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EU revised Urban Waste Water Treatment Directive Art. 20: phosphorus reuse and recycling rates

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EU revised Urban Waste Water Treatment Directive Art. 20: phosphorus reuse and recycling rates

Workshop outcomes

Why this workshop?

This newsletter summarises the workshop organised by ESPP on phosphorus "*reuse and recycling rates*" under the revised Urban Waste Water Treatment Directive (UWWTD 2024/3019 November 2024), with participation of the European Commission and the Spanish Ministries for the Environment and for Agriculture.

The revised UWWTD brings important changes for nutrients, including tighter phosphorus and nitrogen discharge limits for many waste water treatment works (wwtps), including for some sewage works without N and P removal obligations today, and the requirement (art. 20) that "***minimum combined reuse and recycling rates*" for phosphorus** should be set across the EU by January 2028 (see ESPP eNews n°93).

This ESPP workshop, with 60 participants in Madrid and over 100 online enabled discussion between industry and policy makers on how these rates might be defined, presentation of technologies available or developing for phosphorus recycling, UWWTD implementation in Spain, how to support market uptake of recycled phosphorus from sewage, and how the European Commission is preparing proposals for defining phosphorus reuse and recycling rates.

The workshop was opened by **Robert Van Spingelen, ESPP President**, **Bibiana Rodríguez, Spanish Ministry of Agriculture** and **Laia Llenas Argelaguet, BETA Tech Center and Catalan Nutrient Platform**.

This workshop follows a first workshop organised by ESPP on interactions between revised UWWTD tighter discharge consents, chemical P-removal coagulants and P-recovery, Amsterdam, March 2025 (detailed summary in ESPP's SCOPE Newsletter n°156).

Slides and recordings here: https://www.phosphorusplatform.eu/WorkshopMadridArt20

Key discussion points raised

ESPP suggests that **the following questions raised during this workshop should be taken into account in** the European Commission Delegated Act which will implement the revised UWWTD art. 20 phosphorus "*reuse and recycling rates*":

- Requirements should be **technology-open:** not be limited to only two reuse/recycling routes: sludge-to-farmland and sludge mono-incineration + P-recovery.
- A **wide range of different technologies and routes** are demonstrated at pilot scale and others are under development.
- **P reuse and recovery rates should be relative to wwtp influent P, not to P in sludge,** otherwise some technologies are inappropriately penalised. Also this recognises effective P-removal.
- This would take into account **P-recovery in wwtps upstream of sewage sludge disposal: t**echnologies are today in the full-scale testing phase which allow high P-recovery rates including vivianite recovery, solubilisation of P for recovery (iPHOS, Wasstrip, PECO, Cambi and other THP and TAD processes – Thermal Hydrolysis Processes, Thermophilic Anaerobic Digestion)
- **P-recovery upstream of the wwtp** should be included: e.g. nutrient recycling from separative urine.
- **Sludge-to-soil-restoration** should be included, where the P in the sludge is replacing use of fertilisers.
- **Reuse/recycling rates should take into account the fertiliser value / crop uptake:** only the part of the sewage P which is effectively liable to replace virgin fertilisers should be considered (that is: crop available and applied up to crop P needs, not according to N needs). This could be based on crop P availability, but evaluation of this is complex and not consensual.
- **A scenario should consider possible future limitations of sludge-to-farmland**, which could result from pressure related to contaminants (PFAS, industrial chemicals, microplastics …) or nutrient loadings (see e.g. A. Boen in SCOPE Newsletter n°156) or from changes in public policies or food-chain – supermarket purchasing criteria (e.g. Global GAP today excludes use of sewage sludge on land).
- **Urgent need for action at source to prevent contaminants reaching sewage sludge**, in particular a ban on all consumer uses and non-substitutable dispersive industry uses of PFAS.

- **Cooperation is needed to define how to combine quality of recovered materials with water industry constraints** (P-removal obligations and other sewage treatment objectives, existing infrastructure, treatment options …). Both the fertiliser and the water industries expressed their agreement to engage.
- **Choices of technologies and routes should consider the whole sewage treatment system**: optimise overall sewage resource recovery (nutrients, organics, water …), energy and LCA, ensure recycling of materials other than P, e.g. iron, silicates … Operation of wwtp can also be optimised to increase P-recovery rates.

For memory, **conclusions of the first workshop organised by ESPP on the revised UWWTD** Amsterdam in 2025 (SCOPE Newsletter n°156):

- **Iron and aluminium coagulants enable P-removal down to low discharge consents**: 0.5 mg P/l as per the revised UWWTD (larger wwtps), or even 0.2 mg P/l as sometimes required by local regulations,
- **Adsorbents and ion exchange can also remove P to low levels**, with challenges of longevity and robustness,
- **Processes are available to increase the % of total wwtp inflow phosphorus which is available for P-recovery** (soluble P), e.g. as struvite, vivianite, ion exchange,
- **Logistics and infrastructure are obstacles to P-recovery via sewage sludge mono-incineration**,
- Another possible P valorisation route is pyrolysis (**sewage sludge biochar**).



Site visit: struvite recovery at Madrid Sur

Participants in the workshop visited the Ostara struvite recovery facility at the Madrid Sur Wastewater Treatment Plant (WWTP), operated by Canal de Isabel II.

Madrid Sur is the largest WWTP in Madrid, with a maximum influent flow rate of 6 m^3/s and a design capacity of 2.9 million population equivalent (p.e.). Dry-weather flow ranges from 3 to 4 m^3/s, and the plant is designed with substantial additional capacity to treat both stormwater (from retention tanks) and overflow flows from other facilities, for example during maintenance operations. The plant operates using Enhanced Biological Phosphorus Removal (EBPR), with iron-based coagulants applied at approximately 40 mg/l (40% $FeCl_3$) for effluent polishing (influent phosphorus concentration: 8 to 10 mg total P/l under dry-weather conditions; discharge limit: 1 mg total P/l).

Sewage sludge undergoes anaerobic digestion followed by centrifuge dewatering. The digested and dewatered sludge is then thermally pasteurized, dried, and reused for agricultural applications.

The struvite precipitation unit treats between 50% and 100% of the sludge digestate stream, operating at design capacity. The influent to the unit contains up to 200 mg total P/l (mainly in soluble form, as solids are removed by centrifugation) and between 800 and 1,000 mg NH_3-N/l. These concentrations are significantly reduced in the effluent from the unit, which is returned to the WWTP treatment line. Phosphorus removal through struvite formation also helps reduce operational issues related to struvite scaling and pipe blockages within the facility.

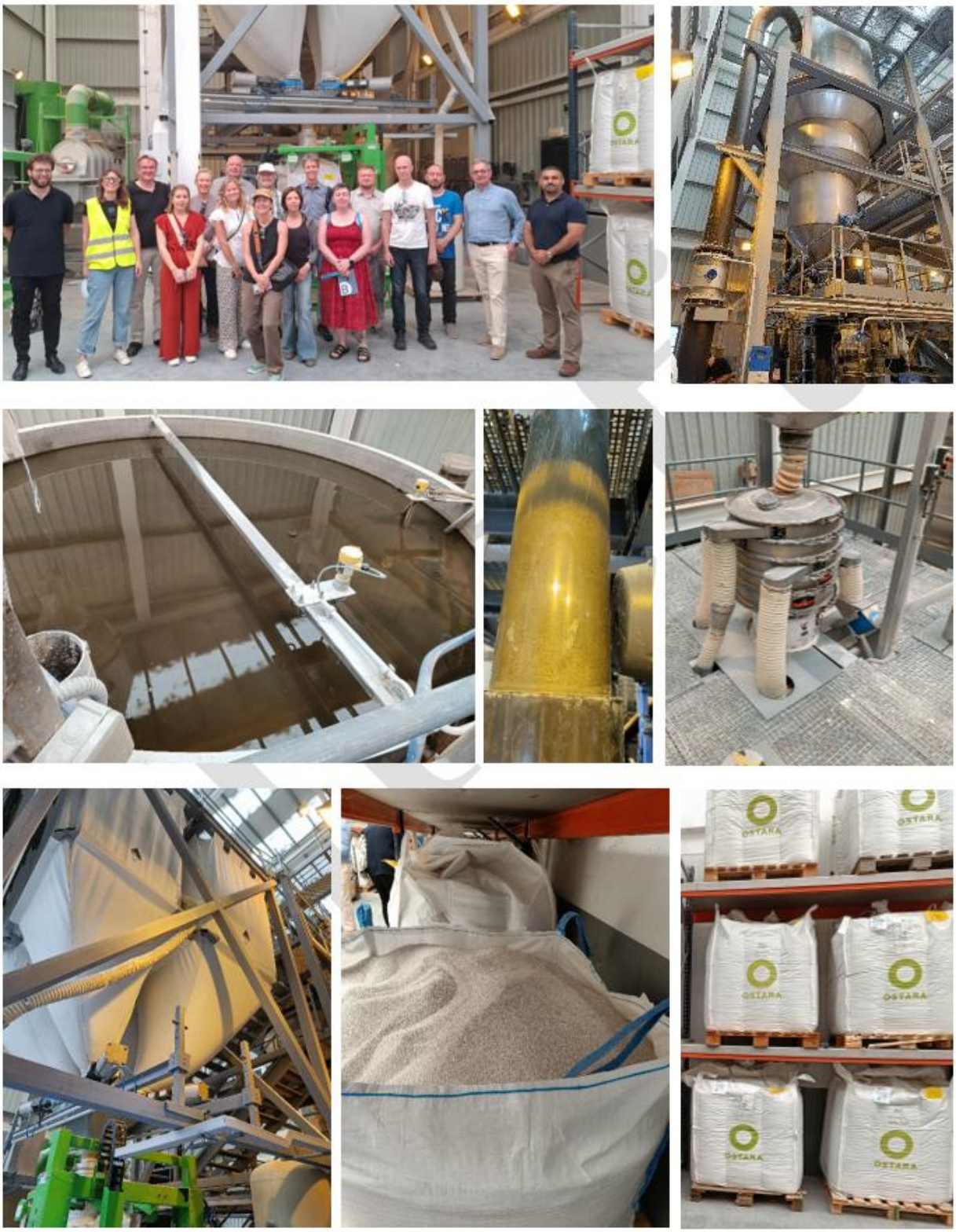
The struvite precipitation unit was designed and installed by Ostara and initially commissioned and optimized by Veolia. Operational responsibility was subsequently transferred to Canal de Isabel II. **The unit has demonstrated reliable performance for eight years**.

The struvite recovery system operates with a continuous influent flow, using a design feed pumping rate of 150 m^3/h and a recirculation flow of 500 m^3/h to maintain upward flow through the fluidized bed reactor. Reactor modifications have included adjustments to the overflow outlet and the upper section of the reactor to minimize the loss of fine particles. The unit produces up to 2 tonnes of struvite per day, recovering between 7% and 15% of the phosphorus entering the WWTP.

Struvite granules are periodically removed from the bottom of the reactor using a screw pump. They are dried in a fluidized-bed dryer operating at an air temperature below 60°C. Because the granule temperature remains lower than the air temperature, there is no risk of struvite decomposition. The dried product then undergoes screening, where it is separated into four different size fractions for packaging in big bags, while finer particles are recycled back into the reactor.

The reactor is controlled through magnesium chloride dosing and pH adjustment with hydroxide. The water supply in Madrid is naturally soft, and therefore the relatively low calcium concentrations do not interfere with struvite precipitation.

Site visit to the Ostara struvite recovery unit, Madrid Sur waste water treatment plant (Canal Isabel II)



Photos: ESPP workshop site visit group, struvite reactor, top of reactor (low flow velocity to avoid loss of fines), struvite settling and extraction from reactor, sieving to sort struvite by granule size, four granule size bags, recovered struvite, big bags of recovered struvite ready for shipment.

Implementation of UWWTD P reuse & recycling rates

Regulatory context

Europe

Chris Thornton, European Sustainable Phosphorus Platform (ESPP), outlined development in EU policy towards phosphorus recycling, from the Urban Waste Water Treatment Directive (UWWTD) in 1991, which addressed phosphorus removal but not recycling, to the first EU consideration of phosphorus stewardship in the "Consultative Communication on the Sustainable Use of Phosphorus" COM/2013/0517, to the adoption in 2024 of the revised UWWTD (2024/3019) requiring phosphorus "reuse and recycling rates" in art. 20.

He noted that the **EU Fertiliser Action Plan** (19th May 2026) – see ESPP eNews n°108- announced an acceleration of actions for nutrient recycling, to reduce EU dependency on imported fertilises, including:

- Amend the Fertilising Products Regulation, review 'Mutual Recognition', to create integrated markets, develop lead markets [Actions 10, 11]
- Define "bio-based (organic) fertilisers [Action 11]
- Develop lead markets, explore quotas (blending requirements) for recycled fertilisers [Action 11]
- Include nutrients in the EU Circular Economy Act to address obstacles in the Waste Framework Directive, the Fertilising Products Regulation, the Animal By-Products Regulation [Action 11]
- Support further work on a 'combined minimum reuse and recycling rate" for phosphorus from sewage (and consider extending this to nitrogen [Action 13]

ESPP also underlined the importance of the **announced EU Circular Economy Act (CEA).** The Fertilisers Action Plan says that this Act should address nutrients, and the importance of phosphorus has been recognised by the EU Commissioner for the environment, water resilience and a competitive circular economy, Jessika Roswall. Yet, the CEA Impact Assessment draft presented to stakeholders appears to consider only technical nutrients (waste electronics, demolition, textiles), whereas nutrient recycling faces regulatory obstacles and requires specific safeguards to ensure quality and safety in the food chain, and farmer and consumer confidence (organic contaminants, pathogens).

*ESPP calls to sign now the **Joint Call for Nutrients in the Circular Economy Act***

Spain

Bibiana Rodríguez Sendón, Spanish Ministry of Agriculture, Fisheries and Food (MAPA), considers that the current fertiliser supply and price crisis, and the EU's high dependency on imports for fertilisers or fertiliser production shows the need to develop the circular economy for nutrients.

Spain underlines that recycled nutrient products must deliver agronomic efficacy and be safe for the health and environment.

Spain notes that the EU Fertilising Products Regulation (FPR) allows to put on the market products manufactured from waste, but that there are difficulties with uptake, in particular with the required Certification Module D1 for recycled nutrient products. A Notified Body is required for the Conformity Assessment, but only recently is there a NoBo in Spain.

Most operators for organic fertilisers are therefore continuing to use Spain's National fertilisers regulation, which in the future will accord National End-of-Waste status. But no sewage-recovered phosphates currently fit into this regulation. Spain is currently updating its National fertilisers regulation, following the structure of the current royal decree (506/2013) but adding a number of new fertiliser groups, including (n°1.5) RENURE materials as specified in the EU Nitrates Directive (2026/288 see ESPP eNews n°106), n°10 products from sewage (which includes struvite) and n°11 products from other waste flows (which also includes struvite).

Germany



Friederike Lauruschkus, Ramboll, summarised the recent Ramboll discussion paper on implementation status of the German Sewage Sludge Ordinance (AbfKlärV) 2017 and perspectives for establishing a market for recycled phosphorus (see ESPP eNews n°106).

The German regulation (AbfKlärV) effectively requires phosphorus recovery in larger wwtps (most wwtps > 50 000 p.e.) from 2029. **The regulation does not specify technology routes, and offers two options:**

- Reduce sewage sludge P content by ≥50% or to < 2%P/DM,
- Recover ≥80% of P from sludge incineration ash.

Today, much sewage sludge from larger wwtps in Germany goes to co-incineration and the current tendency is to move to mono-incineration with P-recovery from the ash.

At present discussions are ongoing concerning what products should be recovered for which market, with technologies ranging from EasyMining (recovered high grade phosphate salts for industrial application) to processes generating fertilisers in which contaminants are reduced but not fully removed.

An indicative calculation estimates that if total quantity of around 1.7 million tDM/y of sewage sludge would go to mono-incineration, resulting in 700 000 t/y of ash, it would **require around 23 plants to recover P from ash** (30 000 t-ash/year).

This would recover around 50 000 tP/y of phosphorus, sufficient to cover around half of Germany's mineral fertiliser use.

Currently however only four P-recovery plants are under testing or construction in Germany at full-scale (Hamburg Wasser/Remondis, Seraplant, Gelsenwasser/EasyMining, Emter sePura ex-AshDec). Required capacity will not be online by 2029.

The problem seems to be a chicken-and-egg lack of certainty across the operator chain: wastewater operators are waiting for results of P-recovery pilots and the availability of capacities, P-recovery operators need a reliable supply of input ash to invest. All actors are waiting for data on full-scale operating experience and technologies and costs.

Political clarification is needed on deadlines to increase investment security. The 2029 deadline has recently been confirmed by the German Government (ESPP eNews n°105). **Clear indications are now needed on the proposed levy on wastewater operators not respecting the deadline and on the support funding that this could provide for initial mono-incineration and P-recovery installations**. Action is also needed to create a market for the recovered phosphate.

Texts of the revised UWWTD

Art. 20: *"The Commission is empowered to adopt delegated acts in accordance with the procedure referred to in Article 27 to supplement this Directive by specifying* ***a combined minimum reuse and recycling rate for phosphorus from sludge and from urban wastewater*** *not reused under the derogation of Article 15(1), taking into account* ***available technologies, resources and the economic viability of phosphorus recovery*** *as well as the* ***phosphorus content of the sludge*** *and the* ***level of saturation of the national market*** *with organic phosphorus from other sources while ensuring that there is safe sludge management and* ***no adverse impact on the environment or human health****. The Commission shall adopt those delegated acts by 2 January 2028."*

Recital 28: *"... sludge management could be improved to better align it with the principles of the circular economy and of the waste hierarchy ... In order to ensure a proper and safe recovery of nutrients, including the critical substance phosphorus, from the sludge, a minimum combined reuse and recycling rate should be defined at Union level giving Member States the flexibility to choose whether to reuse and/or to recycle the urban wastewater and/or sludge to recover phosphorus. This combined minimum reuse and recycling rate should take into account ... Member States should, while taking into account ... take measures to encourage the production and purchasing of recovered nutrients from urban wastewater and sludge."*

Recital 42: *"contribute to the strategic autonomy of the Union fertiliser industry"*

European Commission work on phosphorus recycling



Lukas Egle and Dries Huygens, European Commission Joint Research Centre (JRC), Seville, presented the status of their team's work towards *"a combined minimum reuse and recycling rate for phosphorus"* under by art. 20 of the revised UWWTD.

JRC's work is **stakeholder orientated** and the aim is to collect relevant information from Member States, water operators, recyclers, other companies and organisations. The first objective is to collect information to address the "taking account …" specified in art. 20 (see above).

JRC's preparatory work is organised as follows:

- 1st report on current destinations of sewage sludge in the EU and on existing and future phosphorus recovery techniques: delivered Q3 2025, will be published as part of the final report.
- 2nd report covering **waste hierarchy and market perspectives**: this is currently circulated to and open to comment (to end June 2026) from members of the EU UWWTD Expert Group (*ESPP is a member and will submit comments*). This work is presented at this workshop (see below).
- 3rd report on **risk assessments of selected priority contaminants**: expected to be completed end 2026.
- Provide **technical recommendations for Commission Delegated Act:** before summer 2027 (according to art. 20, the Commission should adopt the Delegated Act before end 2027).

The first JRC report shows that (in 2022) **around 37% of EU sewage sludge was valorised to farmland, with a further 18% going to 'composting',** part of which then also goes to agriculture. Around 32% goes to incineration or co-combustion (including cement industry). 6% still goes to landfill. Destination is unclear for around 6% classified as 'Other' and for 'Compost', some of which may be used for non-agricultural soil: parks, gardens, soil restoration.

Lukas Egle noted that **the Commission has not yet confirmed an interpretation of the words "*reuse*", "*recycling*" and "*recovery*" as used in art. 20.1 and 20.1** of the revised UWWTD (NOTE: ESPP has requested clarification on this by letter to the European Commission 12th December 2025). Pending clarification, JRC considers that "*reuse and recycling*" includes valorisation of nutrients by use of treated wastewater for fertigation, sewage sludge to farmland (after e.g. stabilisation, composting, digestion), phosphorus recovery either to phosphate fertiliser or to industrial products where P has a functional role functional role replacing rock-derived phosphorus (e.g. phosphoric acid). Incineration without P-recovery from the ash, or co-incineration in cement kilns where P is fixed into cement are not included.

To test data and the model, the JRC has defined two extreme scenarios, in order to estimated costs for different hypothetical P "reuse and recycling" rates (30, 50 and 70%,) for each Member States:

- 1 = **Minimum cost scenario: sludge valorised to agriculture** wherever it is not currently incinerated, except in Member States which preclude sludge-to-farmland (sludge mono-incineration and P-recovery from ash elsewhere)
- 2 = **Maximum cost scenario: Sludge mono-incineration and P-recovery from ash** across Europe for all wwtp > 50 000 p.e. (agricultural valorisation as per scenario 1 for smaller wwtps).

  This hypothetical model enables to estimate costs for achieving different possible P reuse and recycling rates, with a low range estimate cost based on assuming that the rate is achieved as far as possible by sludge-to-farmland and a high range cost estimate assuming that the rate is achieved by mono-incineration and P-recovery from ash.

JRC currently estimate costs for P reuse and recycling at:

- Sludge-to-farmland after dewatering =150 €/tDM, after composting = 200 €/tDM
- Mono-incineration then P-recovery = 350 €/tDM of sludge for mono-incineration plus 250 €/tDM (of sludge) for P-recycling from ash.
- If more detailed Member State data is available, Member State specific data is applied.

Stakeholder input on these numbers, with supporting evidence and documentation, is welcome.

JRC estimate that today around 2/3 of Member States are already achieving a 30% P reuse and recycling rate (by sludge-to-farmland) but only one fifth of them are achieving a rate of 70%.

Using the above costs, the model currently estimates (non-finalised interim output, likely to modified) additional costs across the EU at an average 0.6€/person/year for a P reuse and recycling rate of 30% with the scenario of mainly sludge-to-farmland up to 2.2 €/person for 70% with the scenario of mono-incineration and P-recovery from ash.

JRC note data gaps and ask stakeholders to input information on the following:

- Member State specific sludge management costs,
- Capex/Opex of mono-incineration and P-recycling technologies and related logistics,
- Revenue from sales of recovered P products.



Theodora Nikolakopoulou, European Commission DG GROW, updated on recycled nutrient in the EU Fertilising Products Regulation 2009/1009 (FPR).

The FPR is 'optional', that is products can be sold also under National fertilisers regulations. Compliance with FPR rules however gives EU End-of-Waste status, enabling transport and sale across Europe. This obliges the FPR to set clear requirements on input materials and/or recovery operations, on the final fertilising product, on labelling and on conformity assessment.

7 out of 15 of the current input material categories (CMCs) concern secondary materials, but to date only three concern recovery from municipal waste water:

- CMC12 precipitated phosphate salts and derivates,
- CMC13 thermal oxidation materials and derivates,
- CMC15 recovered high purity substances (from off-gases from sewage treatment).

Other sewage-derived materials are currently under assessment (NMI): recovered N and K salts, separately collected human urine, algae grown in sewage treatment, vivianite, sewage sludge pyrolysis materials.

Challenges to including further recycled nutrient materials into the FPR include:

- Absence of EU thresholds for organic contaminants such as PFAS or microplastics,
- Many processes are not today at commercial scale,
- Questions of market acceptance,
- Transport not economic for low-concentration materials.

The **ongoing Evaluation of the FPR** shows that there is a very limited uptake of the regulation for organic and organo-mineral fertilisers (<3% of the market, most continue to be sold under National regulations), but this is increasing. Barriers identified include FPR conformity assessment costs, component materials and processes not today allowed under the FPR) and market fragmentation.

DG GROW aims to implement the commitments of the EU Fertiliser Action Plan, in particular those relevant to the FPR:

- **Assess the feasibility of moving towards a fully integrated single market for inorganic fertilisers** and review mutual recognition rules for other products,
- Establish a clear definition of "Bio-Based Fertilisers",
- Promote market uptake of recycled nutrients.

Industry perspectives

Water industry



Gari Villa-Landa, and **Paula Lindell EurEau** (European federation of water operators) outlined questions the water industry identifies as important for phosphorus reuse and recycling under revised UWWTD art. 20.



Photo Paula Lindell: Sanna Nuutinen, Foto Bakery

Eureau data indicate that in 2024 sewage treatment in the EU generated around 11 million tonnes dry matter of sludge per year. Around 44% of this was valorised in agriculture and around 13% was use in land reclamation, whilst around 29% went to incineration or combustion.

Eureau underlines that over half of sewage sludge phosphorus is thus today effectively recycled. The key to increasing this is market uptake of recycled phosphates.

Eureau considers that for art. 20 reuse and recycling rates for phosphorus to be workable, it is necessary to

- Allow continuing valorisation of sludge-to-farmland and for land reclamation, and account water reuse,
- **Ensure that criteria are technology-open**: there is no single solution as wwtp configurations, market and political contexts are locally specific,
- **Align art. 20 requirements** between requirements with the Fertilising Products Regulation, with the upcoming Circular Economy Act and with other EU policies,
- **Enable End-of-Waste status** for phosphorus products recovered from sewage,
- **Establish clear definitions and metrics** for "reuse" and "recycling" under art. 20, specify sampling regimes,
- **Set reuse and recycling rates at the Member State level**, not the same for each wwtp, to allow cost optimisation, and take into account differing conditions across Member States,
- **Exclude wwtps < 10 000 p.e.** (same cut-off as for other UWWTD requirements),
- **Enable the required 'rates' to evolve over time** as a function of market uptake, technological development, other factors,
- Oblige that the phosphorus is allocated to a valuable use;

To enable implementation by the water industry of art. 20, policy actions are necessary to:

- support market uptake of sewage-derived fertilisers,
- provide harmonised End-of-Waste for sewage-recovered nutrients,
- ensure a level playing field (regulation, price) compared to virgin phosphate fertilisers
- further R&D into cost-competitive processes which recover phosphorus in a marketable and useful form,
- provide investment certainty.

The water industry is willing to cooperate with stakeholders across the value chain to take this forward.

Belén Ramos Alcalde DAQUAS (Spanish Association of Water Supply and Sanitation Management Entities), outlined challenges faced by the water industry to implement the revised UWWTD in Spain.

Water management in Spain is complex. It is the legal responsibility of the 8 100 municipalities, with over 2 000 effective legal operators, and with intervention of Regions and other administrations. Water is invoiced only 2.23 €/m^3, the sixth lowest price in the EU, and significantly below full cost recovery. This will pose difficulties to pass on costs of investments need to meet revised UWWTD obligations, and to update ageing infrastructure.

Spain generates around 1 million tDM/year sewage sludge, over 80% of which goes to agriculture, often after anaerobic digestion to produce biogas. Over 700 Hm^3 of treated sewage water is reused, either directly (to agriculture, street or sewer cleaning …) or indirectly.

Societal and political acceptance of the need for long-term investment in water supply and sewage treatment are needed, to enable necessary administrative, regulatory and economic change.

Concerning the revised UWWTD art. 20, Daquas considers that implementation should:

- Keep all P reuse and recycling routes open, in particular sludge-to-farmland,
- **Harmonise obligations**, to avoid transport of sludge to other regions,
- **Control pollutants at source** to avoid contamination of sewage sludge,
- **Further R&D** into phosphorus recovery,
- Support the market for recycled nutrient fertilisers.

Fertilisers industry



Nicolas Willaume, ICL Group – Growing Solutions, underlined that the fertiliser industry needs to deliver a product which corresponds to farmers' needs: easily handled and applied, reliable (physical form, properties …), plant available nutrients, formulation adapted to local soil and crop.

ICL have several years' experience of processing sewage sludge incineration ash to many different fertiliser formulations. The process involves chemical processing to render P plant available, formulation, granulation. Real challenges are identified:

- Sewage sludge incineration ash is highly variable, with wide ranges of
  - phosphate levels,
  - iron and aluminium: negatively impact phosphate fertiliser quality,
  - heavy metal, in particular lead,
  - reactivity: complex and require deep know-how,
  - other characteristics: some ashes can wear industrial equipment making their use economically not viable.

This means tests are necessary on every incoming sample.

The fertiliser industry needs ashes which are more reliably homogeneous and better characterised, and with lower iron and aluminium levels. Better recycling-quality ash could be generated if sewage works and incineration processes were adapted. If cross-sector partnerships could be developed to guarantee sewage sludge incineration ash quality this could facilitate market uptake.

Policy actions needed include:

- include other circular nutrient materials into the EU FPR
  - fertilisers recovered from sewage sludge incineration ash are today authorised, but not those from ash some biorefinery streams,
  - various other recycled materials are not yet authorised, so cannot benefit from EU End-of-Waste status,
- facilitate rules for transport and storage of secondary nutrient materials intended for recycling, in particular cross-border transport,
- support market trust,
- provide cost support for farmers for using recycled fertilisers.

Recycled fertiliser suppliers



Jouke Boorsma, Aquaminerals, considers that a quota system is needed to create a sustainable market demand for recycled nutrients, but that this must make product quality a key requirement (could be based on CE-Mark or end-of-waste status).

A quota system must be supported by clear proof of origin, whilst keeping reporting and certification proportionate, and should incite recycling processes with low chemical and energy use. **Quotas should be EU-wide and tradeable, including an obligation for imported fertilisers**

In order to make the system workable, quotas should focus on certain sectors (e.g. municipal wastewater recovered phosphates, coherent with the revised UWWTD art. 20) and on larger operators.



Joachim Clemens, Soepenberg, considers that quotas are not necessary and the market for phosphorus recycling is already functional in Germany, with roll-out of the German P-recycling legislation.

Phosphorus recycling, once obligatory, is funded by a gate fee from the wastewater operators, and the cost is paid by the water user under the 'full recovery' principle.

Modulation of the gate fee will push water operators to produce quality recovered phosphate products.

Implementation will require a range of different technologies, adapted to different wwtps and local fertiliser markets. National fertiliser regulations should therefore be maintained, not converged towards the FPR, to respond to local secondary material availabilities and farmer needs.

The future market for recycled phosphorus products will offer opportunities for fertiliser companies of any size: big companies want large volume supply, whereas smaller companies can process smaller volumes from local, small scale recycling routes...

Questions on recycled content 'quotas' for fertilisers



Ann Ballinger, Eunomia, outlined the study carried out for ESPP on questions which policymakers should take into account if considering a 'quotas' (minimum recycled content) obligation for phosphorus in fertilisers.

See summary in ESPP eNews n°104 and study (10 pages, 40+ questions) at https://www.phosphorusplatform.eu/regulatory.

This study is based on experience of 'quotas' in other industry sectors and regulations, literature, stakeholder consultations (in particular with the fertilisers, recycling and waste water industries) and Eunomia's policy expertise.

Quotas, whereby all or some fertilisers placed on the market would be legally obliged to include a certain % of recycled phosphate, are discussed as a possible mechanism to develop market pull for recycled phosphates. The study identifies around 40 questions policy makers would need to address if such a system were to be considered.

The questions identified cover:

- the aims of the quota system,
- how would quality be ensured – including how quota system would ensure a marketable product, usable by farmers?
- to whom the quotas would apply (which types of fertiliser: mineral, organic … ? at what point in the value chain: fertiliser manufacture, distribution, use … ?),
- geographical scope and regulatory context,
- what would be the burdens of the system (e.g. financial burdens producers; costs of administration) and on whom would they fall ?
- would quotas be tradeable, and how to deal with imported fertilisers?

Eunomia concluded that there is a wide range of questions, some difficult to answer, and that mapping out the uncertainties and trade-offs is important to avoid unintended side-effects or negative consequences.

See summary in ESPP eNews n°104 and study (10 pages, 40+ questions) at https://www.phosphorusplatform.eu/regulatory

Technology showcase: the wide range of possible reuse & recycling routes

Some companies presented different phosphorus recycling routes and technologies at this workshop in Madrid 2026 and at the previous UWWTD art. 20 workshop in Amsterdam 2025 SCOPE Newsletter n°156), as listed below.

Together, these presentations demonstrate that:

- there are a wide range of possible routes to reuse and recycle P from sewage, beyond the two considered in the JRC high and low scenarios (mono-incineration + P-recycling from ashes, sludge-to-farmland),
- **solutions are demonstrated to recover over 50% of P from sewage treatment and sludge digestion processes,** including from for wwtps using chemical coagulants for P-removal. This means <50% P lost if sludge were to then go to co-incineration or cement kilns. This can be achieved by (re)solubilisation of phosphorus, e.g. Soepenberg iPHOS, Xylem Ostara Wasstrip, PECO …

The following companies presented processes or technologies at this workshop or at the first workshop in Amsterdam:

P-recovery in the wwtp/sludge processes

- Soepenberg - iPHOS
- Xylem / Ostara – Wasstrip
- Haskoning / Wetsus - BIOPhree
- Cranfield – HAIX ion exchange
- LEQUiA (UdG) - electrochemical crystallisation
- Colsen - UPHOS – Robin Jordaens, Colsen
- Haskoning – ViviMag
- Fertiberia – vivianite
- Phosmag Group – MINEPHOS
- Helsinki Environmental Services (HSY)
- Green Tile – NuReSys
- TU Braunschweig

P-recovery from ashes

- EasyMining – Ash2Phos
- TTBS – Rubiphos
- SusPhos
- Prayon – Ecophos LooP
- Stuttgart University – Flashphos
- ThermusP – Spodophos
- Técnicas Reunidas – Phos4Life
- Emter sePura – R-Rhenania (ex-AshDec)
- University College Dublin – SINFERT

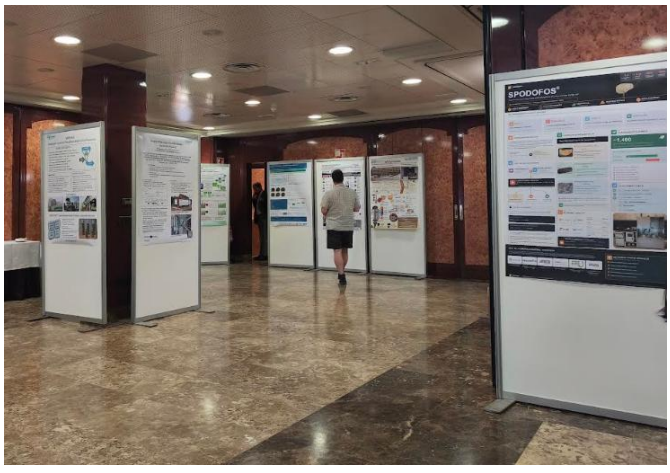
Pyrolysis - biochar

- Pyreg – sludge-to-biochar
- Record – Charlene

Phosphorus removal to low discharge consent levels

- Clean TeQ Water - PHOSPHIX
- MECANA Pile Cloth Media Filters

For more details, the slides and summary from the Amsterdam 2025 workshop at https://phosphorusplatform.eu/AquatechWorkshop and from this Madrid 2026 workshop at https://www.phosphorusplatform.eu/WorkshopMadridArt20

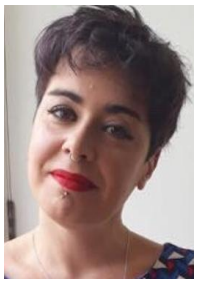


Parallel sessions

Slides of all parallel sessions and recordings of hybrid sessions are here:
https://www.phosphorusplatform.eu/WorkshopMadridArt20

Sewage sludge valorisation to agriculture: risks and benefits

Rapporteur: **Martijn van Leusden (Haskoning)**
Moderator: **Tania Iglesias (UK Environment Agency)**

Speakers were from EU Member States representative of sludge-to-farmland and underlined the benefits of this valorisation route: return of organic matter and nutrients to soil and optimal cost.

Key challenges to sludge-to-farmland were identified as contaminants and pathogens in sludge, and the misbalanced NPK ratio in sewage sludge, meaning that spreading (to agronomic requirements) is limited by P content, and Problematic contaminants include PFAS, industrial chemicals such as flame retardants, microplastics and in some cases heavy metals which all are very difficult to remove from sludge and risk polluting soil and surface waters. Antimicrobial resistance are also growing concerns. All of the above may gain potential social impact due to environmental and health concerns whilst costs are rising.

These challenges can be addressed by:

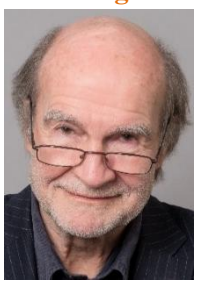
- P-recovery to reduce P levels in sludge,
- Source control to prevent pollutants reaching entering sewage,
- Monitoring, transparency and traceability of sludge application,
- R&D into reducing organic contaminants in sludge,
- Update the EU Sewage Sludge Directive, which is outdated (1986) and does not consider organic contaminants.

EFAR, Eureau and Aqua Publica are developing a Biosolids Observatory to analyse sewage sludges and collate and update data from across Europe, in particular for nutrient content and organic contaminants. To participate and to supply sewage sludge for analysis or data, contact biosolidsobservatory@gmail.com

Future questions for sludge-to-farmland are transport distances if application rates are reduced with tightening contaminant or P application limits and doubts as to whether the food chain will continue to accept use of sludge on agricultural crops (consumers, agri-food companies, farmers …).

P-recovery via sludge incineration ash

Rapporteur: **Ruud Schemen (Waterschap De Dommel)**
Moderator: **Ludwig Hermann (Proman and ESPP)**

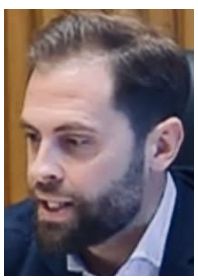



Industry expects the need for sewage sludge incineration to continue to increase as sludge-to-farmland faces increasing challenges, in particular concerns about organic contaminants. These are eliminated by incineration.

Three companies presented processes for P-recycling via sewage sludge mono-incineration:



→ **EasyMining's Ash2Phos** recovers P as a high-purity precipitated calcium phosphates of animal feed grade, so ensuring a commercial market. After successful pilots, a first full-scale (30 000 t/y ash) is under construction in Schkopau Germany (ESPP eNews 100) and a second plant has obtained permitting and investment in Helsingborg, Sweden (also 30 000 t/y ash). EasyMining is part of Ragn-Sells, one of Europe's leading waste and management and recycling companies.



→ **Técnicas Reunidas' Phos4Life** process (*photo below*), presented by **Javier Manzano Gomez**, has been confirmed or is pending as technology choice for several full-scale P-recovery from ash plants in Germany, Switzerland and Austria.

Técnicas Reunidas' is a global energy and engineering company with around 75 000 staff.





→ **Emter's** thermochemical process (*photo below*) developed as AshDec then in the R-Rhenania RePhoR project (ESPP eNews 102) combines sludge mono-incineration with removal of heavy metals down to below fertiliser regulation limits and generates an ash-product in which the phosphorus is crop available (>80% NAC solubility). **Christoph Brey, Emter**, explained that the company has developed this phosphorus recovery system integrated into the sewage sludge combustion process. This is sustainable because no additional energy is necessary for the phosphorus recovery, the energy from the sludge combustion is sufficient and so no additional CO_2 is generated. A 55 000 tDM/y sewage sludge input plant is fully operational in Altenstadt, Germany.



Alternative thermal processes: pyrolysis, gasification



Rapporteur: **Robert van Spingelen (ESPP)**
Moderator: **Marc Sonveaux (Prayon)**

Pyrolysis or gasification of sewage sludge offer alternative routes to incineration, which under appropriate conditions can eliminate organic contaminants.

Advantages include smaller scale than sludge mono-incineration, return of carbon to soil in a stable form which can benefit from climate credits, biochar product with demonstrated agronomic value.

There is now significant evidence showing elimination of organic contaminants, including microplastics, pharmaceuticals and PFAS, for pyrolysis at >600°C, >10 minutes residence time.. Recent studies at several pyrolysis plants show that PFAS are not being transferred to the offgas or to the biochar, confirming that they are being eliminated.

The JRC 2019 "STRUBIAS" report excluded sewage sludge from input materials to the EU Fertilising Products Regulation (FPR) CMC14 because at the time information on elimination of organic contaminants was considered insufficient. The biochar industry has submitted the updated data (see EBI 2024 paper) to the ongoing FPR new materials analysis process and hopes this will concluded positively.



Pyreg, presented by **Helmut Gerber**, has to date brought nine full-scale sewage sludge pyrolysis units across the world into operation and three more will follow in 2026 (total capacity 21 000 tDM/y sludge inputs). The output biochar can be legally used as a fertiliser or soil improver in Sweden, Finland, Czech Republic, Denmark, Estonia, USA, Australia …





Photos: Pyreg sewage sludge pyrolysis plant, Klewe, Germany

Processes to release soluble P for higher P recovery

Rapporteur: **Jouke Boorsma (Aquaminerals)**
Moderator: **Antonio Hernandez (Mecana)**





Demonstrated processes are able to recover 50-75% of phosphorus in sewage sludge, either as vivianite or by solubilisation which then enable recovery by e.g. precipitation (e.g. as struvite), ion-exchange or adsorbents.

Even higher levels of P-release are possible, but imply chemical consumption.

P-solubilisation was presented by:



→ **Joachim Clemens, Soepenberg**, presented the **iPHOS** process, in which sulphide dosing and acidification, for 16 - 20 hours, followed by struvite precipitation, achieves recovery of 50 - 75% of wwtp inflow phosphorus (taking into account losses in primary sludge not treated), including in sewage works using coagulants for chemical P removal.



The process can solubilise 60-80% of P from iron phosphates (at pH4) or up to 100% from aluminium phosphates (at pH2). A benefit is that the acidification means that coagulants function better, reducing dosing needed to achieve P discharge consents. Two 1 m^3/h sludge input, fully containerised pilot units have been 24/7 continuous operation tested in two different sewage works confirming laboratory results (testing at a 3rd works is now underway).



Photos: iPHOS mobile plant in operation at Kläranlage Bernberg urban wastewater treatment works, Lower-Saxony, Germany and inside this mobile technology test trailer.



→ **Thomas Dockhorn, Technical University Braunschweig** presented the **PECO** process, which uses biological acidification to solubilise phosphorus in activated sludge by feeding an available carbon source. The biological process reduces pH to around 5 and achieves 70-80% P-solubilisation, in both biological P-removal and iron coagulant chemical P-removal wwtp sludges, after around 4-7 days. The process has been tested at pilot scale for five years, and operated full scale (up to 20 m^3/h sludge input) for a total of 16 months at two different wwtps . These results confirm similar work on biological P-solubilisation by Daumer et al. INRAE with Veolia (SCOPE Newsletters 134, 138, 141) and by Vanotti in the USA (SCOPE Newsletter 149).

→ Vivianite recovery was presented by **Haskoning** (**ViviMag** process). Iron phosphates in sewage sludge are largely reduced to iron (II) phosphate (vivianite) in anaerobic sludge digestion or sludge storage. The vivianite can be extracted with low organics and contaminant content by magnetic separation. A 1m^3h pilot plant has been tested in three different wwtps, achieving recovery as vivianite of up to 60 % of wwtp total P inflow. Nearly all iron added in coagulant dosing is also recovered.

→ Different approaches were presented, showing how P-recovery can be combined with wwtp operational improvement.



Robin Jordaens, Colsen (**UPHOS** and **AMFER** [*photo below*]) explained how Colsen are transferring experience from industrial and agri-food wastewaters to sewage treatment, including P-recovery as struvite, N-recovery as ammonia salts, optimising anaerobic digestion to solubilise P, electrochemical P-recovery as phosphoric acid.





Gerit Boersma, Clean TeQ Water explained how **PHOSPHIX** uses moving bed ion exchange to reduce P to low levels to achieve discharge consents, then enables P-release to solution. Use of lime for ion exchange resin regeneration means calcium phosphate is recovered. A full-scale unit to treat industrial wastewater and recover phosphate is in commissioning in Ireland and pilot testing in a wwtp is starting.

Advancing phosphorus recovery in Spain: insights for ministries and stakeholders

Rapporteur: **Laura Mejias (BETA Technological Center)**
Moderator: **Belén Ramos Alcalde (DAQUAS)**





This session included presentations from the Hydrological Planning and the Waste sections of the **Spanish Ministry for Ecological Transition and Demographic Challenge (MITECO)**, the **Catalan Waste Agency** and **BETA Technological Center - Catalan Nutrient Platform**.

In Spain, nearly 90% of sewage sludge currently goes to farmland. This however poses issues in regions with significant manure production from livestock, in particular Catalunya.

Spain is today working to prepare implementation of the new requirements of the revised UWWTD, in particular regarding greenhouse gas emissions and energy neutrality of wwtps, monitoring of microplastics in sewage sludge and circularity, including the art. 20 phosphorus reuse and recycling rates.

The **Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITECO)** highlighted the transformational impact of the 2024 revised UWWTD on Spain's approach to sludge management and nutrient recovery. This introduces new obligations on circularity, monitoring, and environmental performance, and notably establishes the basis for future binding targets on phosphorus reuse and recycling via delegated acts under Article 20. **This will require a shift towards a system where reuse and recycling must be measurable and traceable**, placing new demands on national regulatory frameworks and data systems.
The session discussed how Spain can build on its strong existing model, based on direct use of sludge for agriculture, (around 88% nationally), while adapting to these new requirements. MITECO emphasised that this pathway already delivers effective nutrient recycling and will remain central in the future regulatory framework. However, participants highlighted that the revised UWWTD pushes for a paradigm shift from traditional wwtps to true "biorefineries," pointing towards greater value creation, quality assurance, and diversification of recovery pathways. This opens an important reflection on how to complement direct land application with additional solutions that generate higher added-value products and offer greater flexibility across territories. Spain is already preparing its regulatory response through a comprehensive new Royal Decree intended to update technical parameters for emerging contaminants. This may address microplastics and POPs and deploy a digital traceability system.

In this context, the discussion connected strongly with regional experiences such as Catalonia, where agricultural use is well established (routing over 90% of its sludge to soils via composting and direct application) but increasingly faces operational and structural challenges like long transport distances, stricter quality requirements, and competition with livestock manure. Overall, the session highlighted a constructive way forward for Spain: maintaining the strengths of the current system while gradually expanding innovation, market development, and regulatory tools to support a broader portfolio of nutrient recovery solutions.

The session also **showcased the role of collaborative governance initiatives, notably the Catalan Nutrient Platform and the emerging Spanish Nutrient Platform**. These initiatives were presented as essential enablers to achieve the revised UWWTD objectives by bringing together public authorities, researchers, industry, and the agricultural sector to align R&D&I priorities, share knowledge, and accelerate implementation. By fostering coordination across sectors and scales, such platforms can help translate regulatory ambition into practical solutions, support market development for recovered nutrients, and ensure that phosphorus recovery strategies are both technically effective and territorially adapted.

ESNI-NERM Conference

28-29 April 2026, Brussels

The European Sustainable Nutrient Initiative (ESNI) Conference and the Nutrients in Europe Research Meeting (NERM) merged into a single reference meeting (ESNI-NERM) for the community working on research and innovation focused on nutrient management. The event was organised by the Biorefine Cluster Europe and ESPP.



It brought together 160 participants from research projects and institutes, NGOs, industry and institutions, with policy presentations, 9 parallel sessions covering 12 research projects, an "industrial success stories" session and 39 scientific posters.

Slides and conference materials: https://www.biorefine.eu/esni-nerm-2026/

Policy and EU initiatives

Horizon Europe Framework Programme (2028–2034)



Bertrand Vallet, European Commission (DG RTD), presented the European Commission's proposal for the next Horizon Europe Framework Programme (2028–2034), currently under negotiation. The proposed programme has a budget of EUR 175 billion (compared to €95.5 billion of the 2021–2027 framework programme) and introduces several changes aimed at strengthening the link between research, innovation and industrial deployment. A key novelty is the closer integration with the European Competitiveness Fund (ECF), using aligned policy priorities and a "Single Rulebook" to facilitate the transition from research projects to market and industrial deployment.

Vallet also highlighted a series of simplification measures, including wider use of lump-sum funding, streamlined application and reporting procedures, a reduction in the time-to-grant from eight to seven months, and a simplified funding structure designed to encourage greater participation by SMEs and new applicants. The proposal also expands measures to support the integration of Member States with lower participation in EU research programmes and EU accession countries (candidate countries preparing for EU membership) with Ukraine highlighted as a priority example. Other proposed changes include a more focused portfolio of European Partnerships, stronger support for research and technology infrastructures, and greater emphasis on innovation, international cooperation and "dual-use" research (research and innovation with both civilian and defence applications).

Common Agricultural Policy



Maria Fuentes Merino, European Commission (DG AGRI), presented the current implementation of the Common Agricultural Policy (CAP) and the Commission's proposal for the post-2027 framework. Nutrient management has become an increasingly important objective within the CAP, with Member States using eco-schemes, agri-environmental and climate measures and investment support to promote more efficient fertiliser use, organic nutrient sources and precision agriculture. Eco-schemes (today implemented in 60% of EU' agricultural area) support a broad range of practices to improve nutrient management, including restrictions on mineral fertiliser use, optimised application methods and timing, greater use of organic fertilisers, precision agriculture and nutrient management plans. Current CAP Strategic Plans target sustainable nutrient management on around 15% of EU agricultural land, with substantial differences across Member States.

Looking ahead, the proposed CAP for 2028–2034 is built around four objectives (attractiveness for new generations, competitiveness and resilience, sustainability, and fairness) while maintaining environmental sustainability as a central pillar (see also ESPP Scope Newsletter n 159). For nutrient management, the Commission identified several priorities, including improving nutrient use efficiency and circularity, addressing nutrient pollution hotspots, reducing dependence on imported fertilisers through greater use of low-carbon and recycled nutrients (e.g. digestate), and promoting bio-based fertilisers.

The proposal also simplifies the CAP architecture by merging the current eco-schemes and agri-environment-climate measures into a single instrument for "agri-environmental and climate actions". This new "CAP-toolbox" would combine mandatory minimum farm sustainability requirements (the "conditionality" in the current CAP) with voluntary environmental commitments (beyond this mandatory minimum), investment support, advisory services and innovation measures to facilitate the transition towards more sustainable farming systems.

EU Bioeconomy Strategy



Agata Kotkowska, European Commission (DG Environment), presented the implementation of the new EU Bioeconomy Strategy, adopted in November 2025, which focuses on scale up, industrial deployment acceleration and market uptake of bio-based materials, products and technologies. The strategy is structured around four pillars: scaling up bio-innovations and investments, creating lead markets for bio-based products and technologies, ensuring the sustainable sourcing and cascading use of biomass, and strengthening international partnerships. Across these pillars, the Commission plans around 75 actions for 2026–2028, combining legislative and non-legislative measures to accelerate the deployment of the European bioeconomy.

Key upcoming initiatives include the Circular Economy Act, expected to strengthen markets for secondary raw materials and circular bio-based products, and the Biotech Act II, aimed at improving the regulatory environment for biotechnology and bio-based industries. Other planned actions include the establishment of a Regulators & Innovators Forum to facilitate dialogue between innovators and policymakers, an Investment Deployment Group to support scale-up, and closer alignment with the future European Competitiveness Fund.

The strategy also aims to develop five « lead markets », including bio-based fertilisers, together with targeted actions to stimulate demand through bio-based content requirements, voluntary purchasing commitments under the future Bio-based Europe Alliance, and off-take agreements. At the same time, the Commission aims to promote the cascading use of biomass, increase the utilisation of secondary biomass and residues, and improve monitoring of biomass availability to ensure long-term sustainability.

Finally, Kotkowska emphasised that implementation will depend on strong cooperation between Member States, industry and stakeholder organisations, together with the integration of bioeconomy objectives into broader EU policies such as taxonomy, State aid, eco-design and product standards.

Digestate, biogas and biomethane



Laure Baillargeon, European Commission (DG GROW), presented the European Commission's latest policy initiatives to strengthen the European biogas and biomethane sector, highlighting the role of digestate valorisation in improving both resource efficiency and competitiveness. Against the backdrop of recent geopolitical tensions and the need to reduce dependence on imported fossil fuels and primary nutrients, she explained how the work of the Biomethane Industrial Partnership (BIP) has expanded from increasing biomethane production to promoting circular business models that integrate biogas, digestate and biogenic CO_2. Building on this experience, the Commission is now establishing a new Tripartite Agreement for Biogases, bringing together the Commission, Member States and industry to accelerate biomethane deployment, improve permitting, strengthen coordination and support investments across the value chain.

Within this framework, digestate valorisation is considered a key lever to improve the economics of biomethane production by creating additional value from the residual stream, thereby helping narrow the cost gap between fossil natural gas and biomethane. Digestates are already widely used as organic fertilisers, while technologies such as ammonia stripping, struvite recovery, composting, thermal drying, biochar production and plasma treatment are increasingly enabling the production of concentrated, transportable fertiliser products. Many of these technologies have already reached commercial maturity, although market deployment remains constrained by regulatory and economic barriers.



EU projects

Various European projects organised parallel sessions to show projects results, discuss regulatory, economic, social aspects of nutrient recovery and engage with participants on recycled products challenges and opportunities.

Extended summaries of project sessions are available here.

CiNURGi

The CiNURGi session discussed the policy and governance challenges surrounding nutrient recycling in the European bioeconomy. Participants broadly agreed that the main barriers to wider deployment are no longer technological, but regulatory and economic. Priority actions identified included improving coherence between EU regulatory frameworks, harmonising monitoring methods and data collection, strengthening data sharing, and creating market mechanisms that recognise the environmental and resilience benefits of recycled nutrients.

The discussion also highlighted the importance of long-term policy support and economic incentives to overcome the first-mover disadvantage and accelerate the uptake of bio-based fertilisers. Opinions differed, however, on the extent to which legislation should mandate nutrient recycling. While some speakers argued that mandatory recycling targets—such as phosphorus recovery obligations introduced in Germany—are essential to drive investment, others favoured greater market flexibility. Participants also disagreed on how the costs and societal benefits of nutrient recycling should be shared between farmers, industry and public authorities.

https://interreg-baltic.eu/project/cinurgi/

EU FarmBook

The EU FarmBook session presented a long-term European knowledge repository designed to preserve and disseminate the results of EU-funded projects beyond their lifetime. Unlike conventional project websites, which often disappear after project completion, EU FarmBook provides a permanent, open-access infrastructure for storing and sharing practice-oriented knowledge across the agriculture, forestry and rural sectors.

The platform integrates several AI-supported functionalities to improve the accessibility and usability of project outputs, including multilingual translation while preserving document layout, automated metadata extraction, advanced search tools, chatbot functionalities, and flexible options for uploading and automatically importing content from existing repositories. The project also provides guidance on data management and open-access licensing to facilitate the long-term reuse of project results.

Another key development is the creation of thematic community spaces to facilitate networking, knowledge exchange and collaboration between projects. The discussion highlighted the importance of ensuring long-term institutional support for the platform, while continuing to improve user engagement and the reliability of AI-assisted services.

https://welcome.eufarmbook.eu/

ReLEAF / LANDFEED

The ReLEAF and LANDFEED projects presented integrated circular bioeconomy approaches to valorising agri-food and animal residues into bio-based fertilisers and biostimulants through combinations of biological, chemical and thermochemical processes. Rather than focusing on individual technologies, the projects demonstrated how multiple processing steps can be integrated into closed-loop systems at pilot and pre-industrial scale.

Several technological innovations were presented. LANDFEED developed an integrated process for olive mill residues combining green solvent extraction, recovery of residual oil, biomass combustion to produce K-, P- and Mg-rich ash, CO_2 capture for microalgae cultivation, and production of solid biofuel from olive stones. Pilot-scale validation is currently underway. Another technology combines twin-screw extrusion to treat a wide range of animal by-products (fish, molluscs, bones, skins and wool) with enzymatic hydrolysis to produce biostimulants compliant with the EU Fertilising Products Regulation, with scale-up of the extruder currently in progress. ReLEAF demonstrated pilot-scale solid-state fermentation of heterogeneous food waste using *Trichoderma harzianum*, achieving a three-order-of-magnitude increase in microbial growth and producing functional biostimulants. A further process successfully replaced conventional microbial culture media with fish-processing wastewaters, demonstrating cultivation of 13 microbial strains while preserving or enhancing their plant-growth-promoting properties, with selected strains already scaled up to 20 L bioreactors.

The discussion highlighted that the main remaining challenges are no longer technological but concern regulation, market uptake and system integration. End-user trust, certification, harmonised regulatory frameworks, feedstock logistics and economic viability were identified as the main factors determining successful large-scale deployment of waste-derived fertilisers and biostimulants.

https://releafproject.eu/
https://www.landfeed.eu/

Sempre-BIO

The Sempre-BIO session presented the results of two pilot plants demonstrating the cultivation of microalgae using digestate and biogenic CO_2. The pilots, located in Catalonia (BETA Tech Center) and Flanders (Innolab), confirmed the technical feasibility of the process and showed that batch cultivation performs better than semi-continuous operation, providing greater control over digestate concentrations and reducing biofilm formation.

The following discussion focused primarily on the regulatory framework needed to enable commercial deployment. A large majority of participants supported amending EU animal by-products legislation to explicitly allow algae cultivation on manure and digestate, arguing that harmonised European rules would provide greater certainty for investors and accelerate adoption. Around 70% of respondents also considered that algae produced from manure-derived digestate could be authorised for animal feed, provided appropriate quality controls and post-processing requirements are in place.

Overall, participants expressed strong confidence in the technology and saw microalgae cultivated on digestate as a promising local and sustainable protein source for animal feed, with regulation identified as the main remaining barrier rather than technical feasibility.

https://sempre-bio.com/

HarvRESt / Greenhood

The HarvRESt session presented results from the integration of anaerobic digestion into livestock farms to improve nutrient circularity through the use of digestate as fertiliser. Field and pot trials carried out in Spain evaluated nutrient release, fertilisation efficiency, soil health, and the potential impacts of digestate-derived fertilisers on nutrient leaching and environmental performance under practical farming conditions.

The session also introduced Greenhood, which builds on HarvRESt by developing technologies to enhance nutrient recovery from digestate within biogas-based farming systems. The project is now developing tailor-made fertilisers by combining recovered phosphorus with the solid and liquid digestate fractions, with field and pot trials planned to validate their agronomic performance.

The discussion highlighted that the main challenge is not only recovering nutrients efficiently, but doing so while reducing the environmental impact of livestock farms. Although the technologies have demonstrated promising performance, including phosphorus extraction efficiencies above 95% through acid extraction from digestate, their large-scale deployment will require significant investments in on-farm waste treatment systems and nutrient recovery technologies. Participants also debated the most suitable recovery strategy, comparing high-purity products such as struvite with approaches that recover nutrient streams as raw materials for further processing by fertiliser manufacturers.

https://www.harvrest.eu/
https://greenhoodproject.eu/

NutriBudget

The NutriBudget session presented NutriPlatform, a digital decision-support tool designed to support farmers and policymakers in improving nutrient management. Unlike conventional nutrient accounting systems, which mainly focus on nitrogen, phosphorus and carbon, the platform integrates a wider range of macro- and micronutrients, including calcium, magnesium and sodium, to generate farm-level nutrient budgets and assess the environmental, agronomic and economic impacts of different management strategies.

The discussion with stakeholders from policy, ngo and consulting sectors and participants highlighted nutrient budgeting as a key element of climate-resilient agriculture, helping improve nutrient use efficiency, reduce pollution, strengthen soil health and decrease dependence on imported fertilisers. Participants also emphasised that future agricultural governance will increasingly rely on reliable monitoring systems, high-quality farm data and evidence-based policymaking, requiring stronger coordination between agricultural, environmental, climate and waste policies. Public-private partnerships and transition finance were identified as important mechanisms to support the adoption of sustainable nutrient management practices.

The main barriers identified were the complexity of the regulatory framework, limited availability of harmonised farm-level data, and uncertainty surrounding carbon farming and market-based instruments such as nature credits. Participants concluded that wider deployment of nutrient budgeting will require practical advisory tools for farmers, coherent policy frameworks and reliable monitoring systems capable of supporting future agricultural and climate strategies.

https://www.nutribudget.eu/

NUTRI-KNOW

The NUTRI-KNOW session (and official final event) brought together policymakers, researchers and industry representatives to discuss the regulatory and market readiness of three key nutrient recycling pathways: RENURE products, pocket digestion and algae-based technologies. While all three were recognised as technically mature or rapidly advancing, speakers agreed that their large-scale deployment now depends primarily on regulatory clarity, market development and user acceptance rather than further technological innovation.

The discussion highlighted different challenges for each technology. RENURE products were recognised as a promising solution under the Nitrates Directive, but their wider uptake remains dependent on the outcome of the ongoing EU regulatory process on the Directive evaluation and on the EU Fertiliser Action Plan (see ESPP eNews 106). Pocket digestion was presented as a mature technology capable of supporting renewable energy production and nutrient recycling on farms, although complex permitting procedures, inconsistent national regulations and uncertain economic returns continue to limit adoption. For algae-based products, speakers considered market creation the main bottleneck, stressing the need for greater consumer awareness, stronger retail integration and public procurement to stimulate demand.

Across all three themes, participants concluded that successful deployment will require coherent regulatory frameworks, viable business models and stronger engagement with farmers and consumers. Demonstration activities, trusted local advisory networks and collaboration across the value chain were identified as essential to build confidence and accelerate market uptake of circular nutrient solutions.

https://www.nutri-know.eu/

Industrial success stories

A panel formed by **Ignasi Salaet, Fertinagro, Laia Llenas, Beta Tech Center, Kris Ally, SmartRenure, Bertrand Vallet, European Commission (DG RTS) and Maria Fuentes Merino, European Commission (DG AGRI),** explored how to better bridge research, policy and industry to accelerate the deployment of nutrient recycling solutions. Participants agreed that research should be co-designed with stakeholders from the outset, ensuring that technologies address real market and regulatory needs rather than remaining at laboratory scale. The discussion also highlighted the value of collaborative initiatives such as ESNI, which facilitate knowledge exchange across projects, help identify research gaps and provide coordinated policy recommendations to the European Commission. From an industry perspective, speakers stressed that innovation must demonstrate not only environmental benefits but also clear economic value to farmers, while participation in collaborative projects provides valuable technical validation and greater credibility in the market. Commission representatives underlined the importance of stakeholder input in shaping future research priorities and policies, encouraging the nutrient recycling community to contribute through coordinated consultations and policy briefs.

A pitch and panel session then showcased implemented products and processes, highlighting challenges and barriers encountered during the product/technology/process development.



Quinten Van Haecke, presented **Aquafin**'s strategy for transforming phosphorus removal from wastewater from a treatment cost into a resource recovery opportunity. Aquafin currently spends over €6.2 million per year removing phosphorus from wastewater. The revised Urban Wastewater Treatment Directive, which introduces minimum phosphorus recovery targets from sewage sludge (to be defined by end 2027, see this newsletter), further reinforces the need to recover rather than dispose of phosphorus (see above/below).

Aquafin has chosen to focus on phosphorus recovery from sewage sludge incineration ash (SSA) and compared three possible valorisation routes. Direct use of SSA in fertiliser production (e.g. by EuroChem) offers low investment costs but raises concerns over heavy metals, regulatory compliance and product acceptance. Acid leaching technologies (e.g. EasyMining, SusPhos and Remondis) can produce high-purity phosphate products but require significant investment, chemicals and operating costs. A third option, Spodofos (see ESPP eNews n° 99), aims to recover white phosphorus through a metallurgical process, offering a potentially strong business case with low gate fees, low carbon footprint and limited capital investment, although the technology is currently at TRL 5.

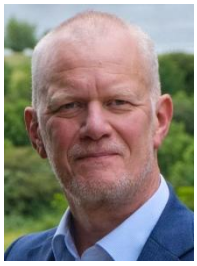
The presentation concluded that the main barriers are no longer limited to technology. Market acceptance of phosphorus recovered from wastewater, concerns over contamination, competition with low-cost primary phosphate, and the need for supportive public policies remain the main challenges to establishing a circular phosphorus value chain.



Anke Valvekens presented **Detricon**'s technologies for recovering ammonia from manure and digestate to produce sustainable ammonium salts (see also ESPP SCOPE Newsletter n°152). The company has developed a patented stripping technology that converts nitrogen-rich waste streams into fertiliser products such as ammonium sulphate and ammonium nitrate. Alongside its air stripping, Detricon has also developing a zero-chemical nitrogen recovery process which reduces the need for scrubber acids by converting the

ammonium salt solution into higher value, as well as higher concentration, end-products (ammonium hydroxide and/or ammonium bicarbonate). These processes aim to reduce greenhouse gas emissions, improve water treatment and support the local production of recycled fertilisers.

The company is a partner in the Horizon Europe NUTRITIVE project, which is developing a decision-support system (DSS) to identify the most sustainable manure management strategy for individual livestock farms. By combining environmental, economic and social indicators, the platform will evaluate more than 20 management technologies across multiple European farming systems to support both farm-level decision making and future policy development.



Paul Roeleveld, Haskoning, presented ViviMag®, a technology that uses a magnetic field to extract vivianite (iron(II) phosphate) from sewage sludge (see SCOPE Newsletter n°156). ViviMag recovers a high percentage of vivianite present in sludge, enabling recovery of around 40 – 60% of sewage works phosphorus inflow as vivianite (iron(II) phosphate) with <1% organics content.

Haskoning is now involved in the design process of the first full scale demonstration ViviMag plant (LIFE-project Phos4EU) with Waterschap Brabantse Delta, a water authority in The Netherlands, with the objective of treating 50% of the digested sewage sludge at the Nieuwveer wastewater treatment plant in Breda (400.000 p.e.), designed to recover 630 t/y of vivianite. The objective is that the recovered vivianite will be sold to the fertiliser industry for agricultural soils where iron-phosphate fertilisers are suitable. In parallel, research will take place at Wetsus to assess the use of vivianite from wastewater as a source for the production of $LiFePO_4$ for cathode materials for LFP batteries. For wastewater utilities, the technology also offers operational benefits through lower sludge production, reduced maintenance associated with vivianite scaling, and the possibility of reusing iron within the treatment process.



Cristian Terrones, ICL, presented Puraloop, a recycled phosphate fertiliser produced from sewage sludge ash (SSA) (see ESPP SCOPE Newsletter n°153). The process converts the poorly plant-available phosphorus contained in incineration ash into a granular fertiliser with high plant availability and gradual nutrient release, offering a circular alternative to conventional phosphate fertilisers while contributing to European phosphorus autonomy.

The presentation highlighted that around 90% of the phosphorus entering wastewater treatment plants is concentrated in sewage sludge, making sewage sludge ash an important secondary phosphorus resource. ICL has developed an industrial process to transform this material into a fertiliser that complies with EU limits for heavy metals and has shown agronomic performance comparable to, or better than, conventional triple superphosphate in pot and field trials. The company also emphasised that scaling up recycled fertilisers requires adapting processes to the variability of different ash streams and overcoming regulatory barriers to wider market uptake.



Ehsan Moslehi, EasyMining, presented the company's portfolio of industrial nutrient recovery technologies, covering nitrogen, phosphorus and potassium. The presentation emphasised the transition from pilot development to commercial implementation, with patented processes designed to recover valuable nutrients from wastewater and incineration residues and convert them into marketable products.

EasyMining highlighted three flagship technologies: AQUA2™N, which recovers ammonium nitrogen from wastewater streams and has completed demonstration through the LIFE RE-Fertilize project (tested at demo scale (4m^3/h) in Stockholm and Copenhagen); ASH2™PHOS, which extracts high-purity calcium phosphate (RevoCaP) from sewage sludge ash while removing heavy metals, with two industrial plants under construction in Germany (Schkopau) and Sweden (Helsingborg), each designed to process 30 000 tonnes of ash per year; and ASH2™SALT, a commercial facility to recover potassium, sodium and calcium salts from fly ash, with a capacity of 150 000 tonnes/year. *For more details, see ESPP Technology Catalogue.*



Wim Moerman, NuReSys, presented the evolution of the company's phosphorus recovery technologies, highlighting the shift from a product-centred approach to Integrated Phosphate Management (IPM). Based on operational experience, NuReSys concluded that phosphorus recovery alone is rarely the main economic driver. Instead, the technology is designed to address operational challenges such as pipe clogging, scaling, dewatering and process stability, while simultaneously recovering nutrients for reuse.

The company now offers customised recovery systems for different wastewater and digestate treatment configurations, with phosphorus recovery integrated into broader nutrient management strategies. Looking ahead, NuReSys is expanding its portfolio towards RENURE, recovery of nitrogen, potassium and sulphur, and synergies with ash-based phosphorus recovery.

For more details, see ESPP Technology Catalogue.



Joachim Clemens, SF-Soepenberg GmbH, presented the iPHOS process (see above), an on-site phosphorus recovery technology that remobilises phosphorus from activated excess sludge before conventional struvite precipitation, enabling significantly higher % of phosphorus recovery than conventional struvite precipitation. Further details are in the summary of the ESPP Urban Waste Water Treatment Directive workshop, Madrid, June 2026 (above in this SCOPE Newsletter).

The presentation highlighted iPHOS as a response to forthcoming German legislation requiring phosphorus recovery from wastewater treatment plants from 2029 onwards. Pilot results with treatment capacities of around 1 m³ of activated sludge per hour. indicate phosphorus recovery rates of 50 – 75 % of sewage works inflow, depending on operating conditions, and a mobile plug-and-operate demonstration unit is today operational for on-site validation.

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