Parameter	Value
Product designation	MSK GEN1
System type	Prototype for a hybrid backup power system with methanol fuel cell
Manufacturer	Gumpert Automobile GmbH
Year of manufacture	2026
Prototype number	01
Intended use	Stationary emergency backup power supply
Fuel cell technology	Reformed methanol HT-PEM fuel cell
Maximum fuel cell output	5 kW
Fuel	Methanol, IMPCA standard
Process water	Demineralized water
Fuel cell startup time	approx. 20 minutes
Operating modes	Automatic (grid detection), manual start/stop
AC output voltage	230 V / 400 V AC
AC output frequency	50 Hz
Continuous AC output power	5,5 kW

Maximum available AC power (end user)	13 kW
DC system voltage (internal)	up to 60 V DC
Battery system voltage	48 V DC
Battery capacity	15 kWh
Battery function	Startup supply, buffering, load support
Photovoltaic function	Continuous battery charging
Methanol tank capacity	150 l
Water tank capacity	120 l
Typical runtime at nominal load	approx. 64 hours
System zones	Zone 1 (fuel cell and tanks), Zone 2 (batteries and power electronics)
Cooling concept	Active, temperature-controlled ventilation
Standby requirement	System must remain energized for frost protection
Operation Temperature	- 10 °C to + 40 °C
Dimensions Zone 1 (W × H × D) (without solar panel)	1480 × 1490 × 930 mm
Dimensions Zone 2 (W × H × D) (without solar panel)	1310 × 1030 × 900 mm
Total system weight	approx. 900 kg

Important Notice – Prototype System (Research and Development Use Only)

The MSK GEN1 (Methanol Power Converter) is provided as a prototype system within the scope of research and development activities. At the time of delivery, the MSK GEN1 is not CE-marked and has not yet undergone a formal conformity assessment according to applicable EU harmonization legislation. The system is therefore not released as a commercially available product. The prototype is supplied exclusively for evaluation, testing, and development purposes in cooperation with the customer. It is not intended for permanent commercial operation, resale, or unrestricted use.

Operation of the MSK GEN1 prototype is limited to:

- defined project scopes
- trained and instructed personnel
- use cases agreed between the manufacturer and the customer

All operation described in this manual refers to the prototype configuration as delivered and may change as part of ongoing system development and validation. Once the conformity assessment process has been completed, including risk assessment, technical documentation, and issuance of an EU Declaration of Conformity, the system will be updated accordingly. Only then will a CE marking be affixed and the system released for regular market use.

Until that time:

- the system shall be treated as a prototype

- modifications and operating conditions are subject to project-specific agreements
- the manufacturer retains control over restricted system areas and safety-critical components

This manual documents the current functional state of the MSK GEN1 prototype and supports its safe and intended use within the defined research and development context.

Table of Contents

1 About This Manual

1.1 Purpose of This Manual

This User Manual provides essential information for the safe operation and basic handling of the MSK GEN1 prototype manufactured by Gumpert Automobile GmbH. The manual is intended to support users and operators during operation within a defined research and development context, including:

- Understanding the system's function and operating principle
- Safe handling of fuel and consumables
- Startup, shutdown, and monitoring of the system
- Recognition of warnings, alarms, and system states
- Execution of operator-permitted actions as defined in this manual

This User Manual does not replace professional training and does not provide detailed instructions for installation, commissioning, or advanced servicing.

1.2 Scope of This Manual

This manual applies to the MSK GEN1 prototype system provided for research and development purposes:

- A reformed methanol HT-PEM fuel cell system
- An integrated battery energy storage system
- Inverter units for conversion to AC power
- A photovoltaic (PV) module for battery recharging
- Associated enclosures, interfaces, and safety components

The manual covers user-relevant aspects only, including:

- General system overview
- Intended use and operating limitations
- Operator interactions (fuel filling, monitoring, basic maintenance)
- Safety information relevant to daily operation

All descriptions and procedures in this manual refer to the prototype configuration as delivered at the time of installation and may be subject to change during ongoing development. This manual is intended for:

- System operators
- Facility managers
- End users responsible for daily operation

All users of the system must:

- Be trained in basic operation of technical equipment
- Be familiar with general electrical and fire safety rules
- Read and understand this manual before operating the system

As the MSK GEN1 is a prototype system, operation is limited to trained personnel within the agreed project scope. Use by untrained persons or outside the defined research and development context is not permitted.

1.3 Product Overview

The MSK GEN1 is a stationary, self-contained prototype emergency power supply system designed to provide electrical energy during grid outages within a research and development context. The system combines multiple energy technologies into one integrated solution:

- a reformer-based methanol fuel cell system as the primary energy source
- a 48 V battery energy storage system used for startup power, buffering, and load stabilization
- inverter units converting stored DC energy into 230 V or 400 V AC power for external loads
- a photovoltaic module supporting battery recharging

The system operates automatically based on defined conditions (e.g. grid availability and system readiness) and is designed for unattended standby operation within the operating limits described in this manual.

The MSK GEN1 is designed to provide both short-term high power and long-duration continuous power, depending on operating conditions and energy source availability. Immediately upon demand, the system is capable of delivering up to approximately 13 kW of electrical power for a period of up to 45 minutes. This high-power capability is supported by the integrated battery system in combination with the inverter units and is intended for peak loads or transient operating conditions. After this initial phase, the system provides a continuous electrical output of up to approximately 5.5 kW supplied by the methanol fuel cell system. With a fully filled internal methanol tank, this continuous operation can be maintained for approximately 64 hours. This corresponds to a usable electrical energy of approximately 320 kWh from the internal fuel supply. The system is further designed to allow connection of an external methanol IBC container. When such an external fuel source is used, total continuous runtime can be extended to approximately 490 hours (nearly three weeks), resulting in a usable electrical energy of up to approximately 2 450 kWh, depending on operating conditions. These values are indicative and may vary depending on load profile, ambient conditions, and system configuration. They are intended to provide the user with a general understanding of the system's performance capabilities rather than guaranteed operating limits.

1.4 Manufacturer and Responsibility

Manufacturer:

Gumpert Automobile GmbH

Carl-Hahn-Strasse 5

85053 Ingolstadt

Germany

Contact:

info@gumpert.de

Gumpert Automobile GmbH is responsible for:

- System integration
- Overall system safety
- Enclosure, interfaces, and user-level functionality
- Documentation provided with the complete product

Only the system configuration and components supplied by Gumpert Automobile GmbH are covered by this manual. As the MSK GEN1 is supplied as a prototype system, Gumpert Automobile GmbH retains responsibility for the defined system configuration and for restricted system areas. Access to such areas is limited to the manufacturer or expressly authorized service personnel.

1.5 Document Validity and Revision History

This User Manual applies to the following product version:

Product name: MSK GEN1 (Methanol Power Converter)

System version: Prototype 01

Manual version: 1.0

Date of issue: April 24, 2026

Gumpert Automobile GmbH reserves the right to update this manual without prior notice as part of ongoing product development and improvement. The latest valid version of this manual shall always be used when operating the system. This manual corresponds to the current prototype status of the MSK GEN1. Future revisions may reflect changes resulting from system development, testing, validation, and the completion of the conformity assessment process.

2 Safety Information

2.1 General Safety Instructions

This chapter contains essential safety information for the safe operation of the MSK GEN1. Failure to follow the instructions in this manual may lead to personal injury, damage to property, or damage to the system. The system combines electrical, thermal, chemical, and electrochemical processes within a closed enclosure. As a result, multiple hazards may be present during operation, even when the system is running automatically and without visible activity.

The system shall only be operated under the conditions described in this manual. Any use outside the intended purpose, any unauthorized modification, or operation with damaged components is strictly prohibited. Before operating the system for the first time, users must read and understand this chapter completely.

2.2 Symbols, Signal Words and Warning Levels

This manual uses standardized safety symbols and signal words to indicate the level of potential hazard. The following signal words are used:

- **Caution** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or equipment damage.
- **Warning** indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.
- **Danger** indicates an imminent hazardous situation which, if not avoided, will result in serious injury or death.

Safety symbols may also be affixed directly to the system enclosures. These symbols must always be observed and shall not be removed or covered.

	**Flammable Material (GHS02)**	This symbol indicates the presence of flammable substances. Methanol used in the system can ignite easily if exposed to heat, sparks, or open flames. Keep ignition sources away and ensure proper ventilation when handling fuel.
	**Toxic Material (GHS06)**	This symbol warns of toxic substances that can be harmful or fatal if ingested, inhaled, or absorbed through the skin. Methanol is poisonous and must be handled with care. Avoid direct contact and follow all safety instructions during refilling or maintenance activities.
	**Health Hazard (GHS08)**	This symbol indicates substances that can cause serious long-term health effects. Exposure to methanol vapors or liquid may damage organs and pose significant health risks. Minimize exposure and seek medical attention immediately if contact occurs.
	**Electrical Hazard (ISO 7010)**	This symbol warns of hazardous electrical voltage and high currents. The system contains energized electrical components that can cause electric shock or severe injury. Switch off and isolate power before accessing electrical components.

	**Hot Surface (ISO 7010)**	This symbol indicates surfaces that may become hot during operation. Contact with such surfaces may cause burns. Do not touch the system components and allow sufficient cooling time before servicing.

2.3 Personnel Qualification and Responsibilities

This User Manual is intended for system operators only. Operators are responsible for monitoring the system, performing permitted user actions, and responding appropriately to system messages and alarms. Installation, commissioning, electrical work, internal servicing, and repair may only be carried out by trained and authorized personnel. Unauthorized access to internal components is not permitted. Operators shall never bypass safety devices, disable monitoring functions, or override system protections.

2.4 Electrical Safety

The system contains electrical circuits operating at 48 V DC as well as 230 or 400 V AC voltages generated by the inverter units. Even though the battery DC voltage level is classified as low voltage, high currents may be present due to the fuel cell. Short circuits, improper handling, or damaged cables can result in serious injury, burns, or fire. The following safety principles apply during operation:

- All enclosures must remain closed during normal operation
- Circuit breakers (MCBs) may only be operated as described in this manual
- Damaged cables, connectors, or enclosures must be reported immediately and the system must not be operated until inspected by authorized personnel

In the event of water ingress or flooding, the system must be shut down and isolated from all power sources.

2.5 Fuel Safety

The system uses methanol as fuel for the reformed fuel cell system. Methanol is a flammable and toxic liquid. Exposure may occur through ingestion, inhalation of vapors, or skin and eye contact. Methanol poisoning can lead to symptoms such as headache, dizziness, nausea, visual impairment, and in severe cases serious organ damage or death.

Methanol handling is limited to filling the designated methanol tank only. During refilling, appropriate personal protective equipment must be worn, including protective gloves and eye protection. Smoking, open flames, and sources of ignition are strictly prohibited in the vicinity of the system during refueling. Only methanol of the specified quality shall be used. The use of contaminated or unspecified fuel may result in system malfunction and safety risks.

2.6 Hydrogen and Reformate Gas Safety

Hydrogen is generated internally during the methanol reforming process and supplied to the fuel cell stack. Hydrogen is a flammable gas with a wide flammability range and low ignition energy. Although hydrogen is not stored, leaks within the system may result in hazardous conditions. The system is equipped with internal gas monitoring and safety mechanisms designed to detect abnormal conditions and trigger protective shutdowns. Operators must ensure that ventilation openings on the enclosures are always unobstructed. Operating the system in poorly ventilated areas is not permitted.

2.7 Thermal Hazards

During operation, several components inside the fuel cell enclosure operate at elevated temperatures. This includes the reformer, fuel cell stack, exhaust components, and internal coolant circuits. Contact with hot surfaces may cause severe burns. Operators shall not open enclosures or attempt to access internal components during operation or shortly after shutdown. Warning labels indicating burn hazards must always be observed.

2.8 Fire Safety and Ventilation

The system contains flammable substances and generates exhaust gases during operation. Adequate ventilation is essential for safe operation. The exhaust contains primarily water vapor, carbon dioxide and traces of residual substances. Prolonged exposure must be avoided. The system must be installed and operated in an area free of combustible materials, volatile chemicals, and flammable vapors. A suitable fire extinguisher appropriate for electrical and chemical fires must be available in the vicinity of the system, in accordance with local regulations.

2.9 Battery Safety

The system includes a battery energy storage system operating at 48 V DC. Batteries store significant electrical energy and may pose risks related to electrical shock, high short-circuit currents, thermal runaway, or chemical exposure if damaged. Operators shall not disconnect battery cables or attempt any battery servicing. Visible damage, unusual noises, odors, or excessive heat must be reported immediately and the system must be shut down if safe to do so.

2.10 Solar Panel Safety

The solar photovoltaic module generates electrical power when exposed to light. Even when the system is shut down, the solar panel may be electrically active. Direct contact with exposed electrical connectors is prohibited. The solar module and its mounting arrangement shall not be modified by the user.

2.11 Emergency Shutdown Procedure

The system is equipped with an emergency shutdown device (red emergency stop button) designed to immediately stop operation and isolate power sources in the event of a hazardous situation. The emergency shutdown shall be activated in situations such as:

- Fire inside or near the system
- Fuel leakage
- Strong odor of methanol or gas

- Uncontrolled system behavior

After activating the emergency shutdown, operators must move to a safe distance and follow local emergency procedures. The system shall not be restarted until inspected and released by authorized personnel.

2.12 Personal Protective Equipment (PPE)

During normal operation, no special protective equipment is required. During permitted user activities such as refilling methanol or process water, appropriate personal protective equipment shall be worn. This includes protective gloves and eye protection suitable for handling chemical liquids.

3 Intended Use and Limitations

3.1 Intended Use

The MSK GEN1 is designed as a stationary emergency and backup power supply for residential applications. The system is intended to provide electrical energy to the connected house or facility electrical network during grid outages. Under normal conditions, the system remains in standby mode and starts automatically when defined start criteria are met, such as loss of grid power and sufficient system readiness. Electrical energy is generated using a reformed methanol fuel cell system and is buffered by an integrated battery energy storage system. Power is supplied to the connected loads via inverter units converting DC energy to AC power. A photovoltaic module supports recharging of the battery system. The system is designed for unattended operation within the operating limits described in this manual.

3.2 Permitted User Interactions

User interaction with the MSK GEN1 is strictly limited. The user is permitted to interact with the system only while the system is in standby mode and only as explicitly described in this manual. Permitted user actions are limited to:

- Monitoring system status and operating information via the operating panel
- Refilling methanol via the designated filling port
- Refilling demineralized process water via the designated filling port
- Performing basic visual inspection of the system exterior

All other actions are not permitted for the user. In particular, the user shall not:

- start or stop the fuel cell system by electrical switching
- switch batteries ON or OFF
- operate or change the position of main circuit breakers (MCBs)
- access internal components, filters, sensors, or enclosures
- perform maintenance, servicing, or electrical work

Technical operations, electrical switching, maintenance activities, and system adjustments are reserved exclusively for qualified electricians or authorized service personnel. A detailed description of permitted routine user actions is provided in Chapter 7. A complete list of actions not permitted for the user is provided in Chapter 3.4.

3.3 Operating Environment

The system is intended for stationary installation in a fixed location outdoors. The fuel cell stack and the reformer can only operate on a level, horizontal surface. The system must therefore be installed on a level, stable foundation. It shall be operated only within the environmental conditions specified in this manual, including allowable ambient temperature range, and installation altitude. Operation outside these limits may result in reduced performance, system malfunction, or safety hazards. The system requires sufficient ventilation to ensure safe dissipation of waste heat and exhaust gases. All ventilation openings must remain unobstructed during operation. Operation in environments with flammable gases, aggressive chemicals, excessive dust loading, or corrosive atmospheres is not permitted unless explicitly approved. In addition, it would be advantageous if the system were oriented in the direction that receives the most hours of sunlight per day, in line with the orientation of the solar panels. Therefore, the system should not be covered by a roof or similar structure, nor should it be in the shade in any way.

The system is designed for outdoor installation and is weather-resistant. The prohibition of roofs or covers refers to ventilation and thermal behavior and does not negate exposure to normal weather conditions.

3.4 Limitations of Use

The system is not designed for mobile use, temporary sites, marine applications, or use in explosive atmospheres unless explicitly stated otherwise. The following uses are strictly prohibited:

- Operation with fuels, fluids, or consumables other than those explicitly specified for the system
- Modification of system hardware, software, safety devices, or control parameters, including maintenance intervals
- Operation of the system with damaged enclosures, cables, or components
- Operation without required ventilation or with blocked exhaust or air paths
- Opening internal system enclosures or accessing internal components
- Access to the fuel cell stack, reformer, internal control units, or other safety-critical subsystems
- Performing electrical work or replacing internal components, sensors, or fluids not explicitly designated for user access
- Bypassing, overriding, or disabling safety functions, protective devices, or interlocks

Using the system outside its intended use or stated limitations voids any warranty and may lead to hazardous situations.

3.5 Responsibility of the Operator

The operator is responsible for ensuring that the system is used only within the scope described in this manual. This includes ensuring that:

- Only approved consumables are used
- The system is kept in a safe and operable condition
- Visible damage or abnormal behavior is reported immediately
- Safety instructions are followed at all times

The operator is not permitted to perform installation, commissioning, repair, or servicing activities unless explicitly authorized.

3.6 Regulatory and Legal Compliance

The system is designed to comply with applicable standards and regulatory requirements at the time of manufacture, including but not limited to electrical safety and fuel cell system standards. The operator is responsible for ensuring compliance with local laws, regulations, and permitting requirements related to installation location, fuel storage, fire safety, and electrical connection. Local regulations may impose additional requirements beyond those described in this manual. Compliance with such regulations is the responsibility of the system operator.

3.7 Important Notice – Standby Operation, Battery Behavior and Winter Use

The following information is essential for safe, reliable, and long-term operation of the MSK GEN1. Failure to understand or consider these points may lead to reduced system lifetime, increased wear of components, or system damage, particularly during winter operation.

Standby Operation as the Normal Operating State

The MSK GEN1 is designed to remain in standby mode as its normal operating state. In standby mode:

- The system is electrically energized
- Internal monitoring and protection functions are active
- Temperature-dependent protection functions (e.g. heating) may operate
- The system is ready to start automatically when required

⚠ User interaction is permitted only while the system is in standby mode.

Battery System and Standby Energy Supply

During standby operation, the system requires a continuous supply of electrical energy to power internal auxiliary loads such as control electronics and heating functions. This standby energy is supplied in one of two ways:

1. Preferentially from the building grid connection, if available
2. From the internal battery system, if no grid supply is present

The photovoltaic module continuously charges the battery system according to the battery management system (BMS) logic when solar energy is available.

Battery Behavior Without Grid Supply

If no building grid supply is connected, all standby energy is drawn from the battery system. If the battery state of charge drops below a defined threshold:

- The fuel cell system will start automatically
- The sole purpose of this start is to recharge the batteries
- Once sufficient battery charge is restored, the fuel cell system shuts down again

These short and frequent start–stop cycles are unfavorable for the service life of:

- The fuel cell stack
- The reformer
- Balance-of-Plant components

Winter Operation – Critical Recommendation

During winter operation, internal heating functions are required to protect system components from freezing.

⚠ For winter operation, continuous supply from the building grid is strongly recommended.

Operating the system in winter without grid supply may result in:

- Frequent battery-driven starts of the fuel cell system

- Increased wear of fuel cell components
- Reduced system lifetime

While operation without grid supply is technically possible, it should be regarded as exceptional and temporary only.

Important User Responsibilities

The user is responsible for ensuring that:

- The system remains in standby mode whenever possible
- A building grid connection is present during winter operation
- Unnecessary de-energization of the system is avoided
- Operation outside the recommended conditions is minimized

Understanding the relationship between standby mode, battery behavior, and fuel cell operation is essential for optimal use of the MSK GEN1.

4 System Description and Components

4.1 General System Description

The MSK GEN1 is a stationary, self-contained prototype backup power system designed to provide electrical energy during grid outages within a research and development context. The system integrates multiple energy technologies into a single functional unit, combining:

- Electrochemical power generation
- Electrical energy storage
- Power conversion
- And auxiliary energy input

The MSK GEN1 uses a centralized DC energy architecture. Both the battery system and the fuel cell system supply energy to a common DC bus. Power conversion to AC is performed by integrated inverter units. All major components are housed in closed enclosures intended for outdoor installation. The system is designed for largely unattended operation once installed and configured.

4.2 System Architecture and Energy Concept

The MSK GEN1 follows a hybrid energy concept based on the interaction of three main subsystems:

- A reformed methanol fuel cell system as the primary energy source
- A 48 V battery energy storage system for startup energy, buffering, and transient load support
- Inverter units converting DC energy into usable AC power

A photovoltaic module supports charging of the battery system when solar energy is available. Electrical energy flow within the system is managed automatically depending on grid availability and internal system conditions. The user does not control internal energy routing or subsystem coordination.

4.3 Zoning Concept and Enclosure Structure

For safety, clarity, and functional separation, the system is divided into two physically distinct enclosures:

Zone 1 – Fuel Cell and Media System

Contains components related to:

- Fuel processing and power generation
- Methanol and process water storage
- Fuel cell stack and reformer
- Associated cooling, ventilation, and safety monitoring

Zone 2 – Electrical and Power Distribution System

Contains components related to:

- Battery energy storage
- Power electronics and inverters
- Electrical protection and external connections

The separation of Zone 1 and Zone 2 allows restricted access to safety-critical components while enabling defined user interaction where required.

4.4 Zone 1 – Fuel Cell, Tanks, and External Interfaces

4.4.1 Fuel Cell System

The fuel cell system is a reformer-based methanol HT-PEM fuel cell and its integrated balance of plant. Methanol and demineralized water are converted internally into a hydrogen-rich reformate gas, which is then used by the fuel cell stack to generate DC electrical energy. The fuel cell system operates fully automatically and includes:

- The reformer unit
- The fuel cell stack
- Internal power conditioning
- Cooling and ventilation systems
- Safety monitoring functions

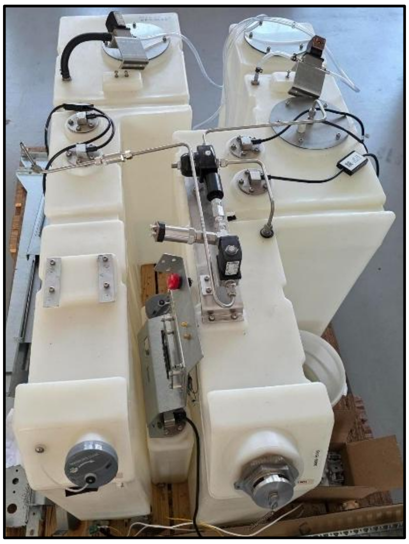
During normal operation, no user interaction with internal fuel cell components is required or permitted.

4.4.2 Methanol and Process Water Tanks

Zone 1 contains two integrated liquid storage tanks:

- A methanol tank with a nominal capacity of 150 liters,
- A process water tank with a nominal capacity of 120 liters.

When filled according to specification, these tanks provide consumables for approximately 64 hours of operation under nominal conditions at 5.5 kW. Tank filling ports are located behind a lockable external access door and are accessible to the user as described in Chapter 7.



4.4.3 Zone 1 External Interfaces

On the exterior of Zone 1, the following user interfaces are provided:

- A lockable access door for methanol and process water filling
- The operating panel, which serves as the primary user interface for the entire system

All normal user interaction is intended to take place exclusively via these external interfaces. No user access to the internal fuel cell compartment of Zone 1 is permitted.

4.5 Zone 2 – Batteries, Inverters, and Electrical Distribution

4.5.1 Battery Energy Storage System

The system includes a 48 V DC battery energy storage system consisting of three battery units with approximately 5 kWh per battery. The batteries serve several functions:

- Supplying electrical energy during fuel cell startup
- Buffering load changes during operation
- Stabilizing the internal DC bus

Direct access to internal battery components is not permitted for the user.

4.5.2 Inverter and AC Distribution System

Three Inverter units convert DC electrical energy into 230 V / 400 V AC electrical power for external loads. The inverter system operates automatically and synchronizes power delivery depending on system state and load demand. The user does not manually control inverter operation. External AC interfaces may include:

- Integrated AC sockets on the system enclosure
- Fixed electrical connections via internal terminals located in Zone 2

Details of installation and wiring are outside the scope of this manual.

4.6 Electrical Connections and Operating Concepts

The MSK GEN1 is designed to support different electrical operating concepts depending on the intended use case. All electrical connections must be planned and implemented by a qualified electrician. The system supports three distinct operating modes, which differ in the way electrical energy is supplied to external loads and how grid availability is handled.

4.6.1 General Electrical Concept

The MSK GEN1 generates electrical energy internally and provides it via integrated inverter units. Depending on the operating mode, electrical energy is supplied either directly to connected consumers or integrated into parts or all of a building's electrical installation. In operating modes with grid integration, the system is supplied with electrical power from the building installation during normal grid availability. This supply is required, among other things, to maintain standby operation and frost protection functions.

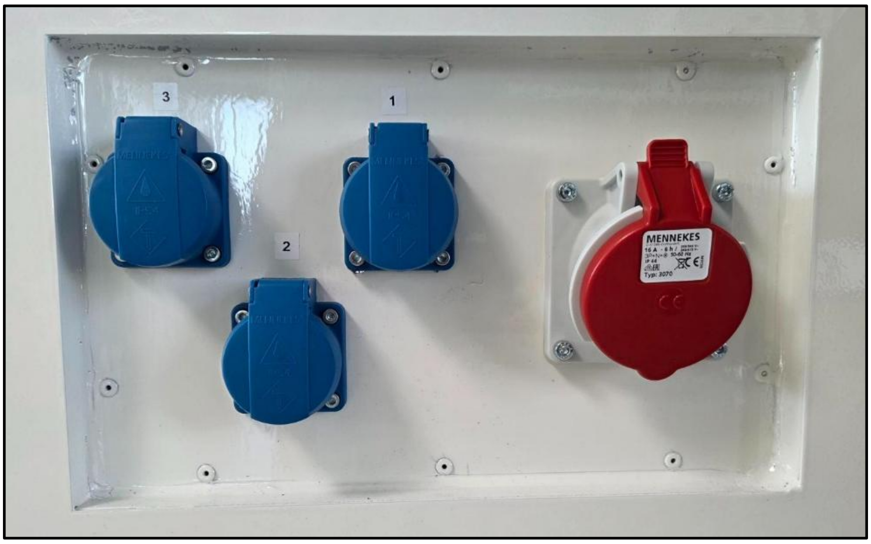
4.6.2 Operating Mode 1 – Island Operation (Standalone)

In island operation, the MSK GEN1 is used as a stand-alone power source, independent of any public grid connection. In this mode:

- The system can be placed at any suitable location
- No grid sensing is active
- External consumers are supplied directly

Electrical energy is provided via:

- Three 230 V AC sockets
- One 400 V AC three-phase connection



External loads may be connected directly to these interfaces. When electrical power is demanded by connected consumers, the battery system and fuel cell system are activated automatically. This operating mode is intended for temporary applications where no grid connection is available.

4.6.3 Operating Mode 2 – Backup Power via 32 A Connection

In this operating mode, the MSK GEN1 is connected to a defined electrical sub-circuit of a building via a 32 A three-phase connection. The corresponding 32 A socket must be provided by the building installation and connected by a qualified electrician. In this configuration:

- The system continuously monitors grid availability via the external electrical connection
- During normal grid operation, the system remains in standby and is supplied from the building installation
- In the event of a grid outage, the system starts automatically and supplies the connected sub-circuit with backup power

This mode allows selected electrical loads to be supplied during a power outage without integrating the system into the full building distribution.

4.6.4 Operating Mode 3 – Full Building Integration

In full building integration mode, the MSK GEN1 is connected to the entire electrical installation of a building. In this configuration:

- All building circuits may be supplied with backup power
- External grid sensing and system activation are handled by additional control equipment installed within the building
- The MSK GEN1 is triggered externally to start backup operation

This operating mode requires:

- Coordination between the manufacturer and the building electrician
- Additional switching and control equipment in the building installation

The MSK GEN1 is prepared for this operating mode, but the specific implementation depends on the building's electrical infrastructure.

4.6.5 Electrical Interfaces and Responsibilities

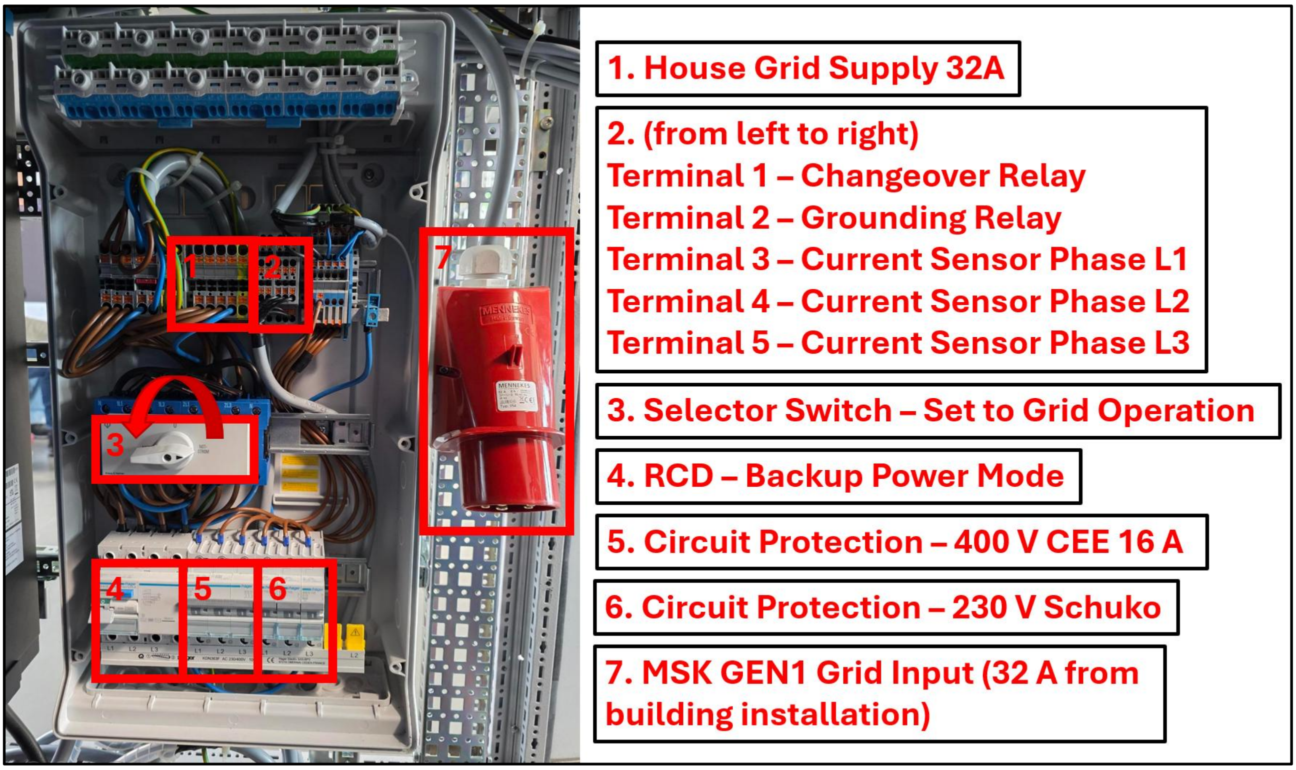
The MSK GEN1 provides defined electrical interfaces for integration into external electrical installations. These interfaces are located inside the white electrical cabinet in Zone 2. Integration into a building installation must be performed by a qualified electrician using appropriate three-phase, five-core AC cables. A selector switch with three positions is provided inside the electrical cabinet:

- Grid Operation
- OFF
- Emergency Operation

The correct selector switch position and the connection logic depend on the selected operating mode of the MSK GEN1. Detailed information on electrical connection options, selector switch usage, grid supply, standby behavior, and winter operation is provided in Chapter 4.6.6.

4.6.6 Information for Qualified Electricians (Electrical Connection Overview)

This section provides connection instructions for qualified electricians integrating the MSK GEN1 into a building electrical installation. It describes which building cables shall be connected to which interfaces inside the electrical cabinet in Zone 2, depending on the selected operating mode. This section does not replace applicable electrical standards or regulations. The electrician remains responsible for correct implementation in accordance with local rules. The manufacturer defines the system logic, interfaces, and operating dependencies described below. The electrical interfaces for building connection are located inside the white electrical cabinet in Zone 2 (see marked elements in figure below).



House Grid Input (Red Connector – Element 7)

The red 32 A connector (Element 7) is the grid supply input of the MSK GEN1. This connector is connected to a three-phase 32 A supply provided by the building installation. In operating modes with grid integration (Operating Mode 2 and 3), this connection supplies:

- Standby power
- Auxiliary loads
- Frost protection functions
- Grid availability for system monitoring

Building Cable Connection at Internal Terminals (Elements 1 and 2)

Inside the electrical cabinet, terminal blocks marked as Element 1 and Element 2 are provided for connection of the building installation.

Element 1 (House connection input, 32 A):

- Connection point for the building's three-phase five-core cable
- Supplies grid power to the system and enables grid supervision

Element 2 (terminals from left to right):

- Internal interface to the changeover relay
- Internal interface to the grounding relay
- Current sensors for Phase L1
- Current sensors for Phase L2
- Current sensors for Phase L3

The electrician shall connect the building supply conductors to these terminals according to the defined phase assignment and grounding concept.

Selector Switch Position (Element 3)

The rotary selector switch inside the cabinet (Element 3) defines how external electrical power is handled. The selector position must be set according to the selected operating mode:

- Island Operation (Operating Mode 1):
  Selector switch set to Emergency Operation ("NOT-STROM")
- Backup Operation via 32 A Connection (Operating Mode 2):
  Selector switch set to Grid Operation ("NETZ")
- Full Building Integration (Operating Mode 3):
  Selector switch set to Grid Operation ("NETZ")

Incorrect selector positioning will prevent proper system behavior.

Protective Devices and Outputs (Elements 4, 5 and 6)

The lower section of the cabinet contains protection and output elements:

- Element 4 – RCD (FI) for backup power operation
- Element 5 – Protection for 400 V CEE 16 A output
- Element 6 – Protection for 230 V Schuko output

These protective devices serve the respective AC outputs and shall not be modified or bypassed.

Standby Supply, Winter Operation and Battery Behavior

The MSK GEN1 must remain in standby operation during winter, as internal heating functions for system components are required. Standby power is preferentially supplied via the building grid connection (Element 7). This configuration ensures continuous standby operation and avoids unnecessary fuel cell operation. If no grid supply is present, the system draws standby energy from the internal battery system. The batteries are then recharged by the photovoltaic module according to the battery management logic. If battery state of charge falls below a defined threshold while no grid supply is present, the fuel cell system will start automatically solely to recharge the batteries and shut down again once charging is completed. These short, frequent operating cycles are unfavorable for the service life of the fuel cell stack, reformer, and Balance-of-Plant components. For this reason, continuous grid supply via the building connection is strongly recommended, especially during winter operation. Temporary adapters may be used at the red grid input for frost protection supply. The use of chain adapters or conversion to standard household plugs (Schuko) is not permitted.

Electrician Responsibility

The electrician shall:

- Select the appropriate operating mode
- Set the selector switch accordingly
- Connect the building installation to the designated terminals
- Ensure correct integration into the building's electrical system

The MSK GEN1 is electrically prepared for all described operating modes; the actual implementation depends on the building installation.

4.7 Solar Photovoltaic Module

A photovoltaic module is mounted across the system enclosures and electrically connected to the battery energy storage system. The photovoltaic system:

- Supplies DC power when exposed to sunlight
- Primarily supports battery recharging
- Operates fully automatically
- Requires no user interaction

Mechanical mounting and electrical integration of the PV module are part of the complete system and must not be modified by the user.

4.8 Ventilation and Thermal Management

Both Zone 1 and Zone 2 are equipped with active, temperature-controlled ventilation using electrically driven fans. Ventilation ensures:

- Removal of waste heat
- Dilution of exhaust gases
- Safe operating temperatures for components

Users must ensure that:

- Ventilation openings remain unobstructed
- The system is not operated in confined or unventilated spaces
- Abnormal noise, odor, or ventilation malfunction is reported immediately

4.9 Access Levels and User-Permitted Areas

The MSK GEN1 incorporates clearly defined access levels in order to ensure operational safety, protect safety-critical components, and clearly separate user operation from service activities. Access to system areas is controlled by mechanical locks. The system is delivered with dedicated keys that define which areas may be accessed by the user.

User-Accessible Areas (Keys Provided to the Customer)

The customer receives individual keys allowing access to the following areas only:

- Zone 1 – Tank Access Door
  Access to the methanol and process water filling ports.
- Zone 1 – Fuel Cell MCB Door
  Access to the circuit breakers related to the fuel cell system, for inspection only.
- Zone 2 – Battery and Main MCB Door
  Access to designated main circuit breakers and external electrical interfaces.

- Zone 2 – Electrical Cabinet Door
  Access to the white electrical cabinet, for qualified electricians only, as described in Chapter 4.7.

These access points are intended solely for the purposes explicitly described in this manual.

Restricted Areas (No User Access)

All other system enclosures, doors, and internal compartments are restricted areas. In particular, the user shall not access:

- The fuel cell stack and reformer compartment
- Internal Balance-of-Plant components
- Internal electrical control units
- Internal safety and monitoring systems

Access to these areas requires special keys, which are retained exclusively by the manufacturer or authorized service personnel.

Access Rules and Responsibilities

The user is responsible for ensuring that:

- only permitted areas are accessed,
- all doors and covers are closed and locked after use,
- no restricted areas are opened under any circumstances.

Opening restricted system areas or using unauthorized keys constitutes unauthorized access and may result in system damage, safety hazards, and loss of warranty or service eligibility.

5 How the System Works

5.1 General Operating Principle

The MSK GEN1 is designed to operate primarily in automatic mode, with the main purpose of supplying electrical power during a grid outage without requiring user confirmation or continuous intervention. Under normal conditions, the system remains in standby mode, electrically energized and ready to start. In this state, all designated main circuit breakers (MCBs) must remain switched ON. While in standby, the system continuously monitors external grid availability via the connected electrical wiring as well as relevant internal system conditions. A loss of grid power is the primary trigger for automatic system startup. The user is not required to confirm or initiate this process during normal operation.

5.2 Standby Operation with Grid Available

When the public grid is available, the system stays in standby mode and does not actively generate electrical power using the fuel cell system. The battery energy storage system remains connected and available, and all monitoring and control functions are active. During standby operation, internal auxiliary consumers such as control electronics, monitoring devices, or temperature-dependent components are supplied from the public grid via the external electrical wiring as described in chapter 4.6. This includes, for example, battery heating functions in cold ambient conditions. Maintaining the system in standby ensures that it can respond immediately and reliably to a grid outage.

5.3 Automatic Start During Grid Outage

If a grid outage is detected, the system automatically initiates the backup power sequence. No user interaction is required for this process. Immediately after grid loss, the battery energy storage system assumes power supply duties. This ensures that internal system components remain operational and that connected loads continue to receive electrical energy. At the same time, the fuel cell system begins its automatic startup and warm-up sequence.

5.4 Fuel Cell Warm-Up and Power Takeover

Before electrical power generation can begin, the fuel cell system must reach its defined operating conditions. This warm-up phase typically lasts approximately 20 minutes and is fully controlled by the system. During the warm-up phase, electrical loads are supplied exclusively by the battery system while internal components such as the reformer and the fuel cell stack are heated in a controlled manner. Throughout this process, all monitoring and safety functions remain active.

Once the operating temperature and other required conditions are reached, the fuel cell system begins generating DC electrical energy from methanol and process water. This energy is then used both to supply the connected loads via the inverter system and to recharge the battery energy storage system. The transition from battery-only operation to fuel-cell-supported operation occurs seamlessly and without any interruption to the user.

5.5 Normal Backup Power Operation

After the fuel cell system has taken over power generation, the system enters normal backup power operation. In this state, electrical energy is continuously produced by the fuel cell system and distributed internally according to system demand. The battery energy storage system acts as an energy buffer, smoothing load variations and stabilizing the internal DC bus. If sufficient solar radiation is available, the photovoltaic module may additionally supply electrical energy to support battery recharging. All power flows are managed automatically by the system controller, and no user interaction is required during this phase.

5.6 Return of Grid Power

When public grid power is restored, the system detects grid availability automatically. Further system behavior depends on the selected operating configuration. During a manual shutdown sequence, power generation is ramped down in a controlled manner. Cooling and ventilation systems remain active as required to ensure a safe reduction of internal temperatures. Once the shutdown sequence is completed, the system returns to standby mode and remains electrically energized and ready for the next grid outage.

5.7 Manual Operation by the User

In addition to automatic operation, the user has access to limited manual control functions via the operating panel. From standby mode, the user may initiate a manual system start. This manual start follows the same controlled startup sequence as an automatic start triggered by a grid outage. During normal backup power operation, the user may also issue a manual stop command. A manual stop always initiates a controlled shutdown sequence and does not trigger an emergency shutdown. The user may completely de-energize the system by switching designated MCBs to the OFF position, see chapter 9.7 for full implications. It is the user’s responsibility to ensure that the system remains in standby mode whenever automatic backup functionality is required.

5.8 User Feedback and System Status Indication

The current operating state of the system is communicated to the user via the operating panel mounted on the exterior of the system. The operating panel provides status and orientation information only and does not replace diagnostic tools or service interfaces. Details regarding the operating panel, user interaction, and available control functions are described in Chapter 6.

6 User Interface and Basic Operation

6.1 General Concept of User Interaction

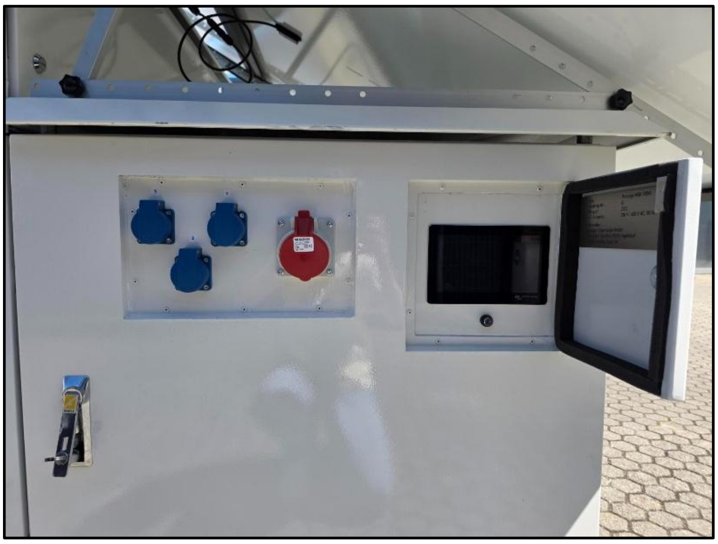
The MSK GEN1 is designed to be operated primarily through a single, centralized operating panel installed on the exterior of Zone 1. This panel serves as the main user interface for all normal interaction with the system. The user interface concept follows a clear and conservative design philosophy: all safety-critical functions and internal control logic are handled automatically by the system, while the user is provided only with essential operating functions and system information. Apart from the operating panel and designated main circuit breakers (MCBs), no additional local user interfaces are required for normal operation. The operating panel provides limited control functions. These functions are intended for supervised operation and commissioning only and are available exclusively while the system is in standby mode.

6.2 Operating Panel Location and Purpose

The operating panel is mounted behind a small lockable access door on the wall of Zone 1. This door can be opened using the key supplied with the system. This allows the user to monitor and control the system safely during normal operation. The panel provides the user with:

- A clear overview of the current system status
- Relevant operating and performance values
- The ability to manually start or stop the fuel cell system
- The ability to set the desired output power

The operating panel is intended for use during normal operation only. It does not provide access to internal configuration parameters or diagnostic functions.



6.3 Displayed System Information

The operating panel displays a defined set of system values that are relevant for operation, monitoring, and basic evaluation of system performance. These values are automatically measured and updated during operation. Displayed values include, but are not limited to:

- Output power
- Methanol tank level
- Process water tank level
- Number of start/stop cycles
- Operating time of the fuel cell system
- Total electrical energy produced
- Oil temperature at fuel cell stack outlet
- Coolant temperature

The displayed values are intended to provide transparency regarding system operation and general system condition. They are not intended to replace professional diagnostic tools or service measurements.

6.4 System Status Indication

The system operates in clearly defined states, as described in Chapter 5. The current operating state is continuously displayed on the operating panel. State transitions are handled automatically by the system and do not require user intervention unless explicitly indicated. The status indication allows the user to quickly assess whether the system is ready, operating normally, or requires attention.

6.5 Operating Panel Functions

The operating panel provides exactly three active control functions that are available to the user. First, the user may start the fuel cell system manually when the system is in standby mode and all required conditions are met. A manual start initiates the same controlled startup sequence as an automatic start caused by a grid outage.

Second, the user may stop the fuel cell system manually during normal operation. A manual stop always triggers a controlled shutdown sequence. Power generation is ramped down in a defined manner, and cooling and ventilation functions remain active as required. Manual stop does not trigger an emergency shutdown.

Third, the user may set the desired output power using a numeric value. The system interprets this value as a target output level within the permitted operating range. Actual power output depends on system conditions and internal limitations and is continuously monitored by the control system. No other control functions are available to the user via the operating panel.

6.6 Circuit Breakers and Standby Availability

Designated main circuit breakers (MCBs) are accessible to the user as defined in this manual. These circuit breakers are not part of the operating panel but are essential for system availability. For automatic backup power operation, all required MCBs must remain switched ON. See chapter 9.7 for full implications.

6.7 Remote Access and Communication

The operating panel communicates with the fuel cell system and the overall system controller via a router-based communication interface. This communication architecture allows the system to be accessed not only locally via the operating panel, but also remotely for monitoring and control purposes. Remote access may be provided via a web browser or a dedicated application, depending on project-specific configuration. Remote access may allow connection to the operating panel user interface.

6.8 User Interaction Principles

During normal operation, user interaction with the MSK GEN1 is intentionally limited. Under typical conditions:

- Automatic operation does not require user confirmation
- Manual interaction is restricted to start, stop, and power setpoint functions
- All safety-critical decisions are handled internally by the system

Users shall not attempt to influence system behavior beyond the functions explicitly described in this chapter.

6.9 User Interface Screens – Overview

The following screenshots provide an overview of the user interface as displayed on the operating panel. Displayed values and layouts may vary depending on system state and configuration.

Figure 6-1 – Basic Control Screen (Start/Stop and Power Setpoint)

This screen allows basic interaction with the system. The AC output can be enabled or disabled, and the desired fuel cell output power can be adjusted using the plus and minus buttons. These controls are available only when the system is in standby mode.

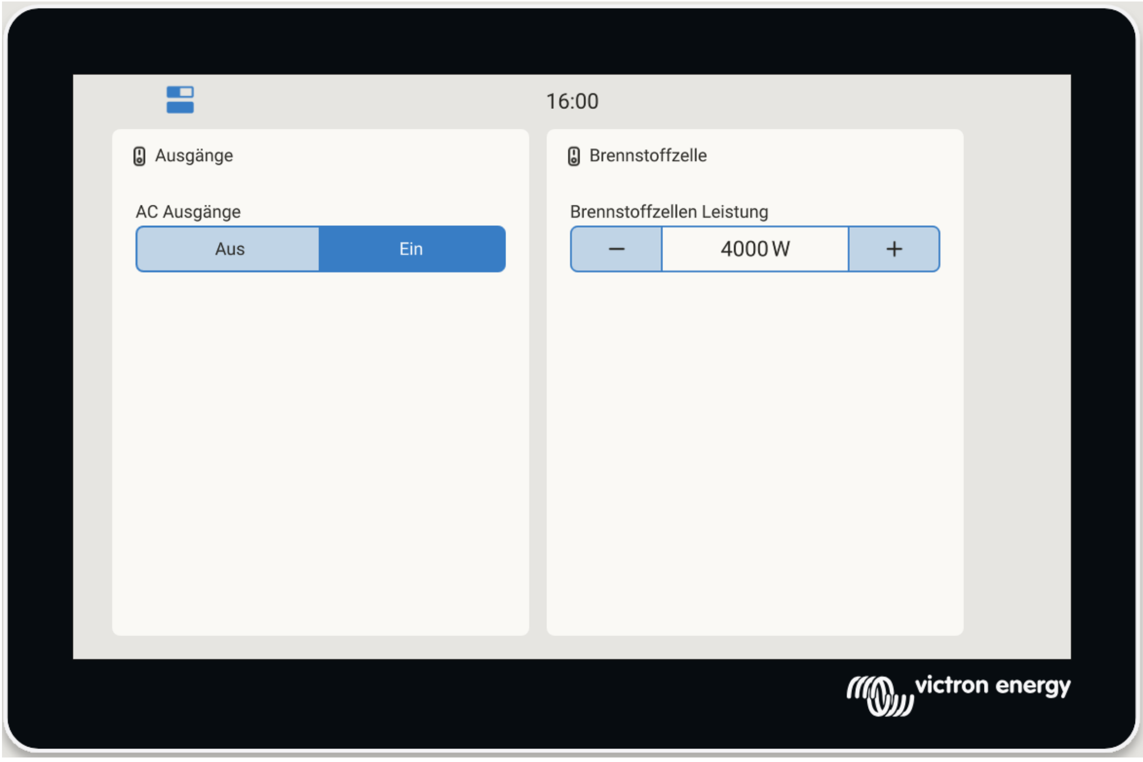


Figure 6-2 – Quick View (Kurzansicht)

The quick view provides a compact overview of the current system status. It shows the battery state of charge, selected tank levels, and current power values at a glance. This view is intended for orientation and monitoring purposes.

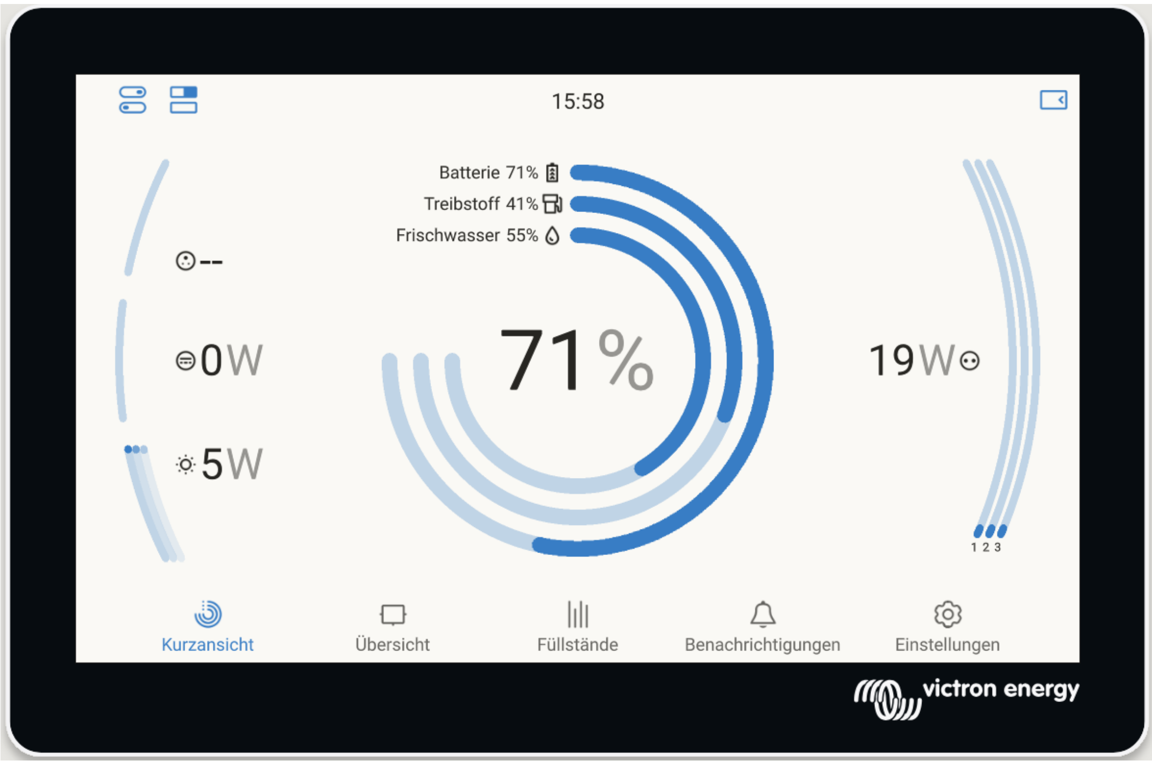


Figure 6-3 – System Overview (Energy Flow)

The system overview screen visualizes the current energy flow within the system. It shows the status of the grid connection, inverter operation, battery charging or discharging, fuel cell activity, and connected AC loads. Displayed values represent the current operating state.

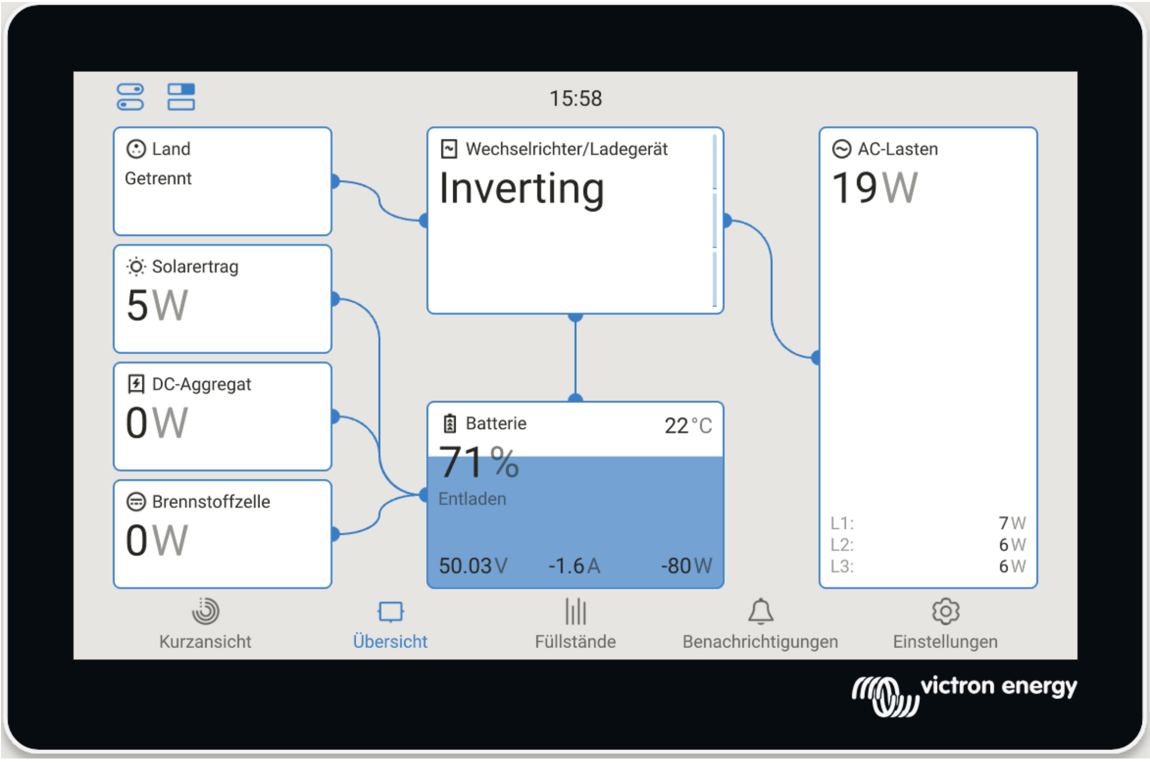


Figure 6-4 – Tank and Media Levels

This screen displays the fill levels of the methanol tank and the process water tank. Percentages and absolute values provide an indication of remaining consumables. These values help the user plan refilling during standby operation.

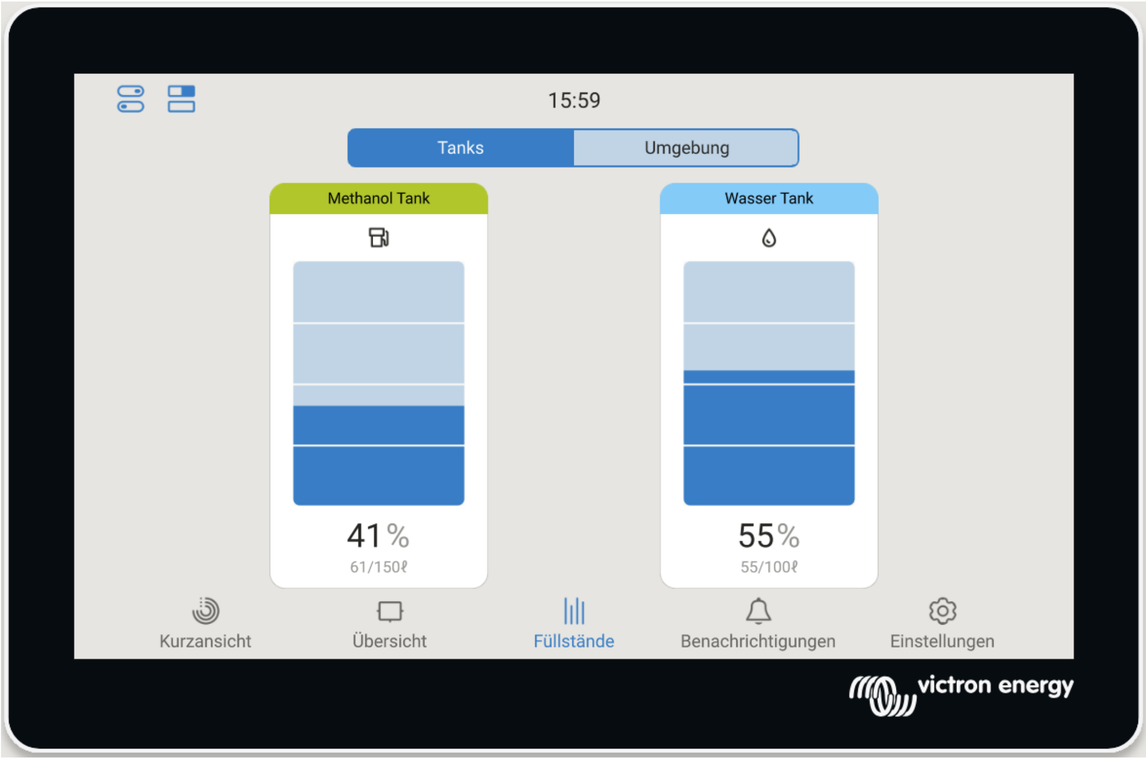


Figure 6-5 – Notifications Overview

The notifications screen shows system messages, warnings, or alarms. If no messages are active, the screen indicates that there are no current notifications. Details on alarms and required user response are described in Chapter 8.

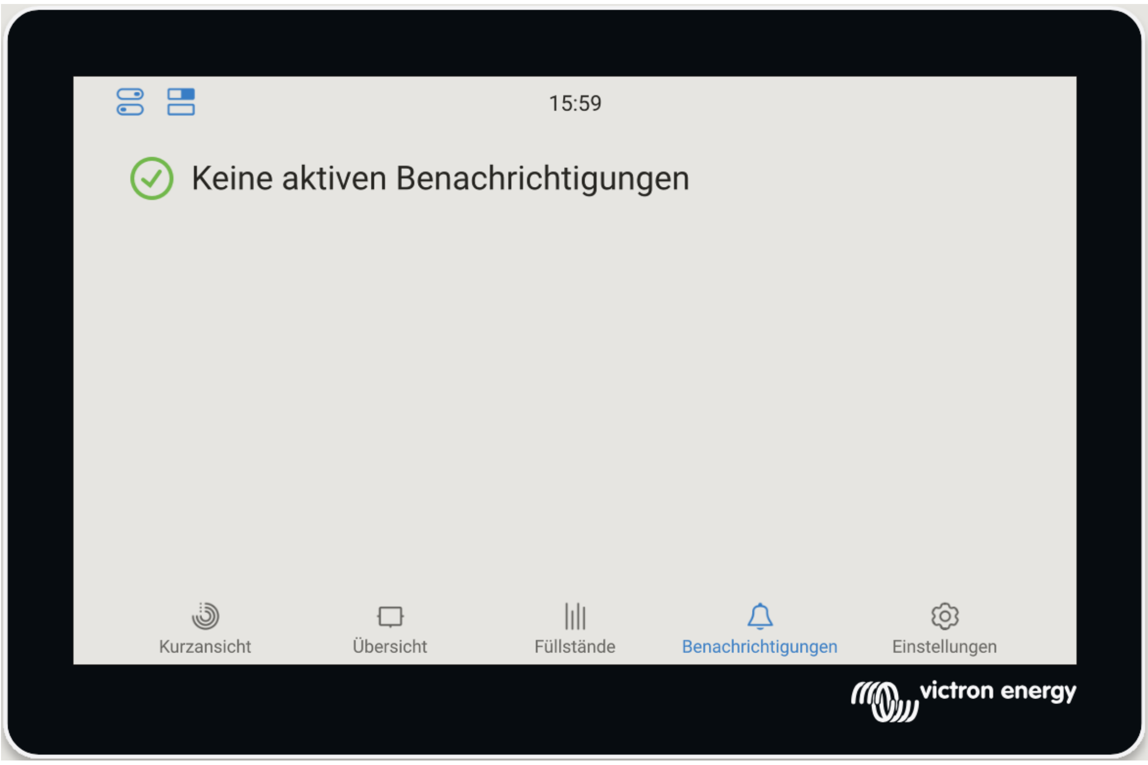


Figure 6-6 – Settings and System Configuration Menu

The settings menu provides access to general system information and configuration sections. Depending on system configuration and user permissions, some menu items may be visible but not accessible. Configuration changes are reserved for authorized personnel.

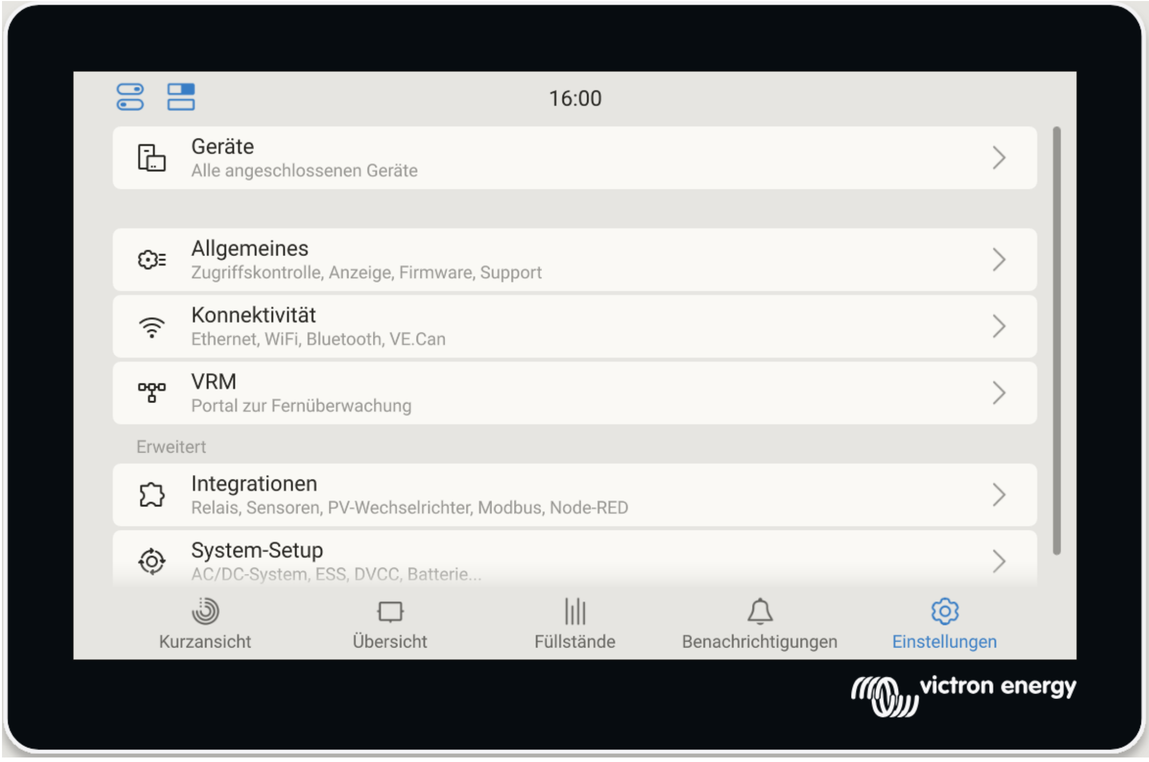
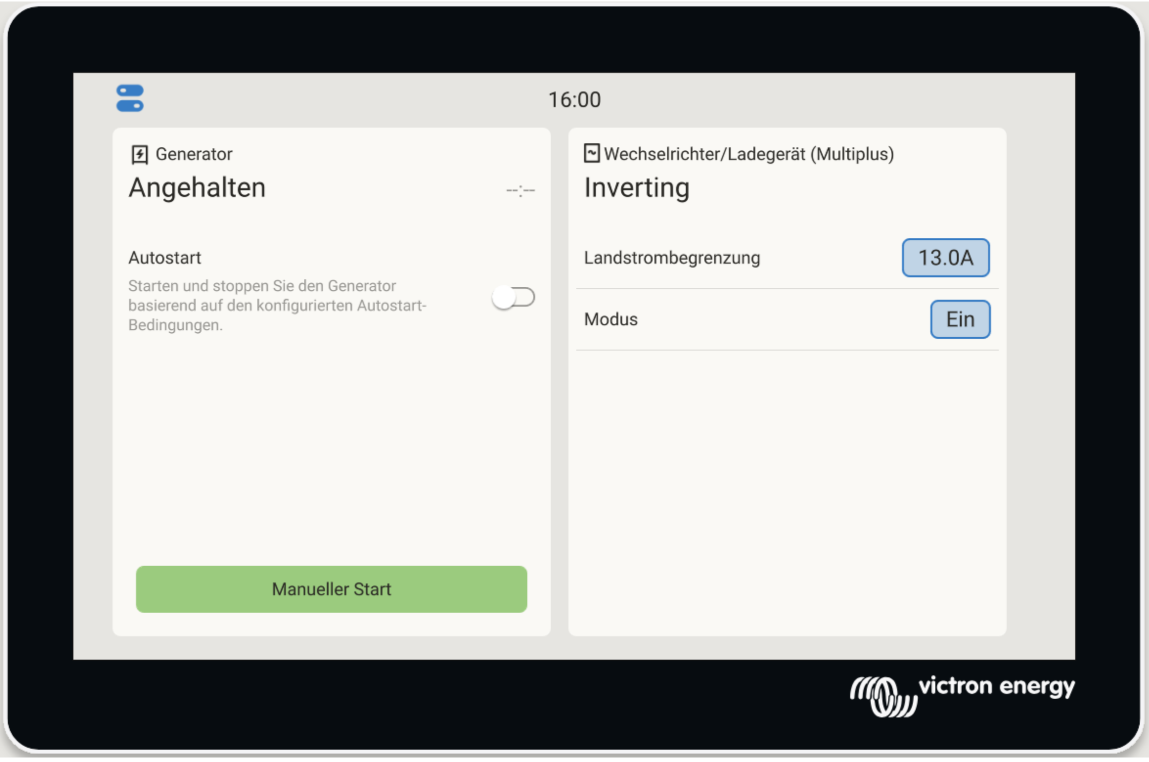


Figure 6-7 – Generator and Inverter Status Screen

This screen displays the current status of the fuel cell system and the inverter units. It shows whether the fuel cell is stopped or running and indicates the operating mode of the inverter system. Manual start options may be displayed depending on system state.


16:00
Generator
Angehalten
--:--
Autostart
Starten und stoppen Sie den Generator basierend auf den konfigurierten Autostart-Bedingungen.
Manueller Start
Wechselrichter/Ladegerät (Multiplus)
Inverting
Landstrombegrenzung
13.0A
Modus
Ein
victron energy

7 Routine User Actions

7.1 Purpose of This Chapter

This chapter describes the only actions that may be performed by the user during normal operation of the MSK GEN1. All user actions are strictly limited to basic consumable handling and visual checks. No technical operation, switching, servicing, or maintenance tasks are permitted for the user.

7.2 General Rules for User Actions

⚠ All user actions are permitted only while the system is in standby mode. The user shall:

- Verify on the operating panel that the system is in standby mode
- Ensure that the system is not actively generating power
- Perform only the actions explicitly described in this chapter

Any action outside the scope of this chapter is not permitted and must be performed exclusively by authorized service personnel or qualified electricians.

7.3 Refilling Methanol

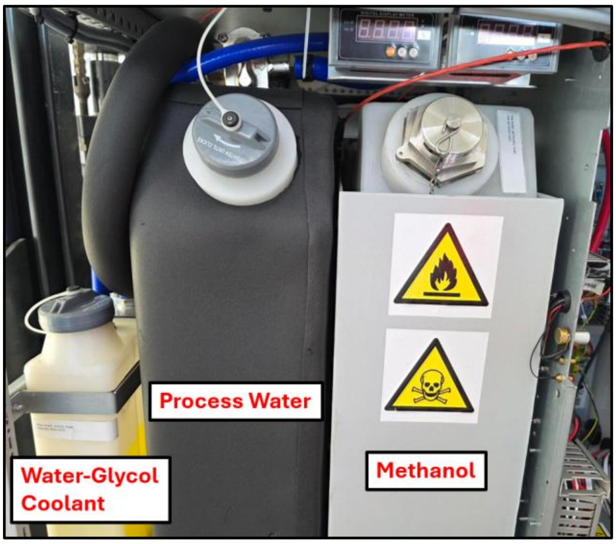
The fuel cell system requires pure methanol compliant with IMPCA reference specifications. The methanol must be of high purity to ensure safe reformer operation and reliable system performance. The electrical conductivity of the methanol shall be below 1.0 µS/cm. Refilling methanol is required to maintain system availability during extended backup operation. The methanol filling port is located on the exterior of Zone 1, behind a lockable access door provided with a dedicated key. Refilling shall be performed only in standby mode. During refilling, the user must ensure that:

- only approved methanol of the specified quality is used,
- no ignition sources (open flame, smoking, sparks) are present,
- appropriate personal protective equipment (protective gloves and eye protection) is worn.

The nominal tank capacity is 150 liters. Overfilling must be avoided. After refilling, the access door shall be closed and locked securely.

7.4 Refilling Process Water

Only deionized water according to ASTM Type 1 shall be used for fuel mixing and internal processes. High water purity is mandatory to protect the reformer and fuel cell stack from contamination. The electrical conductivity of the process water shall be below 1.0 µS/cm. The fuel cell system requires demineralized process water for proper operation. The process water filling port is located next to the methanol filling port in Zone 1, behind the same lockable access door. Only water of the specified quality shall be used. Refilling shall be performed only while the system is in standby mode. Introducing mineralized, contaminated, or unspecified water may cause system damage.



7.5 Actions Not Permitted for the User

The user shall not perform any of the following actions:

- Switching batteries ON or OFF
- Operating or changing the position of main circuit breakers (MCBs)
- Accessing filters, sensors, or internal system components
- Performing cleaning, flushing, or replacement of parts
- Performing electrical work or system configuration changes

These activities are reserved exclusively for qualified electricians or authorized service personnel.
A complete list of prohibited user actions is provided in Chapter 3.4.

8 Alarms, Messages, and User Response

8.1 Purpose and General Concept

The MSK GEN1 continuously monitors its operating condition using internal sensors, control logic, and safety systems. Based on this monitoring, the system may display status messages, warnings, or alarms on the operating panel to inform the user about the current system state or to protect the system from unsafe operation.

8.2 Types of Messages (Overview)

The following message types may be displayed:

- Status messages: Provide information about the current operating state of the system (e.g. standby, startup, operation).
- Warnings: Indicate conditions that require attention but do not immediately stop system operation.
- Alarms: Indicate conditions that prevent safe or reliable operation. Alarms may trigger automatic protective actions such as controlled shutdown or blocking of system operation.

Displayed messages depend on system configuration and operating state.

8.3 User Responsibilities in Case of Warnings or Alarms

When a warning or alarm is displayed, the user shall:

- Observe the message shown on the operating panel
- Avoid repeated restart attempts or manual intervention
- Perform only actions explicitly permitted in this manual (e.g. refilling consumables)
- Contact authorized service personnel if the message persists or if an alarm is indicated

⚠ The user shall not attempt troubleshooting, diagnosis, or system repair. All internal corrective actions, fault analysis, and servicing are reserved for authorized service personnel.

8.4 Emergency Situations

In the event of a hazardous situation (such as fire, fuel leakage, or uncontrolled system behaviour), the emergency shutdown procedure described in Chapter 2 shall be followed. Emergency shutdown is intended solely for real safety hazards and must not be used for routine operation or normal system control.

9 Shutdown, Emergency, and Special Operating Conditions

9.1 Overview of Shutdown Concepts

The MSK GEN1 supports different types of shutdown procedures depending on user intent and system conditions. Shutdown procedures are designed to ensure the safety of the system, protection of components, and controlled temperature reduction where possible. Not all shutdown types behave identically, and it is important for the user to understand the differences. This chapter describes:

- Normal shutdowns initiated by the user or automatically by the system
- Emergency shutdown behavior
- Consequences of switching the system fully off

9.2 Controlled System Shutdown

A controlled shutdown is the standard and preferred method to stop system operation. Controlled shutdowns occur when:

- The user manually stops the system via the operating panel
- Grid power is restored after backup operation
- The system initiates a shutdown due to non-critical conditions

During a controlled shutdown, the system gradually ramps down power generation. Cooling and ventilation systems remain active for the duration required to safely reduce internal temperatures. Once the shutdown sequence is completed, the system transitions into standby mode, remaining electrically energized and ready for automatic restart if required. Controlled shutdowns do not require further user action.

9.3 Manual Shutdown by the User

The user may manually stop the system using the operating panel at any time during normal operation. Manual shutdown follows the same controlled sequence as an automatic shutdown. Power generation is reduced in a controlled manner, and auxiliary systems such as ventilation continue to operate as needed. Manual shutdown via the operating panel does not disconnect the system from electrical power. The system remains in standby as long as all designated MCBs remain switched ON. Manual shutdown is the recommended method when the system is intentionally stopped by the user.

9.4 Automatic Shutdown Initiated by the System

The system may initiate an automatic shutdown in response to certain conditions detected during operation. Typical reasons include:

- Restoration of grid power
- Internal system conditions requiring temporary shutdown
- Protective responses to warnings or alarms

Automatic shutdowns are controlled and follow the same sequence as manual shutdowns unless a safety-critical situation requires otherwise. The user is notified of the shutdown via the operating panel.

9.5 Emergency Shutdown (Emergency Stop)

The system is equipped with an emergency shutdown device intended for hazardous situations. Activation of the emergency shutdown results in an immediate interruption of electrical power, including disconnection of the battery system. Unlike controlled shutdowns, this action does not maintain power to auxiliary systems such as ventilation or cooling. The emergency shutdown is intended for situations where immediate risk to persons or property exists, such as fire, fuel leakage, or severe malfunction. Emergency shutdown shall not be used for routine operation or normal system stopping.

9.6 Consequences of Emergency Shutdown

When the emergency shutdown is activated, the system enters a fully de-energized state. This state is equivalent to switching all relevant MCBs to the OFF position. The system is no longer in standby mode and cannot restart automatically. Following an emergency shutdown:

- A controlled cooldown may not have occurred
- Auxiliary protection functions may be inactive
- A full system restart procedure is required

Before restarting the system, the cause of the emergency shutdown must be identified and resolved. Restarting after an emergency shutdown requires re-energizing the system and following the defined restart sequence, which is described in a separate chapter.

9.7 Switching the System OFF via MCBs

The user may switch designated MCBs to the OFF position intentionally. Switching MCBs OFF removes electrical power from the system and disables standby operation, grid sensing, battery heating, and freeze protection functions. This state is not considered a normal operating condition. It is intended only for extended shutdown, storage, or transport. Implications of this state are described in detail in Chapter 11.

10 Maintenance and Responsibilities

10.1 Purpose of This Chapter

This chapter defines the maintenance concept of the MSK GEN1 and clearly assigns responsibilities for all maintenance-related activities. The MSK GEN1 is designed to require no user-performed maintenance beyond refilling consumables. All inspection, servicing, adjustment, and replacement of components are reserved exclusively for the manufacturer or authorized service personnel.

10.2 General Maintenance Concept

Maintenance of the MSK GEN1 follows a strict responsibility separation.

- The user is responsible only for refilling designated consumables and for basic visual inspection
- All technical maintenance, including filters, sensors, fluid systems, electrical components, and fuel-cell-related subsystems, is performed exclusively by authorized service personnel

The fuel cell system, battery system, and associated Balance-of-Plant components require specialized knowledge, tools, and procedures. User intervention in these areas is neither required nor permitted.

10.3 User-Permitted Actions (Consumables Only)

The user is permitted to perform only the following actions, provided that the system is in standby mode and not actively generating power:

- Refilling methanol via the designated methanol filling port
- Refilling demineralised process water via the designated filling port
- Visual inspection of the system exterior for obvious damage, leaks, or abnormal conditions

⚠ All other maintenance-related activities are not permitted for the user. The user shall not:

- Open system enclosures
- Access filters, sensors, or internal components
- Perform cleaning or replacement of any internal parts

After refilling consumables, all access doors must be closed and locked before returning the system to normal operation.

10.4 Preventive Maintenance (Service and Manufacturer Only)

The MSK GEN1 requires periodic preventive maintenance to ensure safe, reliable, and long-term operation. These activities are not user-serviceable and are carried out exclusively by the manufacturer or authorized service providers. Typical preventive maintenance tasks include, but are not limited to:

- Process water quality sensor inspection and verification
- Cathode air system servicing and flushing

- Replacement of cathode air filters
- Replacement of MultiTherm 503 heat-transfer oil
- Inspection of reformer, fuel cell stack, and Balance-of-Plant components
- Functional testing of safety and monitoring systems

Maintenance intervals are defined based on operating hours, calendar time, and system condition. Exact procedures and intervals are managed within the service concept and may vary depending on system usage and environmental conditions.

10.5 Maintenance Notifications and User Information

The system may display maintenance-related warnings or service notifications on the operating panel. Such notifications are intended to:

- Inform the user that service is due,
- Support timely coordination with authorized service personnel.

Maintenance notifications do not require user intervention beyond contacting the service provider, unless a separate safety-relevant alarm is displayed.

10.6 Responsibilities and Service Contact

The operator is responsible for:

- Operating the system strictly within the limits described in this manual
- Refilling consumables correctly and safely
- Ensuring that only authorized personnel perform maintenance or servicing
- Responding appropriately to warnings and alarms
- Contacting authorized service personnel when required

All maintenance, servicing, adjustments, or repairs beyond the permitted user actions must be carried out by Gumpert Automobile GmbH or a service provider authorized by the manufacturer.

11 Storage, Extended Shutdown and Transport

11.1 Purpose of This Chapter

This chapter describes the conditions and precautions required when the system is not kept in standby operation and electrical power is completely removed by switching the miniature circuit breakers (MCBs) to the OFF position. The procedures described here apply to:

- Extended planned shutdown periods
- Storage of the system
- Transport of the system
- Situations following an emergency shutdown

This chapter is critical for preventing damage caused by freezing, battery degradation, or improper re-energization.

11.2 Standby State vs. De-Energized State

The system is designed to remain in standby mode with all required MCBs switched ON as the normal and preferred condition. In standby mode, the system remains electrically energized, even when not generating power. Switching MCBs OFF disables all standby functions including freeze protection, see chapter 9.7 for full implications. The de-energized state is fundamentally different from standby operation and must be handled accordingly.

11.3 Starting or Restarting the System from a De-Energized State

The following procedure applies when the system is started for the first time after installation, after extended storage, or after a complete shutdown, including shutdown caused by an emergency stop. Before starting, ensure that all system enclosures are closed, all external connections are correctly installed, and no visible damage is present.

Step 1 – Switching on the MCB: In Zone 2, switch the main circuit breaker (MCB) to the ON position. This energizes the internal DC system and allows battery activation.

Step 2 – Activating the battery units: Starting from the top battery downward, switch the I/0 switches of all three battery units to ON (battery 1 (top) → battery 2 (middle) → battery 3 (bottom))

Step 3 – Waking Up the Battery System: On Battery 1 (top battery), press and hold the red, round SW button for approximately 5 seconds. After a short delay, the LEDs on all three batteries should begin blinking green, indicating that the battery system is active and synchronized.

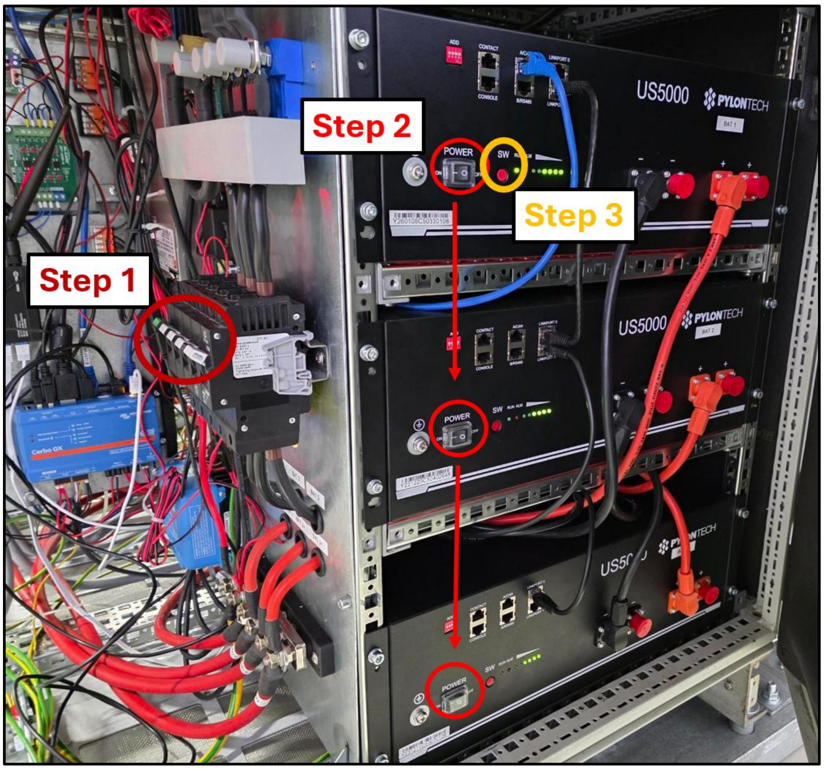
⚠ Do not proceed until all batteries show green blinking LEDs.

Step 4 – Activating the fuel cell system: Once the battery system is active, switch on the fuel cell circuit breakers in Zone 1 in the following order:

- Switch ON the small circuit breaker group for the Balance of Plant (BoP) on the left side
- Afterwards, switch ON the main circuit breaker group for the fuel cell stack on the right side

- After all fuel cell circuit breakers are switched ON, the system will automatically begin its internal initialization process

Step 5 – Transition to Standby Mode: After several minutes, the system will reach standby mode. System status information can be observed on the operating panel. No further user action is required at this stage.



11.4 Temperature and Freeze Protection Requirements

While the system is in standby mode, internal temperature-dependent functions may be active. When the system is fully de-energized (MCBs OFF), these protections are no longer active. Therefore, the following requirement applies: If the system is in a de-energized state, the ambient temperature must not fall below 0 °C. If this condition is not met:

- Process water may freeze and damage internal piping
- Battery heating systems are inactive
- Irreversible system damage may occur

The user is responsible for ensuring that environmental conditions remain within safe limits whenever the system is fully switched off.

11.5 Manual Shutdown Sequence Before De-Energizing the System

If the MSK GEN1 is intentionally shut down for extended periods (for example prior to storage, transport, or prolonged non-use), the following shutdown sequence shall be followed after the fuel cell system has completed a controlled shutdown and the system is in standby mode. The sequence ensures that all system components are switched off in a defined and safe order.

Shutdown Sequence

1. Switch OFF the fuel cell circuit breakers
   In Zone 1, switch all fuel cell-related MCBs to the OFF position.
2. Deactivate the battery system via the SW button
   On the top battery unit (Battery 1), press and hold the red SW button for approximately 5 seconds, until the green LED indicators turn off.
3. Switch OFF the battery unit I/0 switches
   Switch the I/0 switches of the three battery units to OFF, starting from the top battery and continuing downward.
4. Switch OFF the main battery circuit breaker
   In Zone 2, switch the main battery MCB to the OFF position.

After completing this sequence, the system is fully de-energized.

⚠ Important: This shutdown sequence applies only after the system has reached standby mode. Emergency shutdown situations are handled differently and are described in Chapter 11.6. Restart procedures after a fully de-energized state are described in Chapter 11.3.

11.6 Behavior After Emergency Shutdown

When the emergency stop button is activated, all main circuit breakers are automatically switched to the OFF position. The system enters a fully de-energized state. In this condition:

- Internal control and power systems are shut down
- The fuel cell system stops immediately
- The battery units remain switched ON unless manually turned off

Switching off the battery system after emergency shutdown: To fully shut down the battery system, press and hold the red SW button on Battery 1 for approximately 5 seconds. The battery LED indicators will turn off. The I/0 switches of all three batteries may remain in the ON position. These switches do not need to be changed for the next startup.

Restarting the system after emergency shutdown: To restart the system after an emergency shutdown, follow the procedure described in Chapter 11.3, starting from Step 1. The startup sequence is identical regardless of whether the system was shut down intentionally, due to extended storage, or by activation of the emergency stop.

11.7 Storage and Transport Considerations

For storage or transport of the system, the following conditions apply:

- The system shall be fully switched OFF
- No automatic functions are active
- Ambient temperature limits must be respected

No consumables shall be refilled or drained by the user unless explicitly instructed in separate documentation. Transport, relocation, and mechanical handling of the system may only be performed by qualified personnel.