The European Industrial Emission Portal

1.1. The European Industrial Emission Portal

The European Industrial Emissions Portal has mapped the 'Waste and WW management' (i.e. Urban WW treatment plants) as well as facilities of other sectors of activities in EU-MS. This Portal is a tool of assistance in WalNUT's attempt to locate, present and evaluate the valorisation capacity of urban WW -based economically prime important nutrient resource-based products for the manufacturing of bio-based fertilisers. The primary idea is that there is a conflict between the legislation for phosphorus as a resource in fertiliser manufacturing or as a pollutant in WW treatment.

When exploring the data in the European Industrial Emissions Portal by pollutant, one can select the EU-MS of interest, the medium (air or water: water in the case of WalNUT project), the pollutant (Table 1) and the sector (Table 2). Regarding the pollutants, apart from carbon dioxide (CO_2) and monoxide (CO) and methane (CH_4) the tracing of the rest of the pollutants can be beneficial in the scope of Nutrient Recovery from Urban and Industrial WW for they can either be used in Bio-based fertiliser manufacturing as primary/secondary macro-components or micro-components or their presence will need to be monitored and their concentration maintained within the imposed limits by Reg. (EU) 2019/1009 in the attempt of the facility to recover the nutrients from the WW before disposal or valorise the WW (influent or effluent) for the manufacturing of Bio-based fertilisers.

Table 1: List of pollutants mentioned in the European Industrial Emissions Portal that are of interest in the manufacturing of Bio-based fertilisers.

Pollutants in the European Industrial Emissions Portal
Ammonia (NH_3),
Arsenic and compounds (as As)
Cadmium and compounds (as Cd)
Chromium and compounds (as Cr)
Copper and compounds (as Cu)
Lead and compounds (as Pb)
Mercury and compounds (as Hg)
Nickel and compounds (as Ni)

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Nitrogen oxides (NOX)
Nitrous oxide (N_2O)
Non-methane volatile organic compounds (NMVOC)
Nonylphenol and Nonylphenol ethoxylates
Particulate matter (PM10)
PCDD + PCDF (dioxins + furans) (as Teg)
Polycyclic aromatic hydrocarbons (PAHs)
Sulphur oxides (SOX)
Total nitrogen
Total organic carbon (as total C or COD/3) (TOC)
Total phosphorus
Zinc and compounds (as Zn)

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As presented in Figure 1, the European Industrial Emissions Portal (European Environment Agency, 2022b) has mapped the 'Waste and WW management' facilities in EU-MS. These facilities concern Urban WW treatment plants (with the exception of certain cases that can be identified when investigating a certain region with a certain purpose). The European Industrial Emissions Portal (European Environment Agency, 2022b) covers over 60,000 industrial sites from 65 economic activities across Europe in Table 2. The mapping of 'Intensive livestock production and aquaculture' is out of the scope of WalNUT. Moreover, in the European Industrial Emissions Portal (European Industrial Emissions Portal, 2022) one can have access to waste and waste water management sector in Table 3 in the EU. The latest presented data are regarding 2020.

Table 2: The sectors of the activities mapped in the Industrial Emissions Portal

Sectors
Energy
Production and processing of metals
Mineral industry
Chemical industry
Waste and WW management
Paper and wood production and processing
Intensive livestock production and aquaculture
Animal and vegetable products from the food and beverage sector
Other activities

This section provides a close-up view at country level on the most common released pollutants and the total releases at the facility level. By hovering over the bars one can find out the contribution of each facility to the emissions of the selected pollutant in the country of their selection. When clicking on the emissions values in the table below the chart (Figure 1), they will find a link to the website where the facility is located (clicking this link opens a new window).

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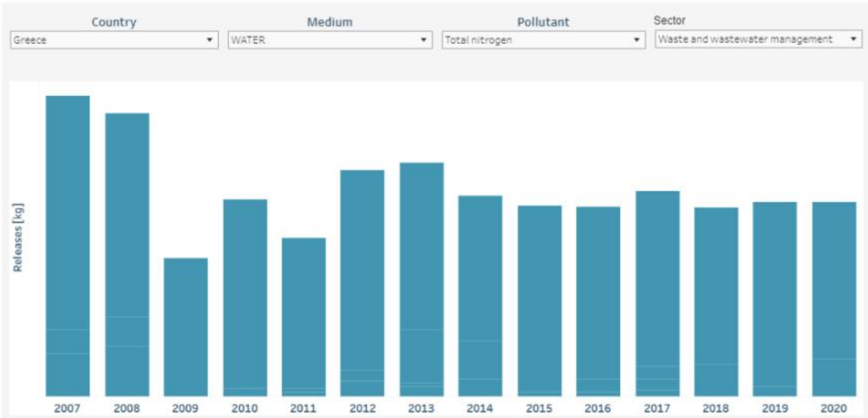

		2012	2013	2014	2015	2016	2017	2018	2019	2020
EYDAP S.A. - PSYTTALIA WASTEWATER TREATMENT PL..	PSYTTALIA	2,670	2,790	2,420	2,290	2,210	2,440	2,620	2,660	2,610
EYATH S.A. – SINDOS WASTEWATER TREATMENT PL..	SINDOS	0,525	0,531	0,637	0,465	0,460	0,473	0,345	0,406	0,419
EYDAP S.A. - METAMORFOSI WASTEWATER TREATMENT PL..	ATHENS	0,130	0,220	0,107	0,185	0,203	0,217	0,185	0,172	0,153
GREATER VOLOS AREA WASTEWATER TREATMENT PL..	VOLOS	0,120	0,132	0,125	0,172	0,211	0,190			
WASTEWATER TREATMENT PLANT OF CHANIA	CHANIA	0,072	0,064	0,065	0,069	0,083	0,102			0,062
HERAKLION WASTE WATER TREATMENT PLANT	HERAKLION									
PATRAS WASTE WATER TREATMENT PLANT	PATRA	0,166	0,166							
	PATRA									
	PATRAS									
SANITARY LANDFILL VOLOS	VOLOS	0,093								
ARGOS – NAYPLIO – NEA KIOS WASTEWATER TREATMENT PL..	NEA KIOS									

Figure 1: Close-up view of Greece on the release of the registered WW treatment plants on nitrogen (European Industrial Emissions Portal, 2022)

In the case of large-scale urban WWTP (Figure 1) the ability to sell recovered P is a secondary economic driver for Nutrient Recovery. The main incentive is P removal to avoid valves and pipes damage by struvite precipitation and reduce the OPEX. Typically, the expenses associated with struvite precipitation issues inside a medium-sized WWTP (25 MGD = 25 106 gallon per day multiplied by 4.54 litres per gallon is 113,500,000 litres per day) surpasse US $100,000 or 83,366.68 euros per year. Depending on the size of the treatment plant, the overall savings could range from 1,470 € to 7,350 € per 4,540 m^3 when accounting for the reduction in operational and maintenance costs brought on by struvite scaling, including chemical addition for chemical struvite precipitation, manpower, and maintenance costs (Achilleos, Roberts, & Williams, 2022). The cost savings is calculated to be 0.97 €/m^3 of waste water if a mean price is considered.

In the Portal, it is stated that the threshold for total nitrogen release in the water is 50,000 kg/year. Accordingly, industry does not have to report total phosphorus emissions as long as they are under 5,000 kg/year. In order to calculate the dimension of the P-leakage, it is enough to mention that for a 150 bushel per ha soybean crop, there is a 53.8 kg P/ha demand for P_2O_5 fertiliser to maintain P levels. Introducing the soybean cultivator to an approximate P- recovering industry would guarantee the autonomy of ~100 ha for a year.

According to the European Industrial Emissions Portal, in 2020, in France, the leakage of total nitrogen and phosphorus in the water bodies from industrial emissions (Table 3) surpassed 41,777 t and 228 t, respectively. The number of industries is also mentioned in the right column of Table 3 for a more explicit interpretation of the data of N and P emissions. Table 3 reports on both urban and industrial waste water-based N and P emissions in order to pinpoint that 38,924 t of N and 2,961 t of P were emitted during

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urban waste and waste water treatment practices in the status of France in 2020. Such data can be accessed (European Industrial Emissions Portal, 2022) to better interpret the necessity for the inclusion in 'other practices' of valorization of waste water – based products as fertilisers as a way to avoid and thus limit N and P emissions to such an extend in all EU-MS, as an outcome of the implementation of WalNUT's delivered pilot plants.

Table 3: Industrial N and P emissions in France in 2020 (European Industrial Emissions Portal, 2022).

Nutrient/Pollutant	Industrial sector	Emission (kg)	No of industries
Total N	Urban Waste and Waste water Treatment	38,924,400	21
Total P	Urban Waste and Waste water Treatment	2,961,240	66
Total N	Chemical Industry	2,147,800	13
Total P	Chemical Industry	32,400	2
Total N	Energy Sector	414,500	4
Total P	Energy Sector	38,140	4
Total N	Paper and Wood production and processing	867,000	4
Total P	Paper and Wood production and processing	99,900	5
Total N	Production and Processing of Metals	186,300	2
Total P	Production and Processing of Metals	–	–

Moreover, the so called pollutants reported in the (European Industrial Emissions Portal, 2022)) are actually not valorised nutrients with the potential to be used as bio-fertilising products. The need of EU to be independent of fertilizing products' imports needs to be highlighted. In matters of supply and demand, as demand increases uncritical disposal of economically prime important nutrient resource-based products will no longer be a sustainable option. And this effort cannot be differentiated between the public (urban waste water) and private (industrial waste water) sectors. One could assume that enforcement of stricter effluent disposal criteria to implement N and P release reporting even from small-scale industries by the public administration would facilitate the transition to gradual obligation to their recovery thus the implementation of Nutrient Recovery options in WWTP and the synthesis of WW-based bio-fertilisers (in addition to the re-use of not valorised nutrients) and definitely avoid their disposal. Such legal obligations for the recovery of nutrients from WW streams, along with others that will be further discussed in D1.4 'Barriers on BBF development' would guarantee the

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valorization of economically prime important nutrient resource-based products as bio-based fertilisers.

Phosphate rock is the raw material used to make most commercial phosphate fertilizers on the market. Phosphate cannot be used as a fertilizer because it is insoluble, but it can be used as a fertilizer. In the past, ground phosphate itself was used as a phosphorus source in acidic soils. Black phosphorus is the most stable form. Atoms are bonded like graphite in wavy layers. Red phosphorus is more thermally stable than white phosphorus. It is a white waxy solid. It is soft and can be cut with a knife. It is also called yellow phosphorus because it turns yellow when exposed to light. Phosphate fertilizers are made by adding acid to crushed or powdered rock phosphate. Using simple or ordinary sulfuric acid, phosphate (SSP) with a phosphorus content of 16-21% is formed as phosphorus pentoxide (P_2O_5). There are many commercially available phosphorous fertilizers such as phosphate rock, phosphoric acid, calcium orthophosphate, ammonium phosphate, ammonium polyphosphate and phosphate nitrate.

'In 2020, the top exporters of Phosphorus were Vietnam ($251M), Kazakhstan ($213M), United States ($39.8M), Poland ($25.8M), and Russia ($21.1M). In 2020, the top importers of Phosphorus were India ($115M), Germany ($95.2M), Poland ($72.9M), Japan ($62.9M), and Czechia ($38.3M)' (Kanbrik.com, 2022).

'In 2019, top importers of Phosphorus from Kazakhstan were European Union ($152,213.64K, 59,520,600 Kg), Germany ($58,334.15K, 21,690,900 Kg), Czech Republic ($47,156.45K, 19,305,600 Kg), Poland ($47,131.88K, 18,576,100 Kg), United States ($18,474.06K, 6,427,430 Kg)' (World Integrated Trade Solution, 2022).

In 2019, 'European Union imports of Phosphorus was $220,277.73K. European Union imported Phosphorus from Kazakhstan ($152,213.64K, 59,520,600 Kg), Vietnam ($57,309.52K, 17,996,700 Kg), China ($7,042.31K, 1,537,360 Kg), Japan ($1,426.72K, 404,762 Kg), India ($1,210.46K, 237,727 Kg), United States ($862.78K, 227,052 Kg), Russian Federation ($12.67K, 2,459 Kg) Australia($3.45K, 1,278 Kg)' (World Integrated Trade Solution b, 2022).

TIn Europe, phosphorus (71% of EU supply from Kazakhstan), phosphate rock (24% of EU supply from Morocco) and magnesium (93 % of EU supply from China) are listed as 'Critical Raw Materials' given their economic importance and risk of supply shortage (Publications Office of the European Union, 2022). Increase in nutrients' demand due to the global population increase, the finite area of arable land and the decreased supply due to the already reported physical depletion of non-renewable mineral resources will lead to a nutrient market price increase that will ultimately render the recovery of nutrients inevitable. This scenario could evolve in the close future (e.g. in Canada in 2008, there was an eightfold price increase from CAD 50 per ton P to CAD 400 per ton, due to an expansion of mortgage credit that resulted in the subprime crisis (2007-2010)). Simultaneously, the current status of NR practices is very limited since the price of nutrients recovered from WW streams does not make NR practices feasible/sustainable/profitable/competitive and WW producers/WWTP cannot be motivated to invest.

Regarding phosphorus recovery however, one has to keep in mind that elemental phosphorus refers to the specific forms of the element phosphorus (P) in which it is produced as an isolated element (P 4) in dedicated electrothermal reducing furnaces (in different forms: white/yellow or red phosphorus). White/yellow and red phosphorus are not used for the production of fertilisers. Phosphate rock is a raw material for fertiliser

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production. 84% is exported from non-EU countries (20% from the Russian Federation and 5% from Syria which is also controlled by Assad government, Russia and Iran). The low cadmium (20-25 mg/kg and low uranium) Russian magmatic phosphate rock is imported from Kola (Russia) (20 %) and another 5 % is imported from Syria. The high cadmium (60-200 mg/kg) and high uranium (10-210 mg/kg) Morocco sedimentary phosphate rock is imported at the level of 24% and it will most likely not be possible to use after July 16th, 2022 as of EU (Reg) 2019/1009. Cadmium removal of this material is extremely costly and technically challenging, as well as demanding in high amount of process sweet water, that is not available in the Sub-Sahara.

1.2. References

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