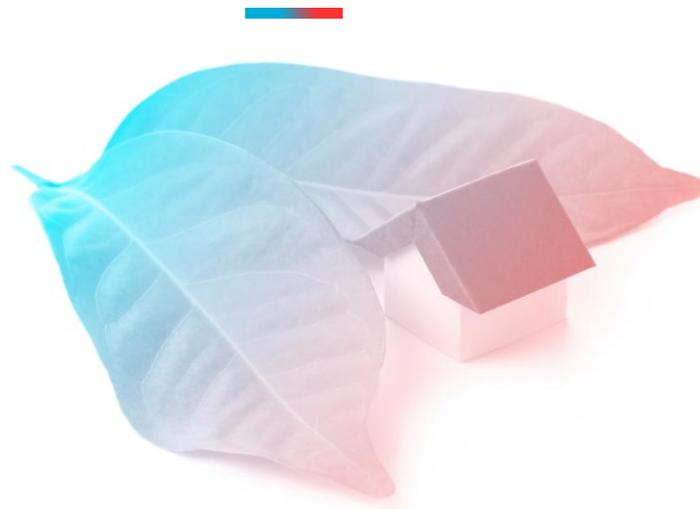




D7.9

System application methodology, protocols and installation guide



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Summary			
<p>The MiniStor project delivers a compact thermal and electrical storage solution demonstrated across five European sites (Cork, Sopron, Santiago de Compostela, Kimmeria, Thessaloniki). This guide outlines the standardized, multi-stage installation workflow including re-installation planning, infrastructure preparation, component placement, system interconnection, and commissioning. It is based on the installation as was performed and presented in Deliverable 6.4.</p> <p>Site preparation covers foundation and access works, roof or ground-mount support for flat-plate (FPC) and photovoltaic-thermal (PVT) collectors, and hydraulic/electrical interface points. On-site work focuses on placing the pre-tested container, mounting the collectors, connecting all utility loops, calibrating sensors, and integrating control and safety systems. Final commissioning entails functional tests, safety verifications, control logic tuning, and formal handover with user training.</p> <p>A list is provided of key supporting documents (installation and operation manuals, calibration procedures, PLC upload guides) and certificates/test reports (pressure and leakage tests, reactor performance, third-party inspections) that must accompany future installations in new sites.</p> <p>Concise case studies illustrate MiniStor's adaptability according to the building typologies encountered in the project, demonstrating how a uniform, factory-tested thermal energy storage unit can be tailored to different types of local climate, building typology, and existing energy infrastructure.</p>			
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1. Introduction

Minimal Size Thermal and Electrical Energy Storage System for In-Situ Residential Installation (MiniStor) is a project funded by the European Union's Horizon 2020 research and innovation programme to offer a sustainable solution to harness the energy efficiency potential of the European building stock. During the development of the project, the MiniStor system is demonstrated and validated in five demonstration sites located in Ireland, Spain, Greece, and Hungary to test its effectiveness under different local climatic conditions, facilitating market replication while offering an innovative, efficient, and clean thermal and electrical energy storage solution for all Europeans.

This installation guide provides a high-level overview of the typical installation procedure for the MiniStor system. It is not intended to serve as a substitute for the detailed installation and commissioning manuals, which are provided as separate documents and referenced throughout this guide. Instead, this document aims to support technical personnel, installers, and project partners by outlining the general sequence of installation activities and by offering guidance on the required documentation and verification protocols.

In Deliverable 6.4 ("Installation and commissioning of MiniStor system on demonstration sites"), each site is examined in full technical detail, with step-by-step accounts of on-site preparation, component integration, and commissioning results. By contrast, the present document (D7.9) focuses on the foundational methodology for installing MiniStor and illustrates the system's inherent adaptability through selected case studies. Readers seeking comprehensive, site-specific installation data are therefore referred to D6.4.

The structure of the document is as follows:

- **Section 2** outlines the general installation procedure, detailing the sequence of major steps from site preparation and components delivery to system commissioning and verification.
- **Section 3** lists and describes the supporting documentation accompanying the system. This list includes detailed instructions and manuals for each subsystem (3.1), as well as a list of relevant certificates and test reports provided by the system manufacturers at delivery (Section 3.2).
- **Section 4** presents a set of exemplary installations across the five MiniStor demonstration sites. For each site—Cork (Ireland), Sopron (Hungary), Santiago de Compostela (Spain), Kimmeria (Greece), and Thessaloniki (Greece)—a brief overview is provided, accompanied by photographs and comments on site-specific conditions, constraints, and implementation highlights.

2. Installation procedure

The installation of the MiniStor system is a structured, multi-stage process that involves a range of preparatory, mechanical, and electrical-related tasks. The system is delivered as a fully pre-assembled and pre-tested unit housed in a compact container, significantly reducing on-site installation time and complexity. The solar thermal (flat plate collector = FPC) and photovoltaic-thermal (photovoltaic thermal = PVT) collector elements are delivered separately and require on-site installation and integration.

While the physical configuration of each installation may vary depending on local site conditions, housing typology, or specific use cases, the overall process follows a standardized approach to ensure system functionality, optimum integration in the existing energy system, safe operation, and compliance with relevant technical and regulatory standards.

This section provides a general overview of the key phases in the installation workflow. It is intended to support planners, installers, and commissioning personnel in understanding the recommended workflow of activities and the interdependencies between various subsystems and stakeholders.

An overview of the installation workflow is illustrated in the flowchart below. This visual representation summarizes the major phases of the process. Detailed descriptions of each phase can be found in the following subsections.

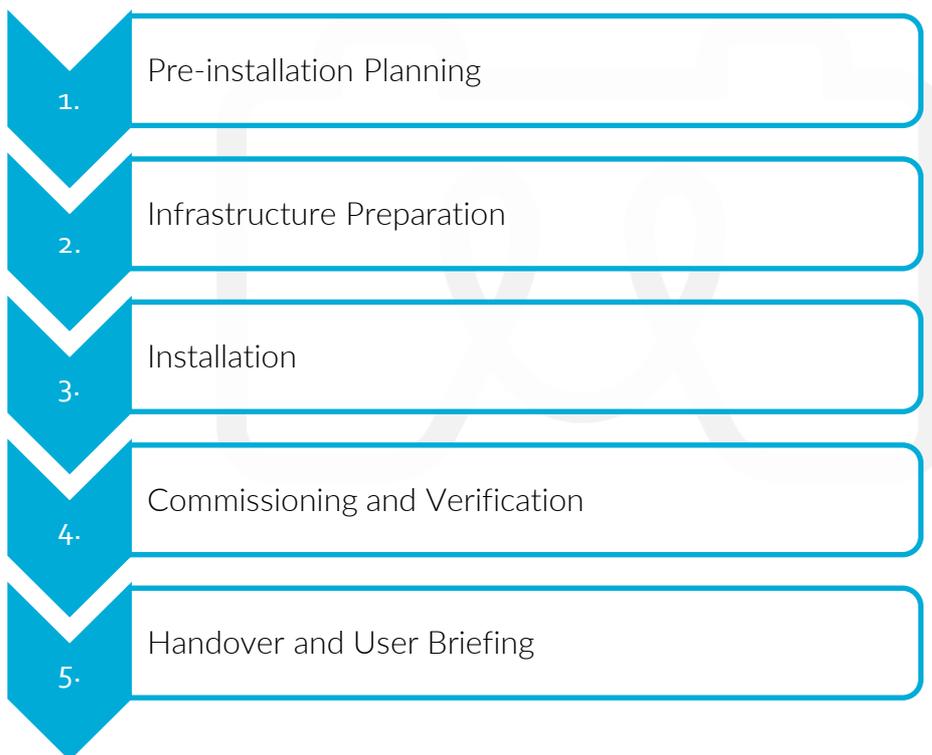


Figure 1 Proposed Installation Workflow

2.1. Pre-installation Planning

Successful implementation of the MiniStor system begins with careful planning and site assessment. At this stage, the following actions are undertaken:

- **Site Evaluation:** An initial survey is conducted to assess spatial and safety constraints, accessibility, roof structure (for PVT/FPC collectors), electrical connection points, plumbing compatibility, ventilation requirements, and existing energy systems which includes both system capabilities as well as spatial planning aspects (e.g. distances between system and connection points).
- **System Design and Configuration:** Based on the findings of the site evaluation and the building's energy profile, a tailored system configuration of the MiniStor system is developed. This adaption process includes component sizing, storage capacity, and control logic. The system is equipped according to the needs of the target energy system and building. For example, if there is no cooling demand or if a renewable energy resource is already available, the system can be customized and some storage options for instance are not integrated (e.g. no cooling PCM).
- **Permitting and Compliance:** Depending on national and local regulations, relevant permits or approvals may have to be inquired. These approval processes need to be completed before the installation begins. For example, but not exclusively:
 - o Construction authorization
 - o Authorization for roof installations
 - o If applicable, permit to enable use of ammonia (using the French case, the installed capacity is below the industrial threshold for mandatory inspections)
 - o Permits for bi-directional electrical grid connection and physical connection to the energy system (e.g. pipes through the garden etc.)
 - o Plumbing work
- **Component Logistics:** It must be ensured that the MiniStor system can be delivered and installed on site. A mobile crane is required, which might need temporary road closure or obstruction. Furthermore, both the site as well as the roads leading to the site need to be checked for the transport and dismounting of the required loads of the MiniStor System.

Detailed documentation, including risk assessments, installation plans, and layout schematics, should be completed and reviewed before physical installation commences.

2.2. Infrastructure Preparation

Following the completion of the pre-installation planning phase and prior to the delivery of the system, a set of targeted preparatory activities must be carried out on-site. Given that the MiniStor system is delivered as a complete assembly in a custom enclosure (3.2m x 2.1m x 2.7m) – with only the flat plate collector (FPC) and photovoltaic-thermal (PVT) modules requiring separate installation – site preparation focuses on enabling a seamless connection between the preassembled system and the building infrastructure.

The preparatory measures typically include:

- **Foundation and Access Preparation for Enclosure Placement:** A level (1cm deviation per meter distance), load-bearing foundation must be prepared to accommodate the MiniStor container. The surface should be accessible for delivery vehicles and allow safe crane or forklift handling during unloading and placement. If required by local regulations or environmental conditions, measures such as vibration damping, frost protection, or anchoring systems should be integrated.
- **Collector Installation Area Preparation (Roof or Ground Mount):** Locations designated for the FPC/PVT collectors—either on the roof or a ground-mounted frame—must be prepared in accordance with the collector manufacturer's guidelines. This preparation includes structural reinforcement if necessary, securing mounting brackets, and ensuring safe access for personnel during installation.
- **Building Interface Preparation (Plumbing and Electrical):** In preparation for hydraulic and electrical connection of the MiniStor system to the building services, access points must be created and appropriately sealed. This preparation of the building/energy system includes:
 - o Installation of conduits and cable trays from the container to the building's electrical distribution board.
 - o Preparation of hydraulic connection points for domestic hot water, integration into existing heating circuits (where applicable), and condensate drainage.
 - o Provision of temperature and pressure relief routes as required by the system's design.
- **Control and Communication Interface Preparation:** If remote monitoring or building energy management system (BEMS) integration is planned, appropriate data cables or wireless gateways must be installed and commissioned prior to container delivery. WiFi communication can be used, but cable is preferred.

All preparatory activities must be completed and quality-checked before the arrival of the MiniStor unit, to minimize on-site installation time and avoid delays in commissioning. Coordination with local installers, civil engineers, and utility service providers may be required at this stage.

2.3. Components Installation

Given the pre-assembled nature of the MiniStor system, most of the mechanical and electrical components—including the thermochemical reactor, thermal storage tanks, control units, and ancillary systems—are already integrated and pre-tested within the system prior to delivery. As such, on-site installation focuses primarily on the safe placement of the container, PVT/FPC installation, and the proper connection of all interfaces with the building infrastructure.

The following steps are typically carried out during this phase:

- **Placement of the MiniStor Container:** The container containing the MiniStor system is placed on the foundation, levelled and secured.
- **Solar Thermal and Photovoltaic-Thermal Collectors (FPC/PVT):** The flat plate and hybrid collectors are mounted on pre-installed roof or ground-mounted supports. Collector placement should ensure optimal solar exposure and minimal shading. Hydraulic supply and return lines, electrical cabling for PVT modules, and temperature sensors are routed in insulated conduits to the MiniStor container. All connections must be sealed and weatherproofed according to the manufacturer's guidelines. They must be installed close to the delivery date of the main unit, to avoid overheating of empty channels, which can damage them.
- **Hydraulic and Electrical Interface Connections:** On-site technicians connect the building's domestic hot water circuit and, if applicable, the space heating loop to the MiniStor system. Electrical wiring is connected from the building's distribution board to the container's power interface, including grounding, circuit protection, and voltage phase alignment. Signal and control cables are also installed where remote control or monitoring is implemented.
- **Sensor Calibration and Control System Commissioning:** All sensors (e.g., for temperature, flow, pressure, solar irradiance, ammonia level sensor) are connected and tested for correct signal output.
- **Safety and Ancillary Systems Integration:** Safety valves, expansion vessels, filters, and air vents are checked for correct orientation and connection. All hazard symbols and safety warnings are verified for presence, legibility, and correct placement. Pumps, fans, and flow controllers—already installed in the container—are tested for response to control signals. Visual inspections ensure that all components are correctly labelled and accessible for future maintenance.

Throughout the installation, quality control is performed after the completion of each subsystem connection. All steps must be documented. Any deviation from prescribed procedures must be recorded and approved by the responsible commissioning authority.

2.4. Commissioning and Verification

Commissioning confirms that the MiniStor system operates safely and as intended under site-specific conditions. Although most components are pre-configured and tested, the following steps must be carried out on-site:

- **Visual and Functional Inspection:** The container installation and external connections are inspected for physical integrity, correct labelling, and secure mounting. All hydraulic and electrical connections are checked for tightness, insulation, and routing.

- **Electrical Safety Testing:** Grounding, insulation resistance, and correct function of safety devices are tested. The battery system (if included) is verified for correct polarity, state of charge, and thermal conditions, following applicable local and international standards. The solar controller is started to verify that the electrical storage part of the system, including battery, are working in the desired modes.
- **Control and Monitoring Validation:** The PLC control system within the thermal storage unit is tested for correct data acquisition, sensor response, actuator commands, and communication with external interfaces and data operation cloud. Control logic is reviewed, and test scenarios (e.g. demand response, thermal charging) are executed to confirm dynamic system behaviour. This stage might need live communication with the service provider for the data operation cloud.
- **First charge and discharge:** An initial phase of charging and discharging is carried out, whereby the system is turned on and circulation is made within the NH₃ circuit, heat pump and PCMs. If any potential leaks (water or NH₃) are detected, the system is stopped and the leaks repaired. Check is made for any faults in ancillary equipment (e.g. pumps, fans or compressor), detection systems (visual inspection of NH₃ levels through peep holes in TCM reactor) and the system is stopped if these occur.
- **Documentation and Reporting:** All commissioning activities are recorded in the commissioning report. This includes checklists, test values, calibration settings, and confirmation of correct system behaviour. Any deviations or open issues must be documented and resolved before final handover.

2.5. Handover and User Briefing

After successful commissioning, the system is formally handed over to the end user or designated operator. This includes both technical documentation and user-level instruction:

- **Documentation Handover:** A complete documentation package is provided, including:
 - o System schematics and interface drawings
 - o Operation and maintenance manuals
 - o Safety instructions and emergency protocols
 - o Warranty terms and contact details for support
 - o Commissioning report
- **User Briefing and Training:** The end user is instructed in the safe and effective operation of the system. Key topics include:
 - o Basic system functions and visual indicators
 - o Regular maintenance and checks (if required)
 - o Safety training
 - o How to access the user interface
 - o Whom to contact in case of faults or alarms
- **Final Sign-Off:** A final walkthrough is conducted, ensuring all system components are accessible, labelled, and clean. The handover form is signed by the installer and the client or project partner, confirming that the system is fully operational and accepted.

3. Supporting documents and instructions

To ensure a correct installation and smooth operation of the MiniStor system, a variety of technical support documents are available. These documents have been compiled and reviewed to support planners, installers, commissioning personnel, and maintenance teams throughout the entire lifecycle of the system.

In this section, a structured list of available supporting documents is provided, including installation manuals, user guides, certificates, and test reports. For each document, a short description and the corresponding source are indicated, helping stakeholders to easily identify the appropriate references for their specific tasks.

By presenting this structured overview, Section 3 aims to facilitate quick access to the relevant technical documentation and to ensure transparency regarding the documentation available for the MiniStor system.

3.1. Instructions & Manuals

This subsection lists installation and operating manuals associated with the MiniStor enclosure, its key components and the PVT/FPC system that were prepared for the specific demonstration installation. These manuals originated from the respective component manufacturers and included essential information such as system layout, connection details, handling procedures, commissioning steps, and safety precautions for the specific components that were sourced for the project. Their listing is provided here as a checklist for future development of a generalised instruction manual where there is potential to use other component suppliers or perform modifications to the original design.

3.1.1. Solar System Commissioning Guide (by Endef)

A slide deck summarising the key steps and configuration details for the FPC/PVT solar field and associated balance-of-system components at the specific sites was prepared by ENDEF, it covers:

- **Site Layout & Hydraulic Schemes:** Base plans for solar field and container placement, one-line electrical diagrams, and general hydraulic circuits.
- **Sensor Deployment:** Locations, types, and installation notes for temperature sensors (PT1000), flow meter, pressure sensor, and 3-way valve actuator.
- **Solar Station Overview:** Components and commissioning notes for the RESOL FlowSol® B HE station, including pump setup and filling procedure.
- **Controller Configuration:** Wiring and terminal assignments for the RESOL DeltaSol® MX Plus solar controller, plus step-by-step menu settings (basic settings, inputs/modules, solar/optional functions, antifreeze, heat dump, holiday mode).
- **Data Logger Integration:** Setup of the RESOL DL2 Modbus/Vbus adapter for data acquisition, network configuration, and static IP assignment.
- **Inverter Commissioning:** Fronius Symo GEN24 Plus installation summary, app-based commissioning via Solar Start, and Modbus data-reading instructions.
- **Battery Integration:** Basic installation and connection overview for the BYD HVS 7.7 battery modules.

The slides served as a high-level companion to the manuals provided by the manufacturers of the sub-components and site-specific plans, guiding on-site teams through the solar subsystem commissioning.

3.1.2. MiniStor Commissioning Guide (by Psycctherm)

This document provided detailed step-by-step instructions for the on-site commissioning of the MiniStor system. It includes procedures for:

- Electrical power-up and safety checks (main and NH₃ electrical panels)
- Initial filling and bleeding of the hydraulic water circuit using solenoid valve and pump controls
- Sensor measurement verification for temperature and pressure in both the water and TCM circuits
- Initial operation and functional testing of the heat pump (including compressor start-up procedure)
- Manual testing and diagnostics of the NH₃ compressor via the inverter panel
- Final verification of compressor wiring and rotational direction

The guide is highly practical and intended for use by trained technicians during the final phase of installation, immediately before system handover.

3.1.3. Ammonia Compressor Manual Operation (by Psycctherm)

This procedural guide provides detailed instructions for manually operating the NH₃ compressor via the system's inverter control panel. The steps are intended for use during commissioning, diagnostic testing, or service interventions.

Key elements include:

- **Accessing Parameter Mode:** Instructions on how to enter parameter configuration mode via the inverter panel using the SET button.
- **Changing Control Source (P.79):** Step-by-step guide for locating and modifying parameter P.79 to switch from external (EXT) to panel (PU) control, enabling manual operation.
- **Manual Frequency Setting and Run Sequence:** Operators are guided through setting a test frequency (e.g., 30 Hz), starting the inverter in PU mode, and monitoring the short manual run.
- **System Reset and Reversion to External Control:** Final steps include reverting P.79 back to its original value (0), restoring external control, and verifying inverter status lights (EXT and PU indicators).
- **Power-Cycle Procedure:** In case of failure to restore EXT mode, the guide includes instructions for power cycling the inverter via the circuit breakers.

This procedure ensures that manual operation is safe, controlled, and easily reversible. It is particularly useful during system verification or troubleshooting of the compressor subsystem.

3.1.4. Ammonia Sensor Calibration Guide (by Psycctherm)

This document provides a site-specific standard operating procedure (SOP) for calibrating the ammonia (NH₃) level sensor within the MiniStor system, based on experience from the demonstration sites of the project. The calibration process is essential for accurate monitoring of the thermochemical storage tank fill level.

The guide outlines a two-stage calibration process, referencing physical sight glass levels:

- **Stage 1 – Low-Level Calibration (8%):** Performed when the liquid reaches the middle of the lower sight glass. Involves activating charging mode, pausing at the correct level, and configuring sensor parameters (P01 and P05).

- **Stage 2 – High-Level Calibration (90%):** Conducted once the liquid reaches the middle of the upper sight glass. Requires adjusting parameter P06 to represent 90% fill level.

It includes detailed instructions for using the Full Parameter Programming Mode via the main electrical panel and checking sensor outputs through the system interface. This guide is particularly useful for commissioning technicians and service personnel tasked with validating or reconfiguring the ammonia level sensor.

3.1.5. Control Program Installation (by Psycrotherm)

A concise technician's guide that explains how to load the MiniStor PLC control program onto the CPU module using a FAT-32 formatted SD card.

Main elements covered:

- **Preparing the SD Card**
- **Hardware Procedure** – power-down, SD card insertion, power-up, LED status checks, and use of the front-panel reset toggle.
- **Verification & Removal** – confirming successful program transfer, final power cycle, and LED indications before removing the card.
- **Supplementary Reference** – link to a short demonstration video for visual confirmation of each step.

The guide is intended for commissioning engineers and maintenance staff to ensure the PLC is flashed with the correct firmware in a safe and repeatable manner.

3.1.6. TCM Unit Manual (by Psycrotherm/Sofrigam)

A comprehensive manufacturer's manual that covers the full lifecycle of the MiniStor thermochemical (TCM) unit:

- **General Safety Notices** – detailed first-aid, operating, and maintenance precautions, plus an explanation of hazard symbols.
- **System Features** – narrative description of major components (compressor, heat exchangers, ammonia circuit, control panel, safety devices) and their functions.
- **Technical Specifications** – qualitative outline of performance parameters and design conditions for compressor, condenser, evaporator, and ancillary equipment.
- **Installation Guidance** – site requirements, levelling and service clearances, electrical connections, and recommended antifreeze provisions.
- **Service & Maintenance** – step-by-step procedures for routine checks, oil changes, refrigerant handling, vacuuming, and charging; includes environmental and safety notes.
- **Start/Stop Procedures** – user instructions for powering up, monitoring via the HMI, and orderly shutdown of the system.
- **HMI Navigation** – description of each touchscreen submenu (modes, sensors, alarms, pumps, fans, solenoids, etc.) and its role in daily operation.
- **Troubleshooting Guide** – common fault scenarios mapped to probable causes and corrective actions.
- **Spare Parts List & Recycling Notes** – qualitative list of key replaceable items and end-of-life recycling contact details.

This manual serves installers, commissioning engineers, and facility operators as the primary reference for safe handling and reliable operation of the MiniStor TCM container unit.

3.1.7. PCM supplier

Website-based manuals for the technical and practical guidance for the installation, wiring, and operation of the PCMs.

Key contents include:

- **Technical Specifications:** Dimensions, water content, capacity, flow characteristics, and control set points.
- **Control System Setup:** Programming logic, temperature sensor configuration, and controller types
- **Installation Guidelines:** Hydraulic connections, wiring diagrams, design for hot and cold water supply, pressure requirements.
- **Application-specific Schematics:** Visual layouts for different battery models in domestic setups.
- **Operation Modes:** External and internal heating, solar PV integration, and hybrid configurations.

3.2. Certificates and test reports

This subsection contains a list of certificates and technical test reports. These include declarations of conformity, performance testing results, and component certifications.

3.2.1. Piping Assembly Pressure Test (by Psycrotherm)

This document details the pneumatic strength testing performed on the stainless-steel piping assembly of the MiniStor unit. It includes:

- **Project & Assembly Identification** – reference to the MiniStor project, customer, manufacturer, and specific assembly serial number.
- **Applicable Standards** – citations of relevant European directives and EN 13480 part 5 requirements.
- **Piping Details** – overview of pipe diameters, material specification, and designated high- and low-pressure circuits.
- **Test Procedure** – description of the pressurization method (nitrogen compression), target pressure level, and test duration for verifying structural integrity.
- **Equipment & Instrumentation** – summary of the measurement devices and setup used to monitor pressure stability.
- **Outcome Statement** – confirmation that the assembly maintained the required pressure without loss, demonstrating compliance with strength criteria.
- **Certification** – test date, responsible personnel, and official sign-off.

3.2.2. Piping Assembly Leakage Test (by Psycctherm)

This report records the pressure-testing of the stainless-steel piping assembly installed in the MiniStor TCM unit. It includes:

- **Project & Customer Information** – identification of the MiniStor project, client, manufacturer, and assembly serial number.
- **Applicable Standards** – reference to European directives and relevant EN 13480 piping standards.
- **Piping Specifications** – material grade, nominal diameters, and operating pressure classes for both low-pressure and high-pressure circuits.
- **Test Procedure** – description of the pressure levels applied, test duration, and monitoring criteria for leak detection.
- **Test Outcome** – confirmation that the assembly maintained pressure without detectable leakage over the test period.
- **Test Date & Sign-off** – official stamping of the test date and responsible party's approval.

3.2.3. TCM Reactor Test Report (by Sofrigam)

This report documents the factory-level performance verification of the thermochemical (TCM) reactor delivered for the MiniStor project. It outlines:

- **Objective & Scope:** Confirmation that the reactor complies with contractual design and performance criteria.
- **Testing Methodology:** Overview of the leak-testing, ammonia charging, and controlled cycling procedures used to evaluate sorption/desorption behaviour.
- **Results Summary:** Narrative confirmation that all key metrics (material mass, ammonia capacity, thermal power, cycling stability) fall within specified tolerances.
- **Visual Documentation:** Photographs and thermal images illustrating assembly quality, test-rig setup, and final inspection.
- **Conclusion & Recommendations:** Statement of conformity and any suggested follow-up actions or equipment upgrades.

3.2.4. Inspection Report

This inspection report summarizes on-site quality assurance activities carried out by an authorized body over multiple visits for the MiniStor thermal storage and refrigeration assembly. It includes:

- **Scope of Inspection:** Identification of inspected assemblies (NH₃ receiver, TCM reactor, separator, oil separator, piping) and key project references.
- **Applicable Standards & Directives:** Reference to pressure equipment regulations and CE-marking requirements.
- **Inspection Activities:** Documentation review, material verification, welding procedure checks, manufacturing and final testing observations.
- **Dispositions & Conclusions:** Acceptance status, any non-conformances found, and recommended corrective or follow-up actions.
- **Sign-off & Certification:** Approval by the inspectors, with dates and signatures.

4. Exemplary installations

In this section, five demonstration sites are described to illustrate the modularity and adaptability of the MiniStor system across diverse European contexts. Although these installations were chosen for project-specific reasons, they collectively demonstrate how a standardized, container-based core package can be configured to meet varying site conditions and operational requirements. For comprehensive, site-by-site installation and commissioning details, please refer to Deliverable 6.4.

Each demonstration site is presented in its own subsection, covering building typology; solar collector layout and mounting strategy; hydraulic and electrical connections; and commissioning highlights. Together, these examples provide a practical reference for planners and installers, showing how the factory-tested MiniStor container solution can be seamlessly tailored on-site to deliver consistent performance, regardless of environmental or architectural constraints.

4.1. Cork, Ireland

The Cork site comprises a two-storey, three-bedroom semi-detached house with a 75.29 m² heated area and a 376.43 m³ internal volume, occupied by five residents. The MiniStor system provides electricity, domestic hot water, and space heating, working alongside an existing 27 kW gas boiler. The MiniStor container is positioned in the rear garden at the property's northern high point, approximately 12.2 m from the house, ensuring minimal shading and a direct southern aspect. A bespoke steel mounting structure was fabricated to support a 37.64 m² array of FPC/PVT collectors, which is installed directly in front of the container. All hydraulic and electrical interfaces are routed via insulated conduits in buried utility trenches linking the container to the plant room per D6.3 specifications. This setup highlights modular integration in a temperate maritime climate.



Figure 2: Installation of the MiniStor container at the Cork demonstration site: a crane positions the pre-assembled energy storage unit on its prepared foundation while technicians guide and secure the connections.



Figure 4: Bespoke steel mounting structure supporting a combined array of flat-plate thermal (upper row) and photovoltaic-thermal (lower row) collectors at the Cork site, positioned directly in front of the MiniStor container for optimal solar exposure and simplified connections.

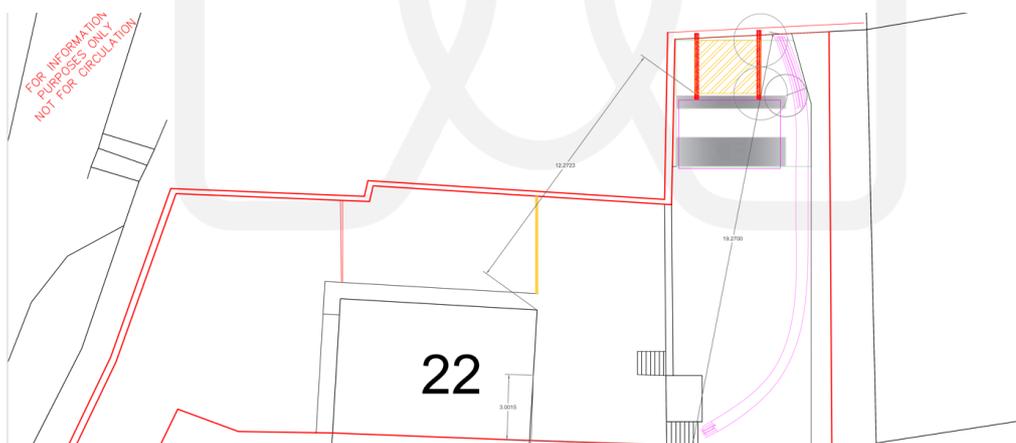


Figure 3: Technical sectional drawing for the Cork site: a side-view detail of the bespoke collector mounting structure in front of the MiniStor container (yellow), showing the support frame (grey), and piping route (purple).

4.2. Sopron, Hungary

The Sopron installation is located at a newly constructed, two-storey home with cellar, intended for both residential and light commercial use. The 176.6 m² heated area (435.6 m³ volume) faces approximately 15° SW under a 35°-tilted gable roof. MiniStor delivers electricity, domestic hot water, heating, and cooling for an estimated five occupants. Indoor HVAC includes dual heat-exchanger units (3 kW each) and electric heating filaments integrated into the ventilation system, alongside two domestic hot-water boilers. The container unit is placed at least 5 m south of the building, benefiting from prevailing northerly winds and clear access for maintenance. Roof-integrated FPC/PVT arrays are mounted on the southern roof slope, as well as on a steel mounting structure in front of the building. All hydraulic and electrical connections follow D6.3 guidelines, with underground conduits routing services to the plant room. This setup exemplifies MiniStor's adaptability to low-density suburban plots and mixed-use building requirements.



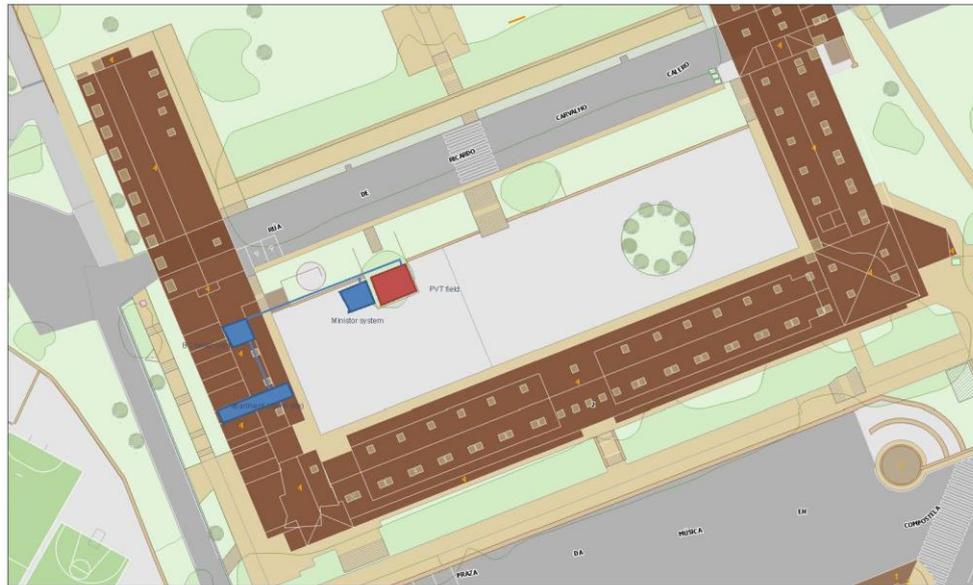
Figure 6: Bespoke steel mounting structure at the Sopron site, with the timber-clad demonstration house and rooftop PV array visible in the background. The MiniStor container is positioned directly beneath the collector array, simplifying hydraulic and electrical connections.



Figure 5: Utility trench excavation at the Sopron site: a narrow trench runs alongside the timber-clad house façade, prepared for burying insulated hydraulic and electrical conduits connecting the MiniStor container to the building's services.

4.3. Santiago de Compostela, Spain

The Santiago de Compostela site is located in the Burgo das Nacións university residence. This single-storey apartment (80.5 m²) houses a family of three and was originally served by campus-wide gas boilers (1.899 MW) and centralized DHW tanks. For MiniStor demonstration, its heating and domestic hot water loops will be hydraulically decoupled from the building. The container is sited on the southwest wing exterior, at least 17 m from neighbouring structures, with the bespoke solar array (FPC/PVT) mounted directly adjacent. The apartment faces approximately west (255°), optimizing afternoon solar gain. This setup illustrates the adaptability of MiniStor to retrofit individual units within larger multi-residential complexes.



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Sección de Cartografía e SIT

Figure 7: Site layout for the Santiago de Compostela demonstration: a section of the university residence U-shaped plan showing the MiniStor container (blue), solar collector array (red), and hydraulic/electrical connection routes within the southwest wing to the apartment (blue).



Figure 8 View of the finished prototype thermal energy storage unit as installed in Santiago de Compostela



Figure 9: Roof-mounted array of flat-plate and PVT collectors at the Santiago de Compostela site, shown behind protective mesh fencing. The south-west orientation and 35° tilt maximize solar gain for thermal and electrical harvesting.

4.4. Kimmeria, Greece

The Kimmeria installation serves a five-room section (75.65 m², 226.95 m³) of a student residence on the DUTH campus, housing up to five occupants. MiniStor covers the apartment's heating and cooling loads by integrating with the campus's existing renewable energy infrastructure—a hybrid solar/biomass boiler system (1 150 kW_{th}). The container is sited on rocky soil in the garden 12 m south of the dormitory façade, with buried conduits routing hydraulic and electrical connections. This setup demonstrates MiniStor's flexibility in leveraging pre-existing renewable sources for enhanced campus-scale energy management.

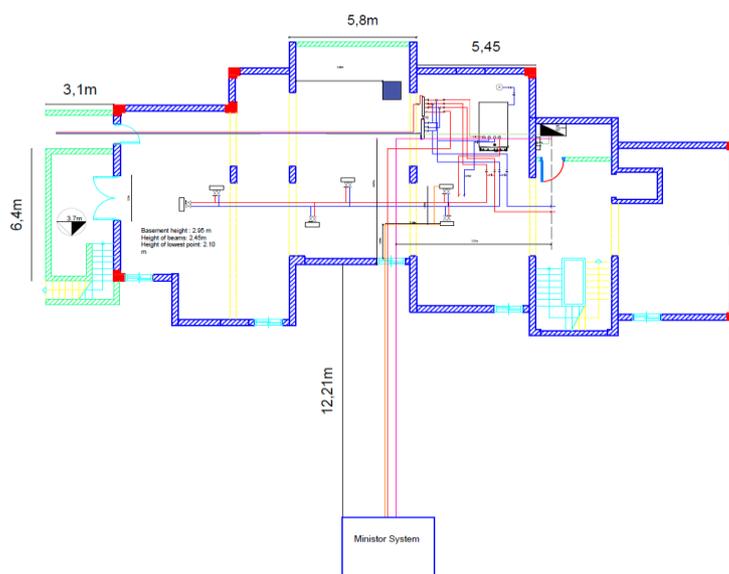


Figure 10: Detailed site plan for the Kimmeria demonstration: the MiniStor container (blue) is positioned 12.21 m south of the dormitory façade; hydraulic and electrical conduit routes to the building's sensor and heat-exchange nodes.



Figure 11: Front view of the MiniStor container at the Kimmeria demonstration site, sited on rocky soil immediately south of the student dormitory; visible are the dual access doors for both compartments of MiniStor.

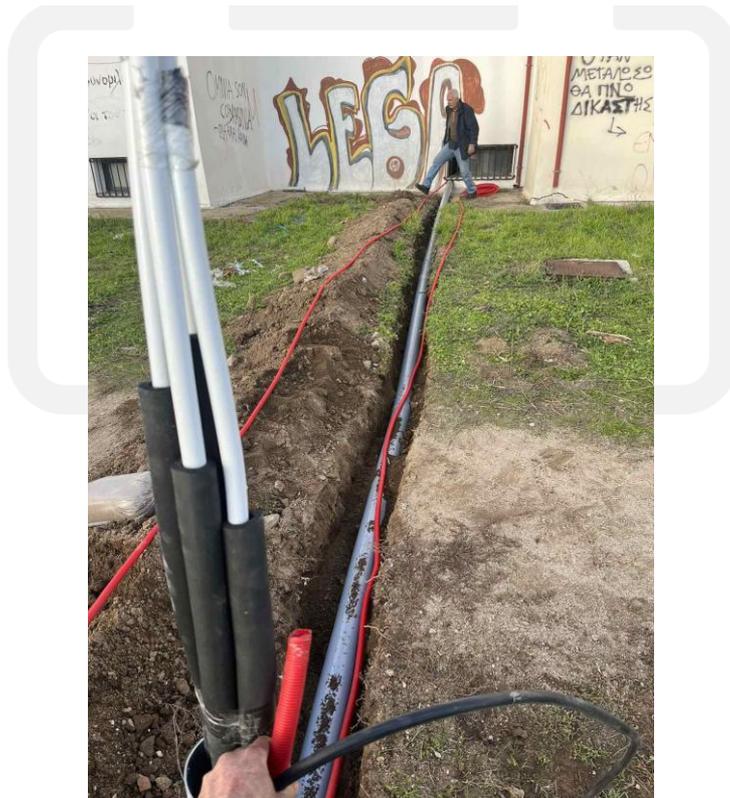


Figure 12: Trench installation for buried hydraulic and electrical conduits: insulated supply pipes (grey) and electrical cables (red) routed from the MiniStor container toward the building.

4.5. Thessaloniki, Greece

The Thessaloniki site is a purpose-built “Smart Home” platform emulating a residential building with integrated office space (317.7 m² footprint, 1 075.8 m³ volume over two storeys). MiniStor supplies electricity, heating, and cooling for a variable occupant load, linking to two LG VRF units (31.5 kW heat/28.0 kW cool and 25.2 kW heat/22.4 kW cool) and a 9.57 kWp thin-film CIS PV array on the flat roof. A section of the solar loop is mounted at the rear of the Smart Home. Hydraulic and electrical connections run through buried conduits as shown in Figure 21. Sensor nodes for thermal, electrical, and flow monitoring (Figure 22) feed the MiniStor control system. This configuration demonstrates MiniStor’s compatibility with advanced HVAC and PV installations in an urban-style pilot.



Figure 14: Rear and side view of the MiniStor container at the Thessaloniki site.



Figure 13: Side view of the MiniStor container at Thessaloniki with external inverter, junction boxes, and ventilation fans installed; the adjacent FPC array is visible on the retaining wall behind.

5. Conclusions

The purpose of this guide is to ensure a coherent understanding of the MiniStor system's deployment and to support knowledge transfer across stakeholders involved in the replication and scaling of the solution throughout Europe.

The examples from the demonstration sites further serve to illustrate the system's adaptability and practical performance under real-world conditions.

The formulation of the workflow and checklist of documentation provides the foundations for industrialised production, while accelerating installation on future sites.

