



HYCOOL-IT

HYBRID COOLING & MANAGEMENT
FOR IT INFRASTRUCTURES

WP7 – Exploitation and Standardisation 2

Task 7.1 Product/Services definition, Exploitable
Results identification & management and IPR
treatment

D7.1 Exploitable Results table V2



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Executive Summary

The goal of HYCOOL-IT project is to propose a standardised comprehensive set of processes, digital tools and advanced adsorption equipment to achieve a replicable cost-effective thermal management and energy optimisation of tertiary buildings with high energy demand IT Rooms.

This report presents an overview of the exploitable results of the Hycool-IT project identified during the first 26 months of the 3-year project and provides an update of the exploitable results table as presented in Deliverable 6.2 in month 18. The report provides an overview of the strategies and actions needed for adoption and exploitation of results generated by the Hycool-T project.

Ten exploitable results have been identified which are summarised under three categories: 5 Products & Applications, 3 Knowledge, and 2 Other (standards, methodology). It is envisioned that 2 of the results will be exploited on a commercial basis and the remaining 8 results will be made available for public or scientific exploitation.

An assessment of expected project foreground conducted within the project revealed two key exploitable results:

- 1. The Hycool-IT solution:** A combination of building digital twin technology and software-in-the-loop simulation software accompanied by engineering guidelines and supported by recommendations for new standards. The Hycool-IT solution combines the individual results of the project into a solution that enables the IT server room construction and operation industry to maximise energy efficiency. Targeted exploitation dissemination activities ensure market fit. BDTA will be the main driver for further development of the smart building digital twin concept after the end of the project.
- 2. Rack-integrated adsorption chiller:** An advanced version of the rack-integrated adsorption chiller as developed by SORGE. The innovations make the chiller more efficient, adaptable, and reliable, particularly in environments with fluctuating demands, such as data centres, thereby offering substantial operational and environmental benefits. Tests with a first prototype uncovered some inefficiencies in the machine which are being resolved in a second prototype. The chiller is expected to be market ready by 2028-2030. The IP will be patented.

During the course of the project the scope of two results has changed because of new insights and after consultations with market players. The idea of generic and specific SIMBot libraries as originally described in the Grant Agreement, has been replaced by the knowledge graphs which better match the work flows of developers and manufacturers. Also the scope of the CWA has been changed to cover the SIMBot methodology and the associated lab testing process of rack-integrated adsorption chillers.

The methods and products developed in Hycool-IT will contribute to the energy efficiency of IT server rooms and the further digitalisation of the construction industry and can be of great benefit for all stakeholders involved.

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Abbreviations

AI	Artificial Intelligence
BMS	Building Management System
CWA	CEN Workshop Agreement
DCIM	Data Center Infrastructure Management
DPP	Digital Product Passport
ER	Exploitable Result
IP	Intellectual Property
IPR	Intellectual Property Rights
KER	Key Exploitable Result
KPI	Key Performance Indicator
PTC	Patent Cooperation Treaty
PUE	Power Usage Effectiveness
SiL	Software-in-the-Loop
SMTS	Simulation Model Tracking System
TRL	Technology Readiness Level

1. Introduction

1.1 Scope

The present public deliverable is the final version of the project's exploitation plan. The main aim of the work presented is to maximise the economic, scientific, and environmental impact of the project and initiate timely action for the preparation of post-project exploitation and replication activities. The presented information will help the project partners with the preparation and focussing of exploitation activities and the management of the accompanying IP.

1.2 Audience

The target group of this deliverable includes:

- Hycool-IT partners, especially those partners who are owners or developers of one or more exploitable results. Specific interest is given to those partners developing a service which can be interconnected with others to increase its efficiency.
- Market players in the construction and renovation industry, especially those players targeting the tertiary sector, manufacturers of IT server room equipment, and developers of simulation and digital twin software.
- The European Commission to provide a clear understanding on which organisations, which results and how the expected results and potential economic, social and environmental impact of the project will be managed.

1.3 Contributions of partners

The main author of this deliverable is R2M Solution (WP6 leader).

R2M Solution periodically contacted all project partners in order to collect their Exploitable Results (ER). This has resulted in the final list of Exploitable Results which can be found in Chapter 3. Partners owning an ER have provided input regarding the status of their result, their exploitation plans, and IPR strategy.

1.1 Relation to other activities

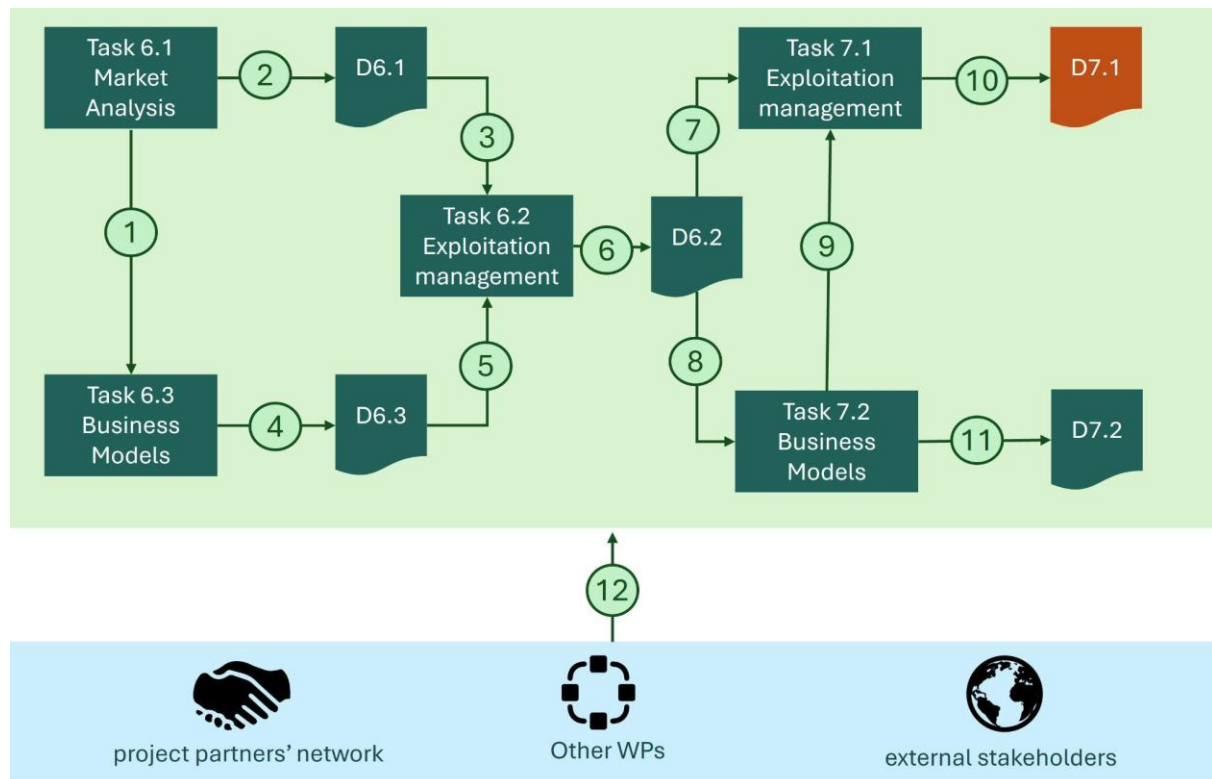


Figure 1 - Relationship of D7.1 with other activities and deliverables

Figure 1 illustrates the relationship of this deliverable to other activities and deliverables in the HYCOOL-IT project. These relationships are represented as links numbered from 1 to 12 and are described as follows:

Link 1: Task 6.1 has conducted a market analysis, focussing on the relevant market segments for HYCOOL-IT covering building digital twin, cooling solutions for IT server rooms, and energy efficiency. The selected target markets have set the scope for the analysis of relevant business models.

Link 2: The results of the market analysis, including an overview of the key actors in the HYCOOL-IT business ecosystem, drivers and barriers, and a PESTEL analysis, are presented D6.1.

Link 3: The results of the market analysis sets the business context for the project results for which the draft exploitation plans have been developed in Task 6.2.

Link 4: Based on the selected target markets, Task 6.3 conducted an analysis of the dominant business models in the HYCOOL-IT business ecosystem and drafted an initial business model for the HYCOOL-IT solution.

Link 5: The overview of the business models of key actors in the HYCOOL-IT ecosystem and the initial business model for the HYCOOL-IT solution, as presented in D6.3, has been input for the preparation of the exploitation plans for the project results as developed in the other WPs.

Link 6: Based on the market research performed in Task 6.1 and the business model analysis from Task 6.3, the initial exploitation plans and IPR strategies for the project results have been described in D6.2.

Link 7: The draft exploitation plans as described in D6.2 have been the starting point for Task 7.1 which will finalise the exploitation plans for the project results.

Link 8: The draft exploitation plans as described in D6.2 have been the starting point for Task 7.2 which will validate and finalise the business model for the HYCOOL-IT solution.

Link 9: The results of the business model validation activities as conducted in Task 7.2 have been input for Task 7.1 which developed the final exploitation plans for the project's results.

Link 10: The final exploitation plans for the project's results, including IPR measures, are presented in this report, D7.1.

Link 11: The final business model for the HYCOOL-IT solution, including an overview of the validation results will be presented in D7.2.

Link 12: The input from the project partners and external stakeholders, together with the solutions developed in the other work packages, are used as input for the market analysis and definition of the HYCOOL-IT business model and exploitation plans.

1.4 Document structure

The report is structured in five chapters. This introductory chapter describes the goals and outline of the document as well as the position of the document related to the project context. The remainder of this document is organised as follows:

- **Chapter 2** describes the methodology used for the management of exploitable results.
- **Chapter 3** provides a summary overview of the exploitable results of the project.
- **Chapter 4** presents the exploitation plans for the two key exploitable results: the Hycool-IT solution and the rack-integrated chiller.
- **Chapter 5** provides the expanded view of the individual exploitable results, presenting more detailed information for each of the results. A short description, ownership, maturity level, short- and mid-term exploitation vision, IPR, related Work Package, and deliverables are described for each of the ERs.
- **Chapter 6** presents the conclusions of the report outlining the implications for the wider activities in the Hycool-IT project.

2 Methodology

This chapter describes the methodology used for the identification and management of the exploitable results of the project. It clarifies the different steps that led to the definition of the exploitable results, exploitation strategies and exploitation plans presented in this report. In doing so it explains how the outcomes of this work will drive future activities and contribute to the impact of the project.

This section has been conceived using R2M's exploitation methodology, which has been developed across time as R2M has fulfilled this role in several EU projects (e.g. PARMENIDES GA: 101096453; ENERGY MATCHING GA: 768766). 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 or very similar to other ERs tables developed in the framework of previous projects.

2.1 Exploitable results

As a base definition, Exploitable Results (ER) are the achieved and/or expected results coming from the project that will have an impact on the economy, environment and/or society as a whole. These results have commercial or social significance and can be exploited as stand-alone products, processes, services, etc. In principle, these exploitable results might need further R&D, prototyping, engineering, validation after the project ends and before they become commercially exploitable.

Exploitable results can be categorized into several areas. They are not rigid but, for here, the following areas are considered:

- **Products & applications** – items for sale (e.g., hardware or software)
- **Processes** – ways to make or do something
- **Knowledge** – valuation of “how to”
- **Services** – by offering the above products, processes, equipment, or knowledge
- **Other** – Platform, publications, patent....

A Key Exploitable Result (KER) is an identified main interesting result (as defined above) which has been selected and prioritised due to its high potential to be “exploited” – meaning to make use and derive benefits- downstream the value chain of a product, process or solution, or act as an important input to policy, further research, or education. For Hycool-IT, two KERs have been identified based on innovativeness and impact:

3. **Hycool-IT Solution**, which combines the individual exploitable results of the project resulting in a solution that helps further digitalisation of IT server room design and management.
4. **Rack-integrated adsorption chiller**, a next generation cooling solution that comes with a smart digital twin.

2.2 Overall strategy for the management of exploitable results

The exploitation of the project's results means to make use of the results produced in further activities (other than those covered by the project, e.g. in other research activities; in developing, creating and marketing a product, process or service; in standardisation activities).

The overall strategy for the management of exploitable results can be broadly divided in the three phases as shown in Figure 2.

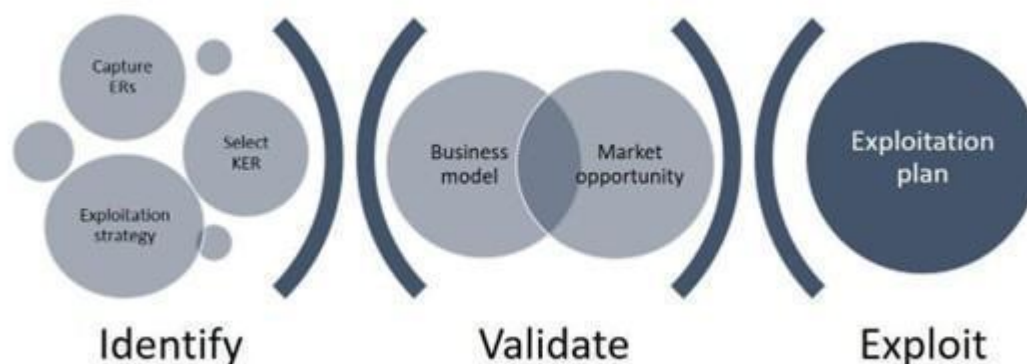


Figure 2 - Overall strategy for exploitation management

The phases consist of a range of activities and are supported by a set of tools. Each phase is explained briefly below.

Identify: In this phase, exploitable results are being identified, collected, and analysed. The starting point is the list of project results as defined in the Grant Agreement. For each identified result key information is being collected like the manager of the ER, type of ER, the used background, the co-developers, the current and expected TRL, development status and initial exploitation vision. For the collection of this information, a first ER-questionnaire has been distributed to the ER managers in July 2024. A follow up questionnaire to collect information for further updating and detailing of the exploitation plans have been distributed in November 2025.

Validate: In the Validation phase, it is being explored what kind of value propositions are being enabled by the ER. The focus shifts from the technical capabilities of the ER to the customer value and accompanying business model. A quick market analysis is being conducted and by engaging with target customers, end-users and other stakeholders, a check is done if the ER addresses a real need or problem. Exploitation actions like workshops with stakeholders and presentations at relevant events, have been organised to ensure market fit. The goal is to come to a validated viable, feasible and desirable business model supported by the ER owner(s). Initial business models are presented in Deliverable 6.3. The final business models will be presented in Deliverable 7.2.

Exploit: In the Exploit-phase the exploitation plan is being detailed out. After having developed the business model in the previous phase, arrangements need to be made to secure post-project exploitation of the ER. This involves setting up partner agreements, IPR agreements and secure funding for further commercialisation or development of the ER. This phase ends with the kick-off of the exploitation plan.

This three-phase strategy is a continuous process where during any time in the project, new project results can be identified as an exploitable result. To ensure timely identification of exploitable results, the list of (key) exploitable results has been reviewed with all project partners during each General Assembly.

3 Exploitable results - consolidated view

The following ER's are an expansion of the preliminary list of technologies and results proposed in the Grant Agreement and include results identified by the partners during the first 26 months of the project. Each ER is assigned to an ER manager who is responsible for providing information and updates on the result, defining the steps needed to reach full exploitation and launching it eventually into the market or in follow-up research activities.

Table 1 - Overview of HYCOOL-IT exploitable results

#	Name & description	Type of ER	ER manager	Exploitation vision
1	Hycool-IT Solution	Other (Method)	IDP/BDTA	Public / Scientific
2	Rack-integrated adsorption chiller	Product	SORGE	Commercial
3	Methodology for SIMBot creation	Knowledge	BDTA	Public
4	Methodology for predicting and optimizing building performance using SiL	Knowledge	BDTA	Public
5	SiL Predictive Control Module	Product / application	IMP	Scientific
6	Simulation Model Tracking System (SMTS) Module	Product / application	IDP	Commercial
7	SIMBot Knowledge Graph	Product / application	BDTA	Public
8	CEN CWA around the use of SIMBots and the associated lab testing process of rack-integrated adsorption chillers	Other (standards)	BDTA	Public
9	Innovative engineering guidelines for ICT Server's Room design	Knowledge	R2M	Public
10	Tool for waste heat reuse for IT server rooms	Product / application	POLIMI	Scientific

Compared to the list of Results as presented in Deliverable 6.2 in Month 18, two changes have been made in the list of Results:

1. Result 8 has been renamed from "CEN TC442/WG9 new working item or CWA aggregating HYCOOL-It's ICT tools and methods" to "CEN CWA around the use of SIMBots and the associated lab testing process of rack-integrated adsorption chillers" which better reflects the changed scope of the result.
2. Two results have been merged: The "Generic Simbot libraries for IT rooms" and "Specific SIMBot of rack-integrated adsorption chiller". They are replaced by the ER "SIMbot Knowledge Graph" since the original SIMBot library approach as described in the Grant Agreement was not supported by industry representatives.

4 Exploitation plan for Hycool-IT's KERs

This chapter presents the draft exploitation and replication plan for the two KERs, being the Hycool-IT solution and the rack-integrated adsorption chiller.

4.1 Exploitation vision for the Hycool-IT solution

4.1.1 Scope of the solution

The Hycool-IT solution is a combination of building digital twin technology and software-in-the-loop simulation software accompanied by engineering guidelines and supported by recommendations for new standards and policies. A new innovative rack-integrated adsorption chiller is a first example where a physical component of an IT server room gets a digital equivalent which can be used for simulation and optimising energy performance purposes. The Hycool-IT solution combines the individual results of the project into a solution that enables the IT server room construction and operation industry to maximise energy efficiency. Figure 3 shows how the combination of exploitable results of the project as presented in Chapter 3, result in the Hycool-IT solution.

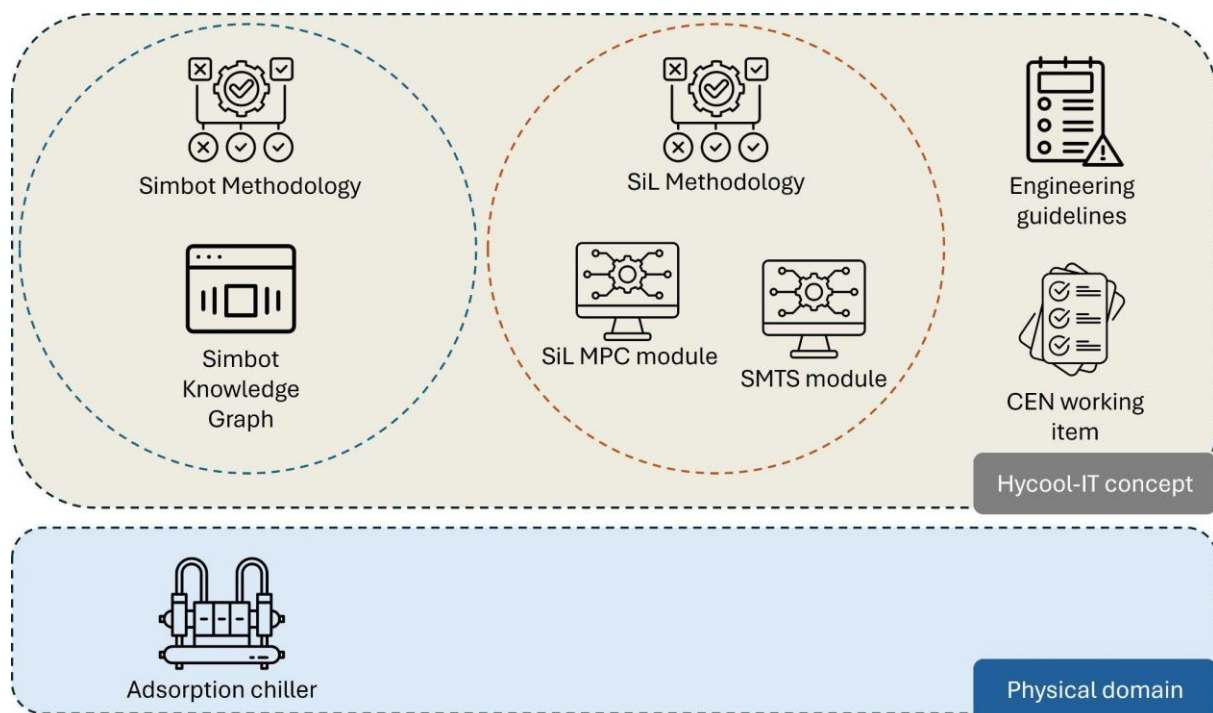


Figure 3 - Clustering of Hycool-IT Results

4.1.2 Hycool-IT value proposition and innovation

The innovative element of the Hycool-IT solution is the real-time coupling of the digital model with the physical IT server room and its components and equipment, allowing for optimisation of the energy performance of the IT server room during all phases of its lifecycle.

The Hycool-IT value proposition is its promise to the customer. Together the project partners developed the following value proposition statement: *“HYCOOL-IT solution enables IT server room operators in tertiary buildings to monitor, optimize, and improve the performance of existing or newly built IT server rooms from design to operation. Using real-time data and simulations, it provides insights into planned vs. actual performance and suggests efficiency improvements.”*

The Hycool-IT value proposition and draft business model is worked out in more detail in Deliverable 6.3 and will be finalised in Deliverable 7.2.

4.1.3 Target market

Hycool-IT targets IT server rooms in tertiary buildings. Tertiary buildings encompass a wide range of structures primarily used for service-based activities. The table below shows the different categories of service industry and buildings.

Table 2 - Overview of tertiary buildings

Service sector	Tertiary buildings
Hospitality and leisure	<ul style="list-style-type: none"> • Hotels • Restaurants • Swimming pools • Gyms • Theme parks
Commercial	<ul style="list-style-type: none"> • Shopping centres • Office buildings
Healthcare	<ul style="list-style-type: none"> • Hospitals • Clinics
Education	<ul style="list-style-type: none"> • Schools • Universities
Transport	<ul style="list-style-type: none"> • Airports • Train stations • Bus terminals • Port
Cultural	<ul style="list-style-type: none"> • Theatres • Concert halls • Museums

For the rack-integrated adsorption chiller to work efficiently, a minimum level of waste heat needs to be available. Service providers that require computing intensive tasks and applications for

delivering their services are therefore the key target customers. Examples of such organisations are universities and hospitals which operate 24/7.

Typically, businesses have the following options for managing the storage and accessibility of their data and applications:

- **On-premise data centre:** A company houses its servers, networking hardware, or other necessary IT equipment in a facility that is owned and run by the company itself, often within their corporate office.
- **Colocation:** Housing hardware and IT equipment (while still owned by the enterprise) in a secure third-party facility.
- **Cloud data centre:** A cloud data centre is a facility owned by a cloud service provider who offer virtualised environments that enable organisations to store, process and analyse data and run applications over the Internet.
- **Hybrid data centre:** A mix of on-premises data centre components and virtual data centres components.

Hycool-IT focusses on the first type of users and customers, more specifically owners of tertiary buildings who are equipped with an in-house server room.

4.1.4 Stakeholders and value web

The design, construction, operation and renovation of IT server rooms is linked to the lifecycle of the building of which the IT server room is part of. Figure 4 shows the key business actors and the value streams connecting these actors.

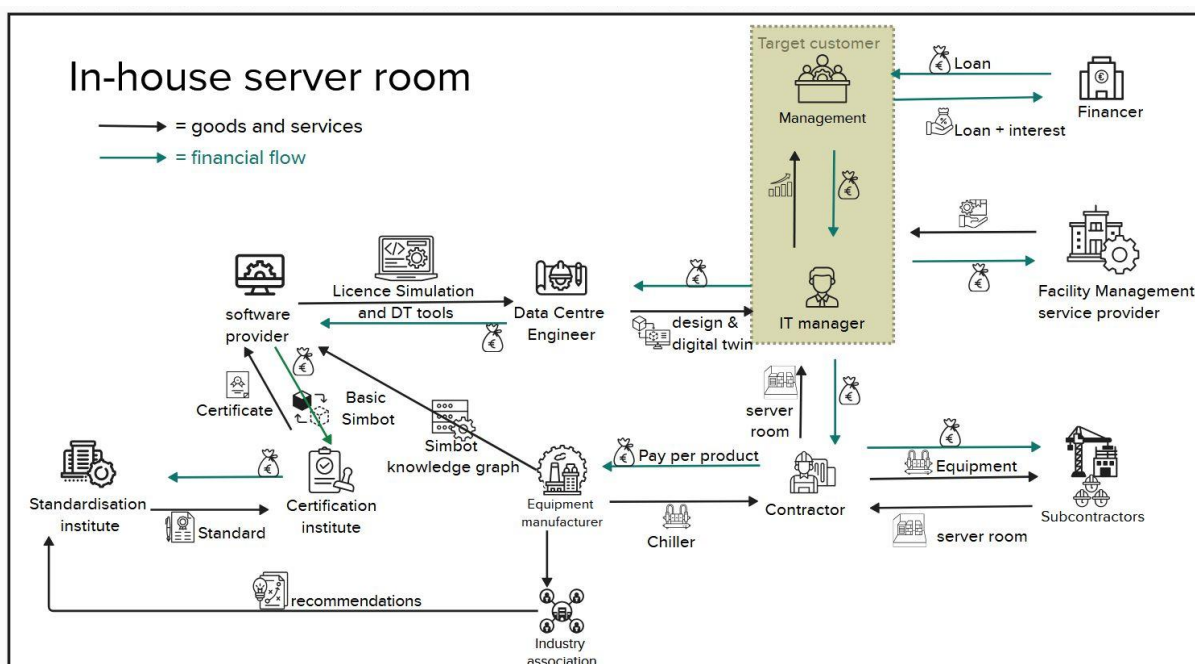


Figure 4 - Hycool-IT value web

Not all actors are active at the same time, depending on the phase in the lifecycle, actors are involved or not. For the Hycool-IT solution to work fully, multiple business actors need to adapt their way of working and business model. The stakeholders in the Hycool-IT ecosystem are impacted directly or indirectly by the Hycool-IT solution. The impact of the Hycool-IT solution on key stakeholder's business models is further detailed in Deliverables 6.3 and 7.2. The table below presents an overview of the archetype and experience of the different stakeholders.

Table 3 - Stakeholders Hycool-IT experience

Stakeholder	Archetype	Experience
IT Manager	Governing user	Receives real-time performance data of the IT server room and recommendations for performance improvement
IT Staff	Direct user	Simulate scenarios and implement efficiency measures in the IT server room
Customer's Management	Governing user	Reduced down-time and increased energy efficiency of IT infrastructure
Facility Management service provider	Ambient user or direct user	Receives data centre performance information from digital twin. Could potentially manage the digital twin and optimise performance
Data Centre Engineer	Direct user	Designs IT server room and digital twin using SIMBOT components
Software provider	Intermediary user	Bundles SIMBOT libraries with its software
Equipment Manufacturer (racks, servers, cooling)	Direct user	Provider of SIMBOT component together with their physical products
Industry Association	Indirect user	Promotion of standard and SIMBOT method across the industry
Contractor	Ambient user	Engages with the digital twin and simulation results during the construction and commissioning of the data centre
Subcontractor	Ambient user	Engages with the digital twin and simulation results during the construction of the data centre
Certification Institute	Direct user	Need to train their staff and organise certification of new SIMBOT components
Standardisation Institute	Intermediary user	Adoption and publication of new digital twin standard

Exploitation and dissemination activities are organised in such a way that the project engages with all stakeholders in order to gain their support for the adoption of the Hycool-IT solution. To ensure commitment and support from the key actors in the business ecosystem, the following organisations are involved in the development of the Hycool-IT solution.

Table 4 - Stakeholders and their role in the Hycool-IT ecosystem

Stakeholder	Involved party/parties	Role
IT Manager	POLIMI	The IT manager of the pilot lab will provide feedback about the perceived value of the solution.
IT Staff	POLIMI	The IT staff working at the pilot lab are end-users of the solution and will provide feedback about the user experience.
Customer's Management	POLIMI	Department management of POLIMI will provide feedback about the business case of the solution.
Data Centre Engineer	IDP, IMP	Developer of the digital twin and SiL solution.
Software provider	EcoSim Pro, Dymola	Providers of simulation software and developers of basic SIMBOTs to be included in their software.
Equipment Manufacturer (racks, servers, cooling)	SORGE, Scheider Electric	Providers of knowledge graphs for their products. SORGE is the manufacturer of advanced rack-integrated adsorption chiller and provides the knowledge graph for their chiller. SE is the provider of the climate control system in the pilot and provides feedback.
Industry Association	REHVA	Promoting the Hycool-IT solution amongst its members and providing feedback from the HVAC industry.
Certification Institute	BDTA	Promoting new building digital twin standards
Standardisation Institute	CEN, UNE	Developing and publishing new building digital twin standards.

In a continuous dialogue with software developers and manufacturers, the feasibility and desirability of the Hycool-IT solution is being validated. These discussions already resulted in a change

in the SIMBot concept to better fit the needs of the software developers. The following exploitation oriented dissemination activities have been performed or are planned to explore the feasibility, viability and desirability of the Hycool-IT solution and to engage with the relevant stakeholders.

Workshops

Table 5 - Overview of exploitation related workshops

What	Where	When	(target) Audience
BDTIC4	Barcelona (ES)	17 April 2024	Software developers, manufacturers, research community
Sustainable Places 2024, cluster workshop	Luxembourg (LU)	23-25 September 2024	Sister projects, research community
BDTIC5	Kaunas (LT)	13-15 May 2025	Software developers, manufacturers, research community
Sustainable Places 2025 (2cool2waste clustering workshop and digital twins workshop)	Milan (IT)	8-10 October 2025	Data center professionals, IT managers, and sister projects
SIMBot training course by BDTA	IDP headquarter (ES)	17-18 December 2025	Software developers
BDTIC6	Brussels (BE)	28 May 2026	Software developers, manufacturers, research community
CWA kick-off	Brussels (BE)	Spring 2026	Software developers, manufacturers
Clustering workshops	To be defined	2026	Sister projects

Presentations and publications

Table 6 - Overview of exploitation related presentations and publications

What	Where	When	(target) Audience
Sustainable Places, presentation POLIMI	Milan (IT)	8-10 October 2025	Data center professionals and IT managers
Peer reviewed publications	To be defined	2026	Research community, industry experts

A more detailed overview of all dissemination activities and workshops is presented in Deliverable 8.2, and upcoming Deliverables 9.1 and 9.2.

Other exploitation actions are the contribution to standards for building digital twins by the development of a CEN Workshop Agreement, gap assessment on LEED and BREEAM standards, and the protection of IP through a patent application for the rack-integrated adsorption chiller by SORGE. BDTA will lead the further development and promotion of the smart building digital twin concept after the end of the project

This combination of exploitation actions ensures that the envisioned Hycool-IT solution fits market needs and is supported and adopted by key stakeholders.

4.2 Exploitation plan for the rack-integrated adsorption chiller

4.2.1 Description of the rack-integrated adsorption chiller

This result is an advanced version of the rack-integrated adsorption chiller as developed by SORGE. Advancements are in the redesign of certain parts (e.g., gear pumps, heat exchangers, valves) and fine-tuning of the control system. The new version of the rack-mounted adsorption chiller will be subjected to extensive energy performance testing in a calibrated calorimeter at the POLIMI facilities. Test conditions are set according to cooling water temperatures and flow rates, room air temperatures and relative humidities, and heating resistor capacities (to simulate variable IT loads).

This result represents a significant leap forward in adsorption chiller technology due to its comprehensive redesign, enhanced control system, space-efficient rack integration, and rigorous performance testing. The innovations make the chiller more efficient, adaptable, and reliable, particularly in environments with fluctuating demands, such as data centres, thereby offering substantial operational and environmental benefits.

A first proof of concept has been built and tested in the lab. The performance of the prototype was not as expected. A new prototype is currently being built and will be tested by Polimi. Preliminary tests at SORGE's lab are promising. The rack-integrated adsorption chiller is expected to reach TRL 5 at the end of the project. The result is described in more detail in Deliverable 5.3.

4.2.2 Value proposition

The unique selling points of the rack-integrated adsorption chiller are:

- Low electrical need;
- Higher PUE compared with State of Art;
- Rack-integrated solution.

Target customer segments are: IT industry, data centres, server providers, and the cooling industry. The key benefits for these customer groups are:

- Energy efficiency and cost reduction;
- Increased reliability and performance under variable conditions;

- Highly scalable and adaptable solution;
- Sustainable solution with low environmental Impact;
- Provides operational flexibility.

Pitch: *"Our innovative rack-integrated adsorption chillers help data centre owners to reduce the energy consumption of their data centers and IT server rooms by increasing their energy efficiency through waste heat reuse technologies."*

Alternative solutions are regular data center cooling solutions like liquid cooling and immersion cooling.

4.2.3 Exploitation plan

The plan is to commercially exploit the rack-integrated adsorption chiller and add the chiller to SORGE's product portfolio. After the end of the project, product development will start in order to reach TRL9. SORGE will partner with data center suppliers and IT providers to secure a market conform product development process. The rack-integrated adsorption chiller is expected to be market ready by 2028-2030.

The key elements of the exploitation strategy are:

- Commercialization of advanced Cooling Technology
- Market Positioning
- Leveraging Testing and Validation Results
- Sustainability and Energy Efficiency
- Strategic Partnerships and Industry Adoption

The exploitation strategy is built around the following three types of exploitation actions:

1. Technology Demonstration and Validation
2. Collaborative and Industry Partnerships
3. Knowledge Sharing and Patents

Exploitation actions taken so far are:

- Presentation and publication at the 11th Heat Powered Cycles Conference (HPC2025) in Lisbon (PO), 25-28 May 2025

4.2.4 IPR strategy

SORGE is the single owner of the IP. The IP will be protected by a Patent & Utility model. The first application is foreseen in Germany. A patent cooperation treaty (PCT) application is expected to be submitted within 18 months. Nationalization for European Patent, US, China, Japan.

5 Exploitation plans for individual Results

This chapter presents a more detailed view of the individual exploitable results of the Hycool-IT project as listed in Chapter 3. The results are presented in no particular order. For each result, the type of result, owner, short- and mid-term exploitation vision, IP ownership and protection measures, and their relation to project deliverables, is presented.

5.1 Methodology for SIMBots creation

ER Type	Knowledge	ER Manager	BDTA
TRL before Hycool-IT	3	TRL after Hycool-IT	4-5
Related WP	WP1	Related deliverable(s)	D1.3

Short description:

Development guidelines for SIMBots. Based on the pilot in the data centre of POLIMI, a set of libraries for real time mathematical simulation have been developed. The guidelines will be extended to underpin the creation of a specific SIMBot targeting KET1.4 new component potential equipment's certification tests, as future key service to manufacturers of appliances and equipment for construction. The methodology is still under development and will be finalised before project end. The Simbot methodology was reformulated after feedback from developers. A new proposal has been prepared based on performance curves (manufacturer or DPP) and abstract components (software developer). The final objective is oriented to get a draft of specification at the end of 2026 and first initial demo libraries for data centers.

Innovation:

SIMBOT standardization enables quick conceptual development of data centres in the design phase. SIMBOT methodology can be used to assist in operation (like a virtual AI operator) and will improve the efficiency of the installation. It can make profitable mathematical simulation, thereby improving control strategies.

The methodology will help data center engineers reduce the time for defining the concept of data centre installations from 3-4 weeks to 3-4 hours. This means increased quality of the concept and better contractual definition. For the engineering firms it is an opportunity to extend their services in the construction, commissioning and operation.

Alternative solutions are proprietary solutions from large manufactures, like ETAP from AVEVA (Schneider), limited to electrical systems, integrating specific hardware and without any reference to standards.

IPR protection plan:

BDTA is the single owner of the IP. The methodology will be protected by copyright. Contents will be public and included in a standard, but protection of copyright makes BDTA the manager for future implementations. The methodology as presented in Deliverable 1.3 has been copyrighted and final libraries with the ontology will be registered. The development guidelines will be made available on a free to use basis and under a Creative Common license like CC-BY-ND.

Short-term exploitation vision:

The guidelines will be published on the Hycool-IT project and BDTA websites. At BDTIC in May 2026 a first agreement between stakeholders will be intended. This will be included in the CWA and will be the base for the standard draft.

An initial knowledge graph with limited demo SIMBOTs will be available at the end of 2026. Proof of concept interaction with manufacturers, auditing bodies and software developers will be tested.

The work on standardisation at CEN442 WG9 during years 2027 and 2028 will continue, supported by BDTA. The estimated costs for post-project exploitation are 60K euro which will be covered by BDTA and continuation projects.

Mid-term exploitation vision:

The standard (possibly as technical specification) could be published in 2 years more (expected 2028). In the meantime, the knowledge graph would be operational and include increasing functionalities. With the publication of the standard both standard and knowledge graphs can be active, together with other certification services and test lab standard methodologies.

Exploitation actions:

The methodology has been published in the Rheva Journal¹. The methodology has been presented at a project internal deck demonstrator at the IRC in December 2025.

A CWA will be initiated in January 2026. The methodology will be presented at the Building Digital Twin International Conference (BDTIC) in Brussels in May 2026.

¹ <https://www.rehva.eu/rehva-journal/chapter/from-digital-twins-to-real-time-simulation-standardisation>

5.2 Methodology for predicting and optimizing building performance using SiL

ER Type	Process	ER Manager	BDTA
TRL before Hycool-IT	3	TRL after Hycool-IT	5
Related WP	WP1	Related deliverable(s)	D1.3

Short description:

Integrated simulation in real time, considering weather and server load, building performance and occupancy. Simulation Model Tracking System (SMTS) methodology for predicting malfunction or operation problems, connected to the Data Center Infrastructure Management (DCIM) system. Includes what-if scenarios and prediction based on expected loads and weather. Optimization strategy assisting the operator in real time.

Innovation:

This methodology uses model-based AI in real time, assisting the operator to make decisions concerning operation modes, maintenance and supervision in general.

IPR protection plan:

BDTA, POLIMI, IDP, and IMP have contributed to this result. To be checked if an IP agreement is needed. The methodology will be protected by copyright. Contents will be public and included in a standard, but protection of copyright makes BDTA the manager for future implementations.

Short-term exploitation vision:

Public. Short term exploitation is directly connected with the CWA, which will be presented at the BDTIC6 conference in May 2026 in Brussels and to have a demo demonstrator at the end of the project.

The result is still under development. The initial real time deck (mock up of an InRow Cooler and simplified chiller) has been deployed. This is going to be used for the integration with monitoring and digital twin supervision. Connection of these disciplines is still under development, but a first scope definition for the data room is already defined. The deck of the data room will be ready in March 2026. Optimization targets and supervision problems for the pilot case have been detected as well.

From the end of the project (2026) until 2028 both the standard and a functional knowledge base will be developed in parallel. During these two years (2027-2028) implication of manufacturers, software developers and engineering firms would be closing the works with a functional standard and maintained knowledge base.

Mid-term exploitation vision:

The methodology will be used to define common uses in real time of SIMBOTs and mathematical simulation. Some KPIs would be accepted as they are coming from standardized simulations. Target customers are software developers and mid-size engineering firms. Usually, the “operator” in a Data Centre usually is not specialized personnel on HVAC or process. This methodology will be assisting that operator to supervise and optimize the installation in a better way.

Exploitation actions:

The methodology will be presented at the BDTIC6 conference in May 2026 in Brussels. The work on standardising the methodology will continue after the end of the project.

5.3 SiL Predictive Control Module

ER Type	Product/application	ER Manager	IMP
TRL before Hycool-IT	5	TRL after Hycool-IT	7
Related WP	WP2	Related deliverable(s)	D2.3

Short description:

IL (Software-In-the-Loop) based MPC (Model Predictive Control) algorithms are a type of control algorithm that use a software simulation of a physical system to optimize the control actions. The algorithm predicts the future behaviour of the system using a data-driven model and optimizes the control actions over a finite time horizon, taking into account constraints on the system inputs and outputs. The algorithm is designed to control equipment by following the input coming from measurements in the data centre and BDT as well as simulation. The SIL-based MPC algorithm can be divided into two main components: the model and the optimizer. The model is a mathematical representation of the system that predicts the future behaviour of the system based on the current state and the control inputs. The optimizer takes the predicted behaviour of the system and determines the optimal control actions over a finite time horizon.

The Control Module will be demonstrated at POLIMI. The results are being presented within the DTwin Platform, where the operator can observe proposed control strategies. The tool features an interface with BIM geometry and a dashboard to assess results. Depending on the practical application, it is necessary to ensure that it is allowed to apply AI-based control directly to the particular equipment. Some integration aspects are still undergoing and field testing is expected to be finished before the end of the project.

Innovation:

- **Simulation-based testing:** The algorithm uses software simulations to predict and test control strategies before they are used in real systems. This reduces risk and allows for safer and more efficient development.
- **Real-time adjustments:** The algorithm continuously adapts based on real-time data from the data centre, optimizing system performance and responding quickly to changes in conditions.
- **Optimized control within limits:** It takes into account system limits, ensuring the best possible control actions without exceeding equipment capabilities, which is important for safe and energy-efficient operation.
- **Predictive control:** By predicting future behaviour, the algorithm can act in advance, improving stability and avoiding potential problems before they happen.

IPR protection plan:

IMP is the sole owner of the result. The result will be protected by copyright. The exploitation of the result as a module within the BDTA platform or as a standalone module will be explored. In that case, an IP agreement needs to be put in place before the end of the project.

Short-term exploitation vision:

Scientific. MPC service development was finalized. The SIL Predictive Control Module is a software solution designed to be easily integrated into Building Management Systems (BMS), helping optimize energy use and control equipment in real time. By connecting with the DTwin Platform, it can use both real-time and simulated data to predict and improve system performance. The goal is to first showcase its ability to enhance efficiency in data centres, with the potential to later be deployed in real-world systems like BMS for broader use. It is planned to publish results in peer-reviewed journals.

The result could be exploited as a module within the BDTA platform or as a standalone module, targeting data centers and building automation companies. The SIL Predictive Control Module allows users to observe the impact of control strategies on the DTwin Platform before deployment. This enables thorough testing and optimization by considering both real-time and simulated data, ensuring the system operates efficiently under various conditions. By providing predictive insights and real-time performance tracking, the module helps optimize energy use and improve operational stability, reducing risks and ensuring cost-effective implementation.

Pitch: "Our SIL Predictive Control Module helps data centres and building automation companies who aim to optimize energy efficiency and enhance system performance by enabling them to test and refine control strategies on the DTwin Platform using both real-time and simulated data before deployment. This unique capability ensures confident implementation of solutions that lower costs, improve operational efficiency, and minimize risks."

Alternative solutions are:

- Siemens integrated solution
- Honeywell Froge solution
- ABB solution

Mid-term exploitation vision:

It is planned to continue the development and improvement of the proposed service through new research projects. The SIL Predictive Control Module allows customers to simulate and predict how the system will perform in real-world conditions before actual deployment. This predictive capability helps identify potential issues early on, enabling more efficient planning and system adjustments. Once integrated into a BMS, the module offers real-time control and optimization, leading to benefits such as reduced energy consumption, improved operational stability, and lower overall costs, all while ensuring that systems run efficiently and within their operational limits.

Exploitation actions:

Publication preparation is in progress. A scientific publication is planned before the end of the project.

5.4 Simulation Model Tracking System (SMTS) Module

ER Type	Product/application	ER Manager	IDP
TRL before Hycool-IT	3	TRL after Hycool-IT	5
Related WP	WP2	Related deliverable(s)	D1.3, D2.2, D2.3, D3.3, D5.4

Short description:

This tool integrated into the DTwin environment will capture the dynamic characteristics and off-design performance of the HYCOOL-IT system under different working conditions. In this way, this tool will unify and display in the same interface/dashboard both Real (Monitoring) and Synthetic (Simulation) Dynamic Data Sets coming from the same Digital Twin Prototype and/or Instance. The effect of heating/cooling load on the dynamic behaviour of the HYCOOL-IT systems in the IT-Server rooms of tertiary buildings can be displayed after running the dynamic simulations, showing the heat thermal performance that has been estimated. The SMTS will display the main parameters values simulated and will make a comparative representation against the real time measurements coming from the installed sensors. The geometrical disposition of the sensors (simulated and real) will be in the same place, so the digital twin can establish precise correlations among the sensors, their location and the parameters estimated and measured.

Innovation:

The simulation will analyse the dynamic behaviour and performance of the Hybrid Cooling system under various operating conditions, including off-design scenarios. A control strategy will be implemented to optimize system performance. Additionally, the simulation will evaluate the system's ability to meet hourly heating and cooling demands of the server room building. An alternative solution is the ETAP eSCADA solution for electrical systems. This solution has not been informed yet as a simulation solution for HVAC or cooling systems.

IPR protection plan:

The Result will be protected by trademark. The Result makes use of IDP's Digital Twin Platform and will be jointly owned by IDP, IMP, and BDTA. IP usage agreements will be considered after the first test results.

Short-term exploitation vision:

Commercial. Toolkit to improve geometrical HVAC simulations supported by real-time measurements. A new dynamic simulation software can be developed and exploited. The tool kit can be adapted and customized according to the building typology; cooling systems used. The main target is to exploit the tool for data centres in the design stages or for the existing DC to optimize their thermal performance.

Mid-term exploitation vision:

Exploitation vision is to provide a testing platform with the options to use specific Data Centre models with different cooling systems.

The regulatory framework for data centres focuses on energy efficiency, renewable sourcing, water usage, and waste heat recovery, driven by climate goals and critical infrastructure status, lead to new reporting mandates (like Spain's draft rules under the EU's Energy Efficiency Directive), stricter design standards, and potential grid connection hurdles, alongside existing concerns like GDPR, data sovereignty, and national security rules affecting location and investment. These regulations can be taken as an opportunity to promote the adoption of a SMTS as a solution to design, install and maintain optimal and sustainable data centres.

Exploitation actions:

Exploitation actions to be taken in the coming period are to define IP ownership and licensing, access control and security, and prepare post-development IP transfer. Next to that, IDP will continue with paper publications, demonstrators at congresses and seminars. IDP is also leading some Spanish data centres projects, the HyCool-IT project results may be used to bring them closer to the market.

5.5 SIMBot Knowledge Graph

ER Type	Product/application	ER Manager	BDTA
TRL before Hycool-IT	3	TRL after Hycool-IT	5
Related WP	WP3	Related deliverable(s)	D3.4, D4.3

Short description:

SIMBOT Knowledge Graphs is an ontology that allows for neutral semantic expression of active building components. The SIMBOT knowledge graph allows software developers to transform basic SIMBOT components into device specific components and combine SIMBOTS to simulate more complex appliances.

As “SIMBOT” we consider the semantic expression in the knowledge graph. Each software developer can have the same SIMBOT, but translated in their legacy library. In this case, that is not really the “SIMBOT”, but the translation, the extension or the expression of the semantic component into a library component in one specific software.

The basic components for the POLIMI chiller are being developed. The performance curves of the adsorption chiller as being developed by SORGE are not yet known, the chiller is still under development.

Innovation:

There is no standard methodology for creating real time components for simulation, other than downstream connecting via input/outputs or co-simulation. This tries to go upstream in the simulation process, defining basic mathematical components (SIMBOTS) of devices and adding to them device specific performance curves so they can be used in real-time simulations. The knowledge graphs can be linked to digital product passports (DPP) allowing for further integration of DPP and building digital twins.

IPR protection plan:

BDTA is the single owner of the IP. The Knowledge Graph will be made publicly available and protected by copyright.

Short-term exploitation vision:

Public. Further development and promotion of the knowledge graph to become an industry standard. The creation of a library of other basic components for data centers is being considered.

Mid-term exploitation vision:

Public. Standardising the development of SIMBOTS.

Commercial: Offering of certification services for the verification of SIMBOTS developed by software developers.

Exploitation actions:

Further development of the SIMBot Knowledge Graph will be funded by BDTA.

5.6 CEN CWA

ER Type	Other (standards)	ER Manager	BDTA
TRL before Hycool-IT	NA	TRL after Hycool-IT	NA
Related WP	WP7	Related deliverable(s)	D7.3

Short description:

The Hycool-IT consortium will initiate a CWA around the use of SIMBots and the associated lab testing process of rack-integrated adsorption chillers, including experimental testing procedure and definition of performance data to feed the SIMBot's mathematical model. UNE, the Spanish association for standardisation, has been selected to support the project consortium with the planning and development of the CWA.

Innovation:

There are currently no standards for the mathematical representation of simulation components. A CWA on the development of SIMBOTS for innovative hardware used in server-room cooling would be strategic for the following reasons:

1. Innovation in server-cooling technology is necessary for sustainability, but requires more guarantees than for the usual cooling market applications being the cooling service 'mission critical' for the end-user (market players are at the same time highly interested in innovative solutions, but very prudent and sceptic).
2. SIMBOT as a standard for simulations can guarantee not only software-neutral semantic descriptions but also classification of technology readiness and alignment of simulation outputs with proper lab testing methods. Their validation could help promote the adoption of new cooling technologies.
3. It is reasonable to assume that standardized testing methods do not exist for machines that are not yet on the market, guidelines are needed to define how to validate a SIMBOT. The rack-integrated adsorption chiller represents an exemplary case.

The CWA will focus on defining what a SIMBOT for these new devices should be (dynamic or steady-state model; possibility to modify the control logic or not; whether internal parameters can be

viewed—generic model—or not—specific model; implementation following a P&I diagram or as a simple black box), arriving at a classification.

IPR protection plan:

Project partners POLIMI and IDP will contribute to the development of the NWI. Once adopted, the new norm will be protected by copyright via CEN. The IP will be part of CEN's IP.

Short-term exploitation vision:

The CWA will be published on the CEN website for a maximum life of 6 years (3+3 with a confirmation after the first 3 years).

Mid-term exploitation vision:

Further development of the standard.

Exploitation actions:

A workshop at the BDTIC26 conference will be organised to support the work of the CWA.

5.7 Innovative engineering guidelines for ICT Server's Room design

ER Type	Knowledge	ER Manager	R2M
TRL before Hycool-IT	NA	TRL after Hycool-IT	NA
Related WP	WP7	Related deliverable(s)	D7.4

Short description:

This result is a set of standard guidelines to be used when designing ICT server rooms in tertiary buildings, either newly built or retrofitted. Such guidelines will align with existing standards to enable full replication. Guidelines will be provided by type of server room (small, medium, large) and by climate zones. Guidelines will include design of waste heat integration with next generation thermal grids.

The know-how available from www.dceureca.eu will be used as a basis and further developed. A chapter of the publication will be devoted to the contribution of HYCOOL-IT's technologies to the SET Plan and shared with IWG5 Energy Efficiency in Buildings.

The structure, scope and outline of the guidelines have been determined. Input from the partners will be collected to complete the guidelines.

Innovation:

The guidelines include state-of-the-art solutions for minimising the carbon footprint of IT server rooms like waste heat reuse, digital twin and software in the loop solutions.

IPR protection plan:

The guidelines will be jointly owned by the Hycool-IT consortium and be protected by copyright. The engineering guidelines will be made available as download (pdf) and in a limited number of printed versions for distribution at relevant events, and include a copyright statement.

Short-term exploitation vision:

The guidelines will be made available on a free to use basis. The target audience are designers of IT server rooms, architects, engineers and IT server room staff. A visual pleasing public version of the guidelines will be published at the end of the project.

Mid-term exploitation vision:

The guidelines will remain available through the project's website. Depending on the development of the smart digital twin and the market uptake, R2M will update the engineering guidelines or transfer ownership to a to be determined party.

Exploitation actions:

Selection of relevant events and channels for distribution of the guidelines.

5.8 Tool for waste heat reuse for IT server rooms

ER Type	Product/application	ER Manager	POLIMI
TRL before Hycool-IT	1	TRL after Hycool-IT	4
Related WP	WP3	Related deliverable(s)	D3.2

Short description:

This result is a first version of a data-driven tool designed to analyse potential benefits of waste-heat recovery in small server rooms. The tool produces financial, environmental, and energy savings KPIs that can be used to support proposed changes in the cooling system of a server room. Waste-heat recovery and integration are important factors of the tool as it can evaluate the possibility of using the server room's waste-heat for space heating within the building. A first version of the tool has been developed, and a conference publication is being prepared for a 2026 conference in Milan. Data from Polimi's Z3 data center and student building BL26 will be used as a first demonstration for the tool.

Innovation:

This tool can be considered innovative because it acts as a data-driven decision support system that can assist managers of small server rooms in improving the energy efficiency of their IT infrastructure, placing an emphasis on the benefits of waste-heat recovery. The tool requires as main inputs the IT consumption of the room, geographical location (local climate is considered), and building information related to space heating. This way, by evaluating changes to the server room cooling system and the introduction of waste-heat recovery for space heating, it produces KPIs that highlight possible energy, financial, and CO2 emission savings. These outputs can provide managers with the required information to evaluate the economic feasibility related to the investment behind those changes, and the possible valorisation of the recovered thermal energy. Building/server room owners could also use these outputs in making decisions for specific building-related targets, such as reducing the cooling system/space heating energy consumption for a decrease of bills related to the cost of energy.

IPR protection plan:

POLIMI is the single owner of the IP. The tool will be made available under a Creative Commons license: CC-BY-SA.

Short-term exploitation vision:

Scientific. Through publications and conferences, its innovative aspects will be highlighted to the academic/scientific community and energy managers. The tool can provide significant KPIs for optimizing small server rooms from public buildings by means of predictive-scenario modelling. The resulting KPIs can be used to evaluate a possible investment to improve the server room PUE and/or use the servers' waste heat for space heating applications.

The development of the first version of the tool is funded by the HYCOOL-IT project. Internal POLIMI will provide funding for future updates/versions.

Mid-term exploitation vision:

New features and functionalities will be added to the tool. In the following years, newer versions of the tool will be presented in publications and conferences. The possibility to develop and publish an online, limited, free to use, public available version of the tool will be explored.

Exploitation actions:

Publications and conference presentations are being prepared for 2026.

6 Conclusion

This report presents an overview of the exploitable results of the Hycool-IT project identified during the first 26 months of the 3-year project and provides an update of the exploitable results table as presented in Deliverable 6.2 in month 18. The report provides an overview of the strategies and actions needed for adoption and exploitation of results generated by the Hycool-T project. As such, it provides a framework for identifying, developing, and optimising the exploitation of the project results during the project and after its completion.

Ten exploitable results have been identified which are summarised under three categories: 5 Products & Applications, 3 Knowledge, and 2 Other (standards, methodology). It is envisioned that 2 of the results will be exploited on a commercial basis and the remaining 8 results will be made available for public or scientific exploitation.

An assessment of expected project foreground conducted within the project revealed two key exploitable results:

- 1. The Hycool-IT solution:** A combination of building digital twin technology and software-in-the-loop simulation software accompanied by engineering guidelines and supported by recommendations for new standards and policies. The Hycool-IT solution combines the individual results of the project into a solution that enables the IT server room construction and operation industry to maximise energy efficiency. Targeted exploitation dissemination activities ensure market fit. BDTA will be the main driver for further development of the smart building digital twin concept after the end of the project.
- 2. Rack-integrated adsorption chiller:** An advanced version of the rack-integrated adsorption chiller as developed by SORGE. The innovations make the chiller more efficient, adaptable, and reliable, particularly in environments with fluctuating demands, such as data centres, thereby offering substantial operational and environmental benefits. Tests with a first prototype uncovered some inefficiencies in the machine which are being resolved in a second prototype. The chiller is expected to be market ready by 2028-2030. The IP will be patented.

During the course of the project the scope of two results has changed because of new insights and after consultations with market players. The idea of generic and specific SIMBot libraries as originally described in the Grant Agreement, was not supported by software developers. In response, the project has introduced knowledge graphs which better match the work flows of developers and manufacturers. Also the scope of the CWA has been changed to cover the SIMBot methodology and the associated lab testing process of rack-integrated adsorption chillers.

The methods and products developed in Hycool-IT will contribute to the energy efficiency of IT server rooms and the further digitalisation of the construction industry and can be of great benefit for all stakeholders involved. Exploitation activities will continue throughout the remainder of the project and beyond.