Project number: 101083899

Project Acronym: SHARP-sCO_2

D6.4 - SHARP - sCO2 outcomes exploitation plan – First emission

Date: 31-10-2023

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101083899. The content of publication is the sole responsibility of

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Project title	Solar Hybrid Air-sCO2 Power Plants
Project Acronym	SHARP-sCO2
Grant Agreement No.	101083899
Project start date	1-11-2022
Project end date	31-10-2025
Duration	36 months
Website	-

Project contractual details

Deliverable details

Number	6.4
Title	SHARP - sCO2 outcomes exploitation plan – First emission
Work Package	6
Dissemination level[1]	PU
Due date (M)	31-10-2023
Submission date (M)	31-10-2023
Deliverable responsible	RINA-C
Contributing author(s)	Andrea Savocchi, Francesca Romana Picone
Reviewer(s)	Silvia Trevisan
Final review and quality approval	Rafael Guedez

DOCUMENT HISTORY

DATE	VERSION	NAME	CHANGES
31-10-2023	1.0	Andrea Savocchi	Initial version
31-10-2023	2.0	Francesca Romana Picone	Revised version based on reviewers comments

[1] PU = Public
CO = Confidential, only for members of the consortium (including Commission Services)

Executive summary

This deliverable is the first release of the “D6.4 SHARP - sCO2 outcomes exploitation plan” document, due in October 2023 (M12), including the Intellectual Property protection plan and the Exploitation strategy of the Project SHARP-sCO2.

SHARP-sCO2 tackles critical technological challenges to enable the development of a new generation of highly efficient and flexible CSP systems. SHARP-sCO2 will develop and validate novel enabling technologies in EU top level CSP labs (TRL5) (including receiver, thermal storage (TES), sCO2-air Heat Exchanger (HEX), electric heater (EH), as well as integrated piping and control). SHARP-sCO2 will maximize sCO2 operation and compensation by introducing a smart hybridization with PV via a new EH, leveraging PV affordability while relying on CSP's unique energy storage capabilities via TES.

The purpose of the present document is to provide an overview of the main rules related to intellectual property rights, use and exploitation of the SHARP-sCO2 results. It is however recommended to always refer to prescriptions included in the Consortium Agreement (CA) and Grant Agreement (GA) to elaborate exploitation agreements.

The list of SHARP-sCO2 project exploitable results is outlined in accordance with the information included in Grant Agreement with the aim of keeping it up to date in terms of the novelty of the proposed inventions, the intention of applying for “formal” or “informal” IP protection as well as the partners’ responsibilities and involvement in each of the project results.

Abbreviations

CA: Consortium Agreement

CBA: Cost Benefit Analysis

CD: Compact Disc

CSP: Concentrated Solar Power

CT: Characterization Table

DMP: Data Management Plan

EH: Electric Heater

EPC: European Patent Convention

EPO: European Patent Organisation

ER: Exploitable Result

EU: European Union

GA: Grant Agreement

HEX: Heat Exchanger

HTF: Heat Transfer Fluid

IEA: International Energy Agency

IP: Intellectual Property

IPR: Intellectual Property Right

KER: Key Exploitable Result

LCA: Life Cycle Assessment

LCOE: Levelized Cost of Energy

PCT: Patent Cooperation Treaty

PV: Photovoltaic

R&D: Research & Development

SC: Steering Committee

TES: Thermal Storage

TRL: Technology Readiness Level

TV: Television

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1 INTRODUCTION

1.1 Project overview

SHARP – sCO2 (Project 101083899) is a project funded under Horizon-CL5-2021-D3-03 and aims to develop and validate (via modelling and laboratory activities – TRL5) innovative technological solutions that can untap the potential of air driven sCO2 CSP plants hybridized with PV, to:

i) reduce LCOE;
ii) overcome limitations of steam cycle based CSP (in start-up, shutdown, load variation, and efficiency);
iii) ensure elevated flexibility/dispatchability;
iv) further promote sCO2 cycles as most suitable power cycles for CSP; and
v) improve environmental profile of future CSP plants.

This objective will be met by the participation of key EU R&D centres specializing in CSP and valorisation of their current tools/facilities/laboratories, which will enable an integrated cycle test using a cyber-physical emulation method.

SHARP-sCO2 tackles critical technological challenges to enable the development of a new generation of highly efficient and flexible CSP systems. SHARP-sCO2 will develop and validate novel enabling technologies in EU top level CSP labs (TRL5) (including receiver, thermal storage (TES), sCO2-air Heat Exchanger (HEX), electric heater (EH), as well as integrated piping and control). SHARP-sCO2 will maximize sCO2 operation and compensation by introducing a smart hybridization with PV via a new EH, leveraging PV affordability while relying on CSP's unique energy storage capabilities via TES.

CSP is currently not on track to meet the IEA's Net Zero Emissions scenario objectives. The global installed capacity of concentrating solar thermal power increased only by 200 MW in 2022 to reach a total of 6.3 GW[2], demonstrating a significant gap between the IEA objective of 6.7 GW average annual capacity increase and market deployment. As a result, the global and EU CSP markets require a new boost to become more grid adaptable and profitable without the requirement for feed-in tariffs. To that end, much more effort is required to develop novel and highly efficient solutions, maximizing CSP flexibility and storage capabilities, lowering costs, and overcoming some inherent barriers related to the use of water in steam cycles or the achievement of high temperatures that could enable the exploitation of high efficient and flexible Brayton cycles. As previously documented in other R&D projects (CARBOSOLA, SOLARSCO2OL, NextCSP, and so on), sCO2 can be the perfect match for CSP plants for this purpose since it can run at higher temperatures than typical gas turbine Brayton cycles.

The CSP market in EU has been almost stagnant since 2013, while PV continues to expand fast. This high penetration of PV into grids necessitates the need of a backup to support grid ability and offer peak power periods outside of central sunny hours of the day. A smart hybridization of PV and sCO2-based CSP plants could be more attractive for the EU, with new-generation CSP plants capable of being more grid flexible and independent from subsidies.

The molten-salt solar tower is a cutting-edge CSP technology that employs "solar salt" as a heat transfer fluid (HTF) at temperatures of up to 570 °C. The EU SET Plan and Agendas aim for considerable cost reductions, as well as the development of novel HTFs, storage technologies, and power systems capable of exceeding 50% thermal efficiency.

[2] www.ren21.net

Due to typical solar salt deterioration at around 600 °C, moving from 570 °C to higher temperatures will need the development of a new HTF as well as thermal storage media. Furthermore, advanced power cycles that are more flexible and capable of operating at greater temperatures and with better efficiencies must be employed to meet the LCOE target.

Each technological shift (e.g. HTF, TES, and power block) will have an impact on the CSP plant, posing a considerable risk to developers and financiers. To drive new innovations in CSP, a step-wise strategy in which key sub-systems and components of the innovative system are individually developed, optimized, and tested prior to their full integration is essential (as previously recommended by Turchi et al). This approach allows for the evaluation of technologies in controlled environments where external boundary conditions can be emulated (e.g. weather), and where components can be gradually optimized by progressively testing these at more challenging operating conditions (e.g. temperature and pressure) and over a number of cycles, while also allowing for data to simulate and evaluate integration and control aspects.

Financing high-risk technologies is highly challenging, and moving towards the EU SET targets in steps that CSP sector participants can support, and implement is crucial for the industry's health and the commercial feasibility of newly developed technologies. **This is the exact approach proposed by SHARP-sCO2 project via its "Multi-lab" validation approach.**

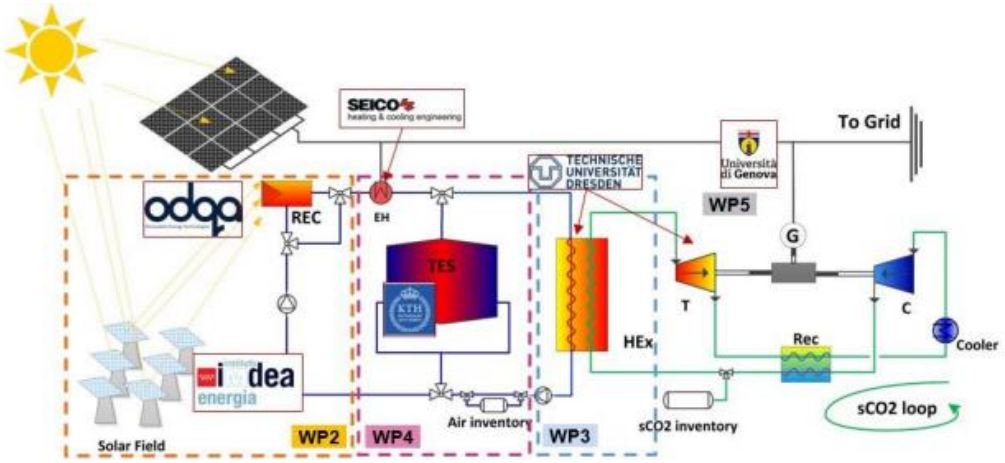

FIGURE 1-1 SHARP - SCO2 MULTI LAB APPROACH

The present report is structured as follows:

Chapter 1 "Introduction" introduces the scenario in which the technologies dedicated to the capture and utilization of carbon are inserted.

Chapter 2 "Methodology" explains the methodological approach adopted.

Chapter 3 "IPRs principles" provides a detailed overview of intellectual property rights.

Chapter 4 "Knowledge management and exploitation" explains the practices of knowledge dissemination according to several methods and tools.

Chapter 5 "IPR Protection strategy" shows the protection strategy in accordance with both the Grant Agreement (GA) and the Consortium Agreement (CA).

Chapter 6 "Exploitation strategy of SHARP sCO2 Key Exploitable Results" is dedicated to the analysis of the characterization table provided by different partners involved in the SHARP-sCO2 Consortium, in order to discover their initiatives, strategies, actions, processes, services, networks, knowledge, and products related to the capture and utilization of carbon through technology.

Chapter 7 "Conclusion" provides several final considerations and explains the next steps to be taken in order to complete the following report.

2 METHODOLOGY

The present document includes two complementary activities: IPR management and Exploitation Strategy. This section reports the methodologies used to carry out both tasks.

IPR management activity: the first version of the present Deliverable is dedicated to main IPR principles and what is agreed upon the Consortium (Grant Agreement and Consortium Agreement) in terms of protection and sharing of the project results in order to guarantee the right protection for each result. At the same time the activity aims to give a comprehensive overview to the Partners about IPR management and procedures to make known all the possible paths to pursue. Dedicated tools will be used (characterization tables, BFMULO analysis) to collect all the IPR intentions from the partners and characterize each result in collaboration with the exploitation activity. In the second and final version of the present Deliverable, attention will be paid to finalizing the best IPR strategies associated with the key exploitable results (KERs) once prioritized along the project and in accordance with the Consortium.

Exploitation activity: At this stage of the project the exploitation strategy aims to research the perceived potential among the project partners; create an initial exploitation action plan; and determine the exploitation results. Additionally, depending on the input from the partners involved, the activity entails the formulation of the exploitation strategy by all partners as well as the identification of project innovations and promising Exploitation Results (KER). In this sense, a characterization table structure was used to investigate the Key Exploitable Results (KERs) in order to produce a cohesive and reliable exploitation analysis. The decision to standardize the analysis through a single framework that identifies, examines, and assesses the technology solutions proposed within the project goes in this direction.

3 IPRs PRINCIPLES

The purpose of the present chapter is to provide a comprehensive overview of the major provisions concerning intellectual property rights. It is however strongly recommended to always refer to prescriptions included in the Consortium Agreement (CA) and Grant Agreement (GA) while elaborating exploitation agreements.

The list of SHARP-sCO2 Key Exploitable Results (KERs) is outlined in Chapter 6, in accordance with the information included in GA with the aim of keeping it updated in terms of the novelty of the proposed inventions, the intention of applying for IP protection as well as the partners' responsibilities and involvement in each of the results achieved within the project.

Before the beginning of the project, it is necessary to ensure that any information needed for the correct running of the project is accessible to project partners, therefore matters related to access right, have already been addressed in the SHARP-sCO2 Consortium Agreement.

3.1 BFMULO Analysis

The BFMULO analysis have been used as one of the methods to characterize the exploitation intentions of the Consortium partners and to evaluate the involvement of each of them within the project and Key Exploitable Results. Each letter of the acronyms refers to a specific intention:

- **(B) Background**
- **(F) Foreground**
- **(M) Making**
- **(U) Using**
- **(L) Licensing**

- **(O) Other**

Background (B) mean, in the context of Horizon 2020[3], "*any data, know-how or information whatever its form or nature, tangible or intangible, including any rights such as intellectual property rights, which is: held by the beneficiaries before they acceded to the Agreement; needed to implement the action or exploit the results.*" Background includes the pre-existing IP, know how, knowledge and any additional data that is needed for the project and that each partner is going to bring to the project itself. It also stated in the GA that If background is subject to rights of a third party, the beneficiary concerned must ensure that it is able to comply with its obligations under the Agreement.

Foreground (F) (or Results) mean "*any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights*". The granting authority does not obtain ownership of the results produced under the action.

The exploitation methods are resumed in the following four cases, reflecting the partner's intention to exploit the results by:

Making (M) the products, manufacturing and selling or directly implementing through own facilities and skills.

Using (U) the result, implemented with own knowledge to develop new ranges of products or newer processing. Furthermore, the direct or indirect use of foreground in further research activities other than those covered by the project, or for developing, creating and marketing a product or process, or for creating and providing a service.

Licensing (L) the result, therefore earning from a negotiation towards third parties outside the Consortium.

Other (O) any other exploitation means (e.g.: consultancy, services, etc.).

The BFMULO matrix is included in the Characterization Table tool (explained within the Chapter 2), shared with all the partners developing a result within SHARP-sCO2. In the related section, partners were asked to claim their background, foreground, and result's exploitation intention.

In the second part of the project, all participants in the Consortium will be asked to declare their intentions in reference to each Key Exploitable Results of the project, by completing a specific BFMULO matrix.

3.2 Access Rights

Access Right stands for the right to use project Results or Background under terms and conditions laid down in the GA and CA. As mentioned in the GA (especially in the Annex 5) and CA (9.2 General Principles) there are several aspects to be considered:

- Unless agreed otherwise in writing with the beneficiary granting access, access rights do not include the right to sub-license.
- Access Rights shall be free of any administrative transfer costs.
- Access Rights are granted on a non-exclusive basis.
- Results ad Background shall be used only for the purposes for which Access Rights to it have been granted.

[3] http://www.iprhelpdesk.eu/glossary/background-horizon-2020

- All requests for Access Rights shall be made in writing. The granting of Access Rights may be made conditional on the acceptance of specific conditions aimed at ensuring that these rights will be used only for the intended purpose and that appropriate confidentiality obligations are in place.
- The requesting Party must show that the Access Rights are Needed.

The following Table 3-1 gives an overview of the access rights established in the CA.

TABLE 3-1: ACCESS RIGHTS

Access Right for:	Description
Implementation	Access Rights to Results and Background Needed for the performance of the own work of a Party under the Project shall be granted on a royalty-free basis, unless otherwise agreed for Background in Attachment 1.
Exploitation	Access Rights to Results Access Rights to Results if Needed for Exploitation of a Party's own Results shall be granted on Fair and Reasonable conditions and upon written bilateral agreement. Access rights to Results for internal research and for teaching activities shall be granted on a royalty-free basis. Access Rights to Background Access Rights to Background if Needed for Exploitation, internal research, or teaching of a Party's own Results, shall be granted on Fair and Reasonable conditions and upon written bilateral agreement.
Entities under the same control	Entities under the same control have Access Rights under the conditions of the Grant Agreement Article 16.4 and its Annex 5, Section "Access rights to results and background", sub-section "Access rights for entities under the same control." Such Access Rights must be requested by the entity under the same control from the Party that holds the Background or Results. Access Rights to an entity under the same control shall be granted on Fair and Reasonable conditions and upon written bilateral agreement. Entities under the same control which obtain Access Rights in return fulfil all confidentiality obligations accepted by the Parties under the Grant Agreement or this Consortium Agreement as if such entities were Parties. Access Rights may be refused to entities under the same control if such granting is contrary to the legitimate interests of the Party which owns the Background or the Results. Access Rights granted to any entity under the same control are subject to the continuation of the Access Rights of the Party with whom it is under the same control and shall automatically terminate upon termination of the Access Rights granted to such Party. Upon cessation of the status as an entity under the same control, any Access Rights granted to such former entity under the same control shall lapse. Further arrangements with entities under the same control may be negotiated in separate agreements.
Additional Access Rights	For the avoidance of doubt any grant of Access Rights not covered by the Grant Agreement or this Consortium Agreement shall be at the absolute discretion of the owning Party and subject to such terms and conditions as may be agreed between the owning and receiving Parties.
Parties entering or leaving the consortium	New Parties entering the Consortium As regards Results developed before the accession of the new Party, the new Party will be granted Access Rights on the conditions applying for Access Rights to Background.

	Parties leaving the Consortium - *Defaulting Party:* Access Rights granted to a Defaulting Party and such Party's right to request Access Rights shall cease immediately upon receipt by the Defaulting Party of the formal notice of the decision of the General Assembly to terminate its participation in the consortium. - *Non-defaulting party:* A non-defaulting Party leaving voluntarily and with the other Parties' consent shall have Access Rights to the Results developed until the date of the termination of its participation. It may request Access Rights within the period of time specified in Section 9.4.3 of the CA. - *Access Right to be granted by any leaving Party:* Any Party leaving the Project shall continue to grant Access Rights pursuant to the Grant Agreement and this Consortium Agreement as if it had remained a Party for the whole duration of the Project.
Specific Provision for Access Rights to Software	The general provisions for Access Rights are applicable also to Software. Parties' Access Rights to Software do not include any right to receive source code or object code ported to a certain hardware platform or any right to receive respective Software documentation in any particular form or detail, but only as available from the Party granting the Access Rights.

3.2.1 Access Rights on the Background of the project

In Attachment 1 of the CA, the Parties have identified and agreed on the Background for the Project and have also, where relevant, informed each other that Access to specific Background is subject to legal restrictions or limits. Anything not identified in Attachment 1 shall not be the object of Access Right obligations regarding Background.

The following Table 3-2 summarize the partner's information provided in Attachment 1 of the CA, related to their background and all the linked limitation and/or conditions for implementation and exploitation.

TABLE 3-2: CLAIMS FOR BACKGROUND IN ATTACHMENT 1 OF THE CA

PARTNERS	BACKGROUND	
	Yes	No
Party 1 – KUNGLIGA TEKNISKA HOEGSKOLAN (KTH)		X
Party 2 – RINA CONSULTING (RINA-C)	X	
Party 3 – FUNDACION IMDEA ENERGIA (IME)	X	
Party 4 – TECHNISCHE UNIVERSITAT DRESDEN (TUD)		X
Party 5 – SEICO HEIZUNGEN GMBH (SEI)		X
PARTY 6 – ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH)	X	

Party 7 – MOROCCAN AGENCY FOR SUSTAINABLE ENERGY (MASEN)		X
Party 8 – UNIVERSITA' DEGLI STUDI DI GENOVA (UNIGE)	X	
Party 9 – ODQA RENEWABLE ENERGY TECHNOLOGIES LIMITED (ODQA)		X
Party 10 – THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD	X	

According to the Grant Agreement (Article 16.1) Background is defined as "data, know-how or information (…) that is (…) needed to implement the Action or exploit the results". Because of this need, Access Rights have to be granted in principle, but Parties must identify and agree amongst them on the Background for the Project. This is the purpose of the CA's attachment, reported in details in the following list:

As to **KUNGLIGA TEKNISKA HOEGSKOLAN (KTH)**, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of KTH is Needed by another Party for implementation of the Project (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the action") or Exploitation of that other Party's Results (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights for exploiting the results"). This represents the status at the time of signature of this Consortium Agreement.

As to **RINA Consulting S.p.A.**, it is agreed between the Parties that, to the best of their knowledge, the following Background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Background	Specific restriction and/or conditions for implementation (Article 16.4 Grant Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the Action")	Specific restriction and/or condition for exploitation (Article 16.4 Grant Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights for exploiting the results")
Tools, models and know-how related to the CFD and FEM analysis for the different components of the sharp-CO2 system (not exhaustive list: the sCO2 heat exchanger, TES system for CSP, electric heater etc…)	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	The access to this background is subject to legal conditions or limits and cannot be granted on a royalty-free basis. RINA-C reserves the right to assess these conditions on a case-by-case basis.
RINA-C Internal accounting tool (FAST) for EU funded projects.	No access will be provided to software code or algorithms but only to the executables of these tools.	No access will be provided to software code or algorithms but only to the executables of these tools.

As to **Fundación IMDEA Energía (IME)**, it is agreed between the Parties that, to the best of their knowledge, the following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Background	Specific restriction and/or conditions for implementation (Article 16.4	Specific restriction and/or condition for exploitation (Article 16.4 Grant

	Grant Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the Action")	Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights for exploiting the results")
In-house and customized software tools for dynamic analysis of concentrating solar power plants, including individual components and subsystems.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	No access is granted to any other application
Very High Concentrating Solar Tower facility, including hardware and software specifically develop for this facility.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	No access is granted to any other application

This represents the status at the time of signature of this Consortium Agreement.

As to **TUD**, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of TUD is Needed by another Party for implementation of the Project (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the action") or Exploitation of that other Party's Results (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", subsection "Access rights for exploiting the results"). This represents the status at the time of signature of this Consortium Agreement.

As to **SEI**, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of SEI is Needed by another Party for implementation of the Project (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the action") or Exploitation of that other Party's Results (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights for exploiting the results"). This represents the status at the time of signature of this Consortium Agreement.

As to **ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH)**, it is agreed between the Parties that, to the best of their knowledge, the following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Background	Specific restriction and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific restriction and/or condition for exploitation (Article 25.3 Grant Agreement)
Tools and know-how generated and gained by CERTH/CPERI research groups in the framework of RFCS, FP7, H2020 funded projects (e.g. CFB800, CAL-MOD, FlexFlores, SCARLET, NIBALO725, AMADEUS, SOLARSCO2L,CO2OLHEAT) , including: - CFD modelling tools and hause-built models for the calculation of, drag-models, Euler-Euler multiphase models, Euler-Lagrange interaction phases - CFD modelling tools, combustion models, heat exchanges modules -	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action. This data may be used, where agreed, to complete requirements and aims foreseen for the Sharp-sCO2 project, but not shared or used outside of this without prior permission of CERTH

LCA/LCC models, databases and algorithms -stakeholder engagement strategies, dissemination, targeted questionnaire formations		

As to the **MOROCCAN AGENCY FOR SUSTAINABLE ENERGY (MASEN)**, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of MASEN is Needed by another Party for implementation of the Project (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the action") or Exploitation of that other Party's Results (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights for exploiting the results").

As to **UNIVERSITA' DEGLI STUDI DI GENOVA (UNIGE)**, it is agreed between the Parties that, to the best of their knowledge, the following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Background	Specific restriction and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific restriction and/or condition for exploitation (Article 25.3 Grant Agreement)
Own thermoeconomic tools and know-how generated and gained by UNIGE research groups in the framework of RFCS, FP7, H2020 funded projects (e.g. PUMP-HEAT, SOLARSCO2OL, FLEXNCONFU), including: - Thermo-economic modelling tools (WTEMP, WECOMP) and in-house-built models for electric market analysis - stakeholder engagement strategies, dissemination, targeted questionnaire formations	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action. This data may be used, where agreed, to complete requirements and aims foreseen for the Sharp-sCO2 project, but not shared or used outside of this without prior permission of UNIGE

This represents the status at the time of signature of this Consortium Agreement.

As to the **ODQA RENEWABLE ENERGY TECHNOLOGIES LIMITED (ODQA)**, it is agreed between the Parties that, to the best of their knowledge, no data, know-how or information of ODQA is Needed by another Party for implementation of the Project (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the action") or Exploitation of that other Party's Results (Article 16.1 and its Annex 5 Grant Agreement, Section "Access rights to results and background", sub-section "Access rights for exploiting the results").

As to **THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD**, it is agreed between the Parties that, to the best of their knowledge, the following Background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Background	Specific restriction and/or conditions for implementation (Article 16.4 Grant Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights to background and results for implementing the Action")	Specific restriction and/or condition for exploitation (Article 16.4 Grant Agreement and its Annex 5, Section "Access rights to results and background", sub-section "Access rights for exploiting the results")

Expertise in heat transfer measurements, thermal modelling, instrumentation.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action.	Access Rights to Background is only granted to the extent that is needed for the implementation of the action

This represents the status at the time of signature of this Consortium Agreement.

3.3 Result Ownership

As mentioned in the CA (Section 8.1), "Results are owned by the Party/Parties or employees where applicable that generates them". In the latter case, such Party shall ensure – to the extent legally possible – that its employee(s) comply with the obligations regarding Results and Access Rights under this CA and the GA.

3.3.1 Joint ownership

Joint ownership is governed by GA Article 16.4 and its Annex 5, Section "Ownership of results". In this section, is reported the specific case of Joint Ownership. Results are owned by the beneficiaries that generate them. However, **two or more beneficiaries own result jointly if they have jointly generated them** and it is not possible to:

- Establish the respective contribution of each beneficiary, or
- Separate them for the purpose of applying for, obtaining, or maintaining their protection.

The Parties must negotiate and agree in writing on the allocation and terms of exercise of their joint ownership ("joint ownership agreement"), to ensure compliance with their obligations under this Agreement.

Unless otherwise specified in the joint ownership agreement or consortium agreement, each owner may grant non-exclusive licences to third parties to exploit the jointly owned results (without any right to sub-license) if the other joint owners are given at least 45 days advance notice and fair and reasonable compensation.

The joint owners may agree — in writing — to apply another regime than joint ownership. If third parties (including employees and other personnel) may claim rights to the results, the beneficiary concerned must ensure that those rights can be exercised in a manner compatible with its obligations under the Agreement. The beneficiaries must indicate the owner(s) of the results (results ownership list) in the final periodic report.

3.3.2 Transfer of results

As mentioned in the GA (Annex 5) and CA (Section 8.3), each Party/Parties or employee where applicable may transfer ownership of its Results, including its share in jointly owned Results, following the procedures of the GA Article 16.4 and its Annex 5 where it is stated:

"The beneficiary may transfer ownership of their results, provided this does not affect compliance with their obligations under the Agreement.

The beneficiaries must ensure that their obligations under the Agreement regarding their results are passed on to the new owner and that this new owner has the obligation to pass them on in any subsequent transfer.

Moreover, they must inform the other beneficiaries with access rights of the transfer at least 45 days in advance (or less if agreed in writing), unless agreed otherwise in writing for specifically identified third parties including affiliated entities or unless impossible under the applicable law. This notification must include sufficient information on the new owner to enable the beneficiaries concerned to assess the effects on their access rights. The beneficiaries may object within 30 days of receiving notification (or less if agreed in writing)

if they can show that the transfer would adversely affect their access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned."

4 KNOWLEDGE MANAGEMENT AND EXPLOITATION

4.1 Knowledge management and protection

Throughout the project, the Consortium will contribute to the generation of new knowledge that will be essential in shaping the expected project outputs, several of which may be eligible for Intellectual Property (IP) protection. On the one hand, it is an obligation, and it is also Consortium's interest to disseminate the suggested new methods and tools especially through certified scientific papers, to which open access must be granted.

A strategy aimed at a proper management of the generated knowledge shall ensure that communication and dissemination activities is duly carried out.

This strategy will consider, on the one hand, the obligation to disseminate results as well as open access rules obligations, and, on the other hand, the need to protect the Consortium partner's intellectual property rights, thereby increasing the chances of effective commercial exploitation of the project's results.

As a result, a specific method for knowledge management and protection was created at the proposal stage and would be followed throughout the project's lifespan (see paragraph below).

4.1.1 Procedure for knowledge management and protection

While useful for IP management along the project, the technique for knowledge management and protection also serves as an important input for the Exploitation Action Plan.

This approach was established with the core concepts outlined in the Grant Agreement as well as the Consortium Agreement, with a particular emphasis on assessing the background of Consortium members and monitoring the partners' potential contribution to new IP generation. Indeed, whenever some outcomes are identified as attractive for one or more of the partners' future commercial potentials, the necessary procedures to protect the related IP must be performed.

IP protection measures (including, but not limited to, patents, copyrights, trademarks, registered designs, design rights, databases, trade secrets, confidentiality, and other forms of protection) may be implemented in accordance with the processes currently in place by the concerned partner(s).

However, in accordance with the Consortium's rules, the Exploitation Manager (RINA-C) will be notified as soon as practicable of the intention of the involved partner(s) to protect that IP. As a result, the Exploitation Manager brings the IP protection intention to the Project Coordinator's notice, who directly informs the Project Steering Committee. Any issue that may arise from the IP protection project will be addressed by the General Assembly in order to protect the research and economic interests of all parties participating. In case of jointly owned IP, procedures for IP protection, use and licensing will comply with the rules set in the Grant Agreement and described in the Consortium Agreement.

In addition to the above, concerns of intellectual property protection will be handled on a regular basis by the Project Steering Committee, as well as, when necessary, by the General Assembly.

4.2 Knowledge transfer to industrial partners

In accordance with the rules outlined in the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities, as well as the Model Grant Agreement, beneficiaries belonging to the category of universities or other public research organizations will consider knowledge transfer to relevant stakeholders as a strategic mission to maximize the impact of this project.

As a result, the consortium's universities and other public research organizations will ensure that knowledge is appropriately transferred, either through licensing to the consortium's existing private industrial and commercial organizations or through potential spin-off companies, if these appear to be the best option for exploitation according to the final exploitation action plan.

4.3 Dissemination and Exploitation of Results

Dissemination in the context of Horizon 2020 refers to the public publication of results through any appropriate means, except those arising from protecting or exploiting results. Dissemination initiatives include scientific papers, general information on websites, and participation in conferences or trade shows.

According to the general model grant agreement, dissemination efforts must begin at the commencement of the project. All partners must actively participate to the dissemination of activities under the direction of IHOBE and the supervision of the Coordinator. To this end, a dissemination plan and coordinated actions will be used to clearly define each partner's roles and responsibilities at the beginning of the project.

Other partners must/have to be consulted prior to any distribution activity in order for them to exercise their right to object if such dissemination might cause serious harm to their background or results. In particular, any distribution action must be announced at least 45 days in advance to the other beneficiaries affected, who must object within 30 days.

Horizon 2020 requires for participants to ensure open access to project results that is free of charge for any user, to all peer-reviewed scientific publications relating to its Horizon 2020 project's results. This does not imply that participants are required to publish their results, nor does it affect their intentions for exploitation. In fact, participants must first decide how to preserve their data, and then evaluate whether and when to disseminate them through scientific publishing.

Participants receiving European Union funding must use their best efforts to take measures aiming at ensuring the exploitation of their results up to four years after the project. This implies that participants must take the following actions to ensure that the results they own are used:

- in further research activities other than those covered by the project concerned
- in developing, creating and marketing a products or processes
- in creating and providing a services
- in standardisation activities.

The exploitation does not have to be done directly by the participants. Indirect exploitation can be accomplished by licensing or transferring the results to third parties in compliance with the GA criteria.

5 IPR PROTECTION STRATEGY

This chapter is dedicated to the IPR Protection Strategy, in accordance with both GA and CA. Beneficiaries which have received funding under the grant must adequately protect their results — for an appropriate period and with appropriate territorial coverage — if protection is possible and justified, taking into account

all relevant considerations, including the prospects for commercial exploitation, the legitimate interests of the other beneficiaries and any other legitimate interests.

Intellectual Property protection methods can be distinguished in:

- **Industrial property** that can be protected through Patents, Designs and Trademarks;
- **Non-technical intellectual creations**, e.g. literature or artistic ones including software that can be protected through Copyrights.

The following graph summarize these differences:

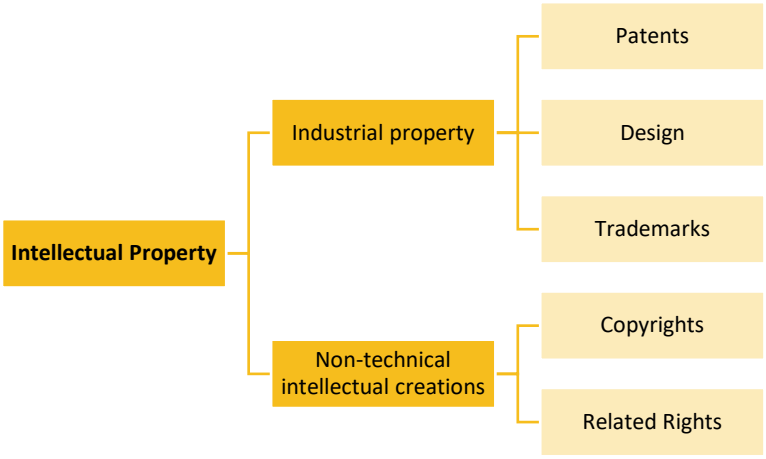

FIGURE 5-1 - INTELLECTUAL PROPERTY RIGHTS

The most appropriate form of IP protection, duration, and geographical coverage are determined by the results at stake, as well as the commercial plans for their exploitation and the legitimate interests of Consortium partners.

Patents, trademarks, designs, and copyrights are discussed further in the following section, whereas related rights are not covered in this "*D6.4 - SHARP - sCO2 outcomes exploitation plan – First emission*" since they deal with rights that benefit to performers (e.g., actors, musicians), producers of phonograms (CDs) and broadcasting organizations (TV, radio).

5.1 Formal and Informal IP protection – Intellectual Property Rights

In the field of Intellectual Property protection there are two different methods to follow: *formal* and *informal.*

"Formal" IP is designed to incentivize innovation by providing a reward system that facilitates for innovators' profits if their innovation is successful, allowing them to exclude imitators for a limited period.

In the following Table 5.1 are listed some common formal IPRs measures[4]:

TABLE 5-1 - FORMAL IP PROTECTION MEASURES

Patents
A **patent** is an industrial property right that protects a technological invention for a limited period of time (usually 20 years), providing the holder the exclusive right to restrict others from selling, producing, or using the patented product. A patentable invention must meet three criteria: it must be novel, innovative, and susceptible of industrial application.

[4] U. Suthersanen, Incremental Inventions in Europe: A Legal and Economic Appraisal of Second Tier Patents, in Journal of Business Law, 2001, 319 ff

Utility Models

A **Utility Model** is an exclusive right granted for an invention that enables the right holder to prevent others from using the protected invention without his permission and for a limited period of time (typically 7 to 10 years, with no possibility of extension or renewal). It may be any useful machine, implement, tools, product, composition, process, improvement, or part of the same, that is of practical utility, novelty, and industrial applicability. In practice, protection for utility models is often sought for innovations of a rather incremental character that may not meet the patentability criteria.

Industrial Desing

Industrial Design Is a type of intellectual property protection dedicated to the intellectual creation used by designers. It is provided for a shape, configuration, surface pattern, color, or line (or a combination of these) that, when applied to a functional product, produces, or increases aesthetics and improves the visual appearance of the design, whether it is a two-dimensional or three-dimensional product. The externally visible look of the product or its portion, packaging, or decoration is the topic of design protection[5].

Copyrights

Copyrights protect non-technical intellectual creations. It refers to all the rights owned by creators over their literary or artistic work. To be protected by copyright, work must first be sufficiently original and, second, have taken form. Protection arises automatically giving the holder the exclusive right to control reproduction or adaptation. This form of protection might be investigated further in the framework of the project.

Trademarks

Trademarks are distinctive signs identifying brands of products or services. Any sign that can be represented graphically may be registered as a trademark for a period of 10 years, with the option for indefinite renewal.

Protection of the Intellectual Property generated within SHARP-sCO2 project can be assured also through "informal" methods, such as:

- Secrecy of information (trade secret);
- Confidentiality;
- Restricted access to information;
- Technical protection (imitation difficult);
- Database and network protection;
- Components and system design protection.

The reported list comprises of conventional procedures that will be implemented by each Partner in SHARP-sCO2 project and will be scrupulously followed also post-project to ensure that no information leaks outside of the Consortium.

The following Table 5-2 provides some examples of project outcomes that may- be subject to IPR protection, as well as feasible IPR protection strategies for each of them.

TABLE 5-2 - PROJECT OUTCOMES THAT MAY BE SUBJECTED TO IPR PROTECTION

Subject Matter	Patent	Utility Model	Industrial Design	Copyright	Trademark	Confidential Information
Invention	✓	✓				✓
Design of product			✓	✓	✓	

[5] https://yourstory.com/2015/07/what-is-industrial-design-protectiontheir-designs/

Name of a product, service/ project					✓	
Know-how						✓
Scientific article				✓		
Software	✓			✓		✓
Website			✓	✓	✓	

5.2 IPR protection procedure

The Article 16 and the Annex 5 of the GA, exhort each beneficiary to examine the possibility of protecting its result(s) through the paragraph:

Beneficiaries which have received funding under the grant must adequately protect their results — for an appropriate period and with appropriate territorial coverage — if protection is possible and justified, taking into account all relevant considerations, including the prospects for commercial exploitation, the legitimate interests of the other beneficiaries and any other legitimate interests.

To ensure a proper share in the protection of joint efforts, it is recommended to notify anytime an invention, or any foreground is developed and to ensure that the foreground sharing is identified and agreed upon among the partners developing it. This should be done on a case-by-case basis and under the supervision of the Project Steering Committee, in the person of the project coordinator, with the Exploitation Manager's assistance.

According to the procedure for knowledge and management protection described in 4.1.1, each partner must notify the Exploitation Manager as soon as possible about the technical content it intends to protect and the related ownership rights (including joint ownership). In this scenario, it is considered best practice to consult with other parties involved before choosing whether and how to protect a specific result.

Any Partner intending to apply for any of the protection measures listed in the previous section, acknowledges the Exploitation Manager of its intention. As a result, the Exploitation Manager must notify the project Steering Committee (SC). The acknowledgment of the intention to protect the generated foreground must be accompanied by a synthetic description of the foreground topic of the intention for IPR protection by filling out the template reported in **Appendix 1**. The template includes several fields to be filled, listed below:

- **Subject**
- **Description**
- **Type of protection (Patent, Trademark, Industrial Design, Copyright, Other)**
- **Protection Rationale** and **Potential market**
- **Scientific Responsible**
- **Keywords**
- **Work-package** and **Partner involved**.

The template's first field - "*Subject*" - allows for the identification (uniqueness) of the innovation. This section should be completed to allow for the quick retrieval of the many claimed inventions. Partners are invited to define the major terms of the invention in the field "*Description*" in simple and unambiguous language that

accurately correspond to the actions undertaken in the project. The "description" must be sufficiently detailed to allow the Steering Committee to assess whether the application for IPR protection could endangered other Consortium Partners, while being sufficiently general to avoid disclosing too much information about the subject. In any case, if the Steering Committee believes that the application for IPR protection may have an impact on the activities or businesses of other Partners, the control body has the authority to request additional information about the application and, eventually, to involve all interested Parties in a discussion to analyse the situation. The different protection techniques can be indicated in the "*Type of protection*" section (multiple choice is available). This is simply a recommendation and preference for the evaluator, but it will not limit the evaluation activities. The sections "*Potential Rationale*" and "*Potential Market*" enable the partner to identify the potential target sector of the invention. This might be beneficial for defining the anticipated economic effect as well as obtaining a general estimate of possible geographical market penetration. Such information may be useful in defining the locations where the claimed innovation must be protected. The field "*Keyword*" is optional. However, it is highly recommended to offer at least one keyword for the innovation's distinctive identification. This allows the Coordinator and the Exploitation Manager to do a better job of reviewing and evaluating the effectiveness of the invention. One or more fields to be completed have been added in order to indicate the "*Work package*" in which the innovation was produced and the "Partners involved" in the new invention. The Coordinator shall track all acknowledgements of partners expressing the intention for IPR protection as well as the date of the acknowledgement. The intention to file an IPR application must be preserved. This will be important in identifying the partner's ownership and assigning a specific date to the claimed invention. Aside from a brief description of the innovation, this will offer the Steering Committee with archival material to refer to in the event of IPR issues amongst partners.

The template provided below needs to be used to specify the list of patent, trademark, registered design, and other applications. However, no applications have been recorded at this point in the project, according to the partners.

SHARP-sCO2 list of applications for patents, trademarks, registered design, etc.			
Type of IP Rights	**Application reference(s) (e.g. EP123456)**	**Subject or title of application**	**Applicant(s) (as on the application)**
Patent	-	-	-

5.3 Patent Application

A patent may be the best approach for ensuring proper protection for the result. However, there are multiple patent protections available, and the nature of the innovation as well as the intended market may impact the selection of the most appropriate one:

- **National Patents**
- **European Patents**
- **European or International filing**

National patents

The national route may be a preferable option for a partner who intends to apply to only a few European nations. The method in this scenario is to file the relevant application at the IP authorities in the countries where protection is sought.

In terms of patentability criteria, patent law in European Patent Organisation (EPO) member states has been harmonised and uniformized by the European Patent Convention (EPC). However, the national route generally leads to national rights that confer protection of differing extent.

European patents

The national approach may be limiting for a partner seeking protection in a wider sector. In this case, the European patent may be a viable option.

The European Patent Convention (EPC) is a multilateral convention that established the European Patent Organisation (EPO) and established an autonomous legal framework for granting European patents. However, the EPO's patent application fees are greater than those imposed by national patent offices. The fees at the EPO do not cover the actual grant of patents by individual countries, so one has to allow for additional official fees following allowance when the patent is validated in those countries in which the patent wish to be in force.

Based on the fees related to the European grant procedure, costs for representation by a single agent and cost of conducting the proceedings in a single language, a European patent costs is as much as about three or four national patents. This means that if a partner wishes to get protection in more than two or three of the European Patent Convention's member nations, the European Patent procedure is likely to be more convenient. If a partner wants to gain protection in just two countries, then separate national applications will probably be cheaper. Finally, if a partner wants patent protection in three countries, a thorough examination is required.

European or International filing

The Patent Cooperation Treaty (PCT) is an international patent law treaty that provides unified procedure for filing patent applications to protect inventions in each of its 148 Contracting States[6]. A PCT application (or international application) is a patent application submitted under the PCT.

A PCT application establishes a filing date in all contracting states and must be followed by the process of entering national or regional stages in order to proceed with the issuance of one or more patents.

The PCT approach essentially results in a standard national or regional patent application, which may be granted or refused in any country where a patent is wanted, according to relevant legislation.

If a partner decides to apply for a European patent, the choice would be to follow the direct European route mentioned before, or the international PCT procedure.

European patent applications are the most likely to happen due to the European scope of the SHARP-sCO2 project. For this reason, this route is described hereafter.

A European patent application consists in[7]:

- A request for grant (obligatory), preferably on EPO form 1001;
- A description of the invention (obligatory);
- Claims;
- Drawings (if any);
- An abstract.

[6] http://ww.wipo.int/pct/en/pct_contracting_states.html

[7] http://documents.epo.org/projects/babylon/eponet.nsf/0/63a9e7299c8e2feec12577d8004beacd/$FILE/poster_grant_procedure_en.pdf

6 Exploitation strategy of SHARP sCO2 Key Exploitable Results

The definition and identification of Key Exploitable Results is a first step towards exploitation in order to give the consortium a clear framework. In order to assess their technological development and commercialization goals, these Key Exploitable Results have been selected and preliminary defined based on their actual development status. Throughout the duration of the project, the aforementioned information will be updated. The analysis tries to identify the appropriate go-to-market strategies and the framework for exploitation, including IPR management elements.

6.1 Identification of SHARP sCO2 Key Exploitable Results

In this paragraph a definition of project result as defined by the European Commission is provided:

"A Project Result is defined as any tangible or intangible output of the action, such as data, knowledge and information whatever their form or nature, whether or not they can be protected."

Thus, project results (or Exploitable Results – ER) are the outputs generated during the project which can be used and create impact, either by the project partners or by other stakeholders. Project outcomes may include elements (knowledge, technology, processes, networks) that have the potential to contribute to future work on research or innovation, as well as reusable and exploitable products (such as innovations, prototypes, and services).

Dealing with exploitation of results means to evaluate the utilization of results in developing, creating and marketing a product or process, or in developing and delivering a service, or in standardization activities.

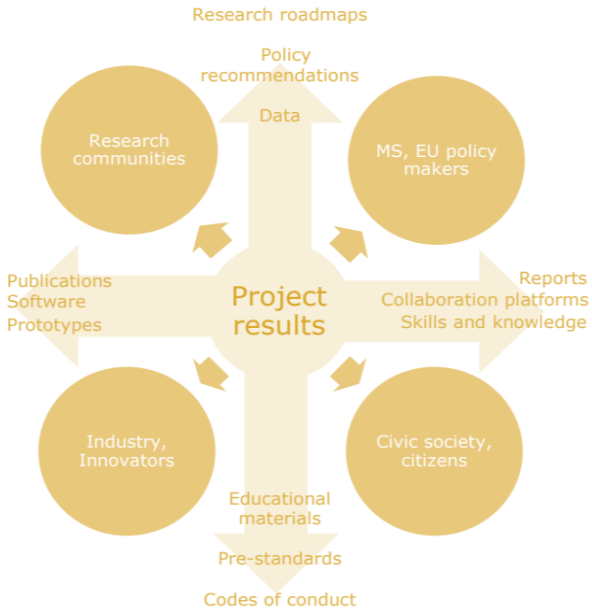

FIGURE 6-1: PROJECT RESULTS[8]

During Dissemination and Exploitation activities, it is crucial to:

- Use the results for scientific, societal, and economic purposes, or to improve public awareness and action (such as policymaking recommendations); recognize exploitable results and their stakeholders as a group of entities that are making concrete use of results; and

[8] https://ec.europa.eu/research/participants/data/ref/h2020/other/events/2018-09-21/9_dissemination-exploitation-activities_en.pdf

- Concretely express the value and impact of the research and innovation activity for societal challenges; in this regard, partners shall make best efforts to exploit the results it owns, or to have them exploited by another legal entity (e.g. through making results available under open licenses).

FIGURE 6-2: DISSEMINATION AND EXPLOITATION OF PROJECT RESULTS[9]

Considering the above definitions, the list of project exploitable results is determined in accordance with the Grant Agreement and contributions of the partners. It specifies that, since this deliverable is a draft of the Exploitation Plan that will be updated throughout the project implementation period, the ERs may still change in the next version of the document.

Table 6-1 provides the list of exploitable results, the related Responsible, and other partners involved in developing the results. This is based on the list of results provided in the project proposal, which has been updated during development and activities carried out over the past few months.

TABLE 6-1: SHARP-SCO2 EXPLOITABLE RESULTS LIST

#	Exploitable Results - ERs	Responsible partner	Other partners involved
1	Novel air receiver able to reach 1000°C and 4MW/m2	Odqa	UOXF, IME
2	Novel electric heater for packed beds / air systems	SEICO	KTH
3	Novel radial packed bed TES optimized for slag and waste media	KTH	UNIGE
4	New air to sCO2 Heat Exchanger design for CSP and waste heat recovery	TUD	RINA-C
5	SHARP-sCO2 air driven/sCO2 hybrid PV-CSP cycles	IME, KTH	Odqa, UNIGE
6	LCA Tools	CERTH	-
7	CFD dedicated tool for granular based material storage systems	CERTH	KTH

[9] https://ec.europa.eu/research/participants/data/ref/h2020/other/events/2018-09-21/9_dissemination-exploitation-activities_en.pdf

In the following paragraphs, each KER has been preliminary characterized according to the information available and inputs provided by the partners, with particular focus on the innovation, potential customers and exploitation perspectives (including IPR management).

6.2 Preliminary characterization of Project Results

An exploitation plan must include an appropriate exploitation strategy to ensure successful implementation and market penetration of the identified results. However, it is important to know the characteristics of each outcome. In this sense, Table 6-2 provides a brief description of the ERs.

TABLE 6-2: SHARP-SCO2 EXPLOITABLE RESULTS OVERVIEW

#	Exploitable Results - ERs	Description
1	Novel air receiver able to reach 1000°C and 4MW/m2	Validation of a new rotating jet-impinging gas solar receiver capable of achieving output air temperatures of 1000°C in a relevant environment with a minimum of 200 hours on sun testing. The prototype will be scaled to 50-100kWth and evaluated in a solar field that is capable of 4MW/m2 peak
2	Novel electric heater for packed beds / air systems	Novel EHs with optimized wire layouts with insulating materials able to operate at medium voltage supply and up to 900°C
3	Novel radial packed bed TES optimized for slag and waste media	Prototyping and validation of a radial flow packed bed thermal energy storage for heat up to 800°C using solid materials as main storage media and providing limited pressure drop with still elevated thermal performance
4	New air to sCO2 Heat Exchanger design for CSP and waste heat recovery	Design and manufacturing of an innovative hot-air to sCO2 heat exchanger. The heat exchanger will be designed with a focus on a modular concept relying on market ready manufacturing solutions. The hex will be experimentally investigated at the suCOO-Lab test rig at TU Dresden. A specially designed calculation tool provides additional information also for off-design situations and is used to supplement the design phase and the experimental testing
5	SHARP-sCO2 air driven/sCO2 hybrid PV-CSP cycles and TEA tools	Hybrid PV-CSP plants have been recently investigated as a solution that seizes upon the low cost of PV and the dispatchability of CSP in order to attain low LCOE. Hybrid PV-CSP solutions are more techno-economically appealing than PV+Batteries, particularly when aiming at capacity factors higher than 65% due to the lower cost of thermal energy storage. The KERS refers to the cycle definition as well as to the developed techno-economic (TEA) tools to assess the cycle performance and to enable replication studies.
6	LCA Tools	A tailor made, high validity Life Cycle Assessment (LCA) model will be developed by CERTH, to quantify and assess the environmental impacts of hybrid air CSP-PV plants proposed by SHARP-sCO2, with specific focus on the Global Warming Potential of the system
7	CFD dedicated tool for granular based material storage systems	The development of a Eulerian-Lagrangian model (DDPM) aims to simulate an innovative packed bed Thermal Energy Storage (TES) system that utilizes particulate matter as the filling material. The working medium (air) flow follows a radial pattern and is

		characterized by high temperature levels. The desired objectives for the system include achieving the following: a working medium (air) outlet temperature of approximately 700°C, a round trip thermal efficiency greater than 70%, a thermal exchange efficiency higher than 90%, a pressure drop lower than 1%, and an operation time with sufficient outlet temperature levels exceeding 70% of the overall operation

Furthermore, in order to present a more accurate analysis, lead partners of the above ERs were asked to answer questions regarding their results and these outputs were then used as a basis for the formulation of results characteristics. The questions focused on the following aspects:

- General description of the Project Result.
- Market context and intentions.
- IPR management.
- Exploitation intentions and strategy.

All the above information has been collected for each Exploitable Result using the template below.

TABLE 6-3: CHARACTERIZATION TABLE TEMPLATE

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**		
	Short description of the project result/Description of the service provided	*Short description of the project result and of the related service provided*	
	Innovation content/ Competitive advantage/Benefits	*Added value of the project result/service provided from the end-user point of view*	
	Legal, normative or ethical requirements connected to the development of the project result	*Any legal, normative or ethical requirements that shall be taken into account during the development of the project result and potentially after the end of the project (e.g., any legal constraints for the exploitation?)*	
	TRL	**Before SHARP-s CO2**	**After SHARP-s CO2**
MARKET	Targeted Market and Sector(s) of application	*Example of application or scenario for the project result/service, including the target sector and alternative one(s)*	
	Time to market	*When the result developed is expected to reach the market*	
	Potential customers	*End-users/customers that could be interested to purchase/use the result developed*	
	Potential competitors	*Other companies potentially involved in the development of similar results*	
IPR	Owner(s) of Result		
	Other Partners involved		
	Joint ownership	*Is there any need of agreement about the ownership of the result before the end of the project? Yes/No*	
	Status of IPR: Background (B)	*List of partners providing existing knowledge to the development of the result* *B = if you provide your background and existing knowledge (already available at your company before the project start) for the development of the result.*	
	Status of IPR: Foreground (F)	*List of partners involved, and role effectively covered by them in the development of the final result*	

		F = if you are strictly involved in the development of the result and so your knowledge acquired during the project is essential to reach the final result.				
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
		If not yet, is it expected to protect the result in the future?				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
		Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
	Revenue streams associated to the above exploitation claim	€	€	€	€	€
	Estimated effort to bring the project result to the market	Activities foreseen	Cost	Time		

At this stage of the project, the exploitable results have been preliminarily characterized, according to their on-going statuses and their incomplete current level of development. It specifies that the tables presented within this deliverable may still be revised and updated until the end of the project, to monitor the evolution of the results and the contributions of partners. The final version of the characterization tables for each exploitable result will be provided in the final deliverable due at the end of SHARP-sCO2 project (M36).

Below, the preliminary characterization tables for the exploitable results are reported. It specifies that for ER #2 and #5, the related information will be provided in the final version of D6.4 since partners' inputs are still missing.

6.2.1 KER #1 – Novel air receiver able to reach 1000°C and 4MW/m2

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#1 - Novel air receiver able to reach 1000°C and 4MW/m2**				
	Short description of the project result/Description of the service provided	Validation of a new rotating jet-impinging gas solar receiver capable of achieving output air temperatures of 1000 °C in a relevant environment with a minimum of 200 hours on sun testing. The prototype will be scaled to 50-100kWth and evaluated in a solar field that is capable of 4 MW/m2 peak.				
	Innovation content/ Competitive advantage/Benefits	The novel design of the solar receiver allows high solar concentration to be sustained using readily available low-cost materials. Adopting air as the HTF simplifies the balance of plant of the power block in comparison to competing systems.				
	Legal, normative or ethical requirements connected to the development of the project result	Observation of existing patents within this field of technology or application.				
	TRL	**Before SHARP-s CO2**	**After SHARP-s CO2**			
		3	5			
MARKET	Targeted Market and Sector(s) of application	Industrial heat applications. Introduce technology via rotary dryers and kilns.				
	Time to market	3 years				
	Potential customers	Consumers of process heat in the region of 800 °C.				
	Potential competitors	Synhelion, Vast Solar, Heliogen				
IPR	Owner(s) of Result	Odqa Renewable Energy Technologies Ltd.				
	Other Partners involved	Fundacion IMDEA Energia, UOXF				
	Joint ownership	No				
	Status of IPR: Background (B)	Solar Receiver Patent: WO2022/034332 (A1)				
	Status of IPR: Foreground (F)					
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
		Odqa Renewable Energy Technologies Ltd.				
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		Yes				
		If not yet, is it expected to protect the result in the future?				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
	Revenue streams associated to the above exploitation claim	€	€	€ Under Evaluation	€	€
	Estimated effort to bring the project result to the market	Activities foreseen	Cost	Time		
		Product Development and Testing	€ Commercially Sensitive Information	3 years		

6.2.2 KER #2 – Novel electric heater for packed beds / air systems

The information related to ER #2 - Novel electric heater for packed beds / air systems will be provided in the final version of D6.4.

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#2 - Novel electric heater for packed beds / air systems**				
	Short description of the project result/Description of the service provided	Prototyping and validation of a novel electric heater able to deliver maximum air temperature of 800°C and operating at medium voltage.				
	Innovation content/ Competitive advantage/Benefits	The design will enable simpler and more cost-effective CSP/PV hybridization reducing costs for the electric heater and all the additional components needed on the electrical side (transformer). In a broader context the electric heater can also be deployed in a different set of power-to-heat applications and industrial contexts				
	Legal, normative or ethical requirements connected to the development of the project result	*Any legal, normative or ethical requirements that shall be taken into account during the development of the project result and potentially after the end of the project (e.g., any legal constraints for the exploitation?)*				
	TRL	**Before SHARP-s CO2**		**After SHARP-s CO2**		
		3		5		
MARKET	Targeted Market and Sector(s) of application	Hybrid CSP/PV, industrial heat decarbonisation and electrification, Carnot batteries and large scale TES				
	Time to market	*N.A*				
	Potential customers	*End-users/customers that could be interested to purchase/use the result developed*				
	Potential competitors	*N.A*				
IPR	Owner(s) of Result	SEICO HEIZUNGEN GMBH				
	Other Partners involved	KTH				
	Joint ownership	*No*				
	Status of IPR: Background (B)					
	Status of IPR: Foreground (F)	*TBD*				
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
		SEICO HEIZUNGEN GMBH				
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		TBD	TBD	TBD	TBD	Yes/No
		If not yet, is it expected to protect the result in the future?				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
		Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
	Revenue streams associated to the above exploitation claim	€	€	€ Under Evaluation	€	€ Under Evaluation
		Activities foreseen	Cost	Time		

	Estimated effort to bring the project result to the market			

6.2.3 KER #3 – Novel radial packed bed TES optimized for slag and waste media

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#3 - Novel radial packed bed TES optimized for slag and waste media**				
	Short description of the project result/Description of the service provided	Prototyping and validation of a radial flow packed bed thermal energy storage for heat up to 800°C using solid materials as main storage media and providing limited pressure drop with still elevated thermal performance				
	Innovation content/ Competitive advantage/Benefits	Layered internal structure with different particle sizing to optimize both thermal and hydrodynamic performance				
	Legal, normative or ethical requirements connected to the development of the project result	None of particular relevance				
	TRL	**Before SHARP-s CO2**		**After SHARP-s CO2**		
		3		5		
MARKET	Targeted Market and Sector(s) of application	CSP, industrial waste heat recovery and flexible industrial heat production and electrification				
	Time to market	2027				
	Potential customers	CSP sector (developer, providers,…), industrial sector (including owner and operators of high temperature processes such as steel, cement, ceramics,…)				
	Potential competitors	High temperature thermal energy storage manufacturer and providers (i.e. Brenmiller, EnergyNest, Kraftblock, RONDO,…)				
IPR	Owner(s) of Result	KTH				
	Other Partners involved	KTH, UNIGE, ODQA				
	Joint ownership	Under discussion				
	Status of IPR: Background (B)	Published design, material and experimental results as produced and obtained by KTH				
	Status of IPR: Foreground (F)	Under discussion				
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
		ODQA	KTH, UNIGE, ODQA		KTH, UNIGE	
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		Potential protection measures are under discussion mainly between KTH and ODQA				
EXPLOITATION	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
				Yes	Yes	Yes

	Revenue streams associated to the above exploitation claim	€	€	50 €/MWh (installed capacity)	30 €/MWh (heat provided)	€
	Estimated effort to bring the project result to the market	Activities foreseen		Cost		Time
		Upscaling and relevant testing and demonstration at higher TRL (7/8)		3 M€		2025-2027

6.2.4 KER #4 – New air to sCO2 Heat Exchanger design for CSP and waste heat recovery

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#4 - New air to sCO2 Heat Exchanger design for CSP and waste heat recovery**			
	Short description of the project result/Description of the service provided	Design and manufacturing of an innovative hot-air to sCO2 heat exchanger. The heat exchanger will be designed with a focus on a modular concept relying on market ready manufacturing solutions. The hex will be experimentally investigated at the suCOO-Lab test rig at TU Dresden. A specially designed calculation tool provides additional information also for off-design situations and is used to supplement the design phase and the experimental testing.			
	Innovation content/ Competitive advantage/Benefits	Optimized modular design by relying on market ready manufacturing solutions. The heat exchanger is supposed to reach a high effectiveness by low pressure drops, a compact shape and will operate at high temperatures and pressures.			
	Legal, normative or ethical requirements connected to the development of the project result	None			
	TRL	**Before SHARP-s CO2**		**After SHARP-s CO2**	
		3		4 or 5	
MARKET	Targeted Market and Sector(s) of application	Renewable energies, main target CSP, but also transferrable to other technologies like waste heat recovery or conventional heat sources.			
	Time to market	5-10 years			
	Potential customers	All companies operating high temperature energy conversion systems.			
	Potential competitors	Companies or research projects dealing with heat transfer from hot air to CO2.			
IPR	Owner(s) of Result	TU Dresden			
	Other Partners involved	None			
	Joint ownership	No			
	Status of IPR: Background (B)	In house component design tools and thermodynamic property software are available and used within the project.			
	Status of IPR: Foreground (F)	Creation of an innovative hex design tool for the targeted application. Resulting hex designs and experimental data gathered in the project.			
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**
		Up to now, there are no specific partners who are interested in the exploitation of the results			
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**

		Not yet patented but depending on the projects outcome patenting would be conceivable.				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
						Gathered results will be used within teaching and for acquiring new projects.
	Revenue streams associated to the above exploitation claim	€	€	€	€	400k€ (potential projects making use of the results)
	Estimated effort to bring the project result to the market	Activities foreseen	Cost	Time		
		Participation in subsequent projects to increase the TRL and reach market maturity. However, as a university we will not directly sell a final product on the market	€			

6.2.5 KER #5 – SHARP-sCO2 air driven/sCO2 hybrid PV-CSP cycles and TEA tools

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#5 - SHARP-sCO2 airdriven/sCO2 hybrid PV-CSP cycles and TEA tools**	
	Short description of the project result/Description of the service provided	Hybrid PV-CSP plants are currently considered a solution that seizes upon the low cost of PV and the dispatchability of CSP to attain low LCOE. This project will provide a new tool to perform technoeconomic analyses of Hybrid PV-CSP based on SHARP-sCO2 innovations.	
	Innovation content/ Competitive advantage/Benefits	Use of real data obtained from experimentation performed in the project. The tool facilitates simulation activities to evaluate advantages, optimize designs, and compare different hybrid PV-CSP plant layouts. While existing simulation tools perform well for established systems, they face challenges when adapting to new components, configurations, and operating strategies. The developed overcomes this challenge by providing a simulation framework and a versatile library of components and control strategies that can be tailored to meet the specific needs of end-users.	
	Legal, normative or ethical requirements connected to the development of the project result	N.A.	
	TRL	**Before SHARP-s CO2**	**After SHARP-s CO2**
		3	5
MARKET	Targeted Market and Sector(s) of application	Energy sector	
	Time to market	At least 1 year after the project end	
	Potential customers	Consultancy, Engineering Firms, Developers	
	Potential competitors	Extensive list due to the current project pipeline in the same area: NREL, DLR, FISE…	
IPR	Owner(s) of Result	IME, KTH	
	Other Partners involved	MASEN, ODQA	
	Joint ownership	Is there any need of agreement about the ownership of the result before the end of the project? Yes	

	Status of IPR: Background (B)	List of partners providing existing knowledge to the development of the result B				
	Status of IPR: Foreground (F)	List of partners involved, and role effectively covered by them in the development of the final result F				
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
		IME, KTH	IME, KTH, MASEN, ODQA			
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		No	No	No	No	No
		Protection measures linked to those form component development (i.e. ODQA solar receiver)				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
		Yes	No	Yes	No	Yes
	Revenue streams associated to the above exploitation claim	300 €/h	€	3000 €/year/license	€	N.A.
	Estimated effort to bring the project result to the market	Activities foreseen	Cost	Time		
		Subsequent developments to enhance user interface and provide a user-frienfly user tool.	Cannot be fully estimated at this stage (around 200 €/year for server + tool maintenance and upgrading)	Immediately after model development and validation		

6.2.6 KER #6 – LCA Tools

PROJECT RESULT GENERAL DESCRIPTION	**Exploitable Result # / Title**	**#6 - LCA Tools**	
	Short description of the project result/Description of the service provided	A tailor made, high validity Life Cycle Assessment (LCA) model will be developed by CERTH, to quantify and assess the environmental impacts of hybrid air CSP-PV plants proposed by SHARP-sCO2, with specific focus on the Global Warming Potential of the system.	
	Innovation content/ Competitive advantage/Benefits	CERTH will create new modules based on the proposed components, which will allow configuring SHARP-sCO2 solutions under the cradle-to-grave perspective and using a circularity approach regarding the used materials.	
	Legal, normative or ethical requirements connected to the development of the project result	N. A	
	TRL	**Before SHARP-s CO2**	**After SHARP-s CO2**
		4	5 linked to SHARP technologies
MARKET	Targeted Market and Sector(s) of application	CSP plants and Circular Economy Sector	
	Time to market	At least 2 years after the end of the project	
	Potential customers	Investors on CSP plant	

	Potential competitors	Other entities working on LCA services				
IPR	Owner(s) of Result	CERTH				
	Other Partners involved					
	Joint ownership	N. A				
	Status of IPR: Background (B)	Data inventory built during SHARP-sCO2 project				
	Status of IPR: Foreground (F)	N. A				
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**	
					Providing feasibility studies based on the replication of the concept by applying an LCA approach	
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		If not yet, is it expected to protect the result in the future? Yes				
EXPLOITATION STRATEGY	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)
		CERTH can provide a full LCA study to the interested stakeholders for scale up projects	Yes/No	Yes/No	Yes/No	CERTH is a research institute, Hence the database inventory built in the project, as well the modules will be used in similar activities in other research project
	Revenue streams associated to the above exploitation claim	€ (It depends on the boundaries of the scale up concept)	€	€	€	€
	Estimated effort to bring the project result to the market	Activities foreseen	Cost	Time		
		Adaptation of data inventory to the scale up scenarios. Main emphasis will be given in the characterization of the materials used and their circularity potential	€ (cannot be estimated at this stage)	2 years after the end of the project		

6.2.7 KER #7 – CFD dedicated tool for granular based material storage systems

PROJECT RESULT	**Exploitable Result # / Title**	**#7 - CFD dedicated tool for granular based material storage systems**
	Short description of the project result/Description of the service provided	The development of an Eulerian-Lagrangian model (DDPM) aims to simulate an innovative packed bed Thermal Energy Storage (TES) system that utilizes particulate matter as the filling material. The working medium (air) flow follows a radial pattern and is characterized by high temperature levels. The desired objectives for the system include achieving the following: a working medium

		(air) outlet temperature of approximately 700°C, a round trip thermal efficiency greater than 70%, a thermal exchange efficiency higher than 90%, a pressure drop lower than 1%, and an operation time with sufficient outlet temperature levels exceeding 70% of the overall operation.			
	Innovation content/ Competitive advantage/Benefits	The implementation of an Eulerian-Lagrangian model (DDPM) for simulating flows with velocities lower than the minimum fluidization velocity presents several non-trivial challenges, requiring the careful handling of numerous numerical aspects. One of the primary difficulties arises from the strong cohesion among particles, leading to high particle loading in space. As a result, developing the appropriate methodology, devising suitable numerical schemes, and creating in-house user-defined functions become crucial milestones for advancing the numerical capabilities in simulating such phenomena. Furthermore, the discrete phase simulation enables the detection of essential inter-particle interactions and associated phenomena, which Eulerian approximation models are unable to accurately capture. This capability is expected to enhance the accuracy and validity of the simulation results and contribute significantly to the deeper understanding of heat transfer within such components.			
	Legal, normative or ethical requirements connected to the development of the project result	N. A			
	TRL	**Before SHARP-s CO2**	**After SHARP-s CO2**		
		4	5 (according to the general purpose of the project)		
MARKET	Targeted Market and Sector(s) of application	CFD simulation of granular-based TES systems			
	Time to market	While commercial exploitation is not feasible, the methodologies presented in this study hold great potential for utilization by other users, referred to as customers hereafter. These findings can serve as valuable resources for customers to benefit from, applying the knowledge gained and implementing the proposed methodologies in their own respective domains			
	Potential customers	Research centers, universities, industry, designers of such components			
	Potential competitors	Other entities that are involved in similar research projects			
IPR	Owner(s) of Result	CERTH			
	Other Partners involved	KTH			
	Joint ownership	N. A			
	Status of IPR: Background (B)	The relative Deliverable owns to the consortium			
	Status of IPR: Foreground (F)	N. A			
	Status of IPR: Exploitation forms (partners interested in the exploitation of the result after the end of the project)	**M = Making the product**	**U = Using the result**	**L = License the result**	**O = Other means of exploitation**
					The CFD results are vital for the optimization of the design of such a component and for the detection of crucial operational aspects
	Protection measures	**Patent**	**Trademark**	**Copyright**	**Industrial Design**	**Other**
		If not yet, is it expected to protect the result in the future?				
EXPLOITATI	Exploitation claim	**Consulting activity**	**License to third parties**	**Making and selling the product**	**Providing a service**	**Internal use** (e.g., R&D, projects)

		CERTH, with its extensive experience in the field of numerical analyses of thermal transfer/storage components, is well-positioned to offer vital guidelines to other entities engaged in similar on-going activities. Its expertise can serve as a valuable reference, providing valuable insights and support to foster progress and success in related endeavors			CERTH is experienced in the field of numerical analyses of the operation of thermal transfer/storage components, so it can provide subcontracted work or can be involved in another EU projects	The numerical schemes, methodologies, and in-house codes developed in this study are intended for future use by CERTH in similar projects. These valuable resources will be applied by CERTH to enhance and contribute to other related endeavors, thereby promoting further advancements in the field
	Revenue streams associated to the above exploitation claim	€ (It depends on the boundaries of the scale up concept)	€		€	€
	Estimated effort to bring the project result to the market	Activities foreseen	Cost		Time	
		Sophisticated numerical methodologies/schemes to approximate and optimize the following working parameters: i) expected charging/discharging cycles, ii) exerted gas flow regimes (fixed or even fluidized bed conditions), iii) charging/discharging inlet/outlet temperature profiles, iv) perforated inner pipe design (sizes of holes), v) TES aspect ratio for a given volume, and vi) examination of thermal ratcheting	€ (cannot be estimated at this stage)		Immediately after model development and validation	

6.3 Draft Exploitation Strategy

At the proposal stage partners had defined a preliminary exploitation framework and possible agreements on exploitation strategies. In this context, this deliverable aims at better detailing the exploitation strategy, both for the single partner as well as at consortium level. For both cases, a general overview is provided and during the project lifetime more details will be provided.

6.3.1 Assessment of Exploitable Results Technology Readiness Level (TRL)

The Technology Readiness Level (TRL) scale is a measure used to describe the maturity level of technology[10]. The scale provides 9 different levels. Each level characterizes the progress in the development of a

[10] https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-g-trl_en.pdf

technology, from the idea (level 1) to the full deployment of the product in the market (level 9), as depicted in Table 6-4.

TABLE 6-4: TECHNOLOGY READINESS LEVELS (TRLS)[11]

Level 1	Basic Research: basic principles are observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include fundamental investigations and paper studies
Level 2	Applied Research: technology concept and/or application formulated	Once basic principles are observed, practical applications can be formulated. Examples are limited to analytic studies and experimentation.
Level 3	Critical function, proof of concept established	Active research and development are initiated. Laboratory studies aim to validate analytical predictions of separate components of the technology. Examples include components that are not yet integrated or representative.
Level 4	Laboratory testing of prototype component or process	Design, development, and lab testing of technological components are performed. Here, basic technological components are integrated to establish that they will work together. This is a relatively "low fidelity" prototype in comparison with the eventual system.
Level 5	Laboratory testing of integrated system	The basic technological components are integrated together with realistic supporting elements to be tested in a simulated environment. This is a "high fidelity" prototype compared to the eventual system.
Level 6	Prototype system verified	The prototype, which is well beyond that of level 5, is tested in a relevant environment. The system or process demonstration is carried out in an operational environment.
Level 7	Integrated pilot system demonstrated	Prototype is near, or at, planned operational system level. The final design is virtually complete. The goal of this stage is to remove engineering and manufacturing risk.
Level 8	System incorporated in commercial design	Technology has been proven to work in its final form under the expected conditions. In most of the cases, this level represents the end of true system development.
Level 9	System ready for full scale deployment	Here, the technology in its final form is ready for commercial deployment.
Beyond 9	Market introduction	The product, process or service is launched commercially, marketed to, and adopted by a group of customers (including public authorities).

For each of the identified exploitable results an estimation of the technology readiness levels will be given by the responsible partners. It specifies that the TRLs might change in accordance to the project development.

6.3.2 Exploitation Strategy at partner level

By definition, exploitation means that the results of the project can be used in research activities other than those covered by the project or to develop, create and commercialize a product or process or to create and provide services. Therefore, the foreground created by the SHARP-sCO2 project, and the composition of the consortium can basically follow 5 operating modes after the end of the project:

- **Further research activities:** partners following this exploitation route plan to use the project results they developed or contributed to within SHARP-sCO2 project for further analysis and exploitation in other research projects and research activities for the purpose of improving and/or perfecting results.

[11] https://acqnotes.com/acqnote/tasks/technology-readiness-level

- **Commercial exploitation:** partners following this exploitation route plan to commercialize the products/services developed within the project. In general, it involves the direct or indirect use of newly created information for commercial purposes. Under this type of activity, the SHARP-sCO2 project is expected to bring progress and competitive advantage to industrial partners in various industrial sectors. It is for this reason that the interest of industrial partners is mainly focused on commercial exploitation. The desire for successful commercial exploitation is emphasized by the participation of qualified industrial entities in the SHARP-sCO2 project.
- **Licencing agreement with other partners or other companies:** partners following this exploitation route foresee to allow other partners or companies to use their IP in return for payment, that normally takes the form of royalties paid at agreed, regular intervals for the duration of the agreement.
- **Academic exploitation:** partners following this exploitation route plan to use the know-how gathered during the project for training activities, university/school courses and other research activities. It refers to the direct or indirect use of new knowledge generated in research activities other than those falling within the scope of the project. Knowledge providers, academic partners, universities, and research centres may decide to use the knowledge generated in the project for other research activities, to open up new research directions or new academic courses.
- **Consultancy services:** partners following this exploitation route foresee to use the knowledge acquired within SHARP-sCO2 project for providing additional consultancy services.

The above-mentioned ways of exploitation will be developed with the cooperation of the Exploitable Results responsible partner during the next months of project.

6.3.3 Exploitation Strategy at Consortium level

Regarding the overall SHARP-sCO2 exploitation strategy, the focus will be on the consortium mix of knowledge and proper balance in terms of competences and competitiveness towards the creation of the market conditions for the deployment of the first commercial system.

More detailed routes for exploiting SHARP-sCO2 results, both at project and partner level, will be provided in the final version of the deliverable D6.4 to be submitted at the end of the project (M36).

7 Conclusion

SHARP-sCO2 tackles critical technological challenges to enable the development of a new generation of highly efficient and flexible CSP systems. SHARP-sCO2 will develop and validate novel enabling technologies in EU top level CSP labs (TRL5) (including receiver, thermal storage (TES), sCO2-air Heat Exchanger (HEX), electric heater (EH), as well as integrated piping and control). SHARP-sCO2 will maximize sCO2 operation and compensation by introducing a smart hybridization with PV via a new EH, leveraging PV affordability while relying on CSP's unique energy storage capabilities via TES.

The intention of this study is to present a complete and comprehensive examination of the methods and initiatives undertaken by the SHARP-sCO2 consortium Partners. The analysis focuses on IPR management and exploitation activity using the Characterization Table tool, which has been sent to each partner in the SHARP-sCO2 project in order to receive data and information useful for the investigation of result characteristics and main intentions in terms of protection and exploitation. Characterization Table is a step-by-step approach to characterize and integrate a wide variety of quantitative and qualitative data that is required to assess the level of maturity of planned and developed initiatives, as well as their capacity to penetrate the market. On the other hand, IPR management aimed to provide a comprehensive overview to the Partners about IPR management and procedures in order to make known all of the possible paths to pursue, in accordance with what the Consortium agreed upon (Grant Agreement and Consortium Agreement) in terms of project protection and sharing in order to ensure the right protection for each of them. In terms of results, this methodological approach ensures a wide variety of information connected to technologies or procedures to be implemented and improved in order to better address the project's present and future challenges. All contributions will be continuously updated along the project and then be included in the final version of the report at the end of the project.

7.1 Next Steps

The exploitation activities and IPR management provide a suitable starting point for further study. This research is a dynamic framework capable of incorporating any input provided by the SHARP-sCO2 consortium members. Therefore, the exploitation activity will incorporate and integrate in the analysis the characterization table not yet received from the partners. Next steps will also focus on KER prioritization in accordance with Consortium intention. IPR and exploitation efforts will thoroughly explore the most promising outcomes and develop future methods for protection and exploitation objectives. The second version of the current deliverable will suggest final recommendations for the KER's launch into the market.

8 Appendix 1

Evaluation Template for potential patentable idea developed within SHARP-sCO2 project.

H2020

Grant Agreement number: 101083899

SHARP-sCO2:

Solar Hybrid Air-sCO2 Power Plants

Innovation Idea
Subject:
Description:
Type of protection: □ Patent □ Trademark □ Industrial Design □ Copyright □ Other
Protection Rational:
Potential Market:
Scientific Responsible:
Keywords:
Work-package(s):
Partners involved:

9 References

1] PU = Public, CO = Confidential, only for members of the consortium (including Commission Services)

2] https://www.ren21.net/

3] http://www.iprhelpdesk.eu/glossary/background-horizon-2020

4] U. Suthersanen, Incremental Inventions in Europe: A Legal and Economic Appraisal of Second Tier Patents, in Journal of Business Law, 2001, 319 ff

5] https://yourstory.com/2015/07/what-is-industrial-design-protectiontheir-designs/

6] http://ww.wipo.int/pct/en/pct_contracting_states.html

7]http://documents.epo.org/projects/babylon/eponet.nsf/0/63a9e7299c8e2feec12577d8004beacd/$FILE/poster_grant_procedure_en.pdf

8] https://ec.europa.eu/research/participants/data/ref/h2020/other/events/2018-09-21/9_dissemination-exploitation-activities_en.pdf

9] https://ec.europa.eu/research/participants/data/ref/h2020/other/events/2018-09-21/9_dissemination-exploitation-activities_en.pdf

10] https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-g-trl_en.pdf

11] https://acqnotes.com/acqnote/tasks/technology-readiness-level