



Funded by  
the European Union



# **CLOSING THE GAP BETWEEN FORK AND FARM FOR CIRCULAR NUTRIENT FLOWS**

**Circular Bioeconomy by  
utilising human excreta  
and wastewater as  
fertiliser and fertigation**

# 1. Introduction to the P2GreenN project

This Policy Brief outlines guidance for policymakers across the European Commission to support the transition from a linearly organised resource and nutrient system within the agri-food chain towards circular clean tech value chains that reduce Nitrogen (N) and Phosphorus (P) emissions and contribute to European food security by reusing and converting N and P into safe bio-based fertilisers thereby reducing dependencies on mineral fertilisers.



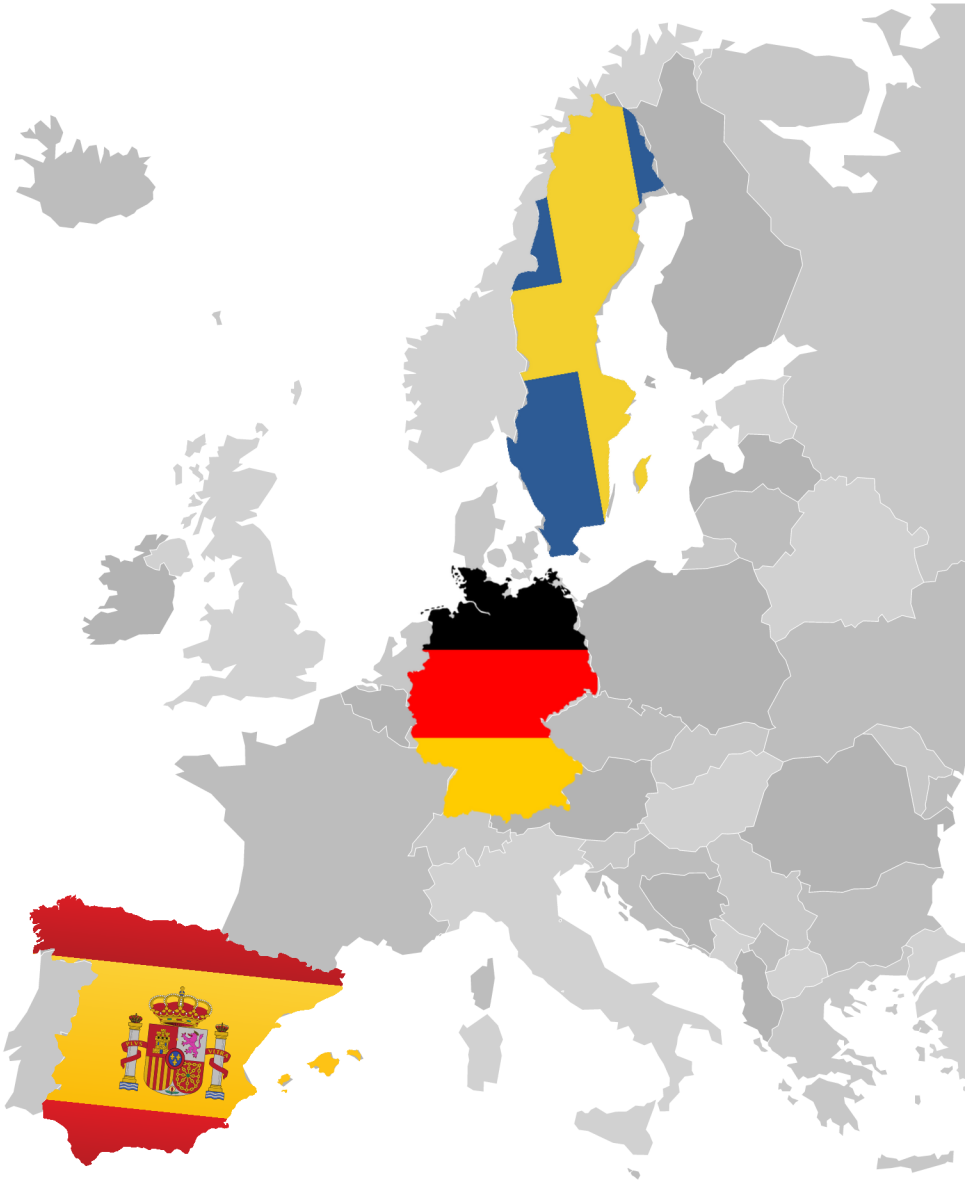
P2GreenN is a Horizon Europe funded project that started in December 2022 and has a duration of four years. P2GreenN's ambition is to foster a paradigm shift in our current linearly organised urban blue infrastructure and agricultural nutrient management. P2GreenN aims to develop innovative circular nutrient management systems that:

- a) use wastewater and human urine and faeces from urban areas as a valuable resource, recycling N and P
- b) turn recycled N and P, via four innovative clean technologies, into bio-based fertilisers
- c) are used for food production in agriculture across Europe, replacing current mineral fertilisers.

This entire new approach is demonstrated initially in three pilot regions on a north-south trajectory from the Baltic Sea region Gotland (Sweden) via the North German Plain area, to the region of Axarquía in Southern Spain. In each of the pilot regions innovative circular systems for the utilisation of human urine, faecal matter and wastewater are implemented, demonstrating that the circular nutrient systems approach is viable.

## Pilot Regions:

- Gotland-Sweden
- North German Plain
- The Axarquia region in Malaga (Spain)



The Pilot Regions will provide an operational environment to develop, adapt and demonstrate innovative circular systems and bio-based fertilisers for agricultural production and thus create innovative governance solutions at the water-agri-food nexus.

Four different technology approaches are established:

**Swedish pilot region:** urine diversion at source to minimise nutrient loss and stabilisation treatment to produce a nutrient-rich pellet fertiliser for barley.



**Swedish Pilot region**



**Urine Drying,**  
Swedish pilot region on Gotland  
**SLU:**  
Developer of the urine converting technology  
**Sanitastion 360:**  
SLU-spin off, fertiliser producer  
**Touch Down:**  
portable toilet company  
**Gotlands Bryggeri:**  
beer producer

**German pilot region:** collection of dry toilet contents from urban public toilets and festivals, thermophilic composting for humus-rich compost fertiliser as well as urine-diversion at source using a dedicated bioreactor to produce liquid urine based fertiliser. Both fertilisers are used for rye and barley production.

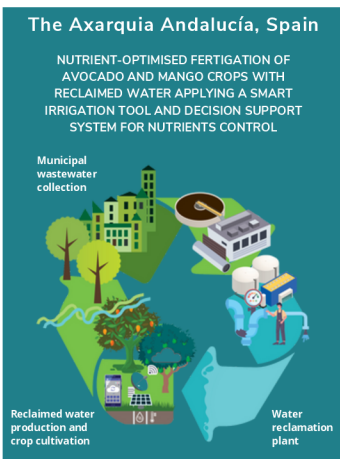


**German Pilot Region**



**Urine and Faeces Treatment,**  
North German Plain pilot region  
**Kreiswerke Barnim,**  
facilitation of yellow treatment location  
**Vuna Nexus**  
technology provider, urine treatment, fertiliser producer  
**Goldeimer GmbH**  
provision of dry toilets contents, technology provider composting  
**Vagtshoff**  
farmer, field trials

**Spanish pilot region:** decentralised processing of municipal wastewater via tertiary treatment (water reclamation plant) to reclaim water. The nutrient rich effluent is used to simultaneously irrigate and fertilise (“fertigation”) Mango and Avocado trees, adjusting nutrient dosage to plant demand.



**Spanish Pilot region**



**Nutrient optimised fertigation with reclaimed water via a Smart Fertigation Tool**  
La Axarquía, pilot region  
**BIOAZUL:**  
technology provider for wastewater reclamation  
**TROPS:**  
cooperative of farmers, technical advisor and crop management  
**CETAQUA:**  
water center research for collected data analysis  
**AgriSmart Data:**  
software developer of Smart Irrigation Tool & decision support system  
**AXARAGUA:**  
public operator of municipal WWTP

## 2. State of play - barriers for the transition towards circular nutrient flows

P2GreeN has now nearly reached its project midterm. Whilst establishing and demonstrating the different transformative, green and circular nutrient flow systems in the pilot regions several critical challenges were identified over the course of the last 20 months that determine if mainstreaming P2GreeNs solutions in the medium-term future is attainable. These identified challenges should not be seen in isolation as overall they have a mutually reinforcing effect.

- a) Inconsistent regulatory framework at EU and Member States level
- b) Lack of an effective European innovation ecosystem for start-ups & highly innovative SMEs
- c) Coordinated framework conditions connecting bio-based and circular economy missing



## Inconsistent Regulatory framework at EU and Member States level

In P2GreeN, 4 different technologies are operationalised in 3 EU Member States (MS). The end product of all P2GreeN technologies is always a fertiliser for use on agricultural farmland. Each of the MS P2GreeN pilot regions have a different national regulatory framework, for example in Sweden it is allowed to use human urine derived fertiliser for agricultural production, whilst in Germany an exemption authorisation is required which is strictly bound to research and development purposes. For the German pilot region this different approach in regulation, which is also known as gold plating of EU legislation, constitutes a regulatory hinderance for operationalisation and upscaling as long application and permission procedures are necessary that require the services of a legal expert. In addition, the overall EU legal frameworks are of concern. An initial legal scoping review conducted within the P2GreeN project concluded that eight different EU legislative frameworks are applicable in general but in various degrees for each of the pilot region. These EU legislative frameworks range from the Waste Framework Directive (WFD), the Urban Waste Water Treatment Directive (UWWTD), the Fertilising Products Regulation (FPR) and even REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) Regulation. Even with a legal expert team conducting the legal scoping review, the analysis shows many areas of uncertainty in the interpretation of the regulatory framework as regards to the scope and applicability of the different frameworks, both for the raw material used and the end products the pilot regions are producing.

The effect of these regulatory barriers on start-ups, young companies and small size businesses is much more pronounced compared to established medium and larger size businesses as they neither have the personnel nor the financial resources to mitigate the effects by mandating and consulting legal experts to establish a permissible path to authorisation for selling their product in the Single Market. Ultimately the regulatory barriers and heterogenous national regulations concerning the same end product -innovative bio-based fertilisers - creates obstacles for P2GreeN pilot regions to leverage their potential from innovation to full market commercialization.

# Lack of an effective European innovation ecosystem for start-ups & highly innovative SMEs

Within the P2GreenN pilot regions, start-ups like Sanitation360 and VunaNexus, and highly innovative SMEs like BioAzul and Goldeimer, are playing a crucial role in the establishment, operationalisation and technological uptake of circular N & P flows. They are providing the core innovative technologies on which the three innovative circular nutrient management systems are built upon. All pilot regions have a transformative approach aiming to establish viable, currently non-existing circular value chains and circular governance solutions. One of the key characteristics of P2GreenN is that it addresses the bioeconomy and the circular economy simultaneously, thus a transition from linearly organised resource and nutrient system to a circular material flow encompassing different hitherto decoupled sectors. Achieving this transition however, is not an easy task and requires, according to a well established body of literature (e.g. OECD 2009), a functioning innovation ecosystem. The established definition of an innovation ecosystem describes it as a complex network of innovation actors contributing their human and financial resources and expertise to collaboration in research, development and commercialisation of new technologies that address shared priorities. These actors include business firms, higher education and research institutions, government agencies and innovation support organisations, as well as investors. Key functions an innovations ecosystem provides (Chatti 2024) can be summarized as follows:

1. entrepreneurial activities in terms of technology development and demonstration;
2. knowledge development involving learning activities, mostly on emerging technology, but also on markets, networks, users and other;
3. knowledge exchange through networks and across value chains;
4. policy support and guidance for all actors and activities with the aim to foster stronger coordination across all innovation ecosystem actors;
5. market formation involving activities that contribute to the creation of a demand for the emerging technologies;
6. resource mobilisation, or the allocation of financial, material and human capital;

7. support from advocacy coalitions to promote new technologies and innovations.

Currently, due to its new and transformative approach, it can be concluded that key functions 1.-3. are being developed within the P2GreenN project whilst functions 4.-7. are missing. Although the P2GreenN project puts strong emphasis and dedicates a large share of its resources in supporting the pilot regions to establish their innovation ecosystem at regional level and moreover is aiming to establish a superordinate innovation ecosystem that can continue even after the end of the project, it cannot be achieved without supportive and effective additional measures at EU level. One such necessary additional measure is the set-up of a dedicated EU level support and coordination platform that acts as a permanent facilitator for innovation ecosystem building, in the combined sectors of bioeconomy and circular economy. The platform should aim to support and accelerate start-ups and innovative small businesses in the pipeline from innovation to commercialisation, accelerating the transition towards the European Green Deal.





# 3. Recommendations for action

P2GreeNs recommendations for action focus on the EU level as we believe that only at the level of the European Commission (EU COMM) can the identified challenges and obstacles be addressed in an effective way, to fully leverage the opportunities from innovation and circularity.

## Consistent regulation across the whole legislative framework

- Gold plating of EU legislation by individual MS should be prevented, this is especially applicable for the FPR and the UWWTD.
- Stronger coordination between DG AGRI, DG ENV and DG GROW to reduce regulatory fragmentation and inconsistencies between the different regulatory frameworks.
- Utilizing knowledge and expertise from Horizon Europe projects like P2GreeN within expert consultation in the respective DG working groups, e.g. DG GROW Fertilisers Working Group (FWG) or DG AGRI Expert Group EU Fertilisers Market Observatory.
- Regular assessment of regulatory obstacles deriving from EU legislation via a continuous dialogue process that focusses on the perspective of innovative start-ups and small-scale businesses.



## Supporting start-ups and small-scale businesses on their pathway from innovation to commercialisation

- Enhancing the mandate of the CCRI Coordination and Support Office (CCRI CSO) towards a one stop shop for knowledge exchange and community building for innovative start-ups and small-scale businesses in the circular bioeconomy independent of project funding within the Horizon Europe framework.
- Thereby building a community of inventors and a network that can support and enhance the building and advancement of innovation ecosystems, similar to what has been achieved with the EU CAP network ([https://eu-cap-network.ec.europa.eu/about/eu-cap-network\\_en](https://eu-cap-network.ec.europa.eu/about/eu-cap-network_en)).
- Maturing the CCRI CSO towards an umbrella organisation for advocating needs of the community of inventors vis-à-vis the EU COMM and its different DGs.
- Streamlining different existing EU initiatives and platforms that offer support towards upscaling and commercialisation into a single point of entry for start-ups and innovative small size businesses.

## Accelerating the transition

- Leveraging the opportunities from a circular bioeconomy by EU COMM conducting cross sectorial regular dialogues with stakeholders across all areas of the bioeconomy, circular economy and finance to identify common trends, opportunities as well as barriers towards the transition to a sustainable circular bioeconomy to foster longtime cross sectorial collaboration.
- Developing an updated Bioeconomy Strategy that supports and enables circular and integrated nutrient flows and its management where one sector's "waste" is encouraged to be used as a valuable resource in another sector.
- Creating a new EU strategy that looks at nutrient management and fertilisation in agriculture from a holistic perspective thereby creating a "safe operating space" for cross sectorial circular nutrient flows.

# Partners

**agrathaer**  
Management & Innovation



# Contact



Programme Coordinator:  
agrathaer GmbH  
Eberswalder Straße 84, 15374  
Müncheberg  
Tel.: +49 33432 82 149  
[Info@agrathaer.de](mailto:Info@agrathaer.de)



[www.p2green.eu](http://www.p2green.eu)



[www.facebook.com/p2greenHorizonEU](https://www.facebook.com/p2greenHorizonEU)



<https://www.linkedin.com/in/p2green-horizon-eu-72aba1259/>



[www.instagram.com/p2green/](https://www.instagram.com/p2green/)



[www.x.com/P2green\\_Horizon](https://www.x.com/P2green_Horizon)



Funded by  
the European Union