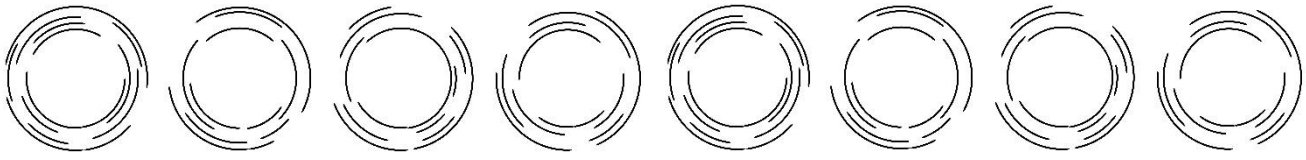
Deliverable 6.1

Innovation management programme

27th May 2025



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Project details

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RECREATE Project abstract

The main objective of the RECREATE project is to develop a set of innovative technologies aimed at exploiting the circularity potential of End-of-Life (EoL) complex composite waste (mainly carbon fibre reinforced composites CFRC, and glass fibre reinforced composites GFRC) as a feedstock for profitable reuse of parts and materials in the manufacturing industry.

The demand for both composites and high-performance fibre materials (especially carbon) at affordable costs is actually foreseen to grow steadily in the next few years. This trend is driven by progressive banning of landfilling of composite waste and growing needs in many sectors like automotive, transportation and in general for the lightweight design field. It is therefore crucial that **new technological alternatives to the more consolidated mechanical grinding and pyrolysis are identified**, so as to allow the recovery and reuse of materials and components in an environmental and economically convincing and sustainable way.

In the light of these considerations, **the ambition of RECREATE project is**:

- To develop and validate in relevant environment (TRL6) novel reuse strategies for current generation, large EoL composite parts (including complex multi-material composites) based on smart recognition and inspection for sorting (Laser Induced Breakdown Spectroscopy - LIBS), high precision dismantling (laser-shock) and repair, T-assisted reshaping, design for disassembly based on reversible joints, AI-assisted decision support systems.
- To develop and validate in relevant environment (TRL6) innovative physico-chemical upcycling technologies (catalyst-assisted green solvolysis, electro fragmentation) allowing simultaneous recovery of high quality, integer, clean fibres and of an organic resin fraction reusable as coating material, at the very end of the multiple reuse processes of parts.
- To demonstrate at TRL6 the use of smart and green reversible thermoset resins as enabling materials for the realization of the next generation of fibre-reinforced composites (FRCs) with easier repairability and enhanced reusability, facilitating the transition towards recyclable-by-design composite materials and structures.

Moreover, RECREATE addresses **another key objective** to develop a set of new digital tools for:

- Quantitative evaluation of the environmental and economic performance of the proposed technologies (LCA/LCC) as well as their circularity assessment;
- Co-design of innovative digital learning resources, including the realisation of MOOCs, serious games and digital twins of some specialty technologies developed in the project, with easy adoption and high replicability.

The objectives and the ambition of RECREATE are fully compliant with the general requirements of the Horizon Europe - Digital, Industry and Space 2021 Work Programme, and with the specific requirements of the call Horizon-CL4-2021-Resilience-01-01.

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Abstract of this deliverable

This deliverable presents the Innovation Management Programme developed within the RECREATE project, which aims to advance the circular reuse and remanufacturing of fiber-reinforced composite materials. The programme serves as a strategic and structured framework to guide the maturation, validation, and exploitation of key technologies developed across the project. These technologies include temperature-assisted reshaping, reversible adhesives, laser-based dismantling, and green solvolysis, among others.

The programme utilises the CASTech assessment tool to measure circularity potential and commitment, complemented by a sustainability assessment framework to ensure environmental, social, and economic viability. Through innovation workshops, technology validation in relevant environments, and exploitation pathway development, the programme enables the translation of technical outcomes into market-ready, sustainable solutions. Circular Business Plans are formulated to guide the integration of technologies into circular business models. This deliverable outlines the programme structure, tools, methodology, and initial results, and provides guidance for future implementation across industry contexts.

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Objectives of the task supporting the deliverable

Objectives

Add description.

Task

T6.1: Innovation management and circular business plans

A comprehensive innovation management programme was developed by G_MEDIA. First, technology concepts were verified in a controlled environment designed in innovation workshops organised to engage all participating actors for each of the streams by construing upon hypothetical scenarios and design testing pathways. Second, component and breadboard validation in relevant environment were carried out for each tested technology. In step three, a feedback loop was used to improve the circularity potential of each proposed technology concept and to identify key competencies to be fostered in research and development teams for each concept. A circularity assessment tool was developed by G_MEDIA and applied at the beginning of the programme and at the entry into each cycle of the stage three of the innovation programme, as well as at its completion.

Activities undertaken

Key activities

- Development of the innovation programme scheme and presented to partners
- Development of Circularity Assessment Tools for early stake technologies (CASTech)
- Testing and updating the CASTech based on feedback by partners
- Innovation programme set up and implementation
- Preparation of circularity maximisation recommendations and reports formation

Follow up

At the end of the project technology holders will undergo circularity assessment to validate if recommendations to improve the circularity potential of their technologies was successful.

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Executive Summary

The Innovation Management Programme within the RECREATE project is designed to systematically guide the maturation, validation, and deployment of innovative technologies related to improving the circularity of complex fiber- and glass-reinforced composites. Its primary goal is to ensure that these technologies not only reach technical feasibility but also find viable exploitation pathways that maximise their circularity and sustainability potential.

The programme follows a four-step process:

1. **Formation of key exploitable technologies** based on the outcomes and results of preceding research activities and definition of their exploitation pathways and use cases.
2. Verification of technologies in a selected use- and user-defined context (for example, demo cases), in a relevant environment by carrying out innovation workshops with selected stakeholders. **Exploitation Pathways** are developed for each demo case and/or Key Exploitable Result through which exploitable technologies can create impact by finding meaningful uses and users.
3. Assessment of circularity and sustainability levels of proposed Exploitable solutions. **The circularity level** is assessed by the Circularity Assessment Score (CASTech). **A sustainability assessment is** also carried out**. Based on the results, recommendations** are integrated into the final **Circular Business Plans as a part of exploitation activities. Circularity maximisation**: Circular Business Plans are developed for each demo case and/or KER in order to improve the circularity level of the proposed solution based on Key technologies. The desired outcome of this step is an improved CASTech score.
4. **Final Innovation Programme Report** is issued at the end of the project with recommendations to maximise the circularity and sustainability of selected technologies in the respective use cases.

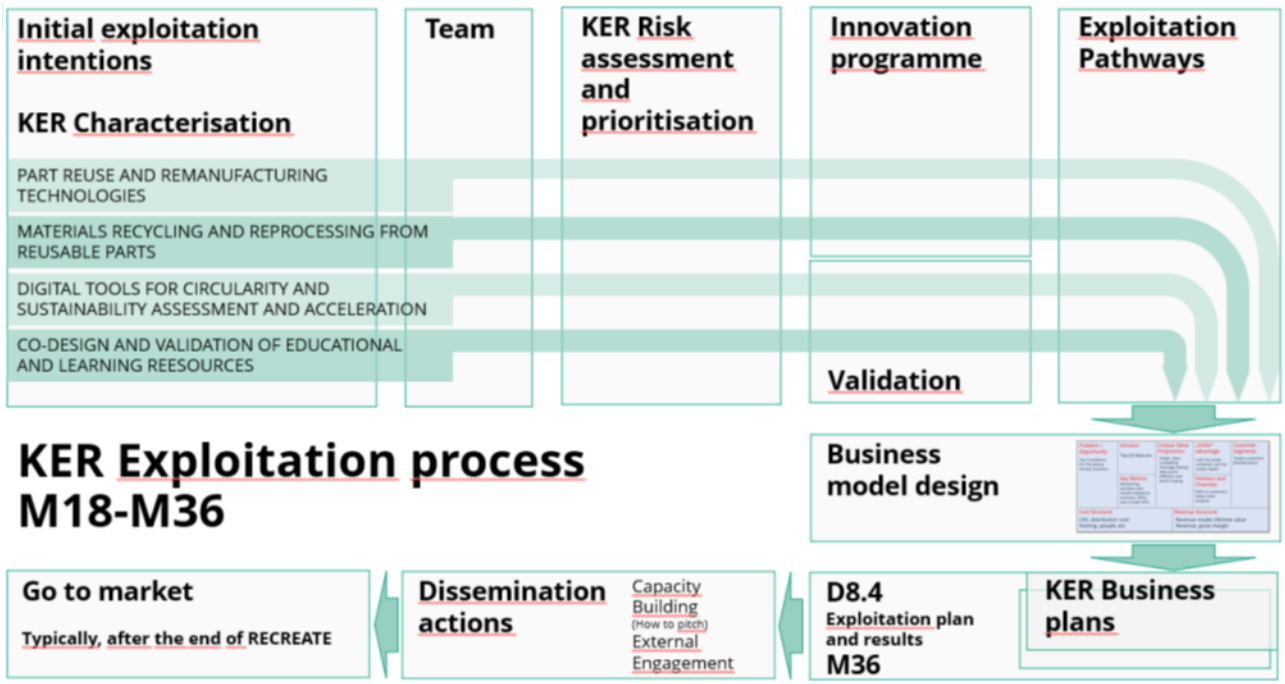
The RECREATE Innovation Management Programme is defined as a structured process that bridges technological development and practical industry application, ensuring successful market uptake of technological solutions.

Innovation programme

Introduction

The main objective of the RECREATE project is to develop a set of innovative technologies aimed at exploiting the potential of end-of-life complex composite waste (mainly carbon fibre-reinforced composites and glass fibre-reinforced composites) as a **feedstock** for profitable reuse of parts and materials in the manufacturing industry. For this purpose, an **Innovation programme** supports the maturation process of these **Key exploitable technologies** and enables them to find the most promising **Exploitation pathways** to meaningful **uses** – and **users** - while maximising their circularity and sustainability levels and entering the **exploitation process**.

Figure 1: Innovation programme as a part of the exploitation process



CASTech is an assessment tool that assesses a specific aspect of the overall **impact** of a proposed solution. Our assessment focus is on a **proposed solution**, which should provide some improvement in terms of circularity level. We consider **an Exploitable solution** to be composed of a (1) **Key exploitable technology** being put in a specific (2) **Exploitation pathway**.

In order to evaluate the circularity level of a proposed solution, which is based on **a key exploitable technology** put in the context of a selected exploitation pathway, we need to collect data at several levels through the **CASTech questionnaire**. Additionally, a sustainability questionnaire was developed in order to assess the social, environmental and economic sustainability aspects of each technology.

Please take into account that we can only evaluate the circularity level of a proposed solution, when a key exploitable technology is put in the context of a specific **exploitation pathways**. In other words, a technology cannot create an impact if it is not put in a context of a meaningful use. Therefore, we first

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define the exploitation pathway chosen for the exploitation of a selected key exploitable technology. Next, we evaluate the circularity level, assessing two dimensions: **circular potential of a proposed Exploitable solution.**

RECREATE's Key exploitable technologies

The portfolio of technologies maturing through the RECREATE initiative includes:

(1) **Temperature-assisted reshaping**
(2) **Reversible adhesives**.
(3) **Design for disassembly**
(4) **Laser-based high-precision dismantling and machining**
(5) **Laser induced Breakdown Spectroscopy (LIBS)**
(6) **Catalyst-assisted green solvolysis**
(7) **Electrofragmentation**
(8) **Vitrimers and reversible green resins**

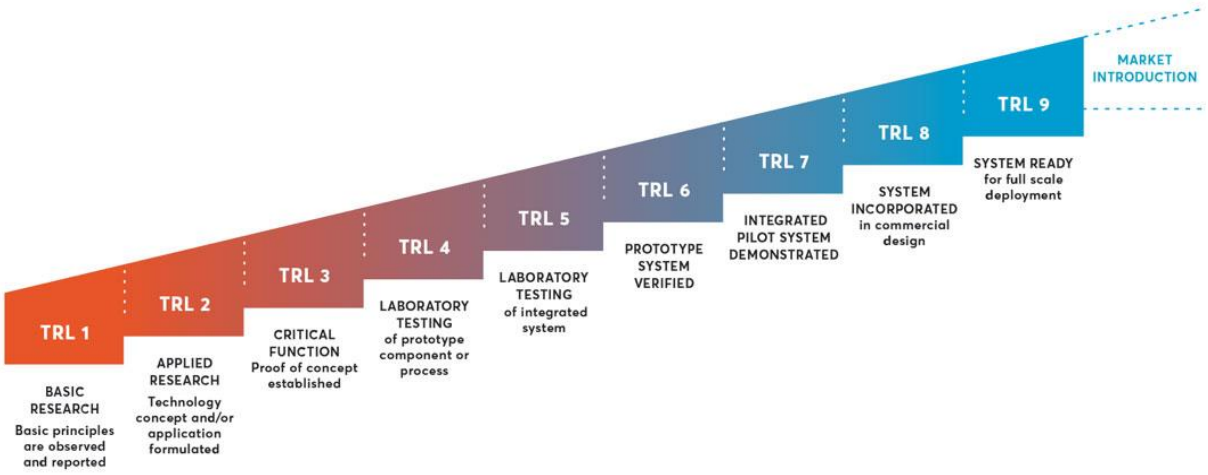
Three additional technologies have been identified through the initial workshops realised under the WP1.

(9) **Recycling and reprocessing of EoL**
(10) **Decision support system (DSS) for part re-use**
(11) **Non-destructive inspection**

These technologies being developed in Work Packages 2 through 5 represent the bedrock for exploitable results. Their expected stage of maturity typically reaches **TRL5** to **TRL6** before entering the **Innovation programme** (WP6), where different pathways, or scenarios, will be selected for each key exploitable technology to be tested in the relevant environment provided by 9 demonstrators.

The aim of the demonstrators is the synergistic integration of all key technologies developed in the project, to be demonstrated in a relevant environment **at TRL6**. In parallel, **a widespread involvement of companies as a result of dissemination actions aims to ensure direct relation and immediate relevance with market opportunities.**

Figure 2: Technology readiness levels



What is an Exploitation pathway?

An Exploitation pathway is **a realistic use case for a technology**, which refers to a specific **user group**, bringing specific benefits to users in comparison to current technologies available on the market.

The Exploitation pathway outlines **steps necessary to commercialise or otherwise exploit the innovation based on the key exploitable technology**, bringing its potential benefits into use, including securing intellectual property rights, conducting market analysis, developing a business model, obtaining funding, ensuring regulatory compliance, and refining the product through prototyping and testing.

An exploitation pathway is well chosen when it is possible to demonstrate that there is **sufficient potential demand** for the consistent use of the proposed solution based on the exploitable technology.

Key exploitable technology solution

By following the chosen Exploitation pathway, **a solution** based on the Key exploitable technology can be effectively positioned to meet market demand in its broadest sense, offering superior benefits to its users in a form of improved performance, efficiency, or cost-effectiveness over existing alternatives, thereby maximising its commercial potential and impact.

An **integrator organisation** is the one that integrates the exploitable technology solution in the answer to its circular challenges. The integration of the key exploitable technology into the integrator organisation is at the **final destination** of the exploitation pathway.

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Steps of the Innovation programme

The Innovation programme is **a step-by step process** through which we can support teams developing **Key exploitable technologies** to:

- select **an optimal Exploitation pathway** and
- maximise both **sustainability** and **circularity** of their proposed **Exploitable solutions**.

Here are **four steps** which the teams working on specific solutions based on a key exploitable technology have to undergo in the Innovation programme.

3. **Key exploitable technologies** based on the outcomes of preceding research activities are formulated in terms of a clear description and their functional impact.
4. By engaging relevant participating **actors** in **an innovation workshop** an exploitable technology is verified in a selected use- and user-defined context, in a relevant environment. Guidelines are set for its validation, possibly in the context of a specific demo case.

   Exploitation Pathways are developed for each demo case and/or Key Exploitable Result through which exploitable technologies can create impact by finding meaningful uses and users.
5. Circularity and sustainability of proposed Exploitable solutions are assessed.
   - **Circularity level** is assessed by the Circularity Assessment Score (CASTech).
   - **Sustainability assessment** is carried out**. Recommendations** are integrated into the final **Circular Business Plans.**
   - **Circularity maximisation**: Circular Business Plans are developed for each demo case and/or KER in order to improve the circularity level of the proposed solution based on Key technologies. The desired outcome of this step is an improved CASTech score.
6. **Final Innovation Programme Report** with recommendations is prepared.

Introduction to CAS Tech

The Circularity Assessment Scoring Model for Emerging Technologies (CASTech) is a tool designed to evaluate and enhance a business potential and a commitment associated with key exploitable technologies to be exploited in specific pathways leading to circular business models. It provides a composite score based on multiple criteria, allowing to assess the potential and the ability of closing, narrowing, or slowing the loops of resource flows, based on a standardised and validated questionnaire.

CAS Tech is divided into two parts: Part A focuses on assessing **the inherent potential of a Key exploitable technology to enable or support circular economy principles (circular potential)**, including aspects such as resource efficiency, lifecycle management, and adaptability. Part B evaluates the **commitment on an underlying organisation (represented also by a development team) to**

implement a circular solution in a specific Exploitation pathway, examining areas like strategic alignment, stakeholder engagement, and financial investment (**circular commitment**).

By providing a structured and detailed assessment, CASTech helps identify strengths and areas for improvement in developing circular technology solutions. The tool covers a wide range of factors, from technological capabilities and market readiness to stakeholder involvement and regulatory compliance, offering a holistic view of how emerging technologies can be integrated into circular business practices.

Upon completing the CASTech assessment, development teams and respective organisations receive a detailed report outlining their scores across both dimensions of circularity; circular potential and circular commitment. The score of both assessment criteria of CASTech is presented in a form of a CASMatrix to visualise in which quadrant the technology is place based on their inputs. There are four quadrants of the matrix: Laggards, Change business model, Improve commitment and Circular frontrunners. The **CASTech Report** highlights areas where the technology excels and identifies specific gaps and opportunities for improvement in order to arrive at a higher degree of circularity. Accompanied by tailored recommendations, the report provides actionable insights to help you enhance their circular practices.

The circularity level of an exploitable technology solution, similarly to a firm, is assessed through its potential application of a key exploitable technology into a circular business model. In a specific situation in which we don't have sufficient information available about a full-fledged business model, we focus on the assessment of the application of a key exploitable technology in a chosen context represented by a chosen exploitation pathway. Taking into account that the assessment is carried out at a **very early stage** of the technology exploitation, we take into account not only linear and circular risks, but also technology and pathway risks, the latter two being idiosyncratic for a specific tech application.

In this context, the circularity level is manifested by its potential to sustainably contribute to the circular economy pre-defined by the characteristics of the key exploitable technology assessed in a given context of an exploitation pathway, and capabilities of an underlying organisation, foreseen by the exploitation pathway, to seize it. So, the circularity as a strategic orientation of an exploitable technology solution, exercised through its underlying organisation (e. g.: an exploitation team, supported by committed real and financial investments), is manifested by a set of criteria demonstrating to what extent the solution releases its capabilities **to contribute to the circular economy**.

While a business model potential can be consistently evaluated across the value chain in which we intend to integrate the key exploitable technology by the use of the chosen exploitation pathway (**circular potential**), the actual level of competencies and practices depends on the managerial abilities, overall organisational practices and availability of resources to seize this potential (**circular commitment**).

Here is why the Circularity Assessment Scoring Model for Emerging Technologies (CASTech) figures as a useful assessment construct (or a tool) of the exploitable technology solution's circularity, considering its composite characteristic and specific adjustments for risks.

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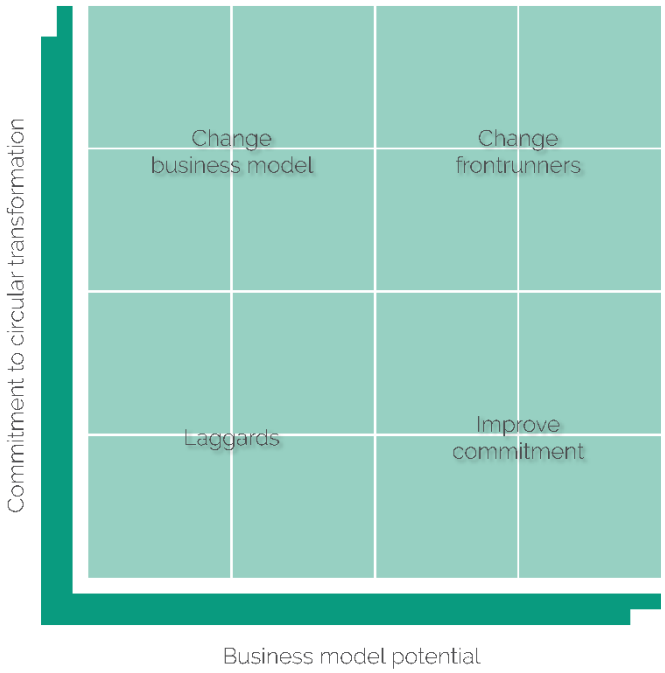
Figure 3: CASTech Matrix



Adjustments for specific risks types in the CASTech assessment

Implementing circular economy principles with emerging technologies involves navigating several risks that can impact the effectiveness and sustainability of the transition. CASTech takes these into account and makes necessary adjustments for a variety of risks, including Circular and Linear risks as well as some idiosyncratic aspects of the chosen Key exploitable technology or Exploitation pathway.

Key exploitable technology risks are specifically related to the maturation of key exploitable technologies through stages beyond TRL6 and reflect their reliability, scalability, and integration. Their identification and assessment require an analysis of a specific Key exploitable technology.

Exploitation pathway risks refer to idiosyncratic challenges that a solution meets in the chosen implementation pathway. Their identification and assessment require an analysis of the specific exploitation pathway.

Circular risks, arise from the complexities of the adoption of innovative solutions in a wider value chain context).

Linear risks are associated with the exposure of conventional, non-circular business practices to the changing context of planetary limitation of resources).

By addressing these risks in the assessment and recommendations, CASTech ensures a robust and realistic approach to achieving circular economy goals, helping organisations mitigate potential issues and enhance their sustainability efforts. The understanding of the type of the circular business model an organisation pursues is crucial to identify financing needs and to select adequate financing sources, even though the organisation may have not yet arrived at its full circular potential.

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Sustainability Assessment

As a part of the Innovation programme, technologies are assessed using an adapted sustainability assessment questionnaire.

The **Sustainability Assessment Questionnaire** is a structured evaluation tool designed to measure the environmental, social, economic, and governance-related impacts of a key exploitable technology solution within an integrator organisation. It offers a multi-dimensional view of sustainability performance, supporting early-stage decision-making, responsible innovation, and long-term value creation aligned with sustainable development goals.

This assessment focuses on how the application of a technology contributes to sustainability across four critical dimensions:

- **Environmental Sustainability**: Evaluates the extent to which the technology reduces environmental impacts through improvements in energy use, emissions, waste management, and resource efficiency.
- **Social Sustainability**: Assesses the technology's influence on human and social factors such as workplace safety, regulatory compliance, labour rights, community engagement, and awareness.
- **Economic Sustainability**: Considers the technology’s contribution to cost-efficiency, job creation, market readiness, and overall economic growth potential.
- **Governance and Compliance**: Measures organisational transparency, risk mitigation, and stakeholder involvement in sustainable practices.

The questionnaire is designed for integrator organisations applying or considering the implementation of key exploitable technologies, especially in early development or transfer stages. It supports a forward-looking understanding of a technology’s potential to enhance sustainable practices and align with circular economy principles.

Scoring across the 21 criteria allows for a comprehensive evaluation of the technology solution’s sustainability profile and highlights both current strengths and areas for improvement. This insight supports organisations in refining their exploitation strategies, managing associated risks (including circular and linear risks), and unlocking funding or partnership opportunities by demonstrating their commitment to sustainability.

Conclusions and prospects

This deliverable outlines the systematic approach taken by the RECREATE Innovation Management Programme to bridge the gap between technological development and real-world application in circular economy contexts. By leveraging structured methodologies such as the CASTech model and tailored sustainability assessments, the programme supports the evaluation, optimisation, and integration of key exploitable technologies into viable exploitation pathways.

The Innovation Programme has enabled the identification and preliminary validation of technologies with high circularity and sustainability potential. The circular assessment tools have proven effective in guiding technology developers through early-stage risk identification and circular business model alignment. Furthermore, the workshops and demo case evaluations have helped generate actionable insights for refining both the technologies and their associated exploitation strategies.

Looking forward, the programme will focus on the finalisation and implementation of Circular Business Plans for each Key Exploitable Result (KER) and democase, ensuring they are supported by market analysis, stakeholder engagement, and sustainability metrics. The final stage will include a reassessment of circularity and a complete report with recommendations on how to maximise circular potential of each technology in a specific exploitation pathway to ensure market uptake.

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ANNEX:

CASTech Questionnaire

1. General information

(Please, use standard prepared questionnaire and modify it if needed to correspond to Exploitation Teams and their respective organisations rather than individual firms.)

2. Key exploitable technology definition

Definition of the Key exploitable technology: description and functional impact

1. Describe here your Key exploitable technology. Please, answer the following questions:

1.0 Please briefly describe what this technology does and what it is main outcome?

1.1 What methodological processes does the technology entail?

1.2 What are the inputs into the process (main materials, additional substances required)?

1.3 What equipment is required to apply this technology?

1.4 Is this equipment widely available?

1.5 How costly is this process? Very low, Low, Medium, Medium High, Very high cost

1.6 Please, explain what is the unique value added of the outcome of this technology? In what ways its results are superior to other comparable technologies (or solutions in general)?

1.7 What impact does this technology create (economic, social, environmental) in comparison to other comparable technologies (or solutions in general)?

1.8 What is the current TRL of the key exploitable technology in the context of the selected exploitable technology solution?

1.9 What resources are needed to advance in the TRL level, in terms of processes, equipment, inputs, human and financial resources?

2. What is the estimated time to market?

- 0: More than four years
- 1: Three to four years years
- 2: Less than 3 years

- 3: Less than 2 years

3. Please, assess the key exploitable technology risks specifically related to the maturation of key exploitable technology through stages beyond TRL6 and reflect its reliability, scalability, and integrability into the target solution.

What are the associated development risks?

- 0: Elevated risk of accomplishment
- 1: Medium development risk of accomplishment
- 2: Reasonable risk of accomplishment
- 3: Low development risks of accomplishment

2. Exploitation pathway description

Describe here one or two exploitation pathways (use-cases) which you will want to assess in this process.

1. Please, answer the following questions for each Exploitation pathway:

1.1 Who are potential users of this technology?

1.2 How will these users benefit from the use of this technology in comparison to currently available alternatives?

1.3 What is a potential modality of use that will bring desired benefits to the user? Please, briefly describe.

1.4 What are the unique required channels to access the users?

a)
b)

2. Do you envisage more exploitation pathways for the same technology beyond the ones exposed in the previous question?

If yes, please briefly outline one or two more.

3. Economic viability: is the exploitation pathway economically viable?

- 0: Cannot verify.
- 0: No.
- 1: Yes, it is potentially viable.

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- 2: Yes, verifiably viable.

4. Pilot projects

Are there successful pilot projects demonstrating the technology use case's viability in circular business models?

- 0: No
- 1: In development
- 2: Completed with minor success
- 3: Completed with significant success

5. What is the level of perceived idiosyncratic exploitation pathway risks?

- 0: Elevated risk of accomplishment
- 1: Medium development risk of accomplishment
- 2: Low to reasonable risk of accomplishment
- 3: Low development risk of accomplishment

Part A:

Circular potential of an exploitable technology solution

1. **Circular design**

To what degree the exploitable technology solution improves the circular design potential of products and services, following the circular economy principles (e.g., easy disassembly, waste minimisation, energy savings, increased reparability, reuse, repurpose or recovery) compared to the next best alternative?

- 0: No improvements in circular design.
- 1: To a minor degree (less than 15% effective)
- 2: To a significant degree (15% to 40%)
- 3: Yes, predominantly or completely redefines circular design potential (more than 40%)

2. **Energy efficiency**

How much does the exploitable technology solution contribute to the optimisation of the use of **energy resources** in production and usage compared to the next best alternative?

- 0: Not at all.
- 1: To a minor degree (some effect is traceable and not neglectable but not of a primary importance)
- 2: To a significant degree (the effect is systematic and noticeable, it could potentially cause a significant impact)
- 3: Yes, predominantly or completely, providing an immense impact. It is a game changer.

3. **Renewable integration**

How successfully can the exploitable technology solution be integrated with renewable energy sources compared to the next best alternative?

- 0: Not possible.
- 1: To a minor degree (less than 15%)
- 2: To a significant degree (15% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

4. **Material resource efficiency**

How much does the exploitable technology solution contribute to the optimisation of the use of material resources in production and usage compared to the next best alternative?

- 0: Not at all.
- 1: To a minor degree (some effect is traceable and not neglectable but not of a primary importance)
- 2: To a significant degree (the effect is systematic and noticeable, it could potentially cause a significant impact)
- 3: Yes, predominantly or completely, providing an immense impact. It is a game changer.

5. **Product longevity**

How much does the exploitable technology solution enhance the lifespan of a product or a service it is used for through reparability or regeneration compared to the next best alternative?

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- 0: Assessment not possible at this stage.
- 1: To a minor degree (less than 15%)
- 2: To a significant degree (15% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

6. **Lifecycle management**

- Does the exploitable technology solution improve the support to the lifecycle management, including end-of-life recovery and recycling in comparison with the next best alternative?
    - 0: No
    - 1: To a minor degree (less than 15%)
    - 2: To a significant degree (15% to 40%)
    - 3: Yes, predominantly or completely (more than 40%)

7. **Adaptability and reuse**

How much is the exploitable technology solution adaptable to different circular business models (e.g., product-as-a-service, sharing economy) allowing for a reuse of materials or parts (components or modules) compared to the next best alternative?

- 0: No adaptability or reuse advancements
- 1: To a minor degree (less than 15%)
- 2: To a significant degree (15% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

8. **Digitalisation for circularity**

How much can the exploitable technology solution be leveraged by applying specific digital tools and solutions to enhance circularity (e.g., IoT for monitoring and maintenance) in comparison with the next best alternative?

- 0: Not at all
- 1: To a minor degree (less than 15%)
- 2: To a significant degree (15% to 40%)

- 3: Yes, predominantly or completely (more than 40%)

9. **User engagement**

To what degree the exploitable technology solution allows for an increased engagement of (corporate, individual) users in circular practices (e.g., incentivizing returns, repairs) in comparison with the next best alternative??

- 0: Not at all
- 1: To a minor degree (less than 20%)
- 2: To a significant degree (20% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

10. **Innovation potential**

Does the exploitable technology solution have the potential to drive innovation in circular business models at a large scale (across an entire industry segment, industry, a value chain or even across more industries) in comparison with the next best alternative?

- 0: No
- 1: To a minor degree (less than 20%)
- 2: To a significant degree (20% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

11. **Collaboration and partnerships**

Does the exploitable technology solution facilitate collaboration with other organisations for circular solutions more successfully in comparison with the next best alternative?

- 0: No
- 1: To a minor degree (less than 20%)
- 2: To a significant degree (20% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

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12. **Regulatory compliance**

Does the exploitable technology solution comply better with current and anticipated regulations promoting circular economy practices in comparison with the next best alternative?

- -1: No, it does not comply
- 0 Significant compliance risk exists
- 1: Minor compliance risk exists
- 2: It is fully compliant or only neglectable compliance risk exists

13. **Scalability**

Can the exploitable technology solution be scaled to meet large-scale circular economy demands?

- 0: No
- 1: To a minor degree (less than 20%)
- 2: To a significant degree (20% to 40%)
- 3: Yes, predominantly or completely (more than 40%)

14. **Value proposition**

Does the exploitable technology solution offer a superior value to the specific user group in comparison with the next best alternative?

- 0: No
- 1: Partly
- 2: Yes

15. **Customer adoption**

Is there evidence of customer interest and willingness to adopt the exploitable technology solution?

- 0: No
- 1: Partially yes
- 2: Yes

16. **Intellectual property**

Is there a potential to protect this solution under the intellectual property regulation (e.g. by a patent, authorial rights, etc.) or through secrecy?

- 0: No
- 1: Through secrecy only
- 1: Partially yes
- 3. Yes

17. **Regulatory Support**

Are there supportive regulations or incentives to deploy the exploitable technology solution?

- 0: No
- 1: Partially yes
- 2: Yes

Part B:

Commitment to Circular Transformation

The questions in the Part B refer to the **integrator organisation** which integrates the exploitable technology solution as a result of a successfully accomplished exploitation pathway.

1. **Strategic Commitment**

Is the organisation leading the exploitation and has the majority of Exploitation Consortium, formally committed to the implementation of circularity (e. g.: by signing and MoU, Consortium Agreement, Joint Ownership Agreement or another binding agreement)?

- 0: No.
- 1: Alignment process is ongoing.
- 3: Yes.

2. **Leadership and Governance**

Is there a dedicated leadership or a dedicated governance structure sponsoring the circular transformation aiming to implement the adoption of the exploitable technology solution in the integrator organisation?

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- 0: No.
- 1: Partially.
- 2: Yes.

3. **Exploitation team engagement**

Are key Exploitation team members engaged with - and trained in - circular economy practices?

- 0: No.
- 1: Partially.
- 2: Yes.

4. **Policy and Advocacy**

Does the integrator organisation advocate for policies that support the circular economy?

- 0: No
- 1: Partially, to a minor degree; the integrator organisation is in an early stage of the circular transformation
- 2: To a significant degree; the integrator organisation is in an advanced stage of the circular transformation
- 3: Yes, predominantly or completely; the integrator organisation frontrunner

5. **Transparency and Reporting**

Does the integrator organisation report on its circular economy performance and initiatives?

- 0: No
- 1: Partially
- 2: Yes, to a significant extent
- 3: Yes, comprehensively

6. **Circular Metrics**

Are there established metrics and KPIs to track progress in circular transformation in the integrator organisation?

- 0: No
- 1: To a minor degree, only for specific test projects or pilots
- 2: To a significant degree, comprising entire branches or business areas
- 3: Yes, predominantly or completely, comprising the entire organisation

7. **Financial Commitment**

Has the integrator organisation an allocated budget and resources specifically for circular economy initiatives, and, specifically, for the integration of the exploitable technology solution?

- 0: No
- 1: Partially, at an experimental level
- 2: Yes, to a significant extent, at a project level
- 3: Yes, comprehensively, at a strategic level

8. **Innovation Culture**

Is there a culture of innovation that supports the development and implementation of circular solutions in the integrator organisation?

- 0: No
- 1: To a minor degree; in specific detached organisational units
- 2: To a significant degree
- 3: Yes, predominantly or completely; the organisation is an innovation leader

9. **Partnerships and Collaborations**

Does the integrator organisation actively seek partnerships to enhance its circular transformation?

- 0: No
- 1: To a minor degree, in limited, specifically defined areas
- 2: To a significant degree
- 3: Yes, predominantly or completely

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10. **Customer Engagement**

Are customers educated and engaged in the organisation's circular economy efforts?

- 0: No
- 1: To a minor degree, in limited, specifically defined areas or in testing activities only
- 2: To a significant degree, in one or several areas, where customer engagement has been fully implemented
- 3: Yes, predominantly or completely

11. **Circular Procurement**

Does the integrator organisation prioritise circular procurement practices (purchasing criteria, standards, quality control etc.) ?

- 0: No
- 1: To a minor degree (less than 20% of total supplies)
- 2: To a significant degree (20% to 40% of total supplies)
- 3: Yes, predominantly or completely (more than 40% of total supplies)

12. **Supply Chain Integration**

Are circular economy principles integrated into the entire supply chain management of the integrator organisation (e. g.: through supplier circular practices verification, circularity standards, materials tracing and “product passport” practices)?

- 0: No
- 1: To a minor degree, in limited, specifically defined areas or in testing activities only
- 2: To a significant degree, in one or several areas, where the supplier engagement has been fully implemented
- 3: Yes, predominantly or completely, circularity is a widely adopted strategic principle across the supply chain

13. **Regulatory Preparedness**

Is the organisation prepared for current and future regulations related to the circular economy?

- 0: No
- 1: Partially
- 2: Yes, to a significant extent
- 3: Yes, comprehensively

14. **Training and Development**

Are there training programmes being carried out or are they being programmed in the integrator organisation, focused on circular economy principles for employees?

- 0: No
- 1: To a limited degree, only in relation to testing activities and projects
- 2: To a significant degree, comprising entire business areas
- 3: Yes, predominantly or completely, circular economy principles for are being followed as a strategic orientation of the integrator organisation by the most employees

15. **Continuous Improvement**

Does the integrator organisation have a system for continuous improvement in circular economy practices?

- 0: No
- 1: To a limited degree, only in relation to testing activities and projects
- 2: To a significant degree, comprising entire business areas
- 3: Yes, comprehensively

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Linear and circular risks assessment

Circular business model typology provides a forward-looking context. The understanding of the type of the circular business model an integrator organisation pursues is crucial to identify financing needs and adequate financing sources, even though the organisation may have not yet arrived at its full circular potential. The same goes for technologies and very early-stage investing in the field of technology transfer.

Each business model type generally has its own peculiar **risk profile** and in relation to other firm's characteristics. From the standpoint of the level of circularity, It is important to examine the degree to which the organisation is exposed to linear risks on one hand and to circular risks on the other hand. Please note that, typically, any integrator organisation is to some extent exposed to both linear and circular risks.

Please, have a look at the table below to be able to distinguish between linear and circular risks exposure in the case of a specific exploitable technology solution. First evaluate each item with "low" (+1), medium" (0) or "high" (-1) exposure. Next, sum up the result for each risk aspects. please, answer the question below.

Table 2: Distinguishing between linear and circular exposures of an integrator organisation

Circular risk	Linear risk
Shift of mind-set needed to see (used) products as valuable sets of modules and/or materials instead of waste.	Dependency on virgin resources (risk of supply chain disruption).
Required initial investment can cause deterioration in short-term margins.	Exposure to resource price volatility.
Balance of short-term margin versus long-term stability.	Increasing environmental legislation.
Market demand for the offered products: customers and companies are currently used to owning products.	Growing population and increasing financial wealth.
Dependency on supply chain collaboration.	Effects of climate change.
Unknown residual value of many products, due to small market of circular output companies (i.e. companies that upcycle, re-use, remanufacture or refurbish).	Demand for environmentally sound products.
Supply chain lock-in risk.	Businesses/products that become obsolete by holding onto old linear business practices (stranded assets).

1. What is the level of perceived linear risks for the integrator organisation?

- 0: Elevated exposure
- 1: Medium exposure
- 2: Low to reasonable exposure
- 3: Low to very low exposure to linear risks

2. What is the level of perceived circular risks for the integrator organisation?

- 0: Elevated exposure
- 1: Medium exposure
- 2: Low to reasonable exposure
- 3: Low to very low exposure to circular risks

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Sustainability assessment questionnaire

Part A: Environmental Sustainability

1. **Energy Consumption**

How effectively does the technology solution reduce energy consumption compared to the next best alternative?

- 0: No reduction.
- 1: Minor reduction (less than 20%).
- 2: Significant reduction (20% to 40%).
- 3: Major reduction (more than 40%).

2. **Carbon Emissions**

To what extent does the technology solution reduce carbon emissions compared to the next best alternative?

- 0: No reduction.
- 1: Minor reduction (less than 20%).
- 2: Significant reduction (20% to 40%).
- 3: Major reduction (more than 40%).

3. **Resource Efficiency**

How well does the technology solution optimize the use of natural resources?

- 0: Not at all.
- 1: To a minor degree (less than 20%).
- 2: To a significant degree (20% to 40%).
- 3: To a major degree (more than 40%).

4. **Incentives for Reuse**

Does your company/premises offer incentives, services, or infrastructure to encourage secondary use or reuse of the product (or physical component services) or to extend its life span?

- 0: No.
- 1: To a minor degree (less than 20%).
- 2: To a significant degree (20% to 40%).
- 3: To a major degree (more than 40%).

5. **Waste Management**

How does the technology solution contribute to waste reduction and management?

- 0: No contribution.
- 1: Minor contribution (less than 20%).
- 2: Significant contribution (20% to 40%).
- 3: Major contribution (more than 40%).

6. **Waste Monitoring System**

Does your company have an established monitoring system of waste-related data?

- 0: No.
- 1: Partially.
- 2: Yes, to a significant extent.
- 3: Yes, comprehensively.

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Part B: Social Sustainability

7. **Regulatory Compliance**

Does the technology solution comply with current and anticipated regulations promoting sustainability practices?

- -1: No, it does not comply.
- 0: Significant compliance risk exists.
- 1: Minor compliance risk exists.
- 2: Fully compliant or negligible compliance risk exists.

8. **Health and Safety**

How does the technology solution impact health and safety of workers in the integrator organization and its consumers?

- 0: Negative impact.
- 1: No impact.
- 2: Positive impact (some improvement).
- 3: Highly positive impact (significant improvement).

9. **Workplace Safety and Health**

What measures does the integrator organization have in place to make employees aware and prevent workplace incidents and health hazards?

- 0: No measures.
- 1: Basic measures (less than 20% coverage).
- 2: Standard measures (20% to 40% coverage).
- 3: Comprehensive measures (more than 40% coverage).

10. **Community Engagement**

How well can the integrator organisation engage with the local community to its benefit when applying the technology solution?

- 0: No engagement.
- 1: Minor engagement (less than 20%).
- 2: Significant engagement (20% to 40%).
- 3: Major engagement (more than 40%).

11. **Labor Practices**

How does the technology solution influence labor practices and workers' rights in the integrator organisation?

- 0: Negative influence.
- 1: No influence.
- 2: Positive influence (some improvement).
- 3: Highly positive influence (significant improvement).

12. **Education and Awareness**

How does the technology solution contribute to education and raising awareness about sustainability issues in the integrator organisation?

- 0: No contribution.
- 1: Minor contribution (less than 20%).
- 2: Significant contribution (20% to 40%).
- 3: Major contribution (more than 40%).

13. **Child Labour Policy**

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Does the integrator organization have a policy on addressing incidents of child labour?

- 0: No.
- 1: Partially.
- 2: Yes, to a significant extent.
- 3: Yes, comprehensively.

14. **Regulatory Compliance**

Does the technology solution comply with current and anticipated social regulations promoting sustainability practices?

- -1: No, it does not comply.
- 0: Significant compliance risk exists.
- 1: Minor compliance risk exists.
- 2: Fully compliant or negligible compliance risk exists.

Part C: Economic Sustainability

15. Cost Efficiency

How does the technology solution impact cost efficiency of the integrator organisation compared to its next best alternative?

- 0: No impact.
- 1: Minor improvement (less than 20%).
- 2: Significant improvement (20% to 40%).
- 3: Major improvement (more than 40%).

16. Economic Growth

What is the potential of the technology solution to contribute to economic growth in general, if applied at a large scale (in one or more industries or economic sectors)?

- 0: No potential.
- 1: Minor potential (less than 20%).
- 2: Significant potential (20% to 40%).
- 3: Major potential (more than 40%).

17. Job Creation

How does the technology solution contribute to job creation in general, if applied at a large scale (in one or more industries or economic sectors)?

- 0: No contribution.
- 1: Minor contribution (less than 20%).
- 2: Significant contribution (20% to 40%).
- 3: Major contribution (more than 40%).

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18. **Market Demand**

Is there some evidence of market demand and willingness to adopt the exploitable technology solution from the standpoint of the integrator organisation?

- 0: No.
- 1: Minor evidence.
- 2: Significant evidence.
- 3: Major evidence.

Part D: Governance and Compliance

19. **Transparency and Reporting**

Does the integrator organization report on its sustainability performance and initiatives including the integration of the exploitable technology solution?

- 0: No.
- 1: Partially.
- 2: Yes, to a significant extent.
- 3: Yes, comprehensively.

20. **Risk Management**

How well does the technology solution mitigate sustainability-related risks?

- 0: Not at all.
- 1: To a minor degree (less than 20%).
- 2: To a significant degree (20% to 40%).
- 3: To a major degree (more than 40%).

21. **Stakeholder Engagement**

Are stakeholders actively engaged in the sustainability initiatives related to the exploitable technology solution?

- 0: No.
- 1: To a minor degree (less than 20%).
- 2: To a significant degree (20% to 40%).
- 3: To a major degree (more than 40%).

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