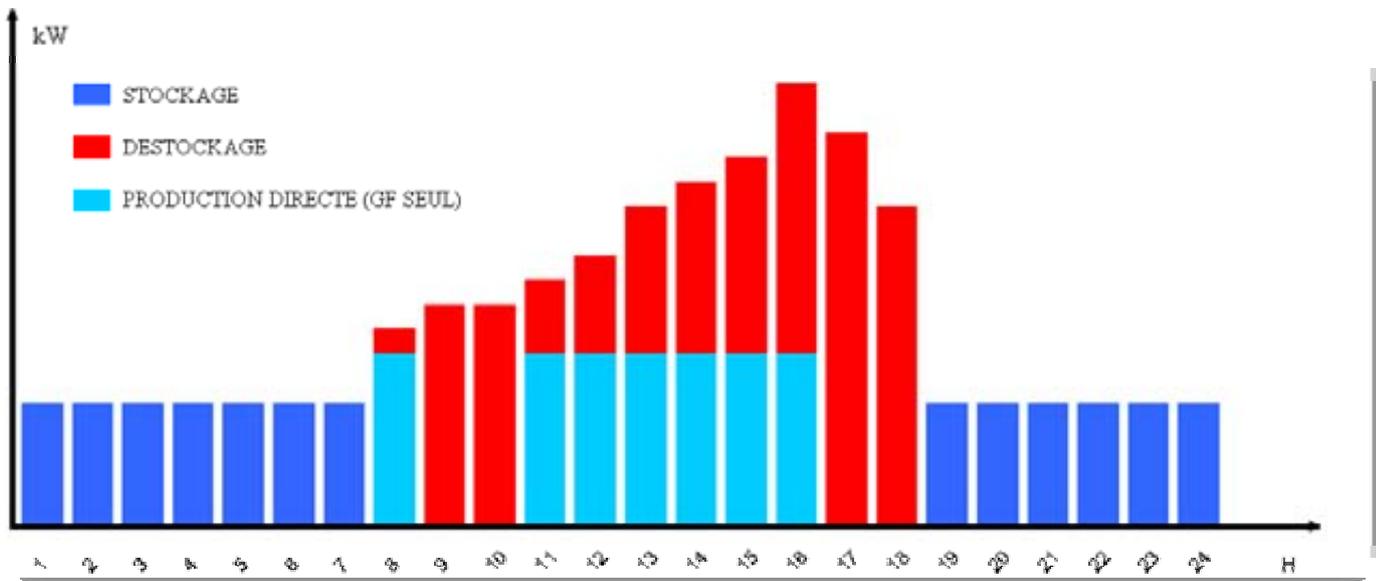


Figure 21: Peak shaving + time-of-day strategy

* *Note*: these usage strategies are all included in the Cristo'Control2 control software, but they can only be applied when the sizing is compatible with the strategy (sufficient capacity and energy quantities available).

Strategy selection is accessible from the pop-up menu on the HMI.

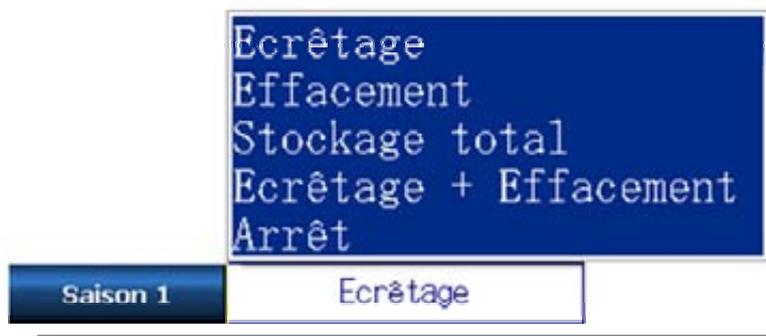


Figure 22: Strategy selection pop-up menu

3.2.6.2 Strategy management method

Several strategy management methods are included in the Cristo'Control2 so that the user can choose the most appropriate solution.



Figure 23: Strategy management method selection pop-up menu

The control methods included in the Cristo'Control2 are:

- **Management by calendar:** this type of management allows the user to graphically define the 3 seasons in the year, spread out over 52 weeks. For example, these seasons can correspond to summer, mid-season and winter. For each season, the user can define the strategy that he/she wishes to use. He/she can modify what has been entered at any time.
- **Management by outer contact:** the user can graphically define 2 strategies for two standard seasons in the year. A contact coming from a BMS allows automatic changeover from one to another.
- **Self-regulating management*:** this management type is completely automatic. Depending on the various measures recorded by the Cristo'Control2 (outdoor temperature, energy available, demand over the last few days, etc.), it determines the best strategy for using the maximum possible energy from the tank and the minimum possible energy from the refrigeration equipment.

* Note: this type of control can be used only if certain necessary measurement equipment is present (flowmeter, outdoor temperature sensor, etc.)

The Cristo'Control2 also includes a limitation on starting equipment according to season.

3.2.6.3 Equipment load shedding

For each season, the user can also select, in cases where there are several chillers and several primary distribution pumps on the system, the number of chillers and pumps that are authorised to operate.

Example:

- Season 1 (peak season): Peak shaving / 3 GF + 2 pumps are authorised to operate
- Season 2 (mid-season): Peak shaving / 2 GF + 1 pump are authorised to operate
- Season 3 (low season): Peak shaving / 1 GF + 1 pump are authorised to operate

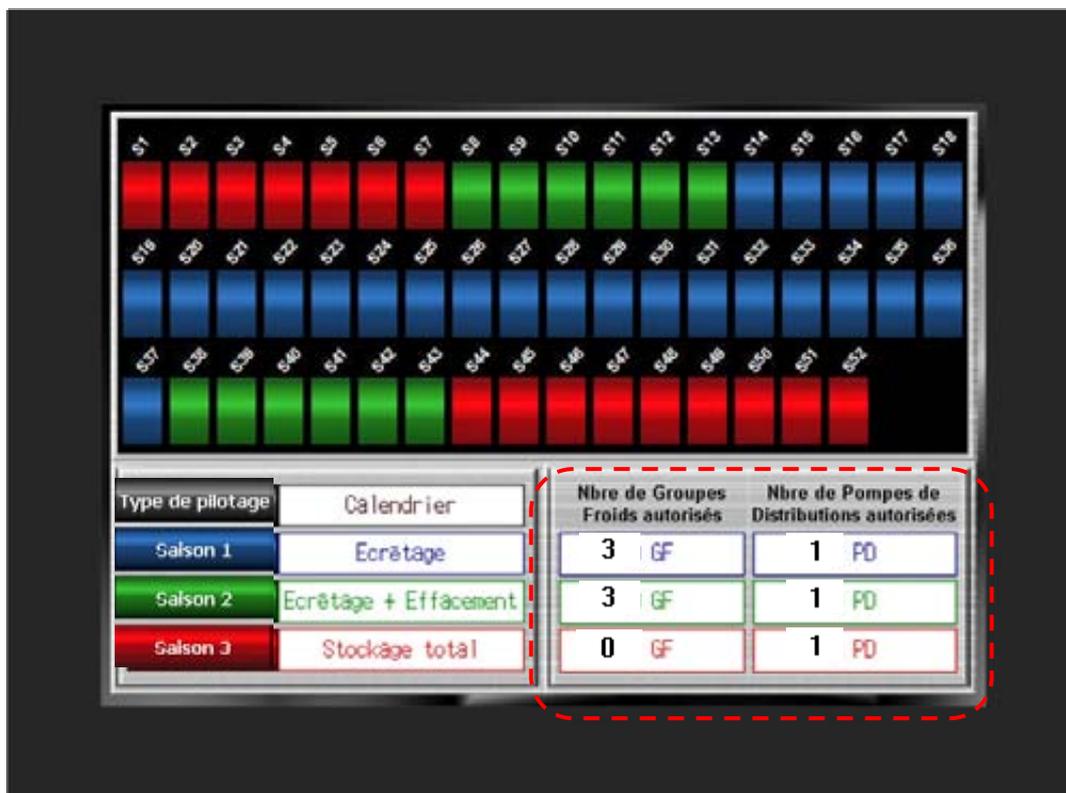


Figure 24: Equipment load shedding

SEASON 1: PEAK SEASON

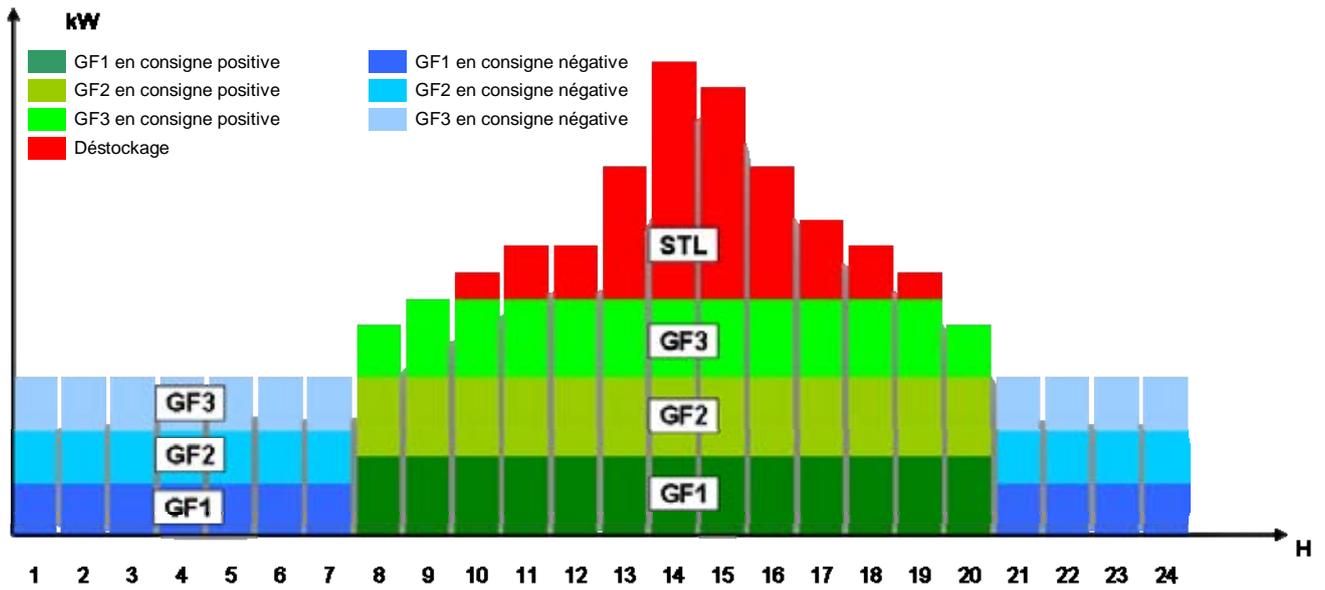


Figure 25: Peak season example

SEASON 2: MID-SEASON

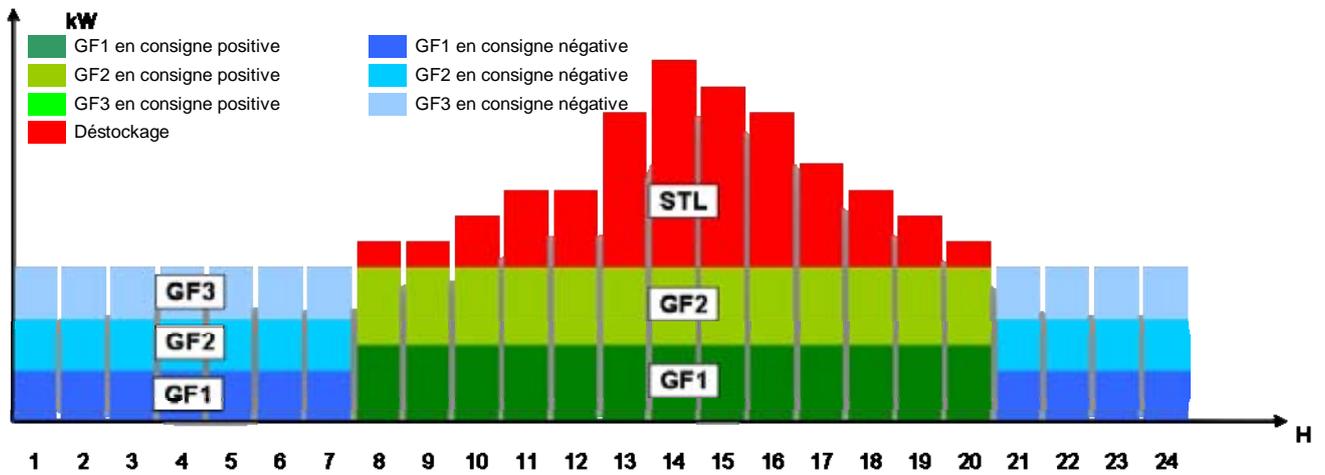


Figure 26: Mid-season example

SEASON 3: LOW SEASON

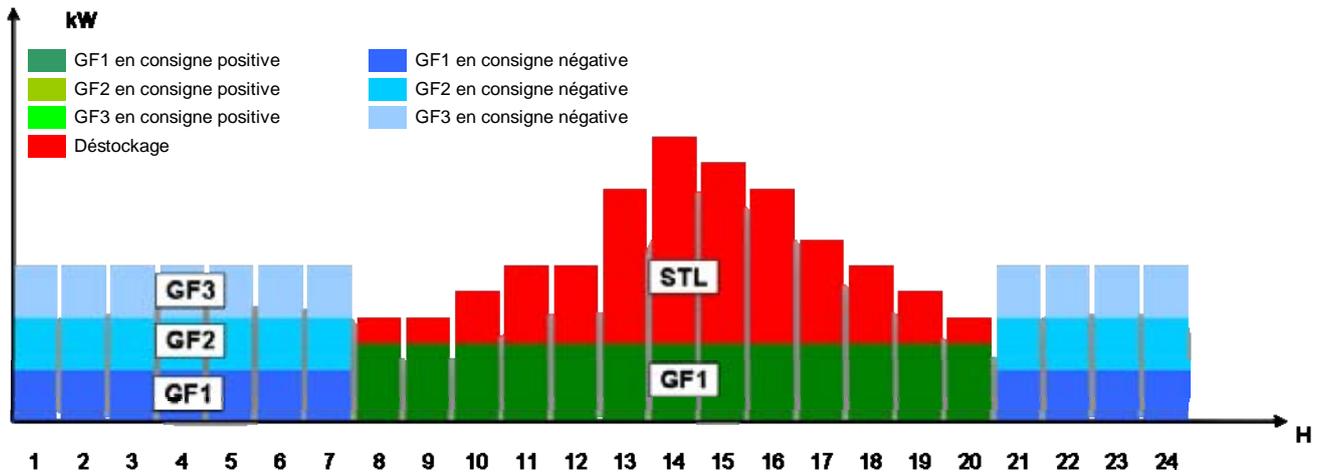


Figure 27: Low season example

3.2.6.4 Strategy control method

It is important to configure the strategy management at system start-up. This configuration can be modified or adjusted at any time.

Configuration method:

1/ Choose the control type

- Click on "Choose control"; several choices will be offered in the pop-up menu.
- Select the desired control type

2/ Define the seasons of the year

- Click on the season to be configured, for example: Season 1,
- Then click on the week number of the first week of the season; the box will be the same colour as the selected "Season X" button,
- Click on the week number of the last week of the season; all the boxes between the beginning and end of the season will be the same colour as the selected "Season X" button,
- Repeat this operation for each of the 3 seasons in the year.

Note: if no season has been defined, the unit will be stopped.

3/ Select the strategies to be used according to the season

- Click on the "strategy" field (white box); several choices will be offered in the pop-up menu.
- Select the strategy to be used during this season,
- Repeat this operation for each of the 3 seasons in the year.

4/ Select the number of devices authorised to operate (*1)

- Click on the number of chillers; a virtual keyboard will appear,
- Enter the number of chillers authorised to function during the selected season and confirm your entry,
- Click on the number of distribution pumps; a virtual keyboard will appear,
- Enter the number of distribution pumps authorised to function during the selected season and confirm your entry.

* Note:

These fields will only be visible if:

- the **number of chillers** is greater than 1,
- the **number of pumps** is greater than 1 or dual pumps have been installed and there is no emergency management.

3.2.7 Events

The Cristo'Control2 allows system events to be managed. It sorts these events according to several levels of criticality, which cause different actions in the system's operation.

3.2.7.1 Defining the different levels of criticality

There are 2 levels of criticality in the Cristo'Control2:

- **Alarms:** critical level
- **Faults:** minor level

3.2.7.2 Indicators

3.2.7.2.1 Local indicators

The "ALARM" and "FAULT" indicator lights on the front of the unit are illuminated, indicating that an alarm or fault is active.

Each time an event is activated, a pop-up will open on the HMI to show that a new event has appeared (fault or alarm).

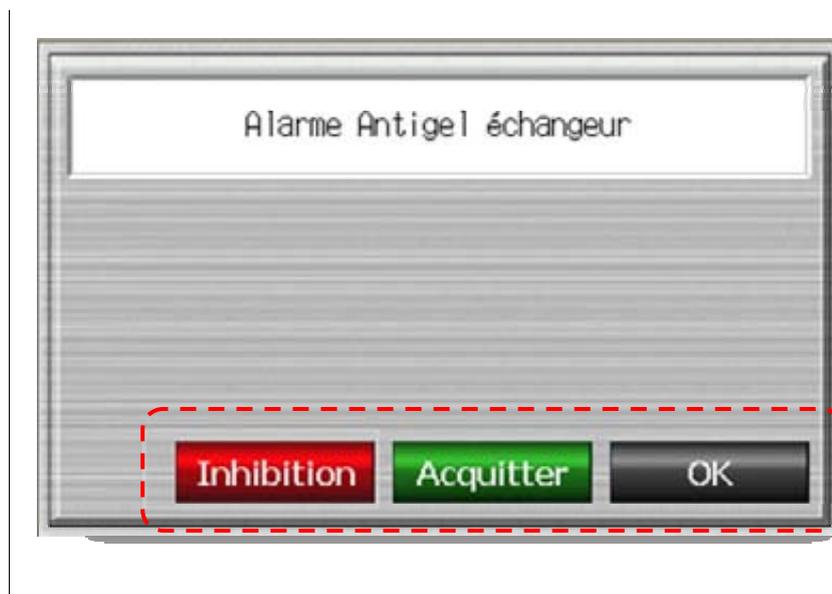


Figure 28: Pop-up alarm indication

Events are also indicated directly on the HMI via the task bar at the bottom of the screen, symbolised by the icon:



3.2.7.2.2 Remote indicators

The Cristo'Control2 can also send alerts to those in charge of maintenance, to inform them as soon as an event appears.

There are several useful methods, that either come standard or as optional extras (to be requested when ordering the Cristo'Control2):

Standard:

- Sending an email
- Sending a trap SNMP
- Sending a put FTP
- Sending to a BMS using MODBUS

Optional:

- Sending an SMS
- Sending a fax
- Sending a voice message
- Sending to a BMS using other protocols

Note: The addresses and phone numbers can be entered during setup.

3.2.7.3 Action on the system

In case of an active alarm, the system will come to a stop, except in the following situations:

- The alarm is disabled (see 3.2.7.6 Disabling events) by the user voluntarily,
- The "starting in degraded mode authorisation" is activated by the user (see 3.2.5.4 Operation overrides).

The faults do not stop the system but they indicate that there is a problem in the system that must be repaired quickly so that a critical level event does not happen.

3.2.7.4 Customer action

If an alarm occurs:

- All alarms need to be released so they can be reset,
- The customer will have the option to disable the alarm if they decide that the system is still able to operate (for example, when the pressure sensor is being replaced),
- Only certain alarms can be disabled,
- Disabled alarms must be reset manually.

If a fault occurs

- All faults are released automatically when their causes are no longer present,
- A combination of several active faults can set off an alarm.

3.2.7.5 List of events

The list of faults and alarms can be found in Appendices 7.2 and 7.3.

The list of parameters involved in activating an event can be found in Appendix 7.1.

3.2.7.6 Disabling events

Disabling an event means that it will no longer be taken into account whether or not it was already active, and it will remain disabled until it is enabled once again.

Only certain events (Alarms and Faults) can be disabled, usually those that depend on a measurement device (flowmeter, pressure sensor, etc.) and do not put the system in danger.

The events that can be disabled are listed in Appendices 7.2 and 7.3.

When an alarm or fault pop-up appears, it will contain the following options:

- **Releasing events:** releasing an event after the repair
- **Disabling events** disabling only if authorised for this event
- **OK:** acknowledging the event, which will be dealt with another way

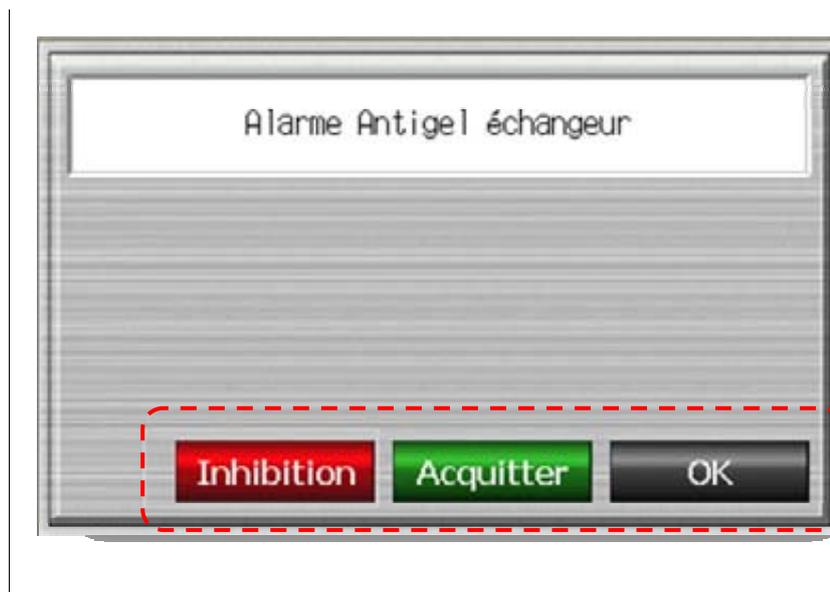


Figure 30: Disabling an alarm via a pop-up

3.2.8 Maintenance

The Cristo'Control2 provides those in charge of maintenance with tools that help diagnose and correct potential problems. It also provides a record of actions taken and offers a maintenance help feature. The various sections are accessed via three buttons:

- **Manual Mode:** Accesses manual mode, which allows the system to be controlled manually,
- **Control system maintenance:** Allows maintenance operations to be carried out on the Cristo'Control2 PLC boards,
- **System maintenance:** Allows the user to view and set up maintenance for the devices present in the system.

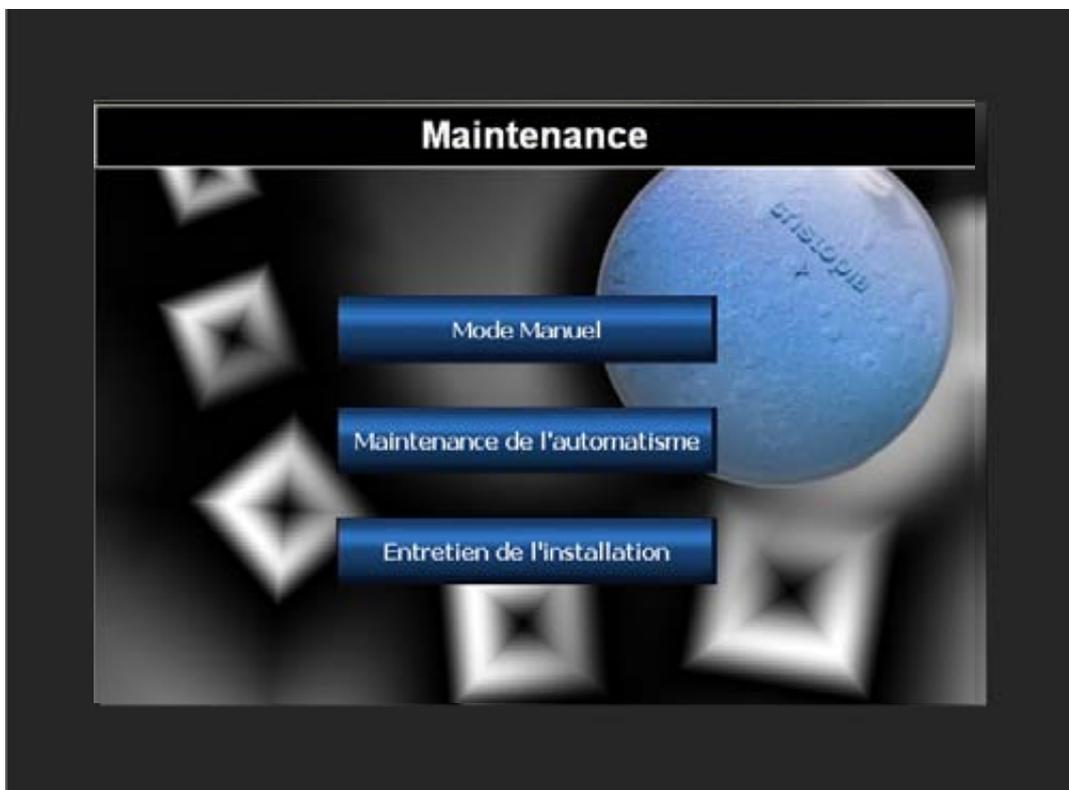


Figure 32: Maintenance home screen

3.2.8.1 Running the system manually

Manual running of the system allows the user to manage the equipment in a controlled way. This operating mode gives those in charge of maintenance the option to control the operating modes independently (storage, storage + demand, chiller production alone, etc.). This mode also allows each system component to be controlled independently (valves, pumps, chillers, etc.).

- **Operating mode:** Allows changeover of the system to manual operating mode; this automatically stops production and puts the system in standby mode.
- **Mode override:** This button allows the various modes to be overridden.
- **Component override:** this button allows the components to be overridden,

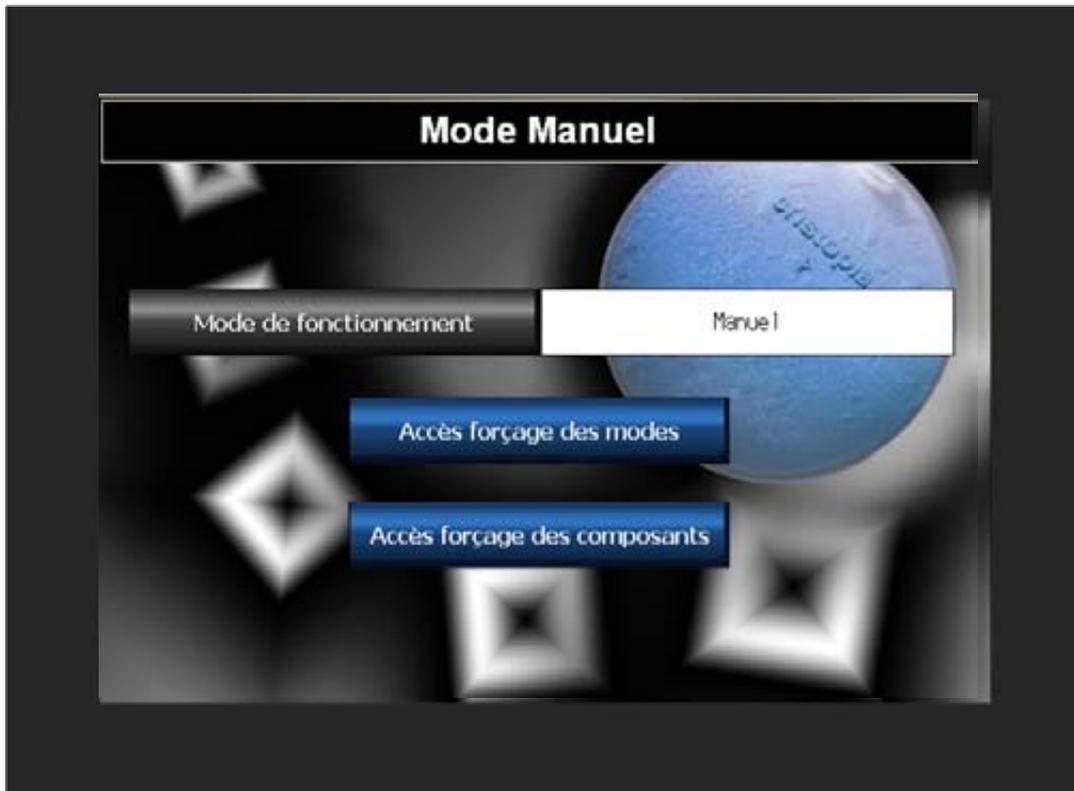


Figure 33: Manual Mode home screen

3.2.8.1.1 Mode override

Mode overriding gives the user the ability to put the system into a particular operating mode, independently of the automatic mode management.

- **Current mode:** Indicates the current operating mode,
- **Select override mode:** Touching this button opens a pop-up menu containing a list of the available override modes:
 - Storage,
 - Storage + Demand*,
 - Chiller production alone,
 - Production with discharge alone*,
 - Chiller production + discharge,
 - Free Cooling*.

* *Note:* if available



Figure 34: Mode override

The selected mode is applied immediately and is effective if there is no alarm currently present in the system. A  button gives direct access to the system overview screen.

3.2.8.1.2 Component override

Component override allows maintenance services to control each component in the system individually. This is why component families are accessible using the buttons on the component override home screen (see **Erreur ! Source du renvoi introuvable.**).

- **Valve override access:** Gives the option to override all the system's motorised valves,
- **Pump override access:** Gives the option to override all the system's pumps,
- **Chiller override access:** Gives the option to override all the system's chillers,

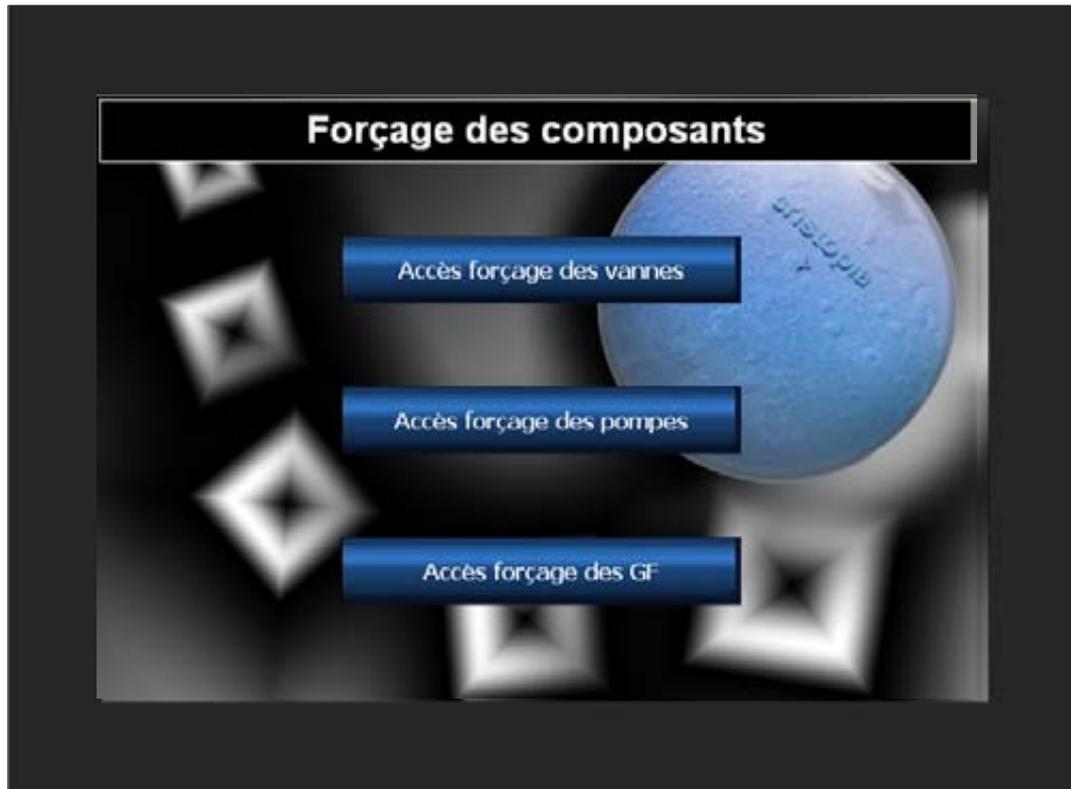


Figure 35: Component override home screen

Important: The component overrides respect safety chains, therefore it is not possible to run a piece of equipment if the system configuration does not allow it (eg: starting a chiller if its pumps are not running).

3.2.8.1.3 Valve override

Valve overrides are done from the overrides interface (see *Figure 36: Valve override*). All the system's motorised valves are present and can be overridden. It is also possible to override the position of a proportional valve (when the system contains a proportional control valve).



Figure 36: Valve override

The  button brings up a pop-up Help window (see **Erreur ! Source du renvoi introuvable.**) which explains how to override a device.



Figure 37: Manual Mode Help

The  button gives direct access to the system overview screen.

3.2.8.1.4 Pump override

Pump overrides can be divided into two sections (see *Figure 38: Pump override home screen*):

- Chiller pump override access (see *Figure 39: Pump override*): This access allows the pumps attached to the chillers to be overridden,
- Override access for other pumps (see *Figure 40: Override for other pumps*): This type of access allows all the system's pumps to be overridden (except chiller pumps):
 - Distribution pumps from the exchanger's primary (if present),
 - Distribution pumps from the exchanger's secondary (if present),
 - Discharge pumps (if present),
 - Mixing pumps (if present),



Figure 38: Pump override home screen



Figure 39: Pump override



Figure 40: Override for other pumps

The  button brings up a pop-up Help window (*Figure 37: Manual Mode Help*) which explains how to override a device. The  button gives direct access to the system overview screen.

Important: The component overrides respect safety chains, therefore it is not possible to run a piece of equipment if the system configuration does not allow it.

3.2.8.1.5 Chiller override

The chiller override screen allows the starting/stopping of chillers, the control setpoint and the control setpoint value to be individually overridden. If there are several chillers in the system, the  button in the navigation bar gives access to the following screens.



Figure 41: Chiller override

The  button brings up a pop-up Help window (see *Figure 37: Manual Mode Help*) which explains how to override a device. The  button gives direct access to the system overview screen.

Important: The component overrides respect safety chains, therefore it is not possible to run a piece of equipment if the system configuration does not allow it.

3.2.8.2 Care and preventative maintenance

The Cristo'Control2 includes a preventative maintenance feature (if a service contract has been purchased). This feature tracks the uptime and the number of starts for each piece of equipment.

According to the periods defined on the pop-up configuration screen (see *Figure 44: Configuration of maintenance periods*) (see

Figure 43: Maintenance pop-up) is displayed on the HMI indicating that maintenance is due for a piece of equipment because the operating period before maintenance has ended. Device information is displayed: brand, model, maintenance advice if available, etc.

A report will be produced for each maintenance task carried out. After carrying out the task, the maintenance operator must indicate his/her name and phone number so that the records indicate who carried out the last maintenance and what tasks were done.

A screen (see *Figure 42: System maintenance home screen*) gives access to the maintenance configuration screen (see *Figure 44: Configuration of maintenance periods*) and the maintenance list (see *Figure 45: Maintenance list*).



Figure 42: System maintenance home screen

3.2.9 HMI options

This section enables the user to make certain adjustments to the Cristo'Control2 touch-screen interface to adapt it to their own needs.

3.2.9.1 Language selection

It is possible to change the HMI language from here:

-  French,
-  English,

The language is immediately changed and affects all parts of the Cristo'Control2 interface.

3.2.9.2 Modifying the system clock

The time shown in the taskbar matches the system clock. This time can be automatically updated when daylight savings time begins/ends. It is however possible to adjust the time manually.

To do this, select the unit to be modified (hour, minute, date), make the change and then confirm your entry by touching "Enter".

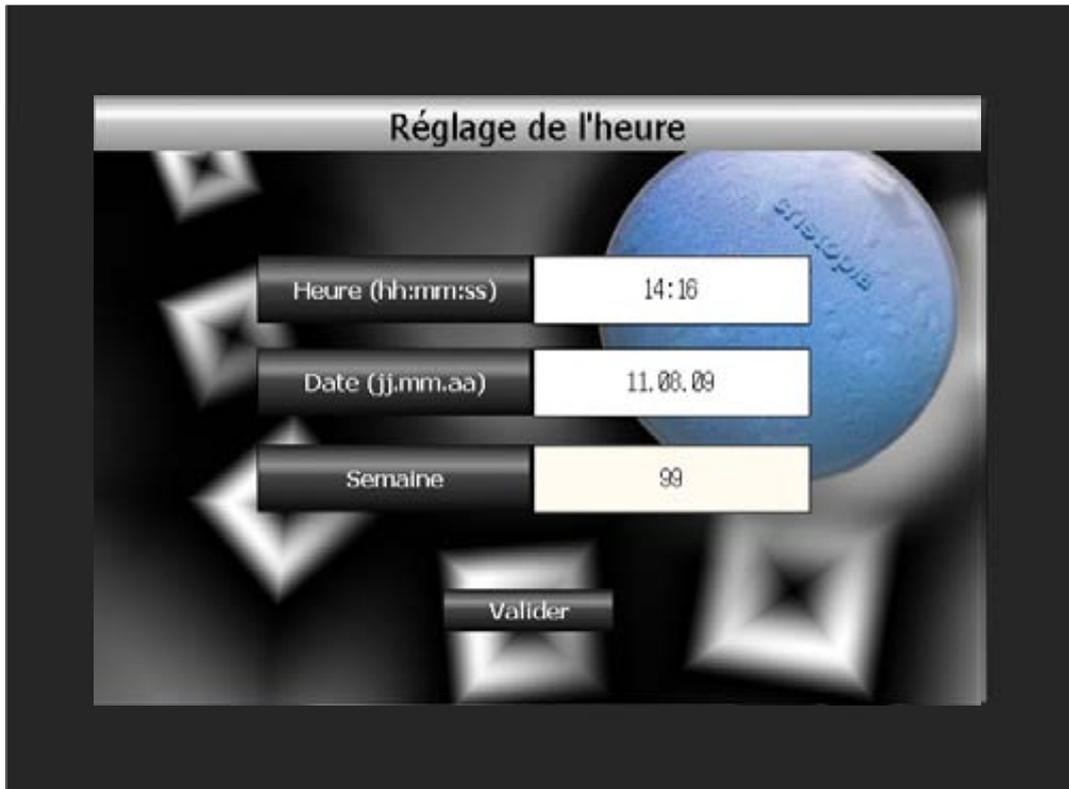


Figure 46: Setting the time

3.2.9.3 Adjusting the screen contrast

Sometimes it can be helpful to adjust the screen contrast. To do this, touch the button corresponding to the desired level of contrast.

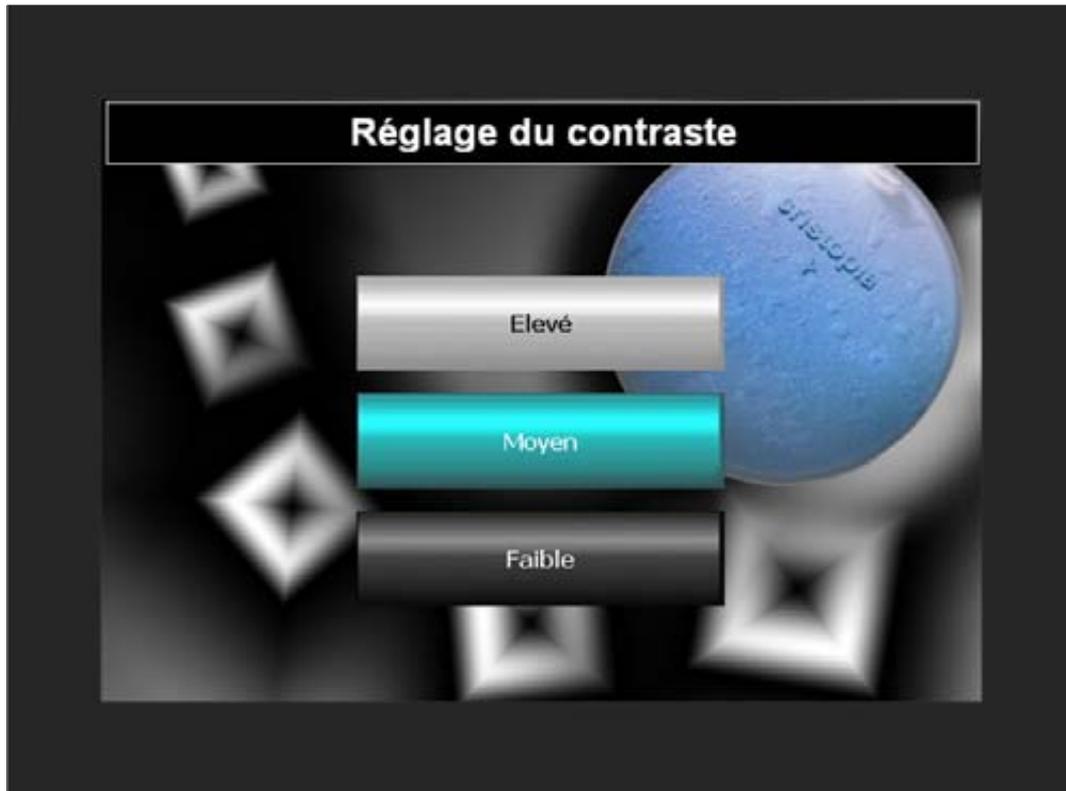


Figure 47: Adjusting the contrast

4 Remote access to the system

CRISTOPIA Energy Systems provides a dedicated Web server for Cristo'Control2 applications and long-term storage of operating parameters for each site connected.

This is not necessary for the daily running of the system, but it allows access to a panel of extra services through a service contract (curves, energy reports, warranty extension for spare parts, hotline, check up, reports, maintenance tools, analyses, etc.).

Access to this server and all the features described (using a Web browser such as Internet Explorer) is free for the first 3 months following installation and this can be extended thereafter for a fee (service contract).

The Cristo'Control2 website is: www.cristocontrol.com

The Cristo'Control2 website gives access to the same tools as can be found locally on the display screen, as well as other tools which mainly allow you to:

- **check system performance,**
- **view the system's operation,**
- **carry out preventative maintenance and planning.**

Note: the monitoring feature should not be used for the purpose of controlling the system, only for viewing the system's operation.

4.1 Overview screen

The Cristo'Control2 website provides the operator with an overview of their system in real time or an image of the system at time t (*1).

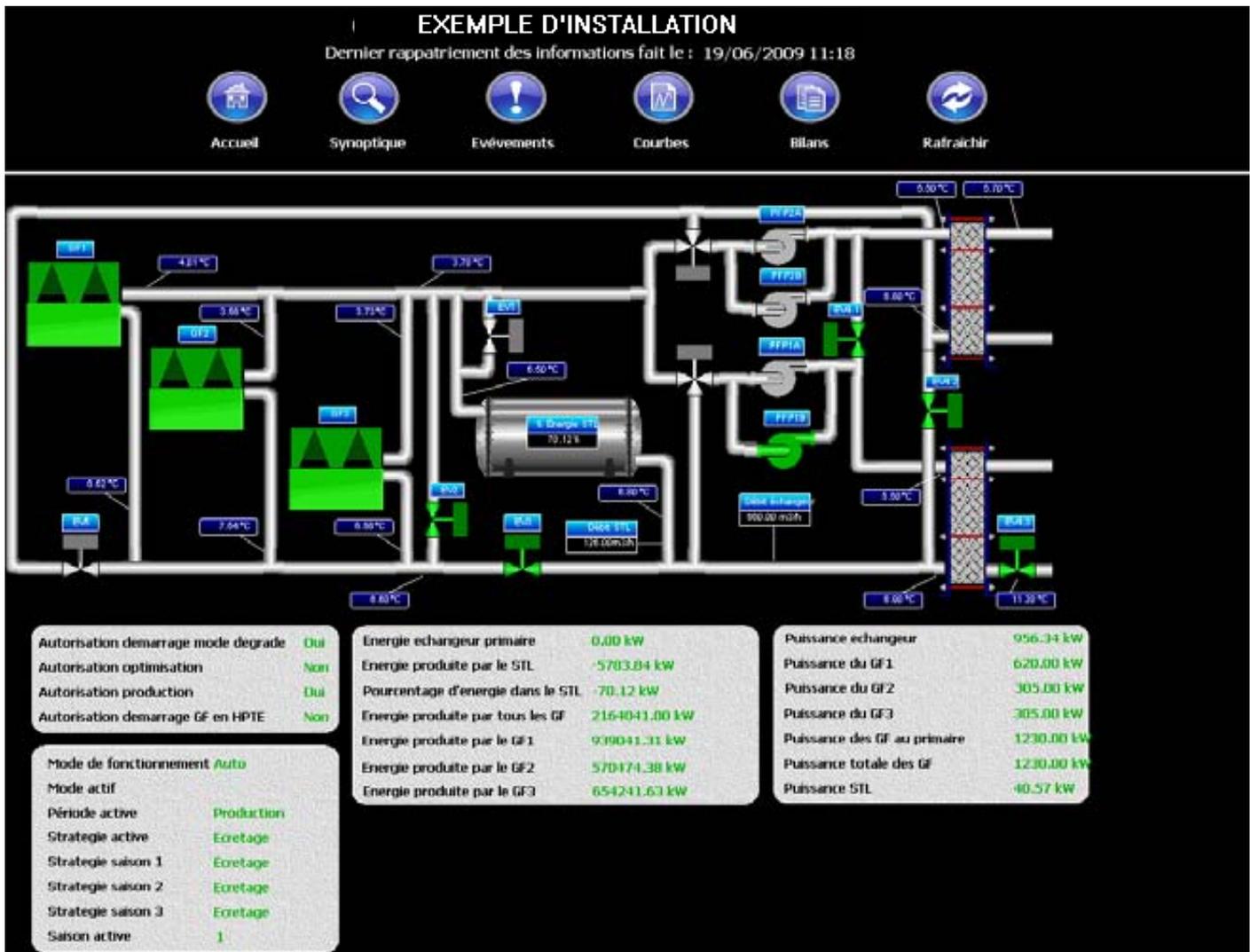
The overview screen allows you to view the system's status:

- **Status of all devices(Running/Stopped/Open/Closed/With fault/With alarm)***
- **Temperatures**
- **Pressure (*2)**
- **Flow rates (*2)**
- **Capacity levels**
- **Energy levels**
- **The current operating mode**
- **The active season**
- **The active strategy**
- **Etc.**

* *Note:*

Status of the devices:

- **GREEN:** open/running
- **GREY:** closed/stopped
- **ORANGE:** fault
- **RED:** alarm



Note:

(*1) depends on the connection type selected when ordering. This will be in real time over an ADSL connection, and will be an image of the system over an RTC line.

(*2) if measurement devices are present in the system.

4.2 Operation curves

Operation curves are useful for verifying that the system is working properly and also for carrying out quick diagnostics to look for potential problems with measurement devices, refrigeration equipment, etc.

Several curves are available as standard depending on whether or not certain measurement devices are present (temperature sensors, flowmeters, pressure sensors, etc.):

- Curve 1: **Building demand** (*1)
 - Basic chiller capacity
 - Primary chiller capacity
 - STL capacity

- Curve 2: **Primary chiller temperature and capacity**
 - Chiller inlet temperature
 - Chiller outlet temperature
 - Chiller capacity
 - Current mode

- Curve 3: **Primary exchanger temperature and capacity:**
 - Primary exchanger inlet temperature
 - Primary exchanger outlet temperature
 - Exchanger capacity
 - Current mode

- Curve 4: **Secondary exchanger temperature**
 - Secondary exchanger inlet temperature
 - Secondary exchanger outlet temperature
 - Current mode

- Curve 5: **STL temperature and energy**
 - Upper STL temperature
 - Lower STL temperature
 - STL energy percentage
 - Current mode

- Curve 6: **STL pressure and energy percentage**
 - Pressure in the circuit
 - STL energy percentage
 - Current mode

Note:

(*1) based on the study carried out with STOCKAID sizing software

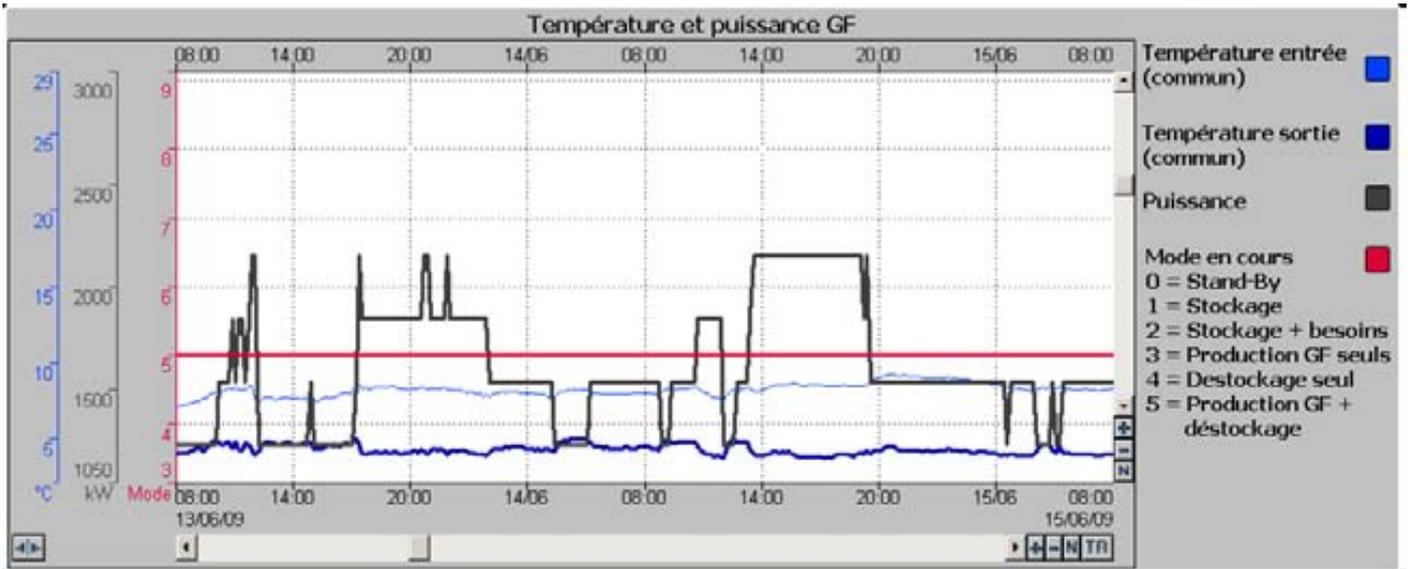


Figure 48: Curve example

4.3 Events

4.3.1 Alarms and faults

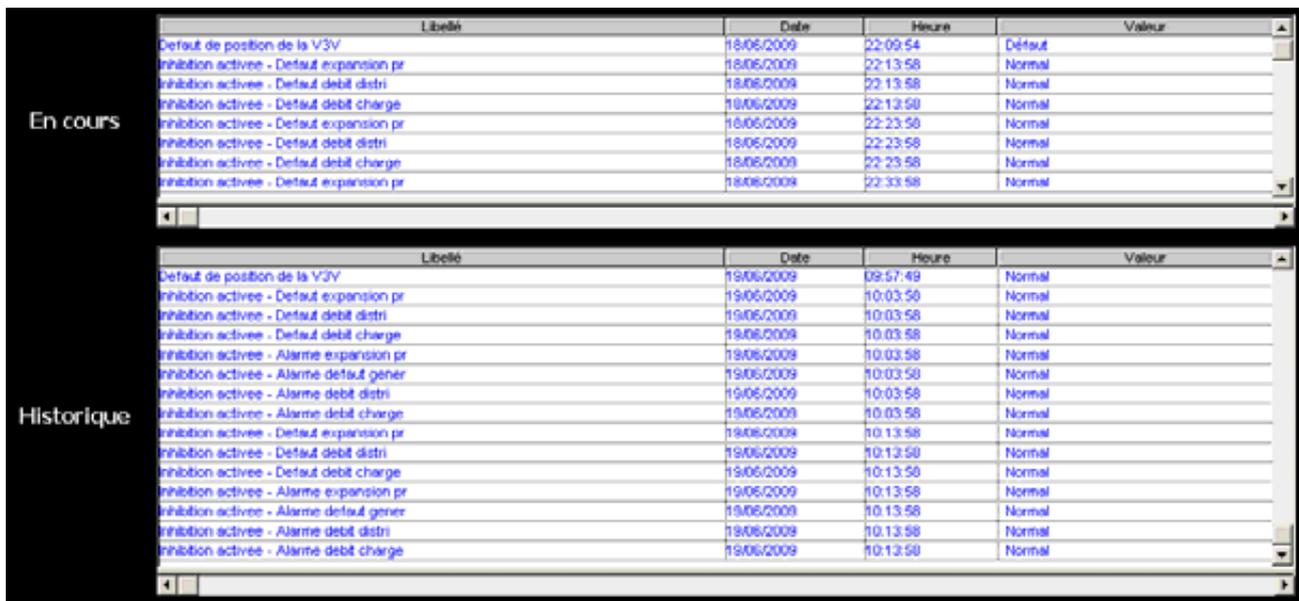
Monitoring includes management of events (alarms, faults and drifts*).

It is possible to view:

- the list of active events
- the events history

* *Note*: For drifts, see the following chapter.

Events can be accessed as read-only, they may not be released remotely. There must first be work carried out on-site, so that the problem can be repaired.



| | Libelle | Date | Heure | Valeur |
|------------|--|------------|----------|--------|
| En cours | Defaut de position de la V3V | 18/06/2009 | 22:09:54 | Defaut |
| | Inhibition activee - Defaut expansion pr | 18/06/2009 | 22:13:58 | Normal |
| | Inhibition activee - Defaut debit distri | 18/06/2009 | 22:13:58 | Normal |
| | Inhibition activee - Defaut debit charge | 18/06/2009 | 22:13:58 | Normal |
| | Inhibition activee - Defaut expansion pr | 18/06/2009 | 22:23:58 | Normal |
| | Inhibition activee - Defaut debit distri | 18/06/2009 | 22:23:58 | Normal |
| | Inhibition activee - Defaut debit charge | 18/06/2009 | 22:23:58 | Normal |
| | Inhibition activee - Defaut expansion pr | 18/06/2009 | 22:33:58 | Normal |
| Historique | Defaut de position de la V3V | 19/06/2009 | 09:57:49 | Normal |
| | Inhibition activee - Defaut expansion pr | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Defaut debit distri | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Defaut debit charge | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Alarme expansion pr | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Alarme defaut gener | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Alarme debit distri | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Alarme debit charge | 19/06/2009 | 10:03:58 | Normal |
| | Inhibition activee - Defaut expansion pr | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Defaut debit distri | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Defaut debit charge | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Alarme expansion pr | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Alarme defaut gener | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Alarme debit distri | 19/06/2009 | 10:13:58 | Normal |
| | Inhibition activee - Alarme debit charge | 19/06/2009 | 10:13:58 | Normal |

Figure 49: List of events

4.3.2 Drifts during operation

As an additional service, the user will be informed of drifts during operation via a preventative maintenance report.

For example, these drifts will be: faults with the temperature sensors, sensor calibration problems, faults due to clogged filters, etc.

4.4 Operations report

As part of the Cristo'Control2 service contract, based on the measurements and events recovered over the past 6 months, CRISTOPIA provides an operations report and suggests measures to implement or advice on optimisation so that efficient performance can be maintained over the long term.

Automatic reports will be made available directly via the Cristo'Control2 website. Below is a list of the available reports that are included as standard:

- **Report 1: Energy report**
 - Exchanger cooling energy
 - Exchanger capacity
 - Stored STL energy
 - Discharged STL energy
 - Primary chiller cooling energy

- **Report 2: Preventive maintenance report**
 - Number of hours of operation for all devices*
 - Number of starts for all devices*
 - List of drifts

- **Report 3: Events report**
 - List of active and released alarms
 - List of active and released faults

* Note: compressors, pumps, etc.

5 Premium service contract

The CRISTOPIA teams will be available to the users to guide them in using the Cristo'Control2, configuring and operating their system for the adjustment period (3 months) following installation.

After this period, the user can extend this contract by choosing the "Premium" offer, which includes:

- Replacement of defective spare parts for the Cristo'Control2 at no additional cost
- Access to a hotline service dedicated to our customers, which provides valuable advice from CRISTOPIA technicians
- Twice a year, a CRISTOPIA technician will remotely test the status of your Cristo'Control2-controlled system and will send you a summary report
- Any problem indicated that relates to the operation of the Cristo'Control2 will be acknowledged and a CRISTOPIA technician will carry out remote diagnostics as soon as possible (maximum 3 working days)
- Access to maintenance help features from the Cristo'Control2 display
- Access to the monitoring services and all Cristo'Control2 features and accessories

6 Conclusion

A refrigeration system is a dynamic system that is continuously trying to establish a balance between the performance of each of its components and the changing needs of the building.

The Cristo'Control2 is central to a well-performing refrigeration system. It allows the system to operate more efficiently, which leads to savings on running costs.

Its intuitive use via a colour touch-screen HMI allows the site manager to easily supervise the system and to maintain its efficiency with the highest level of operational safety.

With CRISTOPIA's Premium service contract, the Cristo'Control2 allows the system's energy output to be adapted according to the changing needs of the building and electricity rates.

This service contract also extends the advantages of the Cristo'Control2 for an unlimited time period, including the benefits of the user assistance and maintenance services as well as extended warranties on the equipment.

7 Appendices

7.1 List of parameters

Below is the list of parameters for the Cristo'Control2 which lead to an event being activated.

These parameters initially have a default value, which is adjusted according to the system's characteristics and the customers' requirements at the time of installation.

| PARAMETERS | DESCRIPTION | FAULT VALUES |
|-------------------------|--|--------------|
| MAN_Seuil_ALPressHaute | High pressure alarm activation level (operating pressure differential) | -2.8 bar |
| MAN_Seuil_ALPressBasse | Low pressure alarm activation level (operating pressure differential) | 3 bar |
| MAN_Seuil_DEFPressHaute | High pressure fault activation level | 2 bar |
| MAN_Seuil_DEFPressBasse | Low pressure fault activation level | -2.5 bar |
| MAN_Seuil_TempALAntigel | Exchanger frost protection alarm activation level | 0°C |
| MAN_Seuil_TempFinStock | Temperature level for confirming the end of storage | -4.5°C |
| MAN_Seuil_DEFPosVanne | Voltage level before the alarm is activated for 3-way valve and proportional 2-way valve position (voltage differential) | 3 DCV |
| MAN_TP_ALPress | Time delay before a high or low pressure alarm is activated | 30 s |
| MAN_TP_ALVanne | Time delay before an open or closed valve alarm is activated | 4 min |
| MAN_TP_ALExpansion | Time delay before an expansion alarm is activated | 24 hrs |
| MAN_TP_ALDebit | Time delay before a flow rate alarm is activated | 10 min |
| MAN_TP_ALProtecAGelEch | Time delay before an exchanger frost protection alarm is activated | 30 s |
| MAN_TP_DEFExpansion | Time delay before an expansion fault is activated | 1 min |
| MAN_TP_DEFPress | Time delay before a high or low pressure fault is activated | 2 min |
| MAN_TP_DEFDebit | Time delay before a flow rate fault is activated | 5 min |
| MAN_TP_DEFGF | Time delay before a chiller fault is activated | 10 min |
| MAN_TP_DEFGF_HPTE | Time delay before a fault is activated for chiller start-up during peak times | 2 min |

| | | |
|--------------------|--|----------------------|
| MAN_TP_DEFPosVanne | Time delay before the fault is activated for 3-way valve and proportional 2-way valve position | 5 min |
| MAN_TP_DEFComm | Time delay before a communication fault with outdoor equipment is activated (BMS, Chiller, etc.) | 2 min |
| MAN_Coeff_ALDebit | Coefficient for activating the flow rate alarm | 50% |
| MAN_Coeff_DEFDebit | Coefficient for activating the flow rate fault | 75% |
| MAN_PressService | System operating pressure | 3 bar |
| MAN_DebPpPCh | Nominal flow rate for charge pumps (chiller) | 80 m ³ /h |
| MAN_DebPpPD | Nominal flow rate for primary distribution pumps | 80 m ³ /h |
| EXP_AD_GF_HPTE_NRJ | Authorisation of chiller start-up during peak time periods in case of insufficient energy | NO |

7.2 List of alarms

| Word sequence of the variable | Definition of the alarm | | |
|-------------------------------|---|---|---|
| | Meaning | Activation | Release |
| ALA_ExpansionPr | Alarm on the primary expansion system | If the accumulated length of the expansion fault exceeds the MAN_TP_ALExpansion time delay, the alarm will activate. | It is released manually . It will reset the counting of the accumulated length of the expansion fault. Authorised disabling |
| ALA_PressionH | Alarm for water circuit pressure being too high | Sensor pressure > [MAN_Seuil_ALPressHaute] + [MAN_PressService] bar Time delay: MAN_TP_ALPress <i>Note: a pressure sensor is required</i> | It is not possible to release the alarm until after the repair has been carried out. It is released manually . |
| ALA_PressionB | Alarm for water circuit pressure being too low | Sensor pressure < [MAN_Seuil_ALPressBasse] + [MAN_PressService] bar Time delay: MAN_TP_ALPress <i>Note: a pressure sensor is required</i> | It will not be confirmed until the circuit pressure is within limits, for the safety of the system. Authorised disabling |
| ALA_OuvVanneEV_XXX_X | Alarm for the valve EV_XXX_X being open | If the data on the position of valve EV_XXX no. "X" does not match the command given, the alarm will activate. Time delay: MAN_TP_ALVanne | It is released manually . |
| ALA_FerVanneEV_XXX_X | Alarm for the valve EV_XXX_X being closed | | It is released manually . |

| | | | |
|---------------------|--|--|--|
| <p>ALA_PompePCh</p> | <p>Alarm for the chiller's charge pump(s) PCh of the exchanger's primary <u>only</u></p> | <p>The alarm is activated if all the charge pumps of the exchanger's primary loop have a fault.</p> <p>Time delay: None</p> | <p>It is released manually.</p> |
| <p>ALA_PompePD</p> | <p>Alarm on the primary distribution pump(s) (PD)</p> | <p>The alarm is activated if:</p> <ul style="list-style-type: none"> - <u>For a single pump</u>, this stoppage has been confirmed, there is a thermal safety fault on pump PD X - <u>For a dual pump</u>, both pumps have a fault (see "Fault on pump PD X") - <u>For a triple pump</u>, all three pumps have a fault (see "Fault on pump PD X") <p>Time delay: None</p> <p><i>Note: the hydraulic diagram must be from EDF or Parallel.</i></p> | <p>It is released manually.</p> |
| <p>ALA_PompePDS</p> | <p>Alarm on the secondary distribution pump(s) (PSD)</p> | <p>The alarm is activated if:</p> <ul style="list-style-type: none"> - <u>For a single pump</u>, this stoppage has been confirmed, there is a thermal safety fault on pump PDS X - <u>For a dual pump</u>, both pumps have a fault (see "Fault on pump PDS X") - <u>For a triple pump</u>, all three pumps have a fault (see "Fault on pump PDS X") <p>Time delay: None</p> <p><i>Note: the pumps must be managed by the Cristo'Control2</i></p> | <p>It is released manually.</p> |

| | | | |
|--------------------------|---|---|--|
| <p>ALA_PompePSTL</p> | <p>Alarm on the PSTL storage pump(s)</p> | <p>The alarm is activated if:</p> <ul style="list-style-type: none"> - <u>For a single pump</u>, this stoppage has been confirmed, there is a thermal safety fault on pump PSTL X - <u>For a dual pump</u>, both pumps have a fault (see "Fault on pump PSTL X") - <u>For a triple pump</u>, all three pumps have a fault (see "Fault on pump PSTL X") <p>Time delay: None</p> <p><i>Note: the hydraulic diagram must be "variable flow".</i></p> | <p>It is released manually.</p> |
| <p>ALA_PompePP_ADV_X</p> | <p>Optional pump(s) alarm PP_ADV X on the variable flow diagram</p> | <p>The alarm is activated if:</p> <ul style="list-style-type: none"> - <u>For a single pump</u>, this stoppage has been confirmed, there is a thermal safety fault on pump PP_ADV X - <u>For a dual pump</u>, both pumps have a fault (see "Fault on pump PP_ADV X") <p>Time delay: None</p> <p><i>Note: the hydraulic diagram must be "variable flow".</i></p> | <p>It is released manually.</p> |

| | | | |
|----------------------------|---|---|---|
| <p>ALA_PompePP_SER_GFX</p> | <p>Optional pump(s) alarm PP_SER of chiller X on the upline or downline diagram series</p> | <p>The alarm is activated if:</p> <ul style="list-style-type: none"> - <u>For a single pump</u>, this stoppage has been confirmed, there is a thermal safety fault on pump PP_SAM X - <u>For a dual pump</u>, both pumps have a fault (see "Fault on pump PP_SAM X") <p>Time delay: None</p> <p><i>Note: the hydraulic diagram must be an "upline series" or a "downline series", the pumps must be managed by the Cristo'Control2 and the chiller must be on the exchanger's primary.</i></p> | <p>It is released manually.</p> |
| <p>ALA_DebitCharge</p> | <p>Alarm on the flow of charge. The chiller is no longer being irrigated.</p> | <p>The lack of flow is confirmed by:</p> <ul style="list-style-type: none"> - Flow read as being lower than the expected level [Flow rate < Nb_PCh_Marche * MAN_DebPpPCh * MAN_Coeff_ALDebit] <p>Time delay: MAN_TP_ALDebit</p> <p><i>Note: a flowmeter must be present on the chiller to activate this fault</i></p> | <p>It is released manually. <u>Authorised disabling</u></p> |
| <p>ALA_DebitDisPr</p> | <p>Alarm on the primary distribution network flow rate. The exchanger's primary is no longer or nearly no longer irrigated.</p> | <p>The lack of flow is confirmed by:</p> <ul style="list-style-type: none"> - Flow read as being lower than the expected level [Flow rate < Nb_PD_Marche * MAN_DebPpPD * MAN_Coeff_ALDebit] <p>Time delay: MAN_TP_ALDebit</p> <p><i>Note: a flowmeter must be present on the exchanger to activate this fault</i></p> | <p>It is released manually. <u>Authorised disabling</u></p> |

| | | | |
|------------------------|---|---|---|
| <p>ALA_DefGenGF_Pr</p> | <p>Alarm on the chiller(s).</p> <p>The chiller(s) on the primary are stopped.</p> | <p>All the chillers on the primary contain a fault and are stopped.</p> <p>Time delay: None</p> | <p>After having repaired or released the fault on that chiller (see the chiller's technical documentation), the alarm must then be manually released on the Cristo'Control2.</p> <p><u>Authorised disabling</u></p> |
| <p>ALA_AntigelEch</p> | <p>Frost protection alarm on the exchanger</p> | <p>This stoppage is confirmed by two pieces of information:</p> <ul style="list-style-type: none"> - [EtEE < MAN_Seuil_TempALAntigel] - [EtSE < MAN_Seuil_TempALAntigel] <p>and no drift from sensors that are not working.</p> <p>Time delay: MAN_TP_ALProtecAGelEch</p> <p><i>Note: the presence of an exchanger must be confirmed.</i></p> | <p>Manual release</p> <p><u>Authorised disabling</u></p> |

7.3 List of faults

| Word sequence of the Variable | Definition of the fault | | |
|-------------------------------|---|---|---|
| | Meaning | Activation | Release |
| FAU_ExpansionPr | <p>Primary expansion system fault.</p> <p>The primary expansion system detects a serious operating problem.</p> | <p>The expansion system sends a synthesis fault to the Cristo'Control2 during MAN_TP_DEFExpansion</p> <p>The length of this fault is accumulated and may activate an alarm (see "expansion system alarm").</p> | <p>The fault is released automatically after normal conditions have resumed.</p> <p><u>Authorised disabling</u></p> |
| FAU_ExpansionSe | <p>Secondary expansion system fault.</p> <p>The secondary expansion system detects a serious operating problem.</p> | <p>The secondary expansion system sends a synthesis fault to the Cristo'Control2 during MAN_TP_DEFExpansion</p> <p><i>Note: a secondary expansion system is required</i></p> | <p>The fault is released automatically after normal conditions have resumed.</p> <p><u>Authorised disabling</u></p> |
| FAU_PressionH | <p>Fault for water circuit pressure being too high</p> | <p>Sensor pressure > [MAN_Seuil_DEFPressHaute] + [MAN_PressService] bar</p> <p>Time delay: MAN_TP_DEFPress</p> <p><i>Note: a pressure sensor is required</i></p> | <p>These two faults are released automatically when the circuit pressure is within limits.</p> |
| FAU_PressionB | <p>Fault for water circuit pressure being too low</p> | <p>Sensor pressure < [MAN_Seuil_DEFPressBasse] + [MAN_PressService] bar</p> <p>Time delay: MAN_TP_DEFPress</p> <p><i>Note: a pressure sensor is required</i></p> | <p><u>Authorised disabling</u></p> |

| | | | |
|----------------|--|--|--|
| FAU_DebitCharg | Fault on the flow of charge. | <p>- Flow read as being lower than the expected level [Flow rate < NbPCh_Marche * MAN_DebPpPCh * MAN_Coeff_DEFDebit]</p> <p>Time delay: MAN_TP_DEFDebit</p> <p><i>Note: a flowmeter must be present on the chiller to activate this fault</i></p> | <p>It is released automatically</p> <p><u>Authorised disabling</u></p> |
| FAU_DebitDisPr | Flow rate fault on the primary distribution network. | <p>The lack of flow is confirmed by two pieces of information:</p> <p>- Flow read as being lower than the expected level [Flow rate < NbPD_Marche * MAN_DebPpPD * MAN_Coeff_DEFDebit]</p> <p>Time delay: MAN_TP_DEFDebit</p> <p><i>Note: a flowmeter must be present to activate this fault.</i></p> | <p>It is released automatically</p> <p><u>Authorised disabling</u></p> |
| FAU_PCh_X_GFX | Charge pump fault PCh no. X of chiller no. X | The thermal safety fault appears. | These faults are released automatically after the circuit breaker has been manually reset |
| FAU_PD_X | Fault on primary distribution pump (PD) no. X | <p>The thermal safety fault appears.</p> <p><i>Note: the hydraulic diagram must be from EDF or Parallel.</i></p> | These faults are released automatically after the circuit breaker has been manually reset |
| FAU_PDS_X | Fault on secondary distribution pump PDS no. X | <p>The thermal safety fault appears.</p> <p><i>Note: the pumps must be managed by the Cristo'Control2</i></p> | These faults are released automatically after the circuit breaker has been manually reset |
| FAU_PSTL_X | STL pump fault, PSTL no. X | <p>The thermal safety fault appears.</p> <p><i>Note: the hydraulic diagram must be "Variable flow".</i></p> | These faults are released automatically after the circuit breaker has been manually reset |

| | | | |
|-----------------|---|--|--|
| FAU_PP_ADV_X | Fault on the optional pump PP_ADV no. X on the variable flow diagram | The thermal safety fault appears. <i>Note: the hydraulic diagram must be "Variable flow" and the pumps must be present.</i> | These faults are released automatically after the circuit breaker has been manually reset |
| FAU_PP_SERX_GFX | Fault on the optional pump PP_SER no. X on chiller no. X on the upline or downline series diagram | The thermal safety fault appears. <i>Note: the hydraulic diagram must be "Variable flow" and the pumps must be present.</i> | These faults are released automatically after the circuit breaker has been manually reset |
| FAU_SG_GFX | General synthesis fault for chiller X , which causes the chiller to stop. | The general synthesis fault appears when 2 conditions have been confirmed: - Report of a "General synthesis fault on chiller X ", and - Chiller X does not resume operation. and - The chiller has been requested to run Time delay: MAN_TP_DEFGF | It is released automatically . |
| FAU_SCX_GFX | Synthesis fault on circuit X of chiller X (the chiller is not required to stop). | Report on the fault synthesis on circuit X sent by the chiller. | It is released automatically . Authorised disabling |
| FAU_GFX_Hpte | Chiller operating fault during a peak time period. | The chiller remains active during peak time periods when the planned strategy is time-of-day or time-of-day + peak shaving. The EXP_AD_GF_HPTE_NRJ parameter has not been confirmed by the user. Time delay: MAN_TP_DEFGF_HPTE | The fault is released automatically . |

| | | | |
|---------------------|--|--|--|
| <p>FAU_StockInc</p> | <p>Incomplete storage fault.</p> <p>The temperature condition that causes the STL storage to end has not been reached.</p> | <p>Air conditioning or active peak hours begin before the conditions to end storage have been met.</p> <p>The upper temperature in the tank must reach the setpoint MAN_Seuil_TempFinStock</p> | <p>This fault is released automatically when the next storage cycle finishes depending on the conditions for end of STL storage (complete storage).</p> <p><u>Authorised disabling</u></p> |
| <p>FAU_PosV3V</p> | <p>3-way valve position fault.</p> <p>The return to position does not match the command</p> <p>The circuit may be clogged and therefore impede control</p> | <p>If the valve's return to position differs by +/- [MAN_Seuil_DEFPosVanne] of the command.</p> <p>Time delay: MAN_TP_DEFPosVanne</p> <p><u>Note</u>: the diagram must be "parallel" or "EDF" and the 3-way valve must be present</p> | <p>This fault is released automatically when the valve position reaches the setpoint requested by the PLC.</p> <p><u>Authorised disabling</u></p> |
| <p>FAU_PosV2V_X</p> | <p>2-way <u>proportional</u> valve position fault.</p> <p>The return to position does not match the command</p> <p>The circuit may be clogged and therefore impede control</p> | <p>If the valve's return to position differs by +/- [MAN_Seuil_DEFPosVanne] of the command.</p> <p>Time delay: MAN_TP_DEFPosVanne</p> <p><u>Note</u>: the diagram must be "parallel" or "EDF" and two 2-way valves must be present</p> | <p>This fault is released automatically when the valve position reaches the setpoint requested by the PLC.</p> <p><u>Authorised disabling</u></p> |
| <p>FAU_ComGFX</p> | <p>Communication fault with chiller X</p> | <p>Communication with chiller X has been lost.</p> <p>Time delay: MAN_TP_DEFComm</p> | <p>It is released automatically as soon as communication is restored.</p> |

| | | | |
|------------|----------------------------------|---|--|
| FAU_ComGTC | Communication fault with the BMS | Communication with the BMS (communication port no.2 R422/485 on board SCU-31) has been lost. Time delay: MAN_TP_DEFComm | |
|------------|----------------------------------|---|--|

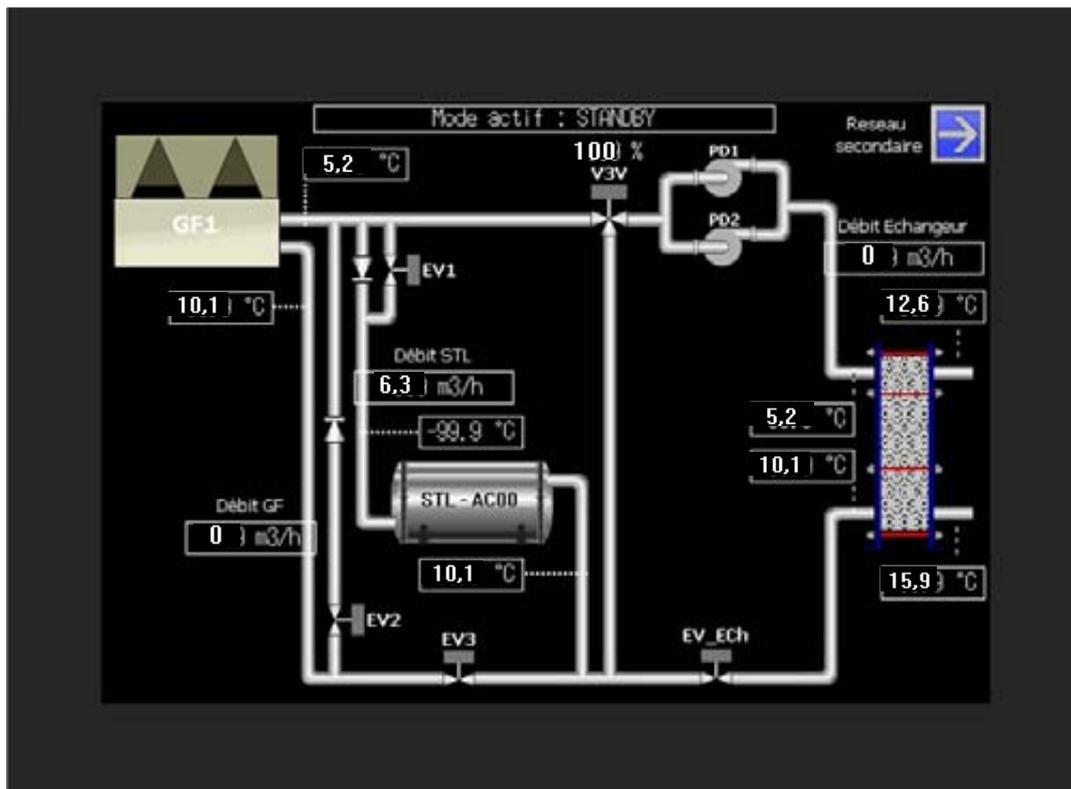
7.4 Configuration example

Here is a configuration example that allows an entire system to be configured via the Cristo'Control2 display.

The complete configuration feature is only used during initial setup, but some adjustments may be necessary for modifying and adapting the system's operation according to current need.

Data:

Hydraulic diagram: parallel
3 chillers



Objective:

1/ **Production** is controlled by entering a schedule or graphically.

2/ **The production schedule** is the same for every day in the week.

3/ **Setpoints**

- Exchanger outlet setpoint during production: 5°C,
- Chiller outlet setpoint during charging: -6°C.

4/ **Overrides**

- Chiller start-up authorisation during peak demand periods when needed,
- Authorisation for start-up in degraded mode in case of active alarms.

5/ **Strategy management** based on the calendar

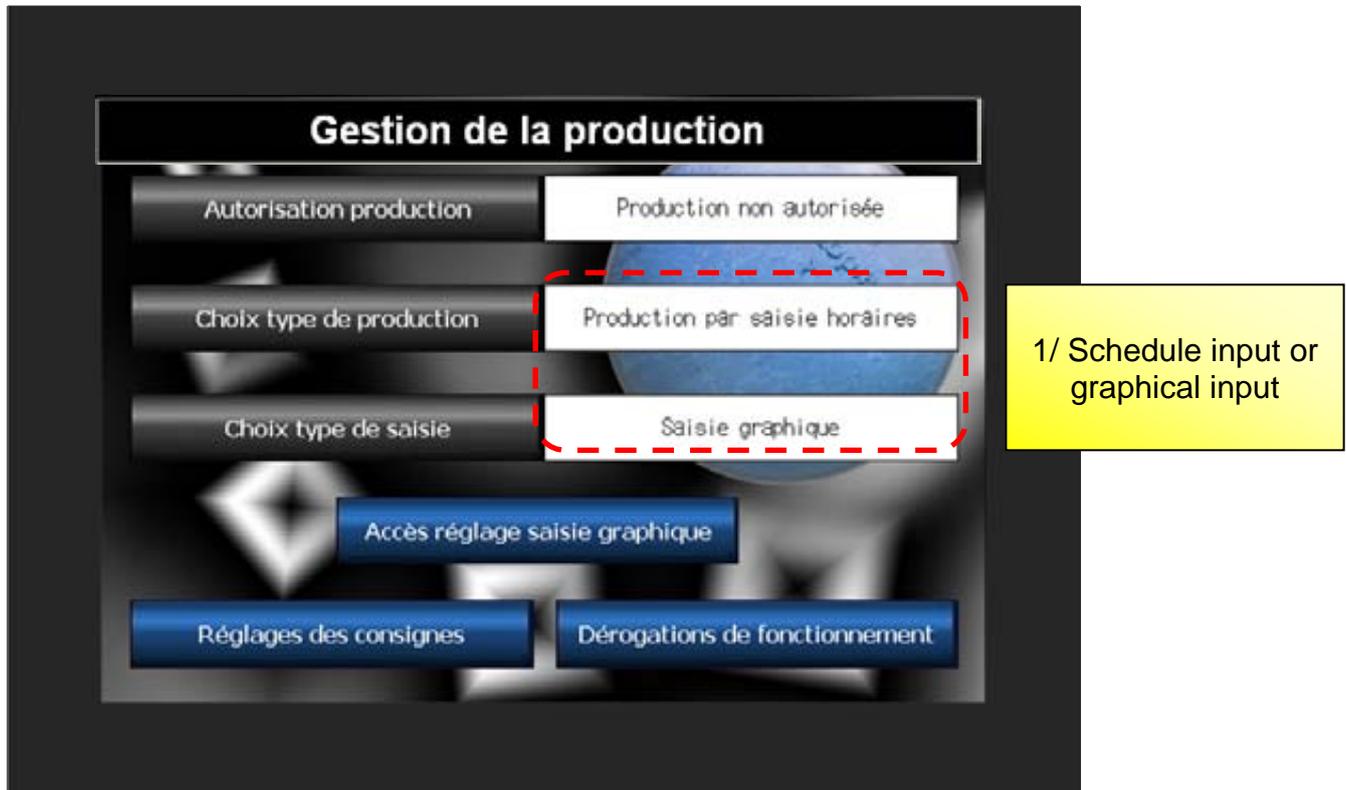
6/ **Strategies**

- Season 1 strategy: Peak shaving,
- Season 2 strategy: Peak shaving + time of day,
- Season 3 strategy: Full storage.

7/ Chiller **load shedding**

8/ **Activation of production**

Configuration via display screen:



Gestion de la production

| | |
|--------------------------|--------------------------------|
| Autorisation production | Production non autorisée |
| Choix type de production | Production par saisie horaires |
| Choix type de saisie | Saisie graphique |

Accès réglage saisie graphique

Réglages des consignes

Déroptions de fonctionnement

2/ Schedule adjustment

2/ Choice of standard day.

Schedule adjustment for each operating mode (standby, production, etc.).

Schedule adjustment for tariff bands.

Entry validation

Gestion de la production

| | |
|--------------------------------|--------------------------------|
| Autorisation production | Production non autorisée |
| Choix type de production | Production par saisie horaires |
| Choix type de saisie | Saisie graphique |
| Accès réglage saisie graphique | |
| Réglages des consignes | Dérogations de fonctionnement |

3/ Setpoint adjustment

Réglage des consignes

| | |
|--|--------|
| Consigne échangeur primaire | 5 °C |
| Consigne échangeur secondaire | 7 °C |
| Consigne distribution secondaire | 10 °C |
| Consigne froid n°1 GF primaires (production) | 4,5 °C |
| Consigne froid n°2 GF primaires (stockage) | - 6 °C |
| Consigne chaud GF primaires | 28 °C |
| Consigne froid GF secondaires | 7 °C |
| Consigne chaud GF secondaires | 28 °C |

3/ Positive and negative setpoint adjustment

Gestion de la production

| | |
|--|---|
| Autorisation production | Production non autorisée |
| Choix type de production | Production par saisie horaires |
| Choix type de saisie | Saisie graphique |
| Accès réglage saisie graphique | |
| Réglages des consignes | Dérogations de fonctionnement |

4/ Operation overrides

Dérogations de fonctionnement

| | |
|--|--------------|
| Fonctionnement GF en heure de pointe si NRJ insuffisante | Non autorisé |
| Démarrage du mode dégradé | Non autorisé |
| Démarrage de l'optimisation | Non autorisé |

4/ Authorisation for operation overrides

| Choix pilotage | Calendrier | Nbre de Groupes Froids autorisés | Nbre de Pompes de Distributions autorisées |
|----------------|-----------------------|----------------------------------|--|
| Saison 1 | Ecrêtage | 3 GF | 1 PD |
| Saison 2 | Ecrêtage + Effacement | 2 GF | 1 PD |
| Saison 3 | Stockage total | 0 GF | 1 PD |

5/ Strategy management based on the calendar

6/ Strategy adjustment

7/ Chiller load shedding

8/ Activation of production





Head Office

Avenue Jean Falconnier B.P. 14
01350 Culoz - France
Tel. : +33 (0)4 79 42 42 42
Fax : +33 (0)4 79 42 42 10
info@ciat.fr - www.ciat.com

Compagnie Industrielle
d'**A**pplications **T**hermiques
S.A. au capital de 26 728 480 €
R.C.S. Bourg-en-Bresse B 545.620.114



ISO9001 + ISO14001
OHSAS 18001

Non contractual document. With the thought of material improvement always in mind, CIAT reserves the right, without notice, to proceed with any technical modification.