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SOCRATCES

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Solar Calcium-looping integRAtion for Thermo-Chemical Energy Storage.

DELIVERABLE D8.11

Report on IPR Issues

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EXECUTIVE SUMMARY

SOCRATCES "Solar Calcium-looping integRAtion for Thermo-Chemical Energy Storage" is a research and innovation action (RIA) funded by the European Union's Horizon 2020 programme and coordinated by the University of Seville. The **general objective** of SOCRATCES is to demonstrate the practical feasibility of the CaL-CSP integration scheme already obtained at laboratory scale, extending the laboratory research in this very promising field by erecting a pilot-scale plant that uses cheap, widely available, and non-toxic materials as well as already mature solar and calcination/carbonation reactors technologies.

SOCRATCES outcomes will lead to significant contributions to the EU challenges in developing new generations of renewable technologies that are feasible, affordable, non-toxic, and sustainable, thus contributing to the goal of decarbonisation and reduction of GHG emissions

To maximise the exploitation of SOCRATCES major outcomes, either or not from a commercial perspective, it is essential to manage and regulate the Intellectual Property Rights (IPR) issues. This document - **IPR issues report** - is elaborated in the frame of SOCRATCES project **WP8 - A, Economic assessment, Business Development, Risk Analyses, and Technology watch**. This report aims to identify the options and tools more appropriate for the protection of the intellectual property generated during SOCRATCES project execution.

This document is organised as follows:

- Section 1 – Intellectual Property Rights overview – This section presents the key concepts associated with IPR, the strategy for project IPR management, including the proposal stage, project development, and post-project phase. Current options available for IP protection are also explored;
- Section 2 – SOCRATCES Intellectual Property – This section describes the SOCRATCES project, and the IP generated during the framework of the project is identified. The aspects related to the IPR management of project major results are covered, including ownership, access rights, and partners intentions regarding the results exploitation;
- Section 3 – SOCRATCES IPR issues – The options for SOCRATCES IP commercialisation are presented, the added value, potential market, competitive technologies, IP protection options and associated risks, and got to market models and main risks. The next steps for the post-project phase are also presented.
- Section 4 – Conclusions – summarises the main conclusions of the document.

IPR issues report is intended to be used by all consortium partners as comprehensive guidance for IPR issues, including the management options of project IPR on the post-project phase, including the IP protection options available, identification of potential risk factors associated with future results utilisation, either as the development of new products, processes or services and possible measures to prevent and overcome of those risks.

1. INTELLECTUAL PROPERTY RIGHTS OVERVIEW

1.1 IPR key concepts

According to the glossary of the European IP Helpdesk, Intellectual Property Rights (IPR) mean "private legal rights that protect the creation of the human mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce. They are commonly divided into two categories: Industrial Property Rights (e.g. patents, trademarks, industrial designs) and Copyright and Related rights (e.g. rights of the authors/creators and those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programmes)."

To better understand IPR management, it is necessary to understand the key concepts involved, including:

Background: EU glossary defined as "*any data, know-how or information whatever its form or nature, tangible or intangible, including any rights such as intellectual property rights, which is:*

- a) *is held by the beneficiaries before they acceded to the Agreement, and*
- b) *is needed to implement the action or exploit the results."*

In H2020, according to Article 24 of the Grant Agreement (GA), all beneficiaries are strongly advised to agree on the background before the GA is signed to ensure that they have access rights to what is needed for implementing the action.

Foreground: In the context of H2020 is referred to as results. EU glossary defines as "*any tangible or intangible output of the project, such as data, knowledge or information, that is generated in the project, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights.*" Results generated outside a project (i.e. before, after, or in parallel with a project) do not constitute Foreground. To be able to prove ownership (as well as the date of generation) of Foreground, it is strongly recommended that all project partners maintain documents showing the development of the generation of knowledge or results.

Access Rights: EU glossary defines it as "*Rights to use the project's results or background*", either for exploitation or dissemination. Are defined in article 25 of the GA.

Owner: EU glossary defines ownership as "*the state or quality of being an owner of a proprietary right. It enables its holder to exercise exclusive rights of use in relation to the subject matter of the IP and to restrict others from using these IP rights*". Background ownership is not affected by participation in a project, meaning each project partner reserves all IPR on the background that it owns.

1.2 IPR Management Strategy

Management of IPR plays an important role in H2020 projects, and it applies to the different stages of the project. Management of IPR begins in the pre-project phase, continues during the project development, and extends to the post-project phase, each one with a focus on different issues (Figure 1).

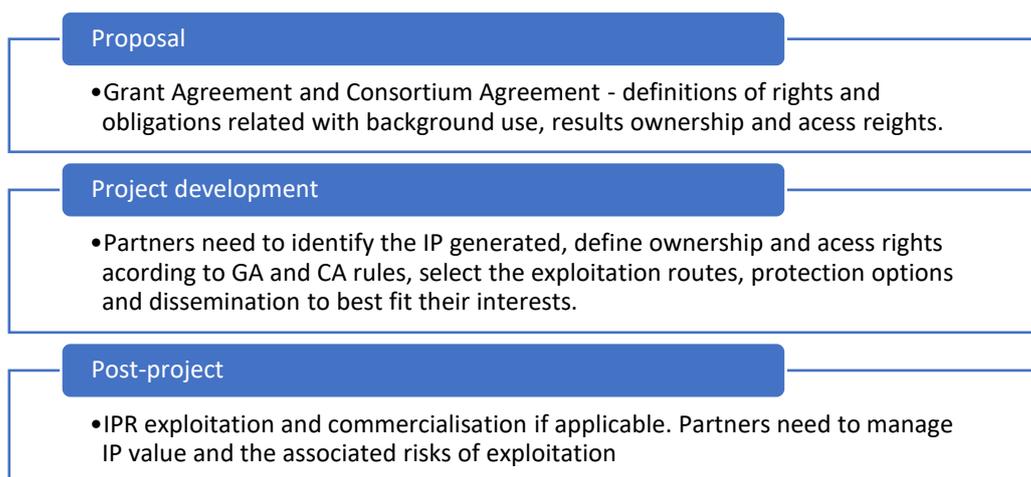


Figure 1 - Project IPR strategy

In the proposal stage, both the Grant Agreement (GA) and the Consortium Agreement (CA) address the rules for IPR management, by identifying the background, foreground, ownership, knowledge transfer, dissemination, and access rights during and until four years after the project development.

The GA is a European Commission (EC) standard contract with the rules and conditions for project financing. In this document, the main points referring to the IPR are described in Section 3, "Rights and obligations related to Background and Results", following articles:

- Art. 26 Ownership of results
 - 26.1 Ownership by the beneficiary that generates the results: Results are owned by the beneficiary that generates them.
 - 26.2 Joint ownership by several beneficiaries.
 - 26.3 Rights of third parties.
 - 26.4 Agency ownership to protect results.
- Art. 27 Protection of results – visibility of EU funding
 - 27.1 Obligation to protect the results: Each beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:
 - (a) the results can reasonably be expected to be commercially or industrially exploited, and

- (b) protecting them is possible, reasonable, and justified (given the circumstances).
- When deciding on protection, the beneficiary must consider its legitimate interests and the legitimate interests (especially commercial) of the other beneficiaries.
- 27.2 Agency ownership, to protect the results: If a beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, the Agency may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.
- Art. 28 Exploitation of results
 - 28.1 Obligation to exploit the results: Each beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure 'exploitation' of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:
 - (a) using them in further research activities (outside the action);
 - (b) developing, creating, or marketing a product or process;
 - (c) creating and providing a service, or
 - (d) using them in standardisation activities.
- Art. 29 Dissemination of results- open access- visibility of EU funding
 - 29.1 Obligation to disseminate results: Unless it goes against their legitimate interests, each beneficiary must — as soon as possible — 'disseminate' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).
- Art. 30 Transfer and licensing the results
- Art. 31 Access rights to results

In addition, the CA, which is signed before the project starting date, includes the confidentiality measures, IPR protection measures, and access rights to the background, foreground, exploitation, and dissemination. Contrary to the GA, the European Commission is not a party to the CA, which is a contract firmed by all project partners.

During the project development phase, the consortium needs to define and take specific actions regarding IP management. Indeed, management of the IP generated includes four key sequential phases, first the IP identification, second the definition of IP ownership, third the selection of IP protection options, and fourth the IP dissemination (Figure 2).

In the first phase - IP identification – all IP generated within the project needs to be identified, listed, and analysed to create the project IP portfolio. After, the consortium needs to fine-tune IP ownership according to the definitions of the Grant Agreement and the Consortium Agreement contracts. Next, the partners directly involved in the IP generation and with access to use the results, as defined by the GA and CA, need to select the IP protection options under their legitimate interests and intentions for results exploitation. These considerations are

especially relevant in the case of results with joint ownership and for those to be commercially exploited. Finally, according to the CA rules, the consortium will select how to proceed with IP dissemination (e.g. scientific publications, conferences, workshops, meetings with relevant stakeholders, etc.), and ensure confidentiality even after the end of the project if necessary.



Figure 1: IP management

In the post-project phase, after the project conclusion, the IPR management should focus on exploiting and disseminating the results. This phase assumes higher relevance if partners intend to explore the results commercially. So, to minimise exposure to risks, partners need to carefully manage the IP value, routes of exploitation, and IP protection and take into consideration the actions needed to prevent risks. IPR potential risks and preventive measures need to be assessed before project conclusion and are presented in section 4 of this report.

1.3 Options for Intellectual Property protection

Once the consortium identifies the IP generated during the project and fine-tuned the ownership according to the rules of GA and CA, it is necessary to select the IP protection options by partners' legitimate interests and exploitation intentions. IP protection is highly relevant if partners are assuming commercial exploitation of the results. According to the World Intellectual Property Organization (WIPO) and the European Patent Office (EPO), options for IP protection include:

- a) Copyright
- b) Patents
- c) Trademarks
- d) Industrial designs
- e) Trade secrets

A. Copyright

Copyright (or author's right) is a legal term used to describe the rights that creators have over their literary and artistic works. Copyright protects works that are:

- original, in the sense that it is the author's intellectual creation;
- exist in some physical form (this requirement is only applicable in some Member States as it is subject to national laws).

What can be protected:

- literary works such as novels, poems, plays, reference works, newspaper articles;
- computer programs, databases;
- films, musical compositions, and choreography;
- artistic works such as paintings, drawings, photographs, and sculpture;
- architecture; and
- advertisements, maps, and technical drawings

How to register copyright: In the majority of countries, and according to the Berne Convention, copyright protection is obtained automatically without the need for registration or other formalities. Most countries nonetheless have a system in place to allow for the voluntary registration of works. Such voluntary registration systems can help solve disputes over ownership or creation, as well as facilitate financial transactions, sales, and the assignment and/or transfer of rights.

Protection and rights are given:

- economic rights, which allow the rights owner to derive financial reward from the use of their works by others; and
- moral rights, which protect the non-economic interests of the author.

B. Patents

A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something or offers a new technical solution to a problem.

The European Patent Convention (EPC) has established that European patents are granted for inventions that are:

- new;
- involve an inventive step, and
- are susceptible to industrial application.

How to register a patent: To get a patent, technical information about the invention must be disclosed to the public in a patent application. Patents are territorial rights. In general, the exclusive rights are only applicable in the country or region in which a patent has been filed and granted under the law of that country or region. The protection is granted for a limited period, generally 20 years from the filing date of the application.

Protection and rights are given: The patent owner has the exclusive right to prevent or stop others from commercially exploiting the patented invention. In other words, patent protection means that the invention cannot be commercially made, used, distributed, imported, or sold by others without the patent owner's consent.

In some countries, is applicable a specific patent category, the utility model which compared with patents requires compliance with less stringent requirements, has simpler procedures, and offers a shorter term of protection. In most countries, patent offices do not examine utility

model applications as to substance before registration, so the process is often simpler and faster compared with patents.

How to register a utility model: In the EU, utility models can be granted at the national level in different countries. The requirements for acquiring a utility model are less stringent than those of patents. While the requirement of novelty is always to be met, that of inventive step or non-obviousness is much lower. Therefore, protection for utility models is often sought for inventions with a limited inventive step, which may not meet the patentability criteria.

Protection and rights are given: The rules for utility model registration and protection depend on each country. In Europe, it generally lasts from 7 to 10 years. Many countries allow the conversion of a patent application into a utility model application (or vice versa) under specific conditions. Fees for obtaining and maintaining utility models are cheaper. Although, in some countries, utility model protection can only be obtained for certain technology fields, such as mechanical devices and apparatus, and only for products but not for processes.

C. Trademarks

A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of other enterprises. Trademarks are protected by intellectual property rights.

What can be protected: Drawings, symbols, three-dimensional features such as the shape and packaging of goods, non-visible signs such as sounds or fragrances, or colour shades used as distinguishing features.

How to protect a Trademark: Trademarks can be protected through registration at the national, EU, or international level. European Union Trademarks (EUTMs) are issued by the European Union Intellectual Property Office (EUIPO). Trademark registration can vary but is usually ten years. It can be renewed indefinitely on payment of additional fees. Trademark rights are private rights, and protection is enforced through court orders.

Protection and rights are given: Trademark registration will confer an exclusive right to use the registered trademark. This implies that the trademark can be exclusively used by its owner or licensed to another party for use in return for payment. Registration provides legal certainty and reinforces the position of the right holder, for example, in case of litigation. Trademark registration can vary but is usually ten years. It can be renewed indefinitely on payment of additional fees. Trademark rights are private rights, and protection is enforced through court orders.

D. Industrial designs

An industrial design constitutes the ornamental aspect of an article, such as the three-dimensional features, such as the shape, or two-dimensional features, such as patterns, lines, or colour.

What can be protected: Industrial designs are applied to a wide variety of products of industry and handicraft items: from packages and containers to furnishing and household goods, from

lighting equipment to jewelry, and from electronic devices to textiles. Industrial designs may also be relevant to graphic symbols, graphical user interfaces (GUI), and logos.

How to protect an industrial design: In the EU, one may obtain a community design registration valid in all member countries through a single application, which can be filed directly in the European Union Intellectual Property Office (EUIPO).

Protection and rights are given: The owner of a registered industrial design or a design patent has the right to prevent third parties from making, selling, or importing articles bearing or embodying a design which is a copy, or substantially a copy, of the protected design, when such acts are undertaken for commercial purposes.

E. Trade secrets

Trade secrets are intellectual property (IP) rights on confidential information which may be sold or licensed. To qualify as a trade secret, the information must be:

- commercially valuable because it is secret,
- be known only to a limited group of persons, and
- be subject to reasonable steps taken by the rightful holder of the information to keep it secret, including the use of confidentiality agreements for business partners and employees.

What can be protected: Trade secret protects confidential business information, which provides an enterprise with a competitive edge and is unknown to others may be protected as a trade secret. Trade secrets encompass both technical information, such as information concerning manufacturing processes, pharmaceutical test data, designs, and drawings of computer programs, and commercial information, such as distribution methods, a list of suppliers and clients, and advertising strategies. A trade secret may also be made up of a combination of elements, each of which by itself is in the public domain, but where the combination, which is kept secret, provides a competitive advantage.

Protection and rights are given: Trade secrets protection is dependent on the confidential status of a trade secret. Once a trade secret is disclosed, it loses its secret status and, therefore, the protection. Trade secrets do not confer "property rights", meaning the trade secret owner cannot stop others from using the same technical or commercial information if they acquired or developed such information independently by themselves through their R&D, reverse engineering, or marketing analysis, etc. Since trade secrets are not made public, unlike patents, they do not provide "defensive" protection as being prior art.

IP protection needs to be fully coordinated with the exploitation and business strategy specifically designed for project results.

2. SOCRATCES INTELLECTUAL PROPERTY

2.1 The SOCRATCES project

Energy storage is the greatest challenge for a short-term deeper penetration of renewable energy sources, which are usually characterised by the intermittency of power production. In Concentrated Solar Power (CSP) systems, the Ca-Looping (CaL) process based upon the reversible carbonation/calcination of CaO is one of the most promising technologies for thermochemical energy storage (TCES).

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The **general objective** of SOCRATCES is to demonstrate the practical feasibility of the CaL-CSP integration scheme already obtained at laboratory scale, extending the laboratory research in this very promising field by erecting a pilot-scale plant that uses cheap, widely available, and non-toxic materials as well as already mature solar and calcination/carbonation reactors technologies. The pilot plant will be validated in an appropriate environment to prove it as:

- **Feasible:** SOCRATCES is a combination of a novel integration of systems in CSP/TCES in a configuration that allows using already tested technologies. Therefore, the use of individual technologies and their integration has a controlled risk due to the recent experience of the partners in the consortium.
- **Viable:** SOCRATCES technologies aim to reduce investment and O& M costs drastically. The global integration is expected to reduce the costs on the commercial scale to an LCOE below 7c€/kWh.
- **Sustainable:** SOCRATCES is environmentally sustainable because it is based on the use of non-toxic minerals as reactants in the TCES system. It allows long-term solar energy storage in chemical form. SOCRATCES is economically sustainable with reduced investment costs. SOCRATCES is socially sustainable as it is based on a technological framework currently in use and fully accepted by end-users.

SOCRATCES main **commercial objective**, linked to R&D objectives, is to introduce a novel technology (and subsystems) into the CSP tower technology market with a relevant reduction of costs at the commercial level (TCES cost <12€/kWh and CSP plant LCOE <7c€/kWh).

SOCRATCES main **social objective** is to provide a new integrated set of affordable, viable, and sustainable CSP technology, with outstanding performance and based on renewable sources and abundantly available cheap materials for the cycle.

SOCRATCES outcomes will lead to significant contributions to the EU challenges in developing new generations of renewable technologies that are feasible, affordable, non-toxic, and sustainable, thus contributing to the goal of decarbonisation and reduction of GHG emissions

2.2 Identification of SOCRATCES IP

During the SOCRATCES project execution were originated a total of 95 new results (table 1), including 3 dissemination materials (project flyer, technical brochure, and the dedicated website), 48 documents (public and confidential deliverables), 32 technological innovations (comprising new models, designs, equipment or prototypes, algorithms, and studies), which will be presented in detail in the Deliverable D8.12 – Final innovation evaluation report, and 12 articles/publications (submitted to a scientific journal with a peer-review process).

Table 1 – SOCRATCES IP identification by category and dissemination level

| Nature of the result | | Dissemination level | | Total |
|--|-------------|---------------------|--------|-------|
| | | Confidential | Public | |
| Dissemination materials (flyer, technical brochure, website) | | - | 3 | 3 |
| Project documentation (Deliverables) | | 27 | 21 | 48 |
| Technological Innovations | Models | 5 | | 31 |
| | Designs | 6 | | |
| | Equipment's | 17 | - | |
| | Studies | 3 | - | |
| Scientific Publications | | - | 63 | 63 |
| Total | | 58 | 87 | 145 |

According to the dissemination level, SOCRATCES IP produced for public dissemination is automatically protected by copyright. Although, SOCRATCES results that, due to their nature, remain confidential, need specific IP protection measures to be selected according to partners main exploitation interests.

2.3 Management of SOCRATCES IP

After IP identification, it is necessary to define ownership, including background and foreground owners and access rights. Both SOCRATCES GA and CA include a description of IPR issues related to ownership, access rights, and results exploitation and dissemination. In the GA Section 3, "Rights and obligations related to Background and Results" are regulated the aspects and obligations related to results ownership (article 26), protection (article 27), exploitation (article 28), dissemination (article 29), transfer, and licensing (article 30), and access rights (article 31). In addition, in the SOCRATCES CA, relevant information about IPR issues is included in:

- Section 8 "Results" – sets results ownership, transference, dissemination, and exclusively license;

- Section 9 "Access Rights" – Defines access to the background, rights for implementation, and exploitation, including for affiliated entities and for parties entering or leaving the consortium. Access rights to the software are also specified;
- Section 10, "Non-disclosure of information" – sets requirements for confidential information, during and until four years after the end of the project;
- Attachment 1, "background included," – includes the list of usable backgrounds.

The technological innovations presented previously (table 1) originated 15 results considered to have higher exploitable potential, which was described in detail in the Deliverable D9.6 - IPR management and Exploitation Plan and D8.9 – Project outcomes Exploitation Plan. In table 2 are presented the IPR issues considered more relevant for the exploitation of these 15 results, including background ownership and access rights to the foreground and protection option. It should be considered that partners directly involved in the development of specific results are the only ones with access rights to the foreground, as stated in the GA and CA. For each exploitable result were also identified partners' exploitation intentions, possibly go to market models and preferential IP protection options.

According to partners' main interests, these 15 SOCRATCES Key exploitable results (KER) (table 2) were grouped by typology into 4 prototypes, 6 models, 1 algorithm, and 4 processes. For all of them were identified the partners' exploitation intentions, which include:

1. Technology Transfer;
2. Direct Industrial Use;
3. Contract Research;
4. Consulting & Training services;
5. New Research Projects

From the five aforementioned exploitation options for each KER were identified the go-to-market models, namely, the 4 prototypes could be exploitable as 4 new products, while the 6 models, the 4 processes, and the algorithm could be exploited as services, or integrating a service, such as engineering, consulting, and training services, depending on the partners' intentions.

Finally, table 2 resumes the IP protection options considered by partners. The first five KER, namely the **Energy Storage System (SOCRATCES Technology)**, the **Carbonator Rector**, the **Calciner Reactor**, the **Solar Calciner based on a vibratory table**, and the **solar receiver geometry materials**, partners intend to protect the IP with the Patent model. The eight KER, the **Simulation of the energy storage process based on Solar Calcium looping**, partners interests for IP protection include the utility model. The other KER listed in the table includes results that are protected directly by publication, results to be used within the consortium, and results that partners do not consider relevant for an immediate IP protection application.

Solids Separation after Carbonation, which could go to market directly as new products were identified by partners as those considered relevant to protect the IP. Although partners have intentions to further exploit the other KER, they do not consider it relevant for IP protection until the end of the project.



Table 2 – IPR management of SOCRATCES exploitable results

| KER ID | Project Result | Short description | Type of Result | Background needed | Rights to use Foreground (*Leader) | Exploitation intentions | Market use model | IP protection options |
|--------|--|--|----------------|--|---|--|------------------|-----------------------|
| 1 | Energy Storage System (SOCRATCES technology) | A Flexible Energy Storage System, compatible with high-temperature receivers concentrated solar power plants. It integrates CSP-CaL for thermochemical energy storage (TCES). | Prototype | USE, CLX, CERTH, VM, TTZ, ZAR, CSIC, POLITO, AUTH, CNR, iSITEC | USE*, CLX, CERTH, VM, TTZ, ZAR, CSIC, POLITO, AUTH, CNR, iSITEC | Technology Transfer; Direct Industrial Use; Contract Research; Consulting & Training services; New Research Projects | New product | Patent |
| 2 | Carbonator reactor | A novel concept of entrained flow carbonator, for storage and exploitation of solar energy. | Prototype | CERTH, USE, CLX, CSIC, POLITO, AUTH, ZAR, TTZ, CNR, VM | CERTH*, USE, CLX, CSIC, POLITO, AUTH, ZAR, TTZ, CNR, VM | Technology Transfer; Direct Industrial Use; Contract Research; Consulting & Training services; New Research Projects | New product | Patent |
| 3 | Solar and/or Electric Calciner Reactor | The solar calciner is an adaptation of Calix's conventional Direct Separation Reactors, which use conventional fuels. Concentrated solar power (CSP) is directed into its cavity, heating the walls. These walls re-radiate the energy to the process on the other side (in the annulus). This heats the limestone that is falling through the process, causing it to calcine. | Prototype | CLX, VM, USE | CLX*, VM, USE | Technology Transfer; Direct Industrial Use; Contract Research; Consulting & Training services; New Research Projects | New product | Patent |
| 4 | Solar Calciner based on vibratory table | A novel vibratory conveyor calciner to improve the control of the | Model | USE, VM | USE*, VM | Engineering & Consulting & Training services; Technology | To be integrated | Patent |

| KER ID | Project Result | Short description | Type of Result | Background needed | Rights to use Foreground (*Leader) | Exploitation intentions | Market use model | IP protection options |
|--------|---|---|----------------|--|---|--|---|-----------------------|
| | | reaction to boost the performance of the system. | | | | Transfer; Contract Research | into new product | |
| 5 | Solar Receiver geometry and materials | Solar Receiver geometry and materials models include the shape of the solar receiver and the concentrated beam pattern with commercially available stainless steel to guarantee homogeneous temperature distribution along the surface of the solar receiver. | Model | VM, CLX | VM*, CLX | Engineering & Consulting services; Direct Industrial Use; Contract Research; New Research Projects | To be integrated into new product | Patent |
| 6 | Sound assisted fluidisation carbonation/calcination reactions | Sound-assisted fluidisation models to hinder the agglomeration of fine limestone particles under TCES-CSP operating conditions. | Model | CNR | CNR | Contract Research; Consulting services; New Research Projects | To be integrated into new product | Publication |
| 7 | CO ₂ sorbents for TCES applications derived from wastes | The exploitation of industrial wastes for the manufacturing of stable, low-cost sorbent materials for post-combustion CO ₂ capture and thermochemical energy storage. | Process | AUTH, CSIC, USE, CLX | AUTH*, CSIC, USE, CLX | Consulting services; New Research Projects | To be integrated into operating service | Publication |
| 8 | Simulation of the energy storage process based on Solar Calcium looping | Computer application to best optimise the operational conditions according to performance simulations of several inputs, including weather conditions, energy necessities, and energy prices. | Algorithm | ZAR, USE, POLITO, iSITEC, CERTH, CLX, VM | ZAR*, USE, POLITO, iSITEC, CERTH, CLX, VM | Consulting services; Commercialisation; Contract Research; New Research Projects | To be integrated into operating service | Utility model |

| KER ID | Project Result | Short description | Type of Result | Background needed | Rights to use Foreground (*Leader) | Exploitation intentions | Market use model | IP protection options |
|--------|---|---|----------------|---------------------------|------------------------------------|--|---|---|
| 9 | Topological optimisation of Stirling engine heat exchangers | A topological model focus on finding and the best design for the fins of the Stirling heat exchanger. | Model | POLITO | POLITO | Consulting services; New Research Projects | To be integrated into operating service | Publication |
| 10 | Solids separation after Carbonator | A device for solid particles separation (CaCO ₃ and CaO) based on density. | Prototype | ZAR, USE, CERTH | ZAR*, USE, CERTH | Commercialisation; Contract Research; New Research Projects | New product | Immediate protection not relevant / Publication |
| 11 | Operations Strategies | Operations strategy design to manage and to improve the energy efficiency of the plant. | Process | USE, POLITO, ZAR | USE*, POLITO, ZAR | Engineering & Consulting & Training services; Technology Transfer; Contract Research | To be integrated into operating service | Immediate protection not relevant / Publication |
| 12 | Solid's transport and management | Solid's transport and management systems are optimised for the conditions observed in the SOCRATCES technology. | Process | USE, CSIC | USE*, CSIC | Engineering & Consulting & Training services; Technology Transfer; Contract Research | To be integrated into operating service | Immediate protection not relevant / Publication |
| 13 | Materials cyclic behaviours | Viability of alternatives for CaO deactivation, which is one of the main drawbacks of the technology. | Process | USE, CSIC, AUTH, CNR, CLX | USE*, CSIC, AUTH, CNR, CLX | Engineering & Consulting & Training services; Technology Transfer; Contract Research | To be integrated into operating service | To be used within the consortium |
| 14 | Improved integration scheme for Stirling engines | Integration scheme for Stirling engines with thermal power sources employs a counterblast technique to enhance turbulence and hence the heat transfer rate. | Model | TTZ | TTZ | Engineering services | Engineering service | Immediate protection not relevant / Publication |

| KER ID | Project Result | Short description | Type of Result | Background needed | Rights to use Foreground (*Leader) | Exploitation intentions | Market use model | IP protection options |
|--------|---|--|----------------|-------------------|------------------------------------|-------------------------|---------------------|---|
| | with thermal power sources | | | | | | | |
| 15 | An improved heat exchanging jacket for carbonator exothermic reactors | In an exothermic reactor, it is very difficult to attain efficient heat transfer from the interior of the reactor to the external heat exchanger. An improved heat exchanging method that involves integrating the jacket in the reactor's wall through spiral channels. | Model | TTZ | TTZ | Engineering services | Engineering service | Immediate protection not relevant / Publication |

3. SOCRATCES IPR ISSUES

3.1 Options for SOCRATCES IP commercialisation

The identification of SOCRATCES IP ownership, rights to use such results, exploitation intentions, and protection options for each KER will allow partners to have the most complete information to decide about the sustainability of the results after the project is finished.

The SOCRATCES project was accompanied by an expert appointed from the EC, within the Horizon Results Booster Service – Module C. This service included an Exploitation Strategy Seminar which focused on helping partners design a specific strategy for the results with higher exploitation potential. From the results presented in table 2, partners identified the first three KER as those with higher exploitation potential, namely the 1- Energy Storage System (SOCRATCES Technology), KER 2- Carbonator Rector, KER 3 - Calciner Reactor, and are interested in selecting the Patent model for IP protection. Moreover, from table 2, for the KER 4 – Solar Calciner based on a vibratory table, and the KER 5 – Solar Receiver geometry and materials, partners express interest in protecting IP with the Patent model, while for the KER 8 – Simulation of the energy storage process based on Solar Calcium looping partners are more interested in the Utility model for IP protection. In the following tables, 3 to 8, the more relevant IP issues regarding these KER are explored in more detail.

Table 3. IPR issues for the Energy Storage System (SOCRATCES Technology)

| |
|---|
| <i>Added Value</i> |
| SOCRATCES Technology based on the application of the CaL process as a TCES system provides promising advantages, including high energy storage density, compatibility with high-efficiency power blocks, complete compact technology, and use of environmentally friendly and abundant materials. |
| <i>Existing alternatives</i> |
| <ul style="list-style-type: none"> - Pumped Hydro Storage (PHS), however, require specific locations for implantation mainly due to other uses of water (irrigation, food). - Electrochemical systems (batteries), however with high-cost. - The power to gas technology, transferring electric power to methane, however, is expensive and the efficiency low. - Converting the power to hydrogen for storing proposes, however, is not competitive because the losses during storage are quite big. |
| <i>Target market</i> |
| <ul style="list-style-type: none"> - CSP plants - CSP technology leading companies (EPCs, equipment, maintenance); - Solar companies working with CSP technologies and thermochemical energy storage; - Grids operators; - High-temperature mineral processes industries – Calcium carbonate producers, Calcination and carbonation technology manufacturers; |

| | |
|---|---|
| <ul style="list-style-type: none"> - Cement production companies; - Utilities. | |
| Market competitors | |
| <ul style="list-style-type: none"> - Current molten carbonate/energy storage systems; - Other energy storage solutions providers; - companies developing alternative energy storage systems. | |
| IP protection costs | |
| Patent estimated costs of 21.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Lack of a proper regulatory framework (legal constraints, delays in permits, etc.). | Monitor regulatory framework to re-design the product. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI |
| Direct commercialisation – Service | <ul style="list-style-type: none"> - High investment, high risk. - Lower TRL at the end of the project. - Requires that the organisation has the necessary skills and resources for manufacturing and supplying the products/services. - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - Development needed to evolve from the prototype to a commercial-grade product. |

Table 4. IPR issues for the Carbonator Reactor

| |
|--|
| Added Value |
| The Carbonator reactor is an autonomous system with higher carbonation efficiencies enabling a continuous and higher heat extraction, contributing to reducing carbon emissions. |
| Existing alternatives |
| <ul style="list-style-type: none"> - Other CO2 capture technologies; - Buying Carbon Emissions rights; - Use of molten salts for energy storage and power generation. |

| Target market | |
|--|---|
| <ul style="list-style-type: none"> - CSP plants - CSP technology leading companies (EPCs, equipment, maintenance); - Solar companies working with CSP technologies and thermochemical energy storage; - Grids operators; - Industries, i.e. materials processing, renewable calcium oxide processing; - Utilities. | |
| Market competitors | |
| Other reactors with thermal processes without the potential for high mass capacity and heat extract. | |
| IP protection costs | |
| Patent estimated costs of 21.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI |
| Direct commercialisation – Service | <ul style="list-style-type: none"> - High-investment, high-risk. - Lower TRL at the end of the project. - Requires that the organisation has the necessary skills and resources for manufacturing and supplying the products/services. - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - Development needed to evolve from the prototype to a commercial-grade product. |

Table 5. IPR issues for the Calciner Reactor

| Added Value |
|--|
| The solar and/or Electric Calciner Reactor, contrary to the conventional options, use direct sunlight to generate the heat for calcination without fuels combustion, contributing to reducing carbon emissions |
| Existing alternatives |
| - Using carbon capture and storage (CCS) to capture and permanently store the fuel and process CO2 emissions, however inefficient and expensive. |

| | |
|--|---|
| <ul style="list-style-type: none"> - Using hydrogen as the fuel, however costly and associated with indirect CO2 emissions if derived from steam methane reforming. - Mainly using fossil fuels. | |
| Target market | |
| <ul style="list-style-type: none"> - CSP plants - CSP technology leading companies (EPCs, equipment, maintenance); - Solar companies working with CSP technologies and thermochemical energy storage; - Grids operators; - High-temperature mineral processes industries – Calcium carbonate producers, Calcination and carbonation technology manufacturers; - Cement production companies; - Utilities. | |
| Market competitors | |
| <ul style="list-style-type: none"> - Solar rotary kiln; - Conventional processes + CSS/biomass; - Hydrogen / ammonia Kilns. | |
| IP protection costs | |
| Patent estimated costs of 21.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI |
| Direct commercialisation – Service | <ul style="list-style-type: none"> - High investment, high risk. - Lower TRL at the end of the project. - Requires that the organisation has the necessary skills and resources for manufacturing and supplying the products/services. - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - Development needed to evolve from the prototype to a commercial-grade product. |

Table 6. IPR issues for the Solar Calciner based on vibratory table

| | |
|--|---|
| Added Value | |
| Solar Calciner based on the vibratory table allows more precise control of the factors that intervene in the reaction, maximising the homogeneity of the calcination of particles. | |
| Existing alternatives | |
| The solar calciners used to date use larger particles, without any of the current reactor proposals becoming predominant for a future launch on the market. | |
| Target market | |
| <ul style="list-style-type: none"> - Owners and operators of CSP plants; - Owners and operators of cement plants. | |
| Market competitors | |
| Companies developing alternative solutions for solar calcination. | |
| IP protection costs | |
| Patent estimated costs of 18.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Lack of a proper regulatory framework (legal constraints, delays in permits, etc.). | Monitor regulatory framework to re-design the product. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI |
| Direct commercialisation – Service | <ul style="list-style-type: none"> - High investment, high risk. - Lower TRL at the end of the project. - Requires that the organisation has the necessary skills and resources for manufacturing and supplying the products/services. - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - Development needed to evolve from the prototype to a commercial-grade product. |

Table 7. IPR issues for the Solar Receiver geometry and materials

| | |
|---|--|
| Added Value | |
| Solar Receiver geometry and materials models focused on providing a homogeneous temperature distribution along the surface of the solar receiver. | |
| Existing alternatives | |
| Currently, only low to medium-temperature solar receivers are being used for Concentrated Solar Power (CSP) thermal energy storage, limiting the energy density and the performance of the steam cycle to produce electrical power. | |
| Target market | |
| Specialised solar research centres willing to mature the technology up to a commercial grade with demonstration pilot plants. | |
| Market competitors | |
| Enterprises already manufacturing solar receivers for use in CSP energy storage applications. Those are typically boilermakers that have experience with standard materials and shapes coming from the oil gas sector, which have the advantage of cost-effective manufacturing processes polished over the years, but with little innovation, capabilities to push the limits beyond the requirements for thermochemical energy storage. | |
| IP protection costs | |
| Patent estimated costs of 21.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI |
| Direct commercialisation – Service | <ul style="list-style-type: none"> - Requires that the organisation has the necessary skills and resources for manufacturing and supplying the products/services. - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - No commercial potential. |

Table 8. IP protection issues for the Simulation of the energy storage process based on Solar Calcium looping

| | |
|--|--|
| Added Value | |
| The simulation of the energy storage process permits the selection of the variables that best optimise operational conditions. | |
| Existing alternatives | |
| So far, energy storage is not deployed widely. The control strategies are not complex, and the system proposed in SOCRATCES is a novel solution. | |
| Target market | |
| Renewable electricity production based on CSP. | |
| Market competitors | |
| Other energy storage solutions providers (R&D and companies developing alternative solutions for energy storage). | |
| IP protection costs | |
| Utility model estimated costs of 15.000 € | |
| IP protection route | |
| International - EU, USA, China | |
| IP associated risks | Preventive measures |
| Difficulties in accessing relevant stakeholders (authorities end-users, industry). | Dissemination and meeting with relevant stakeholders, namely early adopters. |
| The appearance of new alternative technologies. | Technological surveillance to monitor possible competitor technologies. |
| Go to market options | Associated risks |
| PI commercialisation - Licensing | Lose control of the use of the PI. |
| Direct commercialisation – Service | - Difficulties in accessing relevant stakeholders (authorities end-users, industry). - No commercial potential. |

3.2 Recommendation and next-steps for SOCRATCES IPR management

To minimise the potential risks associated with SOCRATCES KER IPR management previously identified (table 3-8) the following recommendations are proposed:

1. Conduct market surveillance

Consortium partners are advised to conduct regular market surveillance and patent searches tailored to the needs of SOCRATCES exploitable results, namely through:

- Monitoring the market;
- Search for new technologies in the same field of SOCRATCES solutions;
- Monitor market barriers, legal constraints, and opportunities;
- Identify new relevant stakeholders;
- Search for key risks and opportunities for results further exploitation;
- Update IP value;

2. Prepare an IPR model agreement

A critical issue to resolve in any collaborative project is the joint ownership of results, being essential to clearly defined ownership of all IP assets generated in the framework of the project. To minimise the risk of conflicts between partners regarding IPR issues, it is advised to prepare an IPR Joint Ownership Agreement to define the terms and conditions for managing and exploiting IP assets co-owned.

4. CONCLUSIONS

SOCRATCES exploitable results – both the intermediary technologies/knowledge and the complete Energy Storage System – reveal a major exploitation potential in different paths that are being considered by the consortium in a comprehensive perspective.

Indeed, all SOCRATCES consortium partners have contributed to the identification of exploitable project results, respective ownership, and access rights according to the terms and conditions previously signed in the GA and the CA.

To maximise the exploitation of SOCRATCES' major outcomes, either or not from a commercial perspective, it is essential to manage and regulate the Intellectual Property Rights (IPR) issues. This report aimed to identify the options and tools more appropriate for the protection of the intellectual property generated during SOCRATCES project execution. The IPR issues analysed are strongly linked to other project tasks, namely:

- **Task 1.3 IP, Exploitation and Innovation management.** This task included the coordination of knowledge management and exploitation of the project results as well innovation-related activities.
- **Task 8.5 Innovation management activities.** The main aim of this task was to define a technology forecasting plan and decision-making mechanisms for innovation management by prioritising innovative project outcomes.
- **Task 8.7 Definition of Exploitation plan.** In his task was defined the best approach for project outcomes/ results exploitation oriented towards direct access users.
- **Task 9.4 IPR management and Exploitation Plan.** It involved the design and agreement of the Exploitation Plan, taking into account the agreements on IPR (Intellectual Property Rights) and Exploitation.

IPR issues report is intended to be a tool to be used by all consortium partners as comprehensive guidance for IPR issues, including the management options of project IPR on the post-project phase, including the IP protection options available, identification of potential risk factors associated with future results utilisation, either as the development of new products, processes or services and possible measures to prevent and overcome of those risks.