BONUS RETURN
Reducing Emissions by Turning Nutrients and Carbon into Benefits
https://www.bonusprojects.org/bonusprojects/the_projects/blue_baltic_projects/return
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Deliverable Title	**D 3.7 – List of Emerging Eco-technologies**
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Dissemination level

X	PU	Public.
	PP	Restricted to other project partners.
	RE	Restricted to a group specified by the consortium.
	CO	Confidential, only for members of the consortium.

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1 INTRODUCTION

The degradation of the Baltic Sea is an ongoing problem, despite investments in measures to reduce external inputs of pollutants and nutrients from both diffuse and point sources. Available technological and management measures to curb eutrophication and pollution flows to the sea have not been adapted adequately to the contexts in which they are being applied. Furthermore, measures are often designed based on single objectives, thereby limiting opportunities for multiple benefits.

In addition, there is a general sense that measures to address the deterioration of the Baltic ecosystem are primarily technologically-driven and lacking broader stakeholder acceptance, and the "experts" who define these measures have little engagement with industry, investors, civil society and authorities. This problem is exacerbated by governance and management taking place in sectoral silos with poor coordination across sectors.

As a result, research shows that regional institutional diversity is presently a barrier to transboundary cooperation in the Baltic Sea Region (BSR) and that actions to achieve national environmental targets can compromise environmental goals in the BSR (Powell et al. 2013). The regional dimension of environmental degradation in the BSR has historically received weaker recognition in policy development and implementation locally. However, developments in recent years suggest a new trend with growing investments in environmental protection supporting social, economic, and territorial cohesion.

The BSR is an environmentally, politically and economically significant region and like other regions globally, its rapid growth needs to be reconciled with the challenges of sustainable development in a global setting that demands unprecedented reductions in GHG emissions. This poses a truly wicked problem exacerbated by the fact many of the challenges in BSR will also magnify in a changing climate. In order to navigate the uncertainties and controversies associated with a transformation towards a good marine environment, BONUS RETURN will enact an innovative trans disciplinary approach for identifying and piloting systemic eco-technologies.

Focus will be on eco-technologies that generate co-benefits within other interlinked sectors and which can be adapted according to geophysical and institutional contexts. More specifically, emphasis will be given to eco-technologies that reconcile the reduction of present and future eutrophication in marine environments with the regional challenges of policy coherence, food security, energy security, and the provision of ecosystem services.

1.1 Project Objectives

The **overall** aim of RETURN is to improve the adaptation and adoption of eco-technologies in the BSR for maximum efficiency and increased co-benefits.

The **specific objectives** of the project can be divided into 6 categories presented below. These categories are interlinked but for the purpose of providing a step-wise description, the following overview of each category proves useful. RETURN will:

1) **Support innovation and market uptake of eco-technologies:**
- Contribute to the application and adaptation of eco-technologies in the BSR through an evidence-based review (systematic map) of the developments within this field.
- Contribute to the development of emerging eco-technologies that have the capacity to turn nutrients and carbon into benefits (e.g. bio-energy, fertilizers), by providing an encompassing framework and platform for rigorous testing and analysis.

- Development of decision support systems for sustainable eco-technologies in the BSR.
- Contribute to better assessment of eco-technology efficiency via integrated and participatory modelling in three catchments areas in Finland, Sweden and Poland.
- Contribute to methodological innovation on application and adaptation of eco-technologies

2) Reduce knowledge gaps on policy performance, enabling/constraining factors, and costs and benefits of eco-technologies

- Assess the broader socio-cultural drivers linked to eco-technologies from a historical perspective
- Identify the main gaps in the policy environment constraining the implementation of emerging eco-technologies in the catchments around the Baltic Sea
- Inform policy through science on what works where and under which conditions through an evidence-based review (systematic map and systematic reviews) of eco-technologies and the regional economic and institutional structures in which these technologies evolve.

3) Provide a framework for improved systematic stakeholder involvement:

- Develop methods for improved stakeholder engagement in water management through participatory approaches in the case study areas in Sweden, Finland and Poland.
- Enact a co-enquiry process with stakeholders into opportunities for innovations in eco-technologies capable of transforming nutrients and pollutants into benefits for multiple sectors at different scales.
- Bring stakeholder values into eco-technology choices to demonstrate needs for adaptation to local contexts and ways for eco-technologies to efficiently contribute to local and regional developments.
- Disseminate results and facilitate the exchange of learning experiences, first within the three catchment areas, and secondly across a larger network of municipalities in the BSR.
- Establish new cooperative networks at case study sites and empower existing regional networks by providing information, co-organize events and engage in dialogues.

4) Support commercialization of eco-technologies:

- Identify market and institutional opportunities for eco-technologies that (may) contribute to resource recovery and reuse of nutrients, micro-pollutants and micro-plastics (e.g. renewable energy).
- Identify potential constraints and opportunities for integration and implementation of eco-technologies using economical models.
- Facilitate the transfer of eco-technologies contributing to win-win solutions to multiple and interlinked challenges in the BSR.
- Link producers of eco-technologies (small and medium enterprises - SMEs), to users (municipalities) by providing interactive platforms of knowledge exchange where both producers and users have access to RETURN's envisaged outputs, existing networks, and established methodologies and services.

5) Establish a user-driven knowledge platform and improve technology-user interface

- Develop an open-access database that maps out existing research and implementation of eco-technologies in the BSR. This database will be intuitive, also mapped out in an interactive geographical information system (GIS) platform, and easily managed so that practitioners, scientists and policy-makers can incorporate it in their practices
- Develop methodologies that enact the scaling of a systemic mix of eco-technological interventions within the highly diverse contexts that make up the BSR and allows for a deeply interactive media of knowledge.

1.2 Project Structure

BONUS RETURN is structured around 6 Work Packages that will be implemented in three river basins: The Vantaanjoki river basin in Finland, the Słupia river basin in Poland, and Fyrisån river basin in Sweden.

Work Package 1: Coordination, management, communication and dissemination.
Work Package 2: Integrated Evidence-based review of eco-technologies.
Work Package 3: Sustainability Analyses.
Work Package 4: Environmental Modelling.
Work Package 5: Implementation Support for Eco-technologies.
Work Package 6: Innovative Methods in Stakeholder Engagement.

1.1 Deliverable context and objective

The current deliverable (D 3.7) is part of WP 3. The objectives of WP 3 are *to evaluate sustainability aspects of eco-technologies selected in WP2 using a decision support-based framework for sustainability analysis for each catchment area. The application of sustainability analysis includes a step-wise systems analysis approach to be carried out together with local stakeholders by: 1) defining system boundaries; 2) selecting criteria covering health and hygiene, environmental issues, economy, socio-cultural dimensions and technical function; 3) selecting and formulating different system alternatives based on the review of eco-technologies from WP 2; 4) comparing the different options using the criteria from step 2. The comparison will be done by using substance flow-, cost- effectiveness and cost benefit analysis, energy analysis and also qualitative assessments. Results of environmental impacts will be imported from WP4. In step 4, a multi-criteria analysis will be used for an integrated assessment of all dimensions to reach a complete decision support system for municipalities or regions. A second objective of WP3 will be to identify upcoming innovations for reuse (TRL 5 or higher), using the same sustainability criteria as above. The final results of WP3 will be a selection of interesting eco-technologies for further development in WP5*

This deliverable includes a report of the process followed throughout the competition including documentation of the call, criteria, number of applicants, jury panel, shortlist of candidates, an overview of the Baltic Sea Future Conference were shortlisted finalists presented their innovations, and the final list of (1-3) winners.

1.2 Outline of the report

This report is structured as follows: Section 2 gives an overview of the preparatory and application stage of the Nutrients and Carbon and Reuse Challenge, including the Terms of Reference (ToR) outlined in the competition (2.1); the timeline of events and the jury (2.2), and a summary of the communication and dissemination strategy of the competition (2.3).

Section 3 summarizes the results of the Challenge, including the list of applicants (3.1); the selection procedure (3.2); and the results (3.3)

Appendix 1 includes the competition guidelines, Appendix 2 the Jury Guidelines, and Appendix 3 the agenda of the Baltic Sea Future Conference.

2 LIST OF EMERGING ECO-TECHNOLOGIES

In December 2017, BONUS RETURN announced an open competition for innovations addressing the reuse of nutrients and carbon in the Baltic Sea. The Nutrients and Carbon Reuse Challenge focused on attracting innovative eco-technologies that with the potential to reuse nutrients and carbon, and which were interested in improving their eco-technology readiness levels, and/or adapt their eco-technology to local markets in the Baltic Sea Region, and/or meet with potential investors and clients.

Up to 3 innovations would be chosen to be part of the project's pre-commercialization process, and present their innovations to a group of investors, researchers and public sector actors at the Baltic Sea Future Conference in Stockholm on 8 -9 March, 2018.

Winners would have the opportunity to:
1. Perform tests.
2. Match their product to local needs.
3. Obtain tailor-made procurement and business plans.
4. Link with private sector and investors.
5. Introduce the product to potential markets.

The Challenge closed on the 16th February 2018.

2.1 Terms of Reference

To be eligible eco-technologies had to comply with the following criteria:

1. Addresses nutrient or carbon reuse from the agricultural or waste water sectors, or both.
2. Can be applied in the Baltic Sea environment.
3. Is a biological, physical, or chemical intervention designed to minimize harm to the environment and provide services of value to society (in line with BONUS RETURN's definition of eco-technologies).
4. Is a prototype Technology Readiness Level (TRL) 5 or higher, according to the EU framework programme H2020

Technology Readiness Level (TRL) is a European-standardized metric system used to assess the maturity of a technology. The scale consists of nine levels where each level characterizes the progress in the development of a technology, from inception (Level 1) to the full uptake of the product into the marketplace (Level 9). In BONUS RETURN, technology readiness refers to an ecotechnology's performance and effectiveness to reuse nutrients and/or carbon from the agricultural or waste water sectors or both.

The images below summarize the four main benefits for innovators generated through the Challenge.

1. IMPROVING INNOVATION READINESS

In BONUS RETURN, technology readiness refers to an eco-technology's performance and effectiveness to **reuse** nutrients and/or carbon from the agricultural or waste water sectors or both.

BONUS RETURN assists in identifying and performing the necessary tests to improve an innovation through on-site testbeds for agricultural and waster water treatment sectors in the Baltic Sea Region.

2. PRE-COMMERCIALIZATION PLANS

1

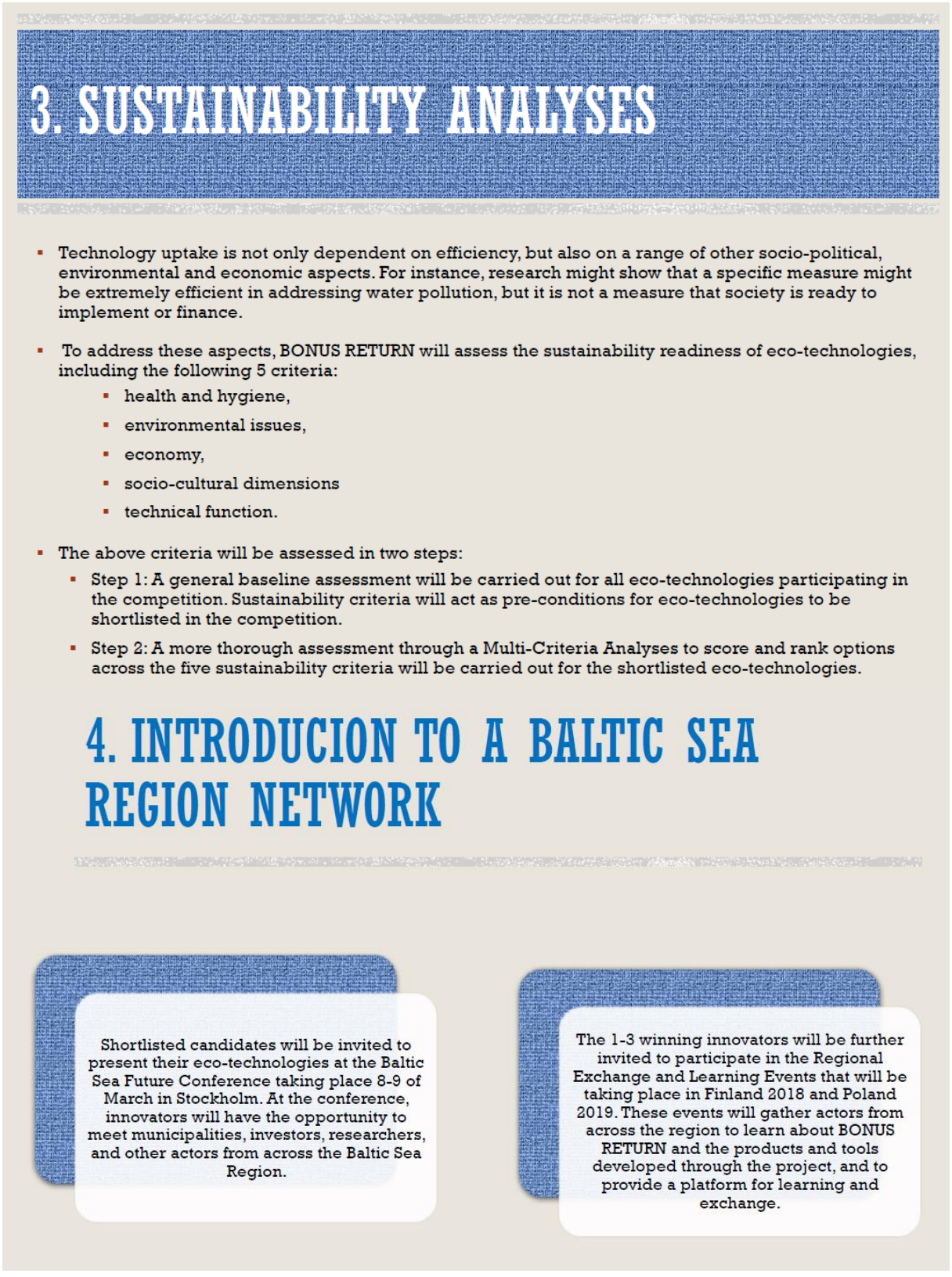
Through a framework for Pre-Commercialization, BONUS RETURN will guide enterprises through the process of analyzing the market and developing a business strategy.

2

The framework will help innovators identify potential clients and take the necessary steps to establish business relationships with municipalities as potential clients.

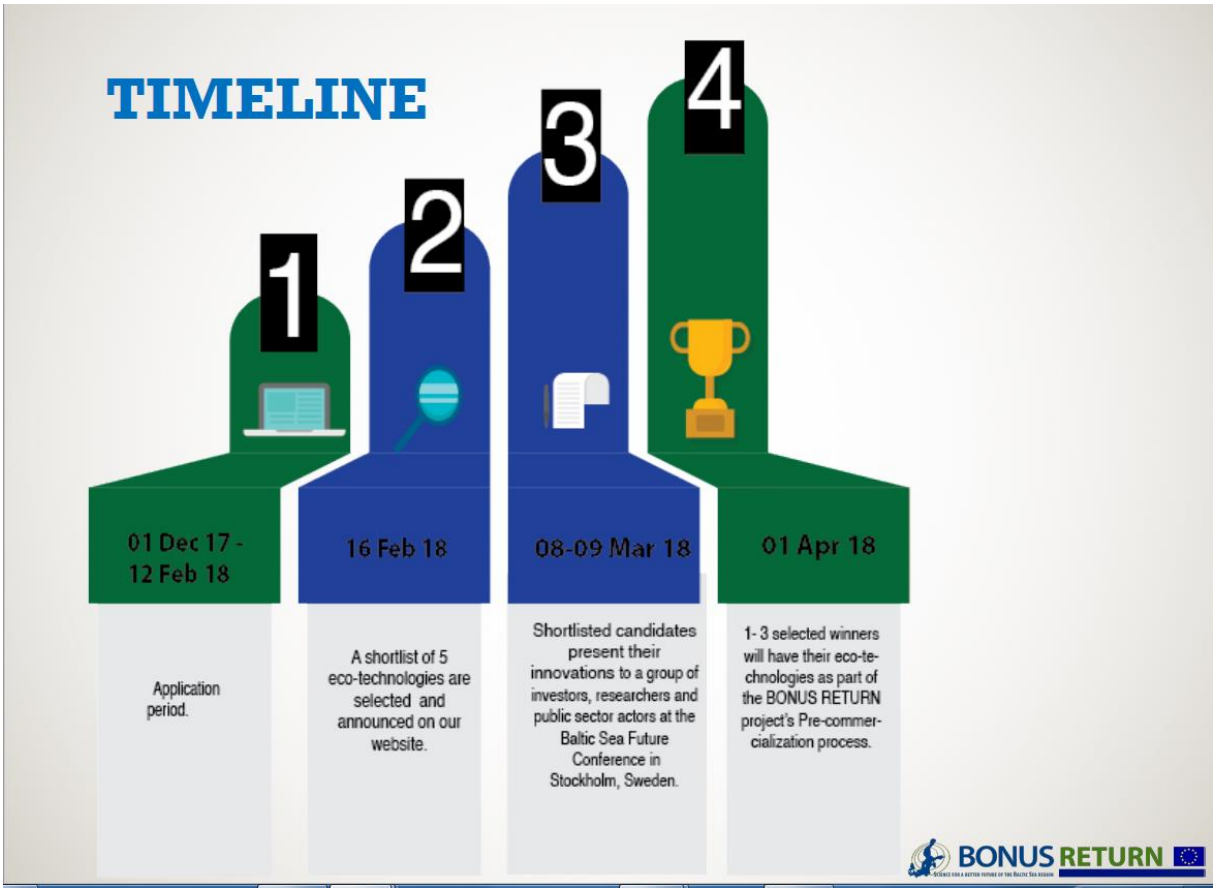
3

BONUS RETURN will then co-develop business and public procurement plans with a particular focus on the three case studies in the project: Finland, Sweden and Poland.



Innovators who applied for the BONUS RETURN competition will remain in full and undisputed possession of their Intellectual Property Rights on their innovation. All applicants will be named in an internal report and shortlisted candidates will be mentioned in BONUS RETURN external reports, publications and dissemination briefs. They will also be mentioned and/or presented at BONUS RETURN events.

2.2 Timeline and Jury



After the application period closed, the jury panel met to shortlist 4 candidates. The panel of internal and external experts consisted of esteemed, national and/or international experts in the agriculture and waste water treatment sectors and representing the three catchment areas in the project:

- Dr. Daniel Hellström, Swedish Water and Wastewater Association, Sweden
- Mr. Piotr Czerwczak, Słupsk Waterworks, Poland
- Mr. Kari Koppelmäki, Agroecological Symbiosis, Finland
- Dr. Måns Lundh, Urban Water management at RISE Research Institutes of Sweden
- Dr. Marek Giełczewski Department of Hydraulic Engineering, Warsaw University of Life Sciences, Poland.
- Dr. Jari Koskiaho, Water Information System, Finnish Environment Institute, Finland.

Before the meeting, jury members were requested to assess the applications and rate them according to each category, as explained in the table below. At the meeting, the panel reviewed all applications and composed the final statements for each application based on the draft statements and the discussion. The preparation of the final statements was done during the panel meeting by the summarizer (i.e., the project coordinator Karina Barquet and the WP 3 lead Erik Kärrman). BONUS RETURN staff facilitated and assisted the panel in preparing the final unanimous panel reviews.

6	Extremely significant	Demonstrates exceptional novelty and innovation to address a solution for nutrients and/or carbon reuse; the innovation can demonstrate positive results; can be introduced to a market; addresses several or all sustainability criteria (see power point presentation for a description of sustainability criteria).
5	Very significant	A novel or timeliness contribution; high potential to address a solution to nutrients and/or carbon reuse; could be introduced to a market; addresses or has the potential to address several sustainability criteria.
4	Significant	An innovation that addresses nutrients and/or carbon reuse; maybe addresses sustainability criteria; and there are indications of enabling market mechanisms.
3	Moderate	Could potentially address nutrients and/or carbon reuse
2	Limited	An interesting idea, but with limited applicability; and/or could have potentially harmful side effects that are difficult to mitigate; and/or market mechanisms not in place to support implementation.
1	Poor	Contribution is not relevant at all, fails to demonstrate sound technology readiness, and does not comply to sustainability criteria at all.

The Jury was instructed to:

- Give evaluative comments rather than descriptive phrases.
- Write coherent phrases that can be communicated to the applicant
- Outline both the strengths and the weaknesses of the application.

The review panel thus evaluated the relevance, expected impact, sustainability, and market potential of each application. The panel members were asked to consider the following issues when writing the draft statements as well as when compiling the final panel statement:

1. Relevance to the programme
Whilst the application have been pre-screened, assess the level of relevance according to the following criteria: 1. Addresses nutrient or carbon reuse from the agricultural or waste water sectors, or both. 2. Can be applied in the Baltic Sea environment. 3. Is a biological, physical, or chemical intervention, or set of interventions, designed to minimize harm to the environment and provide services of value to society. 4. Is a prototype Technology Readiness Level (TRL) 5 or higher, according to the EU framework programme H2020.
2. Impact
Assess the expected impact of the innovation upon nutrients and carbon reduction and reuse.
3. Sustainability
Assess whether the application at the very least causes no harm, and at the very best contributes positively to one or several of the following 5 criteria: • health and hygiene, • environmental issues, • economy, • socio-cultural dimensions
4. Market potential
The innovation can be adapted to local markets. This refers not only to the potential of the innovation per se but also that the (socio-political and economic) conditions to enable its implementation (e.g procurement, national priorities, regional strategies, etc) exist or are underway.
5. Overall Assessment
List of main strengths and weaknesses of the application; additional comments and recommendations; can the project contribute to further developing the innovation?

2.3 Communication and dissemination strategy

The communication and dissemination strategy was developed in November 2017, and divided into two parts:

- A strategic plan for developing communication materials for promotion of the competition.
- A plan to disseminate the information through various sources and channels.

Timeline

November 2017: The communications plan was set and the material required for promotion designed. These included:

- A competition webpage on the project's website.
- A competition booklet with facts, background information and instructions to be read by all applicants before submitting their applications.
- A brochure with a summary of the competition's guidelines, timeline, requirements, and information about the project.

- Communications toolkit: As part of the dissemination plan, the project worked with consortium partners as well as external partners to promote the competition. The toolkit was thereby developed to ease the burden to these partners, as it contained all the necessary material required for promotion. The toolkit was a package containing:
  - A press release
  - The competition fact sheet and guidelines
  - Competition brochure (a digital version)
  - A news story
  - Social media package with prepared tweets

December 2017 – February 2018

The competition was officially launched on 1st December 2017 through an announcement on the BONUS RETURN website and a press release. The marketing campaign launched thereafter included:

- Twitter: a series of tweets and retweets from project partners using the hashtag #BonusReturn throughout the competition.
- Linkedin: promotional posts on Linkedin posted periodically throughout the competition.
- Facebook: marketing campaign ads on Facebook to reach a wider audience within the EU.
- Email marketing: strategic email marketing campaign to specifically targeted groups within the EU such as: innovation hubs, blue-tech companies, universities, Baltic Sea affiliated companies and networks, etc.

March 2018 - Baltic Sea Future Congress

Selected finalists were invited to present their innovations at an event organized by BONUS RETURN during the Baltic Sea Future Congress on 8th March 2018 in Stockholm, Sweden. The communication outputs included:

- Certificates of recognition with the BONUS RETURN logo, designed and issued to the finalists during the event.
- Presentation training with the finalists, provided prior to the event in preparation of their innovation pitches. The training was conducted together with Race For The Baltic, a boundary partner of BONUS RETURN.
- News story published on BONUS RETURN website, SEI website, and the BONUS projects website.
- Livestream of the event, available on BONUS RETURN YouTube playlist.
- Pictures taken during the event.
- Video interviews of the four finalists, posted on the BONUS RETURN website as well as the project's playlist on YouTube.

3 EVALUATION AND SELECTION

13 applications were submitted to the Innovation Challenge. In March-April 2018 a process took place involving coordinator Karina Barquet, WP 3 leader Erik Kärrman, WP 5 leader Charlotta Möller and Måns Lundh, researcher in WP5 to shortlist four innovations which were invited to present their eco-technology at the Baltic Sea Future Conference in Stockholm. The four candidates had the opportunity to further explain their innovation over an interview with team experts from RISE and SEI. Based on the presentations and interviews, three winners were selected to be part of BONUS RETURN: Biophree, TerraNovaUltra and Ravita. The selection process went through a number of criteria, described in the table below.

Company / Eco-Technology	**Aquacare / BioPhree**	**TerraNova / TerraNovaUltra**	**Carbonext AB / Carbonext**	**Helsinki Region Environmental**

				Services HSY / Ravita
Short Description	Reduces phosphorus (P) in water and recover it as phosphate that can be available as a component in the production of fertilizers	Treats wastewater sludge and produces bio coal for fuel and recover phosphorus as struvite/apatite that can be available as a component in the production of fertilizers	Produces advanced bio coal from methane gas from digestion of sludge, which could have potential for improving water holding properties in soil.	Recover phosphorus (P) as phosphorus acid from sludge from post precipitation, which is available as a component in the production of fertilizers.
Technical Description	BioPhree removes phosphorus in water to very low concentrations with ion exchange and adsorption. When the filter material is saturated it is regenerated with NaOH that releases P from the material, which is dissolved in the regeneration liquid. The liquid is thereafter treated in a patented separation process that separates NaOH from the liquid leaving a high concentrated phostphate solution.	TerraNova uses Hydrothermal Carbonization, HTC, followed by a dewatering process to produce bio coal that can be used as bio fuel. Acid is added to the process that releases >70% of P from the sludge, which is then precipitated with calcium silicate hydrate (CSH) to form apatite and struvite. The innovator claim there is also a possibility to strip nitrogen but this has not been tested yet.	The technology is based on the method PACE (Plasma Assisted Carbon Extraction) to crack methane molecules and form two high-quality products; carbon black and hydrogen gas. Carbon black has water holding properties, and thus nutrient holding properties, that could, if used as soil improver, potentially hinder nutrients from leaking to ground and surface waters. This has, however, not been demonstrated.	The technology is based on the addition of phosphorus acid to the sludge from the post precipitation, which causes the P to dissolve from the sludge. The sludge is thereafter treated in a patented separation process that separates P from the sludge leaving phosphorus acid. The sludge is recirculated in the overall treatment in the plant, while the acid is recirculated to the initial sludge treatment step to release more P.
How does the technology reduce emissions of carbon and/or nutrients to the Baltic Sea?	Can reduce P from water/wastewater and thus prevent P from leaking to the Baltic Sea.	The reduction of P from wastewater is performed by the wastewater treatment plant and not the technology in question.	Carbon black has properties to help hold water in the soil when the coal is spread on agricultural farmland. The holding of water also helps contain the nutrients in the soil. The innovator has plans to investigate the coal chemistry to make the coal more adsorbent to nutrients.	The reduction of P from wastewater is performed by the wastewater treatment plant and not the technology in question.

How does the technology recover carbon and/or nutrients?	Phosphorus is recovered as dissolved phosphate.	Phosphorus is recovered as solid struvite and apatite. Carbon is recovered as bio coal. The technology has also potential for nitrogen stripping.	Carbon is recovered as Carbon black (high value coal).	Phosphorus is recovered as phosphorus acid.
How does the technology promote the reuse of carbon and/or nutrients Sea?	Generates a P-product as dissolved phosphate in water that could be of interest to producers of fertilizer, and potentially for other industries that use P. The product will however require complementary components such as nitrogen and potassium to achieve a complete fertilizing function.	Generates bio fuel in the form of bio coal. Generates a P-product in the form of solid struvite and apatite that could be interesting for the producer of fertilizer. The product will however require complementary components such as nitrogen and potassium to achieve a complete fertilizing function. A N-product could be offered If the nitrogen stripping is developed and implemented, which could be interesting for the producer of fertilizer.	Generates a bio coal with consistent quality. The aim for the company is the reuse of the bio coal as soil improvement to increase the water containing characteristics.	Generates a P-product in the form of phosphorus acid that could be of interest to producers of fertilizer, and probably for other industries that use P. Phosphorus acid is already a product that is produced by the industry from phosphorus mineral such as calcium phosphate and apatite. It has thus high value on the market. The product will however require complementary components such as nitrogen and potassium to achieve a complete fertilizing function.
In what Technology Readiness Level (TRL) is the technology?	6-7 for the removal of P from water (there is a well performing prototype/pilot plant in Canada) 5 for the recovery of P as phosphate	9 for the production of bio coal (there is a full scale plant in China) 5 for the recovery of phosphorous as struvite and apatite 2 for the method of stripping nitrogen	3 for the PACE (only lab scale in France) 2 for the function as soil improver. Only an idea at this stage.	5 for the dewatering of the sludge (stationary installation in Helsinki) 3 for the recovery of phosphorus acid (lab scale) – function to be installed in pilot plant during 2018.

What potential customers of the technology can be identified?	Municipalities (Wastewater treatment plants and storm water)	Municipalities (Wastewater treatment plants) Pulp and paper Industry	Owners of bio gas plants	Municipalities (Wastewater treatment plants)
What do the innovators want?	Focus on removal from natural waters Demonstrate the technology with a potential customer Meet the market Test the phosphate function	Develop the recovery of phosphorus Find a partner that want to implement the technology Meet the market and demonstrate the technology	Build a prototype - <50Mkr Find a partner that want to implement the technology Meet the market and demonstrate the technology	Build a pilot plant for 10 000- 20 000 pe. Meet potential customers and partners Get feedback on the technology Meet the market and demonstrate the technology They have money for developing the recirculation technology Get an objective verification
What challenges can we see?	Reduce and/or motivate the cost. Contaminants in the P-product. Find interested customers for the technology and the P-product.	Reduce and/or motivate high cost. Contaminants in the P-product Find interested customers for the technology, the bio coal and the P-product.	Biogas is already a reuse product. Limited production and only when the market for bio gas is low Probably an expensive product as it is an reuse product of a reuse product Find interested customers	Reduce and/or motivate high cost. Contaminants in the P-product Find interested customers for the technology and the P-product.
Identified potential activities to support the Innovators – to be further developed together with the innovator in following meetings.	Identify and coordinate test site in interested municipality Test program for investigating contaminants in the P-product System and sustainability analysis	Technology to be demonstrated at the Duisburgs wastewater treatment plant (the innovators own activity) Test program for investigating contaminants in the P-product	The low TRL makes further cooperation with Bonus return not possible	Technology to be demonstrated at the Helsinki wastewater treatment plant (the innovators own activity) System and sustainability analysis

	Support to the innovators business plan for the Baltic Sea Region	System and sustainability analysis Support to the innovators business plan for the Baltic Sea Region		Support to the innovators business plan for the Baltic Sea Region Support to the innovators development of the application of recirculating the phosphorus acid.
Award decision	Yes	Yes	No	Yes