Horizon 2020 Programme
Research and Innovation Action

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Efficient Carbon, Nitrogen and Phosphorus cycling in the European Agri-food System and related up- and down-stream processes to mitigate emissions

Start date of project: 2018-09-01
Duration: 48 months

D6.2. Completion of Communication, Dissemination and Exploitation plan (intermediate)

Deliverable details	
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Author(s)	Annabelle Williams RISE, Fabian Kraus KWB
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Reviewed by	Victor Riau
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Contact person EC	Giuseppe La Ciura

Contributing partners	
1.	Institut de Recerca i Tecnologia Agroalimentàries, Spain
2.	KWB Kompententzzentrum Wasser Berlin Gemeinnutzige GMBH, Germany
3.	Wageningen University Research, Netherlands
4.	Verein Zur Forderung Agrar-UND Stadtokologischer Projekte (ASP) Ev Institute Fur Agrar-UND Stadtokologische Projekte An Der Humboldt, Germany
5.	Fondazione CRPA Studi Ricerche, Italy
6.	Sogesca S.R.L, Italy
7.	Ema Depuracio I enginyeria De L'Aigua SL, Spain

8.	Nutrients Recovery Systems, Belgium
9.	Asio Spol Sro, Czech Republic
10.	Eidgenoessisches Departement Fuer Wirtschaft, Bildung UND Forschung, Switzerland
11.	Technische Universitaet Muenchen, Germany
12.	Hoehere Bundeslehr-Und Forschungsanstalt Fuer Landwirtschaft Raumberggumpenstein, Austria
13.	Centre De Recerca En Economia I Desenvolupament Agroalimentari – UPC – IRTA, Spain
14.	Teagasc – Agriculture and Food Development Authority, Ireland
15.	The Rural Investment Support for Europe Foundation, Belgium
16.	Pondus Verfahrenstechnik GmbH, Germany
17.	Eastern Africa Farmers Federation, Kenya
18.	Soepenberg Fertilizers BV, Netherlands
19.	Porgaporcs S.L, Spain

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COMMUNICATION, DISSEMINATION & EXPLOITATION PLAN

February 2020
To be updated in M36
Next update due: Aug 2021

Contents

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1 Communication and Dissemination Plan

1.1 Objectives of the Dissemination Plan [WHY]

- To ensure that knowledge developed during the project is properly captured and dissemination is effectively targeted and carried out systematically
- To promote a continuous knowledge exchange and transfer for project outcomes with interested stakeholders beyond the consortium
- To formulate fact-based policy recommendations that stimulate the transition towards a circular economy
- To create public awareness concerning the need for a circular economy and the actions required to move towards its realisation

1.2 Target audience [TO WHOM]

The Stakeholder mapping exercise
An ongoing stakeholder mapping exercise will be carried out to identify which stakeholder groups should be targeted, how and with what means. This is a continual piece of work that will be built upon as the project evolves and added to every 6 months. In year one, an initial mapping exercise was completed to identify which members of the consortium are involved in which collaboration groups (see the full list in section 1.5.5.). In the next phase of the project, the stakeholder mapping exercise will extend to identify the possible dissemination channels and contacts of each of the consortium members. Based on this, RISE will work with the partners to identify the key results which should be targeted to each of the stakeholder groups and develop the necessary timetable and materials to support this process. This will be supported by information from WP4: the socio economic and farmer acceptance studies and the feedback from the farmer workshops WP6.

Policy Makers
European level - European Commission (DG Agri, DG Env, DG RTD, JRC), MEPs, Member State representatives in Brussels.
Member State level – National and regional authorities, municipalities
Policy influencers at all levels – NGO, Industry, representation groups etc.

Innovators and Industry
Potential adopters, end users, input suppliers and food chain actors. This will include farmer organisations, agricultural colleges and training centres, Farm Advisory Services, Industry representative organisations (i.e. for dairy herds) food processing companies, retailers, fertiliser companies, biogas plants.

Public
Consumers, residents in the areas where the case studies are, students.

Research Communities
Universities and research institutions and agricultural colleges

1.3 The Message [WHAT]

1.3.1 Communication messages:

- What are carbon, nitrogen and phosphorus cycles, why they are important
- How more efficient nutrient and carbon cycling in agriculture can have the following benefits:

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- Contribution to the SDGs and COP21 (21st Conference of Parties of the UN Framework Convention on Climate Change (UNFCCC)
- Support improved food security
- Improved soil quality (and the impacts thereof), water quality and air quality
- Contribution to a more circular economy, rural economy
- Potential to reduce farmer production costs, development of SMEs in rural areas

- How the project is working towards these aims – overall, and per case study
- And what the project is actually doing
- To open the discussion and dispel myths concerning food safety (especially vis a vis nutrient recovery and reuse).

1.3.2 Dissemination messaging

Policy messages:

- The policy messaging will be based on the uncovering of potential bottlenecks and policy in cohesions that are handicapping the progress of more efficient nutrient and carbon cycling, or potential policy opportunities that could advance it further. This will be developed by bringing together information from the Environmental Policy Analysis (WP5), simulations with EAB (WP5) and from the case studies.

Results from the project:

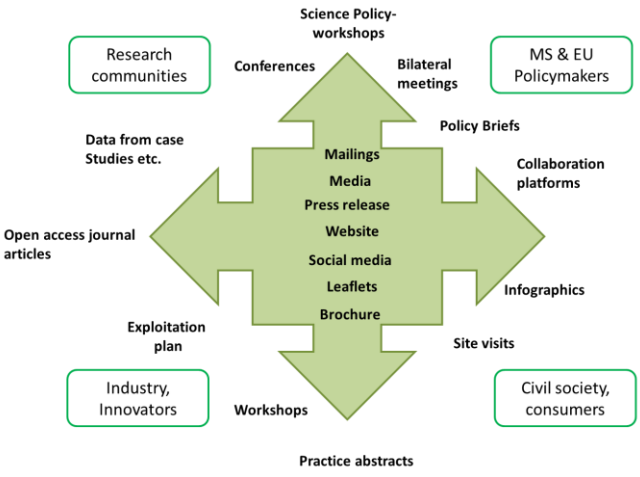
- This messaging will be based on informing potential adopters (farmers, FAS, farmer groups, biogas plants, municipalities, industry and industry representation groups) of the learning developed in the project and to promote the uptake of the techniques developed in this project by other users.

1.4 Branding and logo

- All dissemination material should include the Circular Agronomics logo and should refer to the website: www.circularagronomics.eu
  Twitter: @Circular_Agro
  Newsletter: http://eepurl.com/dJXG3Y

- All official material should display the logo of the EC and the following sentence:
  This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement No 773649

1.5 The Means of Dissemination [HOW]



1.5.1 Sign off Procedures

The following external documents must have full consortium sign off:

- Any formal documents giving policy recommendations/ formal policy asks to European Policy makers (letters to MEPs, Policy notes etc.).
- Any project press releases

1.5.2 Media

- **Press release (start and end of project)**
  A project press release was written and sent to the media and a wide range of stakeholders at the start of the project. This included the RISE Foundation mailing list and journalist list in English (9000 recipients). It was also translated into the case study country languages (CZ, DE, IT, ES, NL) and sent out locally by partners. This process will be repeated at the end of the project with a final press release.

- **Brussels based and local, regional & National Press**
  All consortium partners will be responsible for actively pursuing media exposure in their own countries through offering interviews, site visits, information sheets and op-eds and cultivating journalist contacts.
  The consortium members will also target overarching sites, such as Agriculture.com, Agricultural Entrepreneurship, AgWired, Sciencedaily.com, agri.eu, Horizon Magazine, ENRD etc.
  Consortium members will aim to have information about CircularAgronomics included in the newsletters of other organisations such as local farmer organisation, the European Landowners' Organisation, the Friends of the Countryside, ESPP, European Biogas Association, the Biorefine Network etc.
  RISE will work to have the final project conclusions and recommendations published, where possible, through Brussels media channels such as Euractiv, Agrafacts, Politico etc.
  The aim for the project is to have at least 10 media articles published on aspects of the Circular Agronomics project. These maybe in national/ regional/ European print/online press, industry press or as part of a programme on TV or radio.

1.5.3 Website and print and online material

- **Brochure**
  A project brochure has been developed and distributed amongst the consortium partners at the start of the project. In addition, the file has been uploaded onto the shared drive should any partners wish to print more copies locally. All partners of the consortium are encouraged to distribute the brochure at all relevant meetings and events and consider translating the brochure where needed. The brochure outlines the key messaging of the project. As with all dissemination activities, any distribution of the brochure must be noted in the dissemination reporting file online (external EC reports only).

- **Information sheets**
  A leaflet will be created for each case study – in English and the local language (the Barcelona case study will be in English + two languages). The leaflet will outline the contribution the case study is making to the overall ambition of Circular Agronomics. Case study partners will distribute the leaflets during farmer workshops, site visits, conferences etc.

- **Project poster**
  A project poster has been created for the overall Circular Agronomic project. This will be set up to enable partners to translate it if required and will be used by partners for case study site visits and poster sessions at conferences to outline the work and aims of Circular Agronomics. In addition, a project roll up has been made in English which partners can use at events.

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- **Factsheets**
  Factsheets will be produced to target different audiences (policy makers, farmers, consumers, food processors/retailers). These will be in ENG but will be available to be translated by the partners. These will be developed as part of the stakeholder mapping exercise in year 2-4 when RISE will work with the partners to identify which relevant stakeholders they can access, what information should be disseminated and in what form. This can be updated as the results from the project develop.

- **Infographics**
  RISE will develop an infographic for the project. This will be made available on the website and to all partners for communication, to explain the project and its impact.

- **Website**
  RISE has developed a project website. The content of the website will be regularly updated by RISE using input that is sent in proactively by the consortium partners. It includes a description of the project, its activities and relevant news and will include intermediate and final results and communication and dissemination material. Research outcomes will be integrated into the website and will show the C, N and P flows for each case study as well as inventories on the agricultural and food chain practices, waste types, processing and end products. The link to the website will be included on all consortium members websites and where possible, other research institutional and membership groups.

- **Newsletter**
  A bi-annual newsletter (starting from month 12). Twice a year RISE will ask members of the consortium for input for stories and photos. The letter will be uploaded on the website and sent to a mailing list that is centralised at the RISE Foundation. To ensure the widest possible distribution of the newsletter, all partners will be responsible for notifying their contacts of the newsletter link to sign up: http://eepurl.com/dJXG3Y

- **Social Media**
  A Circular Agronomics twitter account has been set up by RISE. All consortium members have been given the log in details and can tweet, in their own language. In addition, RISE will upload tweets for any partners who do not wish to upload the information directly themselves. All consortium partners who have twitter accounts for their own organisations/ companies, will also proactively retweet Circular Agronomic tweets and write tweets about Circular Agronomics.

1.5.4 Site visits

Each of the case study sites will invite local policy makers/ residents etc. to visit the case study site and to explain about the work of Circular Agronomics at least once over the course of the project.

1.5.5 The Promotion of a Science- Policy Dialogue

- **Involvement in relevant European, Members State and regional working groups and platforms**

Partners of the consortium will be involved in a broad range of working groups and collaboration platforms through which they will communicate and disseminate information about the project and findings developing during Circular Agronomics. A summary of the consortium members involvement is summarised below.

Name of platform/group	Participant (Organisation)	Level of group (International/ European/National/Regional
Biorefine Cluster	IRTA	European

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Bonares Centre	TUM	National
DPP (Deutsche Phosphor Plattform e. V.)	KWB	National
DWA (Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall)	KWB	National/Regional
ARREAU EIP Water Action Group (Working group: nutrients)	KWB	European
EIP Reine Lungau	AREC, Joint Venture of Farms and Austrian Chamber of Agriculture Tamsweg	National
EIP-AGRI Circular Bioeconomy workshop	Fondazione CRPA	European
EIP-AGRI Focus Group on C sequestration in arable farming	Fondazione CRPA	European
EIP-AGRI OG (E)MISSION, for a "green" livestock production	Fondazione CRPA	National
EIP-AGRI OG Nitrati_Ferrara – Agricultural practices to prevent nitrates pollution and promote organic matter conservation	Fondazione CRPA	National
EIP-AGRI OG Riscossa – Saving and conservation of nitrogen in agricultural systems with pigs	Fondazione CRPA	National
ERA-Net SUSAN – ID 34 SusPigSys — Sustainable Pig Production Systems	Fondazione CRPA	European
ESPP	KWB (to be member)	European
European Operational Groups (many)	IRTA	European
Italian Biogas Consortium (CIB)	Fondazione CRPA	National
Italian Biomass Association (ITABIA)	Fondazione CRPA	National
Italian Composting and Biogas Association (C.I.C.)	Fondazione CRPA	National
Kompetenzzentrum für Düngung und Sekundärrohstoffe e.V. (KDS)	Soepenberg Group	National
Unterstützungsverein Reine Lungau	Farms	National
Unterstützungsverein Reine Lungau	Farms	National

- **Participation in relevant and specialized events**

Members of the consortium will participate in relevant and specialised events, fairs, workshops, farm demonstrations and conferences at a regional/ national/ European level and International events to present the project and foster networking opportunities. *Examples of events include: EIP-AGRI workshops, RAMIRAN, ManuREsource, EUBCE, International Anaerobic Digestion Conference, International Anaerobic Digestion Conference Joint International Conferences on intelligent Agriculture, Agritechnica, Aggrotech, ANUGA, Fieragricola (Italy), Salon International de l'Agriculture (Paris), EU Green Week, BRALA and the Open Knowledge Festival.* At such events, members of Circular Agronomics will where possible, engage as speakers/ panellists or have posters. In all such event both the logo of Circular Agronomics, its website, twitter, newsletter link, and EC flag and project funding statement (see footer of this document) should be clearly visible and leaflets distributed.

- **Policy Working Group**

A Policy Working Group was established in 2019 and includes the following partners: KWB, RISE, IRTA, SOGESCA, CREDA and TEAGASC. It will meet every four to six months to discuss policy developments and findings within the project. For the period of M12-M24 policy work will be limited to the support of the development of deliverables in WP5 – the Environmental Policy Analysis, and to join joint policy initiatives (such as the European Sustainable Nutrients Initiative). As of M25 of the project, Circular Agronomics will have delivered key project results and therefore the work of the policy group can turn to developing policy notes and engaging in policy discussions at both the MS and European level.

- **Policy brief**

Based on the policy impact assessment in WP5, and the gathering of information by the Policy Working Group, from the Policy workshop, and the case studies, a policy brief will be developed by the Policy Working Group which will highlight the policy changes that are needed, or policy opportunities that will enable the better uptake of the learning from the project. In addition to the final policy brief (D5.4, M48), additional policy notes maybe be written if suitable policy milestones are identified during the project.

The policy brief will be written in a style that is accessible to policy makers, providing them with clear, concrete policy recommendations. These will be disseminated through bilateral meetings, the clusters and working groups, conferences, the website, social media and newsletter.

- **Policy Workshop**

RISE will organise a policy workshop in Brussels in M36 with the members of the Policy Working Group. The workshop will be targeted towards policy makers and policy influencers and highlight the learning in the project and debate how elements of policy could be improved to better support the roll out of the project learning to promote a circular economy.

- **Meetings**

Where relevant, bilateral meetings should be set up with policy makers and policy influencers, industry and farmers groups, NGOs, academics, local authorities and consumer to disseminate the policy and innovation findings developing during the course of the project.

- **Farmers workshops**

Each case study will organise two workshops. The first workshop will communicate about the project, its aims and activities. The second one will be held at the end of the project to present and disseminate the results. The workshops will include practical farmers and local authorities and inform them about options and consequences of improving agricultural nutrient recycling.

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3 Exploitation Plan

Our exploitation strategy aims to achieve a market-uptake of promising technologies, products and services within 2 – 3 years after the end of the project. The technologies aim to produce a variety of exploitable innovations ranging from residue treatments to avoid emissions through the recycling of residues and the creation of commercial products with lower emission profiles during the entire value-chain compared to conventional products, currently used at farm-level. The involvement of commercial partners, who will profit from the successful demonstration and validation of their products in different demonstration sites, will maximize exploitation. The key components of the exploitation plans are market analyses and business model developments. They form the basis of the strategy formulation and implementation based on concept-studies for different farmers and industries. Therefore, we will characterize relevant markets and market segments for different geographical regions as well as different types of application such as the farming sector, the biogas sector, the waste sector and the food-industry. The analyses will provide a picture of the market size (i.e. number of customers, demand) and economic opportunities (i.e. sales revenues for existing products) and identify opportunities resulting from technology synergies and complementarities. **Error! Reference s ource not found.** summarizes the activities involved in the exploitation task.

Table 1: Listed technology activities, commercial partners and TRL

WP	Case Study	Activity/ Product/ Service	Commercial partners	Project start → Current → Expected TRL
2	Catalonia (ES)	Solar drying of manure by using solar heat, chemical fixing of ammonia, emission reduction and odours treatment.	EMA and PGP	5 → 5 → 7
2	Emilia-Romagna (IT)	Microfiltered digestate fertigation	WAMgroup and Netafilm (FCSR's subcontractors)	5 → 6 → 7
2/3	Brandenburg (DE)	N-depletion of agricultural and food waste residues via vacuum degasification and N-recovery as di ammonium sulphate	PON and SOE	3 → 5 → 7
3	Gelderland/ West Flanders (NL/BE)	Enhanced P-recovery from solid soya bean wastewater and waste by addition of enzymes for phosphorus release and struvite precipitation	NRS	3 → 5 → 7
3	South Moravia (CZ)	Recovery of C-rich compounds (cellulose, lignin and proteins) for reuse on farms from food industry wastewater	ASIO	3 → 5 → 7

2.1 Preliminary exploitation plans for technology activities

Drawing on both, the market analysis and business models, a series of strategic actions for commercialization will be formulated and implemented taking into account the companies' resources (e.g., partners, infrastructure and organizational structures) and competitive advantages. Expected financial impacts will be quantified, **Error! R eference source not found.** to **Error! Reference source not found.** show the preliminary exploitation plans per activity for all 5 case studies listed in **Error! Reference source not found.** for. These include elements from a p reliminary market analysis (e.g. trends, geographical market, size, customer segments and competitors), companies' business models (e.g. organizations key activities, value propositions/competitive advantages of innovative products), financial projections and a series of strategic actions formulated (commercialization roadmap/ dissemination & communication actions) which will promote a successful market entry.

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Table 2: Preliminary exploitation plan for activity demonstrated in Catalonia (ES)

Activity: Solar drying of manure by using solar heat, chemical fixing of ammonia, emission reduction and odors treatment.	
	Key exploitable results
Description:	Reduction of water content of manure and anaerobic digestates by using solar drying with chemical nitrogen fixation to obtain organic fertilizers, and minimization of ammonia and GHG emissions.
Targets:	Recovery of more than 90% of total nitrogen and minimization of emission losses to less than 5%
Development stage:	So far, no commercial systems have been developed for manure treatment on farm based on solar drying for agricultural recovery of nutrients, nor solar concentration systems are known for the different fractions (solid and liquid) coming from a centrifuge separator (TRL5). From the beginning of the project, one of the solar dryers has been already installed and tested using acidified non-separated digestate, under summer conditions (high temperatures around 30ºC), obtaining a product with 85-90% of dry matter.
Differences from competing products/services:	The most recent references so far are based on urban sewage sludge drying which does not take into account the recovery of nutrients or the minimization of nitrogen emission losses.
Expected key areas of application:	It is expected that this highly automated and commercially viable solution, that can be easily operated by the farm technician can be replicated both on farms with anaerobic digestion system, and on farms where no manure treatment or separation system is available.
Customer segments:	Cattle and pig farms, with or without manure treatment, generally of medium - large size, with manure management challenges due to the lack of crops fields or the excess of N application
	Market
Trend/Driver:	Groundwater contamination, high concentrations of farms and the need to export nitrogen to other nutrient-negative-balance areas.
Market:	Livestock farms and waste managers in areas with N surplus coming from livestock farms and strong episodes of groundwater pollution that count on many hours of sunshine, for example, Mediterranean arch countries: Spain (Catalonia, Valencia, Andalusia), Greece, Italy, Portugal or France. In the case of few hours of sunshine and the integration in a biogas plant, the residual heat coming from the cogeneration engine is used as a heat source, examples: Germany, the Netherlands and Denmark.
Size:	Possibility of using it at any farm in which no previous treatments or biogas system are necessary, in nitrate vulnerable zones there is a high concentration of farms. In Spain, it is estimated that 30% of farms are located in areas with excess of manure, which represents a volume of 7,000,000 m^3/year, assuming that large farms generate about 10,000 m^3/year, it follows that there are 700 farms with urgent needs in relation to manure treatment in Spain. With an installation period of approximately three months and without taking into account the competing technologies, it is possible to assume that the system can be implemented in up to 4 farms per year, which would mean a turnover of 1.4 M € per year.
Main competitors and competitive advantage:	• N recovery in the form of Struvite • N recovery by stripping using steam or air • Composting • Bio drying and drying None of these technologies is as simple and as robust as solar drying.
Financial projections:	The increasing restrictions, especially in vulnerable zones, have led in a growing interest on manure treatment. The implementation limit is the market prize of the treated manure

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	and the renting of application fields, in some areas, the price is currently about 5-7 €/m^3 (increasing trend), which is higher than the price for solar drying technology with around 4-5 €/m^3 (fixed trend)
Project activities	
Innovation and Exploitation team:	EMA will build and install solar drying systems, and will lead and market the final solar drying system
Dissemination and Communication actions:	• Technology validation during the project for its commercialization • Presentation of the solar drying solution towards livestock sector • Integration of the solar drying solution in EMA's portfolio • App development for a personalized implementation of a solar treatment
Commercialization Roadmap/ Exploitation routes:	• Technological viability demonstration by means of laboratory and pilot studies • Construction of a solar drying plant for external companies • Integration in a biogas plant
IPR Management:	Currently, solar drying is considered as technically, economically and environmentally viable by the administration of Catalonia. It is intended to apply some type of intellectual property protection during the project.

Table 3: Preliminary exploitation plan for activity demonstrated in Emilia-Romagna (IT)

Activity: Microfiltered digestate fertigation	
Key exploitable results	
Description:	An integrated system for the production of microfiltered digestate is used in fertigation through drip irrigation lines. Raw digestate is first separated in a solid and a clarified fraction, and then this clarified fraction is microfiltered to obtain a thickened and a microfiltered digestate to be transferred to the fields and used to fertigate growing crops. Microfiltered digestate fertigation (MDF) fully fits into the Biogas-done-right model proposed by the Italian Biogas Consortium (CIB), an example of multifunctional and sustainable agriculture according to "The Roadmap to a Resource Efficient Europe (COM(2011)571)".
Targets:	Increase the nutrients use efficiency, reduce emissions and minimize water and energy consumption. The N use efficiency could reach or exceed the levels of N from mineral fertilisers. Efficient application of treated manure/digestate via drip lines fertigation saves 15-20% of water. NH_3 and N_2O emissions into the air can be reduced, too, depending on the reference system by 25-35% and 50-75%, respectively, while NO_3 leaching/runoff is reduced by 40-50% compared to nitrate caused by conventional organic fertilizer application.
Development stage:	Microfiltration has been tested on different kinds of digestates and experiments with digestate injection into drip lines have been conducted (TRL 5-7). The economic feasibility of combining the single processes (digestate treatment, fertigation) has been outlined, but its validation at the real field scale is still required. During the first year (2019), a complete pilot plant at farm scale, applied to the digestate, have been developed and validated. Agronomical tests have been conducted on the exclusive use of digestate as fertilizer on different crops for food/feed and energy production (maize in 2019), in comparison with business as usual that is use of raw digestate on bare soil and sprinkler irrigation. Performance and reliability of the experimental technologies and practices have been investigated and evaluated.
Differences from competing products/services:	Commercial references consist of different and more complex equipment such as centrifuges and membranes, that generally require an additional treatment with chemicals (such as polyelectrolytes) to foster the separation processes. The microfilter can represent an economical alternative with a significant working capacity (estimated between 5 and 10 m^3/hour), and should be therefore more easily integrated into biogas plants of different types and sizes.

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Expected key areas of application:	Commercial applications in biogas plants and sewage treatment plants, but also in livestock farms to treat raw slurry (not treated in a biogas plant). Shift in the purpose of biogas plants from pure energy production towards an integrated energy and material recovery facility improving the nutrients recycling. The microfilter can be optimally combined with the drip lines for fertigation, as it is able to guarantee a microfiltered fraction in which all particles larger than a defined diameter (which depends on the spacing sieve) are excluded so they can't clog up the drippers.
Customer segments:	Biogas plants operators (farmers and industrial clients), farmers in regions with intensive livestock, sewage treatment plants with anaerobic digestion; arable farmers interested in substituting mineral fertilizers with the digestate.
Market	
Trend/Driver:	The boost to reduce ammonia and nitrate emissions (e.g. legal conflicts with legal regulations deriving from National Emissions Ceilings Directive and Nitrate Directive). The boost to circular economy.
Market:	Regions with high livestock density and/or high biogas plants density (e.g. Northern Italy, North-East Germany, Denmark, Netherlands, Flanders, Brittany, Catalonia) and abroad EU (e.g. China, US)
Size:	According to EBA – European Biogas Association, the number of biogas plants in Europe currently exceeds 17,000. Considering, on the one hand, the adaptability of the microfiltration system and, on the other hand, the potential interest for fertigation (which cannot be spread in all European regions) it can be cautiously estimated that 10% of the plants may be interested in the MDF system. By estimation of investments of 60 T€/biogas plant, a total market volume of at least 100 M€ is derived.
Main competitors and competitive advantage:	Main competitors are digestate centrifugation or filtration (by membranes) and the use of clarified fractions by means of irrigation systems other than drip lines (e.g. sprinklers pivot). The MDF system reduces CAPEX due to the cost-effectiveness of the solution and OPEX due to reduced energy consumption and optimal integration into a biogas plant.
Financial projections:	Projections are highly dependent on EU policy in terms of the effective implementation of the legislation and the realisation of the ambitious objectives of the circular economy. It is planned to set up some contracts for complete commercial plants before the end of the project. The exploitation is limited by the magnitude of actors and operators.
Project activities	
Innovation and Exploitation team:	From the first year, a complete pilot plant at farm scale, applied to the digestate, will be developed and validated. Agronomical tests will be conducted on the exclusive use of digestate as fertilizer on different crops for food/feed and energy production, in comparison with business as usual. Performance and reliability of the experimental technologies and practices will be investigated and evaluated. Circular Agronomics partner FCSR will be responsible for the whole activity. Technology providers: Wamgroup for the microfilter and assistance in its management, Netafim for the fertigation system with drip lines and assistance in its management.
Dissemination and Communication actions:	• Workshop/ presentation at conferences: e.g. ManuResource 2019, Events of the EBA (European Biogas Association), IWA Resource Recovery Conference 2019 • Promote MFD system among environmental agencies and farmers in relevant regions • Design and marketing recommendations for combining MDF with biogas production and waste reduction • Pilot plant visits for interested investors/ potential clients • Use results of demonstration activities for paper publication • FCSR organised a workshop combined with a pilot plant visit (Open day) on the 30th July 2019

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Commercialization Roadmap/ Exploitation routes:	• Successful demonstration at pilot-scale within the project • Demonstration of results and benchmarking of costs and energy profiles and results for digestate fertigation to current state of digestate utilization • Concept studies for selected cases/regions and planning/extrapolating cost-benefit of commercial projects • Proof of acceptance towards users: testing materials of potential clients in the pilot plant or if needed, moving mobile pilot plant to potential clients • Commercial implementation
IPR Management:	The microfilter is licensed by WAMgroup and the equipment for fertigation is licensed by Netafim. IPR for the combined system (different know-how input by Wamgroup and Netafim) will be regulated in the cooperation contract.

Table 4: Preliminary exploitation plan for activity demonstrated in Brandenburg (DE)

Activity: N-depletion of agricultural and food waste residues via vacuum degasification and N-recovery as di ammonium sulfate	
Key exploitable results	
Description:	Robust vacuum-degasification to extract ammonium/ammonia from bio-based raw materials such as sewage sludge, manure, agricultural digestate or food waste digestate for production of different ammonia-based products (fertilizer, NH_3-water) and N-depletion of bio-based materials
Targets:	At least 80 % extraction of inorganic N (NH_4^+/NH_3) from bio-based materials and processing of commercial ammonia-based products from gaseous streams by optional usage of available anions (e.g. carbonate obtained from CO_2); higher N-efficiency towards conventional bio-solid recycling on arable land by N-decoupling (recovered N-fertilizer can be applied when needed, instead of bulk spreading with bio-solid).
Development stage:	Vacuum-degasification exploited for methane-removal from sewage sludge (TRL 9, commercial); lab trials for ammonia-removal (TRL 3). Harvesting units commercial in large-scale for concentrated gaseous streams (NH_3-processsing), economic feasible systems (with minimum 5 m^3/h feed), combining these singular processes has not been developed so far. Further trials had been contucted with original feedstock and system had been quantitatively described achieving TRL 5.
Differences from competing products/services:	Commercial references are very rare and use air-stripping for N-removal instead of vacuum-degasification. Air stripping requires a liquid (and mostly particle free) centrate, whereby, vacuum degasification is more robust and can treat mixed phases (solid-liquid-streams). No dewatering of manure or similar agricultural waste is necessary. Furthermore, it will require less energy, an internal recycling loop will increase the efficiency and higher process stability is expected compared to conventional air-stripping. In contrast, air-stripping shows an oxidizing behavior on carbon-rich centrate and emits GHG emissions as CO_2 and the remaining CH_4 from the digestate into the air. For vacuum degasification, these emissions can be minimized by a smart integration into a biogas plant.
Expected key areas of application:	Commercial application in biogas-plants, sewage treatment plants or as stand-alone technology in areas with high nitrogen-surplus; potential shift of feed material to biogas-plants from growing renewable raw material towards waste as excess manure and similar residues; shift of biogas-plants from pure energy production towards an integrated energy and nutrient recovery facility reducing excess nitrogen within residues. During the dewatering of digested sludge, a nitrogen rich centrate is produced. At wastewater treatment plants, this centrate is treated via nitrification and denitrification. Those main-stream processes require much more energy than side-stream vacuum degasification. Here, the process can purge the centrate water from the nitrogen, so that the process of activated sludge is relieved, and the nitrogen fertilizer can be separated.

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Customer segments:	biogas-plant operators (farmers and industrial clients), farmers in regions with intensive livestock, sewage treatment plants with anaerobic digestion
Market	
Trend/Driver:	N surplus, ammonia and nitrate emissions (e.g. legal conflicts with Nitrates Directive)
Market:	Regions with high livestock density and N surplus, e.g. Denmark, Netherlands, Flanders, North-East Germany, Catalonia, Brittany, Emilia-Romagna) and abroad EU (e.g. US)
Size:	Considering the share of large biogas-plants (5 % of German biogas-plants) with volumetric flow rates > 5 m³/h, a number of 500 feasible biogas-plants has been estimated at least for EU. By estimation of investments of 800 T€/plant, a total market volume of at least 400 M€ is estimated. Considering alternative stand-alone solutions in areas with intensive livestock farming, at least 50 commercial plants (5 m³/h) could be built for N-depletion of manure in the Weser-Ems-Region (North-East Germany) and similar quantities in regions with comparable livestock densities (also approx. 500 plants for EU).
Main competitors and competitive advantage:	Main competition is expected to be with providers of stripping units. The PONDUS-N process has reduced CAPEX due to flexibility (no dewatering or particle filter (micro- or ultrafiltration) in pre-treatment) and OPEX with an optimal integration into a biogas-plant by more than 50 %.
Financial projections:	Projection is in strong dependency of EU policy in terms of actual execution of Nitrates Directive within Member States. It is planned to set up a contract for 1 commercial plant before the end of the project and 5 commercial plants up to 2025. So an expected turnover of 4 M€ is planned within the next 8 years. The exploitation is limited by the magnitude of actors and operators. In the case, Germany would increase its activities in the agricultural sector to avoid further infringement of the Nitrate Directive; the market could be significantly larger.
Project activities	
Innovation and Exploitation team:	PON is in charge of the design and construction of the technological unit (technology provider), KWB will operate the plant and will prove the practicability of the concept in pilot scale, SOE will deliver relevant chemicals (if needed) and will be in charge of commercial N-recovery product valorisation, IASP will be responsible for including materials into farming systems determining best practice in N-depleted bio solid recycling. PON, KWB and SOE will elaborate concept studies for commercial projects in existing biogas plants or areas with high livestock densities.
Dissemination and Communication actions:	• Workshop/presentation at conferences: e.g. ManuResource 2019, Events of the EBA (European Biogas Association), IWA Resource Recovery Conference 2019 • Promote PONDUS-N among environmental agencies and farmers in relevant regions • Design and marketing recommendations for combining nitrogen recovery with biogas production and waste reduction • Pilot plant visits for interested investors/ potential clients • Use results of demonstration activities for paper publication
Commercialization Roadmap/ Exploitation routes:	• Successful demonstration at pilot-scale within the project • Demonstration of treatment results and benchmarking of costs and energy profiles and results for N-depleted bio solids recycling to current state of bio solids recycling • Concept Studies for selected cases/regions and planning/extrapolating cost-benefit of commercial projects • Proof of acceptance towards users: testing materials of potential clients in the pilot plant or if needed: moving mobile pilot plant to potential client • Commercial implementation
IPR Management:	PONDUS-N is licensed by PON. IPR for combined system (different know-how input by PON and SOE) will be regulated in the cooperation contract.

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Table 5: Preliminary exploitation plan for activity demonstrated in Gelderland/ West Flanders (NL/BE))

Activity: Enhanced P-recovery from solid soya bean wastewater and waste by addition of enzymes for phosphorus release and struvite precipitation	
Key exploitable results	
Description:	New type of innovative pre-treatment of soya bean wastewater to increase degradation of phytic acid resulting in phosphate release to liquid phase key phosphorus compound for struvite formation, solid-liquid separation and NH4-struvite recovery from liquor by usage of ammonium from parallel soya bean wastewater treatment. Evaluate option for alternative phosphorus recovery as K-struvite.
Targets:	Establish the boundary conditions for conversion of the P present as phytic acid towards free PO4-P in both, wastewater and solid waste to maximize ortho-phosphate in sludge water and define optimum process parameters to convert the liberated PO4-P towards struvite in the view of P-recovery (85 % efficiency), after anaerobic stage treatment, reducing phosphorus load towards final aerobic stage process to obtain residual P < 10 ppm for direct discharge
Development stage:	Struvite reactors in anaerobic wastewater treatment after UASB (TRL 9, commercial); lab trials for phosphorus release from solid waste (TRL 3), no combined economic feasible system available.
Differences from competing products/services:	Commercial references are very rare since organic-bounded phosphorus release is either limited in low release rates or expensive due to the addition of chemicals (such as acids or caustics) or the usage of a thermal process for the conversion of organics. Phytase is a cheap commodity enzyme used in animal feeding to increase the phosphorus availability from fodder and represents thereby a novel alternative to dissolve organic bound phosphorus, to recover phosphorus (and nitrogen) as struvite and simultaneously to achieve P discharge levels of the treatment plant. Contrary to most wastewaters not magnesium but phosphorus is the limiting parameter in soy-bean wastewater, rendering a non-chemical addition approach possible provided phosphorus as phytic is converted into phosphate.
Expected key areas of application:	Commercial application in food-industry waste, food-industry wastewater and food-waste digestion plants, whereby enzyme treatment needs to be modified in dependency on the chemical bonding of phosphorus
Customer segments:	food and fodder processors, food-industry wastewater facilities, food waste disposers
Market	
Trend/Driver:	P surplus, eventually clogging problems in pipes, P discharge limits (Water Framework Directive)
Market:	Food-industry in EU and other developed countries (e.g. US)
Size:	The potential number of installations is estimated at 10 to 15 when addressing the major soya bean processors in Europe. A limited of number of companies do own several processing plants. So, once the technology is introduced to one customer, it might be disseminated to others. The market value of 15 potential plants would be around 12 M€. This will be distributed mainly over local subcontractors. In addition, the market for the recovered struvite will generate recurrent business and employment.
Main competitors and competitive advantage:	Main competition is by other companies selling struvite reactor systems (mainly operating in municipal wastewater). NRS is a leading technology provider in terms of struvite recovery from industrial/food-industry wastewater; ambitions of other companies extend their technologies towards food-industry waste or food waste is unknown as well as expanding the recovered nutrients portfolio.

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Financial projections:	Projection is in strong dependency on the EU policy in terms of the actual execution of the ambitious goal of the Circular Economy targets. It is planned to set-up a contract for one commercial plant before the end of the project and 5 commercial plants until 2025. So an expected turnover of approx. 5 M€ is planned within the next 8 years. The exploitation is limited by the magnitude of actors and operators.
Project activities	
Innovation and Exploitation team:	NRS is in charge of the design and construction of the plant (technology provider), KWB will support NRS with the elaboration of concept studies for commercial projects for similar plants and will investigate the market potential for the technology for similar industries in food and fodder production
Dissemination and Communication actions:	• Workshop/presentation at conferences: e.g. European Sustainable Phosphorus Conference, IWA Resource Recovery Conference 2019, Food Industry Summit • Promote NRS approach among environmental agencies, policy and food-processors • Design and marketing recommendations for combining struvite recovery with biogas production and waste reduction in food industry • Pilot plant visits for interested investors/ potential clients • Use results of demonstration activities for paper publication
Commercialization Roadmap/ Exploitation routes:	• Successful demonstration at pilot-scale within the project • Demonstration of treatment results and benchmarking of costs and energy profiles and results for P-depleted bio solids recycling to current state of bio solids recycling • Concept studies for selected cases/regions and planning/extrapolating cost-benefit of commercial projects • Proof of acceptance towards users: testing materials of potential clients in the pilot plant or if needed: moving mobile pilot plant to potential client • Commercial implementation
IPR Management:	The NURESYS reactor is licensed by NRS. IPR for combined system (different know-how input by NRS) will be regulated in the cooperation contract.

Table 6: Preliminary exploitation plan for activity demonstrated in South Moravia (CZ)

Activity: Recovery of C-rich compounds (cellulose, lignin and proteins) for reuse on farms from food industry wastewater	
Key exploitable results	
Description:	Innovative solutions of food-industry wastewater treatment aiming for recovery of C-rich compounds (cellulose, lignin and proteins) for reuse on farms. Acid whey management and utilization in food processing industry and for enrichment of soils.
Targets:	Establish conditions for efficient acid whey management, proper concentration of acid whey for placement into soil, handling with acid whey before application and techniques for efficient application into the soil; recommendation for acid whey application as soil conditioner; proper management with acid whey for animal fodder application; pathway for efficient acid whey processing to animal fodder; ROI analyses and market replication analysis.
Development stage:	Laboratory reactor for acid whey separation based on nanofiltration (TRL3), application of nanofibrous membranes for acid whey management (TRL3), pathway for animal fodder processing under studies, probably TRL3
Differences from competing products/services:	Acid whey is concentrated for the production of dry whey (protein supplement) or whey is discharged as waste. There are not known market re-processing pathways as introduced in the project (i.e. addition of carbon into soil or management as animal fodder)

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Expected key areas of application:	Commercial application for acid whey separation and management in food processing industry, acid whey treatment for efficient placement into the soil in agriculture, acid whey re-processing into animal fodder in food-processing industry and agriculture
Customer segments:	food-industry disposers, fodder processors, farmers in regions with soils with a lack of organic carbon
Market	
Trend/Driver:	Circular Economy in the point of view of acid whey management, technology solutions for acid whey management; lack of carbon at the agricultural fields; turn of waste to resources as a trend for valorisation of wastes.
Market:	Food processing industry in EU, especially in Eastern Europe that produces quark(curds) with acid whey production; agriculture in EU
Size:	Food processing industry is one of the main industries in EU. Dairy industry with acid whey production is limited mainly for Eastern Europe to around 30-40% dairy works. Approx. 70% of soils throughout of EU have not enough carbon content in the soils. Animal fodder market is established in EU and we will deliver an option that can cover very small amount of the market (less than 1%) in EU.
Main competitors and competitive advantage:	Competitors in the field of acid whey management are companies dealing with membrane separation in dairy industry, e.g. GE, Novasep, Mega. A competitive advantage could be the application of nanofibrous membranes that have lower production costs.
Financial projections:	The exploitation is limited by investments which are necessary for the implementation of the technology for C-compounds separation. Research is still on the level of laboratory experiments and thus, it is very difficult to guess overall projections for now. After a successful scale-up is done, then it will be possible.
Project activities:	
Innovation and Exploitation team:	ASIO TECH is responsible for acid whey separation and management steps. Recommendation of acid whey as soil conditioner and as animal fodder additive is done by local authorities. Case study evaluation is made with support of laboratory analyses (IRTA, IASP) and KWB.
Dissemination and Communication actions:	• Workshop/presentation at conferences: e.g. week of innovations in water treatment 2019 Hustopeče, Czech Republic; IWA Resource Recovery Conference 2019; IWA World Water Congress & Exhibition 2020; Copenhagen, Denmark; week of innovations in water treatment 2020 Hustopeče, Czech Republic; WEFTEC 2019, Chicago • Promotion of the results among environmental agencies, law makers, food-processors, farmers, NGO's, etc. • Propagation of development in local magazines Vodní hospodářství (in English Water Management) and Odpadové forum (in English Waste Management Forum). Both magazines are peer-reviewed • Pilot plant visits for interested investors / potential clients • Two workshops for farmers and public authorities
Commercialization Roadmap/ Exploitation routes:	• Successful demonstration at pilot-scale within the project (case study) • Successful demonstration of pilot plant, field tests and feed tests will lead to the acceptance of the users • Commercial implementation • Recommendations of acid whey processing as soil conditioner
IPR Management:	There will be no outputs that are expected to be covered under IPR

2.2 Cross-cutting comparison of key exploiting factors

A cross-cutting comparison key exploiting factors is shown in Table 7. As mentioned in the previous exploitation plan (D6.1), the following questions are addressed.

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- Is the potential exploitation influenced by the same trends and drivers and what are these trends?

A similar trend, nutrient surplus is addressed as driver for 4 of 5 activities, whereby 3 activities addressing primarily the issue of nitrogen excess and resulting groundwater contamination via nitrate and air contamination via ammonia and 1 activity addresses phosphate surpluses in food-industry related wastewater treatment. The main driver for one activity is a lack of carbon within soils (potential financial drawback, rather than legally motivated) whereby carbon management is not the primary focus of the other activities.

- How do future trends affect potential exploitation?

Certain policy initiatives could have positive effects on exploitation of technologies, however, often the financial incentives are missing, and technologies are costly especially the initial investment for smaller agricultural systems are a burden. This could either be solved via linking policy initiatives to incentives for adequate nutrient management or via financial fines on nutrient release into environment. It should be underlined that both tools may cause damage to the sector, e.g. increased production costs and resulting higher pressure on farmers. Many activities addressing nutrient excess are resulting from intensive livestock farming, whereby a prescription of a maximum number of animals per hectare could more adequately solve the cause instead of treating the symptom. However, this would decrease the capacity of animal production which is unwanted on the background of the EU agricultural productivity. In the end, exploitation will happen, due to the intensity of environmental problems and engaged first movers, which may serve as lighthouses for second movers.

- How can potential exploitation and potential financial turnover (e.g. via stricter environmental legislation) be fostered?

The planned feasibility studies within the project will foster potential exploitation, giving cost- and environmental profiles to engaged practitioners. Regarding the legislative framework, which is highly detailed already in Europe rather actual execution of existing legislation may be worth compared to new and stricter legislation. Furthermore, incentives for adequate nutrient management will foster technology exploitation and financial turnover by innovative technology providers.

- What are the target markets?

Key market of 3 activities is within manure management/ the biogas sector, where the overreaching aim is to adequately improve nitrogen supply and demand via nutrient recovery/depletion and/or new valorisation techniques. The issue of phosphate surpluses in livestock-intensive areas is not a primary aim of these developments. Nevertheless, this will be included within the exploitation studies for areas whereas P is limiting and not nitrogen. 3 out of 5 activities are focusing on food waste/ wastewater streams, whereby potential surpluses are from the environmental issues of eutrophication, or oxygen degradation in water bodies is already sufficiently addressed via the Water Framework Directive. However, technologies are often in place which remove potential harm from waterbodies via so called “elimination” techniques and transferring carbon and nutrients into other forms which are released into atmosphere, disposed on landfills or used for energy recovery. Exploitation studies in that sense must compare state-of-the art “elimination” techniques with novel “recovery” techniques which might require higher costs but also creating additional value via novel nutrient products, which can be reused in agriculture.

- Do activities compete against each other or can they be combined to achieve even higher levels of carbon and/or nutrient sufficiency?

Since key market of 3 activities is within manure management aiming for adequately manage nitrogen and demand, they compete to a certain extent. However, activities consist of different technological units, which can be combined in several ways to design an optimum technical process and valorisation concept reaching higher nitrogen efficiency. Since phosphate is a limiting manure and digestate application in several livestock intensive regions, a combined system aiming for nitrogen and phosphate recovery and their adequate management is a possibility to be investigated.

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- Are there any new developments, which may influence the market potential?

Beside the legal requirements, several emerging technologies and best practices – reaching from low- to high-tech solutions – are tested. Beside their potential combination, several approaches or sub-systems are competing against each other. An evidence-based prediction is therefore currently not available; however, it seems apparent that best-value-for-money approaches, robustness of technologies and overall maintenance of activities are crucial factors for their potential implementation.

- Is there a potential for mobile technology units which can be operated as a service by third parties to cope with the issue of small-scale systems in agriculture?

One main obstacle towards the implementation of technology units is the initial investment to be taken for stationary systems. A mobile system seems an option to cope with the issue of smaller scales in order to share costs…. However therefore, this concludes in new technological challenges and needs to be operated with a reliable business-model, which is still to be developed.

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Table 7: Cross cutting analysis on investigated activities

Case Study	Catalonia (ES)	Emilia-Romagna (IT)	Brandenburg (DE)	Gelderland/ West Flanders (NL/BE))	South Moravia (CZ)
Activity	Solar drying of manure by using solar heat, chemical fixing of ammonia, emission reduction and odours treatment.	Microfiltered digestate fertigation	N-depletion of agricultural and food waste residues via vacuum degasification and N-recovery as di ammonium sulphate	Enhanced P-recovery from solid soya bean wastewater and waste by addition of enzymes for phosphorus release and struvite precipitation	Recovery of C-rich compounds (cellulose, lignin and proteins) for reuse on farms from food industry wastewater
Trend/driver for activity	N surplus: Groundwater contamination with nitrate, Ammonia emissions to air			P surplus is industry/ wastewater treatment	Lack of carbon
Legal framework that could foster implementation	Nitrates Directive, National Emissions Ceilings Directive, Circular economy targets			Wastewater framework Directive, Circular economy targets	Wastewater framework Directive, Circular economy targets
Potential financial trade-offs	Environmental targets vs. financial effort for treatment; no adequate financial instruments in place for release of excess nutrient loads into environment in agriculture, boundary effects (and potential product revenues) vs. efforts			Environmental targets are linked to adequate financial instruments with limit values, conventional "elimination" via precipitation of P, nitrification/denitrification of N and transformation of C into CO2 or CH4 vs. recovery approaches, boundary effects (and potential product revenues) vs. efforts for recovery and competing conventional technologies	
Market/ customers	Livestock farms/ biogas plants	Biogas plants	Biogas plants/ food industry/ wastewater treatment	Food industry/ wastewater treatment	Food industry/ wastewater treatment
Kind of activity	Technology concept, several technological units	Technological unit + Valorisation concept	Technological unit	Technology concept, several technological units	Technology concept, several technological units

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2.3 Outlook

In the future, updating the exploitation plan (D6.3) will be continuously done. Key exploitable results and project activities will be evaluated based on the achievements in the project to that date. Also, continuous TRL achievement will be reviewed.

For all 5 technologies, TRLs will be reviewed by the exploitation team in M25. By then, potential clients for commercial treatment plants will have emerged or being found. Concept studies conducted in the project (D6.8) will also be announced in various relevant national practitioner journals. Applications by operators of external sites will be gathered and five promising external sites will be selected. The exploitation team will selectively cooperate with external sites and technology providers for the development of 5 concept studies for a potential commercial replication. These concept studies comprise:

- compilation of external site data and technology specific data,
- brief feasibility check regarding costs, governance and environmental impacts (e.g. emission mitigation potential) and
- external practitioners will receive a concept study for their site, whereby, they can decide, if they want to pursue the exploitation of the technology or not

Finally, all none-sensible data being approved for publication will be summarized in an exploitation brochure (D6.9).

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