RECOVERED NUTRIENTS: AN INEVITABLE PART OF OUR FUTURE SUSTAINABLE BUSINESS

From Wastewater Treatment Plants to Resource Plants

By adding relevant criteria on recovery of nutrients, detoxification in the treatment and recovery steps as well as quotas in the production of fertilisers and feed materials; the taxonomy can play an important role in the transition from wastewater treatment plants to resource plants.

Today, almost half of our climate impact and 90 percent of water scarcity issues are linked to the way we extract resources and produce goods and food. In this context, nutrients such as phosphorus and nitrogen are key. Without them, global agricultural output would be cut in half. Wastewater from households and industries contain massive amounts of both phosphorus and nitrogen, but today, this is a problem rather than an asset. Wastewater treatment plants (WWTP) put great effort into discarding sludge, even though this sludge is rich in phosphorus, and nitrogen is released from the plants as nitrous oxide (N_20) which has a huge climate effect.

With a different approach, the opportunities are enormous. Phosphorus, listed by the EU as a critical raw material, can be recovered from the sludge and brought back into the loop, securing an endless supply. This goes hand in hand with the taxonomy principles stated in 12.2 for Phosphorus recovery. However, Nitrogen can be captured from wastewater streams and used to produce fertiliser, replacing today's greenhouse gas-heavy production.

This way, the wastewater treatment plants of today will be the resource plants of tomorrow. This scenario is well within reach. However, it requires key alterations in national and international legislation and regulation. Nevertheless, the taxonomy has a great role to play, to set criteria creating tomorrow's resource plants. Recovered nutrients is an inevitable part of future sustainable business.

Proposals

1. Resource flows

In modern society, few flows can compare to the volumes of the water and wastewater sector. Using Sweden as an example, the average Swede uses between 120 and 140 kg of water every day, and that contributes to a flow of 300 kg of wastewater. At the same time, wastewater contains a number of valuable resources; materials which can be captured and put to use in an increasingly circular economy, paving the way for a sustainable society.

Companies and organisations in the water and wastewater sector can contribute to society in several ways above and beyond those which are regulated, encouraged or even possible today. Unlocking this potential means changing the conditions and purposes under which the industry operates. These changes affect the way the industry can direct its efforts towards increasing

circularity, through modernised legislation and regulation, innovative systems, processes, and organisations.

Wastewater and sewage sludge are largely untapped resources today. Traditionally, they are regarded as problematic waste. Hence, the usual purpose of wastewater treatment plants is reduced to handling this perceived problem by simply purifying the water, from a limited waste perspective.

The introduction of circular principles leads instead to substantial potential for reducing climate gas emissions by bringing resources back into the loop. Lawmakers and business leaders around the globe can seize this opportunity and turn wastewater treatment plants into resource plants, creating climate benefits as well as jobs, tax revenue and wealth.

Proposal: The taxonomy should create criteria in chapter 12.1 Urban Waste treatment to push for a general change so that the stated purpose of urban wastewater treatment plants, is to enable increased circularity.

2. Secure recirculation of phosphorus and nitrogen

Without the nutrients phosphorus and nitrogen, farmers would not be able to grow the amount of food we need. Despite this, Europe and many other regions and countries around the world depend on imports, while wasting phosphorus and nitrogen that we already have.

In our cities, we have enormous amounts of phosphorus and nitrogen literally beneath our feet: in the sewage systems. But instead of putting it to use, we waste the vast majority, for example by covering discontinued landfill areas with it.

When nitrogen is removed from wastewater using today's biological methods, it is simply released back into the atmosphere, mostly as N_2. At the same time, new nitrogen compounds for fertilizer are produced by capturing nitrogen, N_2, from the air, using a process invented more than 100 years ago which leads to substantial carbon emissions.

New technology makes it possible to extract very pure phosphorus from sludge of poor quality instead of letting it go to waste. Other innovations have given treatment plants easy ways to recover the nitrogen from wastewater in solid form, which can be used immediately in the production of fertilizer. This process leads to a powerful reduction of greenhouse gas emissions, both at the plant and as production of nitrogen compounds for fertilizer is replaced by raw material straight from wastewater.

When this happens, the wastewater plant has become a resource plant, supplying markets with commercially viable materials while substantially lowering carbon emissions. Countries that make this transition also become more resilient, as their dependence on imports is gradually replaced by recycled nutrients from their own wastewater. What was once a problem has been turned into a huge opportunity.

However, the low costs of production using new materials is a tangible obstacle to such a transition, as it tilts the playing field to the disadvantage of innovations that do not mitigate

climate change. For this reason, politicians must act to usher in functional markets for recycled nutrients, increase demand, and ensure incentives for businesses and treatment plants to invest in new green technology.

Proposals: The taxonomy should add quota obligations for commercial fertiliser and feed products in chapter 1.1 Animal production and 1.2 Crop production; requiring an increasing percentage of phosphorus and nitrogen in the products to be of secondary origin. The taxonomy should introduce a criteria for recovery of nitrogen from wastewater for agricultural purposes in chapter 12.1 Urban Wastewater treatment.

3. Nitrous oxide: The number one climate challenge for wastewater treatment plants

The single largest climate impact of today's wastewater treatment plants is linked to the removal of nitrogen by biological methods. In addition to being vulnerable to several factors for functionality, biological nitrogen removal leads to large emissions of nitrous oxide, N_2O, a powerful greenhouse gas also known – and used – as laughing gas.

It´s effects on climate change is around 300 times as potent as carbon dioxide, making it one of the most important greenhouse gases. According to research published by the Intergovernmental Panel on Climate Change (IPCC) in 2020, global emissions of nitrous oxide are in fact higher than even the most pessimistic climate scenarios.

Several Scandinavian studies from 2020 show that nitrous oxide emissions from individual wastewater treatment facilities may be 10 times higher than previous calculations have indicated. Additionally, increasingly tougher regulation on the share of nitrogen which must be removed from the wastewater in order to curb eutrophication will lead to even more emissions of laughing gas unless new methods are introduced. This puts pressure on governments to act, as they have to make sure that the treatment of wastewater does counteract efforts towards other obligations, such as maintaining healthy marine environments and contributing to lower carbon emissions. The challenge can be addressed by making new use of the nitrogen in wastewater. Countries which are early in implementing modern chemical methods for nitrogen removal will benefit from increased control over emissions as well as establishing a circular industry and replacing imported nitrogen fertilizer compounds with local production.

Research into large-scale solutions is being conducted in several countries. One example is the collaboration between innovation company EasyMining, a subsidiary of the Ragn-Sells Group, and the municipal wastewater treatment company of Danish capital Copenhagen. The method causes nitrogen compounds to crystallise and precipitate, making it suitable for fertiliser production, while cutting nitrous gas emissions to zero. An adjacent facility turns the raw material into commercial fertilizer. This chemical method can replace biological treatment at a lower operating cost thanks to the decreased need for energy and making sure that the nitrogen is circulated instead of released.

Proposal: The taxonomy should add criteria on requirements in chapter 12.1 for the assessment and limitation of nitrous oxide, N_2O, from wastewater treatment plants. The

taxonomy should push for funds for full-scale pilot facilities for extracting nitrogen from wastewater with the explicit purpose of producing raw material for fertilizer production.

Examples of nutrient recovery technologies for sustainable business

EasyMining (part of Ragn-Sells group), dedicated to closing nutrient cycles, welcomes the opportunity to provide input to technical screening criteria for the EU taxonomy. EasyMining has developed and patented several chemical processes and holds a great know-how in chemistry, resource efficiency, circular business models and industrial symbiosis. Our objective is to improve existing or even to create new circular material flows efficiently and commercially viable.

Our technologies; Ash2Phos, Ash2Salt and Project Nitrogen produce clean commercial materials; fertilisers or feed products in a circular economy and are examples of innovations that can help to create sustainable business.

Today, EasyMining has three main processes:

- **Ash2Salt**: from incinerated flyash to potassium chloride
- **Project Nitrogen**: from waste water to ammonium sulphate
- **Ash2Phos**: from sewage sludge ash to precipitated calcium phosphate

SALT RECYCLING
EasyMining, owned by the Swedish environmental company Ragn-Sells, is an innovation company dedicated to closing nutrient cycles. EasyMining's Ash2Salt process, an example of chemical recycling, extracts salts from high chloride containing fly ashes. In this process, heavy metals are precipitated and commercial grade potassium chloride, sodium chloride and calcium chloride as well as an aqueous ammonia solution are extracted. Both the potassium chloride and the ammonium sulphate are produced in a quality suitable as component materials in fertilisers.

The first Ash2Salt production facility is currently being built at Ragn-Sells' recycling plant Högbytorp outside Stockholm, Sweden. The plant will have a capacity to treat 130 000 tons of fly ash per year, producing 3 500 tons potassium chloride (KCl) per year (dry) and will be in operation in 2022.

The recovered potassium chloride has a purity of 99.1% and would fulfil the quality requirements of the new fertilising products legislation.

Needed action; The new fertilise legislation (the EU Fertilising Products Regulation 2019/1009) need to add nutrients recovered from incinerated household waste.

AMMONIUM RECYCLING
EasyMining´s Nitrogen Removal Process enables efficient removal and recovery of ammonium from aqueous flows. EasyMining's new patented innovation enables efficient removal and recovery of ammonium from aqueous flows. In our unique solution nitrogen is captured by an adsorption chemical and separated from the wastewater or process water. As a second step the captured ammonium is recovered in a conversion plant to a fertilizer and the adsorption chemical is regenerated to be used again.

EasyMining's process helps lowering emissions of both CO2 and the even more powerful greenhouse gas N2O and prevents eutrophication by lowering the nitrogen load on the conventional nitrogen removal process and thereby improving the quality of the effluent. The process creates a circular flow with clean ammonium products made from the nitrogen removed from the waste water.

The benefits:

- Prevent eutrophication
- Energy efficiency
- Resource efficiency
- Greenhouse gas reduction
- Cost efficient

The process consists of several successive chemical reactions performed at elevated temperature but atmospheric pressure. There is no need for pressurized vessels or for exceptional materials to be used for the equipment. The mass balance of the process is favourable, since most input chemicals become a part of the product.

EasyMining is now working in a project to demonstrate this new, innovative removal and recovery process for ammonium nitrogen which can be used for different ammonium-containing aqueous flows and enables production of different ammonium products (e.g. fertilizers).

Needed action; The new fertilise legislation (the EU Fertilising Products Regulation 2019/1009) need to add nutrients (i.e. ammonium salts) recovered from waste water.

PHOSPHORUS RECYCLING
EasyMining´s Ash2Phos technology has a high recovery rate, efficient detoxification and great potential to bring recovered products to the market. The recovered P-product (Precipitated Calcium Phosphate) will contribute to substituting virgin materials, prolonging the life time of mines, lowering contaminants like Cd and saving significant amounts of CO_2 emissions. The process maximises recycling of phosphorus, separates hazardous substances (more than 96% of the heavy metals, i.e. <6 kg/ton ash), and produces a silica sand suitable for sustainable concrete. The typical recovery rates from the process are:

Ash2Phos typical recovery	Phosphorus	Aluminium	Iron	Calcium
	≈ 90-95%	≈ 60-80%	≈ 10-20%	≈ 80-90%

These values reflect, that we have optimized the recovery for high-grade P (90% at moderate acid consumption) in clean and commercial form, the key purpose of Ash2Phos.

Needed action; The feed regulation (Regulation (EC) No. 767/2009) need to open to recovered Phosphorus from incinerated sewage sludge.

READ MORE

- **We need a new circular legislation for sustainable sludge handling:**
  https://www.easymining.se/newsroom/articles-news/circular-legislation/
- **Recycled quota crucial for sustainable business**
  Recycled quota crucial for critical raw materials like phosphorous (easymining.se)
- **Make the WWTPs resource plants**
  From Wastewater Treatment Plants to Resource Plants (easymining.se)
- **Eat@home live broadcast: EAT's digital event on recovered nutrients and legal barriers**
  https://www.easymining.se/newsroom/articles-news/eat-event/
- **Barriers to chemical recycling**
  Barriers to chemical recycling (easymining.se)
- **Introduce a quota for recycled nutrients in fertilisers**
  Introduce a quota for recycled nutrients in fertilisers (easymining.se)