# DEMOSOFC

Project n° 671470

## *"DEMOnstration of large SOFC system fed with biogas from WWTP"*

**Deliverable number 3.4**

***D3.4 Installation of the control system (hardware + software) of the complete DEMO (both electrical and thermal section)***

**Task leader: SMAT - Participants: POLITO, CONVION - Start: M9 - End: M12**

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|---|---|
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**Abstract:**

This is a draft document showing results of the control system definition at the DEMOSOFC site. The report includes information on the hardware PLC layout, the software and the logics behind the software itself.

**Keyword list:** biogas, SOFC, WWTP, control system, PLC

# Summary

# 1. PLC system layout

## 1.1 Control system architecture

The layout of the DEMOSOFC control system is shown below. As can be seen, three CPU (with analogic and digital I/O blocks) are located in three different areas of the plant:

- The main CPU is located in the DEMOSOFC technical building (Sala_controllo) close to the SOFC modules and the biogas cleaning unit. Here the DEMOSOFC control room is also located.
- The second CPU (Sala Pompe) is located in the sludge pumps room, where the heat recover section (sludge-water) is located. The air compression system and the biogas blower and chiller are also connected to this CPU.
- The third CPU (Cabina Elettrica) is located in the main electrical cabinet, where the electrical cable from the DEMOSOFC site is connected to the other WWTP electrical lines and the grid.

Figure 1 shows the layout of the CPU connections. Among the main CPU and the other two there are switches to guarantee the reliability of the connections.

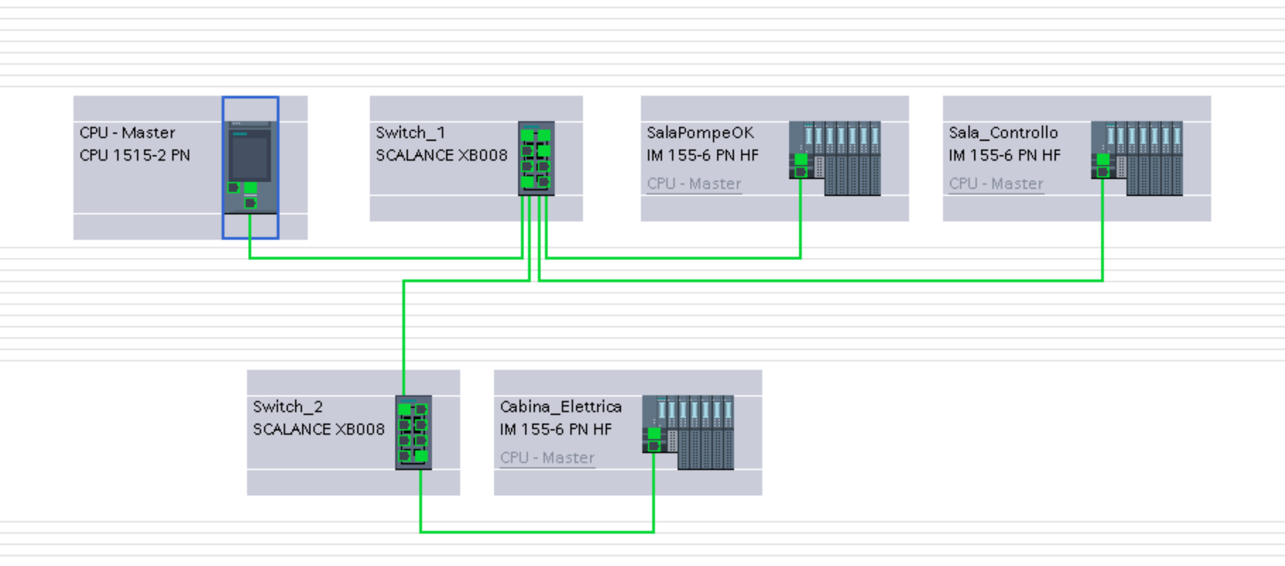



*Figure 1. PLC control system architecture.*

## 1.2 Control system layout

The pictures below are intended to show to the reader the different components of the DEMOSOFC control system. A detailed explanation of the software is indeed presented in the next chapter.

Figure 2 shows the DEMOSOFC control room. Here two operator panels are available. The first one is from Convion and used by the SOFC module supplier to remotely control the system. The layout of the screen for the on-site operators is a simple layout of the SOFC module internal process (see Figure 3). The second one is the DEMOSOFC control system, explained in the next chapter, where the site operators are monitoring and operating the entire DEMOSOFC plant.


*Figure 2. Control room. Convion operator panel and DEMOSOFC main operator panel.*

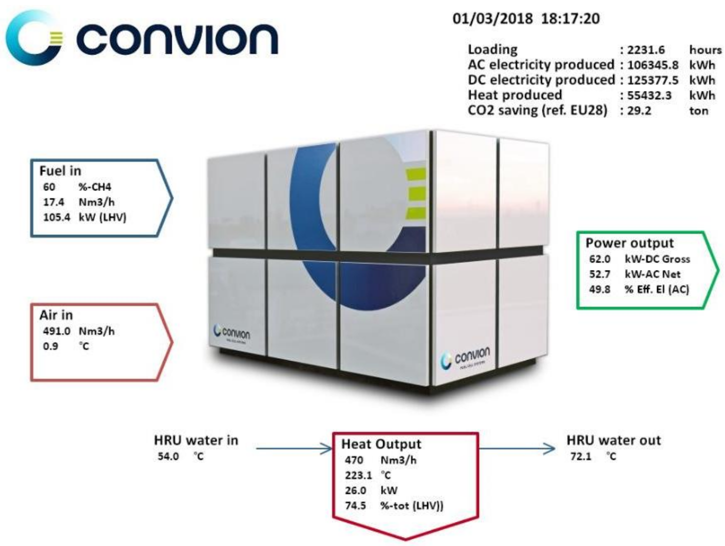



*Figure 3. Convion operator panel layout.*

Figure 4 shows the main PLC cabinet, located in the electrical cabinet room close to the control room. Here are collected cabling signals from the onsite instrumentations (pumps, thermocouples, pressure sensors, etc) and Ethernet signals from Biokomp cleaning and compression unit and the SOFC module.

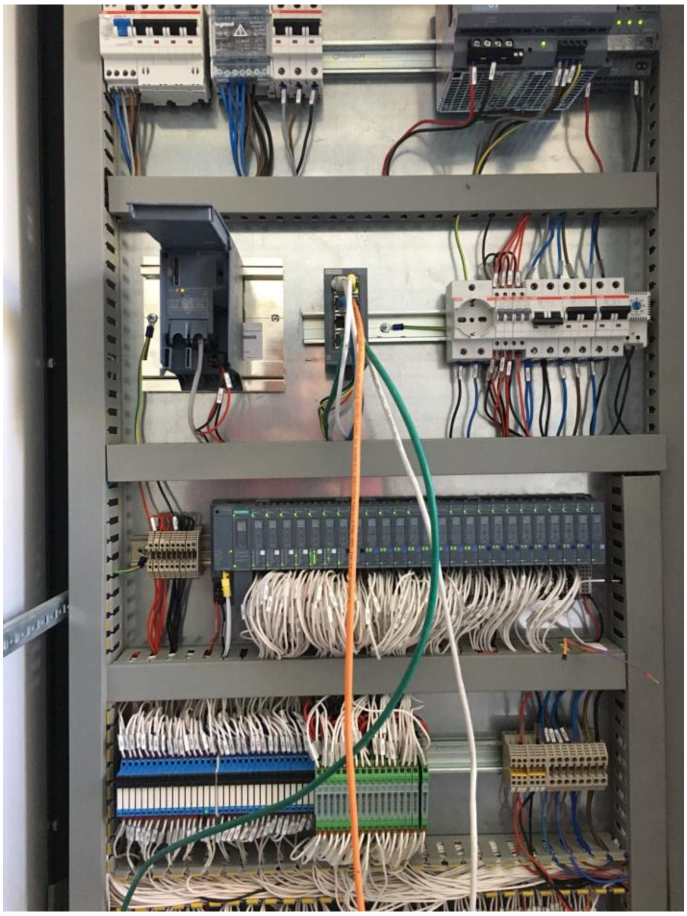


*Figure 4. Main PLC automation cabinet in the control room.*

The figures below show some details of the internal layout of the main PLC cabinet. Figure 5 provides a detailed view of input/output signals (both analogic and digital) from the field. The signals list, divided by PLC, is provided in the following chapters.

Figure 6 shows the PLC in the sludge pump room. From some selected sensors or meters, galvanic isolators are required to filter the measurements and avoid interferences (see Figure 7).

The entire PLC cabinet of the sludge pump room is also shown in Figure 8.

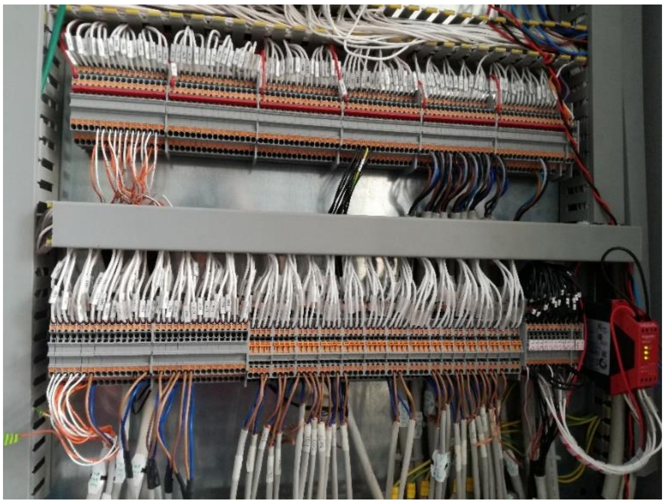


*Figure 5. Input/output anagogic and digital signal in main PLC cabinet.*


*Figure 6. PLC in the sludge pumps room PLC cabinet*

*Figure 7. Galvanic isolators for analogic signals.*

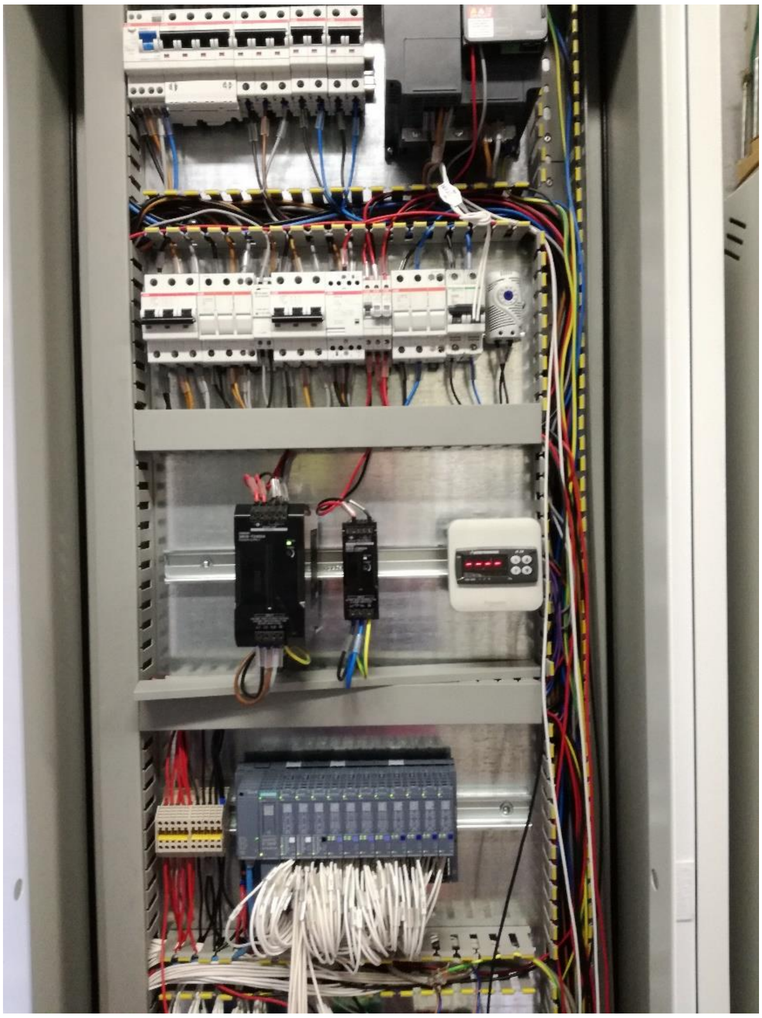


*Figure 8. PLC cabinet in the sludge control room.*

# 2. Software

The second chapter is related to the description of the software layout and control logics.

## 2.1 Home and main page

Figure 9 shows the screensaver page, where the visitors can see the power production from the cell, the total energy produced, avoided CO2 emissions and efficiencies (electrical efficiency of the SOFC module and electrical efficiency of the DEMOSOFC plant. Currently results available are referred to the first SOFC module installed, even if the plant and the software are already designed for the complete installation.

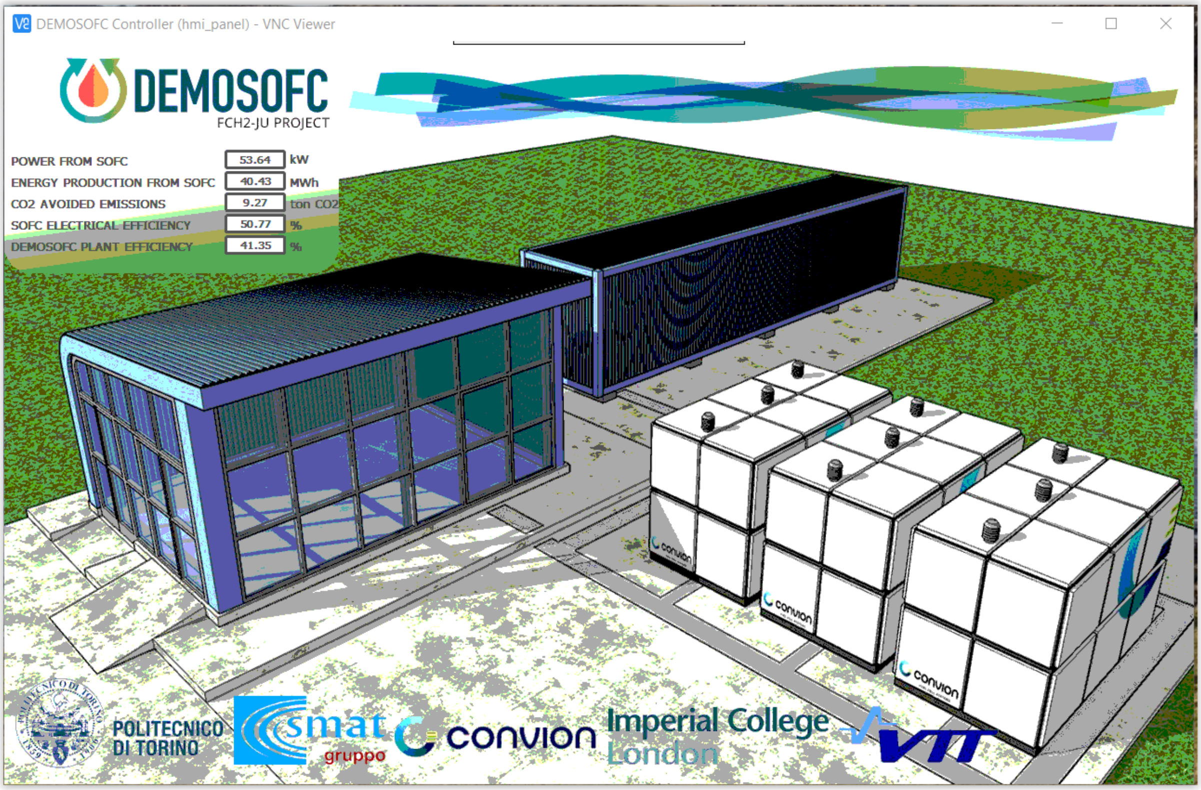



*Figure 9. Screensaver.*

Figure 10 shows the DEMOSOFC plant homepage. Here results are available on the gas holder level, cleaning unit inlet and outlet composition (even if these are non-filtered data, actual results from Qualvista are available from the online tool, see next chapter), biogas flow and pressure, SOFC modules electrical and thermal production (with details on thermal production both the SOFC module side and at the sludge side).

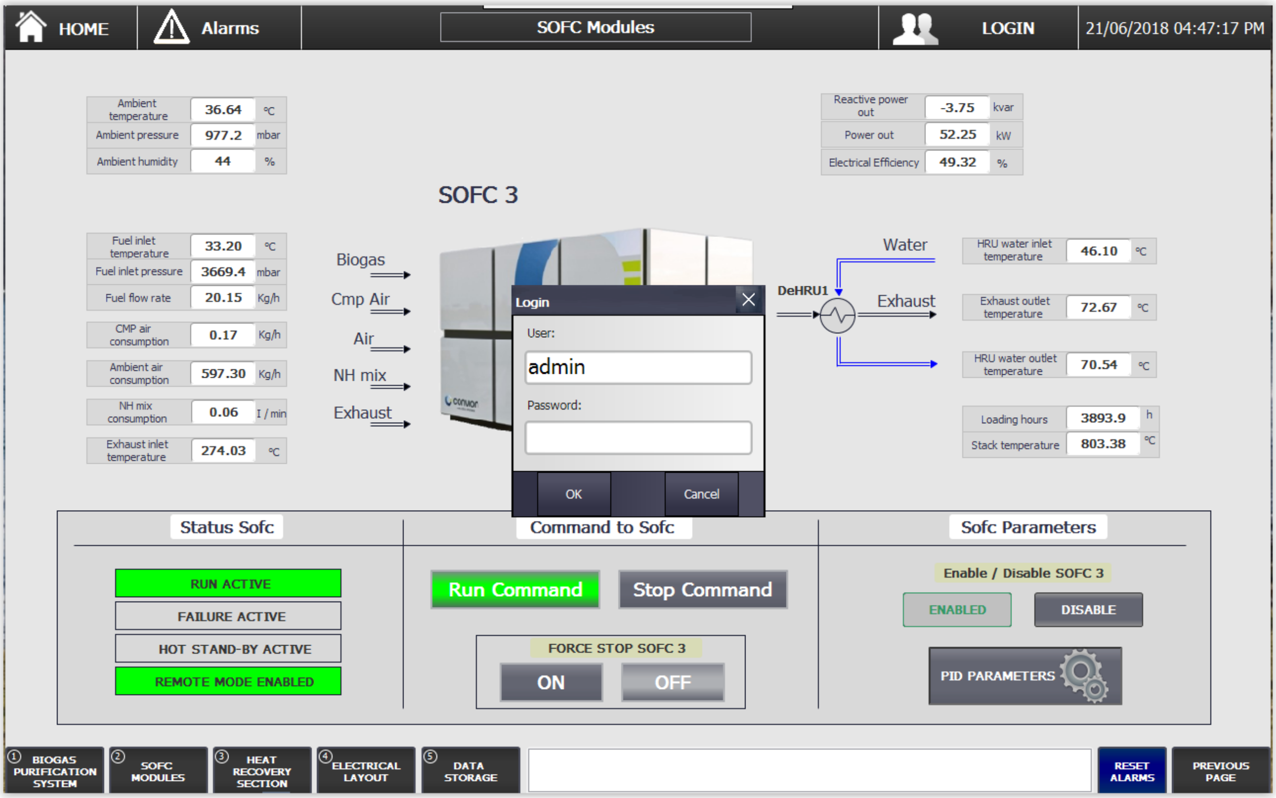



*Figure 10. Homepage.*

## 2.2 Biogas processing system

The first sections of the plant control system are the ones referred to the biogas purification system, which include three pages. The first one (Figure 11) is related to the biogas line from the gas holder with details on the gas holder level, automatic safety valve status, biogas flow, temperature and pressure. The status of manual valves are also available (red = closed, green =opened).

The second page (Figure 12) is related to the lines going to the 3 SOFC modules. The biogas line also includes the container for the biogas purification and compression (and this can be analysed by a dedicated page). Other information are compressed air pressure, N2 (purge gas for maintenance on the biogas line) and NH-mix (95% N2, 5% H2, purge gas for the SOFC modules during hot standby) flow rates and valves status. The third section (Figure 13) is the detailed view on the biogas cleaning and compression unit. The results of the Qualvista online analyser in three different point (S1 - raw gas -, S2 – clean gas in the middle of the purification system - and S3 – clean gas after the purification system). O n the right, information on the compressor are shown (current, inlet and outlet pressure, power consumption, etc) and from this page the compressor can be started and stopped (when set to operator-controlled mode).

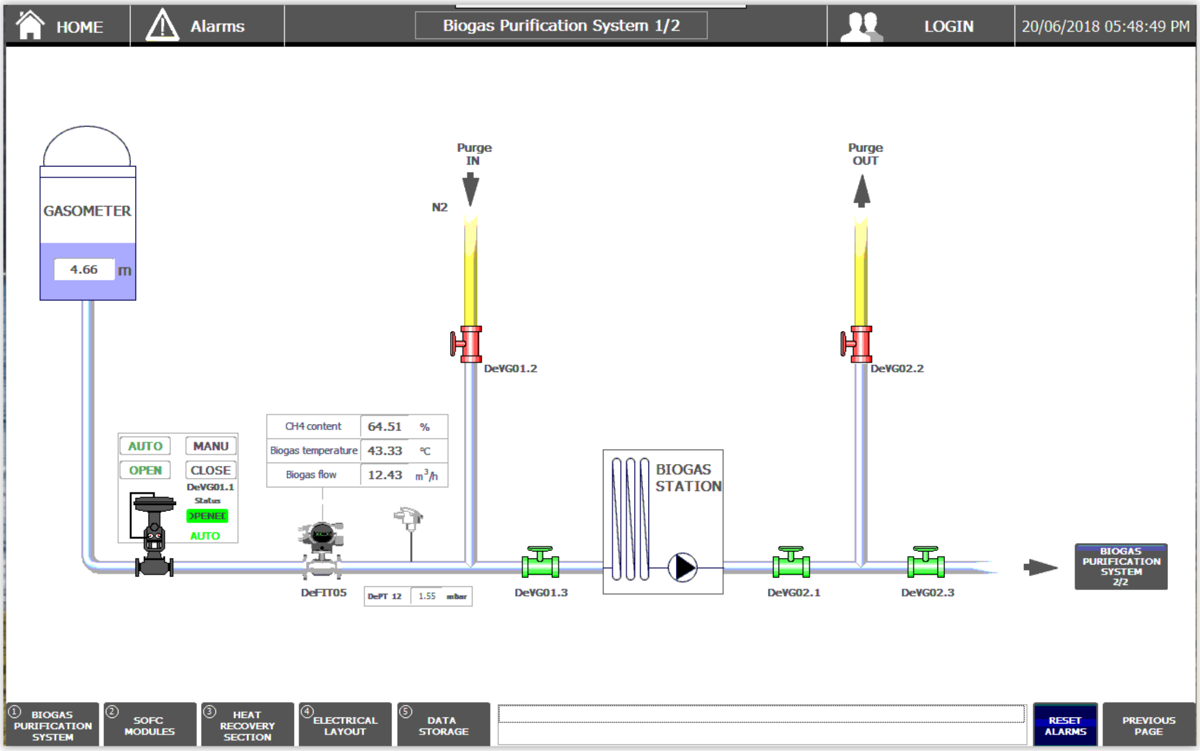



*Figure 11. Biogas purification system - 1.*

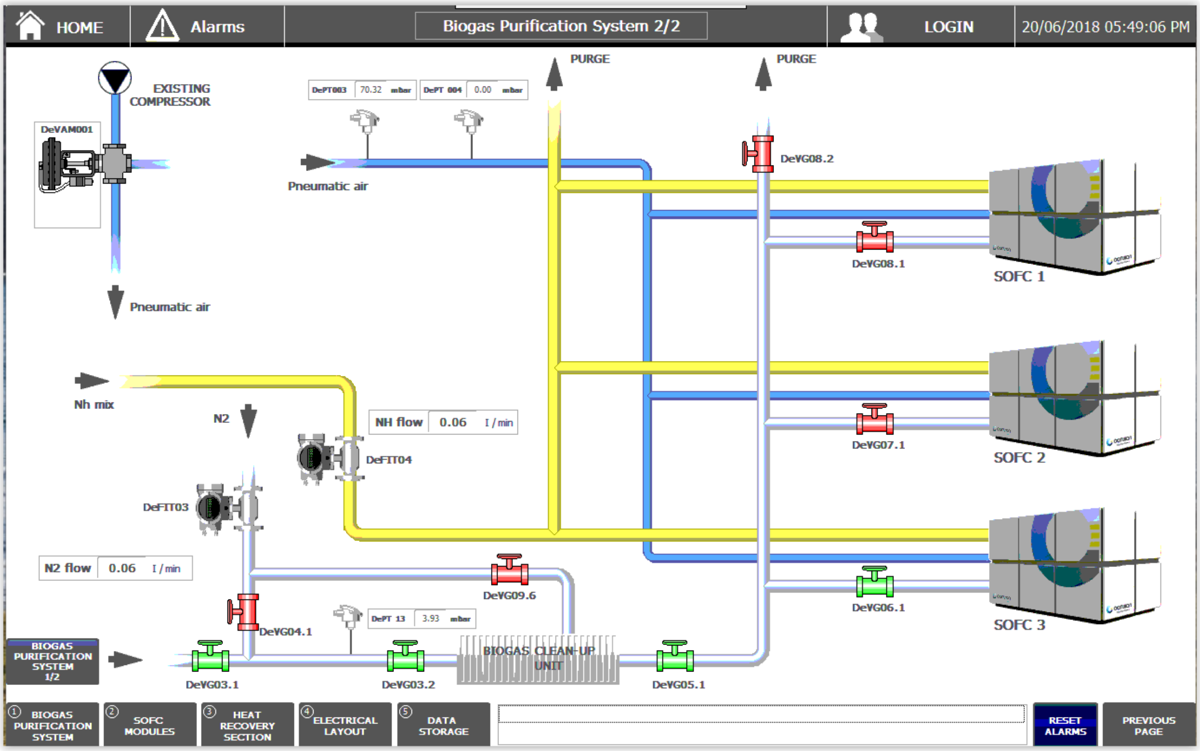



*Figure 12. Biogas purification system – 2.*

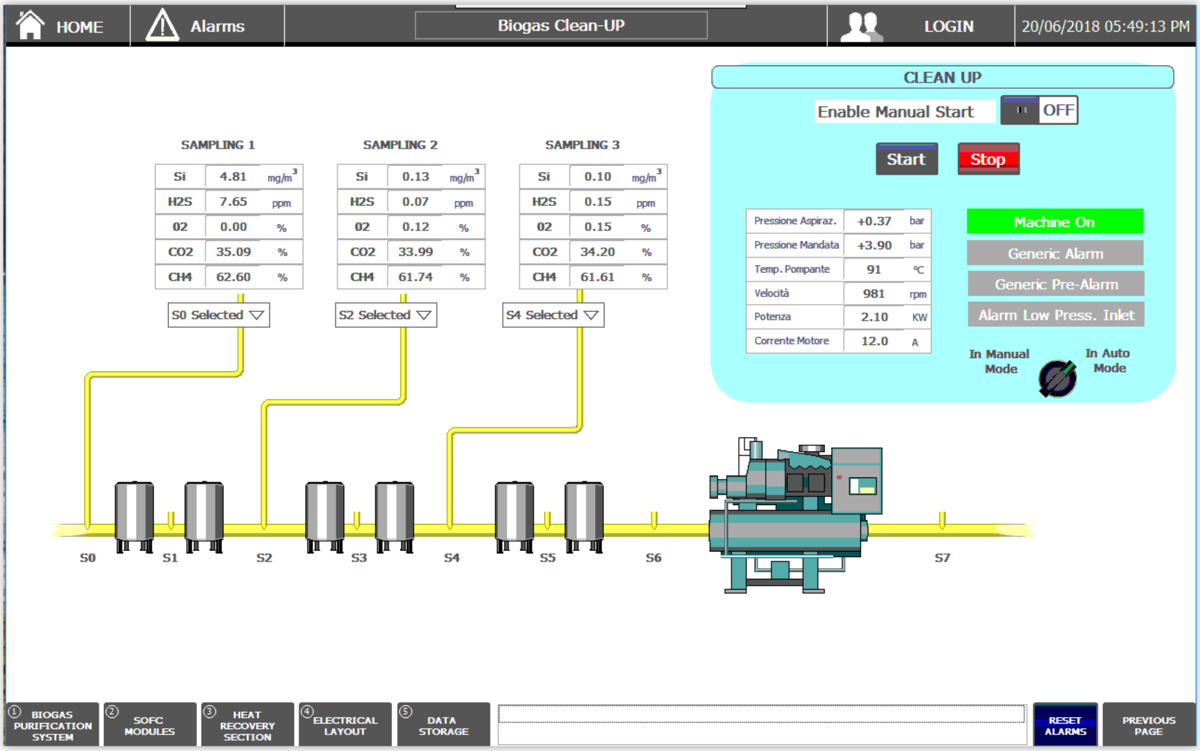



*Figure 13. Clean-up unit.*

## 2.3 SOFC modules

The second part of the system is related to the SOFC modules. A first page is related to the status of the three modules (Figure 14): modules in operation have the green 'run active' mode, while module under stop, maintenance or emergencies have the other status in red. Modules can be enabled and disabled by the user. All the automatic procedures like the start-up sequence are referred to the enabled modules. In the current scenario (June 2018) with only one module installed (located in the position of module #3 from the project drawings) the only enabled module is SOFC 3, which is also running.

By clicking on each module, a detailed view on the SOFC inlet and outlet streams can be seen (Figure 15). Here inlet gas, compressed air and purge gas flows are listed, together with electrical power (and efficiency), thermal recovery (exhaust gas and water temperatures) and external ambient conditions.

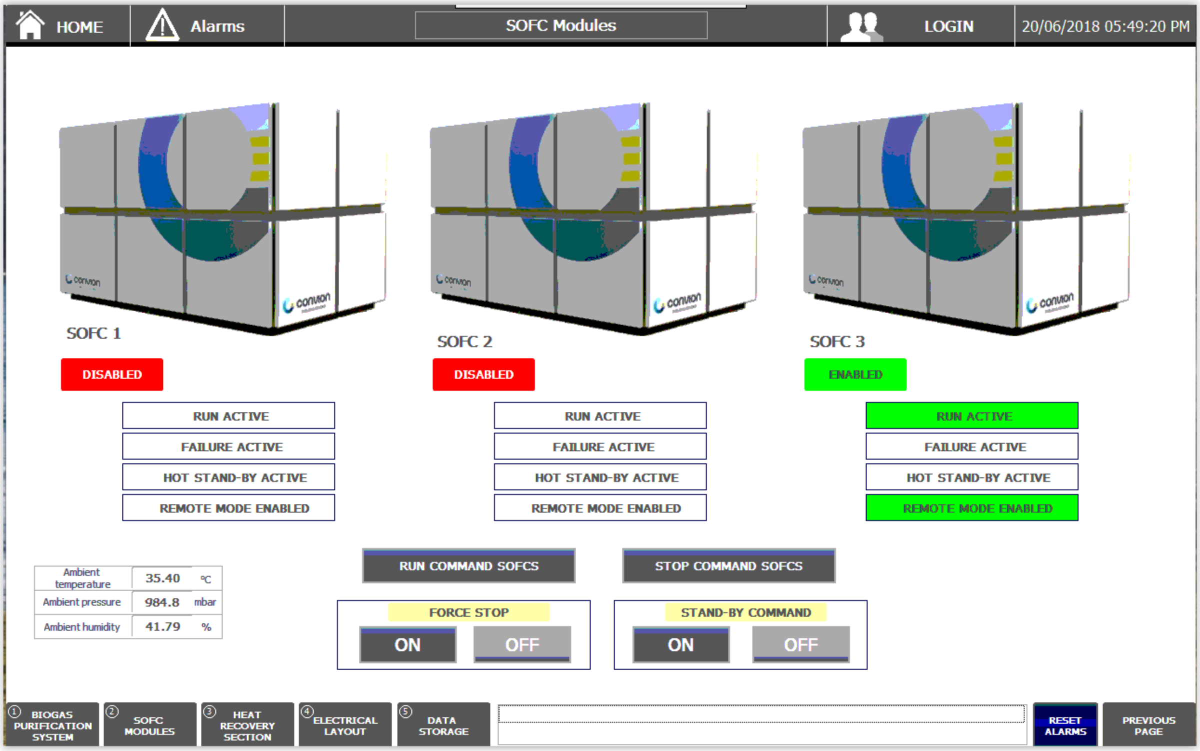



*Figure 14. 3 SOFC modules view.*

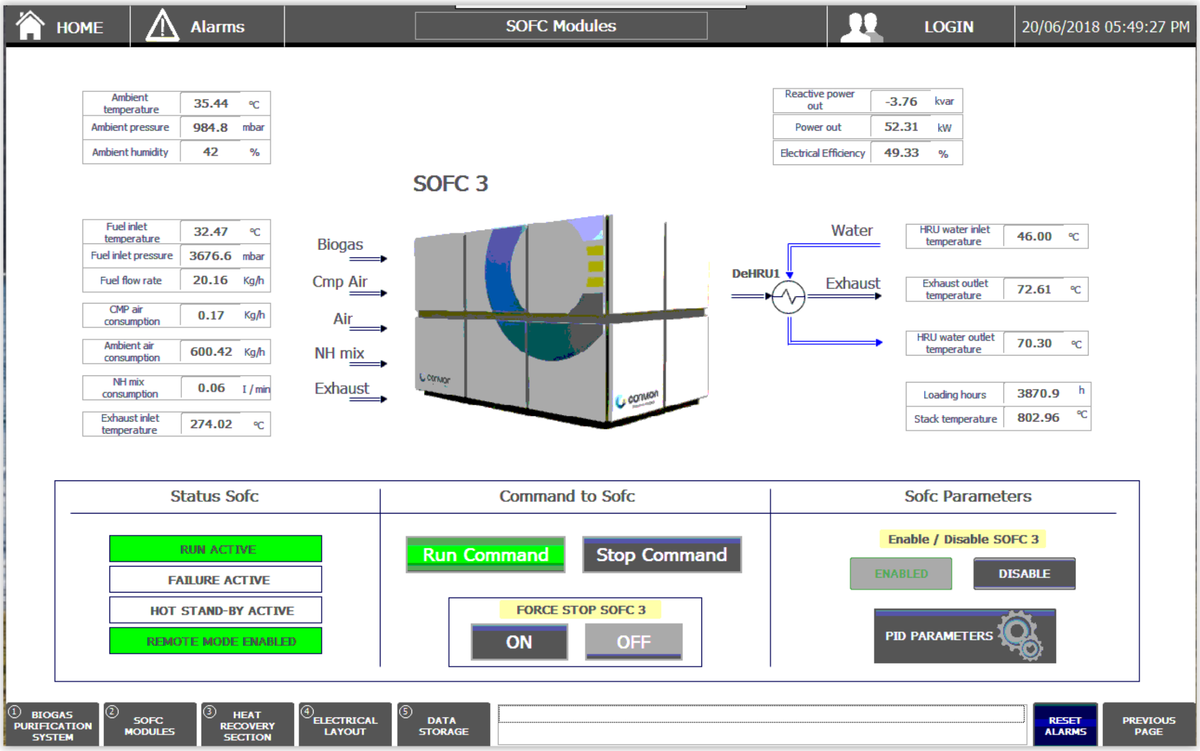



*Figure 15. SOFC unit view (one page for each unit).*

## 2.4 Heat Recovery System

The third part of the control system is the heat recovery section. The first section (Figure 16) of this section is related to the water-glycol loops (three, one for each module) which extracts the heat from the SOFC modules. The three loops are then collected together and sent to a hydraulic separator before reaching the second section, where heat is transferred to sludge. Here pumps speed (%), three-way valves opening ratios (%), water flow rates (m3h) and temperatures (°C) can be seen for the different points of the system.

The second section (Figure 17) is indeed related to the water-sludge heat exchange. The water-glycol loop is transferring the heat to the sludge or to industrial water. Water pump speed (%), valves opening rate (%), sludge pump speed (%), flow rates (m3/h) and temperatures (°C) are shown here for both water and sludge streams.

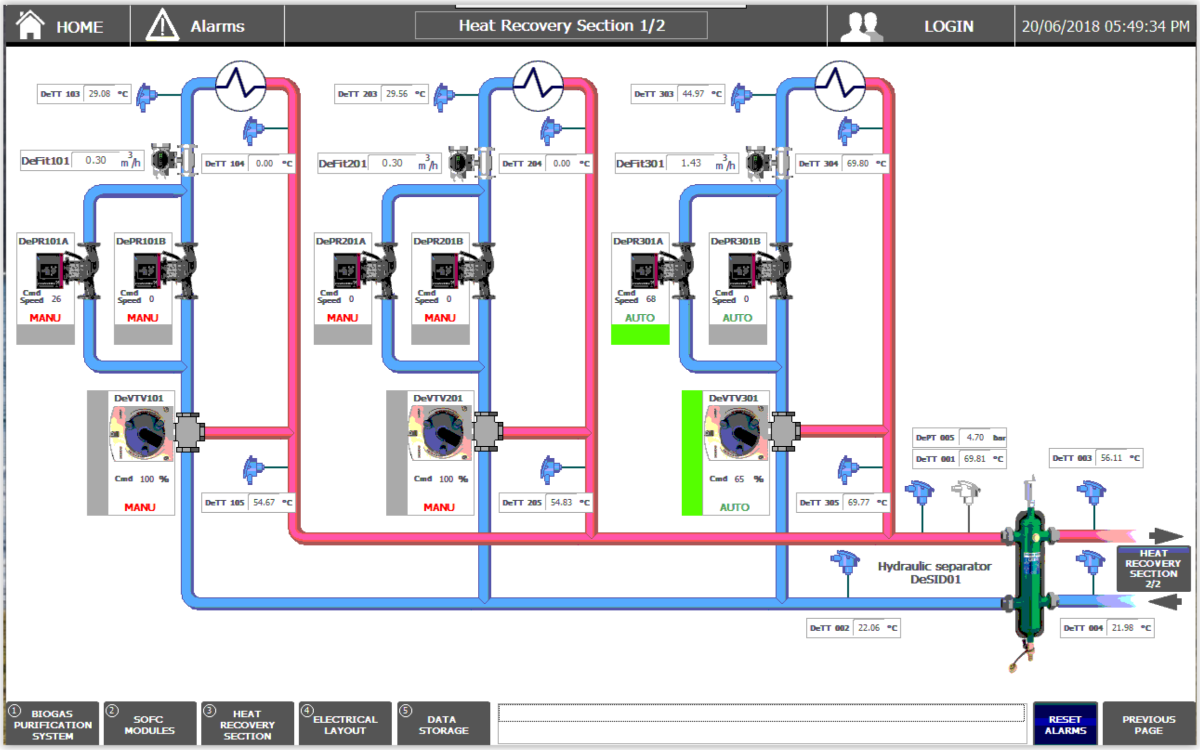



*Figure 16. HRU part 1.*

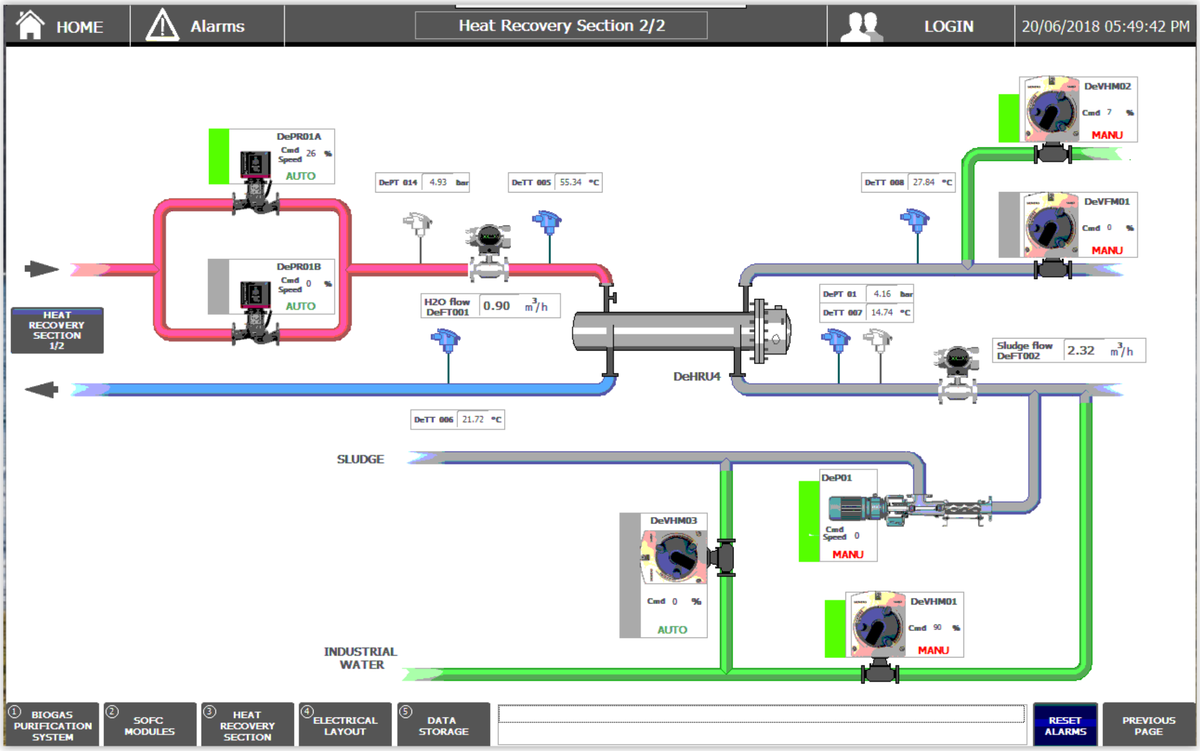



*Figure 17. HRU part 2.*

## 2.5 Alarms

Two levels of deviations are available on the control system:

- Warnings: this deviation from the nominal set point usually brings to a warning yellow message in the alarm page (Figure 18). Actions are automatically taken only in case of switch from twin pumps or similar.
- Alarms: the alarm is related to a critical deviations from the nominal operation. The alarm generates actions aimed to bring the system in a safe state. Table 1 shows the alarm list related to the DEMOSOFC plant. The list does not include alarms generated by the SOFC modules (emergency shutdown) or the cleaning unit (alarms on compressor) because these alarms automatically generates a stop of the plant. Depending on the severity of the alarm the action can be to trigger a fast emergency shutdown on the modules (closing biogas line with the safety valve) or a slower nominal shutdown with biogas in case of less critical deviations.

All the warning and the alarms are generating an email to selected addresses of SMAT and POLITO personnel. Furthermore, Convion has its own internal control system which inform Convion personnel in case of deviations at the module borders. The plant is anyway going into a safety state every time an alarm is triggered, thus leading to a safe operation from the point of view of the end user (SMAT). Alarms which could be dangerous for the site itself generated a phone call to SMAT personnel which has inserted DEMOSOFC inside their ordinary availability outside working hours (during nights, weekends and holidays).

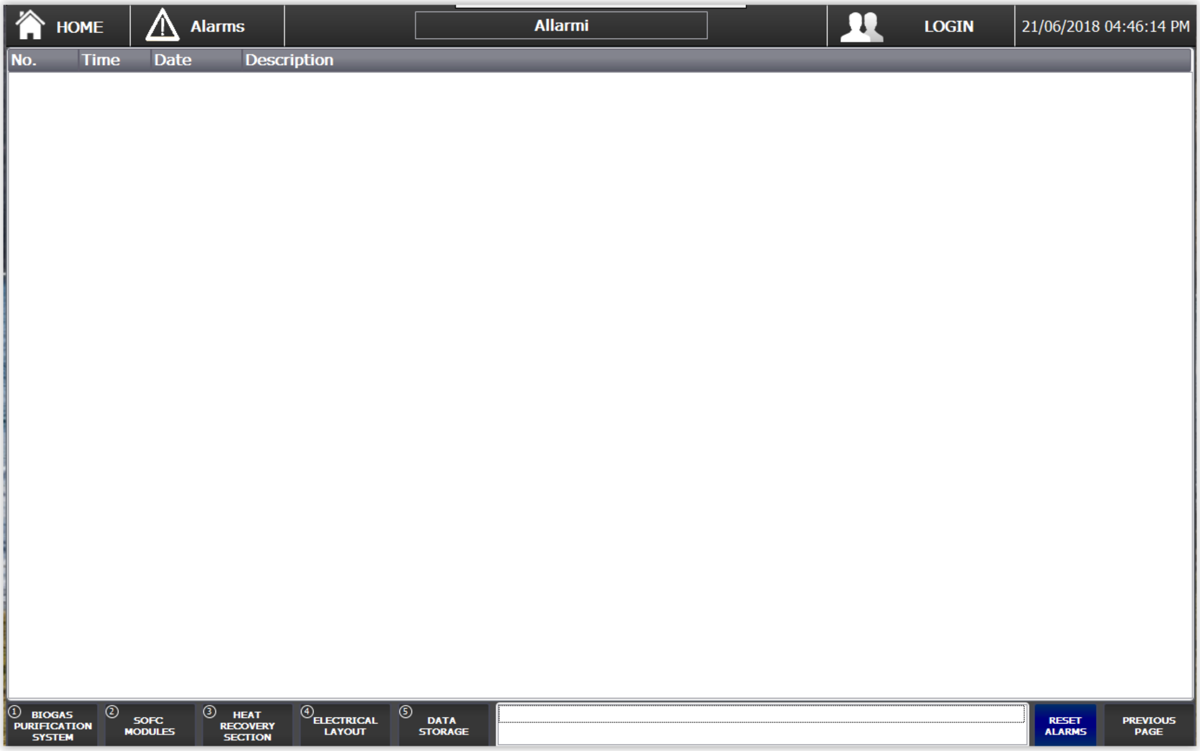



*Figure 18. Alarm page.*

*Table 1. Alarm list.*

| Variable | Warning level | Warning action | Alarm level | Action |
|---|---|---|---|---|
| **Gasometer level** | <= 2 m | Warning message | <= 1,7 m | Warning message + Remove RUN COMMAND to SOFC |
| **DeVG1.3, DeVG1.2, DeVG2.1, DeVG2.3 (in line** | If online valve is closed or status info is lost | Warning message | | |

| | | | | |
|---|---|---|---|---|
| **valves)** | | | | |
| **DeVG2.2 (purge valve)** | If online valve is closed or status info is lost | Warning message | Delay (20 min). If online valve is closed or status info is lost | ALARM |
| **QF24** | If power is OFF | Warning message | | |
| **QF26** | If power is OFF | Warning message | | |
| **DeVG3.1, DeVG4.1, DeVG3.1 (in line valves)** | If online valve is closed (or status info is lost) | Warning message | | |
| **DeVG8.2 (purge valve)** | If online valve is closed or status info is lost | Warning message | Delay (20 min). If online valve is closed or status info is lost | ALARM |
| **DePT04** | < 4 bar | Warning message | | |
| | > 6 bar | Warning message | | |
| **DeVG6.1, DeVG7.1 and DeVG8.1** | If online valve is closed (or status info is lost) with SOFC 1,2 or 3 running | Warning message | | |
| **Compressor ethernet commuication** | If is not active | Warning message | | |
| **Compressor machine working status** | If compressor status goes to OFF | Warning message | | |
| ***With SOFC 3 active*** | | | | |
| **DeTT303, DeTT304, DeTT305** | > 85 °C | Warning message | > 99 °C | Remove RUN COMMAND to SOFC |
| **QF18 + QF19** | | | If power turns OFF on QF18+QF19 | Remove RUN COMMAND to SOFC |
| **QF18** | If power turns to OFF while DePR301A is not running | Warning message | | |
| | If power turns to OFF while DePR301A is ON | Warning message and run DePR301 | | |

| | | | | |
|---|---|---|---|---|
| | | B | | |
| **QF19** | If power turns to OFF while DePR301B is not running | Warning message | | |
| | If power turns to OFF while DePR301B is ON | Warning message and run DePR301 A | | |
| ***With SOFC 2 active*** | | | | |
| **DeTT203, DeTT204, DeTT205** | > 85 °C | Warning message | > 99 °C | Remove RUN COMMAND to SOFC |
| | < 3 °C | Warning message | | |
| **QF16+QF17** | | | If power turns OFF on QF16+QF17 | Remove RUN COMMAND to SOFC |
| **QF16** | If power turns to OFF while DePR201A is not running | Warning message | | |
| | If power turns to OFF while DePR201A is ON | Warning message and run DePR201B | | |
| **QF17** | If power turns to OFF while DePR201B is not running | Warning message | | |
| | If power turns to OFF while DePR201B is ON | Warning message and run DePR201A | | |
| ***With SOFC 1 active*** | | | | |
| **DeTT103, DeTT104, DeTT105** | > 85 °C | Warning message | > 99 °C | Remove RUN COMMAND to SOFC |
| | < 3 °C | Warning message | | |
| **QF14+QF15** | | | If power turns OFF on QF14+QF15 | Remove RUN COMMAND to SOFC |
| **QF14** | If power turns to OFF while DePR101A is not | Warning message | | |

| | | | | |
|---|---|---|---|---|
| | running | | | |
| | If power turns to OFF while DePR101A is ON | Warning message and run DePR101B | | |
| **QF15** | If power turns to OFF while DePR101B is not running | Warning message | | |
| | If power turns to OFF while DePR101B is ON | Warning message and run DePR101A | | |
| | | | | |
| **DeTT001, DeTT002, DeTT003, DeTT004** | > 85 °C | Warning message | > 99 °C | Remove RUN COMMAND to SOFC |
| | < 3 °C | Warning message | | |
| **DePT005** | < 3 bar | Warning message | | |
| | > 6 bar | Warning message | | |
| **DeTT005, DeTT006, DeTT007, DeTT008** | > 85 °C | Warning message | > 99 °C | Remove RUN COMMAND to SOFC |
| | < 3 °C | Warning message | | |
| **QF20+QF21** | | | If power turns OFF on QF20+QF21 | Remove RUN COMMAND to SOFC |
| **QF20** | If power turns to OFF while DePR01A is not running | Warning message | | |
| | If power turns to OFF while DePR01A is ON | WARNING and run DePR01B | | |
| **QF21** | If power turns to OFF while DePR01B is not running | Warning message | | |
| | If power turns to OFF while DePR01B is ON | WARNING and run DePR01A | | |
| **DePT014** | < 3 bar | Warning | | |

| | | | | |
|---|---|---|---|---|
| | | message | | |
| | > 6 bar | Warning message | | |
| **DePT001** | < 0,5 bar | Warning message | | |
| | > 6 bar | Warning message | | |
| **Sludge flow** | Zero | Switch to industrial water | | |
| **QF23** | If power is OFF | Switch to industrial water | | |
| **DeTT008** | < 30 °C | Warning message | | |
| | < 28 °C | Switch to industrial water | | |
| **QF34, QF35** | If power is OFF | Warning message | | |
| **QF29** | If power is OFF | Warning message | | |
| **QF36** | If power is OFF | DeVAM01 switch to grid mode | | |
| **DePR01A/B + H2O flow** | If there is a command on DePR01A/B and H2O flow is zero | Warning message | | |
| **DeFIT001** | If < 0,1 m3/h for 5 sec | Warning message | | |
| **DeFIT002** | If < 0,1 m3/h for 5 sec | Warning message | | |

## 2.6 Electrical layout

The last part of the control system is related to the electrical connections. The electrical layout is divided into two pages to show all the devices included in the plant. The first page (Figure 19) shows the connection between the SOFC modules and the grid. Red parts and lines shows the presence of the voltage. Rectangular blocks on the lines are voltage detection meters installed in the electrical lines. Power meters are also available, one related to the entire WWTP section where the DEMOSOFC plant is also located (on the left), the second related to the SOFC modules production (in the middle) and then three power meters (Q1.2, Q1.3 and Q2.1) related to the power supply to auxiliaries. In particular: Q2.1 is the nominal connection of auxiliaries to the grid, Q1.3 is the power supply from the SOFC modules to the auxiliaries (required when the system goes into island mode) and Q1.2 is a spare extra connectors where the end-user could connect other loads to be secured in case of a grid failure (during island mode). The second page (Figure 20) is related to the status of the SOCOMEC switch (which turns its status in case of island mode) and the status of single auxiliaries power supply. All the QFxx symbols are the power switch to auxiliaries (e.g. compressor, pumps, three-way valves, conditioning, etc.) and are coloured in red when the switch is powered ON.

By clicking on the single power meters icons in the electrical layout, the user can access the values for each single power meter. Furthermore, a summary of all the power meters readings across the plant is also available (Figure 21).

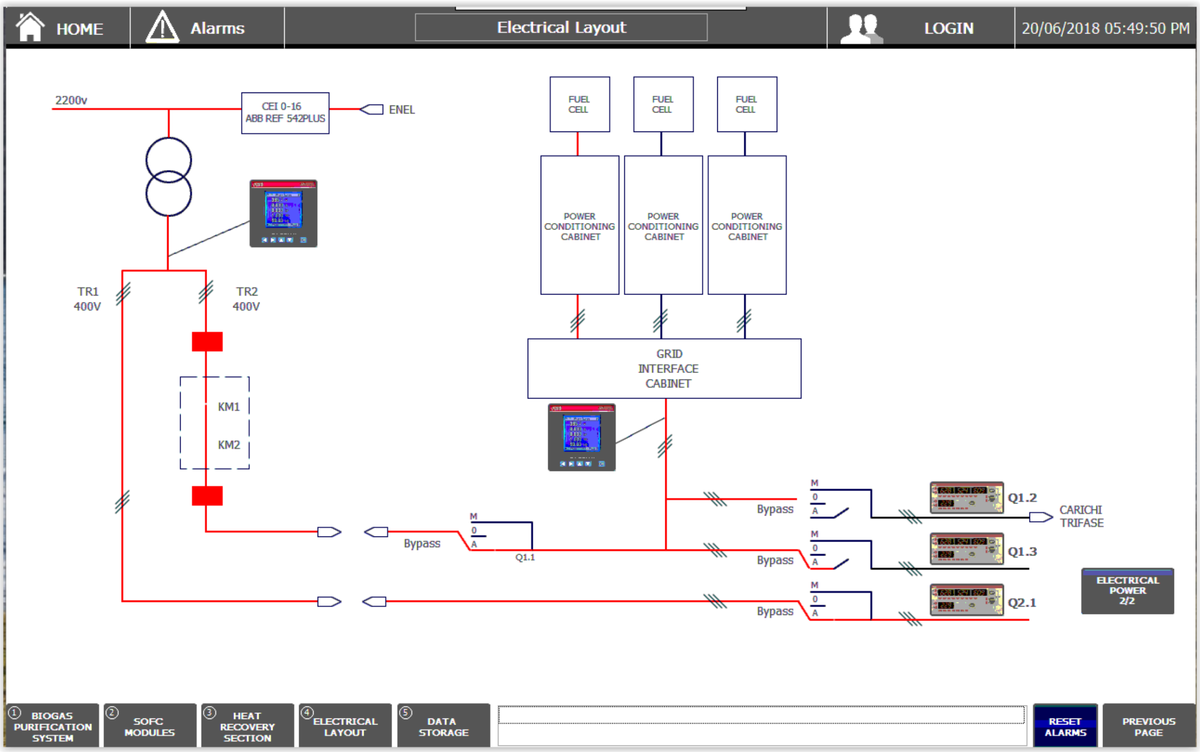



*Figure 19. Electrical layout 1.*

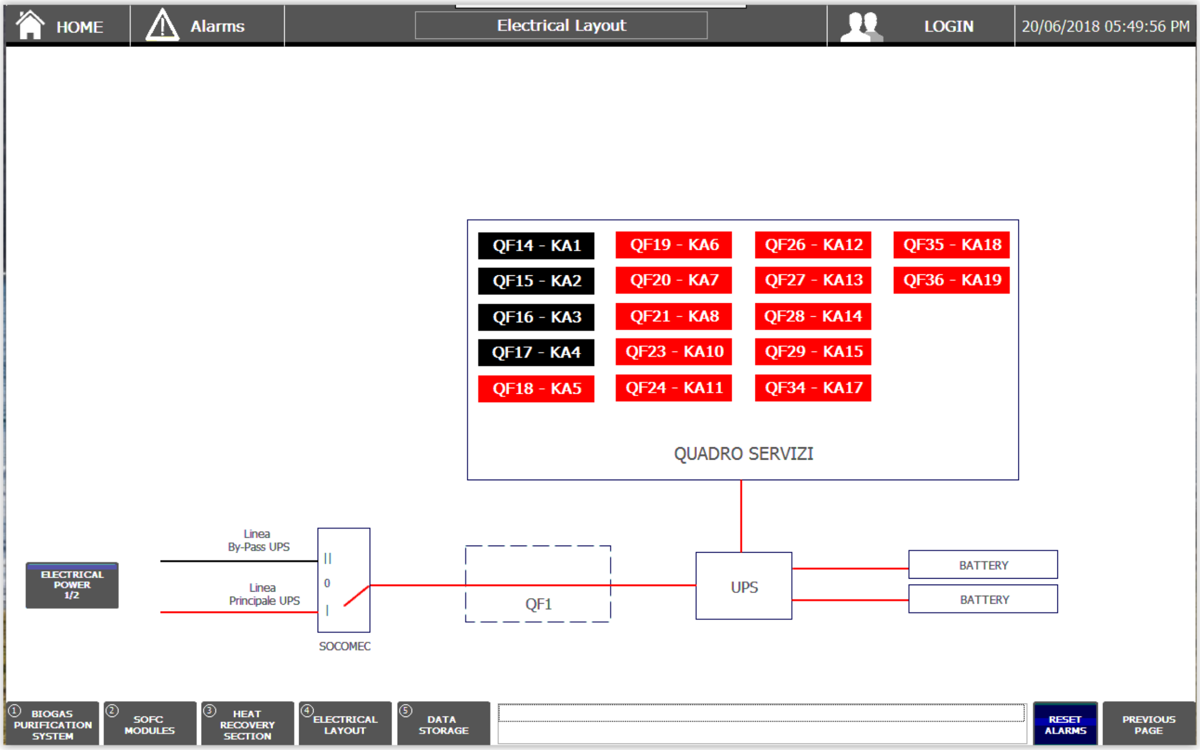



*Figure 20. Electrical layout 2.*

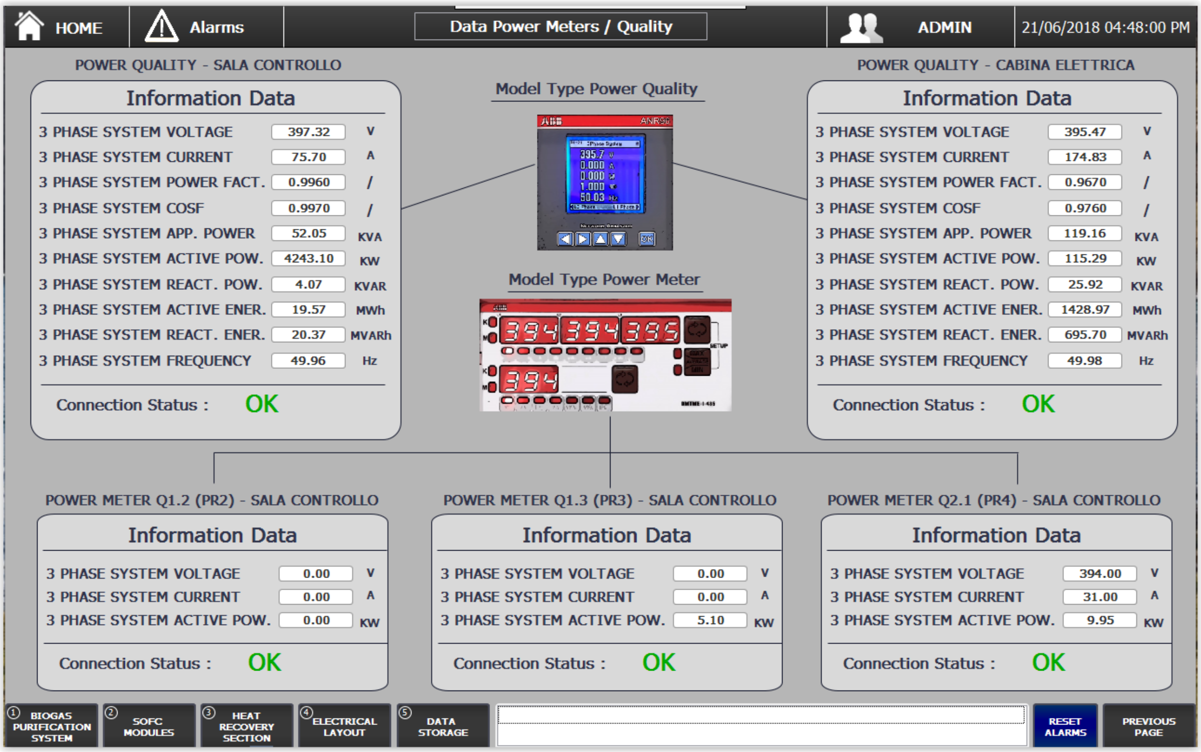



*Figure 21. Power meters summary page.*

## 2.7 Automatic procedures and PID logics

**<u>SOFC modules</u>**

The control system is also developed to include automatic control logics for specific components.

For what concerns the SOFC system, the unit set point (0-100% of nominal power) is given through a dedicated page (Figure 22) where manual or automatic mode are available. Manual mode, currently active because one single module is operating and there is not risk of biogas shortages, let the user fix a set point (%), currently 90% (52-53 kWe). The second option is the automatic PID controller, where the set point is regulated to keep a constant gas holder level (0-100% of maximum level). The SOFC operating set-point is then calculated through a dedicated PID controlled based on the requested gas holder level. This is used to avoid shutdown in case of biogas production decrease, because the set point is slowly reduced in the Convion agreed variation range.

The 'set point' table is where the user can set its objective (one for manual mode, the second for automatic mode); the 'status' table is the results of the controller, while the 'PID parameters' table is here to let the user change the type of PID controller to have a defined response type according to the phenomenon.

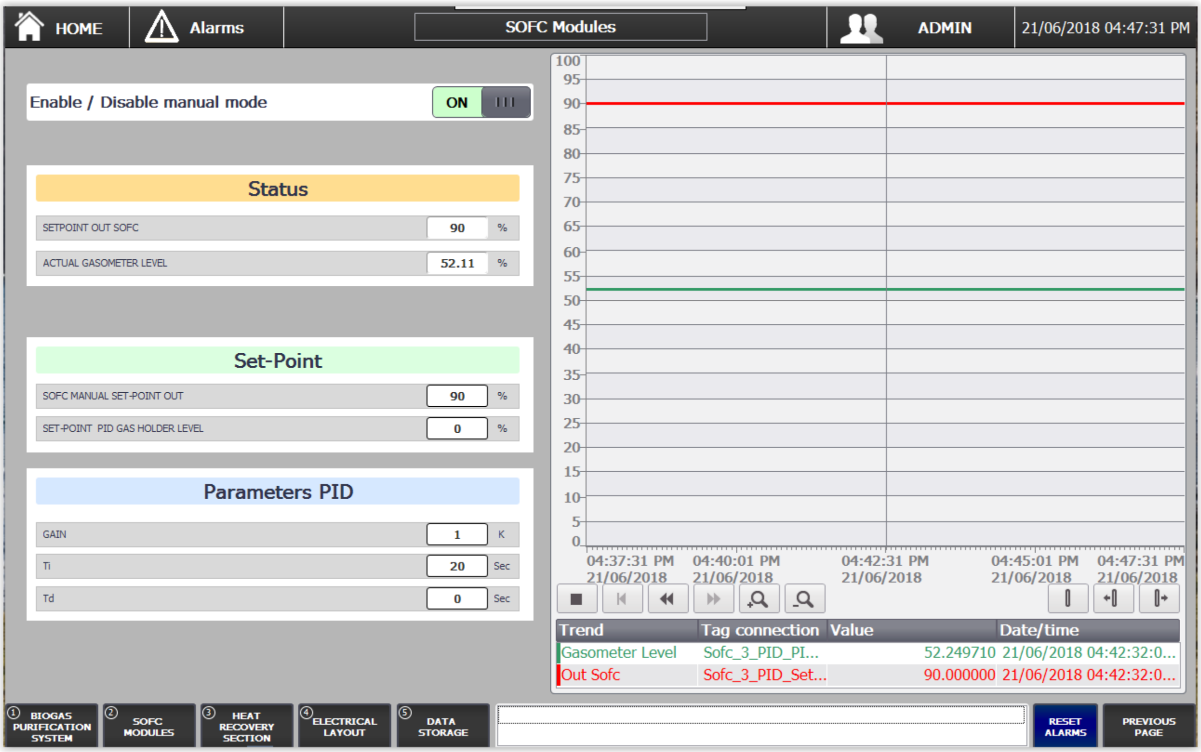



*Figure 22. SOFC set point PID controller.*

Another automatic procedure related to the SOFC modules is the 'sequence of actions' tab, which can be triggered by clicking on the top bar of the operator panel (Figure 23). The top bar also includes: maintenance mode (avoid alarms on the biogas line when gas samplings are performed and valves are moved respect to the nominal position; a password is requested to activate this command), sequence of actions (explained below), clean screen (block the touch screen for 30 seconds to let the user clean the screen), settings (of the operator panel), smart server star and stop (used to deactivate and reactivate the remote connection when blocked) and the exit runtime (which let the user going out of the software, in the Windows environment of the operator panel). The sequence of actions (Figure 24 and Figure 25) is an automatic check of the status of valves, biogas line (fuel feeding to the SOFC module) and water line (heat removal from the SOFC module) which should be OK for the panel to have a start-up of the system. The controls are applied only to the 'enabled' modules and consequently to the related pumps and heat recovery loops. In case some conditions are not verified (e.g. biogas line valve closed, compressor off, pumps off) the system does not allow the user to start the SOFC. In case of an automatic start-up, the control system automatically switches on biogas compressor, pumps, etc. in the order shown below. The aim of this list is to guaranteed fuel feeding and heat removal to the SOFC before starting the module.

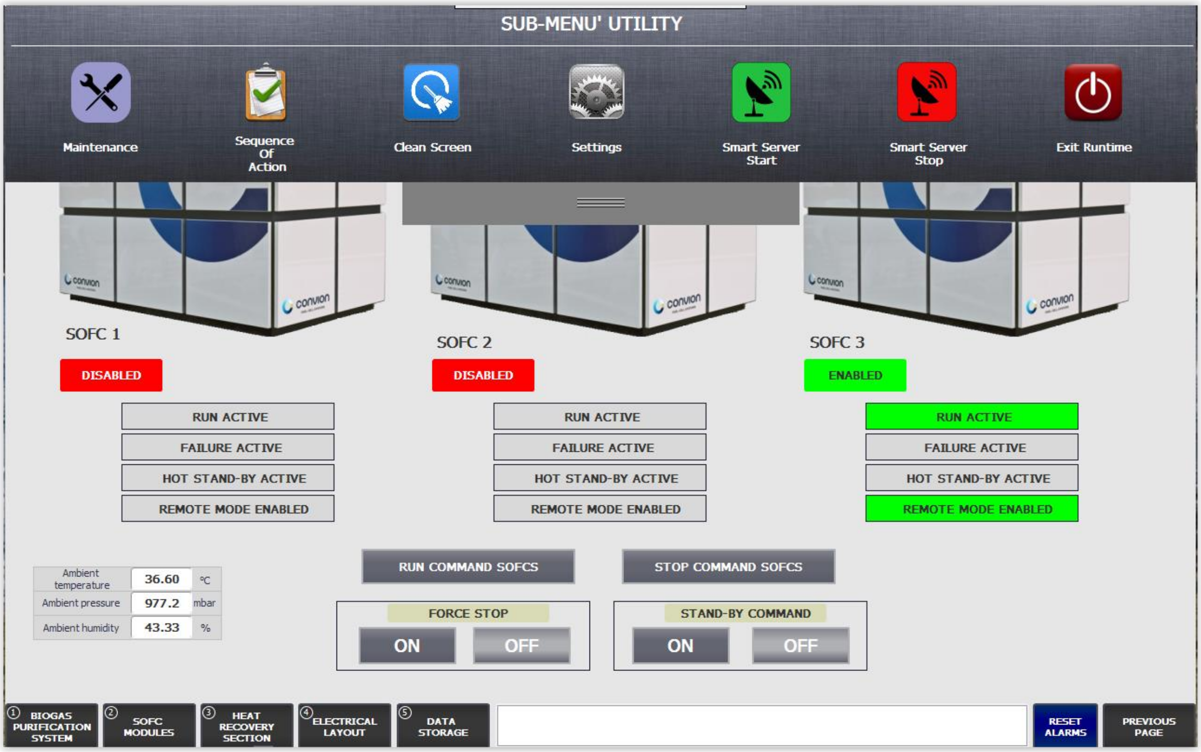
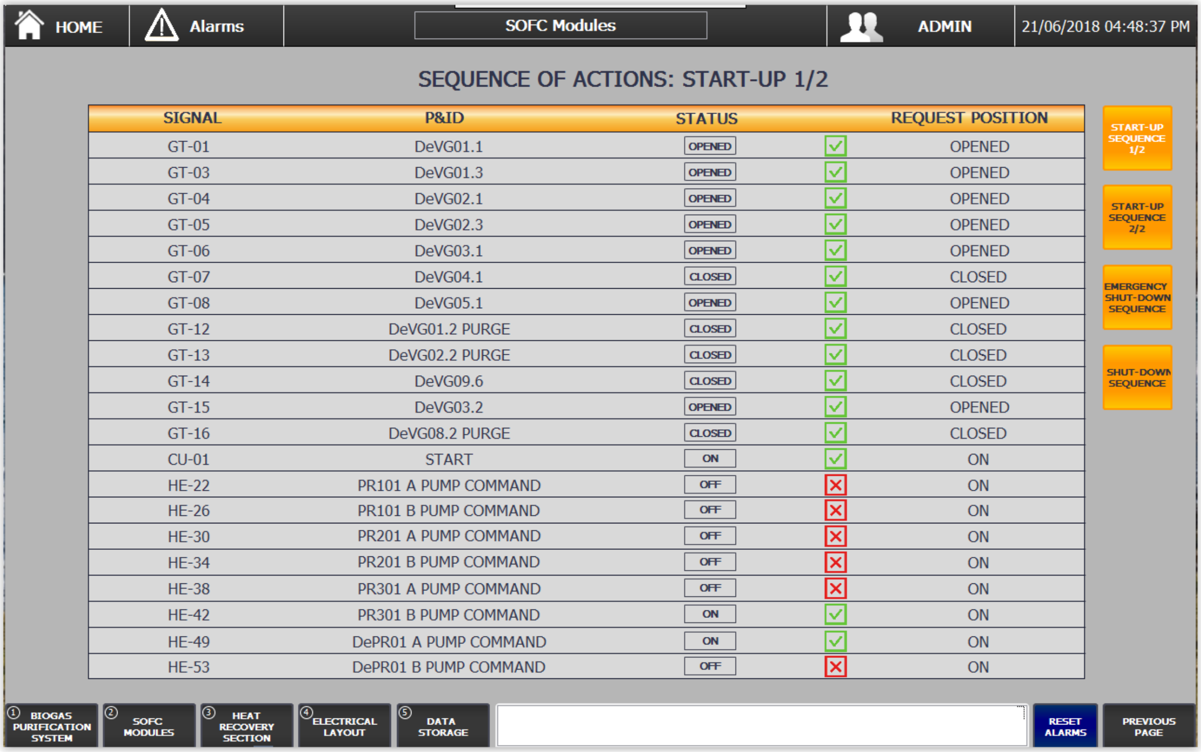
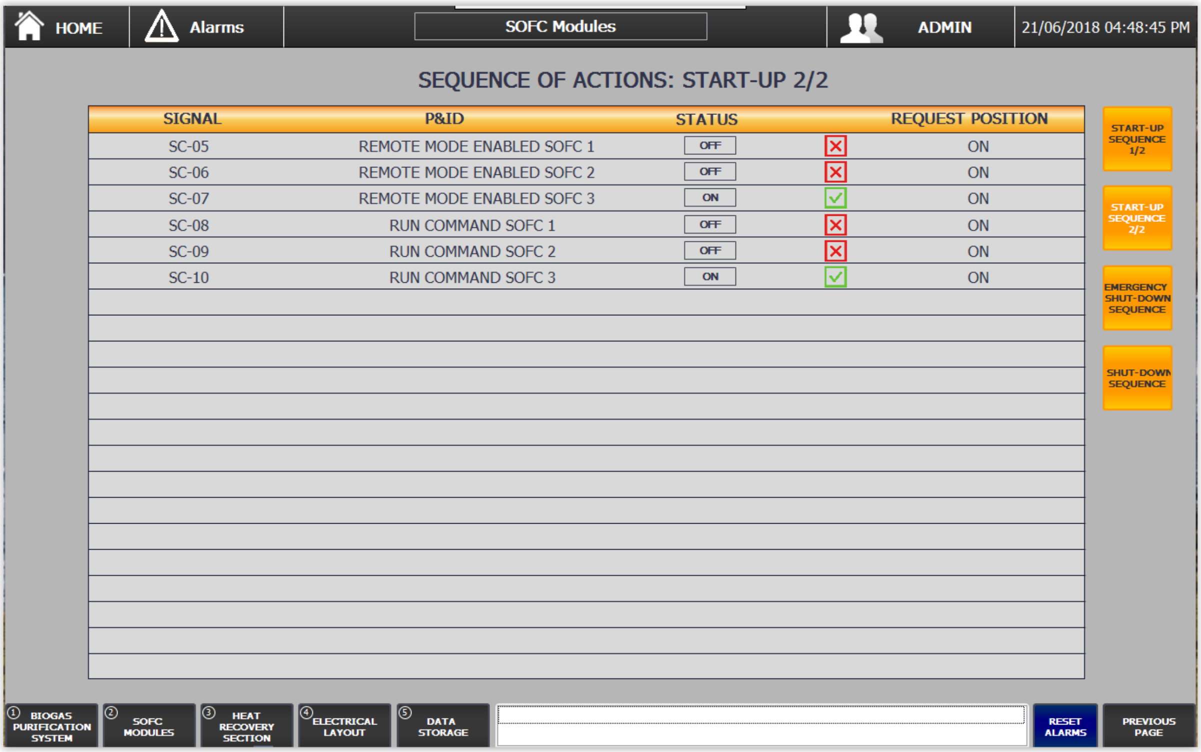



*Figure 23. Top bar of the operation panel.*




| SIGNAL | P&ID | STATUS | REQUEST POSITION |
|---|---|---|---|
| GT-01 | DeVG01.1 | OPENED | OPENED |
| GT-03 | DeVG01.3 | OPENED | OPENED |
| GT-04 | DeVG02.1 | OPENED | OPENED |
| GT-05 | DeVG02.3 | OPENED | OPENED |
| GT-06 | DeVG03.1 | OPENED | OPENED |
| GT-07 | DeVG04.1 | CLOSED | CLOSED |
| GT-08 | DeVG05.1 | OPENED | OPENED |
| GT-12 | DeVG01.2 PURGE | CLOSED | CLOSED |
| GT-13 | DeVG02.2 PURGE | CLOSED | CLOSED |
| GT-14 | DeVG09.6 | CLOSED | CLOSED |
| GT-15 | DeVG03.2 | OPENED | OPENED |
| GT-16 | DeVG08.2 PURGE | CLOSED | CLOSED |
| CU-01 | START | ON | ON |
| HE-22 | PR101 A PUMP COMMAND | OFF | ON |
| HE-26 | PR101 B PUMP COMMAND | OFF | ON |
| HE-30 | PR201 A PUMP COMMAND | OFF | ON |
| HE-34 | PR201 B PUMP COMMAND | OFF | ON |
| HE-38 | PR301 A PUMP COMMAND | OFF | ON |
| HE-42 | PR301 B PUMP COMMAND | ON | ON |
| HE-49 | DePR01 A PUMP COMMAND | ON | ON |
| HE-53 | DePR01 B PUMP COMMAND | OFF | ON |

*Figure 24. Start-up sequence of actions -1.*




| SIGNAL | P&ID | STATUS | REQUEST POSITION |
|---|---|---|---|
| SC-05 | REMOTE MODE ENABLED SOFC 1 | OFF | ON |
| SC-06 | REMOTE MODE ENABLED SOFC 2 | OFF | ON |
| SC-07 | REMOTE MODE ENABLED SOFC 3 | ON | ON |
| SC-08 | RUN COMMAND SOFC 1 | OFF | ON |
| SC-09 | RUN COMMAND SOFC 2 | OFF | ON |
| SC-10 | RUN COMMAND SOFC 3 | ON | ON |

*Figure 25. Start-up sequence of actions -2.*

Another automatic safety procedure available in the control system is the protection of all the commands related to the SOFC module with a password. This generates a second level user, allowed to start the unit. Other generic users are only allowed to monitor the system and perform actions on the other parts of the plant (pumps, valves, etc.).

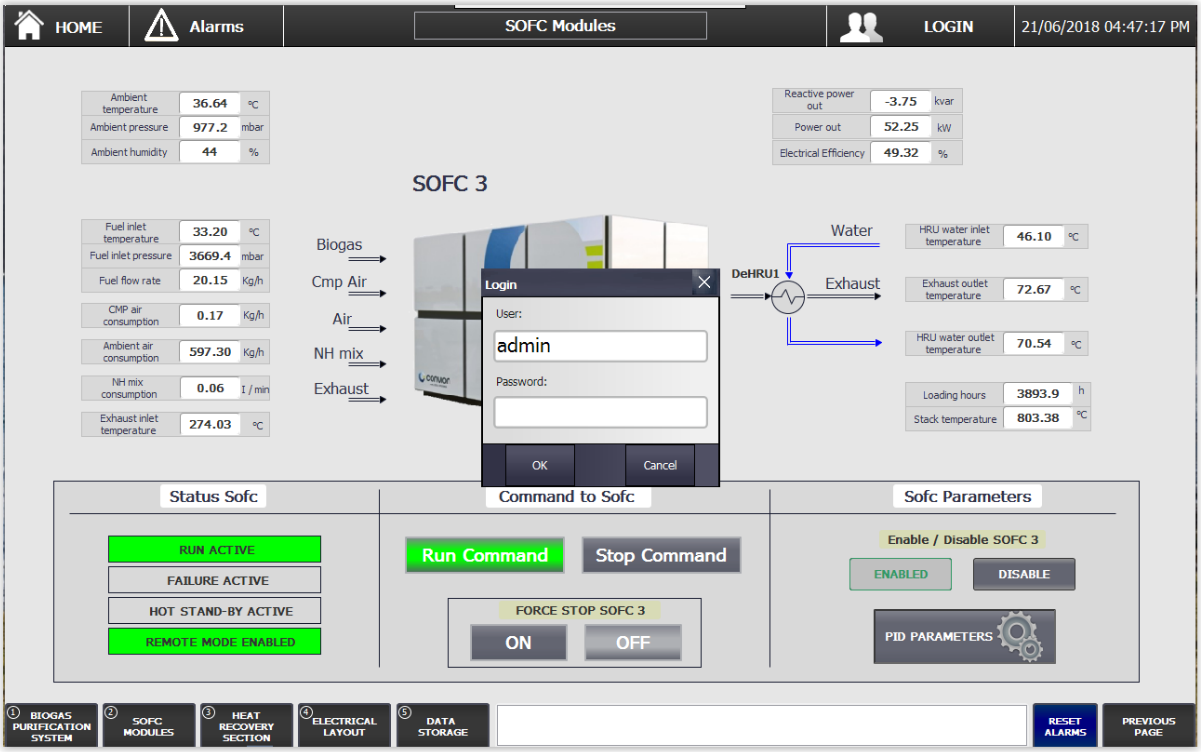



*Figure 26. SOFC module commands and set point.*

## <u>Biogas cleaning and compression system</u>

This section of the plant is almost composed by passive systems like the adsorption vessels which do not need any actions (and provide only feedbacks through the online Qualvista analyser). The blower, chillers and compression sections are all activated by a common START which can be given manually on the operator panel of the unit (Figure 27) or in the control system of DEMOSOFC in the dedicated cleaning unit page (Figure 13). There are almost no set point which the user is normally modifying. All the PID and control parameters of the blower and compressor can be changed only, with different password levels, in the dedicated Biokomp operator panel. Chiller parameters are indeed changed directly in the refrigeration machine.

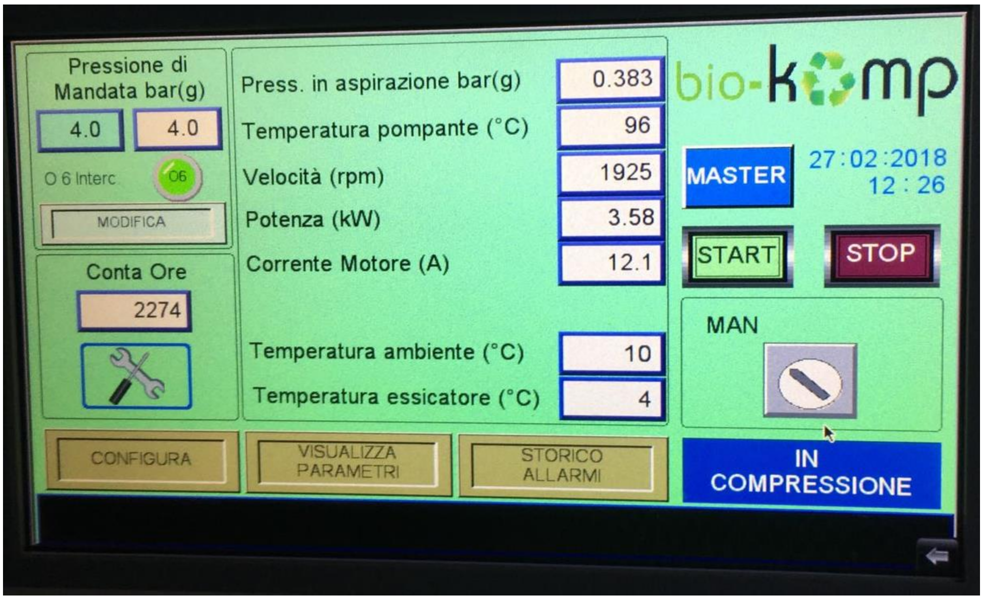



*Figure 27. Biokomp operator panel.*

**<u>Heat recovery system</u>**

The heat recovery section is the third part of the plant where automatic procedures have been implemented. Different PIDs are available and are described below:

- PID on the three-way mixing valves (Figure 28). The mixing valve placed among the outlet and the inlet lines from the SOFC module heat exchanger (exhaust gas – water) is used to control the inlet temperature of the water to the heat exchanger. This control is required to avoid a too cold stream which could bring to exhaust gas condensation (not allowed in the currently installed heat exchanger). Current set point is 45 °C (the PID is then automatically determining the valve opening/mixing rate - %).
- PID on water-glycol pumps in the three single loops (Figure 29). The pump regulation is used to control the water temperature change across the exhaust gas-water heat exchanger and thus the outlet temperature of the water. The current set point is 20 °C, which corresponds to an outlet temperature of 65 °C (and pump speed, in %, is automatically determined by the PID).
- PID on the water-glycol pump in the secondary loop (Figure 30). The PID is simpler and is only regulating the pump speed to reach a desired total water flow rate. In nominal conditions this set point is equal to the sum of the three water-glycol flows in the primary loops. The current set point is 0.90 m3/h.

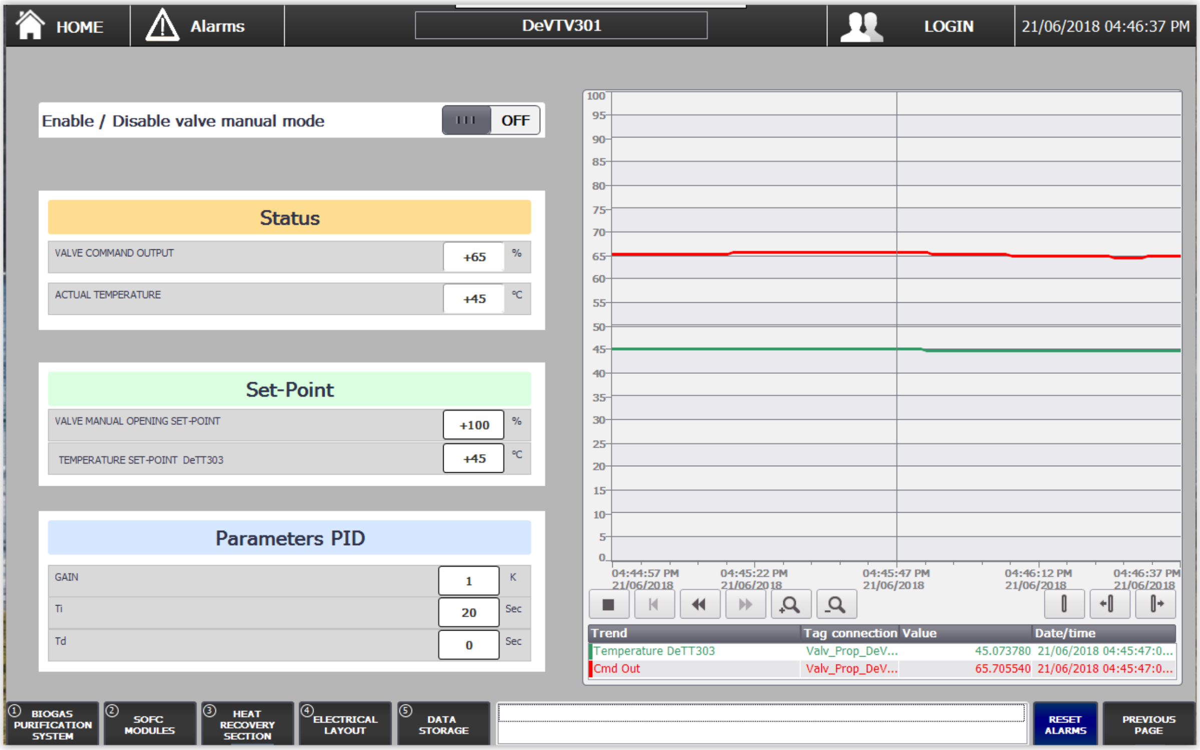



*Figure 28. PID on three way valve with set point on temperature.*

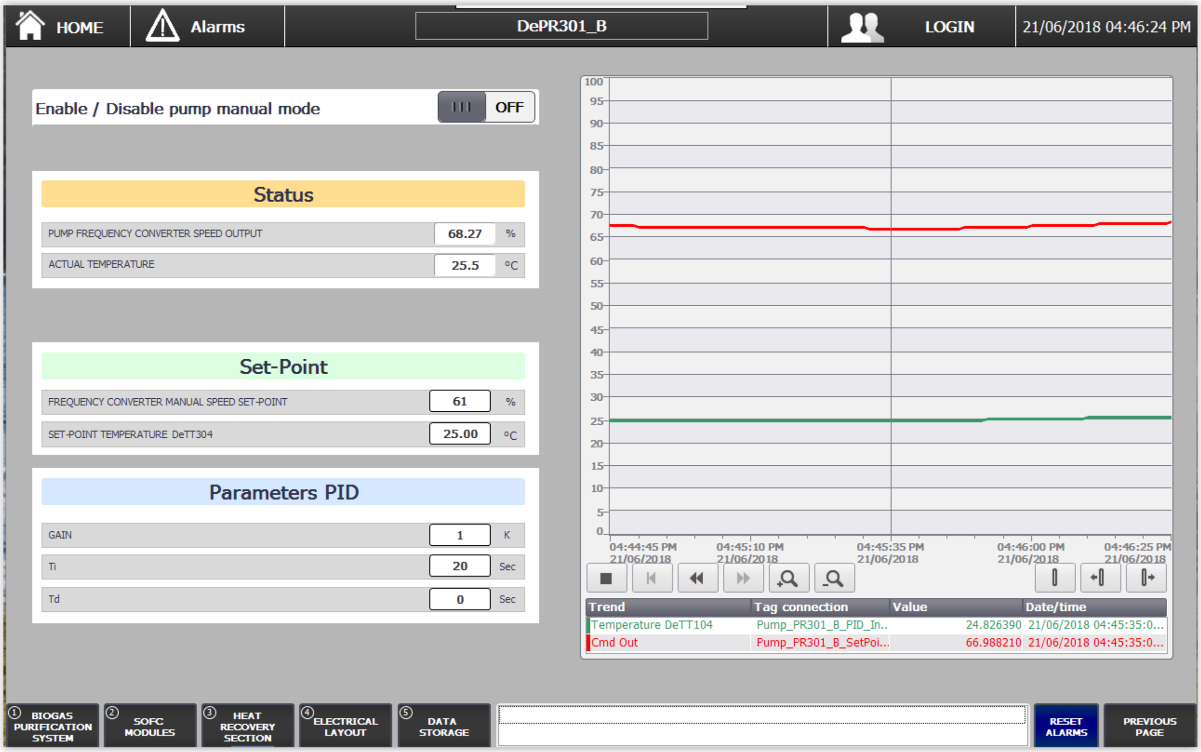



*Figure 29. PID on water-glycol pumps in the three single loops.*

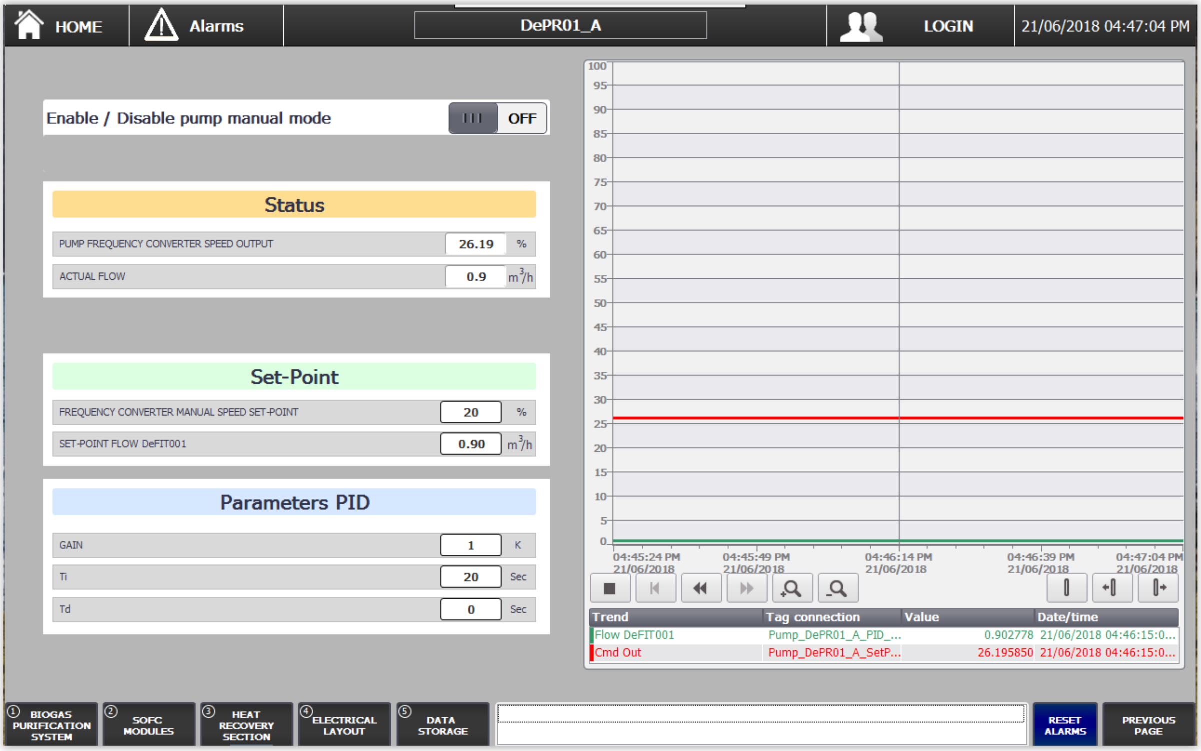



*Figure 30. PID on the water-glycol pump in the secondary loop.*

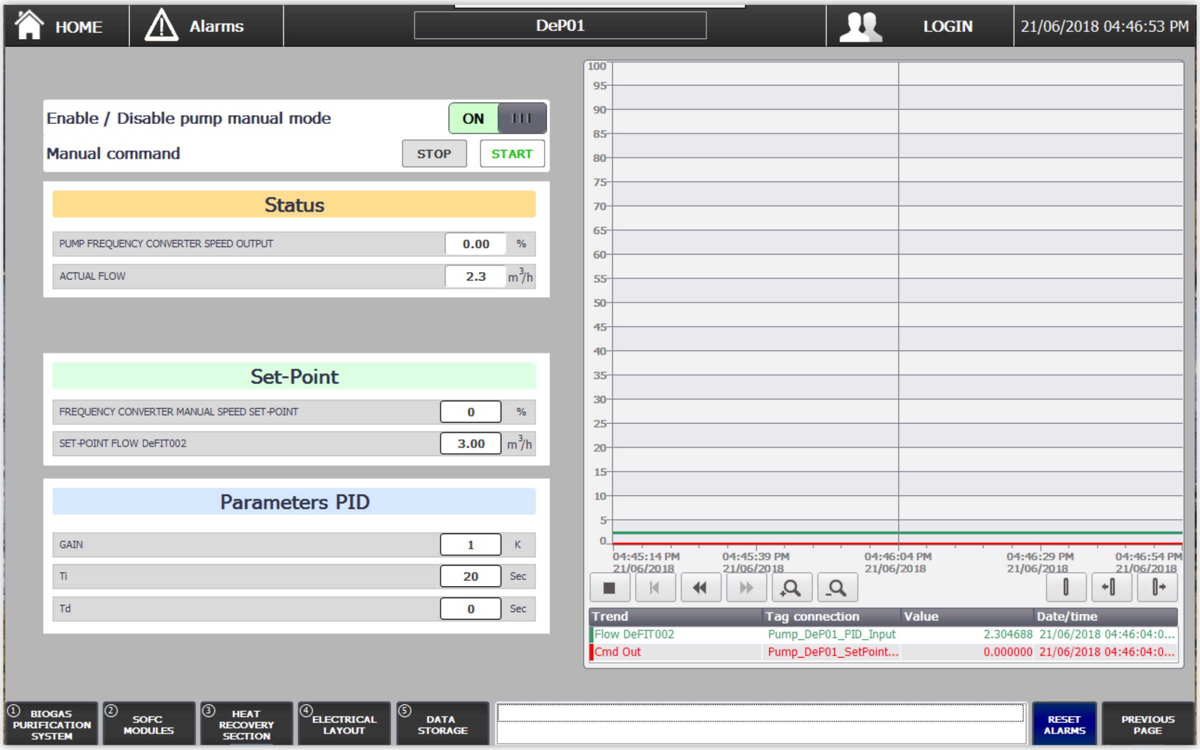



*Figure 31. PID on sludge pump with set point on flow rate.*

- PID on sludge pump with set point on flow rate (Figure 31). The sludge pump has a PID similar to the one used for the total water+glycol stream (explained above) and is regulating the sludge flow rate by varying the pump speed. When industrial water is used instead of sludge, the pumps is not mandatory needed since industrial water already have enough pressure from the water distribution network.

**Electrical layout**

The electrical layout has an automatic switch system which moves the auxiliary supply from the grid to the SOFC modules in case of grid failure (island mode operation). This is an automatic procedure not controlled by the user which is automatically switching the Socomec device (Figure 19) when voltage is not detected in the grid connection line. When grid is back, according to the island mode specifications, the system is waiting for an OK from the modules to reconnect the units and switch the Socomec device back to nominal operation.

# 3. Signal list

The following section shows the list of signals available within the DEMOSOFC site. As explained at the beginning signals are divided into three PLC sections: control room, sludge pumps room and electrical cabinet room (Figure 1).

For each section, signals are then further divide into digital input, digital output, analog input and analog output.

## 3.1 Control room

**Sala controllo**

**Digital Input**

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SC-01_EMERGENCY_SHUTDOWN | **%I0.0** | QCS02_STATO | **%I2.0** | QF14 - KA1 - CIRCOLATORE DePR101A | **%I4.0** | QF36 - KA19 - COMPRESSORE ARIA | **%I6.0** | | **%I8.0** | GT-20_DeVG08.1 OPEN | **%I10.0** |
| SC-02_MAINS_PROTECTION | **%I0.1** | | **%I2.1** | QF15 - KA2 - CIRCOLATORE DePR101B | **%I4.1** | | **%I6.1** | | **%I8.1** | GT-21_DeVG08.1 CLOSE | **%I10.1** |
| SC-03_GRID_PARALLEL_MODE_BY_PLC | **%I0.2** | QCS04_AUTO | **%I2.2** | QF16 - KA3 - CIRCOLATORE DePR201A | **%I4.2** | | **%I6.2** | GT-10_DeVG09.6 OPEN | **%I8.2** | | **%I10.2** |
| SC-04_INTERLOCKING_MAINS_PROTECTION | **%I0.3** | QCS05_BYPASS_MAN | **%I2.3** | QF17 - KA4 - CIRCOLATORE DePR201B | **%I4.3** | CU-03_ALLARME_GENERICO | **%I6.3** | GT-11_DeVG09.6 CLOSE | **%I8.3** | | **%I10.3** |
| SC-05_REMOTE MODE ENABLED | **%I0.4** | QCS07_STATO | **%I2.4** | QF18 - KA5 - CIRCOLATORE DePR301A | **%I4.4** | CU-04_PRE-ALLARME_GENERICO | **%I6.4** | GT-10_DeVG03.2 OPEN | **%I8.4** | | **%I10.4** |
| SC-06_REMOTE MODE ENABLED | **%I0.5** | | **%I2.5** | QF19 - KA6 - CIRCOLATORE DePR301B | **%I4.5** | CU-05_MACCHINA_IN_FUNZIONE | **%I6.5** | GT-11_DeVG03.2 CLOSE | **%I8.5** | | **%I10.5** |
| SC-07_REMOTE MODE ENABLED | **%I0.6** | QCS09_AUTO | **%I2.6** | QF20 - KA7 - CIRCOLATORE DePR01A | **%I4.6** | CU-06_ALL.BASSA_PRESSIONE_ASPIRAZIONE_COMP. | **%I6.6** | GT-10_DeVG03.1 OPEN | **%I8.6** | | **%I10.6** |
| SC-18_HOT_IDLE_ACTIVE | **%I0.7** | QCS10_BYPASS_MAN | **%I2.7** | QF21 - KA8 - CIRCOLATORE DePR01B | **%I4.7** | | **%I6.7** | GT-11_DeVG03.1 CLOSE | **%I8.7** | | **%I10.7** |
| SC-19_ISLAND_MODE_ACTIVE | **%I1.0** | QCS12_STATO | **%I3.0** | QF23 - KA10 - DeP01 POMPA FANGHI | **%I5.0** | | **%I7.0** | GT-12_DeVG04.1 OPEN | **%I9.0** | | **%I11.0** |
| SC-20_RUN_ACTIVE_1 | **%I1.1** | | **%I3.1** | QF24 - KA11 - CLEANUP CONTAINER | **%I5.1** | | **%I7.1** | GT-13_DeVG04.1 CLOSE | **%I9.1** | | **%I11.1** |
| SC-21_RUN_ACTIVE_2 | **%I1.2** | QCS14_AUTO | **%I3.2** | QF26 - KA12 - CLEANUP CHILLER/SOFFIANTE | **%I5.2** | | **%I7.2** | GT-14_DeVG05.1 OPEN | **%I9.2** | GT-30_DeVG08.2 PURGE OPEN | **%I11.2** |
| SC-22_RUN_ACTIVE_3 | **%I1.3** | QCS15_BYPASS_MAN | **%I3.3** | QF27 - KA13 - VALVOLE PRIMARIO | **%I5.3** | | **%I7.3** | GT-15_DeVG05.1 CLOSE | **%I9.3** | GT-31_DeVG08.2 PURGE CLOSE | **%I11.3** |
| SC-23_FAILURE_ACTIVE_1 | **%I1.4** | QCS17_STATO | **%I3.4** | QF28 - KA14 - VALVOLA LOCALE POMPE | **%I5.4** | | **%I7.4** | GT-16_DeVG06.1 OPEN | **%I9.4** | | **%I11.4** |
| SC-24_FAILURE_ACTIVE_2 | **%I1.5** | | **%I3.5** | QF29 - KA15 - MOTORINO SOCOMEC | **%I5.5** | | **%I7.5** | GT-17_DeVG06.1 CLOSE | **%I9.5** | | **%I11.5** |
| SC-25_FAILURE_ACTIVE_3 | **%I1.6** | QCS19_AUTO | **%I3.6** | QF34 - KA17 - QUADRO GENERALI FANGHI | **%I5.6** | | **%I7.6** | GT-18_DeVG07.1 OPEN | **%I9.6** | | **%I11.6** |
| | **%I1.7** | QCS20_BYPASS_MAN | **%I3.7** | QF35 - KA18 - QUADRO PLC | **%I5.7** | | **%I7.7** | GT-19_DeVG07.1 CLOSE | **%I9.7** | | **%I11.7** |

**Digital Output**

| 7 | | 8 | |
|---|---|---|---|
| SC-08_RUN_COMMAND | **%Q0.0** | | **%Q2.0** |
| SC-09_RUN_COMMAND | **%Q0.1** | HE-26_PR101_B_PUMP_COMMAND | **%Q2.1** |
| SC-10_RUN_COMMAND | **%Q0.2** | | **%Q2.2** |
| SC-11_FORCE_STOP_COMMAND | **%Q0.3** | HE-30_PR201_A_PUMP_COMMAND | **%Q2.3** |
| SC-12_FORCE_STOP_COMMAND | **%Q0.4** | HE-34_PR201_B_PUMP_COMMAND | **%Q2.4** |
| SC-13_FORCE_STOP_COMMAND | **%Q0.5** | HE-38_PR301_A_PUMP_COMMAND | **%Q2.5** |
| SC-14_HOT_STANDBY_COMMAND | **%Q0.6** | HE-42_PR301_B_PUMP_COMMAND | **%Q2.6** |
| | **%Q0.7** | | **%Q2.7** |
| QCS01_COMANDO | **%Q1.0** | | **%Q3.0** |
| QCS06_COMANDO | **%Q1.1** | | **%Q3.1** |
| QCS11_COMANDO | **%Q1.2** | | **%Q3.2** |
| QCS16_COMANDO | **%Q1.3** | | **%Q3.3** |
| ~~QCS38_UPS_COMMUTATORE_COMANDO_MAN~~ | **%Q1.4** | | **%Q3.4** |
| CU-01_START | **%Q1.5** | SOCOMEC COMANDO A I | **%Q3.5** |
| CU-02_STOP | **%Q1.6** | SOCOMEC COMANDO A 0 | **%Q3.6** |
| HE-22_PR101_A_PUMP_COMMAND | **%Q1.7** | SOCOMEC COMANDO A II | **%Q3.7** |

**Analog Input**

| 9 | | 10 | | 11 | | 12 | | 13 | | 14 | | 15 | | 16 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AP-01_PRESSURE_DeEPT003 | **%IW512** | HE-02_TEMPERATURA_DeTT104 | **%IW520** | HE-05_TEMPERATURA_DeTT303 | **%IW528** | HE-09_TEMPERATURA_DeTT003 | **%IW536** | HE-56_TEMPERATURA_DeTT105 | **%IW544** | | **%IW552** | GT-34_FLOW METER_GAS_N | **%IW560** | | **%IW568** |
| AP-02_PRESSURE_DeEPT004 | **%IW514** | HE-58_TEMPERATURA_DeTT305 | **%IW522** | HE-06_TEMPERATURA_DeTT304 | **%IW530** | HE-10_TEMPERATURA_DeTT004 | **%IW538** | | **%IW546** | | **%IW554** | GT-35_FLOW METER_GAS_Nhmix | **%IW562** | | **%IW570** |
| HE-57_TEMPERATURA_DeTT205 | **%IW516** | HE-03_TEMPERATURA_DeTT203 | **%IW524** | HE-07_TEMPERATURA_DeTT001 | **%IW532** | HE-16_PRESSURE_DeEPT013_BIOGAS | **%IW540** | | **%IW548** | | **%IW556** | | **%IW564** | | **%IW572** |
| HE-01_TEMPERATURA_DeTT103 | **%IW518** | HE-04_TEMPERATURA_DeTT204 | **%IW526** | HE-08_TEMPERATURA_DeTT002 | **%IW534** | HE-18_PRESSURE_DeEPT005_ H2O | **%IW542** | | **%IW550** | | **%IW558** | | **%IW566** | | **%IW574** |

**Analog Output**

| 17 | | 18 | | 19 | | 20 | | 21 | | 22 | | 23 | | 24 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC-15_SETPOINT | **%QW512** | SC-17_SETPOINT | **%QW516** | HE-24_PR101_A_PUMP_INV_SET POINT | **%QW520** | HE-32_PR201_A_PUMP_INV_SET POINT | **%QW524** | HE-40_PR301_A_PUMP_INV_SET POINT | **%QW528** | HE-59_DeVTV_101_3VIE_SOFC1 | **%QW532** | HE-61_DeVTV_301_3VIE_SOFC3 | **%QW536** | | **%QW540** |
| SC-16_SETPOINT | **%QW514** | | **%QW518** | HE-28_PR101_B_PUMP_INV_SET POINT | **%QW522** | HE-36_PR201_B_PUMP_INV_SET POINT | **%QW526** | HE-44_PR301_B_PUMP_INV_SET POINT | **%QW530** | HE-60_DeVTV_201_3VIE_SOFC2 | **%QW534** | | **%QW538** | | **%QW542** |

## 3.2 Sludge pumps room

**Digital Input**

| 1 | | 2 | |
|---|---|---|---|
| AP-03_ALIMENTAZIONE_QL5 | **%I20.0** | GT-02_DeVG01.1 OPEN | **%I22.0** |
| AP-04_ALIMENTAZIONE_QS_SOFC | **%I20.1** | GT-03_DeVG01.1 CLOSE | **%I22.1** |
| AP-06_EV_ISLAND_MODE_STATUS_DeVAM001 | **%I20.2** | GT-04_DeVG01.3 OPEN | **%I22.2** |
| AP-08_EV_RING_MODE_STATUS_DeVAM001 | **%I20.3** | GT-05_DeVG01.3 CLOSE | **%I22.3** |
| ~~HE-48_DePR01_A_PUMP_STATUS~~ | **%I20.4** | GT-06_DeVG02.1 OPEN | **%I22.4** |
| ~~HE-52_DePR01_B_PUMP_STATUS~~ | **%I20.5** | GT-07_DeVG02.1 CLOSE | **%I22.5** |
| HE-63_DeP01_POMPA_FANGO_STATUS | **%I20.6** | GT-08_DeVG02.3 OPEN | **%I22.6** |
| | **%I20.7** | GT-09_DeVG02.3 CLOSE | **%I22.7** |
| | **%I21.0** | GT-22_DeVG01.2 PURGE OPEN | **%I23.0** |
| | **%I21.1** | GT-23_DeVG01.2 PURGE CLOSE | **%I23.1** |
| | **%I21.2** | GT-24_DeVG02.2 PURGE OPEN | **%I23.2** |
| | **%I21.3** | GT-25_DeVG02.2 PURGE CLOSE | **%I23.3** |
| | **%I21.4** | | **%I23.4** |
| | **%I21.5** | | **%I23.5** |
| | **%I21.6** | | **%I23.6** |
| | **%I21.7** | | **%I23.7** |

**Digital Output**

| 3 | |
|---|---|
| AP-05_EV_ISLAND_MODE_COMMAND_DeVAM001 | **%Q20.0** |
| AP-07_EV_RING_MODE_COMMAND_DeVAM001 | **%Q20.1** |
| HE-49_DePR01_A_PUMP_COMMAND | **%Q20.2** |
| HE-53_DePR01_B_PUMP_COMMAND | **%Q20.3** |
| HE-62_DeP01_POMPA_FANGO_COMMAND | **%Q20.4** |
| GT-01_DeVG01.1 COMMAND OPEN | **%Q20.5** |
| MACERATORE_DeVM01_START | **%Q20.6** |
| | **%Q20.7** |
| | **%Q21.0** |
| | **%Q21.1** |
| | **%Q21.2** |
| | **%Q21.3** |
| | **%Q21.4** |
| | **%Q21.5** |
| | **%Q21.6** |
| | **%Q21.7** |

**Analog Input**

| 4 | | 5 | | 6 | | 7 | |
|---|---|---|---|---|---|---|---|
| SG-01_LIVELLO_GASOMETRO _DeLT001 | **%IW576** | SG-05_TEMPERATURA_DeFIT005 | **%IW584** | HE-14_TEMPERATURA_DeTT008 | **%IW592** | ~~HE-54_DePR01_B_PUMP_STATUS~~ | **%IW600** |
| SG-02_PORTATA _DeFIT005 | **%IW578** | HE-11_TEMPERATURA_DeTT005 | **%IW586** | HE-15_PRESSURE_DeEPT001_FANGO | **%IW594** | HE-19_FLOW_METER_DeFT001 | **%IW602** |
| SG-03_PRESSIONE_FIT005_DePT012 | **%IW580** | HE-12_TEMPERATURA_DeTT006 | **%IW588** | HE-17_PRESSURE_DeEPT014_H2O | **%IW596** | HE-20_FLOW_METER_DeFT002 | **%IW604** |
| SG-04_CH4 DeFIT005 | **%IW582** | HE-13_TEMPERATURA_DeTT007 | **%IW590** | ~~HE-50_DePR01_A_PUMP_STATUS~~ | **%IW598** | | **%IW606** |

**Analog Output**

| 8 | | 9 | | 10 | | 11 | |
|---|---|---|---|---|---|---|---|
| HE-45_DeVFM01_VALVE_SLUDGE_OUT | **%QW544** | HE-47_DeVHM03_VALVE_IND_WATER_IN | **%QW548** | HE-55_DePR01_B_PUMP_INV_SET_POINT | **%QW552** | DeVHM04_VALVE_IN_WATER_IN_2 | **%QW556** |
| HE-46_DeVHM02_VALVE_IND_WATER_OUT | **%QW546** | HE-51_DePR01_A_PUMP_INV_SET_POINT | **%QW550** | HE-64_DeP01_POMPA_FANGO_INV_SET_POINT | **%QW554** | | **%QW558** |

## 3.3 Electrical cabinet room

| Cabina Elettrica | | | |
|---|---|---|---|
| **Digital Input** | | | |
| **1** | | **2** | |
| CE-06_PRESENZA_TENSIONE 1 | %I30.0 | | %I32.0 |
| CE-07_PRESENZA_TENSIONE 2 | %I30.1 | | %I32.1 |
| | %I30.2 | | %I32.2 |
| | %I30.3 | | %I32.3 |
| CE-10_KM1_STATUS | %I30.4 | | %I32.4 |
| CE-11_KM2_STATUS | %I30.5 | | %I32.5 |
| | %I30.6 | | %I32.6 |
| | %I30.7 | | %I32.7 |
| | %I31.0 | | %I33.0 |
| | %I31.1 | | %I33.1 |
| | %I31.2 | | %I33.2 |
| | %I31.3 | | %I33.3 |
| | %I31.4 | | %I33.4 |
| | %I31.5 | | %I33.5 |
| | %I31.6 | | %I33.6 |
| | %I31.7 | | %I33.7 |

| Digital Output | |
|---|---|
| **3** | |
| | %Q30.0 |
| | %Q30.1 |
| | %Q30.2 |
| | %Q30.3 |
| | %Q30.4 |
| | %Q30.5 |
| | %Q30.6 |
| | %Q30.7 |
| | %Q31.0 |
| | %Q31.1 |
| | %Q31.2 |
| | %Q31.3 |
| | %Q31.4 |
| | %Q31.5 |
| | %Q31.6 |
| | %Q31.7 |

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