

**ETV**

Verification report



Project No.: 1005

Date: 24-11-2015

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**ECOGI**

## **Pre-treatment of biomass for anaerobic digestion**

**Mechanical pretreatment and separation of organic waste from households to obtain a pulp for biogasification**

**Verification Report  
J.no. 1005**

Version 1, October 27<sup>th</sup> 2015  
Revised version 7 November 24<sup>th</sup> 2015

## Table of Contents

1	Introduction.....	3
1.1	Name of technology.....	3
1.2	Name and contact of proposer.....	3
1.3	Name of Verification Body and responsible of verification.....	3
1.4	Organisation of verification including experts, and verification process.....	3
1.5	Deviations from the verification protocol.....	<a href="#">56</a>
2	Description of the technology and application.....	6
2.1	Summary description of the technology.....	6
2.2	Intended application (matrix, purpose, technologies, technical conditions).....	8
2.3	Verification parameters definition.....	8
3	Existing data.....	9
3.1	Accepted existing data.....	9
4	Evaluation.....	10
4.1	Calculation of verification parameters.....	10
4.2	Evaluation of test quality.....	11
4.2.1	Control data.....	11
4.2.2	Audits.....	11
4.2.3	Deviations.....	11
4.3	Verification results (Verified performance claim).....	<a href="#">12+1</a>
4.3.1	Performance parameters.....	12
4.3.2	Operational parameters.....	12
4.3.3	Environmental parameters.....	12
4.3.4	Additional parameters, with comments or caveats where appropriate.....	<a href="#">13+2</a>
4.4	Recommendations for the statement of verification.....	13
5	Quality assurance.....	13
6	References.....	15
	Appendix 1 Terms and definitions.....	16
	Appendix 2 – Quick scan.....	20
	Appendix 3 – Proposal.....	20
	Appendix 4 – Specific verification protocol.....	20
	Appendix 5 – Amendment and deviation report for verification.....	20
	Appendix 6 – Test plan.....	20
	Appendix 7 – Test report.....	20

## 1 Introduction

Environmental technology verification (ETV) is an independent (third party) assessment of the performance of a technology or a product for a specified application under defined conditions and quality assurance.

The verification is performed under the EU ETV pilot programme.

The format used in this verification report follows guidelines in Ref.1.

### 1.1 Name of technology

The technology name is ECOGI

### 1.2 Name and contact of proposer

#### Proposer

Komtek Miljø af 2012 A/S, Drivervej 8, DK 6670 Holsted

Contact: Jens Peter Jensen (JPJ), phone: +45 7020 54 89, e-mail: [jpj@komtek.dk](mailto:jpj@komtek.dk)

### 1.3 Name of Verification Body and responsible of verification

Danish Technological Institute, Verification Centre, Life Science Division, Kongsvang Allé 29, DK-8000, Aarhus C.

Verification responsible: Lotte Bjerrum Friis-Holm (LBFH), phone: +45 72201837; e-mail: [lbfh@teknologisk.dk](mailto:lbfh@teknologisk.dk)

Internal reviewer: Nils H Nilson (NHN), phone: +45 72201825, e-mail: [nhn@teknologisk.dk](mailto:nhn@teknologisk.dk)

### 1.4 Organisation of verification including experts, and verification process

The verification is conducted in a collaboration between ETA- Danmark and Danish Technological Institute.

The organization of test and verification is shown in [Figure 1](#).

The verification is planned and conducted to satisfy the requirements of the ETV scheme established by the European Union (EU ETV).

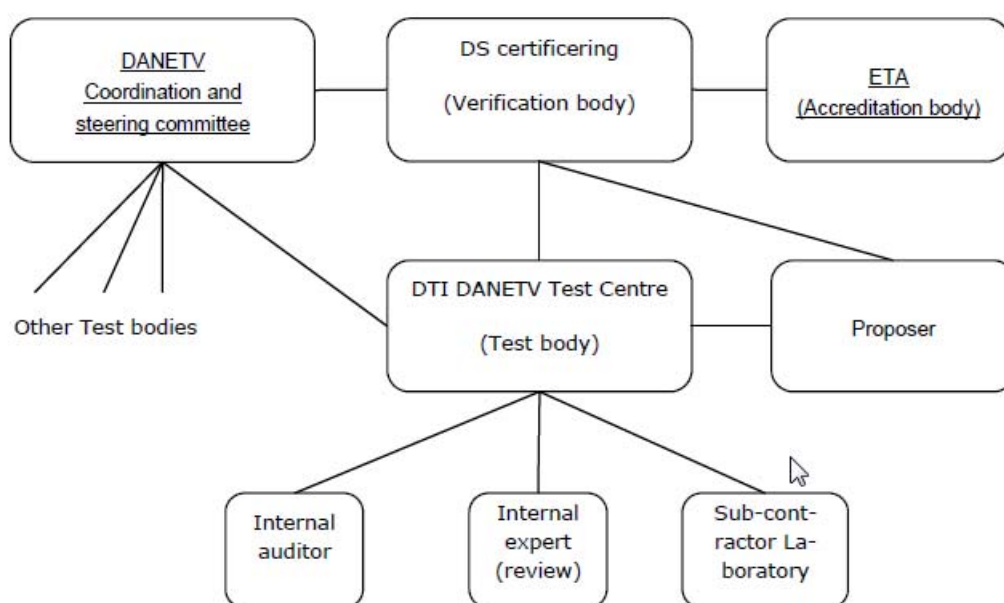
Verification and tests will be performed by Danish Technological Institute (DTI) under EUETV under contract with Komtek Miljø af 2012 A/S.

The day to day operations of the verification and tests is coordinated and supervised by DTI personnel, with the participation of the proposer.

The testing was conducted at Komtek Miljø af 2012 A/S Drivervej 8, Holsted

DTI test centre, Test subbody performed the test as described in the test plan.

Komtek Miljø af 2012 A/S personnel was operating the ECOGI plant and assisted with all tasks necessary for verification as described in the contract.



**Figure 1** Verification organization

**Table 1. Responsible personnel in test organization**

Unit in test organization	Responsible
DTI organization management Life science division	Bo Frølund
DTI Life science division Test Centre, Verification subbody	Lotte Bjerrum Friis-Holm (LBFH)
DTI Life science division Test Centre, Test subbody	Bjørn Malmgren-Hansen (BMH)

The expert group assigned to this verification and responsible for review of the verification plan and report documents includes:

Arne Grønkjær Hansen (AGH), Agrotech, phone: +45 87438430, e-mail: agh@agrotech.dk

Verification and tests are conducted in two separate steps, as required by the EU ETV pilot programme. The steps in the verification are shown in [Table 2](#).

Verification and test are performed by Danish Technological Institute DANETV verification and test centre. The verification sub-body is responsible for preparation and compilation of the Verification protocol and the Verification report. The Test sub-body is responsible for the test plan and the test report.

The day to day operations of the tests and verification will be coordinated and supervised by DTI, with participation of the proposer, Komtek Miljø af 2012 A/S.

Komtek Miljø af 2012 A/S provided the “ECOGI plant” PI diagram (Rev. 8, 10.04.2015) and description of normal operation and other necessary information regarding preparation of the verification protocol and test plan.

A part of the verification organization is the expert group who supports DTI and reviews all plan and report documents during the verification process.

**Table 2 Overview of the three main phases in the verification process and corresponding documents**

Phase	Responsible	Document
Preparation phase	Verification body	Quick scan
		Contract with proposer
		Specific verification protocol
Testing phase	Test body	Test plan
		Test report
Verification phase	Verification body	Verification report
		Statement of Verification

Quality assurance was undertaken by an internal and an external expert. Two audits of the test system was performed, including an internal audit by the test body and an external audit during test by the ETA-Danmark verification body.

The Statement of Verification will be issued by the ETA-Danmark Verification body after completion of the verification process.

## 1.5 Deviations from the verification protocol

None

## 2 Description of the technology and application

### 2.1 Summary description of the technology

The process is a pulper/separator for extraction of organic waste from pre-sorted household waste containing packaging material and other residues.

A DANETV verification exist for an earlier version of ECOGI (statement dated 6.th may 2013) but without verification of the performance of the new dewatering system. In the present verification the complete plant is verified.

The operation is a batch process. The waste is introduced to a pulper with initial addition of water. After approx. 30 minutes pulping the material is transferred to a reject separator which produces an organic pulp (biopulp) and a solid fraction with all solid particles larger than 6 mm. The pulp is then concentrated using a screw separator. The solid fraction consisting of plastic bags, plastic packaging, glas, metal and some organic material larger than 6 mm is washed in the reject separator before transferring to a container for further treatment. Water from washing and screw press is recirculated for use in the next batch production of biopulp.

The principle is shown in [Figure 2](#) with the pulping step, reject separation, washing and dewatering of solid fraction. All these components are used in the test for recovery and purity of the biopulp. In normal operation the water from the screw press (thickener) is used for pulping of the next batch. The water obtained from dewatering of the reject is also reused in the process.

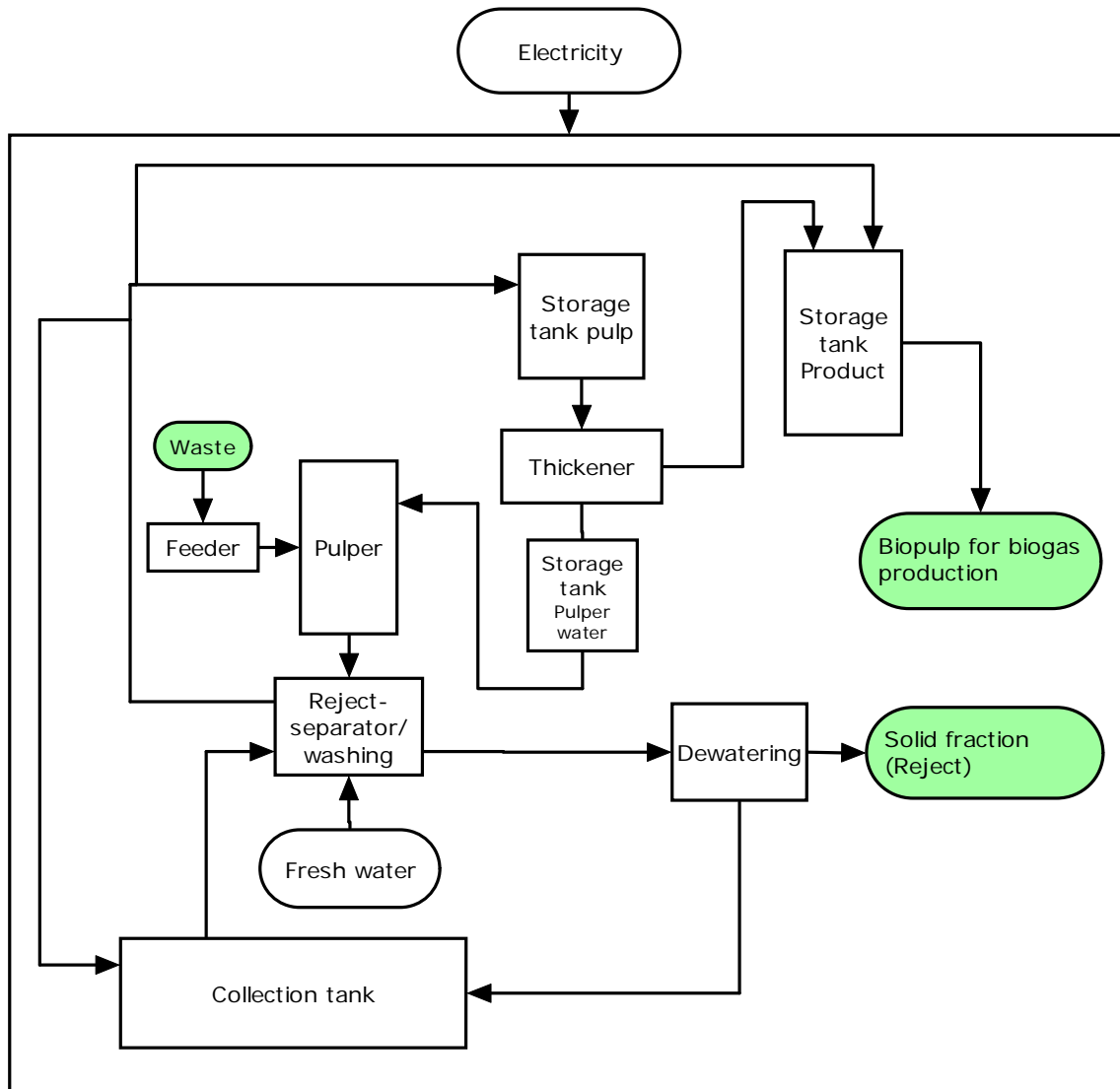


Figure 2 Principle of the ECOGI process, showing inputs and outputs

## 2.2 Intended application (matrix, purpose, technologies, technical conditions)

The ECOGI process is verified as a mechanical pretreatment of separately collected organic household waste into a biopulp and a reject with content of non-biodegradable materials like plastics, metals, glass. The biopulp can be used for anaerobic digestion.

The purposes of the verification is to verify that the process has

- a high purity of the produced biopulp (low content of non biodegradable material such as plastics, glass metal, textile)
- a high recovery of organic matter in pulp.

Additional parameters include

- energy consumption (electricity)
- water consumption

The effects of this application are

- High recovery of organic matter in pulp
- High purity of organic matter in pulp
- Low energy consumption per ton waste
- Low water consumption per ton waste

## 2.3 Verification parameters definition

Performance parameters are defined taking into account e.g. regulatory requirements, application based needs, and state of the art performance. For the verification of the ECOGI Technology the following 4 performance parameters have been defined:

- Recovery of organic matter in pulp
- Purity of organic matter in pulp
- Energy consumption per ton waste
- Water consumption per ton waste

Operational parameters, which was measured include:

- The amount of added biomass for each test run and the time used for the test run
- The amount of added water for each test run
- All other added or removed amounts either through weighing or from calculation



- Electricity consumption for each test run

The user manual and implications on occupational health and environment was not evaluated as part of this verification.

In Table 3 below the performance parameters for this specific verification are presented. The figures mentioned in the Value-column refer to the performance claims of the proposer.

**Table 3 Parameter definition table**

Parameter	Value	Existing legal requirements	Test or measurement methods	Available test data
Recovery of organic matter in pulp (excluding wood >5*5*5 mm)	>90% based on dry matter	Not applicable	Method described in Test plan	The technology has not been tested previously in this modified version
Purity of organic matter in pulp*	>95% based on dry matter	Not applicable	Method described in Test plan	The technology has not been tested previously in this modified version
Electricity consumption	<50 kWh/ton treated organic waste	Not applicable	Electricity meter see test plan	The technology has not been tested previously in this modified version
Water consumption	Depends on produced dry matter content in the pulp. Will be measured for given dry matter content	Not applicable	Calibrated flow meter, See test plan	The technology has not been tested previously in this modified version

*\*In the ECOGI plant the pulp is screened using a 6 mm screen and thus most impurities (plastic, glass, metals) will be less than 6 mm. In the test of purity the pulp is washed using a 1.7 mm screen.*

### 3 Existing data

#### 3.1 Accepted existing data

No existing data has been used in the present verification.

## 4 Evaluation

### 4.1 Calculation of verification parameters

#### Purity

Based on the methods described in the test plan the purity is calculated from data for the amount of dry impurities  $m_{impurity}$  and the amount of used pulp for the analysis  $m_{pulp}$  with total solids TS% in the following way

$$Purity\% \text{ at } TS_{pref} = 100 \cdot \left( 1 - TS_{pref} \cdot \frac{m_{impurity}}{m_{pulp} \cdot TS\%} \right)$$

The amount of dry impurities is  $m_{impurity}$

The amount of used pulp for the analysis is  $m_{pulp}$  with total solids TS%

$TS_{pref}$  is the preferred total solids % used for calculation of the purity.

In order to calculate the purity of the product the amount of produced biopulp (produced to product tank and to storage tank for biopulp) and the amount of produced fibre fraction from thickener is used to calculate the purity of the final product.

#### Calculation of recovery

The recovery is calculated from data for the total amount of volatile solids of biodegradable organic matter  $mtot_{vs}$  and the amount of volatile solids of biodegradable organic matter in the reject  $mR_{vs}$

$$Recovery\% = 100 \cdot \frac{mtot_{vs} - mR_{vs}}{mtot_{vs}}$$

An example of the calculation of recovery (test run 1) is shown in Appendix 2 in the test report.

In test run 1,  $mtot_{vs} = 1.798$  ton and  $mR_{vs} = 0.131$  ton, and the recovery is calculated to  $100 \cdot (1.798 - 0.131) / 1.798 = 92.9\%$  for test run 1.

#### Calculation of electricity and water consumption

Electricity consumption was measured for each test run and the electricity consumption per ton added waste was calculated.

The water consumption was calculated as the used amount of water in ton pr ton added organic waste.

## 4.2 Evaluation of test quality

### 4.2.1 Control data

A test system control was performed by Bjørn Malmgren Hansen, Danish Technological Institute. The waste fractions added to the plant and the reject transported out of the plant were weighed using a certified weighing bridge with a resolution of 20 kg. The weighing bridge was verified 17<sup>th</sup> march 2015 (see test report, Appendix 4).

During the test at the ECOGI plant, lab weights were used for weighing different fractions of reject in connection with analysis of recovery. All weights were calibrated during the test period.

Komtek has made a calibration of all flow and level measurement equipment at the plant. The report is in Danish and made in week 23 and 24, 2015. The data has been evaluated by Danish Technological Institute and the documentation were found sufficient for performing the verification. Details for the calibrations are shown in the test report.

In addition a control of measured data has been introduced for each test run by collecting all data necessary to perform a mass balance. See section 5.

All data from the test runs have been double checked.

### 4.2.2 Audits

A test system audit with inspection of the test set-up at the test site was done by Peter Fritzel from ETA-Danmark Verification Body on the 27<sup>th</sup> of August 2015. As part of the test system audit it was evaluated whether the testing was done according to the requirements specified in the test plan and in the specific verification protocol. It was concluded from the test system audit, that there was consistency with the test plan and the test set-up and that measurements were carried out as described. The audit report of Peter Fritzel is included as Appendix 4 in the test report.

### 4.2.3 Deviations

There are no deviations from the verification protocol.

Minor deviations are described in the test report (App. 3) regarding changes in a test procedure described in the test plan. The deviation is in the laboratory sorting procedure for the reject, which has been simplified. It has been assessed that the simplification has no significant impact on the test results.

### 4.3 Verification results (Verified performance claim)

#### 4.3.1 Performance parameters

An overview of the verified performance of the system is shown below.

**Table 4. verified performance parameters for purity of products and recovery of organic waste. Average values of three test runs are shown.**

	Average %	Standard deviation %	(95% confidence interval)
Purity of product (all impurities, 100% dry matter)	99.76	0.06	99.61-99.91
Purity of product (all impurities, 17% dry matter)	99.96	0.01	99.94-99.98
% Recovery of organic waste	92.96	0.77	91.1-94.9

Results show that the performance claims are fulfilled.

#### 4.3.2 Operational parameters

The electricity and water consumption of ECOGI is shown in table 5.

**Table 5. Electricity and water consumption during test run. Average values of three test runs.**

	Average	Standard deviation %	(95% confidence interval)
Electricity consumption kwh/ton waste added	35.71	2.00	30.7-40.7
Water consumption ton water/ton waste added	0.72	0.06	0.57-0.87

The performance claims for electricity consumption are fulfilled.

There was no claim for the water consumption as it depends on the dry matter of waste and output, which can be adjusted in the plant.

Capacity and dry matter of produced pulp is shown under additional parameters 4.3.4

#### 4.3.3 Environmental parameters

The relevant environmental parameters are included as performance and operational parameters.

#### 4.3.4 Additional parameters, with comments or caveats where appropriate

In addition the capacity of the plant was measured in each the test run as well as the dry matter of the products.

The results are shown in the table below:

**Table 6. Capacity and Dry matter of produced biopulp. Average values of three test runs are shown.**

	Average	Standard deviation	(95% confidence interval)
Waste added tons/hour (Capacity)	6.54	0.6	5.1-8.0
Dry matter of produced pulp (%)	16.5	0.4	15.5-17.5

#### 4.4 Recommendations for the statement of verification

Based on the verified performance described in section 4.3 it is recommended to issue a statement of verification including results on the following parameters:

##### Performance parameters:

- Purity of product (100% dry matter)
- Recovery of organic waste

##### Operational parameters:

- Energy consumption

##### Additional parameters:

- Capacity of the plant
- Dry matter of produced pulp

All the above mentioned parameters can be verified for the ECOGI technology, for extraction of organic waste collected from households in plastic bags.

## 5 Quality assurance

The test activities were undertaken by Danish Technological Institute Test Centre (test body). DTI has a quality management system covering ETV test activities that follows the principles of EN ISO 9001. It is judged that the quality management system fulfils the requirements of the General Verification Protocol (Chapter C.III) and thereby DTI Test Centre is qualified for participation in the EU ETV verification process.

The quality assurance of the tests included control of the test system and control of the data quality and integrity.

A test system audit on the test site, ECOGI plant at Komtek Miljø, Holsted, was done by Peter Fritzel from ETA-Danmark Verification Body on the 27<sup>th</sup> of August 2015. As part of the test system audit it was evaluated whether the testing was done according to the requirements specified in the test plan and in the specific verification protocol. Based on the audit it was concluded, that there was consistency with the test plan and set up and that measurements were carried out as described.

Furthermore a quality control of the measured masses and flows were performed for each test run by collecting sufficient data to be able to calculate a mass balance.

The mass balance for each test run requires the following data for Input:

- Waste added
- Water added

Output

- Biopulp product
- Mass difference in 3 internal storage/collection tanks

The difference in the mass balance was within 10% as seen in the table below. This is acceptable within the accuracy of the measurement equipment used (described in 3.3.2 in test report).

**Table 7 Difference in mass balance**

	Test run 1	Test run 2	Test run 3
Difference in mass balance (input/output) in % (w/w)	-0.18	9.96	2.36

The specific verification protocol and the verification report required external review according to the EU ETV General Verification Protocol (European Commission, 2014). The external review was undertaken by Arne Grønkjær Hansen (AGH) from Agrotech.

Furthermore, the verification body (ETA-Danmark) has reviewed and approved the test plan. And the test report. This review was done by Lotte Bjerrum Friis Holm.

During the verification process the proposer represented by Jens Peter Jensen (JPJ) had the following tasks:

- To review the specific verification protocol
- To review and approve the test plan

- To review the test report and the verification report

## 6 References

1. EU general verification protocol version 1.1 July 7<sup>th</sup> 2014.
2. DTI DANETV Test Centre. Center quality manual. April. 2015.
3. DANETV “ECOGI - Pretreatment of biomass for anaerobic digestion”. Journal no. 1004. Verification protocol, Test plan, test report and verification report 2012, 2013.

## Appendix 1 Terms and definitions

Term	Definition	Comments
Accreditation	Meaning as assigned to it by Regulation (EC) No 765/2008	EC No 765/2008 is on setting out the requirements for accreditation and market surveillance relating to the marketing of products
Additional parameter	Other effects that will be described but are considered secondary	None
Amendment	A change to a specific verification protocol or a test plan done before the verification or test step is performed	None
Analytical laboratory	Independent analytical laboratory used to analyse test samples	The test centre may use an analytical laboratory as subcontractor
Application	The use of a technology specified with respect to matrix, purpose (target and effect) and limitations	The application must be defined with a precision that allows the user of a technology verification to judge whether his needs are comparable to the verification conditions
DANETV	Danish centre for verification of environmental technologies	None
Deviation	A change to a specific verification protocol or a test plan done during the verification or test step performance	None
Environmental technologies	Environmental technologies are all technologies whose use is less environmentally harmful than relevant alternatives	The term technology covers a variety of products, processes, systems and services
Evaluation	Evaluation of test data for a technology for performance and data quality	None



Term	Definition	Comments
General verification protocol (GVP)	Description of the principles and general procedure to be followed by the ETV pilot programme when verifying an individual environmental technology.	None
Innovative environmental technologies	Environmental technologies presenting a novelty in terms of design, raw materials involved, production process, use, recyclability or final disposal, when compared with relevant alternatives.	None
Matrix	The type of material that the technology is intended for	Matrices could be soil, drinking water, ground water, degreasing bath, exhaust gas condensate etc.
Method	Action described by e.g. generic document that provides rules, guidelines or characteristics for tests or analysis	An in-house method may be used in the absence of a standard, if prepared in compliance with the format and contents required for standards, see e.g. [4]
Operational parameter	Measurable parameters that define the application and the verification and test conditions.	Operational parameters could be temperature, production capacity, concentrations of non-target compounds in matrix etc.
(Initial) performance claim	Proposer claimed technical specifications of technology. Shall state the conditions of use under which the claim is applicable and mention any relevant assumption made.	The proposer claims shall be included in the ETV proposal. The initial claims can be developed as part of the quick scan.
Performance parameters (revised performance claims)	A set of quantified technical specifications representative of the technical performance and potential environmental impacts of a technology in a specified application and under specified conditions of testing or use (operational parameters).	The performance parameters must be established considering the application(s) of the technology, the requirements of society (legislative regulations), customers (needs) and proposer initial performance claims.
Potential environmental impacts	Estimated environmental effects or pressure on the environment, resulting directly or indirectly from the use of a technology under specified conditions of	None

Term	Definition	Comments
	testing or use.	
Procedure	Detailed description of the use of a standard or a method within one body	The procedure specifies implementing a standard or a method in terms of e.g.: equipment used.
Product	Ready to market or prototype stage product/technology, process, system or service based upon an environmental technology.	In the EU ETV GVP [1] the term "technology" is used instead of the term "product".
Proposer	Any legal entity or natural person, which can be the technology manufacturer or an authorised representative of the technology manufacturer. If the technology manufactures concerned agree, the proposer can be another stakeholder undertaking a specific verification programme involving several technologies.	Can be vendor or producer
Purpose	The measurable property that is affected by the technology and how it is affected.	The purpose could be reduction of nitrate concentration, separation of volatile organic compounds, reduction of energy use (MW/kg) etc.
Ready to market technology	Technology available on the market or at least available at a stage where no substantial change affecting performance will be implemented before introducing the technology on the market (e.g. full-scale or pilot scale with direct and clear scale-up instructions).	None
Specific verification protocol	Protocol describing the specific verification of a technology as developed applying the principles and procedures of the EU GVP and this quality manual.	None
Standard	Generic document established by consensus and approved by a recognised standardization body that provides rules, guidelines or characteristics for tests or	None

Term	Definition	Comments
	analysis	
Test body	Unit that that plans and performs test	None
Verification body	Unit that plans and performs the verification	None
Test/testing	Determination of the performance of a technology for measurements / parameters defined for the application.	None
Test performance audit	Quantitative evaluation of a measurement system as used in a specific test.	E.g. evaluation of laboratory control data for relevant period (precision under repeatability conditions, trueness), evaluation of data from laboratory participation in proficiency test and control of calibration of online measurement devises.
Test system audit	Qualitative on-site evaluation of test, sampling and/or measurement systems associated with a specific test.	E.g. evaluation of the testing done against the requirements of the specific verification protocol, the test plan and the quality manual of the test body.
Test system control	Control of the test system as used in a specific test.	E.g. test of stock solutions, evaluation of stability of operational and/or on-line analytical equipment, test of blanks and reference technology tests.
Vendor	The party delivering the technology to the customer. In the EU ETV GVP and in this quality manual referred to as proposer.	Can be the producer.
Verification	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.	None

## **Appendix 2 – Quick scan**

The report from the quick scan is attached to the verification report as a separate file.

## **Appendix 3 – Proposal**

The verification proposal is attached to the verification report as a separate file.

## **Appendix 4 – Specific verification protocol**

The specific verification protocol is attached to the verification report as a separate file.

## **Appendix 5 – Amendment and deviation report for verification**

No amendment report has been made for the verification of ECOGI as there was no amendments/deviations from the verification plan.

## **Appendix 6 – Test plan**

The test plan is attached to the verification report as a separate file.

## **Appendix 7 – Test report**

The test report is attached to the verification report as a separate file.