Sunlight Production
of Chemical Fuels

SPOTLIGHT

Grant No. No.101015960

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D6.7 Strategy for IP management

WP6 – Techno-economic and environmental assessment

WP LEADER	RINA Consulting
DELIVERABLE RESPONSIBLE	RINA Consulting
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1 INTRODUCTION

This report provides the initial results from the activities of exploitation activities and IPR management, as integral part of the WP6 - **Techno-economic and environmental assessment.**

The work presented in this deliverable has been carried out in the framework of Task 6.5 – IPR management and exploitation plan towards future marketability, led by RINA-C, with the contribution of all partners involved in the development of the Key Exploitable results.

The results here proposed come from the adoption of a widely tested methodology for KERs and IP management, developed by RINA-C, with the support of the Horizon Booster Team.

Partners have been provided with templates and questionnaires for collecting info and data but they have also been invited to dedicated exploitation workshops.

RINA-C collected, checked and homogenized the feedback from partners and finalized them by setting one-to-one interviews.

1.1 GLOSSARY

KER – Key Exploitable result. This is the result of the project: a product, a service, a software, a database, a design etc. Independently from the format, the result comes from the activities of the project and can belong to one or several partners, in general to all those that actively participated to its development.

Result ownership. This represents the share of KER owned by a partner. When a result comes from the activities exclusively carried on by one partner, it owns the 100% of the KER. If more partners actively cooperated and brought specific innovations to reach a KER, it will belong to all partners in equal shares: 50-50%, 33-33-33%, 25-25-25-25% etc.

Protection. Whenever new intellectual property (including a KER) is being developed, it is worth to evaluate the most efficient ways for protecting it. On the basis of the results from the patent analysis, as a conclusion for each use case the report will provide suggestion on the possible protection and exploitation strategy.

Exploitation. This is the way how partners (in particular owners) get benefits from KERs. Benefits can be commercial (revenues) but not only: the submission of a paper, of an abstract that allows a partner to participate to a conference, the licensing to third parties, the future scientific use of results… Usually every “kind” of partners have different objectives of exploitation, as an example a manufacturer would like to produce and sell a new product, while a University is more interested in the knowledge behind it that can be presented and further explored.

BFMULO table. In a typical EU collaborative project, partners work together to develop several results and, accordingly, there will be different interests in their exploitation.

A useful tool to recap the interest is the so-called BFMULO table. BFMULO is an acronym that stands for:

1. **B – IPR’s on background information.** This is the case when a key exploitable result is mostly built on already secured IP (Background): according to EU rules on IP, this belongs only to the partner that owns the background;
2. **F – IPR’s on foreground information.** The foreground results are those developed within the project: these results can be owned either by one single partner, in case no

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other partner's contribution was necessary during its development, or by several partners, as shared (or joint) IP.

3. **M – Making the result**. Depending on the role in the project, the competences and the role in the value chain, a partner could be interested in making (manufacturing) a result. This is not strictly related to the ownership of IP: in fact, it is possible that an IP owner doesn't have the competences or assets to manufacture a result. In this case, the interest of one other partner to make it would lead to a bilateral commercial agreement with the IP owner;
4. **U – Using the result.** Typically, the demo partners are not interested in commercializing the results or manufacture them. They participate to the project since they advise a potential benefit from the use of the developed solution and its integration in their systems or procedures. Being active part of the project, it is expected that they will have access to the results as users, at fair conditions;
5. **L – Licensing the result**. When a partner doesn't have all the competences, assets for fully exploit a result or wants to explore new areas that cannot commercially cover, an option is to license the secured IP. This means that someone else (from the consortium or not) could sign an agreement with the owner and exploit the IP;
6. **O – Other exploitation means**. Everything else, which has not been mentioned, including for example selling the IP or creating an ad-hoc company to exploit the IP (with or without other project partners).

Unique selling point. This is constituted by one or several features that differentiate the KER from currently available solutions (competitors). When we speak about an innovative solution, usually the price is not considered as (the most important) selling point. In general, the unique selling point is a specific feature that solves a customer's need or pain point that currently is not solved by the state of the art or just partially approached.

Business model. The business model represents an extended portion of the value chain around a KER. It includes at least the main suppliers and consultants needed to develop, manufacture, commercialize, deliver a product/service and the target customers: the different segments and the way to efficiently reach them. The model also identifies the stream of costs and revenues. In the case of software, the most used ones are the SAAS (software as a service), the licensing, the one-shot sell.

1.2 THE KEY EXPLOITABLE RESULTS - KERS

The KER table is designed to initially define the KERs that will be developed during the project.

Starting from the KERs initially defined in the proposal, partners have been involved in a workshop first and, at WP level in a dedicated meeting to finalize the KERs.

Initially, a total ofof 9 KERs have been identified. However, after a technical discussion during a WP3 Technical Meeting, partners agreed to merge the 2 KERS (KER 3 and KER 5) into one.

The table collects the following inputs:

- Name of KER: a self-describing title for the KER, which should be technically valid and "catchy" from a dissemination perspective
- Relevant WP(s) the number of WP where the KER is designed, developed, demonstrated, tested;
- Leading partner(s): partners who are leading the development of the KER and have (in general) the highest level of responsibility (leaders of tasks, WPs, owner of IP)
- Involved partners: all partners that work in the relevant WP(s) and have a direct link with KER's related activities

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- Key moments of the project: a list of the milestone that are directly related to an advancement stage of the KER (a task, a deliverable, a project milestone, a deadline…).

The final version of the table is here reported:

N°	Name of KER	Relevant WP(s)	Leading partner(s)	Involved partners
1	A transparent flow reactor tailored for sunlight-powered processes	WP3	CTR	SNF / TNO / DLR
2	Tailored secondary solar optics for sunlight-powered chemical processes	WP3	DLR	SNF / TNO
3 + 5	Integration knowledge and technologies about artificial and natural light sources for chemical processes - LED light source with dimmable medium to high light intensity	WP3	SNF	DLR / TNO
4	A luminescent solar concentrator (LSC) prototype demonstrated at lab scale for spectral conversion	WP3	EPFL	
6	Newly developed plasmonic nanocatalysts	WP4	UHA	TNO / ISC
7	Upscaling process for the plasmonic nanocatalysts	WP4	ISC	TNO / UHA
8	the entire SPOTLIGHT process	WP5	ALL	ALL

Table 1 - Key Exploitable Results

The project reaching M18, has recently closed a crucial phase of exploitable results refinement, as an integral part of the exploitation strategy, an update of the previously identified IP scenario has been carried out.

The results of this analysis should support partners in the development and refinement of exploitable results for the next period and after the project's end giving an overview of the potential future competitors, the target customers, the value proposition, the alternative technologies and suggestions on how to protect the generated IP. Furthermore, the analysis will provide numbers sufficient to understand how much a certain R&D sub-sector is "crowded".

1.3 EXPLOITATION METHODOLOGY

A first important aspect to consider is that the deliverable has been prepared during the first half of the project, when the design of the systems, modules and features is not yet finalized and still open to review or modifications.

A second important point is that, although some of the partners are already playing in the target market, the solution proposed by SPOTLIGHT project is very innovative and the "rules" to enter the market could differ from their experiences.

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Considering this, the initial activities of exploitation will pass through the following steps:

1. **Characterization table.** The characterization table is the first step to shape and describe the final result and, accordingly, the roles, actions and timing for partners who want to exploit it. The aim of this initial table is to explore the needs or barriers that results are going to solve or overcome, to define who are the customers and relevant segments, who are the competitors and their competitive solutions..
2. **Patent Analysis**. The patent analysis is a very powerful method to investigate the scenario around a certain product or technology. The method is widely detailed in the following chapters and willwill enable partners to have fruitful information about who is working on a certain field, what is the level of investment in a certain technology, where are located the high-potential markets;
3. **Exploitation workshops and one-to-one interviews**. An exploitation workshop was organized by RINA, involving all the participants, to introduce the tools (the tables/checklists) and a number of one-to-one interview has been defined with all involved partners, in order to discuss the data collected in the characterization table and the scenario on alternative solutions. The interviews are aimed to finalize the definition of KERs and the role of every involved partner.

1.4 THE CHARACTERIZATION TABLE

The characterization table is a Word format developed by RINA specifically for European co-funded R&D projects. The table builds on the initial templates received by RINA from the Horizon Results Booster Team, suggested to collect the most relevant data and information on KERs. In the years, RINA has more and more refined the template, making it easier to partner filling with valuable information, in a very time-efficient way. Partners have received the blank tables, prefilled with all possible relevant choices and alternatives.

The template contains the instruction about how to fill it and some “info-box”, where partners can find more details about a certain argument or question to answer.

Here a blank template with the instructions about how to fill it is reported as reference.

Name of the KER: …….	
KER Owners: ……. **KER Leader: …….** **Other owners (if any):**	
Problem /need	**Is this:** • ☐A technical need. Please detail (e.g. higher performance, longer duration, different features, different standards….) • ☐A financial/cost need. Please detail (e.g. lower CAPEX or OPEX, lower price, faster return on investment….) • ☐A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….) • ☐All of them

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	Geographical level: • ☐Local /national (please specify) • ☐Local, linked e.g. to climate zones or other specific local contexts (please specify) • ☐European • ☐Global **Does the need come from:** • ☐Private customers • ☐Business/industrial customers • ☐Public entities • Other (please specify)
Description	**What is the nature of the KER?** • ☐Significantly improved product • ☐Significantly improved service (except consulting services) • ☐Significantly improved process • ☐Significantly improved marketing method • ☐Significantly improved organisational method • ☐Consulting services • ☐New product • ☐New service (except consulting services) • ☐New process • ☐New marketing method • ☐New organisational method • ☐Other (please specify) **Please provide a brief description of the KER.** ……
Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☐It doesn't solve the full problem • ☐It is difficult to implement • ☐It is not commercially mature • ☐It is mature but not robust enough • ☐It is expensive • ☐Other (please specify) **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.**

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	A. ..... - Link: ..... **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. ..... B. ..... C. ..... **Has your company (or someone in the consortium) already developed a solution for the identified need before this project started?** • ☐Yes • ☐No **Can we say that this solution is the starting point of the current project development activities?** • ☐Yes • ☐No **If "Yes" then please specify the product or service already developed ("the starting point").** ..... **Let's compare the KER with what we already had in the consortium. What are the main advancements respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☐Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback)

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	• ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements** **Alternative solution A** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☐Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify
"Market" – *Early Adopters*	*INFOBOX: Let's start from the difference between CUSTOMER and USER.* The customer is the entity (person, company) that buys the product/service/solution. The user is the entity (person, company) that uses the product/service/solution, once bought and implemented. In order to be effectively proposed to the market, the product/service/solution must pay attention to needs and reflect expectations of both. Example 1: I buy a car: I am the customer AND the user Example 2: I buy a toy for my kids: I am the customer, my kids are the users Example 3: My company buys a new SCADA system: the procurement office is the buyer, the employees and technicians are the users

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	Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)
	
	• ☐Individuals
	• ☐Associations of individuals
	• ☐Private Small or medium enterprises
	• ☐Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☐Research and academic bodies
	• ☐Other, please specify
	
	Please name a few potential customers:
	
	1. ……..
	2. ……..
	3. ……..
	
	Who are the potential final users?
	
	• ☐Individuals
	• ☐Industry:
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Public bodies / authorities
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Research and academic bodies
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Students
	  ○ ☐Other

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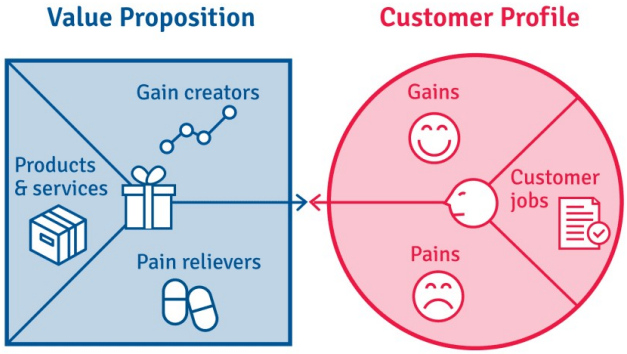
	• ☐Other, please specify
Value proposition	*INFOBOX: Let's identify the value proposed by the KER under investigation.*
Customer profile	 The potential customer can be profiled by considering: • The typical activities the customer usually performs **(Customer Jobs**) • The typical pains that the customer feels or has during these activities or that can be caused by the activity itself, if not properly managed **(Customer Pains)** • The typical gains that the customer can achieve during or thanks to these activities, if properly managed **(Customer Gains)** Let's see what's relevant for the KER under investigation: **What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. …… 2. …… 3. …… **What are the pains the customer encounters while doing the previous activities?** 1. …… 2. …… 3. …… **What are the gains the customer aims at, while doing the previous activities?** 1. …… 2. …… 3. ……

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Value proposition	**CUSTOMER JOBS:**
	
	Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:
	
	• Activity 1: ☐ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity?
	  • ☐Indispensable
	  • ☐Core, but needs to work in synergy with other components/processes
	  • ☐Complementary to a core solution
	  • ☐Nice to have

"Market" – *Target market*	**What is the primary target market?** • ☐Energy production/distribution/consumption • ☐Heavy process Industry (energy intensive) • ☐Manufacturing Industry • ☐Information Technology and telecommunication • ☐Construction • ☐Real estate management • ☐Other (please specify) **Please specify the most relevant sub-sector(s) of the KER, within the selected market:** 1. …… 2. …… 3. ……

"Market" - Competitors	**Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)**
	☐ SMEs:
	  1. ……..
	  2. ……
	☐ Large enterprises:
	  1. ……
	  2. ……..
	  3. ……
	☐ Research bodies /academic bodies:
	  1. ……
	  2. ……..
	  3. ……
	
	☐ Others:
	  1. ……

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<table>
<tr><td></td><td>2. ……..
3. ……</td></tr>
<tr><td>Go to Market – Business model</td><td>What are the relevant Business models[1] and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.
<table>
<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
<tr><td>Subscription model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Bundling model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Freemium model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Razor blades model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Product to service model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Leasing model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>ESCO - energy performance contract</td><td></td><td></td><td></td><td></td></tr>
<tr><td>ESCO - energy supply contract</td><td></td><td></td><td></td><td></td></tr>
<tr><td>ESCO - build-own-operate-transfer</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Franchise model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Distribution model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Manufacturer model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Retailer model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Peer-to-peer model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hidden revenue model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Direct sales model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Affiliate marketing model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Consulting model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Data licensing model</td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

[1] A selection of most relevant Business Models is reported in the Appendix A

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	Pay as go model				
	Software as a service				
	Product as a service				
	Other				
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** □ During the first month after the project: 1. …… 2. …… 3. …… □ Within 6 months after the project: 1. …… 2. …… 3. …… □ Within 12 months after the project: 1. …… 2. …… 3. …… □ Within 24 months after the project: 1. …… 2. …… 3. ……				

1.5 IPR TOOLS AND OBJECTIVES OF THE PATENT ANALYSIS

The patent analysis has been carried out using Patsnap, a comprehensive tool for IP research. Patsnap is a patent research and analytics platform delivering access to globally trusted patents and scientific literature. Its enhanced content, proprietary search and data intelligence technology helps IP professionals find answers to complex questions.

In today's work environment, everyone is looking for efficiency, i.e. to do more with less resources. In the field of research, this is not just a technical perspective: a company or a consortium that is investing in R&D shall have a very clear and updated idea on the international scenario, in order to properly and efficiently address the efforts and avoid infringements.

The analysis is optimized for:

- **Clarity, state-of-the-art search, right-to-use and freedom-to-operate searching**. This analysis confirms if you have the freedom to operate in a particular technology area and avoid potential risk of infringement. Thanks to the tool, we can review patents in the native languages of many countries (e.g., Germany, Japan, Korea, and China) and constantly

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run update analysis to avoid the risk of infringement. This can be achieved by reviewing published patents, applications, and nonpatent literature, and technology trends.

- **Competitive and technical intelligence searching**. The tool helps in performing strategic, technical, and competitive intelligence, with the support of an artificial intelligence.

1.5.1 Strategies for protecting IP

On the basis of the results from the patent analysis, as a conclusion for each use case the report will provide suggestions on the possible protection and exploitation strategy.

The most used protection tools are:

- **Patents**: A patent is a form of right granted by the government to an inventor or their successor-in-title, giving the owner the right to exclude others from making, using, selling, offering to sell, and importing an invention for a limited period of time, in exchange for the public disclosure of the invention. The content of a patent is generally a product or a method/process that should be new, innovative and industrially applicable. Software and algorithms cannot generally be patented (at least in the EU);
- **Copyright**: A copyright gives the creator of an original work exclusive rights to it, usually for a limited time. To enjoy copyright protection, no registration or other formality concerning software is required. Copyright protection is granted from the sole fact of the creation of the computer program.
  Copyright protection extends to any element of expression of the creativity of its author but not to the ideas behind it, procedures, methods of operation, or mathematical concepts as such.
  In other words, an algorithm is not eligible for copyright protection, because it will be considered to be of a factual nature, and therefore not an expression of the creativity of its author. Following the aforementioned, copyright will protect only the computer program in the form written by a programmer i.e. its source code. Neither the functionality of a computer program, nor the programming language nor the format of data files used in a computer program in order to exploit certain of its functions constitute a form of expression of that program, and thus these are not protected by copyright.
- **Industrial design rights:** This instrument protects the visual design of objects that are not purely utilitarian. Not really applicable for SPOTLIGHT KERs.
- **Trademarks:** A trademark is a recognizable logo, sign, design or similar which characterizes products or services of a particular trader from similar products or services of other traders. A clear example is the possibility of protecting the trademark “SPOTLIGHT”, so that all exploitable results of the project could be proposed to the market with a unique logo that further increases their positioning.
- **Industrial secrecy:** this is usually a formula, algorithm, practice, process, design, instrument, pattern, or compilation of information which is not generally known or reasonably ascertainable, by which a business can obtain an economic advantage over competitors and customers. There is no formal government protection granted. The maintenance of secrecy is left to IP owners and their processes to manage. This could be applied for example whenever we are in front of a “black box” exploitable result, which cannot be copied by third parties.

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2 IPR PRINCIPLES[2]

IPR is currently managed in SPOTLIGHT project (as in all H2020 projects) in accordance with what is declared in the Grant Agreement and in the Consortium Agreement, where partners declared their Background (expertise that they will take advantage of in the project) and Results (Foreground in H2020 - expertise and innovation that they will gain in the project and have specific intentions to exploit).

2.1 BACKGROUND

Background Information (B) means, in the context of Horizon 2020, *"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 participants prior to their accession to the EC Grant Agreement;*
- *needed for carrying out the project or for exploiting the results of the project; and*
- *identified by the participants*."

To summarize, **background includes pre - existing IP, know how, knowledge and any additional data that is needed for carrying out the project and that each partner is going to bring to the project itself**.

Before the beginning of the project all relevant background of partners was described as integral part of the SPOTLIGHT Consortium Agreement (CA). In this framework the following have been underlined by every single partner:

- The nature of the Background, its description and the staff in charge (or relevant) for it; with this approach it was clear since the beginning what IP remains the property of the participant that brings it to the project
- The Specific limitations and/or conditions for implementation;
- Specific limitations and/or conditions for Exploitation.

2.2 OWNERSHIP OF RESULTS

As explicitly defined in the Consortium Agreement, results are owned by the Party that generates them. Notwithstanding the foregoing, Parties explicitly acknowledge that in the field of organic synthesis and materials for electronic applications, materials for photovoltaic applications, basic materials for nanomaterials, materials for energy storage, battery technology, sensors, and electrical, physical and chemical characterization, UHasselt and IMEC closely work together through their associated laboratory and Results (including its share in case of joint: ownership) generated by either UHasselt or imec shall be co-owned by IMEC or UHasselt respectively and Article 8.2 applies accordingly in this event.

2.3 JOINT OWNERSHIP

Results **are jointly owned** when:

[2] https://www.iprhelpdesk.eu/node/2227

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- they have been jointly generated by two or more participants
- 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.

Usually joint ownership occurs in very specific situations, mainly for technological results.

It is best practice to regulate in the Consortium Agreement the rules on joint ownership of results. However, since this agreement is entered into force before the launch of the project and the development of the results, participants shall, if needed, establish a **separate joint ownership agreement** during the project implementation, defining practically the allocation and terms of exercising their ownership.

Unless otherwise agreed:

- each of the joint owners shall be entitled to use their jointly owned Results for non-commercial research and teaching activities on a royalty-free basis, and without requiring the prior consent of the other joint owner(s). Non-commercial research activities means use for academic/teaching/scientific purposes, or mere internal use, and
    I. excludes use in contract research (i.e. rendering a research service against payment to a customer, using the joint Result), even when the charge is mere cost reimbursement without profit;
    II. excludes use of results for royalty bearing activities (such as licensing) or other activities leading to monetary benefits (e.g. use in developing, creating or marketing a product or process or creating and providing a service or use in standardization activities);
    III. includes use in further (funded or unfunded) cooperative research projects, including the grant of non-exclusive and non-commercial license (without the right to sublicense) to third parties involved in such cooperative research project. However where such use leads to a grant of further user rights to others (e.g. project partners) for royalty-bearing or other activities leading to monetary benefits, such further user rights shall not be included in the category of non-commercial research activities under this bullet point; and
- each of the joint owners shall be entitled to otherwise Exploit the jointly owned Results and to grant non-exclusive licenses to third parties (other than those granted under the above paragraph iii) (without any right to sub-license) as they see fit without owing the other joint owner(s) any compensation or requiring the consent of the other joint owner(s) if the other joint owners are given at least 45 calendar days advance notice; and
- each joint owner of intellectual property rights protecting such jointly owned Result shall have the right to bring an action for infringement of any such jointly owned intellectual property rights only with the consent of the other joint owner(s). Such consent may only be withheld by another joint owner who demonstrates that the proposed infringement action would be prejudicial to its legitimate interests.

2.3.1 Transfer of foreground

Transferring the ownership of their results to other partners is a possibility for those participating in Horizon 2020. However, it is fundamental that, **whenever transferring the ownership of their results, participants follow the requirements established in the Grant Agreement**:

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- Each Party may transfer ownership of its own Results, including its share in the jointly owned Results, following the procedures of the Grant Agreement Article 30.
- Each Party may identify specific third parties it intends to transfer the ownership of its Results to in Attachment (3) to the Consortium Agreement. The other Parties hereby waive their right to prior notice and their right to object to a transfer to listed third parties according to the Grant Agreement Article 30.1.;
- The transferring Party shall, however, at the time of the transfer, inform the other Parties of such transfer and shall ensure that the rights of the other Parties will not be affected by such transfer. Any addition to Attachment (3) after signature of this Consortium Agreement requires a decision of the General Assembly.
- The Parties recognize that in the framework of a merger or an acquisition of an important part of its assets, it may be impossible under applicable EU and national laws on mergers and acquisitions for a Party to give the full 45 calendar days prior notice for the transfer as foreseen in the Grant Agreement.
- The obligations above apply only for as long as other Parties still have - or still may request - Access Rights to the Results.

2.4 THE PATENT ANALYSIS

The patent analysis has been carried on PATSNAP (https://home.patsnap.com/#/) Innovation, a comprehensive tool for IP research. PATSNAP is a patent research and analytics platform delivering access to globally trusted patents and scientific literature. Its enhanced content, proprietary search and data intelligence technology helps IP professionals find answers to complex questions.

In today's work environment, everyone is looking for efficiency, i.d. to do more with less resources. In the field of research, this is not just a technical perspective: a company or a consortium that is investing in R&D shall have a very clear and updated idea on the international scenario, in order to properly and efficiently address the efforts and avoid infringements.

Once identified and fully refined a search string for the patent analysis, the database provides a number of results that – in this phase of exploitation – could be very high. For this reason, rather than a one-to-one analysis of results, the report will provide charts and figures about the scenario, useful to address the exploitation challenges of the project.

2.4.1 Patenting trend

The trend of patenting is the first figure that will be shown for each analysis, providing the number of patents submitted every year, usually in the last 5 to 10 years. This chart gives several important information on the technology/sector we are investigating. First, the number of patents is related to the global interest and industrial commitment to develop new IP in a certain field. The second very important information is related to the s-shaped Innovation Curve:

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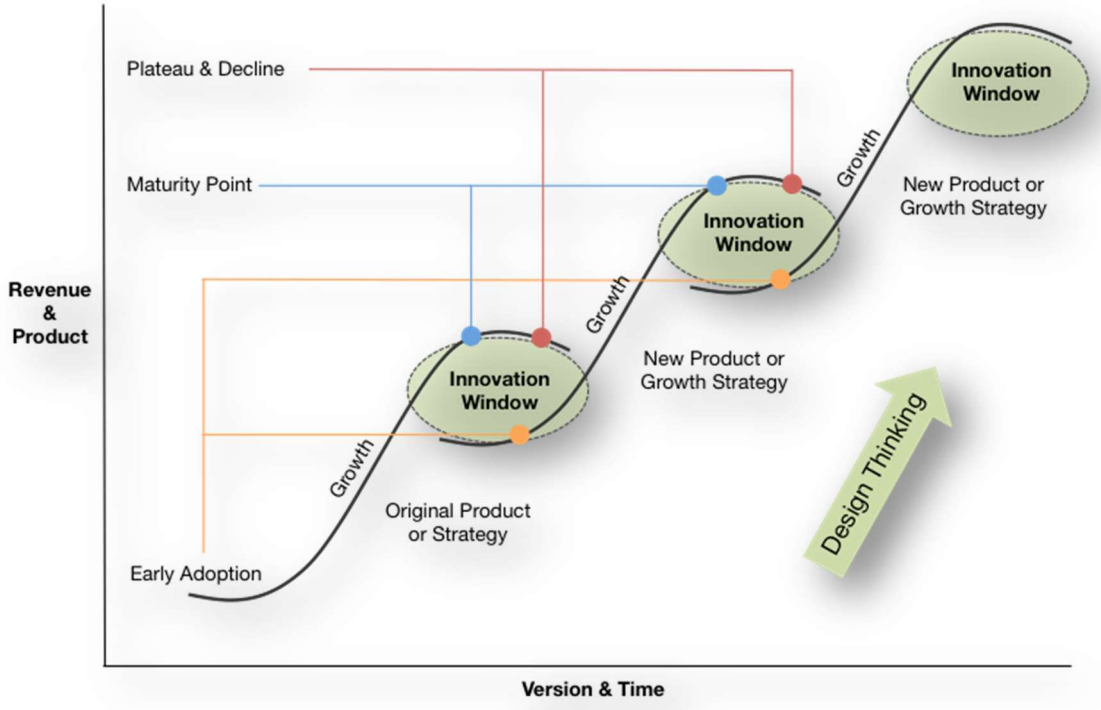

Figure 1 S-Shaped Innovation Curve

In the chart, the "version" of a technology is linked to revenues and products derived from it. In the patenting trend chart, a similar relationship exists between time (x-Axis, years) and the number of submitted patents (Y-Axis). Given the shape of the trend, it is possible to argue about the status (infancy, growth, maturity, obsolescence) of a technology.

Moreover, peaks and drops of the trend will reveal particular situations that positively or negatively affected R&D, such as key enabling patents, new policies, key players entrance, economic crisis, drop of the market etc.

2.4.2 IPC and key areas of research

An important information of a patent is the IPC (International Patent Classification) code. This code reveals the technology cluster the patent belongs to and can be explored digit by digit until the necessary level of information is reached. Thanks to the analysis of IPCs, it is possible to understand which are the most active subdomain of research, addressed globally.

A parallel analysis can be performed by looking at the recurrent keywords (e.g. in the title and abstract of the patents) and clustering the found patents according to them.

As per the full dataset, a temporal trend can be provided for every single cluster of patents, in order to check which ones are growing, which ones are being abandoned and the ones which are emerging.

2.4.3 Assignee and dead/alive patents

The applicant (assignee) is the subject who owns the IP generated and described in a patent. For each use case, a chart with the main applicant will be provided, in order to understand who has

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developed the international know-how and get some insight about the involvement of large enterprises, small companies, universities etc.

A significant figure is that of dead/alive patents. A patent is considered “alive” when the assignee goes on paying the fees to maintain it every year (up to 20 years) and/or the related research is still proceeding, e.g. with patent review, improvements and new submission. Otherwise the patent is considered as “dead”. Given the costs behind it, an alive patent implies that the assignee has interest in maintaining it, for example because it is already commercialized, licensed or there is a clear business plan for it. In other words, when a patent is submitted, granted and alive, most probably a real market has been, is being or will be established.

2.4.4 Geographic areas and markets

Despite the nationality or geographic location of the assignee, a patent can be submitted in one specific or several countries (national patent), in a continent (as in the case of EU patents) or worldwide. This reveal the geographic coverage of patents, i.e. the countries where the protected IP can be “used” (commercialized, licensed, sold…). In the charts, the top countries/geographic areas of coverage will be shown. If we also consider the previous concept of dead/alive patents, it is possible to understand which are actually the key markets of the secured IP. As an example, a new technology can be protected in Europe, USA, China, India; after a few years of commercialization, economic results are good only in the European and American markets: accordingly, the assignee could decide to maintain alive the patents in the USA and EU while leaving the rights (and related maintenance costs) in China and India. Thanks to this analysis, that could show very different results from the initial geographic coverage of a patent, it is possible to understand which market is more attracted by the already developed IPs and address the future choices on coverage of the new ones.

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3 KER 1 – A TRANSPARENT FLOW REACTOR TAILORED FOR SUNLIGHT-POWERED PROCESSES

3.1 CHARACTERIZATION TABLE

Name of the KER: A transparent flow reactor tailored for sunlight-powered Sabatier process	
KER Owners: Chemtrix **KER Leader: Chemtrix**	
Problem /need	**Is this:** • ☐A technical need. Please detail (e.g. higher performance, longer duration, different features, different standards….) **Higher performance respect to the state of the art is necessary** • ☐A financial/cost need. Please detail (e.g. lower CAPEX or OPEX, lower price, faster return on investment….) **OPEX is expected to be lower in the future** • ☐A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….) **Today the use of solar energy is not efficient** • ☒All of them **Geographical level:** • ☐Local /national (please specify) • ☒Local, linked e.g. to climate zones or other specific local contexts (please specify) **The solution is more effective/attractive where solar power is more available** • ☐European • ☐Global **Does the need come from:** • ☐Private customers • ☒Business/industrial customers • ☐Public entities • Other (please specify)
Description	**What is the nature of the KER?** • ☐Significantly improved product • ☐Significantly improved service (except consulting services) • ☐Significantly improved process • ☐Significantly improved marketing method • ☐Significantly improved organisational method

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	• ☐Consulting services • ☒New product • ☐New service (except consulting services) • ☐New process • ☐New marketing method • ☐New organisational method • ☐Other (please specify) **Please provide a brief description of the KER.** The KER is a transparent flow reactor tailored for sunlight-powered Sabatier process
Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☒It doesn't solve the full problem • ☐It is difficult to implement • ☐It is not commercially mature • ☐It is mature but not robust enough • ☒It is expensive • ☐Other (please specify) **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.** A. Creaflow flowreactor - Link: https://www.creaflow.be/system/files/pharmachem_creaflow_article.pdf **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. The combined level of temperature and pressure is not as high as necessary **Has your company (or someone in the consortium) already developed a solution for the identified need before this project started?** • ☒Yes • ☐No **Can we say that this solution is the starting point of the current project development activities?** • ☒Yes • ☐No **If "Yes" then please specify the product or service already developed ("the starting point").**

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	Interreg Lumen project, where some of the partners (TNO, UHA) developed a micro flow reactor to characterize the catalyst (now from an artificial AM1.5 solar simulator to sunlight) **Let's compare the KER with what we already had in the consortium. What are the main advancements respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☒Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☒Improved technical performances (please specify) • ☒Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☒Improved user friendliness • ☐Improved connectivity • ☒Remote operability • ☐Improved interoperability • ☒Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☒Improved environmental impact • ☒New business model (e.g. for self-payback) • ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements** **Alternative solution A** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☒Improved flexibility for diverse applications • ☒Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety

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	• ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☒Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)**
	
	• ☐Individuals
	• ☐Associations of individuals
	• ☒Private Small or medium enterprises
	• ☒Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☒Research and academic bodies
	• ☐Other, please specify
	Please name a few potential customers:
	
	1. Chemical company using local feedstock as source for energy
	
	Who are the potential final users?
	
	• ☐Individuals
	• ☐Industry:
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile
	  ○ ☒One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Public bodies / authorities
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Research and academic bodies
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile

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	○ ☒One specific department/team ○ ☒Students ○ ☐Other • ☐Other, please specify
Value proposition **Customer profile**	Let's see what's relevant for the KER under investigation: **What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. Generation of energy 2. Use of feedstock 3. Carbon capture/use of waste **What are the pains the customer encounters while doing the previous activities?** 1. High costs, especially OPEX 2. Not clear alternatives **What are the gains the customer aims at, while doing the previous activities?** 1. Earn from energy selling 2. Improve its sustainability profile 3. Reduce waste costs 4. Improve circularity

Value proposition	**CUSTOMER JOBS:**
	
	Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:
	
	• Activity 1: ☒ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity?
	  • ☐Indispensable
	  • ☒Core, but needs to work in synergy with other components/processes
	  • ☒Complementary to a core solution
	  • ☐Nice to have

"Market" – *Target market*	**What is the primary target market?** • ☒Energy production/distribution/consumption • ☒Heavy process Industry (energy intensive) • ☒Manufacturing Industry • ☐Information Technology and telecommunication • ☐Construction • ☐Real estate management • ☐Other (please specify) **Please specify the most relevant sub-sector(s) of the KER, within the selected market:** Chemical industry

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<table>
<tr><td></td><td></td></tr>
<tr><td>"Market" - Competitors</td><td>Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)
☐ SMEs:
1. Creaflow
☐ Large enterprises:
1. ……
☐ Research bodies /academic bodies:
1. ……
☐ Others:
1. ……</td></tr>
<tr><td>Go to Market – Business model</td><td>What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.
<table>
<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
<tr><td>Subscription model</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>Bundling model</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>Freemium model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Razor blades model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Product to service model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Leasing model</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>ESCO - energy performance contract</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>ESCO - energy supply contract</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>ESCO - build-own-operate-transfer</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>Franchise model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Distribution model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Manufacturer model</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>Retailer model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Peer-to-peer model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hidden revenue model</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Direct sales model</td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

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	Affiliate marketing model					
	Consulting model					
	Data licensing model					
	Pay as go model		X			
	Software as a service					
	Product as a service					
	Other					
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** □ During the first month after the project: 1. Identify the actual TRL (not predictable so far) □ Within 6 months after the project: 1. Execute market survey for better identify needs and customers □ Within 12 months after the project: 1. Improved prototype to TRL9 □ Within 24 months after the project: 1. TRL9 fully confirmed 2. Create the structure for selling the product					

3.2 PATENT ANALYSIS

The preliminary patent analysis built on a search string that included the keywords “transparent”, “reactor”, “sunlight” and “Sabatier”. The keywords were searched in all text fields (title, abstract, claims) within the patents submitted in the last decade (from 2012 on).

In total 35 entries have been found, belonging to 10 INPADOC families. Given the limited number of records, it is not significant to run statistical analysis of the dataset, rather it is relevant to highlight the titles of most relevant patents and the assignees, in order to go further in the benchmark analysis for KER1.

Publication number	Date	Title	Assignee	Status	Level of relevance
US20210310117A1	07 Oct 2021	Methods and systems for producing structured carbon materials in a microgravity environment	CEMVITA FACTORY, INC.	Examining	Medium

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Publication number	Date	Title	Assignee	Status	Level of relevance
WO2020039205A1	27 Feb 2020	Photocatalytic generation of hydrogen	CHIVERTON, RICHARD ARTHUR	Non-Entry PCT-NP	Medium
US9999870B2	19 Jun 2018	Nanostructured solar selective catalytic supports	THE GOVERNING COUNCIL OF THE UNIVERSITY OF TORONTO	Granted	High
US20120234668A1	20 Sep 2012	Systems and methods of generating energy from solar radiation using photocatalytic particles	COMBINED POWER COOPERATIVE	Withdrawn	Medium
US20160194766A1	07 Jul 2016	Methods and devices for the production of hydrocarbons from carbon and hydrogen sources	PRINCIPLE ENERGY SOLUTIONS, INC.	Withdrawn	High
US9557057B2	31 Jan 2017	Reliable carbon-neutral power generation system	LUTZ, DALE ROBERT	Non-payment	Medium

Table 2 - List of relevant patents

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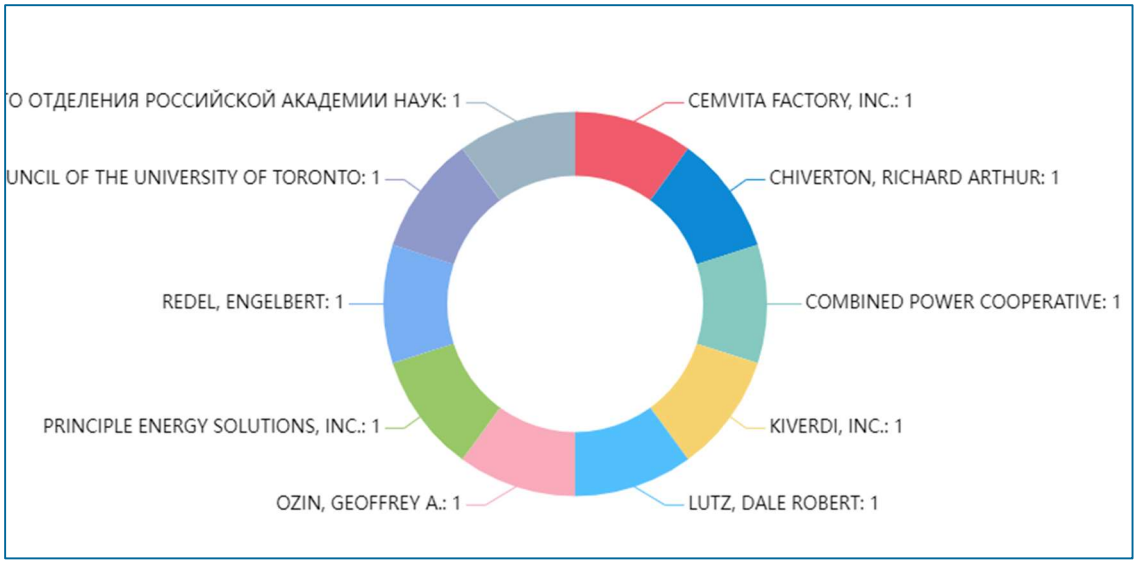

Figure 2 - Top applicants

3.3 PRELIMINARY CONCLUSIONS ON IP MANAGEMENT

This IP is strictly related to a Chemtrix's declared background. The owner is Chemtrix. Joint ownership of IP may be expected, since other consortium partners make key contributions to the design of the reactor, e.g. TNO and EPFL. Furthermore, parts related to the coupling of the reactor to other essential components of SPOTLIGHT's photonic device may be fully owned by other consortium partners, e.g. SNF, DLR.

A discussion with Chemtrix and other related partners about a possible patenting is on-going. However, the initial conclusion is that, according to Chemtrix, the reactor itself is not to be patented, rather the whole SPOTLIGHT system, to better protect and defend the IPR.

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4 KER 2 – TAILORED SECONDARY SOLAR OPTICS FOR SUNLIGHT-POWERED CHEMICAL PROCESSES

4.1.1 Characterization table

Name of the KER: Tailored secondary solar optics for sunlight-powered chemical processes	
KER Involved partners: SNF **Development Leader(s): DLR**	
Problem /need	**Is this:** X A technical need. It is necessary to provide a flat irradiation profile on the reactor in order to allow efficient and safe operation. The secondary optics have to be developed for combined LED+solar operation ☐ A financial/cost need ☐ A sustainability need ☐ All of them **Geographical level:** ☐ Local /national ☐ Local, linked e.g. to climate zones or other specific local contexts (please specify) ☐ European X Global **Does the need come from:** ☐ Private customers X Business/industrial customers ☐ Public entities X Other (please specify). Research institute
Alternative solution	**Probably, there's already a solution to the problem but:** ☐ It doesn't solve the full problem X It is difficult to implement ☐ It is not commercially mature ☐ It is mature but not robust enough ☐ It is expensive

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	X Other (please specify) Optics are very customized on technical needs, including radiation and application. Also, the current size of similar products is difficult to adapt. **Has your company (or someone in the consortium) already developed a solution that was selected as a basis to build the project?** X Yes ☐ No If "Yes" then please specify the product or service already developed (the "starting point"). Flux guide – developed from a previous R&D project. Customized on different demands. **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as project solution? If possible, please copy a link to a reference website for further information.** It is not easy to identify a kind of "competitive solution" as we are speaking about a research component that is fully customized on a specific application. Other research institutes are working on other means to shape the radiation, for other purposes. **Can you say at least one strength and one weakness of the new developed solution?** • Strength……the new product is very tailored for SPOTLIGHT components. Very good performances for SPOTLIGHT application (optimized for it). Optimized for LED as well. • Weakness: very sensitive to geometric changes. Limited for a specific concentrator (very low flexibility)
Description	**We could describe the KER as a:** X Significantly improved product ☐ Significantly improved service (except consulting services) ☐ Significantly improved process ☐ Significantly improved marketing method ☐ Significantly improved organisational method ☐ New or advanced consulting service ☐ New or advanced scientific content ☐ New product ☐ New service (except consulting services) ☐ New process ☐ New marketing method ☐ New organisational method ☐ Other (please specify)

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	Which are the main advancements respect to the "starting point" (the initial solution available in the consortium)? ☐ Decreased production (manufacturing) time ☐ Decreased production (manufacturing) costs ☐ Increased lifetime and or robustness ☐ Improved flexibility for diverse applications X Improved technical performances (please specify) ☐ X Improved design, size, weight, efficiency, materials ☐ New features ☐ Improved customizability ☐ Improved user friendliness ☐ Improved connectivity ☐ Remote operability ☐ Improved interoperability X Improved safety (avoid hot spots) ☐ Improved logistics, distribution ☐ Improved construction/installing phase ☐ Improved maintenance plan ☐ Improved environmental impact ☐ New business model (e.g. for self-payback) ☐ Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers?**
	
	• Individuals
	• Associations of individuals
	X Private Small or medium enterprises (asking for consulting/ testing)
	X Private Large enterprises (asking for consulting/ testing)
	• Non-profit organizations
	• Public bodies / authorities
	X Research and academic bodies, to share knowledge and developed prototypes for further research initiatives
	
	• Other, please specify
	Who are the potential final users?
	
	• Individuals
	• Industry:
	  ○ One or several managers
	  ○ One specific profile
	  ○ One specific department/team
	  ○ Individuals
	  ○ Other
	• Non-profit organizations
	  ○ One or several managers
	  ○ One specific profile
	  ○ One specific department/team
	  ○ Individuals
	  ○ Other

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	• Public bodies / authorities
	  ○ One or several managers
	  ○ One specific profile
	  ○ One specific department/team
	  ○ Individuals
	  ○ Other
	• Research and academic bodies
	  ○ One or several directors
	  ○ One specific profile
	  X One specific department/team
	  ○ Individuals
	  ○ Other
	• Other, please specify

Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where a new solution would be needed?** 1. Chemical applications, relying on concentrated sunlight with flat irradiation profile on active surface 2. Customers interested in investigating stability of materials, to check resistance against solar cycles. **What are the pains the customers encounters while doing the previous activities?** 1. Customization of the optics is of very high importance; customers will look for someone that knows how to tailor this component onto their applications 2. The radiation spectrum is important. For some sapplication it is crucial to set the right length (e.g. space). The KER is as close as possible to the demand. Not fully foreseen this development in SPOTLIGHT but potential for the future. **What are the gains the customer aims at, while doing the previous activities?** 1. The active area decreases and the customer saves money 2. Investigations could develop more knowledge on materials, increased safety and knowledge on further potential applications of materials

Value proposition	**You introduced some activity the customer performs, where the KER can be potentially integrated. Please confirm how much relevant the solution is:**
	
	• YES/NO and respect to the activity, the solution is
	  • Indispensable
	  X Core, but needs to work in synergy with other components/processes (wWith the solar furnace)
	  • Complementary to a core solution
	  • Nice to have

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"Market" – *Target market*	**What is the primary target market?** X Energy production/distribution/consumption • Heavy process Industry (energy intensive) X Manufacturing Industry • Information Technology and telecommunication • Construction • Real estate management **Please specify the sub-sector of the proposed solution:** 1. Solar fuels / sustainable fuels 2. Special materials
"Market" - Competitors	Please make a list of the competitors working in the same field (the manufacturers / providers of the alternative solutions previously mentioned + any others you would like to mention) X Research bodies / academic bodies:
Go to Market – Business model	What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document. DLR is not directly going to sell (commercial activity) the component. The component (including the furnace) can be rented for tests. Other applications will need a further development /customization and this will be paid as consulting activity.
Go to Market - Timing	**Please set the TRL the KER will reach at the end of the project:** • TRL (1-9) = 6 for industry. For research it can be assumed as 9, because the process will be ready to be proposed to other research institutes. **Please select the technical activities towards TRL 9 that most probably should be planned after the end of the project:** ☐ X Select the pilot customers for TRL 9 tests ☐ X Test the solution at TRL 9, in real operational environment (pilot) ☐ Build or finalize manufacturing processes and lines ☐ Build or finalize procedures for: o Quality control o HSE o Further testing o Involvement of third parties o Other ☐ X Prepare the technical manual ☐ Prepare the operation and maintenance procedures and plans ☐ Finalize pre-production tests ☐ Other

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4.1.2 Patent analysis

The patent analysis showed a quite large number of patents, screened by the query. The query was built around the keywords “secondary optics”, “Sunlight” and “chemical processes” and then refined through IPC and dates (last decade).

A total of +3100 patents and +700 INPADOC families were found. So the query was further refined including the keywords “sabatier or hydrocarb* or methan*”, in order to screen only those results that they have to do with the SPOTLIGHT reactions. With this refinement, 1424 total entries and 412 families have been screened.

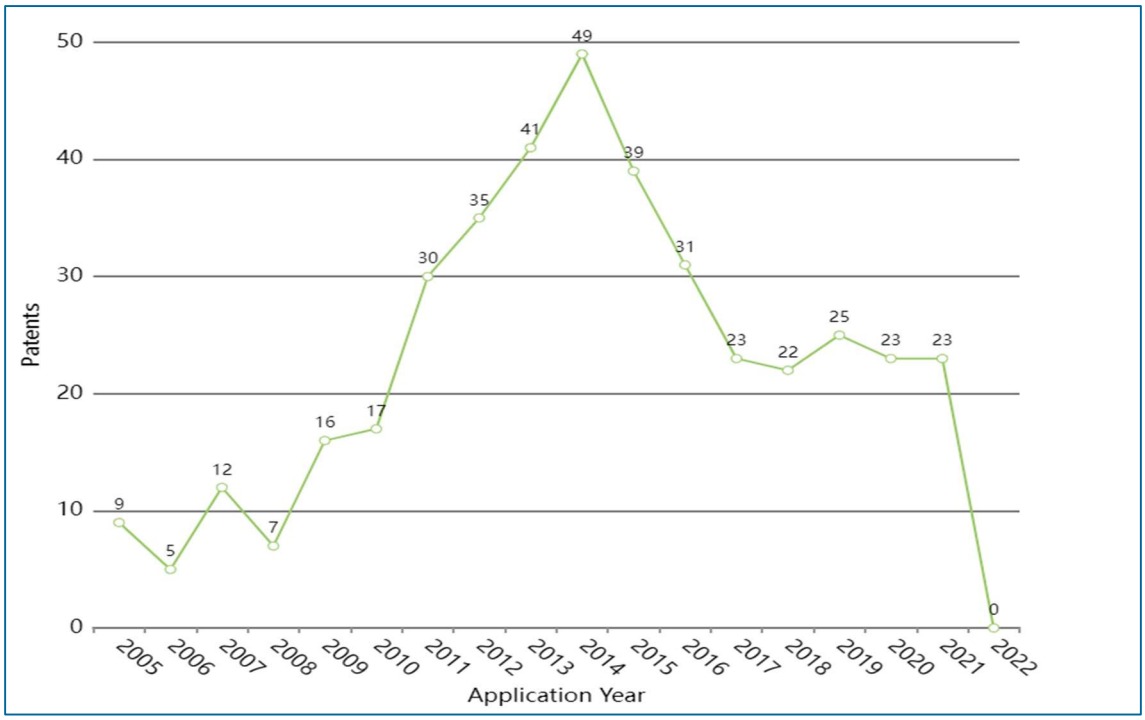

Figure 3 - Patenting trend

This project has received funding from the Photonics Public Private Partnership programme under Grant Agreement **No.101015960**

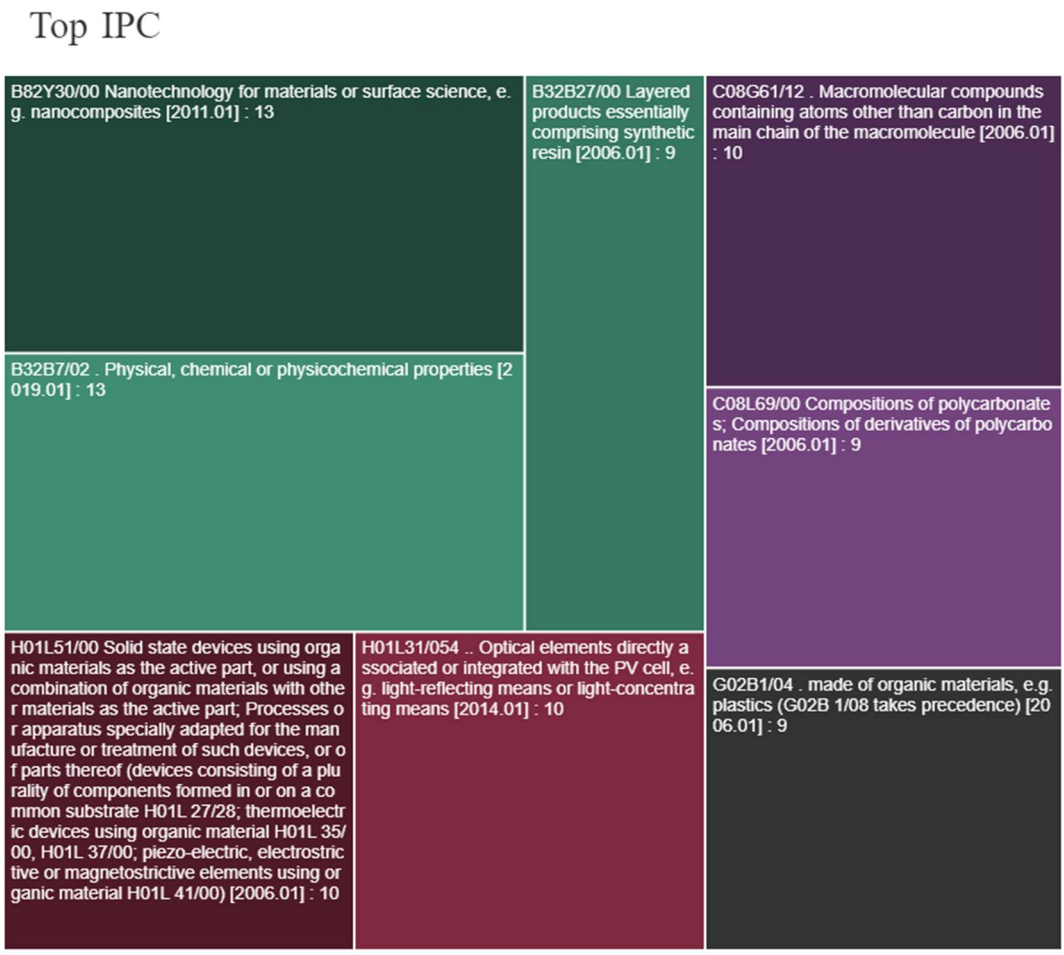

Figure 4 Top IPC

This project has received funding from the Photonics Public Private Partnership programme under Grant Agreement **No.101015960**

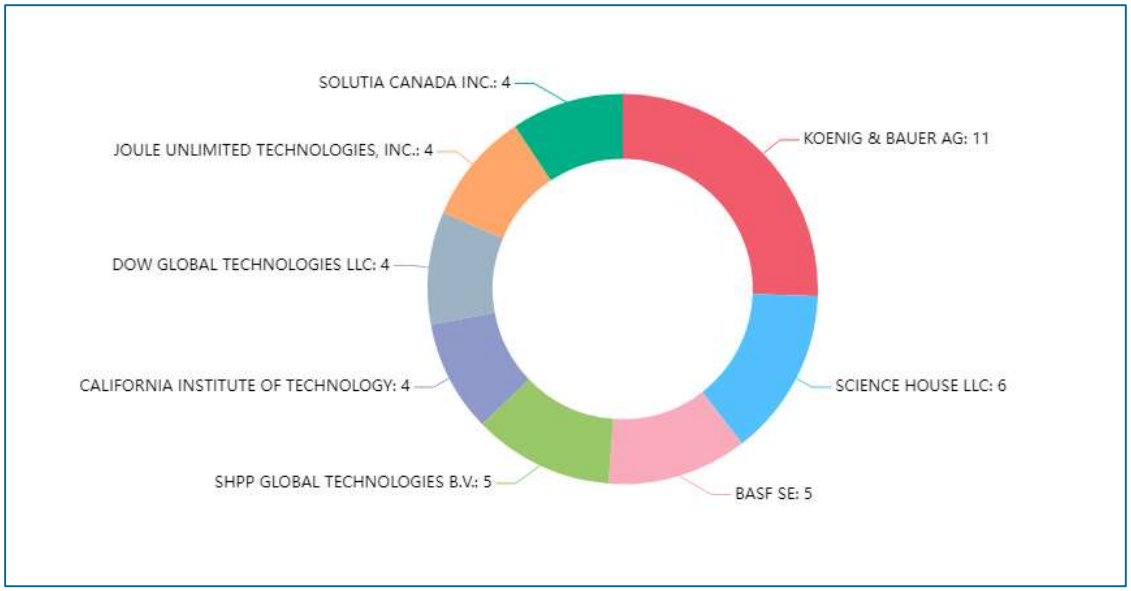

Figure 5 - Top applicants

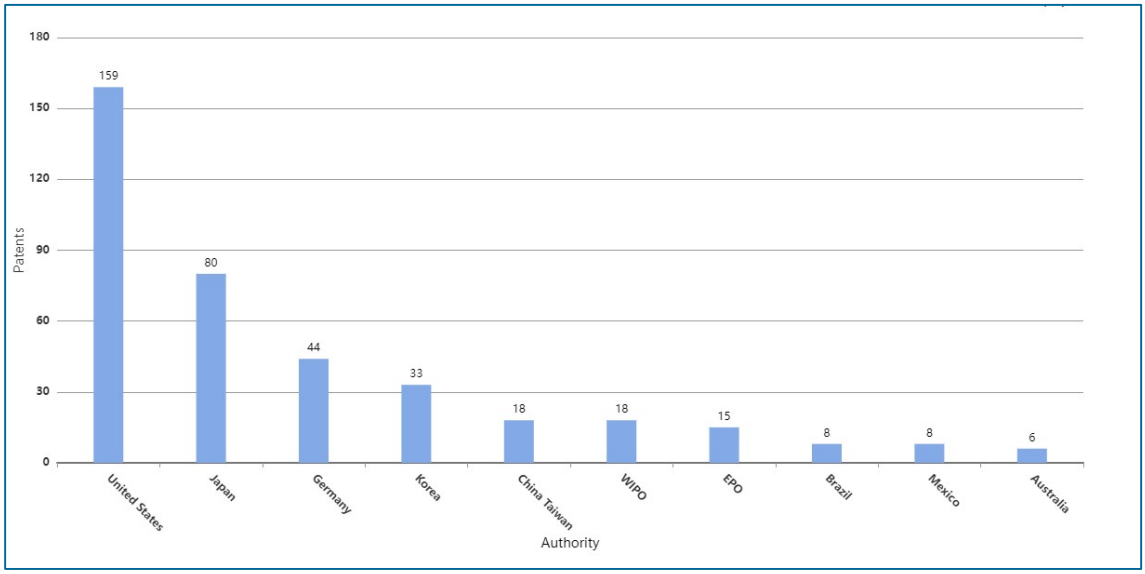

Figure 6 - Top countries

From the analysis, it emerges that the field of research, after an interesting peak in 2013-2014 is now in a stable trend of 20-25 patens/year. This is a niche sector, with good potential for securing new IP. Applicants are in general very focused companies, rather than large multinationals and this allows an easier entry strategy for smaller partners. USA and Japan are the countries where most IP is developed. However, Europe follows with a clear leadership of German applicants.

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4.1.3 Preliminary conclusions on IP management

There is room for a possible patent application. However, the discussion with DLR has not been finalized yet. The main reason is that so far, the technology development is still on-going and it could be too early to take a final decision about the IP protection strategy. More details on the final result will allow DLR taking the correct decision. Patenting remains an option, while the preparation of a scientific article on the result is already planned. This shall be managed in order not to overlap or limit the possible patent application.

4.2 KER 3 + 5 – INTEGRATION KNOWLEDGE AND TECHNOLOGIES ABOUT ARTIFICIAL AND NATURAL LIGHT SOURCES FOR CHEMICAL PROCESSES

4.2.1 Characterization table

Name of the KER: Dimmable LED light source with medium to high light intensity for chemical processes, based on knowledge and technology applicable for artificial and natural light sources.	
KER Owners: SIGNIFY **KER Leader: SIGNIFY**	
Problem /need	**Is this:** • ☒A technical need. Please detail (e.g. higher performance, longer duration, different features, different standards….) : **higher performance requested to the LED source** • ☐A financial/cost need. Please detail (e.g. lower CAPEX or OPEX, lower price, faster return on investment….) • ☒A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….): **there are expectations of a lower power consumption and higher recyclability, to further decrease the overall life cycle impact of the process** • ☐All of them **Geographical level:** • ☐Local /national (please specify) • ☐Local, linked e.g. to climate zones or other specific local contexts (please specify) **The solution is more effective/attractive where solar power is more available** • ☐European • ☒Global **Does the need come from:** • ☐Private customers • ☐Business/industrial customers

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	• ☐Public entities • Other (please specify): **research institute**
Description	**What is the nature of the KER?** • ☐Significantly improved product • ☐Significantly improved service (except consulting services) • ☐Significantly improved process • ☐Significantly improved marketing method • ☐Significantly improved organisational method • ☐Consulting services • ☒New product • ☐New service (except consulting services) • ☐New process • ☐New marketing method • ☐New organisational method • ☐Other (please specify) **Please provide a brief description of the KER.** New building blocks to realize the product (new technologies)
Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☐It doesn't solve the full problem • ☐It is difficult to implement • ☐It is not commercially mature • ☐It is mature but not robust enough • ☐It is expensive • ☒Other (please specify); **in general the available solutions in the market suffer from a low efficiency as well as from low output, in particular considering the overall chemical process they are integrated in** **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.** A. ……discharge tubes… - Link: MASTER LEDspot PAR B. ……parlamps…… - Link: HPL-N 400W **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. Low power, low efficiency B. low efficiency not sustainable

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	Has your company (or someone in the consortium) already developed a solution for the identified need before this project started? • ☒Yes • ☐No **Can we say that this solution is the starting point of the current project development activities?** • ☒Yes • ☐No **If "Yes" then please specify the product or service already developed ("the starting point").** Signify developed a wide range of general light sources, which are not currently tailored for this specific application. These sources can be considered as the starting point for the further development/tailoring. **Let's compare the KER with what we already had in the consortium. What are the main advancements respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☒Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☒Improved technical performances (please specify); high power • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☒Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements**

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	Alternative solution A • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☒Improved technical performances (please specify): higher performance, high efficiency • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)**
	• ☐Individuals
	• ☐Associations of individuals
	• ☐Private Small or medium enterprises
	• ☒Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☒Research and academic bodies
	• ☐Other, please specify
	Please name a few potential customers:
	1. Chemical company using local feedstock as source for energy
	Who are the potential final users?
	• ☐Individuals
	• ☒Industry:
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations

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	○ ☐One or several managers ○ ☐One specific technical profile ○ ☐One specific department/team ○ ☐Individuals ○ ☐Other • ☐Public bodies / authorities ○ ☐One or several managers ○ ☐One specific technical profile ○ ☐One specific department/team ○ ☐Individuals ○ ☐Other • ☒Research and academic bodies ○ ☐One or several managers ○ ☐One specific technical profile ○ ☐One specific department/team ○ ☐Students ○ ☐Other • ☐Other, please specify
Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. Power generation **What are the pains the customer encounters while doing the previous activities?** 1. non-sustainable energy generation **What are the gains the customer aims at, while doing the previous activities?** 3. …higher sustainability…….. 4. ……higher performance…….. 5. ……Long term continuous operation: lifetime…..
Value proposition	**CUSTOMER JOBS:** **Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:** • Activity 1: ☒ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity? • ☐Indispensable • ☐Core, but needs to work in synergy with other components/processes • ☒Complementary to a core solution • ☐Nice to have
"Market" – *Target market*	**What is the primary target market?** • ☒Energy production/distribution/consumption

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<table>
<tr><td></td><td>

- ☐Heavy process Industry (energy intensive)
- ☐Manufacturing Industry
- ☐Information Technology and telecommunication
- ☐Construction
- ☐Real estate management
- ☐Other (please specify)

Please specify the most relevant sub-sector(s) of the KER, within the selected market:

Chemical industry
</td></tr>
<tr><td>"Market" - Competitors</td><td>Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)
Not aware at this stage of the project</td></tr>
<tr><td>n</td><td>What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.
<table>
<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
<tr><td>Subscription model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Bundling model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Freemium model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Razor blades model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Product to service model</td><td></td><td></td><td>x</td><td></td></tr>
<tr><td>Leasing model</td><td></td><td>x</td><td></td><td></td></tr>
<tr><td>ESCO - energy performance contract</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>ESCO - energy supply contract</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>ESCO - build-own-operate-transfer</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Franchise model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Distribution model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Manufacturer model</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Retailer model</td><td>x</td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

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	Peer-to-peer model	x			
	Hidden revenue model	x			
	Direct sales model	x			
	Affiliate marketing model	x			
	Consulting model	x			
	Data licensing model	x			
	Pay as go model	x			
	Software as a service	x			
	Product as a service	x			
	Other	x			
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** □ During the first month after the project: 1. …landscape of innovation / application area… 2. …initiate business development… □ Within 6 months after the project: 1. … value proposition …… □ Within 12 months after the project: 1. ……building a protype…… □ Within 24 months after the project: 1. …validation of the proposition…… 2.				

4.2.2 Patent analysis

The patent analysis found almost 700 patents, clustered in 210 families. The query was built around the keywords “artificial light or LED” and again screened with the keyword “Sabatier reaction”

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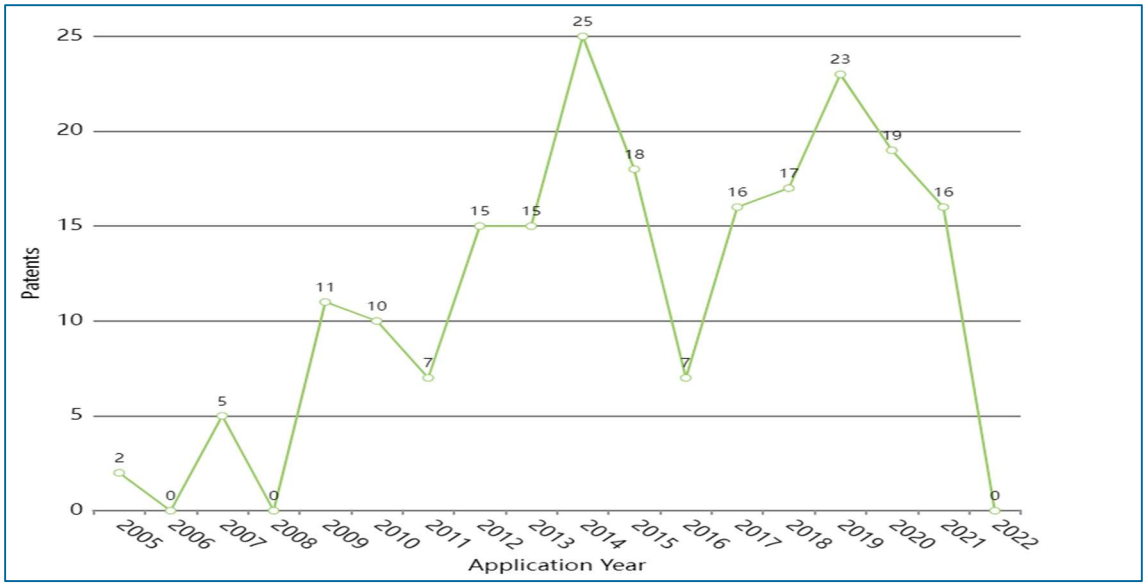

Figure 7 Patenting trend

Figure 8 Top IPC

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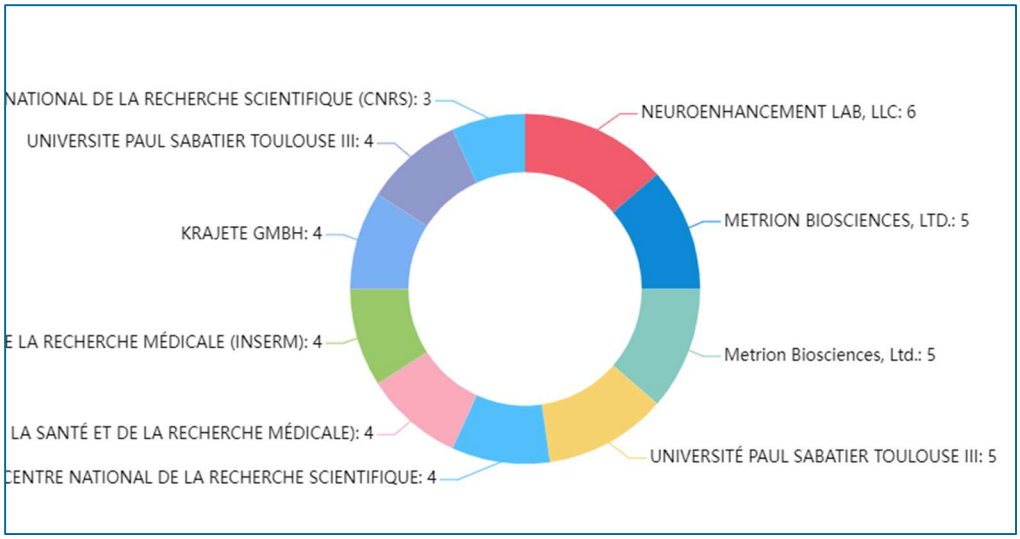

Figure 9 - top Applicants

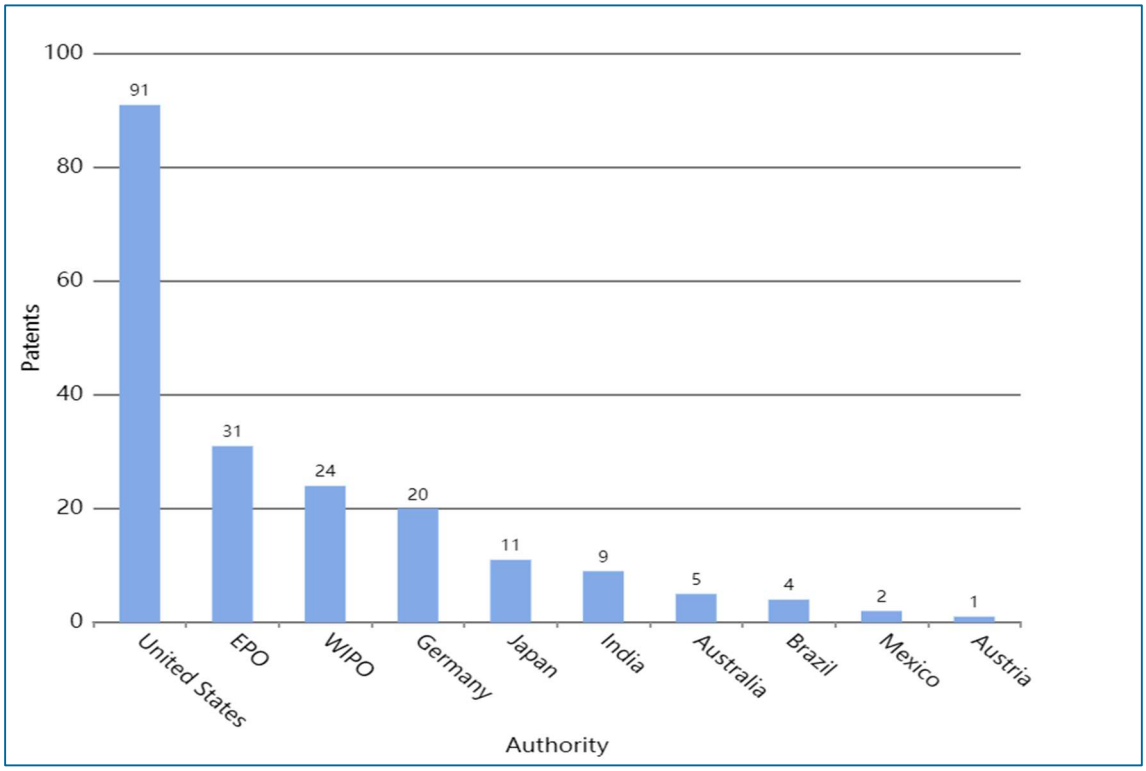

Figure 10 - Top countries

The sector is an important one, especially when screened with “Sabatier reaction” keyword. A good trend of patenting (around 20/years) shows an industrial commitment to new findings. The USA leads the global research. However, Europe is following in the second place, confirming the clear interest of the continent in the technology.

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4.2.3 Preliminary conclusions on IP management

The sector is widely explored by companies that aim at protecting knowledge with patents. From the preliminary screening and clearance search, it seems that the KER is not likely to be patented: the efforts are mostly aimed at understanding better the specific strategies for optimization and tailoring of existing artificial light and LED solutions, rather than developing new ones. It is possible to publish a scientific article to disseminate the results of this optimization process.

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4.3 KER 4 – A LUMINESCENT SOLAR CONCENTRATOR (LSC) PROTOTYPE DEMONSTRATED AT LAB SCALE FOR SPECTRAL CONVERSION

4.3.1 Characterization table

Name of the KER: A luminescent solar concentrator (LSC) prototype demonstrated at lab scale for spectral conversion	
KER Owners: EPFL **KER Leader: EPFL** **Other owners (if any):**	
Problem /need	**Is this:** • ☒A technical need. Please detail (e.g. higher performance, longer duration, different features, different standards….): **the sector is looking for a better spectral fit** • ☐A financial/cost need. Please detail (e.g. lower CAPEX or OPEX, lower price, faster return on investment.….) • ☐A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….) • ☐All of them **Geographical level:** • ☐Local /national (please specify) • ☐Local, linked e.g. to climate zones or other specific local contexts (please specify) The solution is more effective/attractive where solar power is more available • ☐European • ☒Global **Does the need come from:** • ☐Private customers • ☒Business/industrial customers • ☐Public entities • ☐ Other (please specify)
Description	**What is the nature of the KER?** • ☐Significantly improved product • ☐Significantly improved service (except consulting services) • ☐Significantly improved process • ☐Significantly improved marketing method

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	• ☐Significantly improved organisational method • ☐Consulting services • ☐New product • ☐New service (except consulting services) • ☒New process • ☒New marketing method • ☐New organisational method • ☐Other (please specify) **Please provide a brief description of the KER.** Different from the FG that is aimed at achieving homogeneous irradiation, the LSC developed herein is more focused on spectral conversion that is likely to provide better spectral fit between the incident light source and the catalyst absorption.
Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☒It doesn't solve the full problem • ☐It is difficult to implement • ☐It is not commercially mature • ☐It is mature but not robust enough • ☐It is expensive • ☐Other (please specify) **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.** A. Perspex® Fluorescent- Link https://www.perspexsheet.uk/ B. Plexiglas® GS - Link: https://www.plexiglas-shop.com/ C. Altuglas™ colors- Link: https://www.altuglas-online.com/ D. Onyx Solar - Link https://www.onyxsolar.com E. …Physee…….. - Link: https://www.physee.eu/ F. …Ubiquitous Energy.- Link: https://ubiquitous.energy/ **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. The Perspex® Fluorescent, Plexiglas® GS, and Altuglas™ colors sheets are all PMMA-based LSC mainly for aesthetic and displaying purposes using commercially available fluorophores whose spectral characteristics may not meet the Spotlight URS of T2.3. B. The glass windows developed by Onyx Solar, Physee and Ubiquitous Energy are based on luminophores that absorb and convert UV and IR spectrum for electricity generation, which may not meet the Spotlight URS of T2.3.

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	Has your company (or someone in the consortium) already developed a solution for the identified need before this project started? • ☐Yes • ☒No **Can we say that this solution is the starting point of the current project development activities?** • ☐Yes • ☒No **Let's compare the KER with what we already had in the consortium. What are the main advancements with respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☐Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements with respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements** **Alternative solution A** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☒Improved flexibility for diverse applications • ☒Improved technical performances (please specify) better spectral match, higher optical efficiency, higher light concentration

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	• ☐Improved design, size, weight, efficiency, materials • ☒New features • ☒Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)**
	
	• ☐Individuals
	• ☐Associations of individuals
	• ☒Private Small or medium enterprises
	• ☒Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☐Research and academic bodies
	• ☐Other, please specify
	Please name a few potential customers:
	
	1. Chemical fuel processing industry based on photocatalysis
	2. Building and construction companies
	3. Design companies for Interior and exterior lighting and displaying
	Who are the potential final users?
	
	• ☒Individuals
	• ☒Industry:
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile
	  ○ ☒One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Public bodies / authorities

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	○ ☐One or several managers ○ ☐One specific technical profile ○ ☐One specific department/team ○ ☐Individuals ○ ☐Other • ☐Research and academic bodies ○ ☐One or several managers ○ ☐One specific technical profile ○ ☐One specific department/team ○ ☐Students ○ ☐Other • ☐Other, please specify
Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. Photocatalytic chemical processes (Sabatier, rWGS, etc) in industry 2. Energy production or lighting conditions in building envelope **What are the pains the customer encounters while doing the previous activities?** 1. Spectral mismatch between the incident light source and the photocatalyst 2. Low performance 3. Energy cost and unpleasant lighting conditions **What are the gains the customer aims at, while doing the previous activities?** 1. High performance 2. Low cost.
Value proposition	**CUSTOMER JOBS:** **Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:** • Activity 1: ☒ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity? • ☐Indispensable • ☐Core, but needs to work in synergy with other components/processes • ☒Complementary to a core solution • ☐Nice to have
"Market" – *Target market*	**What is the primary target market?** • ☒Energy production/distribution/consumption • ☒Heavy process Industry (energy intensive) • ☐Manufacturing Industry • ☐Information Technology and telecommunication

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<table>
<tr><td></td><td>

- ☒Construction
- ☐Real estate management
- ☐Other (please specify)

Please specify the most relevant sub-sector(s) of the KER, within the selected market:

Chemical fuel processing sector
</td></tr>
<tr><td>"Market" - Competitors</td><td>

Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)

- SMEs: (small and medium enterprises)
  1. Ubiquitous Energy…
  2. Physee ……..
  3. Onyx Solar ……
- Large enterprises:
  1. Trinseo
  2. Imatex…
- Research bodies /academic bodies:
  1. Eindhoven University of Technology
  2. University of Cambridge
- Others:
  1. ……
</td></tr>
<tr><td>Go to Market – Business model</td><td>

What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.

Business Model	Not applicable	Scarcely applicable	Applicable	Very well applicable
Subscription model		✓		
Bundling model		✓		
Freemium model		✓		
Razor blades model		✓		
Product to service model			✓	
Leasing model		✓		
ESCO - energy performance contract			✓	
ESCO - energy supply contract			✓	
ESCO - build-own-operate-transfer		✓		
Franchise model			✓	
</td></tr>
</table>

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	Distribution model			✓	
	Manufacturer model				✓
	Retailer model		✓		
	Peer-to-peer model		✓		
	Hidden revenue model	✓			
	Direct sales model			✓	
	Affiliate marketing model		✓		
	Consulting model		✓		
	Data licensing model		✓		
	Pay as go model				✓
	Software as a service		✓		
	Product as a service			✓	
	Other				
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** □ During the first month after the project: 1. Scale-up of the LSC 2. Reduction of degradation □ Within 6 months after the project: 1. Integration of the LSC with packed bed reaction channels for the Sabatier process 2. Integration of the LSC with packed bed reaction channels for the rWGS process □ Within 12 months after the project: 1. Performance test and optimization for the Sabatier process 2. Performance test and optimization for the rWGS process □ Within 24 months after the project: 1. Scale-up of the LSC-reactor integrated device for the Sabatier process 2. Scale-up of the LSC-reactor integrated device for the rWGS process				

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4.3.2 Patent analysis

The patent analysis was built on the keywords contained in the title of the KER “luminescent solar concentrator” and “spectral conversion”.

A total of about 1000 patents and +260 INPADOC families were found. The query allowed to find other areas and sectors where the technology is being developed (IPC), to evaluate possible technology transfer.

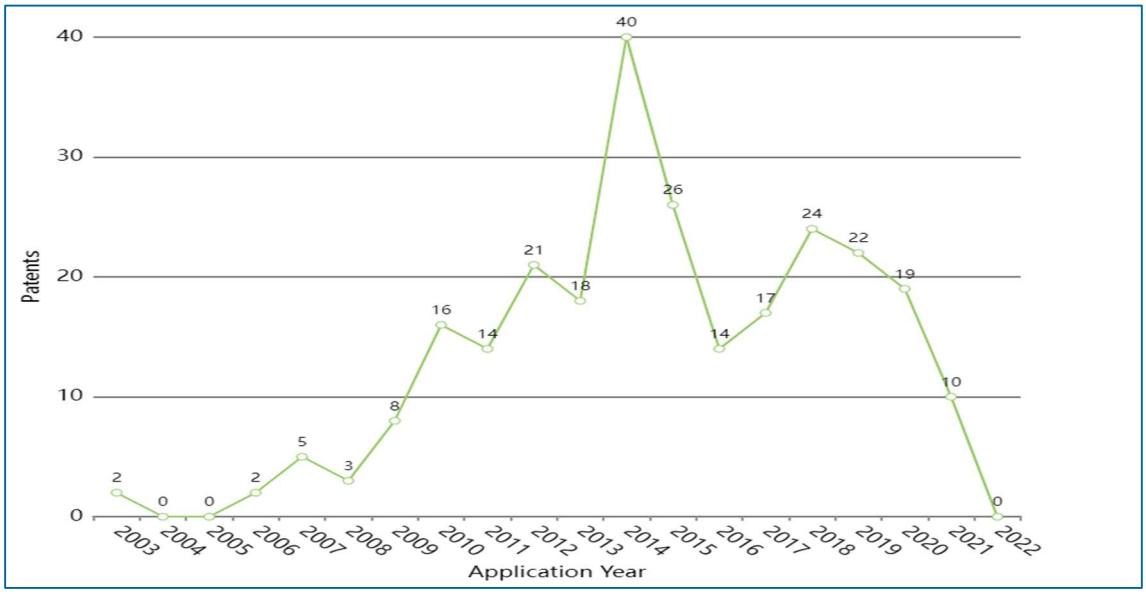

Figure 11 Patenting trend

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Figure 12 Top IPC

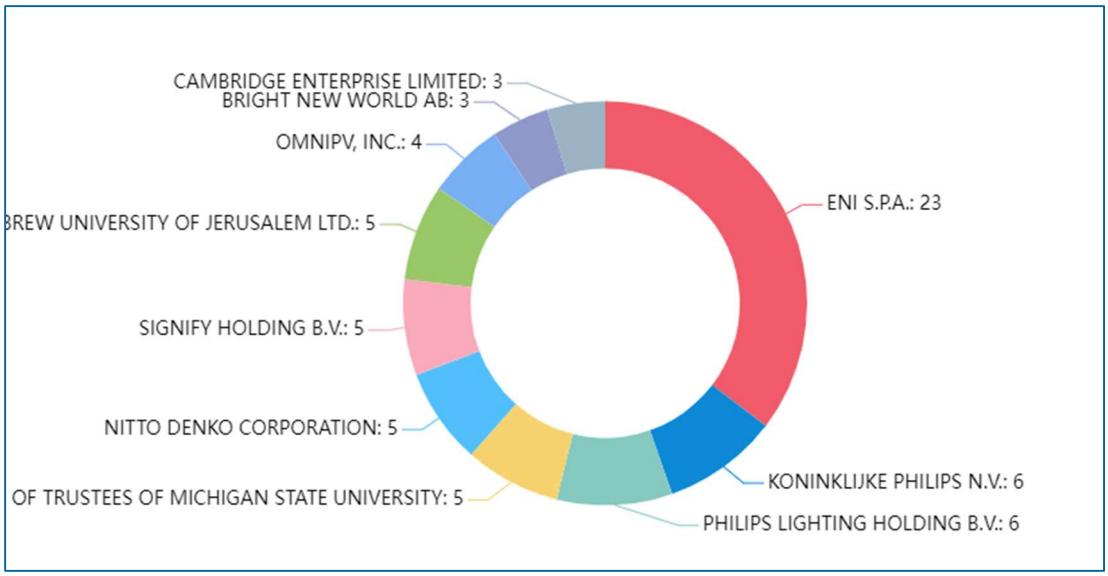

Figure 13 - top Applicants

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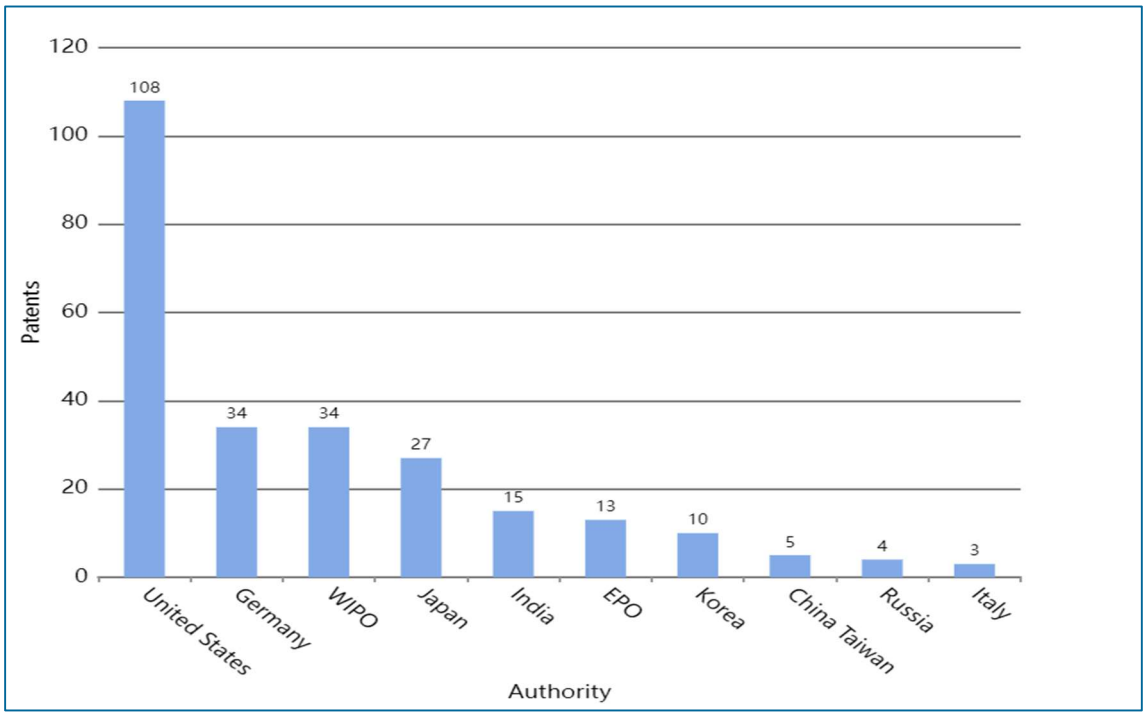

Figure 14 - Top countries

The trend of patenting is a little bit lower than a few years ago and the sector confirms to be a niche. However, considering the total number of patents submitted in the last decade, the sector shall be considered quite relevant for industrial research. One of the top applicant, ENI, is European and in fact it is clear the importance of the sector at continental level (second after the USA.

4.3.3 Preliminary conclusions on IP management

As stated in Spotlight deliverable D2.3, Table 11, EPFL has background in the field, already protected. This project is going to bring further added value to EPFL'sEPFL's IP and for this reason, patenting is a valuable option for protecting the result.

However, given the nature and complexity of the KER, a protection with an industrial secret is another interesting option. The final decision about how to manage the emerging intellectual property will be taken once the technological advancements will be finalized.

4.4 KER 6 – NEWLY DEVELOPED PLASMONIC NANOCATALYSTS AND KER 7 – UPSCALING PROCESS FOR THE PLASMONIC NANOCATALYSTS

The two KERs 6 and 7 are different, separate IP under development. However, given the proximity of the two fields of exploration, similar patents analysis and conclusion can be applied. KER 6 is in fact focused on the structure (chemical and physical properties) of the nano catalysts while KER 7 is more dedicated to the production process, to make it as more scalablescalable at industrial size as possible.

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4.4.1 KER 6 - Characterization table

Name of the KER: Newly developed plasmonic nanocatalysts	
KER Involved partners: TNO / ISC **Development Leader(s): UHA**	
Problem /need	Is this: **X A technical need** ☐ A financial/cost need **X A sustainability need** ☐ All of them Details…… Geographical level: ☐ Local /national ☐ Local, linked e.g. to climate zones or other specific local contexts (please specify) ☐ European **X Global** Does the need come from: ☐ Private customers **X Business/industrial customers** ☐ Public entities ☐ Other (please specify)
Alternative solution	Probably, there's already a solution to the problem but: ☐ It doesn't solve the full problem ☐ It is difficult to implement **X It is not commercially mature** ☐ It is mature but not robust enough ☐ It is expensive ☐ Other (please specify) Has your company (or someone in the consortium) already developed a solution that was selected as a basis to build the project? **X Yes** ☐ No If "Yes" then please specify the product or service already developed (the "starting point").

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	Lab scale synthesis of Ru/AlOx catalysts by impregnation + thermal reduction (TNO) Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as project solution? If possible, please copy a link to a reference website for further information. A. Nanoparts - Link: https://www.nanopartz.com/ B. Aurion - Link: https://aurion.nl/products/gold-nanoparticles / Can you find a drawback or a limitation for each of the alternative solutions you provided? 1. No ruthernium nanomaterials available, only gold 2. Potentially the wrong size to behave as active catalyst Can you say at least one strength and one weakness of the new developed solution? • Strength……scalability • Weakness……raw material costs
Description	We could describe the KER as a: **X Significantly improved product** ☐ Significantly improved service (except consulting services) **X Significantly improved process** ☐ Significantly improved marketing method ☐ Significantly improved organisational method ☐ New or advanced consulting service **X New or advanced scientific content** ☐ New product ☐ New service (except consulting services) ☐ New process ☐ New marketing method ☐ New organisational method ☐ Other (please specify) **Please provide a brief technical description of the proposed solution.** Wet chemical deposition of improved plasmonic nanoparticles on an inert or semiconducting support **Which are the main advancements respect to the "starting point" (the initial solution available in the consortium)?** **X Decreased production (manufacturing) time** **X Decreased production (manufacturing) costs** ☐ Increased lifetime and or robustness ☐ Improved flexibility for diverse applications **X Improved technical performances (please specify)**

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	X Improved design, size, weight, efficiency, materials ☐ New features ☐ Improved customizability ☐ Improved user friendliness ☐ Improved connectivity ☐ Remote operability ☐ Improved interoperability **X Improved safety** ☐ Improved logistics, distribution ☐ Improved construction/installing phase ☐ Improved maintenance plan ☐ Improved environmental impact ☐ New business model (e.g. for self-payback) ☐ Other – please specify **You have inserted 3/4 solutions already available in the market. Which are the main advancements of the KER respect to these alternative solutions?** ☐ **Alternative solution 1** • Decreased production (manufacturing) time • Decreased production (manufacturing) costs • Increased lifetime and or robustness • Improved flexibility for diverse applications **X Improved technical performances (please specify)** **X Improved design, size, weight, efficiency, materials** • New features **X Improved customizability** • Improved user friendliness • Improved connectivity • Remote operability • Improved interoperability • Improved safety • Improved logistics, distribution • Improved construction/installing phase • Improved maintenance plan • Improved environmental impact • New business model (e.g. for self-payback) • Other – please specify ☐ **Alternative solution 2** • Decreased production (manufacturing) time • Decreased production (manufacturing) costs • Increased lifetime and or robustness • Improved flexibility for diverse applications **X Improved technical performances (please specify)** **X Improved design, size, weight, efficiency, materials**

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	• New features **X Improved customizability** • Improved user friendliness • Improved connectivity • Remote operability • Improved interoperability • Improved safety • Improved logistics, distribution • Improved construction/installing phase • Improved maintenance plan • Improved environmental impact • New business model (e.g. for self-payback) • Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers?**
	• Individuals
	• Associations of individuals
	X Private Small or medium enterprises
	X Private Large enterprises
	• Non-profit organizations
	• Public bodies / authorities
	X Research and academic bodies
	• Other, please specify
	Please insert the name of a few potential customers:
	1. Evonik
	2. Umicore
	3. BASF
	Who are the potential final users?
	• Individuals
	• Industry:
	  ○ One or several managers
	  ○ One specific profile
	  ○ **One specific department/team**
	  ○ Individuals
	  ○ Other
	• Non-profit organizations
	  ○ One or several managers
	  ○ One specific profile
	  ○ One specific department/team
	  ○ Individuals
	  ○ Other
	• Public bodies / authorities
	  ○ One or several managers
	  ○ One specific profile
	  ○ One specific department/team
	  ○ Individuals
	  ○ Other
	• Research and academic bodies

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	○ One or several directors ○ One specific profile ○ **One specific department/team** ○ Individuals ○ Other • Other, please specify
Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where a new solution would be needed?** 1. Operating reactors at relatively low efficiency 2. Matching light source (sun) with catalyst (narrow absorption band) 3. Ensuring safe handling and operation of the catalysts 4. Monitoring / sampling quality of gasses produced **What are the pains the customers encounters while doing the previous activities?** 1. Energy loss during process 2. Variable production during day due to wavelength specific performance **What are the gains the customer aims at, while doing the previous activities?** 1. Higher overall efficiency (benefit from plasmonic/photothermal effect) 2. More efficient and continuous production during day time

Value proposition	You introduced some activity the customer performs, where the KER can be potentially integrated. Please confirm how much relevant the solution is:
	
	• YES/NO and respect to the activity, the solution is
	  • Indispensable
	  • **Core, but needs to work in synergy with other components/processes**
	  • Complementary to a core solution
	  • Nice to have
	
	• YES/NO and respect to the activity, the solution is
	  • Indispensable
	  • **Core, but needs to work in synergy with other components/processes**
	  • Complementary to a core solution
	  • Nice to have
	• YES/NO and respect to the activity, the solution is
	  • Indispensable
	  • Core, but needs to work in synergy with other components/processes
	  • Complementary to a core solution
	  • Nice to have
	• YES/NO and respect to the activity, the solution is
	  • Indispensable

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<table>
<tr><td></td><td>

- Core, but needs to work in synergy with other components/processes
- Complementary to a core solution
- Nice to have

</td></tr>
<tr><td>"Market" – Target market</td><td>

What is the primary target market?

X Energy production/distribution/consumption

X Heavy process Industry (energy intensive)

X Manufacturing Industry

- Information Technology and telecommunication
- Construction
- Real estate management

Please specify the sub-sector of the proposed solution:

1. Sustainable fuels (synthetic methane)
2. Energy intensive process industry (e.g. Syngas)

</td></tr>
<tr><td>"Market" - Competitors</td><td>

Please make a list of the competitors working in the same field (the manufacturers / providers of the alternative solutions previously mentioned + any others you would like to mention)

- SMEs:
  1. Avantium
  2. VS Particle
- Large enterprises:
  1. Johnson Matthey
  2. Umicore
- Research bodies /academic bodies:
  1. Max Planck institute
- Others:
  1. ……

</td></tr>
<tr><td>Go to Market – Business model</td><td>

What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.

<table>
<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
<tr><td>Subscription model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Bundling model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Freemium model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Razor blades model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Product to service model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Leasing model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>ESCO - energy performance contract</td><td>x</td><td></td><td></td><td></td></tr>
</table>

</td></tr>
</table>

This project has received funding from the Photonics Public Private Partnership programme under Grant Agreement **No.101015960**

	ESCO - energy supply contract	x			
	ESCO - build-own-operate-transfer	x			
	Franchise model	x			
	Distribution model	x			
	Manufacturer model				x
	Retailer model	x			
	Peer-to-peer model	x			
	Hidden revenue model	x			
	Direct sales model		x		
	Affiliate marketing model	x			
	Consulting model	x			
	Data licensing model	x			
	Pay as go model		x		
	Software as a service	x			
	Product as a service	x			
	Other	x			
Go to Market - Timing	**Please select the technical activities towards TRL 9 that most probably should be planned after the end of the project:** **X Select the pilot customers for TRL 9 tests** **X Test the solution at TRL 9, in real operational environment (pilot)** **X Build or finalize manufacturing processes and lines** ☐ Build or finalize procedures for: ○ Quality control ○ HSE ○ Further testing ○ Involvement of third parties ○ Other ☐ Prepare the technical manual ☐ Prepare the operation and maintenance procedures and plans ☐ Finalize pre-production tests ☐ Other **Please check which are the activities that most probably should be considered to reach the market after the project:**				

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	X Business model and value chain finalization ☐ Commercial agreement preparation **X agreement on common IP (if any)** ☐ Administrative procedures set-up ☐ After-sales procedures set-up ☐ Marketing campaign ☐ Activities to set up the business in specific geographies

4.4.2 KER 7 - Characterization table

Name of the KER: Upscaling process for the plasmonic nanocatalysts	
KER Owners: UHA, TNO and ISC **KER Leader: ISC Fraunhofer**	
Problem /need	**Is this:** • ☒A technical need. **For industrial exploitation, the synthesis of plasmonic nanocatalysts need to be upscalable in order to obtain sufficient amount of catalyst material for the light-powered conversion of CO_2 and green H_2.** • ☒A financial/cost need. **Upscaled processes need less labor work for the same amount of product compared to lab scale processes** • ☐A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….) • ☐All of them **Geographical level:** • ☐Local /national (please specify) • ☒Local, linked e.g. to climate zones or other specific local contexts (please specify) **The solution is more effective/attractive where solar power is more available** • ☐European • ☒Global **Does the need come from:** • ☐Private customers • ☒Business/industrial customers • ☐Public entities • Other (please specify)
Description	**What is the nature of the KER?** • ☐Significantly improved product

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	• ☐Significantly improved service (except consulting services) • ☒Significantly improved process **(regarding amount of obtained product)** • ☐Significantly improved marketing method • ☐Significantly improved organisational method • ☐Consulting services • ☐New product • ☐New service (except consulting services) • ☐New process • ☐New marketing method • ☐New organisational method • ☐Other (please specify) **Please provide a brief description of the KER.** The establishment of upscaling processes for the plasmonic nanocatalysts allows their production in a kg-range. This allows a cost reduction as less labor work is needed for the same amount of product and a time saving as more amount of product is obtained in the same time period. Both factors are essential for industrial exploitation of the SPOTLIGHT reactors.
Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☐It doesn't solve the full problem • ☐It is difficult to implement • ☐It is not commercially mature • ☐It is mature but not robust enough • ☐It is expensive • ☒Other **Upscaling cannot be easily transferred from one labscale synthesis route to another one but has to be developed for every synthesis from scratches.** **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.** A. Our Fraunhofer institute already provides wet-chemical upscaling processes for many other particle types (no catalysts) - Link: Nanokitchen.pdf B. Upscaling of physical nanoparticle syntheses - Link: Final Report Summary - BUONAPART-E (Better Upscaling and Optimization of Nanoparticle and Nanostructure Production by Means of Electrical Discharges) | FP7 | CORDIS | European Commission (europa.eu) **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. Upscaling processes are not for catalytic nanoparticles.

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	B. Upscaling processes is only for physical not wet-chemical syntheses **Has your company (or someone in the consortium) already developed a solution for the identified need before this project started?** • ☐Yes • ☒No **Let's compare the KER with what we already had in the consortium. What are the main advancements respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements** • ☒Decreased production (manufacturing) time • ☒Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☐Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements** • ☐Decreased production (manufacturing) time • ☐Decreased production (manufacturing) costs • ☐Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☐Improved technical performances (please specify) • ☐Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability

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	• ☐Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☐New business model (e.g. for self-payback) • ☒Other – please specify. **Alternative solution A and B do both not work for the upscaling of wet-chemical synthesis of catalyst nanoparticles!**

"Market" – *Early Adopters*	**Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)**
	
	• ☐Individuals
	• ☐Associations of individuals
	• ☒Private Small or medium enterprises
	• ☒Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☐Research and academic bodies
	• ☐Other, please specify
	Please name a few potential customers:
	
	1. Evonik
	2. Umicore
	3. BASF
	Who are the potential final users?
	
	• ☐Individuals
	• ☒Industry:
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☒One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Public bodies / authorities
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other

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	• ☐Research and academic bodies
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Students
	  ○ ☐Other
	• ☐Other, please specify

Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. Development and Synthesis of catalyst materials…… **What are the pains the customer encounters while doing the previous activities?** 1. Labscale synthesis is time and labor power consuming. **What are the gains the customer aims at, while doing the previous activities?** 1. Labscale synthesis allows the development of new materials without a waste of materials / not too high costs for material educts

Value proposition	**CUSTOMER JOBS:**
	
	Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:
	
	• Activity 1: ☒ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity?
	  • ☐Indispensable
	  • ☐Core, but needs to work in synergy with other components/processes
	  • ☒Complementary to a core solution
	  • ☐Nice to have

"Market" – *Target market*	**What is the primary target market?** • ☐Energy production/distribution/consumption • ☐Heavy process Industry (energy intensive) • ☐Manufacturing Industry • ☐Information Technology and telecommunication • ☐Construction • ☐Real estate management • ☒Other : **Chemical Industry**
"Market" - Competitors	**Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)** ☐ SMEs:

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<table>
<tr><td></td><td>1. VS Particle
2. Nanopartz
□ Large enterprises:
1. Umicore
2. Evonik
3. Johnson Matthey
□ Research bodies /academic bodies:
1. ……
□ Others:
1. ……</td></tr>
<tr><td>Go to Market – Business model</td><td>What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.
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<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
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<tr><td>Bundling model</td><td>x</td><td></td><td></td><td></td></tr>
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<tr><td>Distribution model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Manufacturer model</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Retailer model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Peer-to-peer model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Hidden revenue model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Direct sales model</td><td></td><td>x</td><td></td><td></td></tr>
</table></td></tr>
</table>

This project has received funding from the Photonics Public Private Partnership programme under Grant Agreement **No.101015960**

	Affiliate marketing model	x			
	Consulting model	x			
	Data licensing model	x			
	Pay as go model		x		
	Software as a service	x			
	Product as a service	x			
	Other				
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** ☐ During the first month after the project: 1. Identify the actual TRL ☐ Within 6 months after the project: 1. Identify market needs and consumers ☐ Within 12 months after the project: 1. Develop upscaling process adapted to the needs of the market ☐ Within 24 months after the project: 1. confirmed TRL9 2. establish contact with specific customers				

4.4.3 Patent analysis

The sector is a very vertical one. Plasmonic nanocatalysts specifically designed for enabling and/or improving the Sabatier reaction are few. The patent analysis, built right on those keywords ("plasmonic", "nanocatalysts" and "sabatier") shower a very limited number of entries: 15 patents and 6 INPADOC families. For this reason, it has been decided to report the most relevant records in the following table, as a reference for the further development of SPOTLIGHT KER6.

Publication number	Date	Title	Assignee	Status	Level of relevance
US20130168228A1	04 Jul 2013	Photoactive Material Comprising Nanoparticles of at Least Two Photoactive Constituents	OZIN, GEOFFREY A.REDEL, ENGELBERT	Withdrawn	Medium
WO2018140326A3	07 Sep 2018	Method for carbon dioxide methanation	Duke University	Non-Entry PCT-NP	High

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Publication number	Date	Title	Assignee	Status	Level of relevance
		using rh plasmonic photocatalyst			
US10647621B2	12 May 2020	Photocatalytic conversion of carbon dioxide and water into substituted or unsubstituted hydrocarbon(s)	ADELAIDE RESEARCH AND INNOVATIONUNIVERSITY OF SOUTH AUSTRALIAUNIVERSITY OF CANTERBURY	Granted	High
US20200270599A1	27 Aug 2020	Nanocaged enzymes with enhanced catalytic activity and increased stability	ARIZONA BOARD OF REGENTS ON BEHALF OF ARIZONA STATE UNIVERSITY	Examining	High

Table 3 - List of relevant patents

4.4.4 Preliminary conclusions on IP management

The IP, in both cases of KER 6 and 7, may be owned by one or multiple of the involved partners, viz. TNO, UHA and ISC, depending on which partner contributed to a certain inventive catalyst/process. This will be evaluated case by case.

According to the initial findings of the patent analysis, the defined scenario and the nature of the KER, the partners agreed that one very suitable option is to protect the KER with one or multiple patents. As in the case of the previous KER, also given the complexity of the result, keeping it as an industrial secret is a suitable option as well. Again, the final decision shall be taken when the technological development is advanced. Even if that was not suggested by involved partners, a further suggestion is to publish a scientific article. For the scientific community and for the market, this will explicitly correlate the partners to the results, but it will also transform the findings in known art.

4.5 KER 8 – THE SPOTLIGHT PROCESS

4.5.1 Characterization table

Name of the KER: The SPOTLIGHT process
KER Owners: all **KER Leader: RINA-C** **Other owners (if any):**

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Problem /need	**Is this:** • ☒A technical need. Please detail (e.g. higher performance, longer duration, different features, different standards….): **so far volumes are not so large to meet the demand** • ☒A financial/cost need. Please detail (e.g. lower CAPEX or OPEX, lower price, faster return on investment….): **decrease both CAPEX and OPEX of the product to decrease the cost of the final fuel** • ☒A sustainability need. Please detail (e.g. lower consumption, lower level of pollutants, different social impact….): s**olar fuels are a green of solar energy with neutral CO emission** • ☐All of them **Geographical level:** • ☐Local /national (please specify) • ☒Local, linked e.g. to climate zones or other specific local contexts (please specify) **The solution is more effective/attractive where solar power is more available. It is also more efficient if synergy/symbiosis with existing plants are possible** • ☐European • ☒Global **Does the need come from:** • ☐Private customers • ☒Business/industrial customers • ☒Public entities • Other (please specify): research institutes
Description	**What is the nature of the KER?** • ☐Significantly improved product • ☐Significantly improved service (except consulting services) • ☐Significantly improved process • ☐Significantly improved marketing method • ☐Significantly improved organisational method • ☐Consulting services • ☐New product • ☐New service (except consulting services) • ☒New process: **for the market not from a tech point of view** • ☐New marketing method • ☐New organisational method • ☐Other (please specify)

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Alternative solution	**Probably, there's already one (or several) solution to the problem available in the market, but:** • ☒It doesn't solve the full problem • ☐It is difficult to implement • ☒It is not commercially mature • ☐It is mature but not robust enough • ☒It is expensive • ☐Other (please specify) **Can you make a list of 3/4 products (or services) already available in the market that are trying to solve the same need as this KER? If possible, please provide a link to a reference website for further information.** A. NREL is working on how Solar energy can be used to convert basic chemical feedstocks such as carbon dioxide (CO2) and water into clean alternative fuels that offer greater grid stability, energy security, and environmental benefits. Link: https://www.nrel.gov/csp/solar-fuels.html B. Synhelion's process, which efficiently converts concentrated sunlight into heat, is based on taking the carbon dioxide and water out of the air, turning it into gas, and then liquefying it to fuels that could be used by conventional engines. - Link: https://www.power-technology.com/features/bringing-solar-fuel-to-light/ **Can you find a main drawback or a limitation for each of the alternative solutions you provided?** A. cost, weather-dependent with consequent efficiency drop B. price of synthetic fuels, cost of deployment hardware **Has your company (or someone in the consortium) already developed a solution for the identified need before this project started?** • ☒Yes • ☐No **Can we say that this solution is the starting point of the current project development activities?** • ☒Yes • ☐No **If "Yes" then please specify the product or service already developed ("the starting point").** .All components useful for the process have been already preliminary developed by the partners but they will be further developed and integrated in the final process

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	Let's compare the KER with what we already had in the consortium. What are the main advancements respect to the "starting point" (the initial solution available in the consortium)? If possible, please give numerical figures that can quantify advancements • ☒Decreased production (manufacturing) time • ☒Decreased production (manufacturing) costs • ☒Increased lifetime and or robustness • ☒Improved flexibility for diverse applications • ☒Improved technical performances (please specify) • ☒Improved design, size, weight, efficiency, materials • ☒New features • ☒Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☒Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase • ☐Improved maintenance plan • ☐Improved environmental impact • ☒New business model (e.g. for self-payback) • ☐Other – please specify **Let's make some comparison with the benchmark. What are the main advancements respect to the alternative solutions (A, B, C, D) you have previously identified? If possible, please give numerical figures that can quantify advancements** **Alternative solution A** • ☒Decreased production (manufacturing) time • ☒Decreased production (manufacturing) costs • ☒Increased lifetime and or robustness • ☐Improved flexibility for diverse applications • ☒Improved technical performances (please specify) • ☒Improved design, size, weight, efficiency, materials • ☐New features • ☐Improved customizability • ☐Improved user friendliness • ☐Improved connectivity • ☐Remote operability • ☐Improved interoperability • ☒Improved safety • ☐Improved logistics, distribution • ☐Improved construction/installing phase

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	• ☐Improved maintenance plan • ☒Improved environmental impact • ☒New business model (e.g. for self-payback) • ☐Other – please specify

"Market" – *Early Adopters*	**Who are the potential early customers for this KER? Please make sure they reflect your choices in the Need/Problem section (e.g. type of customer, geography)**
	
	• ☐Individuals
	• ☐Associations of individuals
	• ☐Private Small or medium enterprises
	• ☒Private Large enterprises
	• ☐Non-profit organizations
	• ☐Public bodies / authorities
	• ☒Research and academic bodies
	• ☐Other, please specify
	Please name a few potential customers:
	
	1. Chemical company using local feedstock as source for energy
	2. Research centers active in chemical and renewable sources
	Who are the potential final users?
	
	• ☐Individuals
	• ☒Industry:
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile
	  ○ ☒One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Non-profit organizations
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☐Public bodies / authorities
	  ○ ☐One or several managers
	  ○ ☐One specific technical profile
	  ○ ☐One specific department/team
	  ○ ☐Individuals
	  ○ ☐Other
	• ☒Research and academic bodies
	  ○ ☐One or several managers
	  ○ ☒One specific technical profile
	  ○ ☒One specific department/team
	  ○ ☒Students
	  ○ ☐Other

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	• ☐Other, please specify
Value proposition **Customer profile**	**What are the activities (Customer jobs) the customer usually performs, where our KER would be needed?** 1. traditional fuel production from fossil sources 2. studies and experiment on artificial photosynthesis **What are the pains the customer encounters while doing the previous activities?** 1. CO2 emissions, production waste, environmental issue **What are the gains the customer aims at, while doing the previous activities?** 1. Improve sustainability 2. Decrease costs 3. Improve circularity

Value proposition	**CUSTOMER JOBS:**
	
	Please confirm in which customer activity/process the KER can be integrated and how much it is relevant:
	
	• Activity 1: ☒ The KER can be integrated ☐ The KER cannot be integrated How much is the KER crucial to perform the activity?
	  • ☐Indispensable
	  • ☒ Core, but needs to work in synergy with other components/processes; e.g. in synergy with other processes and plants that produce CO2 or H2 as secondary products
	  • ☐Complementary to a core solution
	  • ☐Nice to have

"Market" – *Target market*	**What is the primary target market?** • ☒Energy production/distribution/consumption • ☒Heavy process Industry (energy intensive) • ☒Manufacturing Industry • ☐Information Technology and telecommunication • ☐Construction • ☐Real estate management • ☐Other (please specify) **Please specify the most relevant sub-sector(s) of the KER, within the selected market:** Chemical industry Solar fuels/sustainable fuels Special materials

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<table>
<tr><td>"Market" - Competitors</td><td>Please make a list of the competitors working in the same field (e.g. the manufacturers / providers of the alternative solutions previously mentioned + others)
☐ SMEs:
1. Synhelion
☐ Large enterprises:
1. WOOD PLC
☐ Research bodies /academic bodies:
1. NREL
☐ Others:
1. ……</td></tr>
<tr><td>Go to Market – Business model</td><td>What are the relevant Business models and how much are they applicable. For definition and examples of business models, please refer to the next chapters of this document.
<table>
<tr><th>Business Model</th><th>Not applicable</th><th>Scarcely applicable</th><th>Applicable</th><th>Very well applicable</th></tr>
<tr><td>Subscription model</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Bundling model</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Freemium model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Razor blades model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Product to service model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Leasing model</td><td></td><td></td><td>x</td><td></td></tr>
<tr><td>ESCO - energy performance contract</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>ESCO - energy supply contract</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>ESCO - build-own-operate-transfer</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Franchise model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Distribution model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Manufacturer model</td><td></td><td></td><td></td><td>x</td></tr>
<tr><td>Retailer model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Peer-to-peer model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Hidden revenue model</td><td>x</td><td></td><td></td><td></td></tr>
<tr><td>Direct sales model</td><td>x</td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

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	Affiliate marketing model	x			
	Consulting model	x			
	Data licensing model	x			
	Pay as go model		x		
	Software as a service	x			
	Product as a service	x			
	Other	x			
Go to Market - Timing	**Please make an initial high-level of the actions to be performed after the end of the project, to make the solution ready to market - TRL9 (ATTENTION! The detailed list of actions will be managed in the Exploitation Questionnaire):** □ During the first month after the project: 1. Set up the pre commercial agreement among partners 2. Set up the pre commercial agreement with third parties 3. Determine a technology development roadmap towards TRL9 □ Within 6 months after the project: 1. Identify the key sites for future (pilot) implementation 2. Run a number of replication studies “on paper” 3. Identify new funding opportunities □ Within 12 months after the project: 1. Identify 1 key “testimonial” case and build a success story around it 2. Start the technology development roadmap □ Within 24 months after the project: 1. Refine the business plan 2. Launch the first pre-commercial activities				

4.5.2 Patent analysis

The patent analysis was built and already done in the deliverable D2.1 “URS Spotlight process”. Here some of those results are reported, those used to substantiate the conclusions and suggestions on the IP management.

This search yielded just 148 patents with comparable technologies as aimed for with the Spotlight process. Here, some patents have clear figures on the devices and reactor set-ups to perform plasmonic catalysis. These are represent the most relevant devices and reactor set-ups.

According to this analysis, the following can be concluded:

- Most of the applications found are directed at the plasmonic material and the processes that can be carried out therewith.

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- Reaction conditions and reactors are described and sometimes nicely displayed in the Figures, but the described invention is seldom relying thereon.
- Reactors typically comprise of an inlet, an outlet a catalyst bed that can be illuminated by the sun or an artificial light source (reactors are therefore often partly transparent). Reactor sizes may range from laboratory cells/cuvets that can directly be analyzed spectroscopically to more sophisticated devices of 100 mL.
- Only CN111032212A and WO2020146799A1 (both of CN company Syzygy) are primarily focused on the reactor, but it is unclear what is the discriminating feature that makes the invention. Prosecution of both families is far from successful.
- There are many reactions involving CO, CO2, H2, H2O, hydrocarbons and alcohols. It seems that there is little control over the selectivity of the plasmonic catalysts.
- In fact only WO2018140326A2 / WO2018140326A3 dives into the subtleties of which metals favor one reaction over another (Sabatier vs rWGS).
- Few applications are dedicated to one particular reaction. Only CN108855173A / CN108855173B, CN107075696A / CN107075696B and CN108025285A are a notable exception to this. I find these very interesting because they allow H2 generation by sunlight.
- Plasmonic materials are often broadly described, mentioning many metals and other features/parameters that can be applied in a particular system.
- A notable exception is the TNO patent (EP2999536A1 / EP2999536B1), which is conceptual, not limited to particular chemical elements, and granted all of the National Phase Countries (CN, EP, JP, KR, US).
- Many applications in the 148 hitlist appeared slightly (or more outspoken) off-topic and therefore dropped out.
- The results do not give the impression that there is an increasing understanding of plasmonic catalysis. Lots of empirical data.

4.5.3 Preliminary conclusions on IP management

According to the input so far collected, to the description of KERs and the level of technology advancement of the project, we can say that KER 8 is more than just the sum of all the other KERs. KER 8 is the process as a whole that allows the production of the final products – the solar fuels – at industrial level. All the other KERs are relevant and indispensable part of the whole but they cannot, alone, produce a result. That's why we decided to consider the process as a further KER. Furthermore, it is important to underline that while the other KERs can be transferred, adapted and optimized also for other scopes, the process developed by SPOTLIGHT is right and only optimized for the production of solar fuels through the Sabatier reaction.

For this reason, it is possible to protect the whole process with a patent, leveraging also on every single patent of components that would be published. However, this could result in a weak protection as competitors could replace with other components and technologies some part of the process and obtain similar results without infringements. Also, being this IP potentially owned by multiple project partners, an efficient exploitation and commercialization could be difficult. An interesting alternative is to protect the key components with patent (as seen for the previous KERs) and protect the process with a Trademark. This will not really cover the technical aspects nor protect the result but it will contribute in promoting within the technical and scientific community the process here developed and optimized, with a "name" that will be immediately synonymous of the solar fuel production method or of the Sabatier reaction used for creating synthetic fuels.

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Obviously also in this case it would be important to gain further reputation within the academic and scientific community with a scientific publication.

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5 CONCLUSIONS

This deliverable reports the methodology used so far to manage the arising IP.

The task has been carried on in a very collaborative way, leveraging on several moments of interaction among partners, both in workshops and one-to-one meetings.

The steps that have been accomplished so far include:

- The definition of KERs (KER table) together with their owners and leaders;
- The characterization of KERs, to understand better the non-technical aspects and nature of the IP under development, with a view to future exploitation;
- A patent analysis, aimed at shaping the scenario in the technology domains of the identified KERs;
- A preliminary conclusion on the protection strategy.

As far as the protection strategy concerns, the report describes all the suitable means of protection for the identified KERS. During the workshops and interviews, partners have been trained about these aspects and a preliminary discussion on which is the most efficient strategy has been initiated.

At the end of every chapter on KERs, the deliverable reports the proposed IP strategy. In most cases, the strategy could be refined according to the technical advancements during the project and the evolution of the outer scenario. The final decision on protection tools will be taken by the KER owners before the end of the project.

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6 APPENDIX A – LIST OF THE PROPOSED BUSINESS MODELS

6.1 SUBSCRIPTION MODEL

A subscription business model can be applied to both traditional brick-and-mortar businesses and online businesses alike. Essentially, as we explained in reference to Netflix, the customer pays a recurring payment on a monthly basis (or another specified timeframe) for access to a service or product. A company may directly ship its product in the mail, or you may pay a fee to use an app.
Examples: In addition to Netflix, other businesses using the subscription model include HelloFresh, Beer Cartel, StitchFix, as well as other streaming services like Hulu, HBO Go, and Disney+.

6.2 BUNDLING MODEL

Exactly like it sounds, the bundling business model involves companies selling two or more products together as a single unit, often for a lower price than they would charge selling the products separately.
This type of business model allows companies to generate a greater volume of sales and perhaps market products or services that are more difficult to sell. However, profit margins often shrink since businesses sell the products for less.
Examples: Businesses that use the bundling model include AT&T, Adobe Creative Suite and Burger King, as well as other fast-food companies that offer value meals or deals.

6.3 FREEMIUM MODEL

The freemium business model has gained popularity with the prevalence of online and Software-as-a-Service (SaaS) businesses.
The basic framework goes like this: a software company hosts and provides a proprietary tool for their users to freely access, such as an app or tool suite. However, the company withholds or limits the use of certain key features that, over time, their users will likely want to use more regularly. To gain access to those key features, users must pay for a subscription.
You can see how Spotify follows this model — it gives users free and open access to its entire database of music while sprinkling in ads between songs. At some point, many users opt to pay a recurring monthly fee for the premium service so they can stream music without interruption.
Examples: Spotify, LinkedIn, Skype and MailChimp are all businesses that use the freemium model.

6.4 RAZOR BLADES MODEL

To understand the razor blades model, you can simply look to your local drugstore. You'll notice that replacement razor blades cost more than razors themselves.

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Companies offer a cheaper razor with the understanding that you'll continue to purchase more expensive accessories — in this case, razor blades — in the future. For this reason, this model is referred to as the "razor blades model."
In addition to the traditional razor blades model, you'll also see companies use the reverse razor blades model — in which they offer customers a high-margin product and then promote the sales of lower-margin products that accompany that initial product.
A classic example of this model is Apple iPhones and Macs — you purchase the high-margin item, the phone or computer, and then Apple pushes additional products, tools, and services that accompany that item.
Examples: On top of razor companies, examples of the general razor blades model include Keruig, Brita, Xbox, and printer and ink companies.

6.5 PRODUCT TO SERVICE MODEL

Imagine that you are the owner of a company that makes scooters. Let's say you need two pieces of metal welded together. You might ask another company to weld the pieces of metal together instead of purchasing a welding machine yourself. In essence, this example shows how the product to service business model works.
Companies that follow this type of business model allow customers to purchase a result rather than the equipment that delivers that result.
Examples: Companies that use the product to service model include Zipcar, Uber, Lyft and LIME.

6.6 LEASING MODEL

Under a leasing business model, a company buys a product from a seller. That company then allows another company to use the product they purchased for a periodic fee. Leasing agreements work best with big-ticket items like manufacturing and medical equipment.
Examples: U-Haul, Enterprise and Rent-a-Center are all examples of companies that use the leasing model.

6.7 FRANCHISE MODEL

Of all the different types of business models, the franchise model is perhaps the one that people are most familiar with — after all, we each see and likely visit franchise businesses often in our daily lives.
In short, a franchise works like this: A franchise is an established business blueprint that is simply purchased and reproduced by the buyer, the franchisee. The franchiser, or original owner, works with the franchisee to help them with financing, marketing, and other business operations to ensure the business functions as it should. In return, the franchisee pays the franchiser a percentage of the profits.
Examples: Starbucks, Domino's, Subway, McDonald's and the UPS Store are all common examples of the franchise model.

6.8 DISTRIBUTION MODEL

A company operating as a distributor is responsible for taking manufactured goods to the market.

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Hershey's, for example, manufactures and packages its chocolate, but distributors are the agents that transfer and sell the goods from the factory to a retailer. To make a profit, distributors buy the product in bulk and sell it to retailers at a higher price.
Examples: Other examples of companies that use the distribution business model are HD Supply, Avent, Cheney Brothers, and ABC Supply Co.

6.9 MANUFACTURER MODEL

One of the most traditional business models, the manufacturer model refers to when a manufacturer converts raw materials into a product.
Companies like Dell Computers or Hewlett-Packard, both of which assemble computers with parts manufactured by other companies, would still be considered manufacturers.
Examples: Additional examples of this type of business model include Intel, Magic Bullet, Black + Decker and LG Electronics.

6.10 RETAILER MODEL

The last business model on our list is the retailer model.
A retailer is the last link in the supply chain. These businesses purchase goods from distributors and then sell them to customers for a price that will both cover expenses and turn a profit. Retailers may specialize in a particular niche, such as kitchenware, or carry a range of products.
Examples: This is a popular type of business model — used by big-name companies like Nordstrom, Home Depot, Target and Best Buy.

6.11 PEER-TO-PEER BUSINESS MODEL

As per this model, a company acts as a middleman between two individual parties and create value for both demand and supply side. It's different than a typical relationship of a business selling its services to consumers (B2B or B2C). It makes money through commissions. Airbnb is the right example that allows transactions between hosts and hostees.

6.12 HIDDEN REVENUE BUSINESS MODEL

This model refers to a revenue generation system in which users don't have to pay for the services offered, but the company still earns revenue streams from other sources. Like, **Google** earns from advertising money spent by businesses to bid on keywords while users don't pay for the search engine.

6.13 DIRECT SALES BUSINESS MODEL

In this model, products are directly sold to the end customers either in a one-on-one conversation or small gathering, remember **Tupperware house parties**? The salesperson gets a share of every sale. Although technology has superseded the direct sales method in many ways, still many companies prefer to give a personal touch to its customers.

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6.14 AFFILIATE MARKETING BUSINESS MODEL

In this model, companies make money by featuring, reviewing, and recommending other company's products or services. Think about product review websites. These websites are paid based on sales opportunities that they bring to their vendor companies.

Examples: NerdWallet, Capterra, MoneySavingExpert.com, and thewirecutter.

6.15 CONSULTING BUSINESS MODEL

Companies that provide consulting services by hiring experienced and qualified people and having them assigned on client's projects follow the consulting business model. These companies tend to charge on the hourly basis and/or they take a percentage share based on the successful completion of the project (cost reduction project). **Mckinsey** and **Boston Consulting Group** are multi-billion-dollar businesses that are based on this model.

Examples: Deloitte, Mckinsey, BCG, software or website development firms

6.16 DATA LICENSING BUSINESS MODEL

A business model of 'data' has gained a new meaning in this modern world, especially in the technology sector. Data is a critical component in web technology where companies require critical information to carry out operations and earn revenue.

Example: Twitter sells real-time data to its partners, which is then used for advertising and customer insight.

6.17 PAY AS GO (UTILITY) BUSINESS MODEL

The business model charges as per the usage of the product or service.

In recent years, the Pay-As-You-Go model has been adopted by governments and organizations to distribute common goods like solar panels to rural communities, which they pay for gradually over a long period.

Example: This model includes electricity, water, and cell phone companies and Amazon Web Services

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