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D7.10 Plan for Exploitation and Dissemination of Results

Marco Rocchetti (R2M)

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D7.8 Plan for Exploitation and Dissemination of Results

Summary	
This deliverable provides a summary of the dissemination, communication and exploitation activities done during the MiniStor project. The report in form of a public document drives the potential future exploitation activity after the end of the project. A market overview reports the main trends for the thermal energy storages market applied at residential level, updating the Market Analysis done in the middle of the project as D7.4. Main competitors and PESTLE analysis compete the market assessment. Dissemination and exploitation actions are summarised in form of tables as a guideline.	

Deliverable Number	Work Package
D7.10	WP7
Lead Beneficiary	**Deliverable Author(S)**
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Beneficiaries	**Deliverable Co-Author (S)**
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Abbreviations

BM	Business Model
CAPEX	Capital Expenditure
D.x	Deliverable #
DHW	Domestic Hot Water
DR	Demand Response
EESS	Electrical Energy Storage System
EU	Europe
EPBD	European Performance Building Directive
ER	Exploitable Result
GHG	Green House Gas
HEMS	Home Energy Management System
HP	Heat Pump
IEQ	Indoor Environmental Quality
IoT	Internet of Things
IP	Intellectual Property
KER	Key Exploitable Result
KPI	Key Performance Indicator
LHS	Latent Heating Storage
M.x	Month #
NZEB	Net Zero Emission Building
PCM	Phase Change Material
PEDR	Plan for Exploitation, Dissemination and Replication
PV	Photovoltaic
PVT	Photovoltaic Thermal Panel
RES	Renewable Energy System
ROI	Return of Investment
SHS	Sensible Heat Storage
SAM	Serviceable Available Market
SOM	Serviceable Obtainable Market
TAM	Total Addressable Market
TCM	Thermochemical Material
TES	Thermal Energy Storage
TRL	Technology Readiness Level
WP	Work Package

Disclaimer

The information contained in the document reflects only and exclusively the point of view of the author. The European Commission is not responsible for any use that may be made of this information.

This deliverable has been conceived using R2M's exploitation methodology, which has been developed across time as R2M has fulfilled this role in several EU projects. Although continuous improvements happen, the core of the methodology is common to other deliverables and, for this reason, the table of contents, some pictures and some text modules are similar to other exploitation deliverables developed in the framework of previous projects and defined ad replication plan.

The contents here are project-specific and are the main result of R2M's and all contributors' effort in creating this report.

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1. Introduction

MiniStor is an innovative integrated and compact system able to satisfy energetic needs in a residential building covering heating, cooling, thermal and electrical energy storage and enabling energy flexibilities.

The principal customer segment defined at the beginning of the project is residential sector for the following reasons:

- *Collectively, buildings in the EU are responsible for* ***40% of our energy consumption*** *and* ***36% of GHG emissions****, which mainly stem from construction, usage, renovation and demolition*[1]
- *Today, roughly* ***75% of the EU building stock is energy inefficient***[1]*.*
- *Renovating existing buildings could* ***reduce*** *the EU's total energy consumption by* ***5-6%*** *and lower carbon dioxide emissions by about* ***5%***[1]*.*
- *The renovation of the building stock offers an opportunity for EU to* ***increase its energy security*** *considering that an additional* ***1% in energy savings can reduce EU gas imports by 2.6%***[2]***.*** *The use of thermal and electrical energy storage can help leverage the variability of renewable energy sources that are used to replace fossil fuels and reduce emissions.*

This means that MiniStor can provide a relevant contribution to the decarbonisation of the residential sector in accordance with the EU targets and the Green Deal goals.

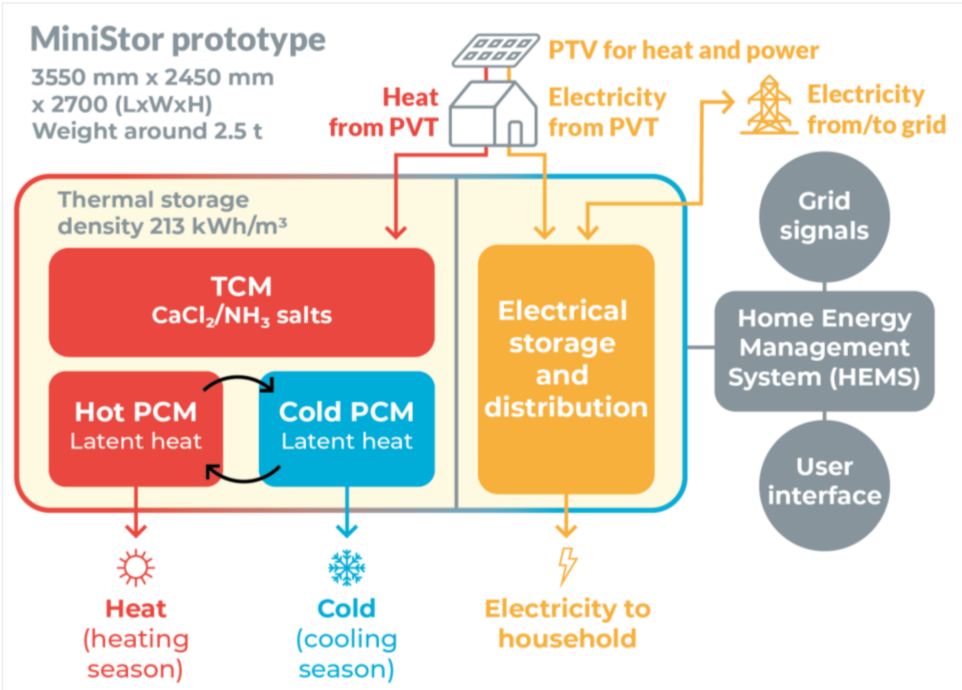

Figure 1. Principles of MiniStor integrated system

MiniStor combines Thermochemical (TCM) and Phase Change Materials (PCM) technologies for year-round thermal storage for heating and cooling. The MiniStor compact system is characterized by:

(i) Very high energy storage density (for Heating and cooling) about 10 times higher than the water based thermal energy storages.
(ii) Electrical energy storage system based on lithium batteries.
(iii) An intelligent smart home energy management system (HEMS).

[1] https://ec.europa.eu/info/news/focus-energy-efficiency-buildings-2020-feb-17_en
[2] Directive (EU) 2018/844 of the European Parliament of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on EE (OJ L 156/75, 19.6.2018)

The necessary energy input to MiniStor is provided by various energy systems such as photovoltaic thermal (PVT) panels and solar thermal collector but it can work with all the Renewables Energy Systems (RES) as Heat Pumps (HP) or biomass boilers.

1.1 Objective of the report

To ensure the effective use of MiniStor innovations, the Exploitation and Dissemination of Results (PEDR) plan is utilized to establish the most significant public messages currently available in the project. It collects inputs from "Dissemination and communication plan" (D8.2, FEUGA), "Exploitable Results Table" (D7.4, R2M), "Business models" (D7.5; R2M) and "Replication plan" (D7.8, R2M). From the literature the definition of PEDR is reported as follow:

"***The PEDR is a strategic document for the beneficiaries*** *helping them to establish the bases for their intellectual property (IP) strategy, dissemination and exploitation activities. By definition, the PEDR is a document which summarises the beneficiaries' strategy and concrete actions related to the protection, dissemination and exploitation of the project results. The PEDR follows the evolution of the project from the proposal until the submission of the final project report*" [1].

1.2 Structure of the report

The deliverable is structured in order to recap and describe the contributions of the MiniStor project in the dissemination, communication and exploitation actions following the articles 2.2.3 and 2.2.4 of the Grant Agreement.

- Chapter 1 is the introduction, with a short description on the MiniStor impacts and the description of the report and its scope.
- Chapter 2 focusses on the project results, firstly considering the project as a whole and then the Key Exploitable Results. Key (KERs) message for the dissemination and competitors are listed for all the selected KERs.
- Chapter 3 provides a short recap about the market trend of the thermal storages, updating some key figures from the MiniStor market analysis which will be reference for the TRL upscaling process. The second part of the chapter 2 is tailored to the PESTLE analysis.
- Chapter 4 report the dissemination action done in the project with particular attention on the exploitation oriented to dissemination.
- Chapter 5 summarises the activities in MiniStor with KPIs.

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2. Key Message, market targets and competitors

Chapter 2 outlines how the innovative MiniStor system, based on *thermochemical material and phase-change materials*, addresses building efficiency challenges and how the business plan developed in the context of the D7.5, can be analysed to expand commercial activities.

The main concept is that the system allows for innovative compact storage of RES-based energy using hybrid PVT or other RES sources as biomass boilers and HP. This system includes also a home energy management system (HEMS) able to optimise the building consumptions enabling energy flexibility strategies and energy sharing with other buildings or apartments.

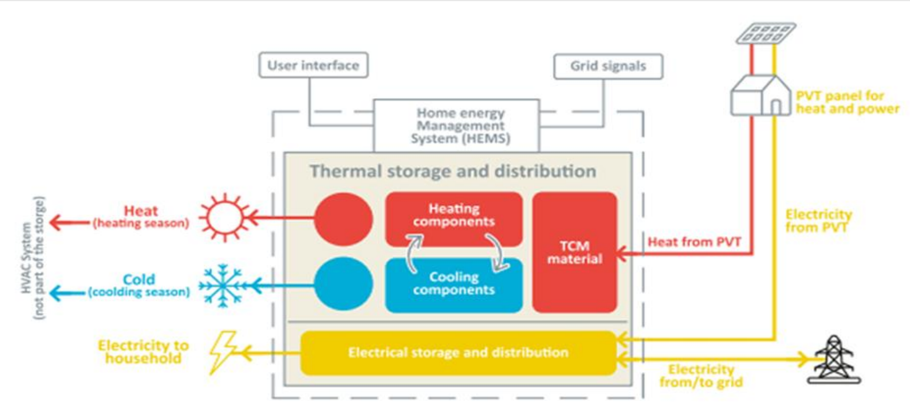

Figure 2. MiniStor concept applied at residential building

In order to increase the awareness around those innovations, key messages have been defined to be reused in the project replication strategy.

The first key message strategy used in MiniStor in the exploitation roadmap is the "Ad Lib" message [2], that in a simple way explain the role of the innovation applied to the customer segment (Figure 3).

Figure 3. Ad Lib template

Since the project started in May 2019, starting from month M21, these MiniStor messages has been communicated as results from pre-pilot implementation and stakeholder training and are linked to both paragraph: "project as a whole" and to "Key Exploitable Results" (KERs) identified in the previous deliverable D7.4 "Exploitable Results (ER) Table" and D7.8 "Replication plan".

2.1 Project as a whole

The project as a whole concept is represented by the KER#1 where the MiniStor system is considered not only as a thermal storage system, but as an integrated energy system for the heating, cooling, domestic hot water (DHW) production in a concept of smart building with a high level of energy flexibility enabled by the TES, PCM and lithium batteries modules.

2.1.1 MiniStor Ad Lib message

The MiniStor compact and integrated energy storage system helps *building owes and manager and in general way the residential sector* who want to *cover the energy needs (heating, cooling and DHW) of the building and enabling energy flexibility* by *increase the RES self-consuming and reduce energy costs,* *environmental impact and CO_2 emissions* and *increase the awareness of building energy inefficiency by the optimisation of consumptions and energy flexibility*, unlike traditional systems using fossil fuels.

2.1.2 Key Message 1: "What is the problem addressed by MiniStor?"

The transformation of the European energy landscape is characterized by a shift towards sustainability, energy efficiency and security, driven by the need to reduce carbon emissions and dependence on fossil fuels and at the same time to support the RES integration at local level.
The European climate plan, "FIT for 55", makes reaching the EU's climate goal of reducing EU emissions, by at least 55% by 2030 (from 1990 levels), a legal obligation and make the EU climate-neutral by 2050 [3]. In addition, increase the share of renewable energy consumed to over 42.5% [4] (Revised Renewable Energy Directive) and set an energy savings at least 11.7% in 2030 compared to 2020 (REPowerEU initiative) [5].
However, an estimated 75% of the European Union building stock (around 30 billion m^2) is considered energy inefficient [5]. Most of the existing European residential building stock was constructed before the Energy Performance of Buildings Directive (EPBD), which mandates requirements for energy efficiency of buildings, including reduction of thermal energy demands in buildings.
In 2022, EU households or the residential sector, represented 25.8 % of final energy consumption. The heating of space and water represent 78.4% of this energy consumed by households. Cooling is a small share of total final energy use, but its demand from households in the EU is rising during summer months.

In order to address the above challenges, the overall objective of the MiniStor project is to design and develop a novel compact, integrated thermal storage system for achieving sustainable heating, cooling and electricity storage that can be adapted to new and existing residential buildings.

2.1.3 Key Message 2: "How will MiniStor help solve the problem?"

To address households heating, cooling and DHW demand issues, MiniStor is equipped with two thermal storage systems. The first is based on a high-performing $CaCl_2/NH_3$ TCM reaction. The second represented by hot and latent heat storage based on PCM.

With those technologies, MiniStor can provide energy building services from RES production. In fact, the thermochemical reactor harnesses the heat from a novel PVT system to trigger a heating and cooling cycle year-round. In addition, MiniStor is equipped with a conventional lithium-based electrical energy storage system charged as well by PVT.

The system can integrate also a heat pump, needed in climatic zones with less solar radiation, but also in situations where the MiniStor system cannot cover 100% of the yearly energy demands. In this way MiniStor can effectively contribute to reduce carbon fuels for residential uses.

2.1.4 Message 3: "What makes MiniStor innovative"

MiniStor is an innovative compact system that collect several innovations in a unique system. Its core concept is based to a TCM heat storage technology, which is considered as a promising alternative to wide applied sensible (SHS) or latent heat storage systems (LHS), utilizing sorption and/or chemical reactions to generate heat. This guarantee an hight energy density and facilitate the integration in residential buildings.

MiniStor combines TCM and PCM materials for year-round thermal storage for heating and cooling materials that can be used in existing and new residential buildings.

The use of renewable solar heat and increasing flexibility with parallel use of TCM, PCM, and electrical storage battery will contribute to savings in electricity and gas expenses, which combined with reduced CO_2 emissions will allow a very high overall system efficiency.

A HEMS will be used to improve energy efficiency by applying adaptive and human based control strategies to major building thermal equipment. It will also measure and control household energy consumption.
Some of our most interesting technical aspects are:

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- *An extremely high energy storage density, around 182 kWh/m^3 at 60°C, 10.6 times higher than the respective value for water-based storage systems for operating heating temperature difference in the range of 15° C.*
- *The reduced size of the storage material and its equipment (0.72 m^3) and the versatility to adapt it to different thermal and electric systems allow installation in compact spaces.*
- *A highly efficient system will be versatile and easily integrated with solar-based RES solutions and conventional fuel sources that may be already available in households.*
- *More than 20 years lifetime with no performance degradation due to the highly stable salt selected.*

2.1.5 Key Message 4: "What will be the impact of MiniStor?"

The MiniStor impacts are well defined from the proposal phase and reported in the webpage of the project as shown in the Figure 4.

Figure 4. MiniStor Impacts as shown on its project website

The MiniStor project will demonstrate the impact of TCM ammonia-based storage system combined with PCM, to increase the RES penetration in the residential sectors contributing efficiently to the decarbonisation of the building sector. MiniStor aims to penetrate the residential sector by an innovative circular Business Model concept that can contribute to:

- *Increase the share of RES consumed at least 32% of renewable energy share*
- *Reduce the greenhouse ga emission at last by 40% by 2030 (from 1990 levels)*
- *Contribute to 27% of energy saving by 2030*
- *Reduce the building sector inefficiency*
- *Improve building energy efficiency of 32.5% by 2030*
- *Increase the building stock life*

Additionally, the MiniStor system can be proposed into the market by an advanced circular business approach that guarantee the recyclability and reuse of the main components and a low environmental impact ant the end of life.

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2.2 Key Exploitable Results

The exploitation process in MiniStor started from the beginning of the project with the aim to maximise the potential impact. The process followed the indications included in the CA and reported here in the Annex II as exploitation guidelines.

The Table 1 shown the list KERs selected during the MiniStor project from the entire list of Exploitable Results (ERs - Annex I). Iven if the detailed selection criteria have been presented in the D7.8 Replication Plan, this chapter report the list to present the Ad Lib message, the key public message defined for each KERs as well as a recap of the main target markets and the list of competitors (the entire competitor's assessment is included in the D7.6 "Market Analysis").

Table 1. Final KERs table

KER#	KER Name	Owner	Type	Partners
KER1	MiniStor Compact Energy Storage System	Joint Ownership	Product	MiniStor consortium
KER2	Home Energy Management System (HEMS)	CARTIF	Product	CERTH-ITI;
KER3	Novel PVT System	ENDEF	Product	
KER4	Thermochemical Unit (TCM)	CNRS	Product	Psyctotherm, Sofrigam
KER5	Visual interface IoT-platform for user interaction	CERTH-ITI	Software	

2.2.1 MiniStor Compact Energy Storage System

Ad Lib Message:

The MiniStor compact and integrated energy storage system helps *building owes and manager and in general way the residential sector* who want to *cover the energy needs (heating, cooling and DHW) of the building and enabling energy flexibility* by *increase the RES self-consuming and reduce energy costs, environmental impact and CO_2 emissions* and *increase the awareness of building energy inefficiency by the optimisation of consumptions and energy flexibility*, unlike traditional systems using fossil fuels.

General Message:

The MiniStor Compact Energy Storage system is an integrated system able to satisfy the energy needs (heating, cooling and DHW) of a building (single house or apartment) by the integration of different storage technologies such as TES, PCM, Electrical Energy Storage System (EESS) that permit the integration of RES and enable energy flexibility. It is based on the following skills:

- *Salt ammonia TCM unit, reversible, with high durability, high thermal of 182 kWh/m^3;*
- *Equipped with PCM technologies;*
- *Able to satisfy energy needs of a 80-100 m^2 dwelling with a reduced occupied volume (0,72 m^3);*
- *Easy to be integrated with all RES system for support RES penetration and provide energy self-consumption;*
- *More than 20 years lifetime with no performance degradation due to the highly stable salt selected;*
- *Integrated with an advanced HEMS for energy optimisation;*
- *Available with extended producer responsibility;*
- *Completely based of circular economy approach.*

Global market players:

As defined in the general description and during the characterisation of the MiniStor compact integrated system, it can be considered a group of sub-systems working towards the same objectives at residential level.

The MiniStor system is composed of PVT, TCM, PCM, and an electric energy storage battery, and can provide heating, cooling and DHW for residential applications. This characteristic makes it unique among the compact energy systems market.

For this reason, it is difficult to find competitors in the market, able to satisfy all the MiniStor skills in a unique system and developed by a unique company. Therefore, this report indicates only one competitor that can offer a solution compared to MiniStor (Table 2).

Table 2. MiniStor compact integrated system market competitors

Manufacturer	Country	Typology	Used Reaction
SaltX Technology	Sweden	Heat/Cooling compact system	Salt/Water

2.2.2 Home Energy Management System (HEMS) & Visual interface IoT-platform for user interaction

This chapter takes in consideration both KER#2 and KER#5 because the second is tailored on the KER#2.

Ad Lib Message:

The MiniStor Home energy Management System helps *building (owners and managers)* who want to *reduce energy costs and building environmental impact* by *the optimisation of energy consumption and energy production* and *enable energy flexibility strategy in the building*, unlike *traditional control systems not integrated with the whole building.*

General Message:

The advanced HEMS developed in the MiniStor project is a tailored system for the management of the MiniStor Compact Energy Storage system, but it can be integrated also to other energy system. The main skills are:

- *Smart and interoperable digital HEMS designed for residential applications;*
- *Dynamic control over the entire energy consumption and the indoor environmental quality (IEQ);*
- *Optimisation of energy consumption with RES production and energy forecasting;*
- *Adaptable to every smart energy system;*
- *Continuous real-time monitoring and Intelligent controls;*
- *Advanced prediction services and User-Centric interaction;*
- *Customisable with end user preferences;*
- *Machine learning approach;*
- *Secure data management.*

Global market players:

Started as a niche market, global market for the HEMS is growing fast as well as the smart appliances and systems for residential application. This is a consequence of the digitalisation process that in the last years, reached interesting levels in all sectors.

The MiniStor HEMS is a tailored solution for the MiniStor compact integrated system, but it can also work integrated with other system. In this assessment we can consider it combined with the Visual interface IoT platform in order to provide a complete solution and compare it with other market products.

Table 3. HEMS & Visual Interface IoT platform market competitors

Producer	Country	Device Monitoring and Control	Monitoring and data analysis/ KPI calculation	Seamless Communication between Devices	Comp. with ISO 50.001[3]	Security and Privacy (comp. ISO 27.001[4])
Evergen	Australia	Yes	Yes	Yes	Yes	Yes
KNX	Belgium	Yes	Yes	Yes	NA	Yes

[3] https://www.iso.org/iso-50001-energy-management.html
[4] https://www.iso.org/standard/27001

E.ON	Germany	Yes	Yes	Yes	Yes	NA
Enopte	Australia	Yes	Yes	Yes	No	Yes
ABB	Swedish Swiss	Yes	Yes	Yes	Yes	Yes
Denso	Japan	Yes	Yes	Yes	Yes	NA
Solarwatt	Germany	Yes	Yes	Yes	NA	Yes
Smappee	Belgium	Yes	Yes	Yes	Yes	Yes
Bosch	Germany	Yes	Yes	Yes	Yes	Yes
powerley	US	Yes	Yes	Yes	Yes	NA
Honeywell	US	Yes	Yes	Yes	Yes	NA
Lumin	US	Yes	Yes	Yes	NA	NA
Crabontrack	Australia	Yes	Yes	Yes	NA	NA
Solaredge	Israel	Yes	Yes	Yes	NA	Yes
ems3	US	Yes	Yes	Yes	NA	NA
Panasonic	Japan	Yes	Yes	Yes	NA	NA

2.2.3 Novel PVT System

Ad Lib Message:

The Novel PVT System helps *building (owners and managers)* who want to *reduce dependency on fossil fuels* by *the production of RES energy (thermal and electrical)* and *the disconnection from the fossil fuel value chain,* unlike *traditional control systems not integrated with the whole building.*

General Message:

The Novel PVT system developed by ENDEF in MiniStor guarantee increased energy thermal efficiency through a new adhesive between the PV laminate and absorber and a mono-PV laminate. *Two versions of PVT panels provide tailored solutions optimising electrical and thermal production. Main skills are:*

- *Increased energy performances – maximisation of energy production per occupied surface*
- *Tailored RES integration for optimisation of electricity or thermal energy*
- *Increased building EPBD*
- *Low environmental impact*

Global market players:

The PVT system sector is a growing market. PVT combines electricity and heat production from a single solar surface, optimising space usage and increasing efficiency compared to traditional photovoltaic panels. Considering that, it can be analysed yet as a niche market inside the RES market where PV technologies play the role of leader. The market is more expanded in countries where there are clear well defined decarbonisation plans, so they have to be firstly considered for the exploitation.

MiniStor PVT manufactured by Endef fits in a highly expanding market with several competitors as shown in the following Table 4.

Table 4. EndeF PVT system market competitors

General Information			Thermal Characteristics		Photovoltaic Characteristics	
Manufacturer	Country	Product name	Thermal power (W_{th})	Module Thermal efficiency (%)	Nominal power (W_p)	Module Electrical efficiency (%)
Dual sun	France	SPRING 400 Shingle black	895,05	48%	425	21,30%
Abora solar	Spain	aH72 SK	1372,105	70%	350	17,80%

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3F Solar	Austria	Solar one	825	49%	265	15,69%
SoLINK	Italy	Cellafredda	1291	70%	375	20,27%
Naked energy	UK	VirtuPVT	275	60%	74	20,00%
Solimpeks	Turkey	Volther POWERVOLT	630	41%	200	15,04%
Sidite solar	China	HYBRID PVT 540	1397	55%	540	21,12%
SolarMaster	China	PVT-545M	1436	70%	545	21,30%
Tyll Solar	US	Tyll 1500 W	1200	47%	350	13,57%
Solator GmbH	Austria	Solator PV+THERM AUFDACH	1075	52%	435	20,90%
NELSKAMP	Germany	MS 5 2Power	256	33%	120	15,27%
Consolar	Germany	SOLINK	508	21%	500	20,68%
Triple solar	Netherlands	M5 450 P	883	43%	450	21,95%
Solarus	SWEDEN	Hybrid-PC2S	1300	50%	260	10,10%
Qsilence	Netherlands	Qpanel	750	40%	425	22,71%
PVTSOLAR	Switzerland	BlackDiamond BSM-425	975	50%	425	21,76%

2.2.4 Thermochemical Unit (TCM)

Ad Lib Message:

The TCM System helps *building (owners and managers)* who want to *reduce dependency on fossil fuels* by *the integration with RES systems (thermal and electrical) and optimisation of energy produced by* and *optimising the energy flexibility during the day and the seasons,* unlike *traditional storage systems that have a limited energy capacity.*

General Message:

The advanced HEMS developed in the MiniStor project is a tailored system for the management of the MiniStor Compact Energy Storage system, but it can be integrated also to other energy system.

- *Smart and interoperable digital HEMS designed for residential applications*
- *Dynamic control over the entire energy consumption and the indoor environmental quality (IEQ)*
- *Optimisation of energy consumption with RES production and energy forecasting*
- *Adaptable to every smart energy system*
- *Continuous real-time monitoring and Intelligent controls*
- *Advanced prediction services and User-Centric interaction*
- *Customisable with end user preferences*
- *Machine learning approach*
- *Secure data management.*

Global market players:

The MiniStor ammonia based thermochemical unit is an innovative system compared to other types of thermal storage, offering advanced performances in a limited volume. The global market of TCM unit for residential applications is still a niche market inside the global TES market with a high potential of development not yet exploited. The market penetration for the MiniStor TCM solution is limited now by the TRL as well as by the CAPEX costs. The most interesting solutions which could be compared to the MiniStor TCM result, are not yet totally validated and are outputs from research projects under development.

The Table 5 resumes the main competitors analysed in the MiniStor market analysis.

Table 5. TCM market competitors

Manufacturer	Country	Typology	Used Reaction	Operating Temperature
Neothermal Energy Storage	Canada	Salt hydrate decomposition	Sodium acetate trihydrate mixed with water	Up to 100°C
HIT Nano	US	Molten salt	N.A.	> 500°C
Heat Insyde	EU	Molten salt	Potassium carbonate fusion	/
WTZ-Ost	Austria	Salt decomposition	Boric acid - boric anhydride cycle	Up to 150°C
ANTORA	US	/	Heated Carbon block	>1500°C
HoCoSto	Netherlands	/	Heated water tank	/
Alumina Energy	US	Alumina/salt composite	waste heat	20 - 1600°C
MOSS Project	Danmark	molten hydroxide	/	480°C
1414 Degrees	Australia	silicon-based	/	>900°C
Energynest	Norway	HEATCRETE® based	/	120-300°C

3. Reviewed Market Trend

The market analysis for the MiniStor project has been developed within D7.4. However, given that the project had a lifespan of more than 5 years and is in a growing market, it is important to provide a general overview of the market potential here, update the main trends and highlight the progress made in relation to the energy decentralisation scenario, particularly about the market for flexibility assets.

The aim of this chapter is to provides a comprehensive analysis of the potential market for the MiniStor solution using a top-down approach based on the TAM–SAM–SOM framework. This methodology estimates market size and identifies growth opportunities by positioning MiniStor within its relevant industry segment. The Total Addressable Market (TAM) refers to the overall demand for the solution, assuming unlimited resources and full market penetration. The Serviceable Available Market (SAM) narrows this scope to the portion of the TAM that aligns with MiniStor's target market, factoring in specific technologies, applications, and user profiles. Finally, the Serviceable Obtainable Market (SOM) focuses on the realistic share of the SAM that MiniStor can capture, based on current capabilities, competitive positioning, and market dynamics (Figure 5).

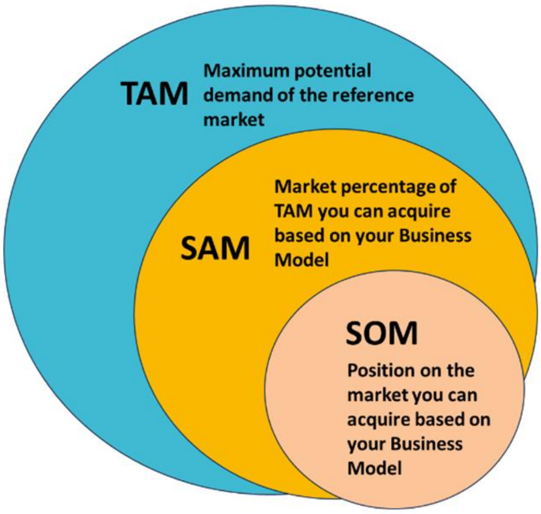

Figure 5. TAM, SAM, SOM methodology

3.1 Market Size

Total Addressable Market (TAM): The MiniStor system is designed to store thermal energy during periods of low demand or when surplus renewable energy—such as solar power—is available.

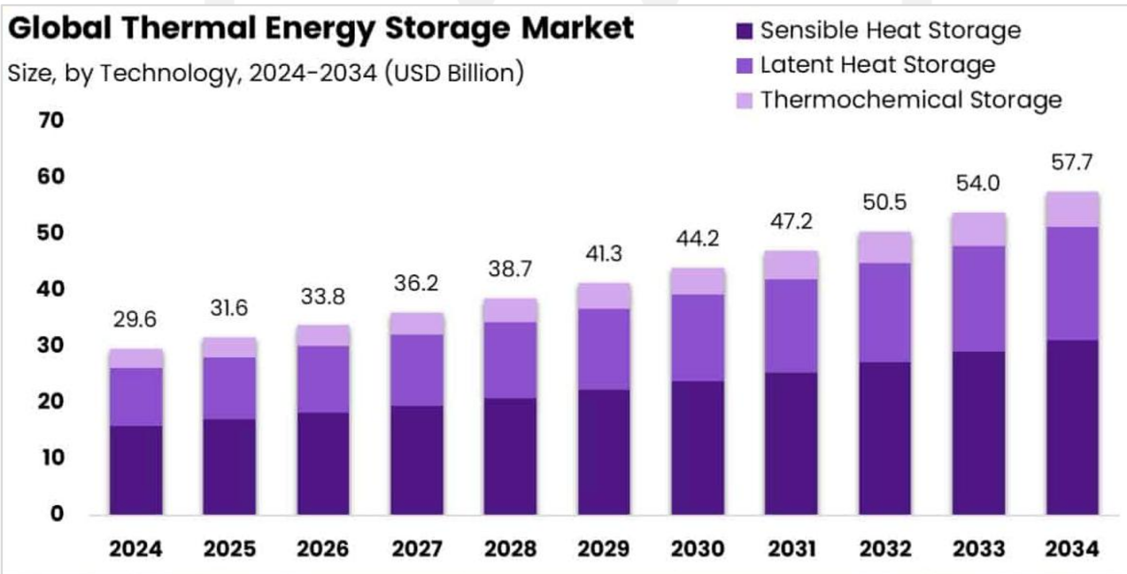

Figure 6. Overview of the TAM[5]

This stored heat can then be used during peak demand periods or when renewable sources are not producing energy. As such, MiniStor directly targets the global thermal energy storage market, which

[5] Source 1 Market.us - Report ID: 142639

was valued at USD 29.6 billion in 2024 and is projected to reach approximately USD 57.7 billion by 2034, growing at a compound annual growth rate (CAGR) of 6.9% from 2025 to 2034. [6]

Serviceable Addressable Market (SAM): The thermal energy storage market can be categorized by technology into three main segments: sensible heat storage, latent heat storage, and thermochemical storage. Among these, **sensible heat storage** currently dominates the market, accounting for approximately **54.3%** [6] of the total market share in 2024. This leadership is largely due to its technological maturity and cost-effectiveness compared to other storage methods.

The MiniStor solution specifically targets the thermochemical storage segment, which represents around **12%** of the total thermal energy storage market—equivalent to approximately **USD 3.58 billion** in 2024. Although currently a smaller segment, thermochemical storage holds significant potential due to its high energy density and long-duration storage capabilities. This positions MiniStor within a niche market with strong growth prospects. However, the widespread adoption of thermochemical technologies may be constrained by varying regulatory frameworks and the need to establish industry-wide standards, which could potentially slow down commercial expansion.

Serviceable Obtainable Market (SOM): The MiniStor storage system is primarily intended for application in residential buildings, making homeowners, real estate developers, building managers, architects, designers, and energy utility providers potential early adopters. The demand for thermal storage systems like MiniStor is closely linked to the installed capacity of renewable energy systems used for heating in residential buildings—such as heat pumps, photovoltaic panels, solar thermal collectors, and underground thermal energy storage units. These systems often produce energy intermittently, while building demand is continuous. Therefore, thermal storage systems like MiniStor, bridges this gap, aligning renewable energy production with building consumption and helping achieve the nearly zero-energy building (NZEB) standard. The market potential for such storage solutions can be characterized as the non-renewable primary energy currently required for space heating, domestic hot water, and cooling in residential buildings.

By storing surplus renewable energy, systems like MiniStor can significantly reduce reliance on non-renewable sources. This demand, however, varies according to climate zone, building energy efficiency, and the type and scale of renewable systems installed. According to Eurostat, in 2022 European households consumed 10.1 million terajoules (TJ) of energy. The primary energy sources were natural gas (30.9%), electricity (25.1%), and renewables and biofuels (22.6%), underscoring a significant opportunity to displace non-renewable energy with integrated renewable systems and thermal storage.

3.2 Market Trends & Key drivers

The thermal energy storage (TES) market is undergoing significant growth, driven by the increasing adoption of renewable energy sources and the need for more efficient and sustainable energy systems. Advancements in storage materials and technologies are making TES solutions more attractive and economically viable.

A major driver of this growth is the rising demand for renewable energy integration. As the installation of solar and wind power systems accelerates, managing their intermittent output has become a critical challenge. Additionally, the market is benefiting from rising energy prices and heightened global efforts to reduce carbon emissions. Both businesses and governments are increasingly investing in TES technologies to cut energy costs and meet carbon reduction targets. Europe currently leads the global TES market, accounting for 35.2% of the total share and generating approximately USD 10.4 billion in revenue [6]. However, despite its promising outlook, the TES market faces several challenges, such as the high upfront cost of installation, which often results in a low return on investment (ROI). Furthermore, varying policies, regulations, and standards across regions may hinder the widespread commercialization of TES technologies, particularly thermochemical storage, which remains at an early stage of deployment in the residential sector.

3.3 PESTLE analysis

The PESTLE analysis aims to summarise the results of the exploitation activity done within the MiniStor project with reference on external factors that can facilitate or block the market entrance for the MiniStor solution (MiniStor Integrated compact system- KER#1). The PESTLE, in form of table, groups opportunities and threats for the MiniStor solution and its business models. The Table 6 can be considered for future strategic decisions at consortium level but also at single partner level.

The identification of potential risks is a crucial point at this level of TRL, where external factors could drive company industrial plans in potential failures. For this reason, the PESTLE analysis will be considered in this final report.

Table 6. MiniStor PESTLE analysis

Factor	Description
Political	• Public support: Financial incentives and regulatory pressure for decarbonizing residential heating systems are created by the European Green Deal and REPowerEU initiative, which are significant regulatory tailwinds. These frameworks usually have funding mechanisms, tax incentives, and potential mandates that make thermal storage technologies more economically viable for consumers and developers. Public support and incentives play a significant role in market penetration, particularly in the early stages of innovative technologies. • Strategic Planning Integration: The National Energy and Climate Plans (NECPs) provide a structured roadmap that explicitly forecasts an increase in renewable thermal adoption while decreasing down natural gas dependency. This creates predictable market conditions that encourage investment in thermal storage solutions, as they become essential for managing the intermittency of renewable thermal sources like solar thermal and heat pumps. • Political and energy stability: The focus on reducing foreign energy dependence adds a strategic dimension beyond environmental goals. Local thermal storage systems can provide resilience against supply disruptions and price volatility, making them attractive from both economic and security perspectives.
Economic	• Current Economic Challenges: The high initial costs reflect the early stage of Thermochemical Thermal Storage development. Being pre-commercial means that it has not achieved economies of scale than mature technologies such as sensitive heat storage (using materials like molten salt) or latent heat storage (phase change materials) have achieved through years of implementation and optimization [7] [8]. • Long-term Economic Value: The significance of renewable integration lies in the potential for reducing energy bills. The value of renewable investments can be maximized by TCM systems by storing excess renewable energy during peak production periods and releasing it when needed [9]. To overcome the intermittency challenges of solar and wind power across different seasons, can improve overall system efficiency and reduce fossil fuel consumption. • Access to funding: EU funding landscape provides multiple pathways for TCM development such as: The National Recovery and Resilience Plan (NRRP), Horizon Europe supports research and innovation in clean energy technologies. On the other hand, also nation founding and desacralisation mechanisms can play a significant role. • Market Risk Factors: TCM, like many other capital-intensive technologies, faces real challenges due to economic volatility. Project economics may be greatly affected by fluctuations in material prices, especially for technologies that need specialized materials or components that could be affected by supply chain disruptions.

Social	• User acceptance: User acceptance of Thermochemical Storage Systems technology currently faces challenges due to low public awareness and potential cultural resistance to adopting this relatively new and less familiar technology (Complex thermochemical processes). This can slow market penetration and requires targeted education and outreach to build trust and understanding. The dissemination campaign done in MiniStro can facilitate the social acceptance, especially presenting the results in the pilot's integrations. • Growing interest in sustainability and environmental consciousness: There is a growing interest in sustainability among consumers, who are increasingly sensitive to reducing emissions and improving home energy comfort. This trend can positively influence acceptance of TCM, especially as it enables renewable integration, energy savings over time and the willingness to pay premiums for green technologies. At the same time TES integrated at building level can enable the participation of prosumers in the flexibility market, directly or by the negotiation of flexibility aggregators. • Demographics and urbanization: Regarding demographics and urbanization, TCM systems tend to be more suitable for single-family homes or small buildings because of their current modular design (tailored for limits the use of ammonia as regulated by the EN378). In contrast, TCM is less relevant or more challenging to implement in dense urban environments with limited space and different heating infrastructure, which may limit its adoption in cities.
Technological	• Maturity level: There are currently few commercial products available in the pilot or demonstration stage of TCM technology, showing that it is an emerging and innovative solution in the thermal energy storage market [10]. There are some gaps in commercial preparation, such as: no established industrial supply chain, limited performance data for prolonged operation, uncertainty of reliability and lifetime metrics and regulatory approval processes still under development etc. • Technological advantages: TCM's technological benefits include its high (i) energy density compared to sensible and latent heat storage, which allows for more compact systems and efficient use of space; (ii) The decoupling of heat generation and use over long periods for seasonal storage because of near-zero heat loss during storage; (iii) Compatibility with other technologies such as heat pumps and solar thermal systems, enhancing overall system efficiency and renewable integration. • R&D challenges: TCM technology success will depend on continued R&D investment, successful demonstration projects focusing on improving cycle stability, reaction kinetics, and cost-effectiveness. Scaling up from laboratory or demonstrators to commercial scale requires overcoming material degradation, reactor design optimization, and integration challenges [10] [11].
Legal	TCM technology currently faces several regulatory and policy challenges that impact its wider adoption. • Lack of specific technical regulations and standards: TCM systems do not have specific safety certifications, performance standards, or integration guidelines. This regulatory gap creates uncertainty for manufacturers, installers, and end-users regarding safety, reliability, and interoperability with existing heating and energy systems. The available regulations vary country by country and are strictly related to the type of material used in the TCM reaction. In the case of MiniStor, as ammonia based TCM, the use of ammonia is regulated by the standard EN378 (safety regulation for

	refrigerant and HP systems). The standard limits the maximum volume of ammonia in residential context and at the current state this represent a limitation in some applications (residential sector in countries as Italy, France, etc.). • Building and installation codes: Legal and procedural barriers may be created for integrating TCM into residential or commercial buildings, particularly retrofit projects, due to existing building codes and installation regulations that do not explicitly accommodate TCM systems. • Absence of direct policy incentives: In contrast to other mature energy technologies, TCM doesn't have yet, any targeted incentives like tax credits, subsidies, or energy efficiency bonuses to stimulate market uptake and offset its relatively high upfront costs. In spite of this, TCM could benefit from some types of taxes such as *"Conto Termico"* in Italy [12].
Environmental	TCM technology offers several environmental advantages that contribute to its sustainability profile: • Low carbon footprint: TCM systems usually use eco-friendly materials and help reduce the use of fossil fuels by storing renewable heat for later use, which reduces greenhouse gas emissions associated with heating. The circular economy approach proposed by MiniStor business vision perfectly fit with eco-friendly materials. • Support for seasonal energy efficiency: By storing the excess thermal energy produced in summer (e.g., from solar thermal systems), TCM can improve energy efficiency and reduce fossil fuel consumption in colder months. • Life cycle impact: In order to achieve the environmental performance of TCM, it is necessary to use thermochemical materials such as salts, hydrates, or other sorbents, as well as consider their impact on recyclability or disposal. • Renewable synergy: Integrating renewable energy sources like PVT, PV and HP becomes easier with TCM's flexible, long-duration thermal storage, which balances intermittent renewable generation and heating demand, improving the overall sustainability of energy systems.

4. Update of planned Dissemination actions

This chapter describes the dissemination actions planned and done as well as the exploitation potential. The Table 7 shows the conceptual overview of the three pillars of Horizon 2020[6] outreach as detailed in subsequent sections 4.1" Awareness raising dissemination", 4.2 "Scientific dissemination" and 4.3 "Exploitation oriented dissemination". Section 4.4 qualifies the exploitation potential of the MiniStor outreach.

Table 7. Pillars of Horizon 2020 outreach

Communication	Dissemination	Exploitation
About the project, the main results, and progresses	About the results only	About results and key exploitable results
Targeted in a tailored way to defined audience	Targeted in a tailored way to defined stakeholders' groups	Specific targets, IPRs, patents, copyright, etc., for commercial use based on the TRL
Multiple audience Beyond the project's own community (include the media and the public)	Peers Scientific or the project's own communities	Partners within the consortium, business partners
Specific targeted message	No particular messages	Specific message
Grant Agreement	Grant Agreement	Consortium Agreement, Grant Agreement

Dissemination is defined as "the act of spreading something, especially information, as far as possible". In this case, it involves transferring your research results to those who can best make use of them. Taking into account the three pillars of dissemination — creating awareness, fostering understanding, and encouraging action — our project's dissemination strategy aims to maximise its impact.

4.1 Awareness-rising dissemination

This chapter provides an overview of the communication objectives and tools employed to disseminate MiniStor results throughout the project lifecycle.

To support the dissemination and exploitation of MiniStor project, a range of communication activities have been planned and undertaken to promote main results as they emerge. These activities are internally assessed by the consortium based on:

i) the purpose of the communication action
ii) the message
iii) the audience
iv) the timing

The MiniStor communication strategy deliberately targets relevant stakeholders through knowledge transfer. FEUGA leads the project's communication activities, setting up the most appropriate organisation and tools to maximise the project's visibility and increase its awareness in the scientific communities and stakeholder frameworks. A set of communication activities has been implemented since the start of the project, with more to be developed during the remainder of the project lifecycle.

All outreach aimed towards target audiences follows a three-level strategy, described as follows:

(i) online
(ii) offline
(iii) physical / virtual dissemination

[6] https://rea.ec.europa.eu/dissemination-and-exploitation_en

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under the grant agreement No 869821

A detailed description of these activities can be found in the following paragraphs.

Online: The project website is an easy reachable and powerful channel for disseminating the main project information and provide a wide coverage of the WP's activities as well as to present the main results. The website has been used to ensure in an easy way the exchange of news, pilots' information and elicit the opinions of relevant stakeholders. The Table 8 summarises the MiniStor online communication activities being undertaken.

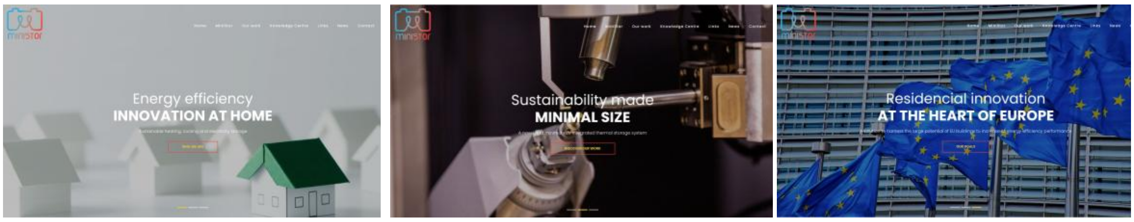

Figure 7. MiniStor website

Table 8.Online MiniStor communication tools

Online channel	Intended result and frequency of usage
Project website	Monthly, with both scheduled and non-scheduled updates to show consistent results
Partner websites	As applicable, to maximise visibility amongst interdepartmental human resources
Newsletters	Periodic updates for keeping the MiniStor stakeholder community informed on results
Marketing collateral	Video, brochures, infographics, etc. for easy sharing and presentation at various physical events.
Social media	LinkedIn followers with tracked "likes" to measure social awareness
Press releases	Presentation of the project and background info targeted at various stakeholder groups

Offline: The main offline dissemination material is represented by the public deliverables developed by the consortium partners.

Additional project publications, both scientific and general, presented at conferences and workshops also constitute MiniStor offline dissemination materials, if they do not contain any confidential information. Wherever possible, a public version that respects background, side and foreground privacy shall be created.

Physical meetings and events: Project events, virtual meetings and workshops, bilateral engagement, and clustering workshops, as well as to the participations in trade fairs represent an effective means to communicate MiniStor results.
The Table 9 reports the list of events (victual and in person) where MiniStor participated. It is important to note that the first part of the project followed Covid restrictions of that time, so the events and workshops were organised in a virtual model.

Table 9. List of MiniStor attended event

Event	Date	Partners	Location	Dissemination Level
Sustainable Places 2020	29/10/2020	FEUGA, IREC, R2M, CARTIF, CERTH, ENDEF	Virtual workshop	European
SSTES 2020	24/01/2020	HSLU	Lucerne, Switzerland	International
Sustainable Places 2021	30/09/2021	IREC, R2M, DUTH	Virtual workshop	European
IEA – SHC	02/10/2020	ENDEF	Virtual workshop	European

Galicia Innovation Days	26/10/2021	FEUSGA, IREC, DUTH, CARTIF, WOODSPRING	Virtual workshop (mid-term dissemination)	European
ECTP Conference 2021	02-03/12/2021	FEUGA	Madrid	European
Genera 2021	16-18/11/2021	ENDEF	Madrid	EU Trade fair
Planet Budapest 2021	03/12/2021	EMI	Budapest, Hungary	International
Construma 2022	06/04/2022	EMI	Budapest, Hungary	International
SEAI Energy Show 2022	30/03/2022	IREC	Dublin, Ireland	National
EUROSUN 2022	25-29/09/2022	ENDEF	Kassel, Germany	International
D^2EPC	08/06/2022	SGS, IREC	Virtual	European
Sustainable Places 2022	30/09/2021	IREC, R2M, DUTH	Virtual workshop	European
EUSEW 2022	06/09/2022	R2M, CERTH, ENDEF, DUTH, CNRS	Nice, France	European
BUILDUP Webinar	26/01/2023	IREC, CERTH	Virtual	European
ECCA 2023	19-21/06/2023	IREC, FEUGA	Dublin, Ireland	European
ECPT Assembly 2023	07/06/2023	FEUGA	Barcelona, Spain	European
Sustainable Places 2023	14-16/06/2023	R2M	Madrid, Spain	International
Construma 2023	29/03/2023	EMI	Budapest, Hungary	International
Pollack Expo 2023	13-14/04/2023	EMI	Pècs, Hungary	National
III International Seminar on Sustainable Engineering	25/11/2023	ENDEF	Barranquilla, Colombia	International
CES 2024	09-12/01/2024	Sofrigam	Las Vegas, US	International
International Symposium on Applied Science 2023	13-15/10/2023	Woodspring	Ho Chi Min City, China	International
PowR Earth Summit	13-15/03/2023	Sofrigam	Paris, France	International
Eurosun 2024	26-30/08/2024	ENDEF, CARTIF, CERTH	Limassol, Chipre	International
ENLIT 2024	23/10/2024	R2M	Milan, Italy	International
AEPIBAL Day. III National Energy Storage Meeting	28/11/2024	ENDEF	Zaragoza, Spain	National
ECTP 2024	05/03/2024	FEUGA, CARTIF, ÉMI	Brussels, Belgium	International
Pôle Cristal 2024	05/11/2024	Sofrigam	Dinan, France	National
ICRES 2025	11/04/2025	CERTH	Thessaloniki, Greece	International
IEA - Solar Heating and Cooling (SHC) Program, Task 73	13/02/2025	ENDEF	Berlin, Germany	International
MiniStor Final Conference	09/06/2025	All	Brussels, Belgium	International
Congreso CAE	25/06/2025	SGS	Madrid, Spain	National
Jornada CAE	20/06/2025	SGS	Castellón, Spain	National

The Table 10 reports here the final list of KPIs for the MiniStor communication activity.

Table 10. Final list of communication KPIs

Channel / activity	Key performance indicators (KPI)	Common objectives	Achieved
MiniStor website (SSL domain)	N° of visitors	1000 visitors /month in the last year of the project	6.845
	Time of visit	with +2 min average staying	1 min 4 sec
	N° of news	> 50	40
MiniStor Social Media	N° of followers (X/Twitter)	> 700	486 followers
	N° of followers (LinkedIn)	>200	248 followers
Youtube	N° of views	>1000	1004 total
Press releases	N° of press releases	2 per project partner	7
Partners' existing communication channels	N° of audience members reached	To reach a combined audience over 40,000 people (all partners)	178.750 from partners only, 375.550 including networks
Leaflet	N° of Leaflets distributed	50000	300
Newsletters	N° of newsletters	yearly	3
Videos	N° of promotional videos	2	2

4.2 Scientific dissemination

The scientific dissemination of MiniStor has been mostly done by the academic and scientific partners. It includes actions planned, including journal publications in green and gold open access and conferences contributions within the project lifespan. Table 11 reports the list of dissemination actions performed during the MiniStor project.

Table 11. MiniStor scientific and academic dissemination actions

Partner(s)	Title	Type	Planned date	Published/ Location
CERTH, CNRS, ENDEF	Conceptual design and dynamic simulation of an integrated solar driven thermal system with thermochemical energy storage for heating and cooling	Green Open Access	21.01.2021	Journal of Energy Storage
DUTH	Thermal/Cooling Energy on Local Energy Communities: A critical review	Gold Open Access	02.02.2022	Energies, MDPI
ENDEF	Energy Performance of Four Prototypes of PVT Collectors. A Comparative Study.	Green Open Access	10.07.2022	EuroSun 2022 proceedings
CARTIF	Programación de controlador para sistema de generación y almacenamiento térmico en edificio	Green Open Access	2022	Universidad de Valladolid
CERTH	Power Load Forecasting: A Time-Series Multi-Step Ahead and Multi-Model Analysis	Green Open Access	30.08.2023	UPEC Conference
CERTH	Optimizing the performance of a novel compact integrated thermal storage system (MiniStor) under diverse climate conditions	Green Open Access	31.05.2025	Green Energy and Sustainability (ICRES Special Issue)

4.3 Exploitation oriented dissemination

This section lists the strategies of exploitation oriented to dissemination already in place and suggested to the KERs owners to continue the KERs improvement and TRL upscaling.

The MiniStor partners planned joint exploitation-oriented dissemination activities, such as the participation to trade fairs for the presentation of the MiniStor integrated solution, and transversal activities with multipliers as meetings with industrial associations, or sister projects.

Foreground multipliers are channels that could increase the impact and visibility of MiniStor results. Examples include events that are managed or frequented by partners (e.g. Sustainable Places in the case of R2M and IREC), strong commercial departments with access to end users or email distribution lists, relevant memberships to associations, etc.

The data collected here summarise the business vision indicated in the KERs business modelling (D7.5) and in the replication plan (D7.8). Even if IREC and R2M are not proprietary of KERs, here they are reported considering the role in the project as coordinator and exploitation leader.

IERC Exploitation-oriented dissemination actions planned: As project coordinator, IERC aimed to increase the awareness about the project, maintain the stakeholder interest live and active, and acquire a high level of knowledge to reuse in future EU research activities in the field of building energy modelling. During the project, IERC presented its results in several events promoting the MiniStor integrated system as a disruptive solution for heating, cooling and DHW production in the residential sector.

The role of coordinator facilitates the organization of events and workshops as demonstrated in the multiple participation in Sustainable Places editions (Table 9). In this activity, the main targeted stakeholders were research institutes (RTO and academics) and citizens from the Irish context with the aim to produce learning and scientific materials and promote the results at public level. This activity will continue after the MiniStor project's conclusion as part of the IERC background knowledge.

R2M Exploitation-oriented dissemination actions planned: R2M solution has the business vision to bring the gap between the financed research and the market, working as a booster for innovative solutions, products and services. The participation in MiniStor increase the general knowledge about innovative thermal energy storage systems for residential applications to be reused in consultant services and innovation processes. R2M solution participated in several events promoting the MiniStor result (KER#1) in a tailored way on the target of the event and the stakeholder participation.

During the project R2M organised three exploitation workshops with the scope to drive the consortium partners in a harmonised exploitation strategy. In particularly, the last workshop focussed to the circularity approach of the MiniStor business model, involved external stakeholders and external experts.

R2M as a co-organiser of Sustainable Places lead the organisation of collaborative workshops and dissemination events like poster sections where MiniStor has been presented.

Sometimes R2M works as a reseller in Italy, Spain and France for innovate products, output of research project. In this way, even if the interest in the thermal storage solution, the TRL is far from the market and the market entrance is not well defined. Nevertheless, R2M will continue to promote TCM solutions and the result of MiniStor in new research proposal and innovation founds programmes.

CNRS Exploitation-oriented dissemination actions planned: CNRS is considered the main scientific contributor for the TCM unit that represents the core technology for MiniStor. As scientific partner, the dissemination actions done in the project focussed on the production of articles and scientific papers targeting the academic and research community in the European context. Future activities will take in consideration the results of MiniStor in order to contribute to the TRL upscaling, considering the possibility to put in place the MiniStor NewCo (which refers to a potential future joint entity for exploitation) with the role of scientific leader.

CARTIF Exploitation-oriented dissemination actions planned: CARTIF developed advanced knowledge in field of energy management systems, control systems and smart appliances represent the main research objective of the CARTIF group. The exploitation activities done in the project touched scientific dissemination activities for advanced HEMS and control strategies for flexibility management.

The MiniStor HEMS is a product that can be easily brought to the market with some TRL improvements and mass production certifications and represents an interesting solution in the context of flexibility management applied at residential level. As explained in the previous chapter, the market is growing and open. The no profit policy of CARTIF implied a market entrance in form of NewCo or spinoff and the collaboration with the MiniStor newco proposed in the MiniStro business model represent a good opportunity.

Nevertheless, additional studied will be done in the MiniStor context and additional scientific publication will be produced.

CERTH Exploitation-oriented dissemination actions planned: CERTH contributes to the exploitation roadmap by scientific dissemination mostly oriented to academics and RTOs. The initial objective of CERTH remains active and oriented to the industrialisation of the TES units in collaboration with industrial partnership. This exploitation roadmap remains the most interesting strategy also in collaboration with other partners.

CERTH participated in the project with two divisions, CERTH-ITI and CERTH-CPERI producing several project results in the context of data monitoring (DR contribution and IoT visual tool) and LCA (CERTH-CPERI).

ENDEF Exploitation-oriented dissemination actions planned: ENDEF is one of the MiniStor partners already active into the RES market with their PVT solutions. They contributed to the exploitation activities supporting the promotional strategy for the PVT system improved in the project, participating in events and international training fairs. They also contribute to the scientific dissemination by scientific papers. The business model of the company is directed to the commercialisation of the PVT systems with a tailored approach to the clients.

The interest of ENDEF is to continue the collaboration with the MiniStor solution that represent a multiplier channel for their business that currently is limited to the Spanish market.

SOFRIGAM Exploitation-oriented dissemination actions planned: Sofrigam entered in the MiniStor project with the role of ammonia reactor developer for the TCM reactor. The exploitation activity was concentrated on the TCM unit with the interest to attract industrial partners and investors for the commercialisation of the product in collaboration with CNRS and PSYCTOTERM.

Sofrigam provided to MiniStor awareness at European and International level promoting the MiniStor solution also in an international conference in Las Vegas (US).

PSYCTOTHERM Exploitation-oriented dissemination actions planned: Psyctotherm entered in the MiniStor project with the scope to develop the ammonia circuit (compressor, evaporator, condenser, valves, etc.). They contributed to the exploitation in joint activities in relation to the TCM unit.

4.4 Summary of Dissemination activities

Table 12 summarises the contributions of MiniStor to the dissemination actions and exploitation activities.

Table 12. MiniStor dissemination actions overview

Channel / activity	Key performance indicators (KPI)	Common objectives	Achieved
Stakeholders & mid-term workshop, National workshops	N° of attendees	50 per workshop 400 stakeholders approx. attending project's events	937

Final Conference	N° of attendees	100 Final conference	164
Demonstration / dissemination workshops	N° of workshops + 1 link EC Policy*	6 / 50 stakeholders each	5 / 796 *EUSEW
Participation in events	N° of international events	At least 2 per partner after 2nd year	27
	N° of national conference	2 per partner	8
Infographics	Per pilot site	5	14
Publications	N° of publications in sector-specific magazines	1 publication/year per partner	20
Scientific Articles	N° of published articles	More than 10 articles	6
Clustering with other projects/entities	N° of Joint actions	At least 10 joint actions	19
Policy Briefs	N° of policy briefs	3	3

MiniStor is expected to have a significant impact on the residential thermal energy storage sector, as well as on other applications in the industrial sector, through the likely establishment of a start-up/spin-off company formed by one or more of the consortium members, as detailed in the "MiniStor business model (D7.5)".

As a result of the planned outreach activities, MiniStor will promote knowledge sharing and raise awareness among relevant stakeholders in Europe and beyond. The MiniStor partners therefore aim to achieve short-, medium- and long-term impacts during and after the project, with a particular interest in continuing the pilot monitoring.

All dissemination activities targeting specific stakeholder groups (e.g. public authorities and standardisation bodies) aim to encourage more informed policymaking and certification practices and have a positive impact on the aforementioned sectors.

4.5 MiniStor final Conference

As part of the European Sustainable Energy Week (EUSEW), Europe's flagship annual event dedicated to renewable energy and energy efficiency, the MiniStor project held its final conference in Brussels on June 9–10, marking a key milestone in the project's journey. The event, titled "Reaching the Decarbonisation Goal", celebrated the project's conclusion by presenting its most impactful research findings, technological innovations, and policy recommendations.

Hosted in a hybrid format, the conference welcomed both in-person attendees and a wider online audience via livestream on the MiniStor YouTube channel. Participation was significant, with the engagement of 26 Institutions.

The event was structured around two core sessions:

- June 9 – Presentation of Project Results
- June 10 – Policy Session

The conference opened with remarks from Óscar Bernárdez, EU Projects Manager at FEUGA, responsible for MiniStor dissemination and communication. He introduced the consortium partners and outlined the conference objectives. Following the introduction, Carlos Ochoa, Senior Researcher at IERC and MiniStor Project Coordinator, presented the project's purpose, objectives, and key outcomes.

A highlight of the conference was the presentation by Driss Stitou, Scientific Director at CNRS, who introduced the project's core technological innovation: the TCM system. This system leverages the reaction between calcium chloride and ammonia salts, combined with parallel hot and cold PCMs. Compared to conventional thermal storage solutions, the TCM technology demonstrated a thermal storage density 10 times greater than water, positioning MiniStor as a groundbreaking solution for managing the variability of renewable energy sources.

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under the grant agreement No 869821

Figure 8. MiniStor presentation at EUSEW and Roll-up

Georgios Martinopoulos, research associate at CERTH-CPERI, presented the testing and demonstration activities. MiniStor was evaluated across five sites tailored to different European climate zones: two in Mediterranean climates, two influenced by Atlantic Ocean conditions, and one in a continental-humid environment. Results showed highly promising performance, achieving an interesting efficiency and reducing residential thermal energy consumption.

Marco Rocchetti, Head of Energy & Technology at R2M Solution, discussed the market potential and scalability of the MiniStor solution. The financial analysis demonstrated that MiniStor is not only economically viable but also highly scalable, with strong potential for commercial uptake, especially in the residential sector.

To close the conference, Yolanda Lara, R&D Manager at EndeF Engineering, presented the project's policy brief alongside Carlos Ochoa. The session highlighted key performance indicators related to MiniStor environmental and economic impact, with the goal of incentivising the adoption TES in buildings. The brief also aimed to engage potential investors and regulators to support the solution's path to market.

The event also featured presentations from sister projects such as HYSTORE, STEAMDRY, and PRODUTECH R3, which shared their objectives and collaborative achievements. These exchanges opened new opportunities for synergies and future cooperation across the sustainable energy landscape.

Figure 9. MiniStor final event roundtable

The final event has been disseminated via video link, by social media and the MiniStor webpage. Figure 10 and Figure 11 report screenshots of the MiniStor event on the social channels as well as the visualisations reached.

Figure 10. Visualizations of MiniStor events

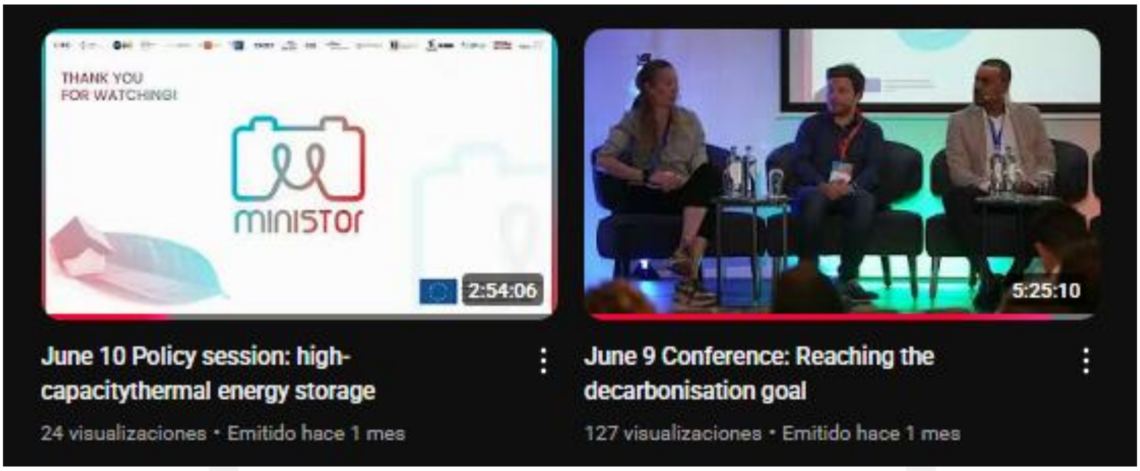

Figure 11. Visualization of MiniStor final event by YouTube

5. Conclusions

The MiniStor dissemination and exploitation strategy has been planned from the beginning of the project to maximise the impact of the project outcomes by tailored activity and well-defined stakeholder groups.

During the project, R2M as project innovation leader and FEUGA as dissemination and communication leader, worked in synergy to drive the consortium with a strategy aimed to ensure that all outcomes and results of research has been managed in respect to the IPR and sensibility. At the same time the consortium provides sufficient and sustainable exploration of the main concepts analysed, during the project and after the project life cycle. It is crucial that the strategy is adapted to the different stages and developments, and that as the project develops and the results are delivered, there is a stronger focus in the development of exploitation tools and activities.

This public report is a point of reference for current and foreseen MiniStor communication, dissemination, and exploitation activities.

Enclosed concepts:

- Key Message: The report contains 12 Key messages related to the MiniStor integrated system and the KERs to be used in dissemination activities.
- Reviewed market trend assessment: an updated analysis of the thermal energy storage market trend for residential application and a PESTLE analysis that contextualise MiniStor for the market entrance.
- A summary of the dissemination actions: The list of dissemination actions done in MiniStor.

Moving Forward:

The consortium partners, in particular the KER owners and the pilot managers agreed to maintain the pilot monitoring process alive in order to acquire missing data and update the performance assessment of the systems.

References

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Annex I –Exploitable Resoult Table final vertion

The table below reposts the Exploitable Result table presented in Deliverable 7.4.

Table 13 – Final Exploitable Result table version 6

#	Exploitable Result	Type	WP	ER Manager
1	MiniStor compact energy Storage	Product	WP3, WP4, WP5, WP6	R2M
2	Model to implement the system in state-of-the-art whole-building energy modelling programs	Model	WP3	IERC
3	Home Energy Management System (HEMS)	Product	WP5	CARTIF
4	Visual interface IoT-platform for user interaction	Software	WP5	CERTH-ITI
5	Enhanced Energy Modellers (DR forecasting and optimization tool)	Software	WP3, WP5	CERTH-ITI
6	Cloud base monitoring Tool and data mine	Software	WP4, WP5	CERTH-ITI
7	HEMS - High level control	Knowledge	WP5	CARTIF
8	Distributed Energy Resource (DER) prediction model	Model	WP5	CARTIF
9	Novel PVT System	Product	WP3	ENDEF
10	Water flat plate PVT collectors (Conventional PVT)	Product	WP3	ENDEF
11	Strategies for connecting Conventional PVT, with the TCM storage	Knowledge	WP3, WP6	ENDEF
12	Hybrid Energy Storage testing procedures	Knowledge	WP4	EMI
13	Thermochemical Unit (TCM)	Product	WP4	CNRS
14	Simulation for BESS unit according to PVT electrical production and the electrical load profiles	Knowledge	WP3, WP5	ENDEF
15	MiniStor time and cost-effective construction methods	Knowledge	all	IERC
16	MiniStor footprint impact tool	Software	WP6, WP7	CERTH-CPERI
17	Circular economy MiniStor Business Model	Knowledge	WP6, WP7	R2M
18	AR/VR interaction with end-users	Knowledge	WP3	CERTH-ITI
19	Methodology for MiniStor O&M	Knowledge	WP2, WP7	HSLU

Annex II: Exploitation and IPR management guidelines

Exploiting research results depends on the proper management of IPR (intellectual property rights), which is part of the overall management of knowledge in the project. Due to the novelty of the research foreseen within the MiniStor project, the necessary measures are required to be applied towards protecting the legitimate interests of the involved parties with respect to the background introduced into the project and the foreground developed within. To this end, special focus will be placed on ensuring appropriate knowledge management and protection.

The management of IPR is strictly ruled by the consortium agreement (CA) which includes all provisions related to the management of IPR including ownership, protection and publication of knowledge, access rights to knowledge and pre-existing know-how as well as questions of confidentiality, liability and dispute settlement. In the CA, partners have identified the background knowledge included and excluded. Guidance shall be governed according to "Fact sheet on "How to manage IP in Horizon 2020: project implementation and conclusion".

The CA regulates the ownership of results (Sub-section 3). The knowledge acquired in the course of the project shall be considered as a property of the beneficiary generating it, and in this sense the originator is entitled to use and to license such right without any financial compensation to the other contributors. If the features of a joint result are such that it is not possible to separate them, the contributors could agree that they may jointly apply to obtain and/or maintain the relevant rights with appropriate agreements in order to do so.

The CA also regulates the transfer of results ownership (Section 3 – Article 30). Each signatory party may transfer ownership of its own foreground following the procedures of the grant agreement (GA). Each signatory party may identify specific third parties it intends to transfer the ownership of its foreground to. The other signatory parties waive their right to prior notice and their right to object a transfer to listed third parties according to the GA (article 30). The transferring party shall, however, at the time of the transfer, inform the other parties of such transfer and shall ensure that the rights of the other parties will not be affected by such transfer.

The Exploitation Manager (EM) in MiniStor is R2M, who is responsible for oversight of the commercial exploitation of MiniStor results for up to four years following the project (Article 28.1 of the grant agreement. The EM shall also: (i) coordinate and implement exploitation activities; (ii) propose IPR / exploitation strategies and (eventual) associated CA updates; (iii) prepare the master plan for the exploitation; (iv) contribute to proper exploitation of the results by helping industrial partners to prepare adequate business plans and/or to get, if required, auxiliary funds for further industrialization of products and processes; (v) monitor the use of resources for exploitation issues; and (vi) monitor trends in related markets (e.g. solar cooling, industrial heat pumps, etc.) to assess the needs for early adoption and commercial deployment.

The EM supports the Project Coordinator (PC) on exploitation related issues. The EM is always updated on the scientific and technical progresses of the project and of current IPR scenario to detect potentially exploitable results. An additional responsibility of the EM is to make sure that technological progress remains consistent with the industrial perspective and assist the PC to evaluate the impact of the project from an industrial point of view.