
Small-scale Wastewater treatment system based on Innovative filter Materials

# PROJECT OUTLINE

ACQUEAU OPEN CALL 2013

ESE
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BELGIUM

**Apart from the Executive Summary which can be disclosed by ACQUEAU Office for communication in the public domain, all information contained in this PO will be seen only by persons who have signed a Declaration of Non-Disclosure.**

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| **SWIM** | **S**mall-scale **W**astewater treatment system based on **I**nnovative filter **M**aterials | **Submission date: 25/10/2013** |

| | |
|---|---|
| Budget (K€): **2612** | Duration (months): **18** |
| Project leader: **Bioptech AB** | |

The SWIM project aims to develop an innovative solution for small-scale residential wastewater treatment based on novel recyclable filter materials. The SWIM solution is based on a series of filters that can remove 100% of the phosphorus, 50% of the nitrogen and 99.9% of the bacteria while enabling the recycling of nutrients.

A majority of residential wastewater treatment systems are based on sand filtration that can filter residual suspended matter but are very poor at capturing nutrients. More advanced systems such as "mini treatment plants" rely on the chemical precipitation of nutrients, which have a number of drawbacks: toxicity, energy requirements, inability to recycle the nutrients once precipitated, prohibitive installation and maintenance cost for a single household. In practice, over 50% of the households that lack connection to the municipal sewer system are not compliant with the EU Water Directive as their sewage system lacks effective tertiary treatment capabilities.

Calculations show that the phosphorus emission from a single sewer system can be equivalent to all the municipal cleaning plants together. Locally, a single sewer can be the biggest source of phosphorus emissions to the water, and the Baltic Sea eutrophication is a direct result of the nutrient pollution generated by these "rogue" sewage systems. The top 3 countries contributing to this phenomenon are Poland (24%), Sweden (19%), Russia (17%) for the nitrogen input and Poland (36%), Russia (14%), and Sweden (13%) for the phosphorus input. Phosphorus is also an essential component in all living organisms and the use of phosphorus fertilizers in agriculture must increase in order to produce more food for the growing population despite the fact that phosphate rock is a limited and rapidly declining resource. It is therefore of great importance to develop and optimize filter materials for removal and subsequent recycling of nutrients from these systems.

The Baltic Sea eutrophication is a European issue, and a Swedish-Polish consortium has been established to tackle the problem of nutrient capture and recycling in small-scale decentralized wasterwater treatment systems: three SMEs in Sweden and Poland (Bioptech AB, Renall AB and Bioptech Sp z o.o.), and a leading edge university (KTH) focusing on environmental technologies.

The SWIM solution is a passive (using gravity when possible – not electricity and pumps) treatment solution that is simpler, cheaper and safer to install and maintain than current solutions, making it the solution of choice for upgrading or installing the 20M of European residential systems required to comply with the EU water directive.
The project impact is twofold:

- Reduced nutrient discharge to water sources, preventing the eutrophication process and therefore protecting aquatic life and water quality
- Increased recycling of phosphorus that can be sold at cheaper prices than commercial fertilizers, reducing the pressure on the limited supply of phosphorus, and providing cost-savings to the agricultural industry

# 2. PROJECT DESCRIPTION

## 2.1. General and detailed goals

Small-scale wastewater treatment facilities and on-site residential treatment and disposal systems release substantial amounts of phosphorus to recipient waters due to the lack of innovative technologies in wastewater treatment.

Phosphorus is the key element of concern because it can trigger a significant algal growth, lowering light penetration and dissolved oxygen levels (eutrophication), causing aesthetic degradation of surface water bodies, and more importantly, decreasing the survival rates of aquatic life.

Phosphorus is also an essential component in all living organisms and the use of phosphorus fertilizers in agriculture must increase in order to produce more food for the growing population. At present, 80-90% of the phosphate rock that is mined is used for food production and by 2050 the supply will have to increase by 70% to meet the demand despite phosphate rock is a limited and rapidly declining resource. Most of the phosphorus that is consumed by food is excreted and the global population excretes around 3 million tons of phosphorus annually through urine and feces[1], thereby making wastewater an important source of phosphorus. It is therefore of great importance to develop and optimize filter materials for removal and subsequent recycling of phosphorus from wastewater[2].

However, there are factors that impede the field implementation of efficient treatment systems: for example the phosphorus removal capacity of filter materials is dependent on several parameters, such as the Total Organic Carbon (TOC) present in the wastewater. The project research will therefore focus on developing the right combination of filters and reactive filter media, in order to maximize the capture and subsequent recycling of phosphorus, while effectively removing nitrogen and bacteria. The prototype will consist in a wastewater treatment solution that is simpler, cheaper and safer to install and maintain than current onsite sewage facilities.

## 2.2. Strategic relevance (for Europe)

The SWIM project is directly related to current eutrophication problem of the Baltic Sea[3], a region including 9 European countries (Denmark, Finland, Estonia, Latvia, Lithuania, Russia, Germany, Poland and Sweden) and connected to 5 other European countries (Belarus, Czech Republic, Norway, Slovakia and Ukraine) by waterways. The population of the drainage basin is 85 million, of which 45% are from Poland. Based on the PLC-5 data (Helsinki Commission Report)[4], it is estimated that waterborne inputs in 2006 amounted to 638,000 tons of nitrogen and 28,400 tons of phosphorus. About 95% of the nitrogen load and 92% of the phosphorus load are coming from river effluents. The Baltic Proper and the Gulf of Finland received the largest amounts of nutrients, and the main countries contributing were Poland (24%), Sweden (19%), Russia (17%) for the nitrogen input and Poland (36%), Russia (14%), and Sweden (13%) for the phosphorus input. Therefore, the issue of Baltic Sea eutrophication is a European issue, and the involvement of two of the main “polluting” countries (Poland and Sweden) in the SWIM consortium is key in order to tackle the issue and disseminating the project results to stakeholders.

The dependency to phosphorus (92% in 2011, according to the EC Consultative Communication on the Sustainable Use of Phosphorus) is also a European issue: the supply of phosphorus in the world is depleting, which means that prices are increasing, impacting specifically Europe’s agro-industries. It is therefore important to develop concerted and combined innovation in Europe so that phosphorus can be recycled and used more efficiently, in alignment with the European Phosphorus Platform (http://www.phosphorusplatform.eu/)

[1] Jönsson, H., Stintzing, A. R., Vinnerås, B., & Salomon, E. (2004). Guidelines on the use of urine and faeces in crop production. EcoSanRes Programme.
[2] P. Cornel and C. Schaum (2009) Phosphorus recovery from wastewater: needs, technologies and costs. Water Science & Tech. Vol 59 No 6 pp 1069–1076.
[3] HELCOM, 2013. Approaches and methods for eutrophication target setting in the Baltic Sea region. Balt. Sea Environ. Proc. No. 133.
[4] HELCOM, 2011. The Fifth Baltic Sea Pollution Load Compilation (PLC-5). Balt. Sea Environ. Proc. No 128

The SWIM project will specifically address the required breakthrough technologies highlighted in the ACQUEAU Blue Book, such as:

- Processes to polish effluents at small (decentralized) WWTWs.
- Improved processes for nitrogen and phosphorus removal
- Recycling processes for phosphorus, metals and other materials removed in WWTWs
- Simple, forgiving processes requiring low manual input

## 2.3. State-of-the-art (technical background)

In households lacking connection to the municipal sewer system, sewage is treated close to where the sewage is created in a decentralized system (based on septic tanks, biofilters or aerobic treatment systems) involving three stages:

- Primary treatment consists of temporarily holding the sewage in a quiescent basin (septic tank/sludge separator) where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface.
- Secondary treatment removes dissolved and suspended biological matter.
- Tertiary treatment is focusing on nutrient removal (nitrogen, phosphorus) and is critical in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, etc.)

Most tertiary treatment decentralized systems are based on sand filtration that can filter residual suspended matter and remove bacteria. However these systems are very poor at capturing nutrients and their performance and durability depends on installation and local conditions[5]. More advanced systems such as “mini treatment plants” rely on the chemical precipitation of nutrients, which have significant drawbacks: energy requirements, inability to recycle the nutrients once precipitated, prohibitive installation and maintenance cost for a single household, and potential toxicity of the chemicals used!

In practice, over 50% of the Swedish households that lack connection to the municipal sewer system are not compliant with the EU Water Directive as their sewage system lacks effective tertiary treatment capabilities and this percentage is even higher in other Baltic Region countries such as Poland and Russia.

The project will develop a low cost, low maintenance, recyclable on-site residential wastewater treatment system based on two novel filter materials: Polonite and Sorbulite.

Polonite comes from the siliceous sedimentary rock opoka (a mineral found in Lithuania, Poland, Ukraine and Russia) and has been investigated for its phosphorus-retaining capacity (Johansson and Gustafsson, 2000[6]; Brogowski and Renman, 2004[7]). Polonite is manufactured by heating opoka to 900 °C, causing calcium carbonates to transform into calcium oxides, which are more reactive. After this transformation, which is aimed at enhancing the phosphorus removal capacity of the material, it is crushed and sieved to appropriate size, usually 2-5.6 mm (Renman and Renman, 2010[8]). Polonite has been thoroughly investigated for its phosphorus retention capacity in batch, column and full-scale experiments, in which good reduction of phosphorus has been reported (Gustafsson et al., 2008[9]).

[5] Weiss P, Eveborn D, Kärrman E, Gustafsson J.P. (2008) Environmental systems analysis of four on-site wastewater treatment options. Resources Conservation and Recycling, 52(10), 1153–1161.
[6] Johansson, L., & Gustafsson, J. P. (2000). Phosphate removal using blast furnace slags and opoka-mechanisms. Water Research, 34(1), 259-265.
[7] Brogowski, Z., & Renman, G. (2004). Characterization of opoka as a basis for its use in wastewater treatment. Polish Journal of Environmental Studies, 13(1), 15-20.
[8] Renman, A., & Renman, G. (2010). Long-term phosphate removal by the calcium-silicate material Polonite in wastewater filtration systems. Chemosphere, 79(6), 659-664.
[9] Gustafsson, J. P., Renman, A., Renman, G., & Poll, K. (2008). Phosphate removal by mineral-based sorbents used in filters for small-scale wastewater treatment. Water research, 42(1), 189-197.

Sorbulite is made by crushing autoclaved aerated concrete (AAC), which is used in building, for insulation purposes and as reinforcement in house construction. AAC is produced by foaming a mixture of sand and/or fly ash with lime and cement. The foaming is activated by aluminium powder and the product is then autoclaved, converting the minerals into torbermorite, a strong crystalline structure (Hellers and Schmidt, 2011[10]). Only a few studies have been performed on the removal of phosphorus from water using AAC, but the results of these are very promising (Oğuz et al., 2003[11]; Renman and Renman, 2012[12]).

Polonite is very effective filter for phosphate, total phosphorus and bacteria, because of its higher pH and its components (reactive calcium and wollastonite), while Sorbulite has a high removal rate of TOC and TIN (and some action on phosphorous and bacteria as well).

In full-scale experiments[13], Polonite has been tested with 2 different bacterias: Escherichia Coli with >99% removal, and Enterococcus Faecalis with 96-99% removal. In laboratory experiments (column tests)[14], the removal of Enterococci was investigated at low hydraulic loading rate (120 L m2d-1) showing a result of 91% and at very high hydraulic loading rate (3000 L m2d-1) showing a reduction of 56%. A long-term column test showed a reduction of coliform bacteria with 99.5% at a low level of wastewater loading.

*The mechanisms used by Polonite for phosphorus removal* are precipitation and chemisorption: the phosphorus present in the wastewater is precipitated with free calcium ions and then a reaction occurs at the surfaces of the Polonite grains (Gustafsson & Renman, 2008)[15]. The reaction between the Phosphorus (in the wastewater) and the Calcium (in the Polonite) is forming Calcium Phosphate [Ca3(PO4)2], which is not soluble in water, thus is precipitated.

*The mechanism used by Polonite for BOD and nitrogen reduction* is known as “activated sludge” (Renman et al, 2010)[16]. It is an aerobic (microorganisms-based) process, in which the microorganisms degrade the organic material (BOD) present in the wastewater. The process requires an aeration mechanism where an aerobic zone is followed by an anaerobic zone or facultative zone, and the nitrogen is removed by microorganisms in a process known as nitrification-denitrification (conversion of nitrogen dissolved in wastewater to nitrogen gas).

*The resulting filter media can be used as a soil amendment* because it is rich in phosphorus (1-3% of dry weight) and calcium. The alkaline character of Polonite can help acidified soils to increase their pH values. It does not need any special pre-treatment (as there are no bacteria left) and can be mixed with soil in plantations using traditional machines at a farm.

The project will verify, both in lab and in the field, that a combination of filters connected in series, with e.g. Sorbulite as a first material to some of the phosphorous but mainly TOC and TIN, followed by Polonite as the second material to remove all remaining phosphorus, can provide efficient treatment of wastewater in small-scale systems, while allowing the recovery of the nutrients for agricultural applications.

[10] Hellers, B. G., & Schmidt, B. R. (2011). Autoclaved aerated concrete (AAC)–the story of a low-weight material. In 5th International Conference on Autoclaved Aerated Concrete, Bydgoszcz, Poland, http://www. 5icaac. utp. edu. pl.

[11] Oğuz, E., Gürses, A., & Canpolat, N. (2003). Removal of phosphate from wastewaters. Cement and concrete research, 33(8), 1109-1112.

[12] Renman, G., & Renman, A. (2012). Sustainable use of crushed autoclaved aerated concrete (CAAC) as a filter medium in wastewater purification. In 8th International conference on sustainable management of waste and recycled materials in construction, Gothenburg, Sweden, 30 May–1 June, 2012. Proceedings. ISCOWA and SGI.

[13] Nilsson, C. (2012). Phosphorus removal in reactive filter materials: factors affecting the sorption capacity (Doctoral dissertation, KTH).

[14] Nilsson, C., Lakshmanan, R., Renman, G., & Rajarao, G. K. (2013). Efficacy of reactive mineral-based sorbents for phosphate, bacteria, nitrogen and TOC removal–column experiment in recirculation batch mode. Water Research.

[15] Gustafsson, J. P., Renman, A., Renman, G., & Poll, K. (2008). Phosphate removal by mineral-based sorbents used in filters for small-scale wastewater treatment. Water research, 42(1), 189-197.

[16] Renman, A., Hylander, L. D., & Renman, G. (2008). Transformation and removal of nitrogen in reactive bed filter materials designed for on-site wastewater treatment. Ecological Engineering, 34(3), 207-214.

## 2.4. Market relevance

The primary target market is composed of small households whose wastewater is not channeled to municipal treatment plants. These are typically located in the more remote and rural areas.

For example, there are more than 750 000 households in Sweden that lacks connection to the municipal sewer system. 500 000 of these are small houses for year around living ant the rest of them summer houses (Environmental Protecting Agency, 2010)[17]. According to the Environmental Protection Agency, over 50% of these households do not fulfill the demands in the EU water directive. Calculations show that the phosphorus emission from a single sewer system is equivalent to all the municipal cleaning plants together. Locally, a single sewer can be the biggest source of phosphorus emissions to the water (Jönsson et al, 2002)[18].

The European market consists of more than 20M residential wastewater treatment plants in need of upgrading in order to comply with the EU water directive, for which simple systems based on reactive filters are the solution of choice.

This project secures the competitive power of Bioptech in the European industry sector of reactive filter media for wastewater treatment. The current market is under strong development in Sweden, using reactive filter media mainly for phosphorus removal and expanding into complete on-site-treatment solutions. Competing filter materials are Filtralite P (Weber Saint-Gobain) and derivatives of Blast Furnace Slag (for example Hyttsand from Merox) but the properties of these substances are inferior to Polonite, and degrade very quickly over time (phosphorus reduction of 96–99 and 77–93 %, respectively, in the beginning, but decreasing rapidly within a few months of operation to the level of 60–74 and 2–20 %)[19].

Based on the superior performances of the Polonite/Sorbulite combination, Bioptech aims to develop a market share of 10% in the Baltic Sea Region, and 5% overall in Europe, within 5 years of project completion.

## 2.5. Balance of Research, Development and Innovation

The SWIM project will focus primarily on the development of a packaged, ready to install, decentralized wastewater treatment solutions for single households.

The project does not intend to carry out a significant amount of fundamental research as mechanisms of action and performances of the filter media (Polonite and Sorbulite) have been the subject of previous studies and are therefore well documented. However, the project will focus on innovation beyond the current state of the art in the following areas:

- Optimization of the filter media combination: the project will seek to combine Polonite and Sorbulite (and potentially, other processes such as aeration) in order to optimize the capture of phosphorus and nitrogen. To that end, various implementations will be tested in the lab and the best performing implementations will be deployed in the field for realistic tests.

- Reduction of the solution cost: the project will seek to minimize the overall total cost of ownership of the solution (acquisition, installation, maintenance) by exploring various integration and packaging alternatives. At product-level, this will be achieved by minimizing the cost for material and components, maximizing recyclable components and favouring easy to install components. At solution-level, this will be achieve packaging the solution as a service (WTaaS ie “water treatment as a service”), thus facilitating and integrating purchase, financing, payment, insurance, maintenance and operation in a one stop-shop.

[17] Wastewater treatment in Sweden. ISBN 978-91-620-8416-5
[18] Jönsson, H. Malmén, L. Palm, O. (2002). Robusta, uthålliga små avloppssystem. En kunskapssammanställning. Naturvårdsverket, Stockholm.
[19] Amofah, L. R.; Hanaeus, J. (2006). Nutrient recovery in a small scale wastewater treatment plant in cold climate. In: VATTEN; 62, 4; 355-368

Therefore it is expected that the project activity balance will be 10% research (led by KTH), 60% development & innovation (led by Bioptech) and 30% demonstration (co-led by Renall and POMInnO)

## 2.6. Exploitation plan/Dissemination of Results

The SWIM project intends to carry out the following dissemination and exploitation activities:

| Name | Short term (dissemination) | Long term (exploitation) |
|---|---|---|
| KTH | Publish 2 peer-reviewed articles and 1 conference paper or presentation. Involve at least 2 PhD candidates in the project. | Include the project results in KTH's Bachelor and Master's education |
| Bioptech Sweden | Participate to 3 major environmental technology seminars in Europe, initiate discussion with at least 5 wastewater treatment system suppliers in Sweden. File 1 patent. | Develop a commercial solution ready to launch within 18 months of project completion and certify the solution for the Swedish market |
| Renall AB | Promote the use of novel residential wastewater treatment to 500 households | Deploy the commercial solution in 500 households within 36 months of project completion |
| Bioptech Poland | Participate to 3 major environmental technology seminars in Europe, initiate discussion with at least 5 wastewater treatment system suppliers in Poland | Develop a commercial solution ready to launch within 18 months of project completion and certify the solution for the Polish market |
| DOT-EKO | Write and publish an article in Polish Journal (e.g. Forum Ekspoatatora). Participate in 3 polish/international conferences and/or seminars (**IWA 2015** focusing on nutrient removal and recovery will take place **in Gdansk**) and present the project results. | Promote the product among potential users/clients. Develop a commercial solution ready to launch within 18 months of project completion and commercialize the product in the Polish market. |
| POMInnO | Publish at least 1 peer-reviewed article. Involve at least 1 Master student from Gdańsk University of Technology. Test the use of novel treatment in 10 households in Poland. | Involve results of the project in education for graduate and postgraduate students at Gdańsk University of Technology. Promote the use of novel treatment to 50 households in Poland. |

## 2.7. Expected impact

The SWIM project will demonstrate a substantial positive environmental impact via two major mechanisms:

- Reduced nutrient discharge to water sources, preventing the eutrophication process and therefore protecting aquatic life and water quality
- Increased recycling of phosphorus that can be sold at cheaper prices than commercial fertilizers, reducing the pressure on the limited supply of phosphorus, and providing cost-savings to the agricultural industry

Specifically, the project will demonstrate the following KPIs:

- The SWIM solution can remove 100 % of phosphorus, 50 % of nitrogen, 99,9 % of bacteria, and reduce the Biological Oxygen Demand (BOD) by 90 %
- The SWIM solution acquisition and installations costs will be 10 % less than existing tertiary onsite wastewater systems
- The SWIM solution maintenance costs will be 25 % less than existing tertiary onsite wastewater systems
- The SWIM solution will be an open solution allowing for easy control and maintenance (in contrast with traditional sand filtration systems that work as "blackboxes")
- The SWIM solution will allow for the recycling of 100 % of the phosphorus captured

**Key process parameters**

Removal of Phosphorus: >99%
Removal of E.Coli: >99%
Removal of E. Faecalis: 96-99%
Removal of odour
Removal of Nitrogen: 20-70% (depending on $T^{o}$)
Removal of BOD: >= 95%
Phosphorus recycling: 100%

## 3. Expected project duration (start, end, duration)

| | |
|---|---|
| Start | 01/04/2014 (if possible) |
| End | 30/09/2015 |
| Duration | 18 months |

## 4. Short consortium description

The consortium will include the following companies:

- Bioptech (Sweden): a research performing SME focusing on the development of innovative wastewater treatment solutions for the European market
- Renall (Sweden): an SME offering waste collection, recycling, and system maintenance
- KTH Royal Institute of Technology (Sweden): a world leading technical university with R&D on environmental technologies, and specifically, filter media for wastewater purification (with world leading expert Prof. Gunno Renman)
- Bioptech (Poland) : a daughter company of Bioptech Sweden focusing on the production and development of Polonite (based on opoka, a mineral that can be quarried in Poland) and the implementation of new reactive filter technologies in Poland
- DOT-EKO (Poland): an SME offering assistance, advice, consultancy and R&D services in environmental projects, with expertise in municipal and private water and wastewater treatment for private businesses, industries and communities.
- POMInnO (Poland): a research-performing SME focusing on developing and applying innovative solutions within the environmental and energy sectors.

Please note that

- no single company represents more than 70% of the budget (Bioptech Sweden + Poland = 58%)
- no single country represents more than 70% of the budget (Sweden = 61%)

## Partners

| Name | Country | Address | Type | | | Size (employees) | Turnover (M€) |
|---|---|---|---|---|---|---|---|
| | | | LE | SME | U/I | | |
| Bioptech AB (project leader) | Sweden | Dalagatan 23, 113 24 Stockholm, Sweden | ☐ | ☒ | ☐ | 6 | 0,7 |
| Renall AB | Sweden | Tenngatan 4 602 23 Norrköping, Sweden | ☐ | ☒ | ☐ | 12 | 3 |
| KTH Royal Institute of Technology | Sweden | Teknikringen 76, 100 44 Stockholm, Sweden | ☐ | ☐ | ☒ | 3500 | 320 |
| Bioptech Polska Sp. z o.o. | Poland | ul. Radziwie 7 lok 8 01 -164 Warszawa Poland | ☐ | ☒ | ☐ | 2 | 0.05 |
| DOT-EKO | Poland | Kołobrzeska 55 i/14 80-396 Gdańsk Poland | ☐ | ☒ | ☐ | 1 | 0.04 |
| POMInnO | Poland | Krasickiego 15/10, 81-377 Gdynia, Poland | ☐ | ☒ | ☐ | 5 | 0.1 |

## Subcontractors

No subcontracting is planned as part of the SWIM project.

## 5. Short Description of the work plan

| Work Package | Title / Short description | Partners involved | Milestone | Month of Project | Main Deliverables |
|---|---|---|---|---|---|
| WP 1 | Management | Bioptech Sweden (lead), KTH, Renall Bioptech Poland, DOT EKO, POMInnO | | M1-M18 | D1.1 Project Quality Handbook<br>D1.2 Progress Report (M6)<br>D1.3 Progress Report (M12)<br>D1.4 Progress Report (M18)<br>D1.6 Final Report |
| WP 2 | Laboratory Tests | KTH (lead), Bioptech Poland, Dot Eko, POMInnO | M1 – SWIM filter media ready | M1-M4 | D2.1 Nutrient Capture Report<br>D2.2 Nutrient Recycling Report<br>D2.3 Other Purification Report |
| WP 3 | Solution Development | Bioptech Poland (lead), Bioptech Sweden, Dot Eko | M2 – SWIM filter implementation ready | M4-M10 | D3.1 Solution Iteration 1<br>D3.2 Solution Iteration 2<br>D3.2 Solution Iteration 3 |
| WP 4 | Solution Packaging | Bioptech Sweden (lead), Bioptech Poland, POMInnO | M3 – SWIM solution ready | M7-M13 | D4.1 Wastewater treatment as a service (WTaaS) report<br>D4.2 Total Cost of Ownership Report |
| WP 5 | Demonstrator | Renall (lead) , Bioptech Sweden, Bioptech Poland, POMInnO | M4 – SWIM demonstrator ready | M13-M18 | D3.1 Testbed Deployment Report<br>D3.2 Testbed Monitoring Report |
| WP 6 | Exploitation & Dissemination | Bioptech Sweden (lead), Bioptech Poland, KTH, Renall, Dot Eko, POMInnO | | M1-M18 | D6.1.1 Dissemination Plan<br>D6.1.2 Dissemination Report<br>D6.2.1 Exploitation Plan Draft<br>D6.2.2 Exploitation Plan Final |

## 6. Preliminary Budget Information

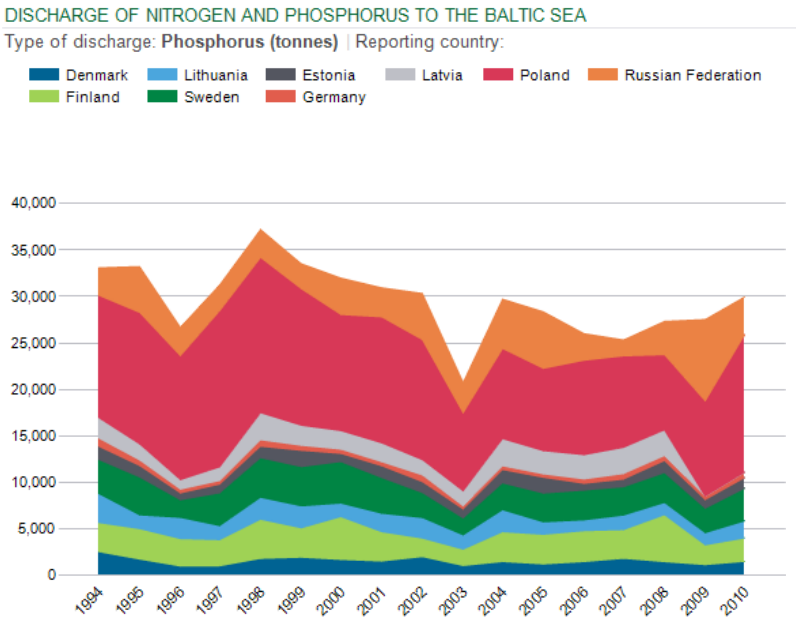
| | Budget in kEUR | BIOAB | RENALL | KTH | BIOSP | EKO | POM |
|---|---|---|---|---|---|---|---|
| **Total kEUR** | **2,612** | **906** | **376** | **427** | **568** | **53** | **281** |
| WP1 - Management | 184 | 88 | 12 | 12 | 55 | 8 | 9 |
| WP2 - Laboratory Tests | 320 | 49 | 9 | 201 | 17 | 7 | 37 |
| WP3 - Solution Development | 760 | 308 | 21 | 97 | 224 | 18 | 93 |
| WP4 - Solution Packaging | 588 | 250 | 98 | 78 | 110 | - | 53 |
| WP5 - Demonstrator | 472 | 142 | 169 | 19 | 115 | - | 27 |
| WP6 - Exploitation & Dissemination | 288 | 70 | 67 | 21 | 47 | 21 | 62 |

## 7. Rationale for public funding

The involvement of the main "polluting" countries (Poland and Sweden) in the SWIM consortium is key in order to effectively tackle the issue and to disseminate the project results to important stakeholders

The consortium expects funding from national authorities of Poland and Sweden for this initial project and plans to carry follow-on projects with European Regional Development Funds from the Baltic Sea Region, in order to be able to secure the participation of the third main polluting country (Russia) and other Baltic Sea countries.

Public support is necessary for the successful completion of the project because of the asymmetrical costs and benefits of the Baltic Sea pollution.




The Baltic Sea is a common property resource utilized freely by sovereign countries in the absence of a supranational body. Some countries benefit from the pollution (ex: Russia, Poland) while some countries suffer from the pollution (ex: Finland, Sweden). The economic incentives of countries that benefit from the pollution to reduce their loads are low, while economics costs of countries that are victims and wish to reduce loads are high.

It is therefore critical to find arrangements for a true binding international agreement in order to make nutrient reductions profitable to some actors in all countries. The insufficient water protection practices and poor infrastructure of sewage systems contribute greatly to the eutrophication of the Baltic Sea. The quickest way of promoting abatement is to direct Europeans funds to countries who are the main polluters (ex: Poland), provided that there is local willingness to take action (through an ecosystem of manufacturer of sewage systems and national incentives or obligations to upgrade)

# 8. Contact persons

## Project leader

| Project leader | Country | Surname | First Name | telephone | e-mail | full address |
|---|---|---|---|---|---|---|
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## Partners

| Partner | Country | Surname | First Name | telephone | e-mail | full address |
|---|---|---|---|---|---|---|
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| KTH | Sweden | Renman | Gunno | +46 706 413 932 | gunno@kth.se | Teknikringen 76,<br>100 44 Stockholm,<br>Sweden |
| Bioptech Sp. Z o.o. | Poland | Babis | Beata | +48 694 526 193 | b.babis@eurobillfusion.pl | Bioptech Polska Sp. Z o.o.<br>ul. Radziwie 7 lok 8<br>01 -164 Warszawa<br>Poland |
| DOT-EKO | Poland | Szatkowska | Beata | +48 506 516 424 | dot-eko@dot-eko.pl | Kołobrzeska 55i/14<br>80-396 Gdańsk |
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# 9. APPENDIX – SWEDISH EXECUTIVE SUMMARY

| | | |
|---|---|---|
| **SWIM** | **S**mall-scale **W**astewater treatment system based on **I**nnovative filter **M**aterials | **Submission date: 25/10/2013** |

| | |
|---|---|
| Budget (K€): **2612** | Duration (months): **18** |
| Project leader: **Bioptech AB** | |

SWIM-projektet avser att utveckla en innovativ lösning för småskaliga avloppssystem, baserade på nya filtermaterial. SWIM-lösningen baseras på en serie filter som kan rena 100% av fosfor, 50% av kväve och 99,9% av bakterier samtidigt som det möjliggör kretsloppet av näringsämnen.

De flesta avloppssystem med efterpolering (sista reningssteg) använder sig av sandfilter som kan rena kvarvarande uppslammade rester, men som inte kan fånga näringsämnen. Mer avancerade system, såsom minireningsverk bygger på en kemisk fällning av näringsämnen, som har ett antal negativa effekter: toxicitet, krav på energiförbrukning, oförmåga att kretsa näringsämnen efter utfällning, höga kostnader för enskilda avlopp. Detta resulterar i att över 50% av hushållen som saknar koppling till kommunalt avlopp, inte följer vattendirektiven från EU då deras avloppssystem saknar effektiv reningsförmåga.

Beräkningar visar att den fosfor ett enskilt avlopp står för kan jämföras med den fosfor som kommer från alla hushåll kopplade till kommunala avlopp. Lokalt kan ett enskilt avlopp vara den största enskilda källan till fosforutsläpp i vatten och övergödningen av Östersjön är ett direkt resultat av dessa dåliga avloppssystem. De tre länder som bidrar mest till detta är Polen (24%), Sverige (19%) och Ryssland (17%), när det gäller kväve, och Polen (36%), Ryssland (14%) och Sverige (13%), när det gäller fosfor. Fosfor är en livsviktig beståndsdel i alla levande organismer och användandet av fosfor i gödningsmedel för jordbruk måste öka för att tillgodose den ökade populationens efterfrågan på livsmedel, trots att fosfor är en ändlig råvara. Det är därför av största vikt att utveckla filtermaterial som renar och kretsar närningsämnen från dessa system.

Östersjöns övergödning är en europeisk angelägenhet och ett svensk-polskt konsortium har grundats för att utreda hur näringsämnen ska fångas och kretsas i småskaliga, decentraliserade avloppssystem. Konsortiet består av tre SMEs i Sverige och Polen (Bioptech AB (publ), Renall AB och Bioptech Sp z o o), samt KTH, ledande inom forskning när det gäller miljövänliga teknologier.

SWIM-lösningen är en passiv avloppslösning som är enklare, billigare och säkrare att installera och och upprätthålla än nuvarande lösningar, vilket gör att denna är att föredra för uppgradering eller installering av de 20 miljoner avloppssystem som finns i Europa, för att möte EU-direktiven. Projektets påverkan är:

- Reducera utsläppet av mängden näringsämnen i avloppsvatten, vilket leder till minskad övergödning och därför skyddar ekosystemet i vattnet och ökar vattenkvaliteten
- Ökat kretslopp av fosfor, vilket kan säljas billigare än kommersiella gödningsmedel, minskad efterfrågan på den ändliga råvaran fosfor och möjlighet för lantbruk att minska kostnader

# 10. APPENDIX – POLISH EXECUTIVE SUMMARY

| | | |
|---|---|---|
| **SWIM** | **S**mall-scale **W**astewater treatment system based on **I**nnovative filter **M**aterials | **Submission date: 25/10/2013** |

| | |
|---|---|
| Budget (K€): **2612** | Duration (months): **18** |
| Project leader: **Bioptech AB** | |

Celem projektu SWIM jest opracowanie i rozwinięcie innowacyjnego rozwiązania w zakresie małych przydomowych oczyszczalni ścieków w oparciu o nowe i oryginalne materiały filtracyjne. Rozwiązanie typu SWIM składa się z układu filtrów, które umożliwiają usunięcie 100% fosforu, 50% azotu i 99.9% bakterii przy jednoczesnym ponownym wprowadzeniu do ponownego obiegu substancji odżywczych.

Większość trzeciorzędowych przydomowych systemów oczyszczalni opiera się na filtrach piaskowych (gruntowych), które umożliwiają filtrację zawiesin ale mają bardzo niską skuteczność w wychwytywaniu substancji odżywczych. Bardziej zaawansowanych systemach, takich jak "mini oczyszczalnie" wykorzystywany jest mechanizm chemicznego strącania substancji odżywczych, który posiada kilka istotnych wad: toksyczność, zuzycie energii, brak możliwości wprowadzeniu do ponownego obiegu strąconych substancji odżywczych, horrendalny koszt dla pojedynczego gospodarstwa domowego. W rezultacie, ponad 50% gospodarstw domowych, które nie są podłączone do systemu kanalizacji zbiorczej dla ścieków komunalnych nie spełnia wymagań Dyrektywy Wodnej Unii Europejskiej ponieważ systemy te nie posiadają efektywnej zdolności trzeciorzędowego oczyszczania.

Kalkulacje pokazują, że emisja fosforu z pojedyńczych wolnostojących systemów ściekowych może być równa emisji ze wszystkich komunalnych oczyszczalni ścieków łącznie. Lokalnie, pojedyńczy wolnostojący system ściekowy może stanwić główne i największe źródło emisji fosforu do wody a eutrofizacja Morza Bałtyckiego jest bezpośrednim rezultatem zanieczyszczenia substancjami odżywczymi wytwarzanymi przez te "zgniłe" systemy ściekowe. Trzy główne kraje, które przyczyniają się do tego zjawiska to: Polska (24%), Szwecja (19%), Rosja (17%) jeżeli chodzi o wprowadzanie azotu i Polska (36%), Rosja (14%) i Szwecja (13%) w zakresie wprowadzania fosforu. Fosfor stanowi również podstawowy składnik we wszystkich zyjących organizmach i używanie nawozów fosforowych w rolnictiwie musi zostać zwiększone w celu wyprodukowania żywności dla ciągle powiększającej się popilacji pomimo faktu, że złoża skał fosforanowych są ograniczone a ich dostepne zasoby szybko maleją. Dlatego też, jest bardzo istotne, aby opracować i zoptymalizować materiały filtarcyjne służące do usuwania i jednczesnego wprowadzaniu do ponownego obiegu substancji odżywczych z tych systemów.

Eutrofizacja Morza Bałtyckiego w Europie stanowi poważny problem i zostało utworzone Szwedzko-Polskie konsorcium w celu próby uporania się z problemem usuwania i wprowadzaniu do ponownego obiegu substancji odżywczych z małych zdecentralizowanych systemów oczyszczalni ścieków: trzy SME w Szwecji i Polsce (Bioptech AB, Renall AB i Bioptech Sp z o.o.), i wiodący uniwersytet (KTH) skupiający się na technologiach związanch z ochroną środowiska.

SWIM jest rozwiązaniem wykorzystującym metodę pasywną, która jest prostsza, tańsza i bezpieczniejsza w instalacji i utrzymaniu w porównaniu z obecnie stosowanymi rozwiązaniami co sprawia, że stanowi idealny wybór do umowocześnienia i zainstalowania łącznie 20 milionów systemów pojedynczych przydomowych systemów tak aby spełniały wymagania Dyrektywy Wodnej Unii Europejskiej. Projekt ma dwojaki wpływ:

- Zredukowane uwalnianie substancji odżywczych do źródeł wody, zapobiegające procesowi eutrofizacji co chroni życie wodne i poprawia jakość wody
- Zwiększone odzyskiwanie i wprowadzaniu do ponownego obiegu fosforu, który może być sprzedawany w niższych cenach niż komercyjne nawozy zmniejszając tym samym obciążenie na ograniczone zasoby fosforu i zapewniając oszczędności w rolnictwie.

BIOPTECH
sewage treatment

ACQUEAU- 0828 .194.215

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1200 Brussels

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# Letter of intent

15.10.2013

Dear Sir,

I hereby confirm that the company **Bioptech AB (publ.)** that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-scale Wastewater Innovative filter Materials (SWIM).

Therefore, I confirm that **Bioptech AB (publ.)** has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.

For the time being, **Bioptech AB (publ.)** has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".

On Full Project Proposal submission, **Bioptech AB (publ.)** will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.

*This document is not binding.

Date: 15.10.2013

By:

NAME: Anders Norén

POSITION: CEO

COMPANY NAME: Bioptech AB (publ.)

Signature:

Renall

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Rue Neerveld 107
1200 Brussels
Tel. : +32 (0)2 777 0986

# Letter of intent

15.10.2013

Dear Sir,

I hereby confirm that the company **Renall AB** that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-scale Wastewater Innovative filter Materials (SWIM).

Therefore, I confirm that **Renall AB** has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.

For the time being, **Renall AB** has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".

On Full Project Proposal submission, **Renall AB** will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.

*This document is not binding.

Date: 15.10.2013

NAME: Anne-Marie Holmberg

POSITION: Sales Manager

COMPANY NAME: Renall AB

Signature:

KTH Land and Water Resources Engineering

2013-10-16

ACQUEAU- 0828 .194.215
Rue Neerveld 107
1200 Brussels
Tel. : +32 (0)2 777 0988

# Letter of intent

**15.10.2013**

**Dear Sir,**

**I hereby confirm that the company KTH – Royal Institute of Technology that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-scale Wastewater Innovative filter Materials (SWIM).**

**Therefore, I confirm that KTH – Royal Institute of Technology has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.**

**For the time being, KTH – Royal Institute of Technology has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".**

**On Full Project Proposal submission, KTH – Royal Institute of Technology will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.**

***This document is not binding.**

**Date: 15.10.2013**

**By:**

**NAME: Gunno Renman**

**POSITION: Professor, Department of Land and Water Resources Engineering**

**COMPANY NAME: KTH – Royal Institute of Technology**

**Signature:**

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# Letter of intent

15.10.2013

Dear Sir,

I hereby confirm that the company **Bioptech Sp. z o.o** that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-scale Wastewater Innovative filter Materials (SWIM).

Therefore, I confirm that **Bioptech Sp. z o.o** has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.

For the time being, **Bioptech Sp. z o.o** has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".

On Full Project Proposal submission, **Bioptech Sp. z o.o** will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.

*This document is not binding.

Date: 15.10.2013

By:

NAME: Anders Norén

POSITION: CEO

COMPANY NAME: Bioptech Sp. z o.o

Signature:

ACQUEAU- 0828 .194.215
Rue Neerveld 107
1200 Brussels
Tel. : +32 (0)2 777 0986

# Letter of intent

05.12.2013

Dear Sir,

I hereby confirm that the company DOT-EKO that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-scale Wastewater Innovative filter Materials (SWIM).

Therefore, I confirm that DOT-EKO has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.

For the time being, DOT-EKO has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".

On Full Project Proposal submission, DOT-EKO will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.

*This document is not binding.

Date: 05.12.2013

By:

NAME: Beata Szatkowska

POSITION: owner

COMPANY NAME: DOT-EKO Beata Szatkowska

Signature: Beata Szatkowska

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ACQUEAU- 0828 .194.215
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# Letter of intent

December 5th, 2013

Dear Sir,

I hereby confirm that the company POMInnO sp. z o.o. that I represent intends to participate as a partner in the ACQUEAU project referred to below: Small-Scale Wastewater Innovative Filters Material (SWIM).

Therefore, I confirm that POMInnO sp. z o.o.has familiarised itself with the ACQUEAU Call Handbook available on the ACQUEAU website, and accepts these terms and conditions.

For the time being, POMInnO sp. z o.o. has also familiarised itself with the Project documentation provided by ACQUEAU and is confirming its contribution in the attached "Project Outline".

On Full Project Proposal submission, POMInnO sp. z o.o. will submit a commitment letter to confirm its liability to pay related administration fee due at FPP submission as well as the project management fee due at the start project.

Date: December 5th, 2013

By:

NAME: Andrzej Tonderski

POSITION: Vice-President, CEO

COMPANY NAME: POMInnO sp. z o.o.

Signature:

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