European Sustainable Phosphorus Platform

ESPP position on EU Strategic and Critical Raw Materials

Public Consultation and proposed Amendments to draft EU Critical Raw Materials Act COM(2023)160

Summary of proposed Act and background documents: ESPP eNews n°74

Public consultation to 30th June 2023 HERE *- draft Act and other documents - European Commission Critical Raw Materials web page:*

Summary:

Elemental Phosphorus P_4 and Purified Phosphoric Acid should be on the EU Strategic Raw Materials List. Both are essential for all identified 'Strategic' industries: batteries, renewable energy, electronics-data, aerospace. All these sectors need phosphorus flame retardants to meet fire safety requirements. The EU is import-dependent for P_4 on China, Vietnam and Kazakhstan. Also, **food security should be recognised as "Strategic" for EU**.

Without phosphorus it is impossible to manufacture chemicals necessary for:

- **Batteries**: lithium ion battery electrolytes ($LiPF_6$)* and lithium iron phosphate battery cathodes ($LiFePO_4$)**.
- P-acid **fuel cells****
- **Electronics**: microchip production*, semiconductor doping*.
- Lubricants and **hydraulic fluids** (power and control systems)*.
- Steel **anticorrosion****.
- **Fire safety** of polymers, composites, cables, circuit boards, natural and synthetic fibres, wood, etc. ***

* = Elemental Phosphorus (P_4 and derivates), ** = Purified Phosphoric Acid, *** = both

All the 'Strategic' industries need phosphorus-based flame retardants to meet fire safety requirements, to meet obligatory safety standards and to achieve proactive industry safety specifications. Fire safety requirements and the need for phosphorus flame retardants are increasing due to fire risks related to batteries, ubiquitous electronics (connectedness of things), data transmission dependency. Phosphorus flame retardant demand is growing 6-8% per year.

The EU is 100% dependent on imports of elemental phosphorus (P_4), and supply is almost entirely limited to three countries: China, Vietnam (dependent on electricity from China) and Kazakhstan.

Investment of around 20 billion € in phosphoric acid purification capacity is needed to supply PPA for "Strategic" industries in coming decades.

Including Elemental Phosphorus (P_4) and PPA (Purified Phosphoric Acid) in the "Strategic Raw Materials" list would allow "Strategic Projects" and appropriate company cooperation to re-establish P_4 production in Europe and to invest in acid purification capacity. An EU-funded project is developing technology to produce high-quality P_4 from wastes https://flashphos-project.eu/. Inclusion of Elemental Phosphorus in the "Strategic Raw Materials" list would enable public-private cooperation necessary for industrial implementation. This could enable the EU to achieve independence in P_4 supply. Several technologies are also today implemented to recover high-quality phosphoric acid (PPA) from sewage sludge incineration ash and other wastes, with significant development potential.

ESPP proposes to amend the proposed CRM Act to add Elemental Phosphorus (P_4 and derivates) and Purified Phosphoric Acid to the list of "Strategic Raw Materials".

ESPP also suggests that **food security should also be recognised as "Strategic" for Europe**. We propose that the CRM Act should specify that, within four years, raw materials critical for food production should be identified as "Strategic", and that supply and recycling targets and resilience actions should be defined in the same way as for technological materials.

The CRM "Phosphorus" (P4) should be a "Strategic" Raw Material

Elemental phosphorus (P_4 or "white phosphorus") is a specific form of phosphorus, produced only in dedicated P_4-furnaces, and which is non-replaceable (chemically required) in the production of many organophosphorus chemicals necessary for electronics, semiconductors, batteries, fire safety, hydraulic fluids, lubricants, pharmaceuticals, agrochemicals, catalysts, metal alloys … This is detailed in SCOPE Newsletter n°136 (2020, co-produced with nearly all relevant industry actors, and validated by the European Commission JRC and DG GROW).

The EU has extremely high supply risk for P_4. There is today no P_4 furnace in Europe (the last one closed in 2012). The EU is 100% dependent on imports, entirely[1] from only three countries: China, Vietnam (production largely dependent on electricity from China) and Kazakhstan.

P_4 is essential, in the "Strategic" technology sectors defined in the proposed CRM Act:

- **Electronics**: microchip production (thermal phosphoric acid for microchip etching), semiconductor doping.
- **Batteries**: for the electrolyte of lithium ion batteries ($LiPF_6$).
- **Fire safety of all "strategic" sectors**: electronic and electrical systems (circuit boards, components, wires and cables, optical fibres, casings …), 3D-printing, renewable energy (PV, wind …), batteries, electric vehicles, aerospace, … P_4 is non-replaceable to produce non-halogenated phosphorus flame retardants[2] used in polymers, composites, fire-protective coatings, organic electrolytes, and so is necessary to reduce fire risks and to ensure obligatory product fire safety standards[3].
- **Hydraulic fluids and lubricants:** essential for aerospace, renewable energy (wind turbines), electric vehicles and trains. P_4-derived additives reduce wear and corrosion under pressure, so improving reliability and increasing lifetimes of hydraulic systems and components.

Important growth of demand for P_4 is expected in all of these sectors, in particular:

- Fire safety: The need for phosphorus flame retardants is expected to **grow 6 – 8 % per year in coming decades[4]**, driven by increasing use of flammable materials (polymers and composites, natural fibres), demand for fire safety (accentuated by risks linked renewable energies and batteries, connected things, miniaturised electronics …).
- Batteries**:** rapid growth especially in electric vehicles, grid energy storage. World demand for P_4 for electric vehicle batteries alone is expected to reach 600 000 tP/y by 2035[5], meaning **current P_4 production would have to be more than doubled in a decade just for EVs**.

The JRC and CEA background documents show considerable confusion and misunderstandings concerning P_4 (called "Phosphorus" in the CRM list). Despite this, they identify P_4 as having very high supply risk (it is identified as having the highest supply risk of all raw materials for batteries, and amongst the highest 15 for several other technologies). They also identify some (but not all) of the essential uses of P_4 in the strategic technologies considered. They identify P_4 as essential for fire safety for "data storage and servers", but inexplicably do not consider fire safety for any other sector.

A project is being developed with EU Horizon 2020 funding (Flashphos) to produce very high-purity P_4 in Europe from secondary materials (such as sewage sludge) using innovative electrochemical technology. Recognition as a "Strategic" project could enable full-scale implementation by facilitating cooperation between the EU companies who are potential customers (art. 16 off-take agreements, art. 24 joint purchasing).

ESPP suggests that the CRM "Phosphorus" should be included in the list of "Strategic" Raw Materials

Proposed amendment:

Modify Annex I Section 1 to add: **"(x) Elemental phosphorus (P_4 and derivates)"**

[1] Except some within-company transfer from USA for use in agrochemicals, not relevant to P_4 in « Strategic » industry sectors.
[2] e.g. ammonium polyphosphates for coatings and polymers, phosphinates and polyphosphonates, red phosphorus, DOPO, …
[3] e.g. EU Construction Products Directive, International Electrotechnical Commission, International Maritime Organisation, Federal Aviation Authority, EN45545 for railways in Europe …
[4] Summary of a number of market studies in pinfa Newsletter n°148 www.pinfa.eu
[5] GTK – Proman at Vienna mineral resources workshop, 26th April 2023

The CRM "Phosphate Rock" (PPA) should be a "Strategic" Raw Material

Although use of phosphate rock in batteries and fuel cells is expected to remain a small proportion of total mined rock (c. 90% is used in food production: fertilisers and animal feeds), the EU faces **high supply risk for the Purified Phosphoric Acid (PPA), produced from phosphate rock, needed for "strategic" technology applications**.

The CRM "Phosphate Rock" as purified wet-route phosphoric acid PPA (not via P_4 = CRM "Phosphorus"), is used:

- to produce $LiFePO_4$ for **lithium iron phosphate (LFP) battery cathodes**, for which the market is expected to grow rapidly (see JRC Foresight Report).
- for **Phosphoric Acid Fuel Cells** (PAFCs), for which the market is also expected to grow rapidly (see e.g. here).
- for **anticorrosion treatment of steel**, including for applications in renewable energy, electric vehicles, aerospace, etc.
- **for fire safety**: to produce non-halogenated inorganic phosphate and nitrogen-containing phosphates, used in wood and cellulose materials and in some polymers (for these applications, P_4 is not required for the chemistry, but high levels of purity are necessary, so PPA).

Growth of LFP batteries alone may require 0.5 – 0.9 MtP/y in coming decades, see CRU Phosphates Conference 2023 here . This corresponds to 4 - 5 million tonnes/year of phosphate rock. This will thus remain a small part of the 20 - 30 MtP/y in phosphate rock mined annually worldwide (P content of c. 200 million tonnes/year of phosphate rock), see ESPP FactSheet, and of the wet-acid route "green" (non-purified) phosphoric acid derived from this rock (merchant grade acid MGA, used in particular in fertiliser production).

However, this "green" acid must be intensively purified, using specific technologies and installations, to achieve the high level of purity required in batteries, fuel cells or anticorrosion treatments (PPA). This will be competing with use of purification capacity to produce inorganic phosphates for food and beverages, toothpastes, and pharmaceuticals, because production of these is moving from energy-intensive thermal acid (from P_4) to wet-route acid, as P_4 will be increasingly used only in applications where it is essential (and which are growing, such as electronics, battery electrolytes, fire safety, hydraulic fluids and lubricants, water treatment …).

The world phosphoric acid purification capacity, is currently c. 1.4 MtP/y with around 30% of this capacity currently in the EU and over half of the capacity in China (AVECIENNE expert report for an ESPP member). This capacity is already used for other applications as indicated above (mainly food and beverage). A 30% to 50% increase in global phosphoric acid purification capacity is thus needed, to supply PPA for batteries and fuel cells, corresponding to a global investment of nearly 20 billion € (ESPP members' estimate: 150 M€ for 100 000 tP_2O_5/y purification capacity). If this phosphoric acid purification capacity is not built in the EU, then Europe will be dependent on imported purified acid for LFP batteries and PAFC fuel cells, as well as for other applications.

The JRC Foresight Report wrongly states that production of LFP battery cathodes requires P_4. This is incorrect (see our SCOPE Newsletter n°136, 2020, co-produced with nearly all relevant industry actors and validated by the European Commission JRC and DG GROW). However LFP cathode production does require highly purified wet-route phosphoric acid (PPA). This confusion may explain why phosphoric acid purification and PPA are not considered in the JRC Foresight Report, nor in the SCRREEN Factsheet background documents, leading to not include "Phosphate Rock"/PPA in the proposed list of Strategic Raw Materials.

ESPP suggests that, because of major supply chain risks for purification, "Purified Phosphoric Acid" (PPA) should be listed as a Strategic Raw Material.

Proposed amendment: Modify Annex I Section 1 to add: **"(x) Purified Phosphoric Acid"**

ESPP regrets that food security is not considered "Strategic"

A subset of around half of the materials on the "Critical" Raw Materials (CRM) List are identified as "Strategic", and for these materials only (not for other CRMs) EU supply resilience targets are specified and actions are proposed. This "Strategic" list targets technological uses only: energy, IT, aerospace – but not food security.

ESPP suggests that food security should also be recognised as "Strategic" for the EU.

The EU is self-sufficient in food production, but this is only possible because of import of raw materials necessary for agricultural production and food processing, in particular phosphorus (necessary for fertilisers and for animal feed, and around 90% imported).

Products and crops themselves are not covered by the draft Act, but raw materials critical for food production should be identified as "Strategic" and supply and recycling targets and resilience actions should be defined in the same way as for technological raw materials.

ESPP proposes that supply and recycling targets and resilience actions should be defined for the key plant nutrients (phosphorus, nitrogen, potassium), comparable to those for technological materials. We suggest to add this principle into the draft CRM Act with a timetable for defining targets and actions.

This will ensure coherence with EU policies on nutrients, in particular: Green Deal (Farm-to-Fork and Biodiversity Strategies) nutrient loss reduction targets, Circular Economy, Integrated Nutrient Management Action Plan, Soil Health, Common Agricultural Policy, energy policy (for nitrogen fertiliser production).

In the case of nitrogen, fertiliser supply is linked to natural gas supply and price, and to the development of Green Ammonia (using renewable energy) and of White Ammonia (nitrogen recycling).

Proposed amendments:

Add to preamble $1: *"There is a set of non-energy, non-agricultural raw materials that due to their high economic importance and their exposure to high supply risk … are considered critical.* ***Also, some raw materials with high supply risk are critical for agricultural production and so food security.*** *…."*

Add to preamble $4: *"The list of strategic raw materials should contain raw materials that are of high strategic importance, taking into account their use in strategic technologies underpinning the green and digital transitions or for defence or space applications …* ***This list of strategic raw materials should be later completed with a list of raw materials which are strategic for food supply****. …".*

Art. 3: add a point (4): "***The Commission shall assess and if appropriate propose an update of Annex I to add to the list of strategic raw materials, a list of raw materials and agricultural input supply chains identified as of the highest importance for EU food security,*** *by [OP please insert: four years after the date of entry into force of this Regulation] and every 4 four years thereafter*".

Clarification of terminology for the CRMs Phosphorus and Phosphate Rock

The JRC and CEA background documents show considerable confusion and misunderstandings concerning the two CRMs "Phosphorus" and "Phosphate Rock".

"Phosphorus" effectively means only the specific form of phosphorus P_4 (also known as White or Yellow Phosphorus) and its derivates or vector chemicals.

"Phosphate Rock" is defined in the current version of the SCRREEN Factsheet as "an indicator of phosphorus in different forms (mineral, organic) used in agriculture and industry (fertilizer chemicals or phosphoric acid, but also organic fertilizers, manures, crop products used as animal feed)."

The current CRM terminology also leads to confusion of stakeholders.

Proposed amendment:

Modify Annex II Section 1 to read:
"(y) ~~Phosphate Rock~~ ***Phosphate rock and derivates****"*
"(z) ~~Phosphorus~~ ***Elemental phosphorus (P_4) and derivates"***

The supporting documents are confused and misleading on phosphorus

The JRC Foresight Report cites "Phosphorus" (P_4) as essential for all five technology sectors considered as "Strategic", and as one of the highest supply-critical materials, but then fails to propose it as a "Strategic Raw Material". However, it also misses identifying a number of essential uses of P_4 relevant for many of the technologies considered. The report does not identify or address the supply-chain criticality of acid purification for "Phosphate Rock" (Purified Phosphoric Acid = PPA).

This report contains significant errors suggesting confusion between the two CRMs "Phosphorus" (P_4) and "Phosphate Rock" (phosphorus – P – in any form). For example, the need for P_4 in batteries seems to be based on the error that P_4 is needed to produce lithium iron phosphate for LFP battery cathodes. This is incorrect: battery grade $LiFePO_4$ can be and is already today produced via purified merchant-grade phosphoric acid = PPA (see SCOPE Newsletter n°136, 2020, which was co-produced with and validated by nearly all relevant industry actors, and by JRC and DG GROW). The report further suggests that LFP batteries will compete with fertiliser production for phosphate rock (this is referenced to only one P-rock mine project company's commercial press release, Epstein 2022). This is largely wrong: LFP is expected to only represent a few percent of mined phosphate rock use (see above).

The Report also notes (p.90) that P_4 is increasingly essential for fire safety, but only for data storage and servers, stating "*increasing move to green materials and chemicals … Phosphorus flame retardants (PFRs) are often proposed as alternatives to brominated flame retardants (BFRs)".* The report however ignores the essential need for phosphorus in fire safety for all of the other "Strategic" industry sectors: batteries, computers, wind turbines, photovoltaics, heat pumps, space-satellites, 3D-printing, etc … These all depend on flammable polymers and composites in e.g. printed circuit boards, wires and cables, casings (ensuring electrical insulation), components, structural elements …

Other essential uses of P_4 in the considered technology sectors are not cited, in particular thermal phosphoric acid for micro-chip etching, phosphine for semi-conductor doping (partial modification of Si to P in semiconductors), production of gallium indium phosphide and indium phosphide which cannot be produced without P_4 (despite these materials being cited in the report).

Phosphate rock is indicated as needed for data transmission networks, but for none of the other technologies (p84), with no explanation (p.81). This is probably again confusion between "Phosphorus" (P_4) (cited for fire safety for this application) and "Phosphate Rock". There is no specific need for "Phosphate Rock" (or purified wet-route phosphoric acid PPA) in data centres.

Overall, the designations of which technologies require "Phosphorus" (meaning P_4/derivates) and which require "Phosphate Rock", and why, are largely unexplained, often incoherent, have important omissions, and in some cases seem to be based on erroneous information, inappropriate references and confusion between these two CRMs.

The SCRREEN2 input to the CRM Act also confuses the two CRMs 'Phosphorus' (P4) and 'Phosphate Rock' and contains relevant errors. ESPP had understood that the EU-funded SCRREEN2 project (3 million € EU money, led by the French Atomic Energy Commission CEA), was supposed to deliver input information to support the update of the CRM List, in the form of SCRREEN2 CRM "Factsheets". The project has apparently failed to do this in time for Phosphate Rock and P_4, in that the draft Factsheet (not dated, version online 19th March 2023) contains errors suggesting an embarrassing lack of relevant understanding. For example, sodium is cited as one of the three main plant nutrients p.16. The SCRREEN2 authors do not seem to understand the chemical difference between "phosphate" and "phosphorus", in that on p.26 phosphate is calculated to have the molar weight of the element phosphorus.

Importantly, this SCRREEN2 Factsheet confuses the CRM "Phosphate Rock" with "Phosphorus" (P_4) by treating both in the same Factsheet. The separation into two Factsheets of the two different CRMs Phosphate Rock and P_4 was requested by ESPP six months ago, but is apparently not done in time to input to the CRM Act.

ESPP has pointed to these problems of confusion and understanding already at SCRREEN2 workshops and in letters in July and September 2022 (see HERE). Many comments are not taken into account in this draft Factsheet. This failure of SCRREEN may explain the apparently confused treatment of P_4 in the JRC Foresight Report.

ESPP suggests that future reassessments of Critical and Strategic Raw Materials should engage experts with understanding of phosphorus, its chemistry, its uses and its cycle.