FISSAC

FOSTERING INDUSTRIAL SYMBIOSIS FOR A SUSTAINABLE RESOURCE INTENSIVE INDUSTRY ACROSS THE EXTENDED CONSTRUCTION VALUE CHAIN

Guideline for the application of ETV in the sector

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[1] PU = Public
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0. Summary

This Guideline has been developed by RINA SERVICES S.P.A. in the European Project FISSAC for the application of ETV in the industrial activities related to the construction sector: recycling processes and production of innovative materials with the use of secondary materials. It aims to put into practice the inputs provided by the ETV General Verification Protocol, version 1.2 - 27th July 2016[2] (from now on called "GVP") and by the Guidance Documents published by the ETV Technical Working Groups.

The FISSAC project aims to develop and demonstrate a new paradigm built on an innovative industrial symbiosis model towards a zero waste approach in the resource intensive industries of the construction value chain, leading to material closed-loop processes and moving to a circular economy.
Switching from a linear business model to a circular one can lead to a more sustainable and resource efficient way of supplying products and services to the market. It is therefore crucial to evaluate new production systems from an environmental, social and economic point of view, in order to ensure that investments in circular models are producing tangible results and paving the way to a more sustainable future. The EU-Environmental Technology Verification (ETV) pilot programme has been selected as specific evaluation tool.

This Guideline is the first deliverable of a series of four documents (D3.9, D3.10, D3.11 and D3.13) that will be drafted by RINA on ETV, as foreseen in the Work Package 3 (WP3). RINA's goal, at this stage of the FISSAC project, is to:

- Give an overview of the EU-Environmental Technology Verification (ETV) Pilot Programme;
- Define FISSAC Project's technologies: Materials, Waste and Resources;
- Describe the Eligibility Assessment of the technologies;
- Define Parameters and Indicators useful to analyse the specific technology.

The purpose is therefore to instruct FISSAC partners about the ETV programme's structure and scope in order to let them comprehend the added value given to the technology by a full verification protocol. Partners also need to figure out whether their technologies are suitable or not according to the eligibility requirements described in the ETV programme and eventually be aware of the evaluation method and validation process, which will be applied in the aforementioned three deliverables that will follow:

- D3.10: ETV: Eligibility check performed/Quick Scans verified;
- D3.11: ETV: Initial performance claims approved;
- D3.13: ETV: Specific Verification Protocols approved for each innovative solution.

The RINA team drafted the current Guideline considering the GVP, the relevant Guidance Documents produced by the Technical Working Groups and the material produced during the ETV stakeholder forums as main resources. Technologies already verified under the ETV Pilot Programme by RINA or by other third-party bodies[3] have been considered in order to understand which parameters have been applied in the specific cases and to transpose this knowledge into the Guideline.

[2] This version of the GVP is available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/pdfs/env-16-003-rapport-etv-en-web.pdf. Last visit: 06/07/2017.

[3] A list of every verified technologies under the ETV programme is publicly available on the European Commission website: http://ec.europa.eu/environment/ecoap/etv/verified-technologies_en. Last visit: 14/07/2017.

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Abbreviations and acronyms

C&DW: Construction and Demolition Waste
EC: European Commission
ETV: Environmental Technology Verification
EU: European Union
GVP: General Verification Protocol
SRM: Secondary Raw Material
VB: Verification Body
TA: Technology Area
TB: Test Body
TG: Technology Group
TWG: Technical Working Groups

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ETV Glossary

General Verification Protocol (GVP) means the description of the principles and general procedures to be followed by the EU ETV pilot programme when verifying an environmental technology.[4]
When GVP is mentioned, the author refers to version 1.2 - 27th July 2016.

Specific Verification Protocol means the protocol describing the specific verification of a technology and applying the principles and procedures of the General Verification Protocol.[4]

Technology means the practical application of technical or scientific principles to achieve a given purpose. The term technology covers products, processes, systems and services.[4]

Environmental technologies are all technologies which provide an environmental added value compared to relevant alternatives.[4]

Relevant alternatives are commercially available technologies relevant for comparison with the technology under verification and performing the same or a similar function.[4]

Innovative environmental technologies are environmental technologies presenting a novelty in terms of design, raw materials and energy involved, production process, use, recyclability or final disposal, when compared with relevant alternatives.[4]

Environmental added value means the reduction of the environmental pressure or a positive impact on the environment including but not limited to removal, prevention, reduction, mitigation of pollutants released to the environment, restoration of environmental damages or use of natural resources in a more efficient and sustainable manner.[4]

Performance claim means a set of quantified and measurable technical specifications representative of the technical performance and environmental added value of a technology in a specified application and under specified conditions of testing or use.[4]

Verification means the provision of objective evidence that the technical design of a given environmental technology ensures the fulfilment of a given performance claim in a specified application, taking any measurement uncertainty and relevant assumptions into consideration.[4]

Technology Areas (TA): are the main categories in which the GVP divides technologies addressed by the verification process. TAs are further divided into Technology Groups (TG).

Technology Group (TG) means a class of technologies serving the same or closely related purposes (i.e. is used in the same application).[4]

Proposer can be the legal entity or natural person that owns the technology, a manufacturer or an authorised representative of either. It voluntary submits the innovative environmental technology to a Verification Body (VB) in order to get a third-party validation of the technology's performance.

Verification Body (VB) evaluates the technology submitted by the proposer according to the procedure laid down in the GVP. It shall have a legal personality and it is accredited to comply with the requirements of ISO/IEC 17020 by an Accreditation Body. It is an independent third-party body with no relations with the proposer or any other party interested in the verification.

Accreditation shall have the meaning assigned to it by Regulation (EC) No 765/2008.[4]

[4] Source: this definition comes from the Appendix 1 of the General Verification Protocol (GVP), version 1.2 - 27th July 2016.

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National accreditation body shall have the meaning assigned to it by Regulation (EC) No 765/2008.[4]

Test Bodies (TB) are organisations responsible for performing the testing of a technology, if required.

Technical Working Groups (TWG) are appointed to identify new Technology Areas, to keep updated the list of technologies eligible for the programme and to provide Guidance Documents on the application of ETV procedures useful to Verification Bodies when implementing the GVP. At least one representative of each Verification Body and a similar number of other experts should constitute the Technical Working Groups.

Performance parameters related to the performance of the technology in fulfilling its purpose.

Operational parameters means measurable parameters that define the application and the verification and test conditions.[4]

Environmental parameters means measurable parameters related to potential environmental impacts or the environmental added value in a life-cycle perspective.[4]

Additional parameter means information on a technology, not covered by performance, operational or environmental parameters, but considered in the verification process because of its usefulness and relevance for technology users.[4]

Life-cycle perspective means the consideration of the main environmental benefits and pressures or impacts generated by a technology along its life cycle, from the extraction of raw materials, manufacturing process, use and maintenance, until the end of life of related equipment or products.[4]

Ready to market means that the technology is available on the market or at least available at a stage where no change affecting its performance will be implemented before introducing the technology on the market.[4]

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1. Objective of the Guideline

This document has been developed by RINA SERVICES S.P.A. according to the European Project FISSAC (Grant Agreement N° 642154) for the application of ETV in the sector: recycling processes and production of innovative materials with the use of secondary materials. It aims to put into practice the inputs provided by the ETV General Verification Protocol and by the ETV Technical Working Groups.

The Objective of the Guideline is to train FISSAC partners on the ETV programme in order to let them comprehend the added value given to the technology by a full verification protocol.
Thanks to this Guideline, partners would be able to actively participate in a more conscious way in the ETV process, giving to RINA all the needed information about their technologies. Moreover, they would be aware of the evaluation method and validation process, which will be implemented by RINA.

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2. EU-Environmental Technology Verification (ETV) Pilot Programme

2.1 General Overview

The Environmental Technology Verification (ETV) pilot programme, operating since 2013 as one of the key initiatives under the "Eco-Innovation Action Plan" of the European Commission, is a tool aimed to support and promote eco-innovation at a European-level by helping innovative environmental technologies to reach the market. The programme is addressed to innovative technologies whose benefits in environmental and health terms cannot be proved through existing standards or certification schemes and whose performance claims could be stated from a credible verification procedure as a guarantee to investors.

According to the General Verification Protocol (GVP), any legal entity established within or outside the European Union has the possibility to submit an innovative environmental technology for a voluntary verification under the ETV pilot programme if the technology fulfils the following criteria:

- It corresponds to the definition of "innovative environmental technology" provided under Appendix 1 of the GVP and here reported: "environmental technologies presenting a novelty in terms of design, raw materials and energy involved, production process, use, recyclability or final disposal, when compared with relevant alternatives with the potential to contribute to efficient use of natural resources and a high level of environmental protection". This topic will be discussed at the sub-chapter 4.3: "Environmental Added Value Assessment";
- It belongs to one of the following three Technology Areas (TA): Water treatment and monitoring – TA 1; Material, waste and resources – TA 2; Energy technologies – TA 3. These TAs will be later described in the sub-chapter 2.4: "Technology Areas (TA)";
- It is ready to market or it is already commercially available. This topic will be more widely discussed in the sub-chapter 4.2: "Readiness to Market: Technology Readiness Level (TRL)".

If a technology fits the requirements fixed by the programme, the verification procedure can start. The main stages of the procedure start with a first phase where the eligibility of the technology is checked. The second step consists of a deeper knowledge of the technology by the Verification Body and ends with a verification contract. At this stage, a specific verification protocol describes how the verification has to be conducted, including the eventual need of further tests. Upon completion of the testing phase and the collection of all the relevant data, the assessment and verification phase finally starts. The final products of the process are the Verification Report and a Statement of Verification, which will be published on the dedicated website managed by the European Commission.

Within the FISSAC European Project, the ETV scheme will be used to evaluate the environmental performance of closed loop recycling process designed by the Industrial Partners. Partial objectives of the Work Package 3 (WP3) are indeed to develop, optimize and validate new cost-effective construction products through the total or partial replacement of virgin raw materials by higher amounts of secondary high-purity raw materials recovered from industrial waste, with a specific focus on eco cement, green concrete, innovative ceramic tiles and rubber wood plastic composites.

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2.2 Entities involved in ETV programme

Many different entities are involved in the ETV programme; all of them having a specific role aimed at creating an efficient and reliable scheme. A first group, consisting of Proposers, Verification Bodies and Test Bodies, is responsible for the individual verification processes while a second one with the remaining entities has set up and still manages the entire ETV programme's structure.

European Commission (EC) and Steering Group

The European Commission is the European Union's politically independent executive arm since 1958. It is an institution that promotes the general interest of the EU by proposing legislation as well as by implementing policies and managing the daily business of the EU.
The EC ensures the general co-ordination and supervision of the EU ETV pilot programme, convenes and chairs the Steering Group and the Technical Working Groups. In consultation with the Steering Group, it defines the rules governing the programme, including the GVP and the Technology Areas covered.

A Steering Group composed of representatives of the participating EU Member States assists the EC in the implementation of the EU ETV pilot programme. More specifically, it advises the EC on the Technology Areas covered by the programme, on the GVP and on the activities of Technical Working Groups.

Proposer

The proposer can be the legal entity or natural person that owns the technology, a manufacturer or an authorised representative of either. It voluntary submits the innovative environmental technology to a Verification Body (VB) in order to get a third-party validation of the technology's performance. The submission defines the beginning of the verification procedure.
Between the proposer and the VB there should be a productive relationship of collaboration since they have the same goal: proving the quality of the technology from an environmental perspective in an objective way. During the verification, the proposer supports the VB since the beginning of the process to the very end by providing the necessary information about the technology, reviewing and approving documents in key phases of the process. It contracts with the VB and, where needed, with the Test Bodies, paying for any required contracted services.

The proposers in the FISSAC project's contest are the partners holding a suitable technology that can then be an innovative recycling process for C&DW or a construction material involving a share of secondary raw materials in its production process.

Verification Bodies (VB)

The Verification Body evaluates the technology submitted by the proposer according to the procedure laid down in the GVP, which is descripted in the sub-chapter 2.3. The complete list of the requirements, responsibilities and duties a VB must fulfil is available in the GVP; only the most relevant ones are here reported with the aim of highlighting the crucial role of the VB in an ETV Process.

The Verification Body shall have a legal personality and it is accredited to comply with the requirements of ISO/IEC 17020 by an Accreditation Body. It is an independent third-party body with no relations with the proposer or any other party interested in the verification. Being independent means that the VB is not directly involved in the design, manufacture or construction, marketing, installation, use or maintenance of the specific environmental technologies submitted to this body for verification.
Confidentiality, objectivity, professional integrity and impartiality of the verification activities need to be ensured by the VB and by every subsidiaries or subcontractors involved in the verification.
The "Part C: Quality management" of the GVP defines a strict quality management of the organizations involved and quality assurance of the verification process. Because of these reasons, the VB shall have in place:

- the necessary personnel with the relevant technical knowledge to perform the verification tasks;
- the descriptions of procedures in accordance with which verification is carried out, ensuring the transparency and the ability of reproduction of those procedures;
- appropriate recording and reviewing procedures of the products of verification activities ensuring their high level of quality and reliability.

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The main duty of the VB is to receive and process proposals for verification up to the final phases of the process. Besides this, it ensures compliance with the quality management requirements and general test requirements of the GVP of Test Bodies eventually involved; it requires or validates test methods, assesses and accepts test data provided by a Test Body; it takes part to the Technical Working Groups relevant for their technology scope; it provides technical advices to the proposers in the context of ETV procedures; it reports annually to the European Commission and the national Accreditation Body on the activities implemented in the contest of the ETV Programme.

In the FISSAC project's scenario, RINA SERVICES S.P.A. will cover the role of Verification Body having obtained the accreditation for the ISO/IEC standard 17020 from ACCREDIA for all the Technology Areas of the ETV Programme.

Test Bodies (TB)

Test Bodies are organisations responsible for performing the testing of a technology, if required, in accordance with the specific verification protocol. Tests are necessary during the verification process in those cases where a lack of fundamental information regarding the technology occurs.
The Proposer designates the Test Body, in consultation with the Verification Body, even when the VB has itself the qualification to act also as a TB.

Test Bodies shall fulfil some quality management and general test requirements; specifically the ones of ISO/IEC Standard 17025 – "General requirements for the competence of testing and calibration laboratories", that are considered relevant by the VB for the tests to be performed. Moreover, the staff of the TB shall not be the same as those responsible for the evaluation of the test results in the VB and they shall not be dependent upon these.
When the Proposer performs the tests in-house, it shall fulfil the same requirements for TB outlined in the GVP, as it would be a third-party body.

Accreditation Bodies

National accreditation bodies are established under national law in each of the Member States in application of Regulation (EC) N° 765/2008. Their role in the ETV Programme is to accredit VBs according to ISO/IEC 17020 to implement the verification procedure.
This ensures the technical competence and capability of VBs to implement ETV procedures for specified technology groups so that the ETV "Statements of Verification" can be recognised and accepted in all relevant markets. An adequate quality management system can be guaranteed, together with the required level of quality and reliability for ETV deliverables.

The Technical Working Groups (TWG)

TWGs are appointed to identify new Technology Areas, to keep updated the list of technologies eligible for the programme and to provide Guidance Documents on the application of ETV procedures useful to Verification Bodies when implementing the GVP.
According to the GVP, at least one representative of each Verification Body and a similar number of other experts should constitute the Technical Working Groups, trying to keep a balance between technical, scientific and marketing expertise of the members.

Stakeholder Forums

They are open to industrial associations, environmental non-governmental organisations, public or private technology centres, organisations representing public or private purchasers of technologies, public authorities, individual companies or persons with an interest in the ETV Programme. The forecasted aim of the forums is to advise on general and specific issues relevant to the implementation of the programme.
The first two Stakeholder Forums took place in December 2012 and April 2014 in Brussels (Belgium) and Hanover (Germany) respectively.

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2.3 Verification Procedure

In order to assure the reliability of the ETV scheme, every verification process needs to implement these essential requirements:

- Clearness of information;
- Transparency of procedures;
- Accuracy in the statement and reporting of technical performances of any technology under assessment.

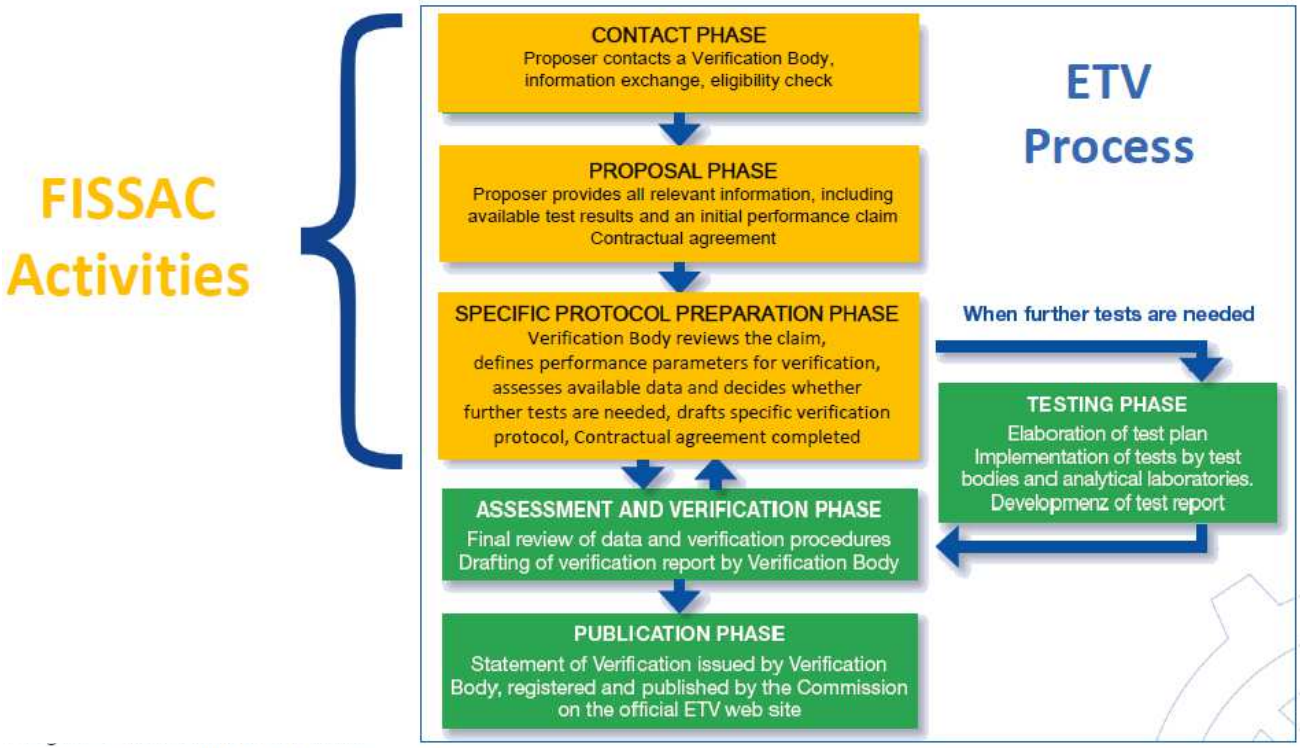
These requirements are easily fulfilled thanks to the precise protocol available in the GVP, which prevents mistakes or undesired situations to arise if properly respected.

The verification procedure described in the GVP consists in a number of distinct phases, shown in the Figure 1:

1. **Contact phase** *(phase in the FISSAC framework)*
2. **Proposal phase** *(phase in the FISSAC framework)*
3. **Specific Verification Protocol phase** *(phase in the FISSAC framework)*
4. **Testing phase** *(phase outside the FISSAC framework)*
5. **Assessment and Verification phase** *(phase outside the FISSAC framework)*
6. **Publication phase** *(phase outside the FISSAC framework)*

RINA's activity in the FISSAC framework ends with the Specific Verification Protocol phase and the related phases are highlighted with a yellow background. The remaining three phases, on the green background, are outside the FISSAC framework.

Figure 1 – Phases of the ETV programme verification procedure[5]



5 Source: "General Verification Protocol (GVP)" version 1.2 - 27th July 2016. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/pdfs/env-16-003-rapport-etv-en-web.pdf. Last visit: 06/07/2017.

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2.3.1 Verification Procedures in the FISSAC framework (Phases 1, 2, 3)

The "Task 3.5 Environmental Technology Verification (ETV)" of the FISSAC project states that RINA will receive a quick scan form from the Industrial Partners and will therefore perform the eligibility assessment of the submitted technologies (Deliverable 3.10). Later on RINA will revise and approve the initial performance claim (Deliverable 3.11) and, as the last phase considered by the FISSAC framework, it will draft and approve the specific verification protocol for each innovative solution (Deliverable 3.13).
These duties correspond with the first three phases of the verification procedure, which will be described in the current chapter. A description of the second part of the procedure, which will be excluded by the FISSAC framework, is available in the next sub-chapter 2.3.2.

Phase 1 - Contact Phase

The very first stage of an ETV Process starts with a contact between the VB and the proposer, which provides a "**quick scan**" document outlining the main characteristics of the technology to be verified. The information available in the quick scan allow the VB to assess the eligibility of the technology and to give an early indication of the complexity and potential range of costs of a complete verification. The "**eligibility assessment**" is an important phase of the process that will be treated in detail in a dedicated part of this dissertation, specifically in the chapter 4.
The quick scan document shall follow a template available in the GVP at the "Appendix 3: Template for the Quick Scan". A version of this document, which will be useful in the FISSAC project, is attached to this paper: "ANNEX 1: Quick scan document template".

In the FISSAC project's scenario, a "**pre-contact phase survey**" has already been submitted to the partners in order to identify their interest in the application of ETV procedure on their technologies. Feedback comes from manufacturers of the following products: eco-cement; noise absorption panels made by recycled rubber, plastic and wood; mineral-based thermal insulation boards. The survey was asking:

- Do you have (or are you developing) a technology (product/service/process) that could be eligible for ETV?
- Is it already on the market or not yet?
- Please, give a short description (use, material involved, strengths, innovative aspects, etc.)
- Do you have identified environmental benefits for this technology compared to existing products/services/processes already on the market? Could you briefly describe these benefits?

Phase 2 - Proposal Phase

If the technology is considered eligible and if the proposer decides to perform the verification, the proposer provides the information needed by the VB to conclude a verification contract and draft the specific verification protocol. Note that the information provided at this stage can reverse the eligibility assessment previously delivered by the VB.

The proposer submits a "**Verification Proposal**" to the Verification Body, following the template provided in the Annexes (ANNEX 2: Verification proposal template) and including:

- Technical documentation sufficient for the VB to understand the technology, review the performance claim and assess the conformity of the technology design with the performance claim. User manuals if available, the conceptual design, results of design calculations made, examinations carried out and test reports if available;
- The forecasted application of the technology specified in terms of matrix, purpose and technical conditions;
- The initial performance claim consisting of a set of parameters and values describing the technology's performances, highlighting the advantages and innovative features of the technology and describing the direct environmental impacts of the technology. These data have to be quantifiable and verifiable through tests;
- Available information on the environmental added value;
- The legal requirements applicable to the technology in the target market for which the verification is performed and evidence that the technology performs in line with these requirements;
- Any relevant documents from any previous evaluations, verifications or certifications implementing the same or similar procedures to ETV.

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After the VB has reviewed the proposal, it provides a detailed cost estimate for the whole procedure, excluding tests, together with a list of potential tests to be performed and prepares the contractual agreement. Based upon this cost estimate, a verification contract will be drafted and signed by the proposer and the VB. It is recommended to follow the template in Appendix 5 "Template proposed for the Verification Contract" of the GVP in order not to miss any important item that should be covered by the document.

Phase 3 - Specific Verification Protocol phase

The "**Specific Verification Protocol**" document defines how the verification will be conducted, including a precise description of the verification parameters and all relevant requirements on tests and test data. The VB is responsible for the preparation of the specific verification protocol, following the provisions of the GVP and any relevant guidance provided by the TWG. The specific verification protocol shall follow the structure given in the table of contents provided in Appendix 6 of the GVP and here available in the Annexes: "ANNEX 3: Table of contents and parameter definition table for the specific verification protocol".

In this phase, the VB and the proposer should agree on requirements on test data, on testing and calculation methods, and on how other parameters are to be dealt with in the verification process. The VB shall assess the existing data provided by the proposer and therefore decide if additional tests are needed or not. If additional tests are required, the procedure continues with the "Testing phase", it is otherwise possible to proceed straight to the "Assessment and Verification phase".

The verification parameters and their numerical values are one of the core elements of the verification process since they express the performance of the technology to be verified. Because of this reason, the verification of a technology under ETV Programme requires a precise definition of the verification parameters, which should be carried out by the VB in co-operation and agreement with the proposer.
It is possible to divide the verification parameters into the following categories:

- **Performance parameters** related to the performance of the technology in fulfilling its purpose. More details at chapter 5.1;
- **Operational parameters** related to the technical conditions of the intended application and particularly useful to determine the testing conditions. Operational parameters can be the ambient temperature or the relative humidity, for example. More details at chapter 5.1;
- **Environmental parameters** related to potentially significant impacts on the environment, directly and indirectly, along the life cycle. Examples are energy consumption or emission of pollutants to air or water. These parameters are usually useful in the assessment of the environmental added value in the Proposal Phase and. More details and a general list of the main environmental parameters, which will be considered in the FISSAC framework are given in the sub-chapters 4.3.3 and 5.2;
- **Additional parameters** can be considered if they are useful for users but cannot be included in one of the three categories previously listed, e.g. the overall service life, health and safety issues, installation and maintenance requirements and operating costs.

When defining the verification parameters, these have to be selected separately for each technology in order to reflect the different requirements for different applications and technologies. This is a customized operation aimed at describing the characteristics of the technology in the best way available. It is a crucial phase, which will be widely discussed at the chapter 5.

Circular Economy Indicators applicable in the ETV verification will have a relevant role in the verifications run in the FISSAC scenario since the technologies that will be evaluated in this European Project have been developed with the aim of leading to material closed-loop processes and moving to a circular economy. Circular Economy Indicators will be discussed later on in the core part of this paper, at the chapter 5.3.

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2.3.2 Verification Procedures outside the FISSAC framework (Phases 4, 5, 6)

The Specific Verification Protocol is the last step that will be performed by RINA in accordance with the FISSAC project. The following phases described in this sub-chapter are here listed to illustrate the complete process required to obtain the Statement of Verification, which can eventually be carried out outside the FISSAC framework. The Statement of Verification is a public document intended for Business-to-Business (B2B) relationships, which claims the environmental performances of the technology based on the procedure carried out by an independent third-party body.

Phase 4 - Testing phase

In this phase, needed only when additional tests are required, the Test Body elaborates the test plan, implements the tests and drafts the test report.
The essential requirements for the test design and test methods are described in the specific verification protocol. They shall reflect the definition of verification parameters and shall include the overall test design, the scale and matrix used for tests, the parameters to be measured, the methods to be used and the testing conditions. Other requirements concerns the data management, the quality assurance and the contents of test report.

The Proposer designates the Test Body, in consultation with the Verification Body; alternatively, the proposer may perform the necessary tests in-house, which can be particularly likely when the necessary test equipment or skills are not easily available outside of the proposer. Whether the tests are carried out in-house by the proposer or by a third party TB, the test sites shall be defined in accordance with the requirements set in the specific verification protocol.

The "**Test Plan**" is a document that contains the exact information required by the testing staff to conduct the tests. It shall be drafted by the test body and approved by the proposer and the VB while, if tests are performed in-house by the proposer, the test plan shall be drafted by the proposer and approved by the Verification Body.
The test method used shall refer to standards, preferably international or European standards.

After the testing, the TB drafts a "**Test Report**" and submits it to the proposer and the VB for approval. The report indicates the format and location for archiving the raw data, the list and summary of any amendments to the test plan and deviations recorded during tests, the measured and calculated data as well as naming the staff that performed the test. The test and calculation methods shall be described, together with the equipment and software used.

Phase 5 - Assessment and Verification phase

In the core part of the process the VB proceeds with the assessment and verification phase that consists of test report review, conclusion of the test system assessment, assessment of all test data and verification.

The VB reviews the test report, as prescribed in the quality assurance guidelines of the GVP. This review can support the test system assessment and the assessment of data presented. The review shall also include an assessment of whether the tests followed the requirements of the specific verification protocol and the test plan.
The VB concludes then the test system assessment, deciding whether the test system in which the data has been produced is suitable; considering in particular the quality management and general test requirements of the GVP.

The next step consists of collecting and assessing all the available data relevant for the verification. The data considered in this phase comprehend both the results of the test phase and the previously existing data. The VB needs to assess if these collected data are complete and satisfy the requirements and criteria for acceptance provided in the specific verification protocol and test plan. The VB shall also carry out a critical review of the data, e.g. through random consistency checks.

At this stage, the VB evaluates whether there is a reliable and complete data set for verification and reporting. If this is not the case, previous phases of the procedure have to be re-iterated until the data evaluation gives a positive result.
The VB establishes then the verified performance and associated uncertainty in conformity with the calculation methods provided in the specific verification protocol, and determines whether the data supports the performance claim, using appropriate statistical techniques, and considering appropriate levels of confidence.
The result of this stage is a confirmation or determination of the performance of the technology based on reliable test results (the verified performance claim).

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Where applicable, the Verification Body shall assess the appropriateness and usefulness of additional information for the Statement of Verification, and draft the necessary caveats to avoid confusion or misleading interpretation of this additional information. These will include:

- Additional parameters mentioned in the specific verification protocol phase;
- Information on operating conditions not considered for verification;
- Qualitative information on environmental impacts (e.g. origin of raw materials, reference to complete life-cycle analysis or life cycle inventory, requirements on suppliers, instructions for re-use or recycling of materials);
- Other information, e.g. information about operating costs, provided by the proposer under its own responsibility.

Phase 6 - Publication phase

Based on the outcome of the assessment of data and verification, the ETV procedure ends with the drafting and publication of the "Verification Report" and the "Statement of Verification" by the VB.
The VB produces a full report on the whole procedure and results obtained in the implementation of the verification contract, and a draft Statement of Verification. After possible revision and with the agreement of the proposer, the VB approves the Statement of Verification and submits it to the European Commission for registering and publication.

The "**Verification Report**" shall summarise all information relevant for the verification, following the structure of the table of content provided in Appendix 8 of the GVP. It shall also include all relevant documents produced during verification as appendices:

- The quick scan;
- The proposal;
- The specific verification protocol;
- The test plan;
- The test report.

The verification report is delivered by the VB to the proposer. In order to guarantee the transparency of the process, it is recommended that the proposer accepts publication of the report, eventually without appendices if the proposer considers that publishing these may harm the protection of intellectual property.
The verification report shall be shared with the TWGs under the same conditions of confidentiality applying to the VB.

The "**Statement of Verification**" is a short document of approximately four pages, summarising the verification report. It shall include:

- A summary description of the technology verified, exact commercial name, type or reference number, purpose and conditions of use;
- The verified performance including the field of application, conditions and assumptions under which the verified performance is met;
- A summary of the procedures followed by the VB and by TBs;
- Any information necessary to understand and use the verified performance claim.

The template of the cover page and the structure of the document's body are available in Appendix 9 of the GVP.
The Statement of Verification may include a disclaimer related to legal compliance, e.g. "Unless stated otherwise, this verification has not evaluated and cannot guarantee compliance with specific legal requirements. Ensuring legal compliance is the responsibility of the proposer".
After possible revision and with the agreement of the proposer, the VB approves the Statement of Verification and submits it to the European Commission for registering and publication on the dedicated website. The document shall be signed by the VB and the proposer.

Post Verification phase

The GVP defines some duties relative to the post verification phase, in order to promote a healthy and serious dissemination of the ETV Programme and to guarantee its reliability and trustworthiness.

The proposer can include the Statement of Verification in the technical documentation of the verified technology and use it for marketing purposes. The proposer shall make the statement available in full and shall not use parts of the statement for any purpose.

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The proposer shall not use the ETV logo alone either on products or on publications other than the Statement of Verification. The ETV logo should be used on publications only when lies together with the reference to the Statement of Verification as long as the meaning of ETV is correctly reflected by the publication, avoiding in particular any confusion with endorsement or approval of the technology.

The verification is valid as long as the verified technology continues to conform to the published Statement of Verification. If any of the following changes to the verified technology occurs, the proposer shall report to the VB with the data needed to evaluate whether the conditions for verification have changed:

- Change of ownership;
- Design changes;
- Change of intended application or operational conditions;
- Other changes able to modify the performance results reported in the Statement of Verification.

The VB shall evaluate reported changes and data and if it concludes that the conditions for verification have changed, a new verification procedure shall be engaged by the proposer for this technology or alternatively, the Statement of Verification shall be withdrawn. The evaluation of the changes are at the cost of the proposer.
The Statement of Verification shall be withdrawn by the VB if misused by the proposer, where misuse is defined as violation of the conditions of ETV Programme verification. In the case of withdrawal, the Statement of Verification and verification report shall be removed from all web sites.

The EU ETV pilot programme strives to support verified technologies, which are published by the European Commission services and are included in ETV outreach materials. In addition to this, the technologies verified under the FISSAC project will benefit of its dissemination plan.

2.4 Technology Areas (TA)

In this first stage of application, the ETV Pilot Programme is running in three specific Technology Areas (TA). As previously mentioned, a technology has to belong to one of these areas in order to be submitted to the ETV Programme:

1. Water treatment and monitoring;
2. Material, waste and resources;
3. Energy technologies.

Figure 2 – Technology Areas[6]

Further Technological Areas are supposed to enter the process as soon as the scheme will gain deeper implementation:

4. Soil and groundwater monitoring and remediation;
5. Cleaner production and processes;
6. Environmental technologies in agriculture;
7. Air pollution monitoring and abatement.

In the following tables, the reader can find the Technology Areas with corresponding examples of technology groups and applications as described in the “Appendix 2: List of technology areas in the EU ETV pilot programme” of the GVP.

[6] Source: “European Commission website”, http://ec.europa.eu/environment/ecoap/etv/verified-technologies_en. Last visit: 07/07/2017.

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Table 1 – Technology areas in the scope of the EU ETV Pilot Programme[7]

Technology Area	Examples of Technology Groups/Applications with illustrative technologies
1. Water treatment and monitoring	• Monitoring of water quality for microbial and chemical contaminants (e.g. test kits, probes, analysers); • Treatment of drinking water for microbial and chemical contaminants (e.g. filtration, chemical disinfection, advanced oxidation) and desalination of seawater; • Treatment of wastewater for microbial and chemical contaminants (e.g. separation techniques, biological treatment, electrochemical methods, small-scale treatment systems for sparsely populated areas); • Treatment of industrial water (e.g. disinfection, filtration, purification).
2. Materials, waste and resources	• Recycling of industrial by-products and waste into secondary materials, recycling of construction waste into building materials (e.g. reworking of bricks), recycling of agricultural waste and by-products for non-agricultural purposes; • Improved resource efficiency through material substitution; • Separation or sorting techniques for solid waste (e.g. reworking of plastics, mixed waste and metals), materials recovery; • Recycling of batteries, accumulators and chemicals (e.g. metal reworking technologies); • Reduction of mercury contamination from solid waste (e.g. separation, waste mercury removal and safe storage technologies); • Products made of biomass (health products, fiber products, bioplastics, biofuels, enzymes).
3. Energy technologies	• Production of heat and power from renewable sources of energy (e.g. wind, sea, geothermic and biomass); • Reuse of energy from waste, biomass or by-products (e.g. 3rd generation biofuels and combustion technologies); • Generic energy technologies (e.g. micro-turbines, hydrogen and fuel cells, heat pumps, combined heat and power production, heat exchangers), distribution, energy storage; • Energy efficiency in industrial processes and in buildings (e.g. thermal envelope, wall insulation, energy efficient windows, heating, ventilation and air conditioning systems).

Table 2 – Potential additional technology areas in the EU ETV Pilot Programme scope[8]

Potential Technology Area *(not yet in force)*	Examples of Technology Groups/Applications with illustrative technologies
4. Soil and groundwater monitoring and remediation	• Soil and groundwater monitoring (e.g. test kits, probes, analysers); • Soil pollution remediation in situ and on site (e.g. thermal treatment, air venting, chemical oxidation); • Management and de-pollution of sediments, sludge and excavated soils.
5. Cleaner production and processes	• Savings of material resources by process optimisation, e.g. savings of chemicals or carbon; • Improved energy efficiency by process optimisation (i.e. specific techniques applicable to particular industrial processes); • Prevention and reduction of pollution and waste from industrial processes (e.g. new methods in surface coating).

[7] Source: "General Verification Protocol (GVP)" version 1.2 - 27th July 2016. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/pdfs/env-16-003-rapport-etv-en-web.pdf. Last visit: 06/07/2017.
[8] Source: "General Verification Protocol (GVP)" version 1.2 - 27th July 2016. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/pdfs/env-16-003-rapport-etv-en-web.pdf. Last visit: 06/07/2017.

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6. Environmental technologies in agriculture	• Reduction of air contamination and odour (e.g. housing techniques, air treatment), efficient use of water; • Recycling of nutrients and organic carbon from manure (e.g. separation, digestion), re-use of sewage sludge and re-use of waste water after treatment; • Reduction of pesticide use and contamination (e.g. spreading equipment, precision application), prevention of pollution from nitrates and phosphates.
7. Air pollution monitoring and abatement	• Air emissions monitoring (e.g. sensors, analysers and monitors, including continuous emission monitors); • Abatement of pollution from stationary sources (e.g. filtration, scrubbers, stabilisation of by-products, leakage prevention).

The variety of categories and applications causes uncertain borders between the different Technology Areas. Some technologies or applications are difficult to place because of their nature that touches more than one area; for example it could be difficult to decide whether a treatment process of waste water falls under the TA1 (Water treatment and monitoring) or the TA2 (Materials, waste and resources). In these uncertain situations, it is necessary to understand which one is the main Technology Areas involved since this may affect, among others, the possibility of a Verification Body to deal with a particular technology (eligibility for verification depends on the accreditation to the specific area). On this topic, the ETV TWGs have issued the "Guidelines for addressing the interfaces between Technology Areas in the context of the EU-ETV Pilot Program" (Guidance document 008/2015-04-08, Version 1.0), aimed to treat possible interfaces between Technology Areas.
The technologies involved by the FISSAC project should not be interested by this ambiguous situation since they are all belonging to the "Technology Area 2: Materials, Waste and Resources". The next chapter will provide more information about the TA2.

2.5 The added value of ETV

Some considerations about the potential added value that ETV can bring to these technologies are also given.
The **added-value of the Statement** is the assurance of the credibility of the claim as to the performance of the relevant technology, thus facilitating subsequent recognition by purchasers across and beyond the European Union. Under the current practice, performance claims are stated by the technology manufacturer without third-party verification. In the best case, the technology manufacturer provides a test report supporting the claims, but the value of a test report depends on the design and quality of the tests and on the competence and independence of the testing laboratory. Unverified test reports may not be recognised on foreign markets or may not be understood beyond a circle of technology specialists.
With proof of performance credibly assured, innovations can expect an easier market access and/or a larger market share and the technological risk is reduced for technology purchasers.

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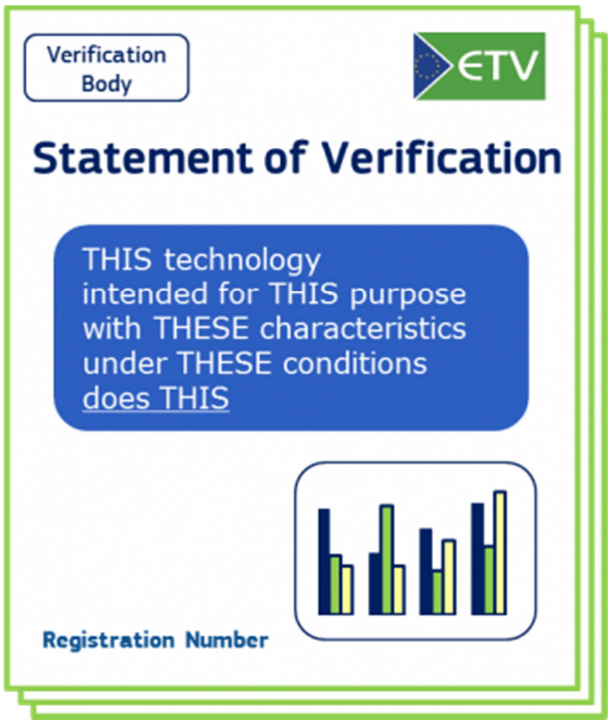
Figure 3 – Statement of Verification[9]



[9] Source: "European Commission website", http://ec.europa.eu/environment/ecoap/etv/verified-technologies_en. Last visit: 07/07/2017.

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3. FISSAC Project's technologies: Materials, Waste and Resources

The FISSAC project focuses on recycling processes to convert waste materials into valuable secondary raw materials and on the design of eco-innovative construction products: new Eco-Cement and Green Concrete, innovative ceramic tiles and Wood Plastic Composites (WPC) in pre-industrial processes under a life cycle approach. These technologies entirely fall under the "Technology Area 2: Materials, Waste and Resources" and, in particular, they correspond to the Technology Groups A, B, C of the following table:

- Sorting techniques for solid wastes *(Technology Group C);*
- Recycling solutions for waste streams from industrial sectors into secondary materials *(Technology Group A)*;
- Recycling solutions for C&DWs into secondary materials *(Technology Group A)*;
- Production processes of construction materials *(Technology Group B)*;

Table 3 – Technology groups of Technology Area 2: Materials, Waste and Resources[10]

Technology Area	Examples of Technology Groups/Applications with illustrative technologies
2. Materials, waste and resources	A. Recycling of industrial by-products and waste into secondary materials, recycling of construction waste into building materials (e.g. reworking of bricks), recycling of agricultural waste and by-products for non-agricultural purposes; B. Improved resource efficiency through material substitution; C. Separation or sorting techniques for solid waste (e.g. reworking of plastics, mixed waste and metals), materials recovery; D. Recycling of batteries, accumulators and chemicals (e.g. metal reworking technologies); E. Reduction of mercury contamination from solid waste (e.g. separation, waste mercury removal and safe storage technologies); F. Products made of biomass (health products, fibre products, bioplastics, biofuels, enzymes).

The task 3.4 of the FISSAC project states that the ETV will evaluate the environmental performances of each closed loop recycling process designed, comprehensive of the different technologies useful in the different phases of the circular process. This means that the technologies submitted to RINA under the FISSAC scheme can span from recycling processes of waste materials to the production processes of the final products and therefore the correct Technology Groups of the specific technologies that will feed the ETV process will be evaluated once the verifications will start.
The present work focuses on the Technology Groups A, B, C that have deemed to be the most promising in the "materials, waste and resources" area and that best fit with FISSAC objective.

3.1 Sorting techniques for solid wastes

Better collection and sorting for recycling processes, guarantee the generation of high quality scrap ready for recycling into new valuable end-use products. Relevant performances and environmental parameters when evaluating this group of technologies can include:

- Purity of the secondary raw material, to evaluate the quality of the process;
- Efficiency of the process;
- Energy and water consumption since separation and sorting techniques usually impacts in terms of energy and/or water consumption. However it has to be considered that the process consumption is usually more than balanced by the avoid resources consumption for the production of goods from virgin raw materials;
- Use of hazardous chemicals can be a relevant aspect to be verified in some specific process.

[10] Source: "General Verification Protocol (GVP)" version 1.2 - 27th July 2016. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/pdfs/env-16-003-rapport-etv-en-web.pdf. Last visit: 06/07/2017.

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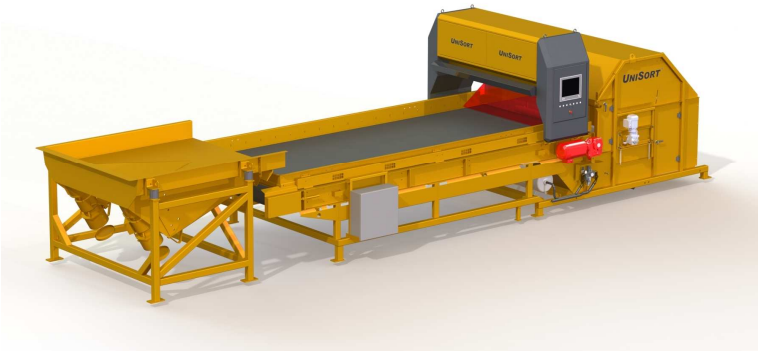
3.1.1 Sensor based automated sorting technologies

Sensor based sorting technologies can identify and separate a wide variety of materials by using sensors, spectrometers, cameras and scanners able to scan up to several thousands of points per second. About the complexity of the technologies, sorters available on the market can nowadays combine:

- Visible range spectrometer cameras able to detect colour and non-transparent elements;
- Near infrared spectrometers, which can detect different types of polymers;
- Metal sensors for detecting ferrous and non-ferrous particles.

Innovative technologies in this field can combine different optical sensor systems into one single stream, reaching higher levels of energy efficiency when compared to inline separate sensor based sorting solutions.

Figure 4 – Sensor based automated sorter [11]



3.2 Recycling solutions for waste streams from industrial sectors into secondary raw materials

Together with the expected products, industrial activities produce undesired waste materials and by-products, which come in many different shapes such as metal slags, wooden sawdust, stone powder, scraps and even air/water/ground pollutants. Some of these materials can still have a function as secondary raw materials and therefore an economical value; in addition, reusing or recycling them reduce the environmental pressure of the industrial activities themselves.

One goal of the FISSAC framework is to define innovative technological and non-technological processes for obtaining cost-effective secondary raw materials from different industrial waste streams to be used in the design and manufacturing of eco-innovative construction products, with a specific focus on Eco Cement, Green Concrete, ceramic tiles and Wood Plastic Composites (WPC).
Partial objectives of the Work Package 2 (WP2) are to define the technical requirements of the secondary raw materials, to determine critic parameters of the current industrial waste streams through exhaustive characterization and to optimize cost-effective technologies for the production of secondary raw materials.
The industrial sectors considered within the FISSAC scheme are the metallurgic sector, in particular steel and aluminium, glass sector, quarry/mining industry and chemical sector. From these industrial streams, it is possible to obtain secondary raw materials useful in the production of the aforementioned eco-innovative construction materials (Eco Cement, Green Concrete, ceramic tiles and WPC). The raw materials will be expected to reach defined standards in terms of:

- Physical characteristic: particle-size, particle shape, colour, humidity, volumetric stability;
- Chemical characteristics: chemical composition, homogeneity, potential reactivity, presence of impurities.

The following table represents industrial sectors and SRMs involved in FISSAC project, belonging to these areas. Considering each SRM, it is important to note that each of them belongs to the TA2 of ETV programme.

[11] Source: "HISER European Project website", http://www.hiserproject.eu/index.php/our-activities/automated-sorting-and-recycling-technologies. Last visit: 19/07/2017.

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Table 4 – Industrial sector and SRMs involved

Industrial sector (origin)	Secondary raw materials	Eco-innovative construction materials	Application
Metallurgic sector (steel industry)	EAF slag - Electric Arc furnace steel slag	Green concrete	- Aggregates
	LF slag - Ladle furnace slag	Eco cement	- Clinker raw materials
	Aluminium oxide-based materials	Ceramic product	- Source of alumina
	Aluminium oxide-based materials	Eco cement	- Source of Aluminium, Clinker raw meal
Ceramic Industry & Recycling Industry (from C&DW)	Ceramic waste	Eco cement	- Clinker raw meal and mineral additives; - Additions/aggregates
Recycling Industry & Chemical sector	Glass Waste	Eco cement	- Clinker raw materials and mineral additives
	Wood Waste	WPC	- SRM
	Plastic Waste	WPC	- SRM
	Tyre Waste	WPC	- SRM
Quarry/Mining Industry	Marble Slurry	Ceramic product	- Source of $CaCO_3$

C&DW: Construction and Demolition Waste
SRM: Secondary Raw Material
WPC: Wood Plastic Composites

3.2.1 Metallurgic sector (steel and aluminium)

The steel industry uses advanced technologies and techniques to increase production yield rates, reduce its energy requirements, and facilitate the use of by-products. Recycled steel (sometimes called scrap steel) is one of the industry's most important raw materials. It comes from demolished structures and end of life vehicles and machinery as well as from the yield losses in the steelmaking process.
Secondary raw materials from steel sector that could be applied to construction sector, focus of the FISSAC project, are Electric Arc Furnace slags (EAF) and Ladle furnace basic (LF), usable especially as aggregates in concrete manufacture. To guarantee a high quality and performance of the previous named SRMs, it is important to remove any metallic traces through magnetic separators in order to induce pozzolanic activity, to avoid undesirable oxidizing environment during clinker process due to the high amounts of FeO slag wastes, to limit chlorides and fluorides for specific waste streams.
Considering these technologies under ETV process, it will be important to evaluate their chemical composition, to determine their potential use to get the typical composition of clinker; to consider an acceptable grain size, as the industry usually needs a particle size below 0.5 mm to feed the kiln; and to determine the moisture content, as it may trigger an increase in energy efficiency with high water content.

3.2.2 Glass sector

The glass recovery system is fairly simple, the majority of recovered glass comes from packaging waste (used glass containers) and a small amount is recovered from construction waste (flat glass).
Within the FISSAC Project, glass wastes are used as SRMs for clinker raw meal for eco cement production and as aggregates or mineral addition for green concrete production. These different applications depend on: waste glass composition (percentage of lightly tined flat glass, presence of highly transparent thermal insulating coatings, percentage of SiO_2, Al_2O_3, MgO, etc.); particle size (the smaller particle size fraction that is generally unsuitable for glass manufacturers will be ideal for use in ECO cement) and presence of contamination (ferrous metal, nickel-containing steels or alloys, inorganic material, etc.).
Technologies from this sector should be paying attention to technical requirements related to impurities or harmful substances contained in pulverized glass waste and to particle sizes.

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3.2.3 Quarry/Mining Industry

Processing of natural stone at factories is still producing a series of subproducts or residues, which originate an important environmental impact because those products are usually poured in dumps.
With reference to FISSAC Project, SRMs from quarry/mining industry include in particular small size waste consisting of fine particles (dust or slurry), which are preferable to be incorporated into the wet milling of ceramic slip. Specific requirements for marble slurry have been developed in the WP2 activities, regarding in particular humidity, aggregate and particle size, percentage of CaO, Al_2O_3, SO_4, Na_2O, etc.
In order to correctly develop an ETV verification protocol applied to this specific area, the following aspects should be analysed: the preparation and disaggregation of the slurry, the drying process and the disaggregation of the dried slurries, etc. These aspects should be expressed through performance and operational parameters.

3.2.4 Chemical sector and recycling industry

SRMs from both chemical sector or its recycling chain and recycling industry, constitute an interesting application for wood plastic composite (WPC) manufacture, which are composed of wood flour/fibre, a plastic matrix and chemical additives and mineral fillers. Typical SRMs from this sector are wood waste from sawmills and from wooden product manufacture, rubber waste and plastics waste from end-life industrial waste or post-consumer/in-process waste.
Considering these materials, especially the difficulties to make them disappear once used and the large amount of energy to produce them, it would be important to emphasise the environmental benefits considering the entire life cycle. To express this value, during the ETV process, it could be useful to better express the technologies benefits through circular economy indicators such as, for example, the mass of virgin feedstock used in a product, the embodied energy, the efficiency of the recycling process used to produce recycled feedstock for a product and the mass of unrecoverable waste generated when producing recycled feedstock for a product.

3.3 Recycling solutions for C&DWs into secondary raw materials

Construction and Demolition Wastes (C&DW) are materials generated when new buildings and civil-engineering structures are built or when existing buildings and civil-engineering structures are renovated or demolished. Civil-engineering structures include public works projects, such as streets and highways, bridges, utility plants, piers, and dams. C&DW materials are often bulky and heavy such as:

- Concrete;
- Wood;
- Asphalt;
- Gypsum;
- Metals;
- Bricks and tiles;
- Glass;
- Plastics;
- Salvaged building components like doors, windows, frames and plumbing fixtures;
- Trees, stumps, earth, and rock from clearing sites.

These wastes can feed recycling processes with the aim of obtaining secondary raw materials, which will have to reach defined standards in terms of physical and chemical characteristic such as for the materials obtained from the recycling of the industrial by-products and wastes treated in the previous chapter.
When considering a technology falling in this category, the ETV procedure should pay particular attention to critical themes such as the purity of the SRMs obtained, polluting substances, overall efficiency and the energy and/or water consumes of the recycling process. From a sustainability perspective, it is also relevant to consider if the recycling activity of the C&DW takes place on site or it has to occur in specific plants since the material transfer has an environmental impact.

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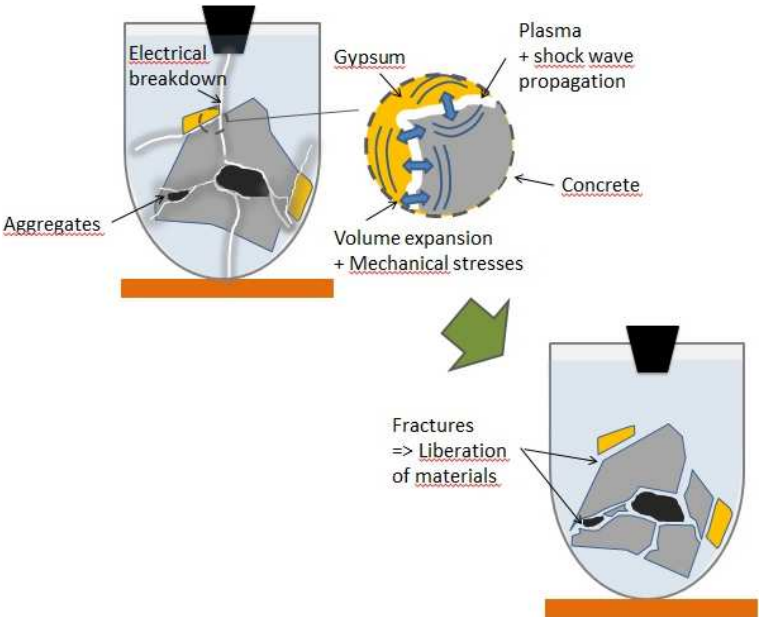
3.3.1 Electro-fragmentation technologies

This technologies lead to the production of a monophasic fraction via intergranular breakage in the recycling processes of composite materials. They perform selective separation of a wide range of different materials into their component parts, such as: waste concrete, adhered gypsum, insulating materials, incineration slag and carbon-fibre-reinforced plastics.
The process is based on ultrashort (< 500 nsec) underwater pulses. Spark discharge travels along the phase boundaries in the solid material and selectively breaks up solid materials into fragments.
Innovations in this field are mostly addressed to develop low energy intensive processes of fragmentation and to avoid damaging materials and therefore increasing the value of the final secondary raw material obtained.

Figure 5 – Electro-fragmentation diagram [12]



3.3.2 Advanced Dry Recovery (ADR) classification units

When recycling municipal solid waste incinerator bottom ashes (IBA) and construction and demolition wastes (C&DW) into high grade metal and mineral products, the size classification of the fine fraction (0-12 mm) is problematic at their typical moisture contents. Advanced Dry Recovery (ADR) is a classification method that allows in situ classification of the moist material down to 2 mm without drying or the addition of water.
ADR-unit uses kinetic energy to break the water bond formed by the moisture associated with the fine particles. The fine material can then be separated from the coarse material, which is suitable for conventional upgrading processes.
Innovations can include better energetic performances and an improved quality of the result.

[12] Source: "HISER European Project website", http://www.hiserproject.eu/index.php/our-activities/automated-sorting-and-recycling-technologies. Last visit: 19/07/2017.

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Figure 6 – Advanced Dry Recovery (ADR) classification unit on site [13]

3.4 Production processes of construction materials

A resource is a useful or valuable possession that can be used for economic production or consumption, which is subject primarily to quantitative depletion through human use. Every phase in the life cycle of a product, from manufacturing to disposal, has an impact on resource use. Actually, the use of resources happens during the manufacturing, distribution, use, maintenance, recycling and discarding phases of the product. Therefore, aside from the design stage, the way these processes take place has an important influence on the overall resource use of a product.
By using fewer resources and optimising their use, businesses can become more environmentally friendly, competitive and profitable.

The percentage of virgin feedstock used in a product compared to the percentage of recycled or reused feedstock is an important data when it occurs to evaluate the resource efficiency of a technology. Higher levels of secondary raw materials carry to a smaller amount of virgin raw material and therefore a higher resource efficiency, compared to traditional solutions.
The prolongation of a product's life is also crucial in terms of resource efficiency of the products and technologies.

3.4.1 Eco Cement

In order to substitute the virgin raw materials for the production of Portland cement clinker (e.g. limestone, marl or chalk, sand, shale, clay, iron ore, etc.) a diversified amount of waste is currently used to product cement. In this field, waste treatment and selection phases are crucial to guarantee the quality of clinker.
SRMs can be used on two different stages: at the clinker production step or at the cement production step. In the first case, SRMs are used as raw meal for the rotary kiln feed (Electric Arc Furnace (EAF) slag, Ladle Furnace (LF) slag, glass waste, ceramic waste and aluminium saline slag). In the second case, ceramic wastes, glass wastes, aluminium saline slag, Electric Arc Furnace (EAF) slag and Ladle Furnace (LF) slag will feed the cement mill as additions for cement production.
As a basic rule, waste/by-products accepted as raw materials should provide the clinkerization process with an added value. The following aspects have to be considered: volumes and categories of waste materials, physical and chemical compositions, characteristics and pollutants. On this topic, a more detailed list of technical characteristic and potential treatments is available in the deliverables of WP 2.
In order to asses this kind of technology under ETV, potential parameters and indicators to be applied are:

- Particle size;
- Compressive strength (MPa);

[13] Source: "HISER European Project website", http://www.hiserproject.eu/index.php/our-activities/automated-sorting-and-recycling-technologies. Last visit: 19/07/2017.

Project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 642154.

- Physical and chemical requirements for the components of cement, clinker and additions; e.g. chlorine, sulphur, alkali and phosphate content, trace elements and relevant metals content;
- Percentages of raw ingredients (virgin materials or secondary raw materials) used to produce the clinker;
- Durability;
- Moisture content.

3.4.2 Green Concrete

The main characteristic of a green concrete is a total or partial substitution of the natural aggregates by recycled ones, such as EAF (Electric Arc Furnace) steel slag and/or glass waste aggregates, in order to reduce the embodied CO_2 emissions and the embodied energy of the concrete.
SRMs used in the manufacture of concrete could have various source: from ceramic tile industry (for example calcined clays from tile ceramic industry), C&DWs (an heterogeneous source with a high level of contamination from different materials which includes tiles and concrete fine with impurity, bricks, etc.) and glass wastes.
To use previously named SRMs as aggregates is necessary: when using EAF slags, to perform a treatment processes, including crushing, sieving and magnetic separators; when using LF slags, to remove any metallic traces through magnetic separators in order to induce pozzolanic activity (LF steel slags can be used as fine fractions for the concrete manufacturing process); when using ceramic waste streams, to granulate for use in concrete. The main source about detailed requirements for aggregates is the prEN 12620 and its national transpositions.
When evaluating the new products with the traditional ones (the relevant alternatives in the ETV scheme), the main characteristics considered will be related to the density, compressive strength and thermal conductivity. In particular, parameters and indicators useful to evaluate this technology during ETV process could be:

- Mineralogical composition, MgO content, CaO content, chloride content, total sulfur;
- Content of trace elements especially leachable elements;
- Presence of constituents which alter the rate of setting and hardening of concrete;
- Presence of constituents which affect the volume stability of air-cooled blast furnace slag;
- Particle size, fineness content and quality;
- Particle density;
- Volume stability;
- Resistance of fragmentation;
- Resistance surface abrasion;
- Water absorption;
- Drying shrinkage;
- Freeze-thaw weathering.

3.4.3 Ceramic Tiles

Ceramic bodies, such as tiles, are heterogeneous materials having a wide range in composition; ceramic tiles, in particular, are typically made of clay and other inorganic raw materials that are ground and/or mixed and then moulded before drying and firing at temperatures high enough to acquire the necessary stable properties. This is the reason why, they could tolerate different type of SRMs with minor critical aspects, even in high percentage. Several inorganic recovered materials can become useful candidates for clay-based ceramics products; the most common SRMs used to product ceramic tiles come from both the aluminium industry (ex. aluminium oxide based materials) and the marble slurry from the natural stone section.
Below a short list of useful performance indicators to analyse the technology according to ETV:

- Dimensional precision (tolerance level);
- Water absorption capacity;
- Chemical and stain resistance;
- Mechanical strength and dry mechanical resistance;
- Bulk density;
- Waterproof level of the faces;
- Expansion after pressing;
- Drying shrinkage;
- Firing shrinkage;

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- Presence of impurities.

3.4.4 Wood Plastic Composites (WPC)

Wood Plastic Composites (WPC) are made of wood or other cellulose-based fibre fillers like straw, peanut hulls and bamboo, and plastics, which may be Polyethylene (PE), Polypropylene (PP), Polyvinyl chloride (PVC) etc. Both wooden and plastic parts can come from virgin or waste material. Additives, colorants, reinforcing agents and lubricants complete the recipe according to the specific product.
The most common use of WPCs is in outdoor deck floors, but it is also used for railings, fences, landscaping timbers, noise absorption barriers, cladding and siding and park benches. German and British markets appear to be the most advanced ones for this specific sector.
SRMs used in the manufacture of WPC come from wood waste from C&DW or other log or timber industries, plastic waste and rubber waste. With reference to wood waste to be re-used, it is decisive taking into account the wood particle size, to avoid issues during production, such as line speed, moisture, appearance quality standards, etc., and the moisture content, to avoid humidity ranges below explosion hazard and over production and quality issues.
During an ETV analysis of a WPC technology, it could be appropriate to consider:

- Particle and pellet size (large wood particle could influence the final appearance to the final product or big plastic pellet could require high temperature for melting);
- Moisture content (especially if SMR is wood);
- Density;
- Drying time;
- Melt flow index (if SRM is plastic).

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4. Eligibility Assessment of the Technologies

The ETV procedure starts with the contact phase, where the Proposer submits a quick scan document regarding the specific technology to the Verification Body. The VB is then able to assess the eligibility of the technology and to give an early indication of the complexity and potential range of costs of a full verification. The GVP accurately describes this phase, providing a list of seven criteria useful to assess the quick scan.
The three main requirements have already been introduced in the sub-chapter 2.1: "General Overview" about ETV:

- Does the technology fall within the scope of the ETV programme? In other words, it needs to belong to one of the three Technology Areas actually considered by the programme. Specifically for the FISSAC project, it fits the TA2: Materials, Waste and Resources. See sub-chapter 4.1.
- Is the technology ready for the market or if not, is it developed to the extent that no change affecting performance is likely before introduction to the market? See sub-chapter 4.2.
- Does the technology present an environmental added value? See sub-chapter 4.3.

Four additional requirements are here provided:

- Is the technology description sufficiently clear? Are the preliminary elements for the performance claim specific to the technology and verifiable?
- Does the technology meet user needs in terms of functionality, claimed performance and environmental added value?
- Does it perform in line with applicable legal requirements?
- Does it show a sufficient level of technological innovation?

The answer from the VB includes information on the eligibility of the technology and on the corresponding technology area. The Verification Body makes a recommendation on performing a full verification or not and a first indication of the range of costs.
The VB shall exclude a technology from verification if it does not fall within the scope of the EU ETV pilot programme, is not ready to market, or if its performance, environmental added value and innovation levels are insufficient such that inclusion would harm the reputation of the programme. Otherwise, the decision to proceed is up to the proposer, even when the VB does not recommend performing the verification.

4.1. Field of Application: Technology Areas (TA)

To be eligible, the technology needs to belong to one of the three Technology Areas actually considered by the ETV programme and described at the chapter 2.4: "Technology Areas (TA)".
Focusing on the FISSAC project, the technologies involved belong to the "Technology Area 2: Materials, Waste and Resources" widely treated in the chapter 3: "FISSAC Project's technologies: Materials, Waste and Resources".

4.2. Readiness to Market: Technology Readiness Level (TRL)

According to the GVP and to the "Guidelines for the eligibility assessment of technologies proposed to the EU-ETV scheme"[14] a technology to be considered eligible should be ready for the market or already commercially available.
The definition of "ready to market" available in the GVP's Glossary provides two cases:

1. The technology is available on the market;
2. The technology is at least available at a stage where no substantial stage affecting the performance will be implemented before introducing the technology on the market.

To avoid any uncertainty, a technology is considered **available on the market** if at least one full-scale product has been manufactured, and at least two of the three following items are available:

- Product operation and maintenance manual;
- Product listed on the price catalogue of the manufacturer;

[14] "Guidance document 003/2014-04-23", Version 1.2. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files/files/documents/GD/twg_guidance_003_v1.2_final_-_eligibility_assessment_.pdf. Last visit: 06/07/2017.

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- Marketing materials or advertisements.

About the possibility of considering a technology **ready to market but not available on the market yet**, the proposer should be aware that if, at any stage before publication of the Statement of Verification, a change affecting the performance of the technology is introduced, the VB may stop the verification process, revise the verification protocol and/or require testing to be partially or fully done again, at the cost of the proposer.
The prototype nature of the technology will be clearly indicated on the Statement of Verification, with all the necessary information on its representativeness of a full-scale unit and condition on scaling-up to the commercial version.
Non-EU ETV programs have different policies in accepting technologies at the pre-commercialisation stage; this may prevent the recognition of the Statement of Verification of this technology by some non-EU ETV programs in future or it may be subject to specific acceptance procedures.

To better understand the maturity level of a specific technology, a **Technology Readiness Assessment (TRA)** can be carried out. The **Technology Readiness Level (TRL)** defines whether it is eligible or ineligible to be verified under the ETV process.
The Table 5 gives a description of the Technology Readiness Levels (TRL) through an evaluation from 0 to 9, where 0 refers to an idea or concept which has not been examined in depth through peer review or testing yet and 9 represents the full commercial application stage. This table comes from the "Guidelines for the eligibility assessment of technologies proposed to the EU-ETV scheme"[15] and it is based on the standards defined by the European Commission through the "Annex G. Technology readiness levels (TRL), HORIZON 2020 – WORK PROGRAMME 2016-2017 General Annexes".

Based on the TRL it is possible to assume that:

- Technologies responding to the description of TRL 8 and 9 may be considered as "available on the market";
- Technologies responding to the description of TRL 7 may be considered as "ready to market but not available on the market yet". In general, their stage of development would make them eligible for verification under ETV as prototype;
- Technologies responding to the description of TRL 6 may be considered as "ready to market" and eligible for verification under ETV as prototype if there is no indication or a low probability that the technology will be subject to significant changes affecting its performance before the launch on the market.

Table 5 – Table of Technology Readiness Level (TRL)[16]

Technology Readiness Levels (TRL)			
TRL	**Definition**	**Description**	**Supporting Information**
0	**Idea**	Unproven idea or concept where no peer reviewed analysis or testing has been performed.	No scientific publication.
1	**Basic Research**	The initial scientific research has been completed. The basic principles of the idea have been qualitatively postulated and observed. The process outlines have been identified. No experimental proof and detailed analysis are yet available.	Published research that identifies the principles that underlie this technology.

[15] "Guidance document 003/2014-04-23", Version 1.2. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files/files/documents/GD/twg_guidance_003_v1.2_final_-_eligibility_assessment_.pdf. Last visit: 06/07/2017.
[16] Source: "Guidance document 003/2014-04-23", Version 1.2.

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2	**Technology Formulation**	The technology concept, its application and its implementation have been formulated. The development roadmap is outlined. Studies and small experiments provide a "proof of concept" for the technology concepts.	Publications or other references that out-line the application being considered and that provide analysis to support the concept.
3	**Applied Research**	The first laboratory experiments have been completed. The concept and the processes have been proven at laboratory scale, table-top experiments. Potential of materials and up scaling issues have been identified.	Results of laboratory tests performed to measure parameters of interest.
4	**Small Scale Prototype Development Unit (PDU)**	The components of the technology have been identified. A PDU has been built in a laboratory and controlled environment. Operations have provided data to identify potential up scaling and operational issues.	Measurements validate analytical predictions of the separate elements of the technology. Simulation of the processes has been validated. Preliminary LCA and economy assessment models have been developed.
5	**Large Scale Prototype Development Unit**	The technology has been qualified through testing in intended environment, simulated or actual. The new hardware is ready for first use. Process modelling (technical and economic) is refined. LCA and economy assessment models have been validated. Where it is relevant for further up scaling the following issues have been identified: Health & safety, environmental constraints, regulation, and resources availability.	Results from testing in intended environment, simulated or actual. How does this environment differ from the expected operational environment? How do the test results compare with expectations?
6	**Prototype System**	The components and the process have been up scaled to prove the industrial potential and its integration within the complete system. Most of the issues identified earlier have been resolved. Full commercial scale system has been identified and modelled. LCA and economic assessments have been refined.	Results from laboratory testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?
7	**Demonstration System**	The technology has been proven to work and operate at a pre-commercial scale. Final operational and manufacturing issues have been identified. Minor technology issues have been solved. This is the typical TRL for prototype verification under ETV.	Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?

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8	**First of the kind commercial System**	The technology has been proven to work at a commercial level through a full-scale application. All operational and manufacturing issues have been solved. This is the typical TRL for technology verification under ETV.	Results of testing the system in its final configuration under the expected range of environmental conditions in which it will be expected to operate. Assessment of whether it will meet its operational requirements. What problems, if any, were encountered? ETV Statements and reports.
9	**Full Commercial Application**	The technology has been fully developed and is commercially available for any consumers.	Certification and labels where appropriate standards or specifications exist. Inspection reports of actual installations.

This table has been adapted from a preliminary European Commission definition drafted in the context of Horizon 2020. The descriptions are illustrative only and not necessarily applicable to all technologies. The column "supporting information" is freely adapted from the Technology Readiness Assessment Guidance of the US Department of Defense. This is also for illustration only.

4.3. Environmental Added Value Assessment

An environmental technology can be submitted to the ETV pilot programme if it corresponds to the definition of "innovative environmental technology" provided under Appendix 1 of the GVP: "an environmental technologies presenting a novelty in terms of design, raw materials and energy involved, production process, use, recyclability or final disposal, when compared with relevant alternatives with the potential to contribute to efficient use of natural resources and a high level of environmental protection".
At a practical level, it can be challenging to choose a relevant alternative and then to compare the two different technologies. The "Guidelines on assessing the environmental added value of an environmental technology in a life-cycle perspective at the proposal stage"[17] provides some advices about this phase by giving a life-cycle perspective approach. The Guidance document will be used as reference for this crucial part of the ETV process during the evaluation of technologies under the FISSAC scheme.

4.3.1 Defining the Relevant Alternative

In order to determine the environmental advantages and disadvantages of each new technology, the proposer needs to designate the "relevant alternative(s)" against which a qualitative comparison (quantitative if data is available) can be made. The VB can then accept the proposed relevant alternative or suggest a different one. If no appropriate relevant alternatives are found, the VB can take into account the EU/country legal requirements and the available recommendations of the TWGs.
In principle, the relevant alternative technology should be the answer to the following question: "If the proposer's technology would not be available, what would be the alternative?"

The relevant alternative's purposes and end-results should be ideally the same of the technology under verification. The relevant alternative should be commercially available, legal and accepted by the end-users on the specific targeted market. The VB will confirm whether this alternative is appropriate, or whether a more suitable technology should be used based on existing operational technologies for the targeted market.
If the technology is a similar or improved version of something already on the market, then the most desirable relevant alternative is the existing version of the technology on the market.
If the proposer's technology is a completely new solution for a certain problem, then the relevant alternative is not using the technology at all.
Preferably, the relevant alternative should be recognised as having the highest possible general level of environmental protection but also a fair market acceptance. This is to avoid making comparisons with technologies that are so

[17] "Guidance document 004/2016-01-26", Version 1.0. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files-new/twg_guidance_004_-_environmental_added_value_v1.0.pdf. Last visit: 06/07/2017.

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innovative and so advantageous in providing an environmental added-value that the assessment does not truly reflect the advantages in comparison to what is commonly used in the market.

The verification performed within the FISSAC scheme will likely interest recycling processes and/or advanced construction products characterised by the total or partial replacement of virgin raw materials by higher amounts of secondary high-purity raw materials recovered from industrial waste, with a specific focus on eco cement, green concrete, innovative ceramic tiles and rubber wood plastic composites.
The relevant alternative will be evaluated case by case according to the specific technology. Considering construction materials seems natural to compare them with similar innovative products available on the market or eventually their traditional form when innovative alternatives are missing.

4.3.2 System Boundaries

The method proposed by the Guidance document 004/2016, which will be applied in the verification, simplifies the life cycle of the technology into four stages:
1 – Extraction, refining, processing, transformation and transport of natural resources. All the activities involved before the production of the technology's equipment or products; this is likely to include the extraction, treatment, transformation and processing of natural resources. This comprehends all the raw materials, the energy and water used and all waste or emissions released to the environment.
2 – Manufacturing of parts, components, machinery and products. All the activities involved in the production of the technology. This includes all of the water, energy and consumables used, together with all of the emissions and all of the products and wastes.
3 – Use and maintenance stage of a product, a process or a service. Every aspect of the use of and maintenance of an equipment and/or a product by the end-user, including consumables and where applicable their life cycle, and all the raw materials, energy and water used for its functioning, as well as all the emissions, products and wastes.
4 – End of life of an equipment or of a product. Every aspect of all activities involved in the final “end-of-life” phase of a product or an equipment, when it is discarded by the end-user, including its recycling, dismantling, reusability and/or disposal of all components. It includes all of the water, energy and consumables used, together with all types of emissions, all of the products and wastes.

In order to proceed with the eligibility assessment, the proposer provides the following steps:
Step 1: Identify the life cycle stages that could result in different environmental impacts than the relevant alternative. Life-cycle stages that result in identical environmental impacts do not need to be considered.
Step 2: Define the key life-cycle stages for the technology. The proposer evaluate if the stages identified at the Step 1 present relevant differences from an environmental point of view in comparison to the relevant alternative.
Environmental hotspots in which the particular technology differs from the alternative are here identified. "Environmental hotspots" refer to those specific life-cycle stages, processes, or individual material/energy inputs/outputs that cause concern. If hotspots have already been identified for similar technologies or for the relevant alternative, this information can be used here.[18]
Step 3: For every key life-cycle stage identified in step 2, provide qualitative or quantitative information for the various Environmental Parameters available at the sub-chapter 5.2. Information should be available for at least the manufacturing and use stages since the proposer usually possesses relevant information, as designer and manufacturer of the technology.
In the event the proposer cannot provide information for one or more of the stages, it can justify it by stating that the technology will lead to environmental pressures that are not significantly different from those of the relevant alternative or that those environmental pressures are negligible compared to those of the other stages. There is also the chance that information are simply not available or not relevant for the considered technology.

Defining the system boundaries, a lack of information can occur, especially concerning raw materials, sub-assemblies and components. The proposer may not have access to full details of all of the activities described in the four life-cycle stages, especially where materials are supplied by third-party bodies. In these cases, if specific information is not available, consideration should be given to the materials, based on generic information that is reasonably available. For example, if a specific raw material is required, unless particular information is available it could be assumed that it

[18] For further information regarding the identification of hotspots it is recommended to consult the EC Communication on Building the Single Market of Green Products COM (2013) 196 and the respective Commission Recommendation 2013/179/EU.

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will be sourced from the country which is the major producer of this material, using the methods and processes which are prevalent in that country.
Important environmental parameters should be considered for inclusion in the verification phase. If after verification there is still uncertainty about potentially important environmental factors, this should appear in the verification statement.

4.3.3 Environmental Parameters and Assessment

The proposer should provide information about a list of Environmental Parameters, which will be given and described in the next chapter, for each of the identified relevant life cycle stages, according to the specific technology.
It is desirable to consider quantitative information, when possible, otherwise at least qualitative information should be provided. In addition to information about the listed environmental parameters, the proposer has the chance to provide extra information that might be useful for the assessment relating to economic, social and safety aspects.
The proposer should provide relevant documentation to support the information given, especially when this information is crucial for the evaluation. The VB evaluates the reliability of the information provided and requests supporting information when needed.

Based on the information provided, the VB assesses the environmental added-value of the technology in order to take a decision at the eligibility stage on whether recommending a verification, not recommending a verification since the environmental added value does not seem to justify the need for an ETV or refusing the verification due to serious environmental issues that may harm the reputation of ETV.
In this assessment phase, every item of information gets a score according to the comparison between the technology and its relevant alternative. The Guidance document 004/2016 describes then an evaluation method[19] useful to analyse the data in a rational way, which will be used in the FISSAC framework also.

[19] See "Chapter 5. Assessment of the environmental added-value" of the Guidance document 004/2016.

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5. Analysing the specific Technology: Parameters and Indicators

As discussed earlier in the dissertation, in order to analyse a specific technology (TA2) under the ETV process is fundamental to identify and evaluate the parameters that better represent the environmental added value of the technology.
As natural consequence of the innovative nature of each technology, often an "unicum" in its sector, it is not possible to identify a general unique list of indicators and parameters universally applicable. In particular, when defining the technological performances, it is necessary to consider the specific characteristics and operations related to the technology. The definition of the verification parameters and their numerical values, aimed to express the performance of the technology, is a core element of the ETV process and it is developed by the VB together with the Proposer, to better emphasise the specific attributes and singularities of the technology.
With reference to FISSAC project, this activity will be performed by RINA together with partners in the next steps of the Task 3.5. Here below a description of the possible applicable parameters and indicators with reference to FISSAC sector is given.

5.1. Performance and Operational Parameters

Performance and operational parameters depend on the specific attributes of the specific technology; shown below a list (non-exhaustive) of parameters applicable to the FISSAC sector:

- **Dimension and surface quality**: length and width, thickness, straightness of side, surface flatness (tiles), etc.
- **Geometrical parameters**: particle size, fines content and quality, etc.
- **Physical properties**: water absorption, modulus of rupture, breaking strength, particular density, resistance to thermal shock, resistance of fragmentation, volume stability, resistance to surface abrasion, resistance of fragmentation, resistance to deep abrasion, frost resistance, moisture expansion, moisture content, impact resistance, crazing resistance, thermal expansion, absence of debris, fibre content, etc.
- **Chemical properties**: mineralogical composition, MgO content, CaO content, chloride content, sulfur content, Carbon black content, alkali and phosphate content and relevant metals content, resistance to concentration of acids and alkalis, stain resistance, etc.
- **Mechanical properties**: compressive strength (MPa), tensile strength, hardness, etc.
- **Durability**: constituents which alter the rate of setting and hardening of concrete, constituents which affect the volume stability of air-cooled blast furnace slag, freeze-thaw weathering, volume stability – drying shrinkage, etc.
- **Others**: Thermal conductivity, pH values, Hydraulic conductivity, Calorific value, Compact density, colour, etc.

5.2. Environmental Parameters

The most relevant Environmental Parameters[20] considered during an ETV procedure are here provided:

- **Emission of pollutants to air**: identify or quantify additional, increased, reduced or removed air pollutants including greenhouse gas emissions compared to the relevant alternative.
- **Emission of pollutants to water**: identify or quantify additional, increased, reduced or removed water pollutants compared to the relevant alternative.
- **Emission of pollutants to soil**: identify or quantify additional, increased, reduced or removed soil pollutants compared to the relevant alternative.
- **Consumption of natural resources**: identify differences in consumption of rare raw material required for the process compared to the relevant alternative.
- **Energy consumption**: identify differences in energy consumption and in energy sources (indicate differences in use of non-renewable or renewable energy) compared to the relevant alternative.
- **Water consumption and related processes**: identify differences in the consumption or the use of water compared to the relevant alternative but also the quality of the water used and the necessary treatment before and after use.

[20] The list here provided comes from the "Guidance document 004/2016-01-26", Version 1.0.

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- **Production of non-hazardous waste**: identify or quantify any additional, increased, reduced or removed non-hazardous waste compared to the relevant alternative.
- **Production of hazardous waste**: identify or quantify any additional, increased, reduced or removed hazardous waste compared to the relevant alternative. The type of hazardous waste should also be specified where possible using the list provided in Commission Decision 2014/955/EU[21] at the level of two digit code.

If relevant, additional information on the productivity of the technology should also be provided, namely:

- **Production efficiency – productivity**: indicate any significant differences in productivity of the technology vs. the relevant alternative. The proposed technology could have a higher performance but at the expense of a lower productivity or vice-versa.
- **Production efficiency – final quality**: indicate the differences in the quality of the final product vs. the relevant alternative. The technology could be more environmentally beneficial but resulting in a product that is of lower quality than the relevant alternative (e.g. for recycling: the level of purity of the recovered substance; or for a particular material such as a plastic: a material that costs less energy to make but that resulted in lower quality characteristics).

5.3. Circular Economy Indicators

When dealing with technologies designed with the declared aim of moving toward a Circular Economy business model, such as the ones developed within the FISSAC project framework, verification parameters should take into account not only the technical performance but also the environmental impacts throughout a life cycle and sustainability assessment study.
Complete and in-depth life cycle studies are time consuming and often economically unsustainable, therefore a good compromise is to simplify the approach by utilizing Circular Economy Indicators. During the ETV procedure, the RINA team will select and apply some of the parameters defined by the "Ellen MacArthur Foundation[22]" and listed in the Table 6, which best represent the specific technology.

Table 6 – Circular Economy Indicators applicable in the ETV process[23]

Circular Economy Indicators			
Indicator	**Description**	**Formula**	**Unit**
F_R	Fraction of mass of a product's feedstock from recycled sources		–
F_U	Fraction of mass of a product's feedstock from reused sources		–
V	Mass of virgin feedstock used in a product	$V = M\,(1 - F_R - F_U)$	Kg
E_F	Efficiency of the recycling process used to produce recycled feedstock for a product		%
W_F	Mass of unrecoverable waste generated when producing recycled feedstock for a product	$W_F = M\,\frac{(1-E_F)F_R}{E_F}$	Kg
Life Cycle Indicators	Life Cycle Impact indicators / Carbon Footprint / Water Footprint (usually not included in ETV indicators because too complex… simplified?)		
Embodied Energy	Embodied energy is the energy used during the entire life cycle of a product, including its manufacture, transportation, and disposal, as well as the inherent energy captured within the product itself.		MJ/Kg

[21] Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0955&from=EN. Last visit: 06/07/2017.
[22] The Ellen MacArthur Foundation was launched in 2010 to accelerate the transition to a circular economy. The Foundation works across business, education, analysis and communications to build a more resilient economic model. More information at: https://www.ellenmacarthurfoundation.org/.
[23] Source: "Circularity Indicators. An Approach to Measuring Circularity. Methodology". Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/insight/Circularity-Indicators_Methodology_May2015.pdf. Last visit: 10/07/2017.

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Indicators regarding Energy Quality	Exergy - Exergy is a measure of quality of energy and it can be consumed or destroyed through the operation of any physical or mechanical system.		
W_0	Unrecoverable waste: Mass of unrecoverable waste through a product's material going into landfill, waste to energy and any other type of process where the materials are no longer recoverable. Where C_R represents the fraction of the mass of the product being collected for recycling at the end of its use phase and C_U the fraction of the mass of the product going into component reuse.	$W_0 = M (1 – C_R – C_U)$	

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5.4. Real case applications

Set up below is a description of some real cases of an ETV verified technology (TA2), the first one with reference to RINA experience. The examples aim at underlining which and how many performance parameters were considered and verified during ETV process.

Example 1: GW Dryer

The verified technology is a novel drying technology for converting liquid foods and other related biomaterials into powders, flakes, or sheets with added value.

To verify the technology performance, were considered the following aspects:

- **Thermal Efficiency of the Dryer**. The evaporation of water from the product at the air–puree interface constitutes a major part of energy consumption. For this reason, the verification activities focused on the "thermal efficiency" expressed as the ratio of the theoretical thermal energy for drying the wet products to the actual thermal energy supplied for drying by the heating unit.
- **Ability of the Dryer to maintain color of initial feed material**. The dryer can be used to gently remove moisture from delicate products like anthocyanins and other natural colorants preserving the natural color. The Color Loss parameter shows the ability of the Dryer to maintain color of initial feed material.
- **Minimal Product Loss**. The Solid Yield parameter shows the ability of the Dryer to perform the drying process with a high percentage of the product recovered.

Table 7 – GW Dryer: Summary of parameters[24]

Aspect	Related Performance Parameter (unit)
Thermal Efficiency of the GW Dryer	**Thermal Energy consumption** (kJ/kgH2O) **Thermal Efficiency** (%) **Surface Evaporation capacity** (kgH_2O/ hm^2)
Ability of the GW Dryer to maintain color of initial feed material	**Color Loss** (%) **Extinction Value (EV) on a dry basis at (λmax)**
Minimal Product Loss	**Solids Yield** (%) **Dry Product Loss** (%) **Feed material** (kg / h) **Input's moisture content** (%) **Product material** (kg / h) **Product's moisture content** (%)

[24] Source: "ETV Statement of Verification: GW DRYER. Registration number VN20160012. Issued on: 16/03/2016." Available at: https://ec.europa.eu/environment/ecoap/etv/gw-dryer_en. Last visit: 19/07/2017.

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Example 2: EWA Fermenter

The verified technology is a discontinuously working device intended for the processing of biodegradable waste. Processing takes place in a closed non-outflow space (container) with a volume of 36 m^3. The uniqueness of the aerobic fermenter consists in its ability to perform the digging up of filling inside the fermenter.
The verified parameters are:

- Hygenisation efficiency: occurance of pathogens (salmonella, E.coli, enterococci, etc.)
- Annual capacity of aerobic fermenter (from 1400 t/year): Filling weight, fermenter volume, time of filling processing, etc;
- Specific electricity consumption: kWH/t filling;
- Qualitative parameters of the filling and fermentation product: proportion of materials, pH, humidity, etc;
- Hygienisation temperature
- Climatic conditions: temperature and relative humidity.

Table 8 – EWA Fermenter: Summary of parameters[25]

Parameter		Required and expected values
Hygienisation efficiency: (occurrence of pathogens)	Salmonella spp. (in 25 grams**)	Negative (5 test samples)
	E. coli (out of 5 samples **)	1 sample < 5.10^3; 4 samples < 10^3 CFU/gram*
	Enterococci (out of 5 samples **)	1 sample < 5.10^3; 4 samples < 10^3 CFU/gram*
Annual capacity of the fermenter: (from 1 400 t/year)	Filling weight	12 - 18 tons (depending on composition)
	Fermenter volume	36 m^3
	Time of filling processing	min. 96 hours
	Utilisable annual working time capacity	340 days
Specific electricity consumption:		4.0 – 6.0 kWh/t filling
Qualitative parameters of the filling and fermentation product:*	Proportion of materials of cat. 2 and 3	5 – 30 % mass units
	Humidity	50 – 60 %
	pH	5.5 - 8
	Combustible substances (% in dry matter)	80 %
	Total nitrogen (% in dry matter)	1.8 %
	C:N ratio	1: 20 - 30
Hygienisation temperature:		60 – 75 ° C
Climatic conditions:	Temperature	-5 to +40 °C
	Relative humidity	30 – 100 %

[25] Source: "ETV Statement of Verification: EWA FERMENTER. Registration number VN20160014. Issued on: 15/04/2016." Available at: https://ec.europa.eu/environment/ecoap/etv/ewa-fermenter_en. Last visit: 19/07/2017.

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6. Conclusions

This Guideline constitutes a key point to start involving partners in the ETV FISSAC project. It gave them technical instruments useful to implement the EU-Environmental Technology Verification (ETV) and illustrated the procedure that will be applied to the eligible technologies belonging to the FISSAC's framework in the next phases of the project. FISSAC partners having a technology in the "Materials, Waste and Resources" area should now be able to cover an active and conscious role during the Eligibility Assessment performed by RINA.

The next step, related to the evaluation phase, comprehends a bilateral dialogue between RINA and the proposer partners to assess the eligibility of the technologies to the ETV scheme: more technical information are required. RINA will contact the involved partners expecting feedback from them in order to proceed.

RINA will then define Parameters and Indicators useful to analyse the specific technology together with the proposer partner. These parameters cannot be left general for every ETV procedure because of the nature of the ETV scheme and there should be no doubt at this point.

As anticipated, this document is the first deliverable of a series of four documents that will be drafted by RINA on ETV, as foreseen in the Work Package 3 (WP3).
The next three steps are the following deliverables:

- D3.10: ETV: Eligibility check performed/Quick Scans verified;
- D3.11: ETV: Initial performance claims approved;
- D3.13: ETV: Specific Verification Protocols approved for each innovative solution.

Information about these documents are available at the sub-chapter 2.3.1 and in the Annexes.

Project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 642154.

7. References

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[2] "Guidelines for the eligibility assessment of technologies proposed to the EU-ETV scheme - Guidance document 003/2014-04-23", Version 1.2. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files/files/documents/GD/twg_guidance_003_v1.2_final_-_eligibility_assessment_.pdf. Last visit: 06/07/2017.

[3] "Guidelines for addressing the interfaces between Technology Areas in the context of the EU-ETV Pilot Program - Guidance document 008/2015-04-08", Version 1.0. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files/documents/twg_guidance_008_v.1.0_-_interfaces_between_technology_areas.pdf. Last visit: 19/07/2017.

[4] "Clarification on the meaning of 'verification' under ETV and differences from certification - Guidance document 001/2016-06-07", Version 1.0. Available at: https://ec.europa.eu/environment/ecoap/sites/ecoap_stayconnected/files/etv-files-new/etv_ref_doc_001-_verfication_vs_certification_v_1.0.pdf. Last visit: 19/07/2017.

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[12] "Annex G. Technology readiness levels (TRL)" from "HORIZON 2020 – WORK PROGRAMME 2016-2017 General Annexes", European Commission, Available at: https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016-2017/annexes/h2020-wp1617-annex-ga_en.pdf. Last visit: 19/07/2017.

Project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 642154.

[13] The communication of the European Commission entitled “Closing the loop - An EU action plan for the Circular Economy”, dated 2nd December 2015.

[14] “European Commission, EU Environmental Technology Verification ETV website”, http://ec.europa.eu/environment/ecoap/etv. Last visit: 07/07/2017.

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8. Annexes

ANNEX 1: Quick scan document template[26]

EU Environmental Technology Verification

Quick-Scan

Purpose: This form intends to collect sufficient information about the technology you would like to propose for verification in order to evaluate whether your technology is eligible for verification under EU ETV Programme and to provide you with a first indication of the costs involved. This Quick Scan is to be completed by the proposer and assessed by the Verification Body. The boxes for responses, in grey, may be extended but the responses should remain brief (no more than one half-page each).

Verification Body *(to be filled in by the (to be filled in by RINA)*	**Proposer** *(to be filled in by the Proposer)*
Name: Contact person: Address: Telephone: Telefax: Email:	Name: Contact person: Address: Code NACE: Number of employees Telephone: Telefax: Email:

Quick-Scan date: *(to be filled in by the Proposer)*	
Previous Quick Scan performed: ☐ No ☐ Yes, date:	*Indicate if you have already submitted a quick-scan on the same or similar technology to be evaluated by this Verification Body*

[26] This document has been drafted by RINA according to the Appendix 3 of the GVP.

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Identification of the Technology *(to be filled in by the Proposer)*

Name of the Technology:

NB : A technology can be a product, a process or a service

Technology Area:

If the technology could fit in more than one area, please signal this and insert a clarification in the comment section.

☐ Water Treatment and Monitoring

☐ Materials, Waste and Resources

☐ Energy Technologies

☐ Other:

Comments:

General description of the Technology *(to be filled in by the Proposer)*

Introduction or context:

Briefly explain the specific problem(s) or opportunities your technology wishes to address

Main purpose of the technology:
Relevant alternatives

How does the technology address the problems or opportunities?

The 'relevant alternative' helps to determine the environmental added-value and innovation level through a qualitative comparison (quantitative if data is available). It should perform an identical or similar function than the technology under verification but it can correspond to different technologies working in sequence, e.g. a sorting procedure including dismantlement can be an alternative to a crusher. It should be a technology that is both current and commercially available, it should be legal and accepted by the end-users on the specific targeted market, It should also be effective in achieving a reasonably high level of protection of the environment

Principle used:

Which are the scientific or technical principles and techniques used by this technology

Which are the main claim(s) on the technology's performance that wouldneed to be verified? (Preliminary elements for the performance claim)

Consider as much as possible verifiable, quantifiable features, expressed in absolute (i.e. not comparative) terms. Please note that the initial performance claim is starting point for the verification and may evolve during the verification process

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Under which conditions is this performance(s) achieved?

Detail the key operational parameters and the limits in order for the technology perform as described in the claim.

Main standards, regulations or references applicable to this technology:

Are there already standards that cover (parts of) this technology? What would be the main regulations relevant for this technology? Are you aware of any guidelines that would be useful for the verification of this technology?

Market readiness *(to be filled in by the Proposer)*

Is the technology already on the market?
☐ No ☐ Yes, number years:
If no, is there a prototype or a demonstration unit available?
☐ No ☐ Yes ☐ Pilot scale ☐ Full-scale
When transforming the prototype/ demonstration unit into a marketab product, will any changes affect the technology's performance?
☐ No reason:
☐ Yes How substantial will the changes be?

Comments:

A verification will check whether the technology matches the claimed performance. Ideally this verification should only be done once the product is finished, so as to reduce costs of new verifications with changes or upgrades to the technology.
The intention is to determine if the technology is ready to market: "is it available on the market or at least available at a stage where no substantial change affecting its performance will be implemented before introducing the technology on the market (e.g. full-scale or pilot scale with direct and clear scaleup instructions)".

Innovation level *(to be filled in by the Proposer)*

Description of the innovation provided by the technology, in comparison with relevant alternatives on the market:

Novelty presented by the technology in terms of design, raw materials involved, energy used, production process, use, recyclability or final disposal, when compared with the alternatives identified above

Environmental added-value *(to be filled in by the Proposer)*

Please provide a short overview of the major positive and negative environmental aspects resulting from your technology in each of the four main life-cycle stages identified below:

You are expected to provide as much information as possible, especially for the manufacturing and use phases. Qualitative or quantitative information may be given on emissions, waste streams, consumption or use of raw materials, energy and water. The information provided will help the Verification Body assess whether your technology would fit and benefit from an ETV. If you have no

In some cases you may limit the amount of information, in particular when:
i) the technology will lead to environmental pressures/impacts that are not significantly different than those of the relevant alternative
ii) those environmental pressures/impacts are negligible compared to those of the other phases
iii) the information cannot be obtained – please provide a short justification in this case

Natural resources (raw materials, energy) extraction and

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transformation phase *(to be filled in by the Proposer)*

Is this stage under your direct control? ☐ Yes ☐ No
Do you have information concerning environmental aspects for this stage? ☐ Yes ☐ No ☐ Partial
In terms of environmental impacts or environmental added value, are there significant differences in this stage between your technology and relevant alternatives?
☐ Yes ☐ No
Major positive and negative environmental aspects:

Extraction, refining, processing, transformation and transport of natural resources including every aspect of all activities involved before the manufacture of the technology's equipment, subassemblies or products. By definition, this also includes all of the raw materials, the energy and water used and all waste or emissions released to the environment during these activities

Manufacturing phase *(to be filled in by the Proposer)*

Is this stage under your direct control? ☐ Yes ☐ No
Do you have information concerning environmental aspects for this stage? ☐ Yes ☐ No ☐ Partial
In terms of environmental impacts or environmental added value, are there significant differences in this stage between your technology and relevant alternatives?
☐ Yes ☐ No
Major positive and negative environmental aspects:

Manufacturing of parts, components, machinery and of products including every aspect of the production of the technology. In general, it is expected that this will include the production of most if not all sub-assemblies. This also includes all of the water, energy and consumables used, together with all of the emissions and all of the products and wastes. This will generally occur on production sites under control of the proposer

Use phase *(to be filled in by the Proposer)*

Is this stage under your direct control? ☐ Yes ☐ No
Do you have information concerning environmental aspects for this stage? ☐ Yes ☐ No ☐ Partial
In terms of environmental impacts or environmental added value, are there significant differences in this stage between your technology and relevant alternatives?
☐ Yes ☐ No
Major positive and negative environmental aspects:

Use and maintenance phase of a product, a process or a service including estimates of its use by the client/end-user refers to consumables, maintenance, and all raw materials, energy and water used for its functioning, as well as all the emissions, products and waste streams.

End of life phase *(to be filled in by the Proposer)*

Is this stage under your direct control? ☐ Yes ☐ No
Do you have information concerning environmental aspects for this stage? ☐ Yes ☐ No ☐ Partial
In terms of environmental impacts or environmental added value, are there significant differences in this stage between your technology and relevant alternatives?
☐ Yes ☐ No
Major positive and negative environmental aspects:

End of life of a technology including every aspect of all activities involved in the 'End of Life' of a product or an equipment, when it is discarded by the client/enduser, including its recycling, dismantling and/or disposal of all components. This also includes all of the water, energy and consumables used, together with all types of emissions, all of the products and wastes..

Potential to meet user needs *(to be filled in by the Proposer)*

Does the technology have the potential to meet user needs?
☐ Yes ☐ No
What specific user needs is the technology addressing? How does this technology meet the user needs?

Does this technology address a need in the market? Are the advantages provided a real advantage to the user? If the technology is already on the market provide general information on its success

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in addressing user needs.

Fulfilment of legal requirements *(to be filled in by the Proposer)*

What is the target market for this technology?
☐ EU ☐ Specific country/countries:
☐ Other:
Does the technology fulfil the legal requirements in the targeted market(s)?
☐ Yes ☐ No
Comments:

Intellectual Property Rights (IPR) *(to be filled in by the Proposer)*

Are you the sole and full owner of the technology? ☐ Yes ☐ No
If no, do you detain intellectual property or other rights on the technology?
☐ Yes
Description of the license or other contractual arrangement giving you the legal right to ask for the technology to be subject to a verification procedure:

☐ No

Are there any Intellectual Property issues in respect of this technology or any part or aspect of the technology that might prevent its development and/or which could result in any legal or other issues for the ETV Programme?

☐ Yes ☐ No
Comments:

☐ Please tick here to authorize the Verification Body to share the information provided in the Quick Scan in a confidential way with the ETV Technical Working Groups

The purpose of information sharing is harmonization and improvement of the EU-ETV programme. All members of the Technical Working Groups have the same confidentiality obligations as theVerification Body

Please note that, once a verification contract is concluded, the main process documents including the Quick Scan, specific verification protocol and verification report, will be shared with the ETV Technical Working Groups in a confidential way.

Existing data *(to be filled in by the Proposer)*

Are there available test results or other data to back-up the technology's performance?
☐ Yes ☐ No

Comments:

Please include in our comments, if a test plan was followed, if standard methods were used, if testing was done by accredited/ certified testing bodies, i.e. ISO 17025

or EN ISO 9001

If test results are not available, please indicate if you have a test plan prepared and/or if there are test methods

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	available, *including standard methods.*

Assessment of Quick-scan (for the Verification Body)

Assessment of the technology description *(to be filled in by the VB)*

The technology fits within the scope of the EU ETV programme? Comments:	☐ Yes	☐ No
Description/principles clear*: Comments:	☐ Yes	☐ No
Clear and verifiable performance claim(s)? Comments:	☐ Yes	☐ No
Ready-to-market*: Comments:	☐ Yes	☐ No
Prototype in advanced stage of development? Comments:	☐ Yes	☐ No
Technology shows innovative characteristics? Comments:	☐ Yes	☐ No
Potential to meet user needs? Comments:	☐ Yes	☐ No
Fulfilling legal requirements (limited to VB's expertise)?*: Comments:	☐ Yes	☐ No
Technology shows environmental benefits? Comments:	☐ Yes	☐ No
Life-cycle aspects described? Comments:	☐ Yes	☐ No

(*) mandatory eligibility requirements

Assessment of available test results *(to be filled in by the VB)*

Test results available? Comments:	☐ Yes	☐ No
Further testing would/could be necessary? Comments:	☐ Yes	☐ No

Conclusions of quick scan by the Verification Body *(to be filled in by the VB)*

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Enough information is provided to conclude? ☐ Yes ☐ No

If no, indicate the information that needs to be provided:

If yes, is the technology recommended for ETV? ☐ Yes ☐ No

Why?

Technology in the scope of VB ? ☐ Yes ☐ No

Comments / remarks / recommendations:

Estimated cost range for a verification (excluding tests):

Proposer:
Name:
Date:
Signature:

Verification body: RINA Services SpA
Name:
Date:
Signature:

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ANNEX 2: Verification proposal template[27]

EU Environmental Technology Verification

Verification Proposal

Purpose: This form intends to collect further information on the technology you would like to propose for verification after the first eligibility check. At this stage, all relevant information is exchanged between the proposer and the Verification Body in order to conclude a verification contract and allow for the preparation of the specific verification protocol. This Proposal is to be completed by the proposer and assessed by the Verification Body. The boxes for responses, in grey, may be extended. Additional information and documents may be attached, with references in the core text for clarity.

Verification body	**Proposer**
Name: Contact: Address: Telephone: Telefax: Email: Date Quick Scan:	Name: Contact: Address: Telephone: Telefax: Email:

Previous Verification:

Remarks out of Quick Scan to be considered (for Verification Body):

All information shared in this verification proposal is treated in a confidential way. For more information please contact RINA.

[27] This document has been drafted by RINA according to the Appendix 4 of the GVP.

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Technology Description– technical documentation

The technical documentation shall make it possible to understand the technology, to define the performance claim and to assess the conformity of the technology design with the performance claim. It shall contain at least the following elements:

- *Unique identifier of the technology, e.g. commercial name,*
- *a general description of the technology,*
- *conceptual design and manufacturing drawings and schemes of components, sub-assemblies, circuits, etc.*
- *descriptions and explanations necessary for the understanding of those drawings and schemes and operation of the technology,*
- *where relevant, standards or technical specifications applied in full or in part,*
- *results of design calculations made, examinations carried out, etc.*

Technology Description:

The application of the technology should be defined by describing the matrix and the purpose(s) of the technology. The matrix refers to the type of material which the technology is intended for e.g., soil, drinking water, ground water, cooling water, alkaline degreasing bath, effluent from domestic wastewater treatment plant etc. The purpose(s) is a measurable property that is affected by the technology e.g., reduction of nitrate concentration, separation of volatile organic compounds, reduction of energy use (MW/kg), bacterial removal, monitoring of NO_x, improvement of heating value etc. It is important that the purpose describes the claimed effect in quantitative terms, e.g. reduction of nitrate concentration in mg NO_3/L. For further information on how to define the matrix and the purpose, please refer to the General Verification Protocol, Table 1 in Section B.III.1 or to the Guide for Proposers.

Matrix:

Purpose:

Technical conditions:

Initial performance claim

The specifications included in the initial performance claim shall relate to the technology itself and shall be quantitatively verifiable through tests. The initial performance claim shall state the conditions under which the specifications are applicable and mention any relevant assumption made. For further information on how to define a clear initial performance claim, please refer to the Guide for Proposers.

Initial performance claim:

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Description of tests performed and existing data

The tests performed on performance parameters shall be described with all necessary details, including the qualification of testing bodies, test methods used (references to standards where appropriate), test plans and test reports. Consult the Verification Body if there are confidentiality issues related to the information on tests.

Are there available test results or other data to back-up the technology's performance?

☐ Yes

Description of test plan:

Description of test methods, including reference if standard methods were used:

Description of existing data:

Qualification of the test body:

☐ ISO 17025 ☐ ISO 9001 ☐ none ☐ other:

Qualification of analytical laboratory:

☐ ISO 17025 ☐ none ☐ other:

☐ No

Is there a test plan available? ☐ Yes ☐ No ☐ Unknown

Is there a test method available? ☐ Yes ☐ No ☐ Unknown

Full description:

Environmental added-value

Please provide as much information as possible on the positive and negative environmental aspects resulting from your technology First, please identify the technologies that constitute relevant alternative(s) to your technology since this may help to identify the environmental added-value of the technology. Then indicate the phases which are most relevant to your technology, in terms of environmental aspects. You may indicate that a particular phase is not relevant to assess the environmental aspects of your technology when:

- *the technology will lead to environmental pressures/impacts that are not significantly different than those of the relevant alternative(s)*
- *those environmental pressures/impacts are negligible compared to those of the other phases*
- *the information cannot be obtained – please provide a short justification in this case. It is expected that for the manufacturing and use stages the proposer will normally possess relevant information, as designer and manufacturer of the technology.*

For each of the identified phases, and especially for the manufacturing and use phases please indicate as much qualitative information as possible regarding each environmental parameter. When available, support the elements provided with quantitative information. You may present information based on a comparison with the relevant alternative, or you may present absolute values, if you are unable to compare the performance of your technology with the one of a relevant alternative(s).

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Relevant alternatives (if available):

For the phases identified in the Quick Scan as different from the relevant alternative(s), please provide information as detailed as possible on the following environmental parameters:

Indicate relevant phase:

Emission of pollutants to air:

Identify or quantify air pollutants including those listed under the green-house gas emissions

Emission of pollutants to water:

Identify or quantify water pollutants

Emission of pollutants to soil:

Identify or quantify soil pollutants

Consumption of natural resources:

Identify consumption of natural resources, especially rare raw material required for the process Energy and water consumption will be addressed in the two following points.

Energy consumption:

Identify energy consumption and energy sources (indicate use of non-renewable or renewable energy)

Water consumption and related processes:

Identify the consumption or the use of water but also the quality of the water used and the necessary treatment before and after use, the consumption or the use of water. This section includes process water, but also water used in bulk such as cooling water.

Production of non-hazardous waste:

Identify or quantify non- hazardous waste

Production of hazardous waste:

Identify or quantify hazardous waste

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If relevant, additional information on the overall productivity of the technology should also be provided, namely:

Production efficiency – productivity:

Indicate any significant differences in productivity of the technology vs. the relevant alternative (e.g. for recycling: ratio of substance recycled vs. quantity of substance contained in the waste).

Production efficiency – final quality:

Indicate the differences in the quality of the final product vs. the relevant alternative (e.g. for recycling: the level of purity of the recovered substance).

Other information (extra information that might be useful for the assessment relating to e.g., economic, social and safety aspects):

Indicate extra information that could justify or complement the information provided for environmental criteria. For example, a technology might be proposed that has little or none environmental benefits in comparison to the already commercially available alternatives but that provides greater social, economic or safety benefits

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Assessment of Proposal (for the Verification Body)

Assessment of the technology

Performances parameters correctly described:	☐ Yes	☐ No
Innovative technology:	☐ Yes	☐ No
Ready-to-market:	☐ Yes	☐ No
Prototype in advanced stage of development:	☐ Yes	☐ No

Assessment of environmental aspects

Conclusions:

Preliminary assessment of existing data

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Tests performed on technology:	☐ Yes	☐ No
Comments:		
Test body suitably qualified:	☐ Yes	☐ No
Comments:		
Test plan available:	☐ Yes	☐ No
Comments:		
Test plan suitable:	☐ Yes	☐ No
Comments:		
Test method available (standards):	☐ Yes	☐ No
Comments:		
Test methods described:	☐ Yes	☐ No
Comments:		
Test methods suitable:	☐ Yes	☐ No
Comments:		
Test methods reproducible:	☐ Yes	☐ No
Comments:		
Test methods accurate:	☐ Yes	☐ No
Comments:		
Test results available:	☐ Yes	☐ No
Comments:		
Test results in line with performance claim:	☐ Yes	☐ No
Comments:		
Test results can be used in the verification process	☐ Yes	☐ No
Comments:		

Conclusions on the Proposal:

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Work carried out by Technical Manager:	☒ No distribution without permission from the Client or organizational unit responsible ☐ Strictly confidential ☐ Unrestricted distribution

Proposer:
Name:
Date:
Signature:

Verification body: RINA Services SpA
Name:
Date:
Signature:

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ANNEX 3: Table of contents and parameter definition table for the specific verification protocol[28]

Table of Contents and parameter definition table for the specific verification protocol

The specific verification protocol shall have the following table of content.

Table of contents

18 Including the consideration of regulatory requirements, application based needs, key environmental factors and state of the art performance of similar technologies as provided under B.IV.2.

[28] This document is the Appendix 6 of the GVP.

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8. Verification schedule
9. Quality assurance including test system audit where applicable
10. References
Appendix 1 Terms and definitions

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Parameter definition table

The parameter definition table, included in the specific verification protocol as section 3.5, shall follow the
following template. This template may be modified by the ETV Technical Working Groups and published in a guidance document, without updating the General Verification Protocol.

Table 6: Parameter definition table

Parameter (list of parameters to be considered in the specific verification protocol)	Value	Existing legal requirements and/or BAT values	Test method(s)	Test/available data (+ performer of tests)
Performance parameters (technical or functional performance)		e.g. Required in France, legal reference	e.g. ISO....	available data + sample (laboratory)
Operational parameters e.g. temperature	e.g. max 80° C			e.g. monitored for 2 months (subcontractor)
Environmental parameters				
Resource use during production of the product or equipment				
Resource use during use phase Water Electricity Raw materials	e.g. 600 m^3/year		e.g. flow meter type...	
Consumables				
Use of hazardous substances				
Waste generated				
Emissions (air, water)				
Reusability, recyclability (fully or in part)				
End of life decommissioning and disposal				
Additional parameters				
Man-power needed operation maintenance				
Space needed operation maintenance				
Service life				
Robustness/vulnerability to changing conditions of use				

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