RecoPhos



www.RecoPhos.org

# The thermo-reductive RecoPhos Process

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From Sewage Sludge Ashes to elementary Phosphorus for industrial Applications

**Dr. Daniel Steppich**

SGL GROUP – The Carbon Company

RecoPhos – Demonstration Event
Leoben, February 24th 2015

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# RecoPhos - Project

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## Company profile:

SGL GROUP
THE CARBON COMPANY








- One of the world's largest manufacturers of carbon-based products
- Comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites
- 43 production sites worldwide
- Service network covering more than 100 countries
- Sales of ~€ 1.5 bn in 2013
- Head office in Wiesbaden/ Germany
- ~ 6,300 employees worldwide
- Stock listed in Germany

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# Outline

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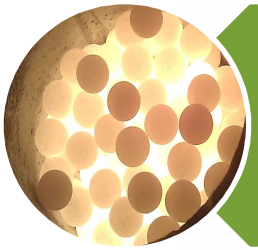
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***Sewage Sludge Treatment***



***Production of elementary Phosphorus***



***Thermal Phosphorus – Market Overview***

# Sewage Sludge Treatment
## Europe

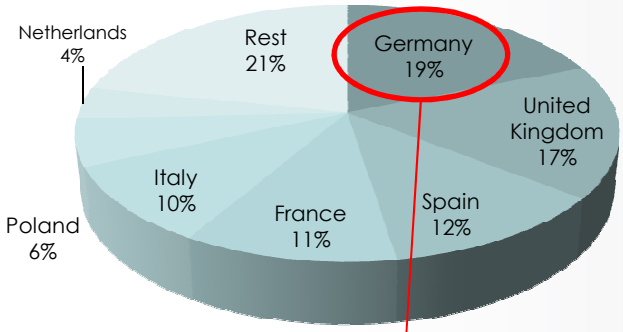
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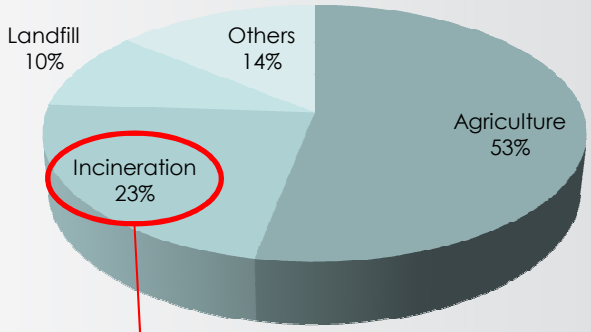
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**Sewage sludge production (~10 Mio mt DM per year)**




Significant share of thermal treatment in Germany

**Sewage sludge disposal routes**




Mono-incineration prerequisite for P recovery

**Germany has the biggest market place in Europe**

**References:**
- Brandt, Masterarbeit „Nutzung von Klärschlamm als Rohstoffquelle“, Universität Rostock, 2011
- Eurostat, 2011

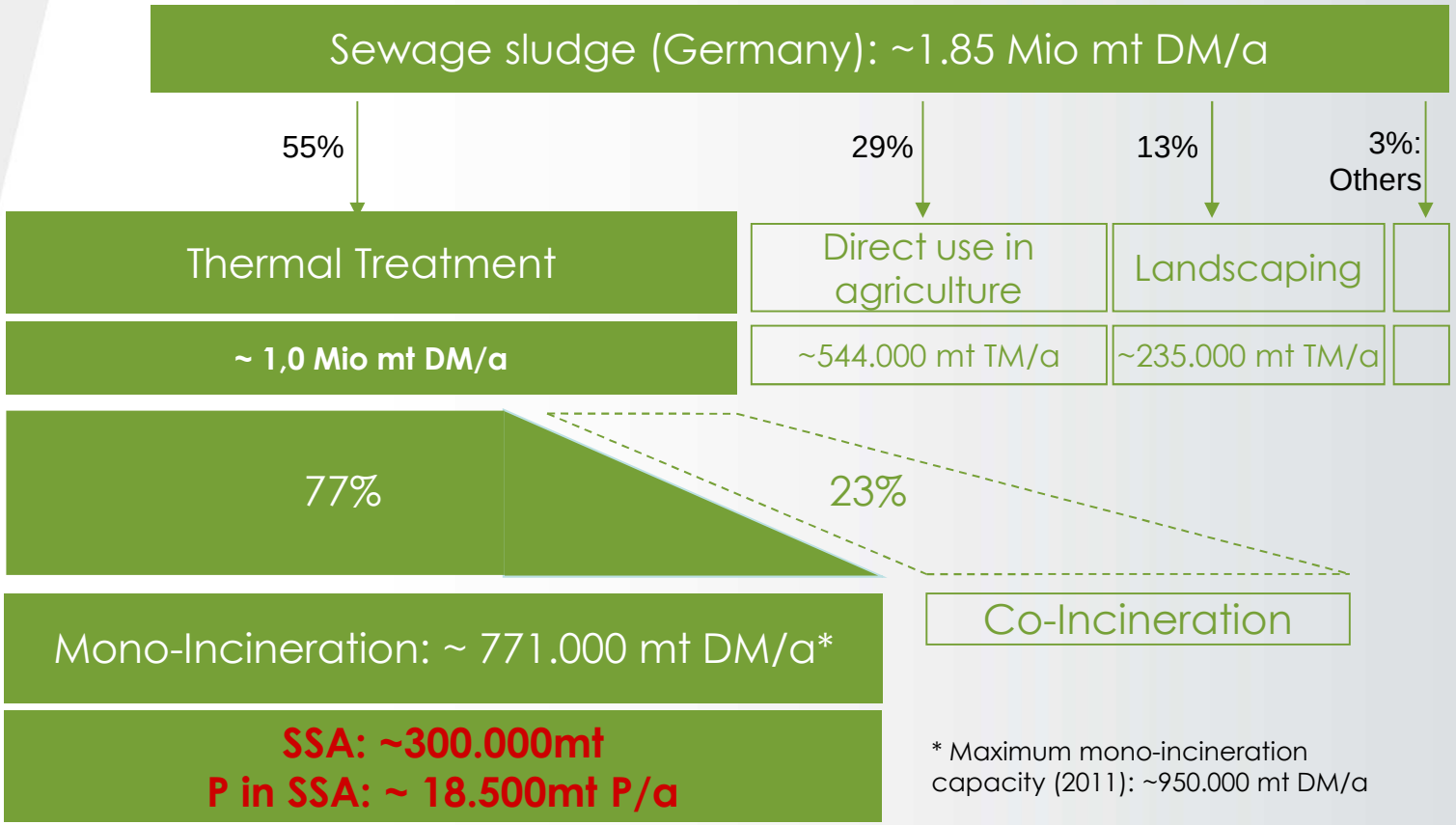
# Sewage Sludge Treatment
## Germany

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* Maximum mono-incineration capacity (2011): ~950.000 mt DM/a

**References:**

- Krüger, Monitoring von Klärschlammmonoverbrennungsaschen hinsichtlich ihrer Zusammensetzung zur Ermittlung ihrer Rohstoffrück-gewinnungspotentiale und zur Erstellung von Referenzmaterial für die Überwachungsanalytik, Texte 49/2014, Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit
- Statistisches Bundesamt, Pressemitteilung Nr. 421 vom 12.12.2013: https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/12/PD13_421_32214.html

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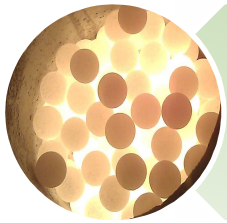
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*Sewage Sludge Treatment*



**Production of elementary Phosphorus**



*Thermal Phosphorus – Market Overview*

# Production of elementary P
## Woehler - Process

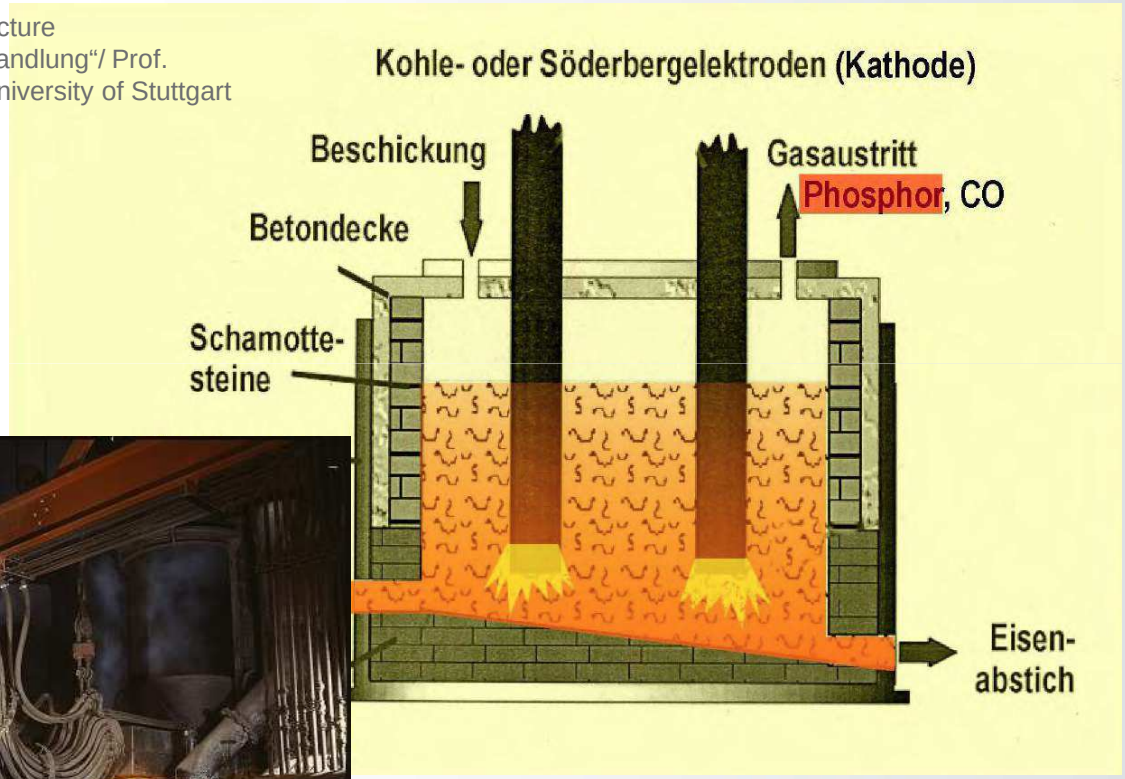
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Reference: Lecture „Schlammbehandlung“/ Prof. Thomanetz, University of Stuttgart






After termination of Thermphos in 2012 there is **no European producer of elementary phosphorus**.

# Production of elementary P
## RecoPhos - Process

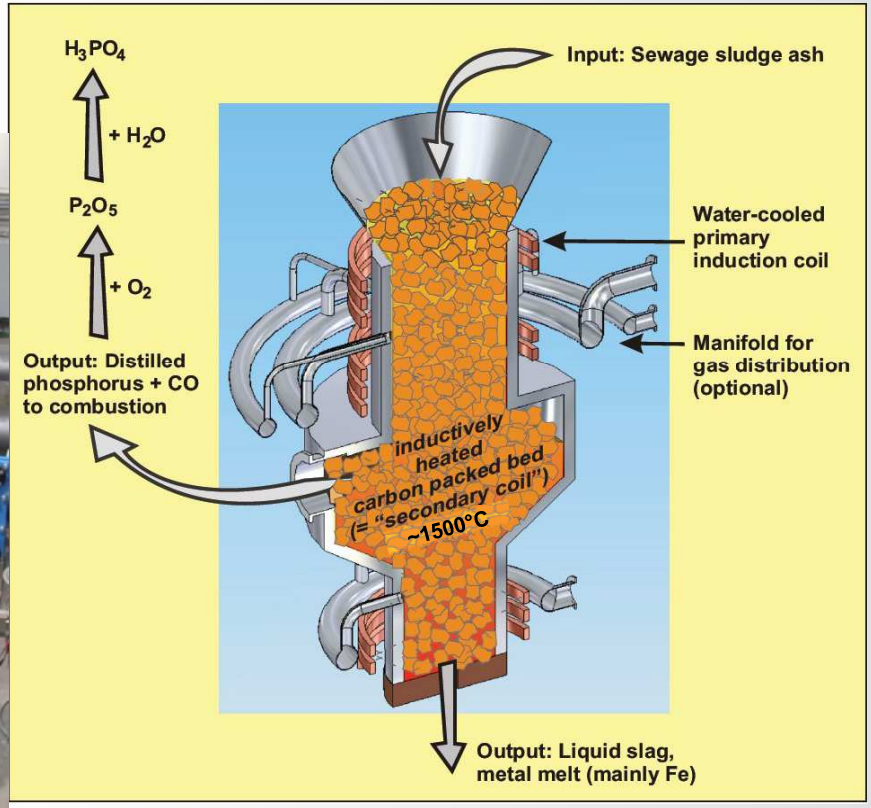
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# Production of elementary P
## Comparison

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| Woehler process | RecoPhos Process |
|---|---|
| High CAPEX, maintenance costs -> needs high throughput to be economical | Simple design, easier maintenance, smaller scale possible |
| Pelletizing/ sintering of raw material required (including binder) | No pelletizing/ sintering |
| Woehler process cannot accommodate with high content of SSA (P-loss to $Fe_xP$) → Only SSA from Al-precipitation | RecoPhos can run entirely on SSA; SSA from Al-precipitation possible |
| Energy efficient heating due to furnace design (>95%) | Energy demand comparable to Woehler process; slightly higher heat losses in product gas stream |
| By-products: Construction material | RecoPhos slag to be used in cement or concrete industry |

# Production of elementary P
## Energy Consumption (calculated*)

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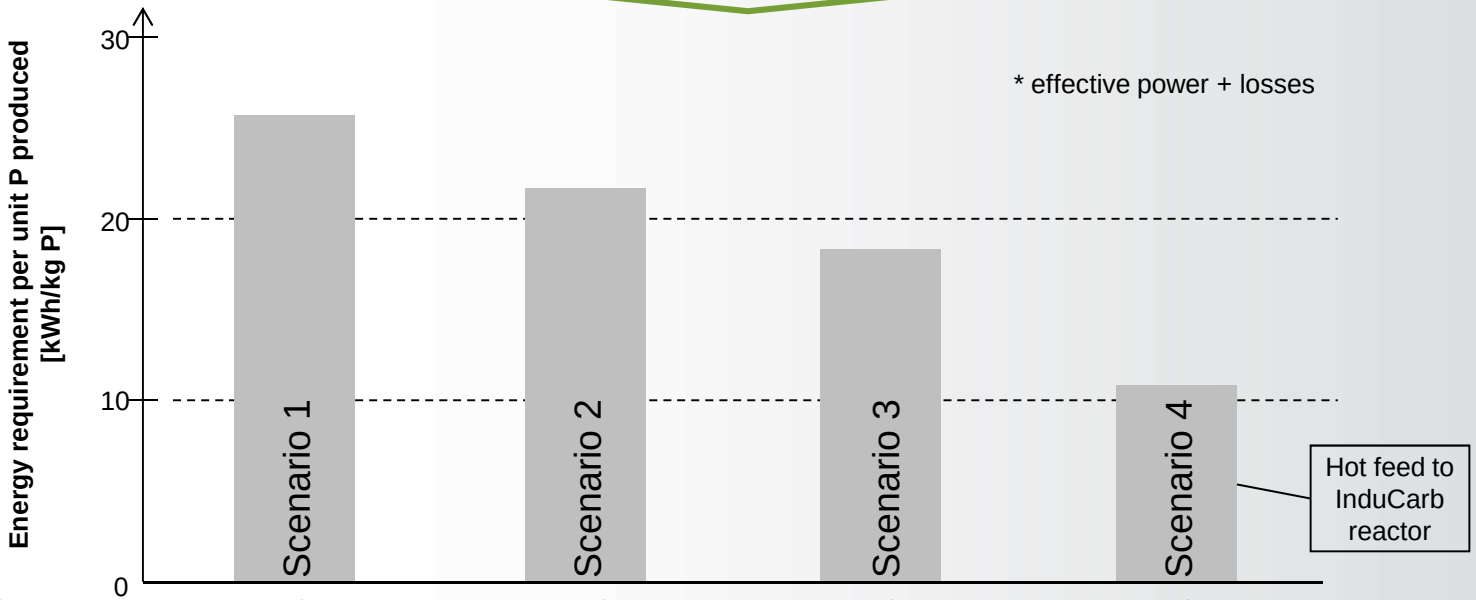
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| System | Input Materials |
|---|---|
| • Efficiency induction system ~ 0.9<br>• heat demand /power input ~ 0.8 | P-content (6-13%), Additives (~12% C, slag tuner), Fe-rich/ Al-rich ash, … |

**Process**

P recovery efficiency (60– 90%)




| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Power input* | 600kW | 600kW | 600kW | 400kW |
| P recovery rate | 70% | 85% | 85% | 85% |
| Additives | 120kg/h | 120kg/h | 60kg/h | 60kg/h |

Calculated for a reactor comprising a throughput of ~500kg sewage sludge ash per hour; P conc ~ 8%; Fe conc. ~11%

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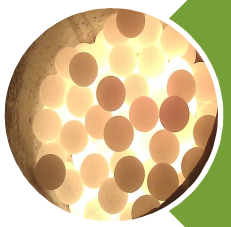
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*Sewage Sludge Treatment*



*Production of elementary Phosphorus*



***Thermal Phosphorus – Market Overview***

# Thermal Phosphorus – Market Overview

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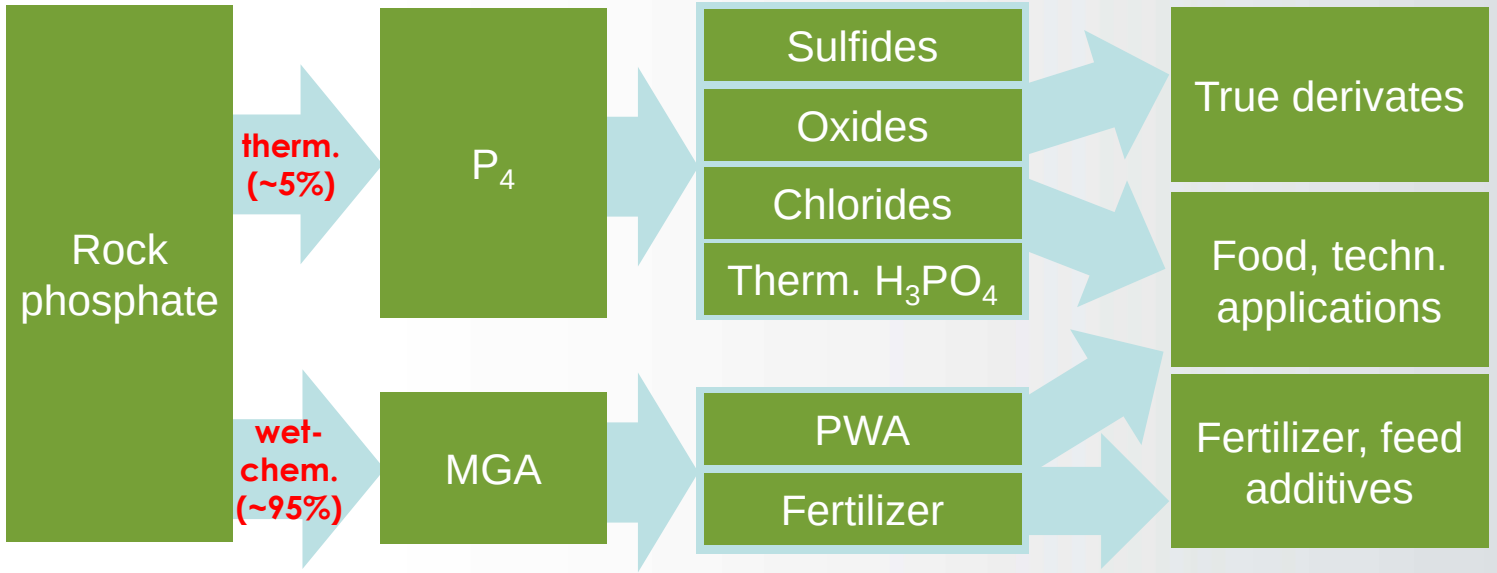
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## Value Chain

Raw material → End product




MGA: Merchant Grade Phosphoric Acid
PWA: Purified Wet Acid

# Thermal Phosphorus – Market Overview

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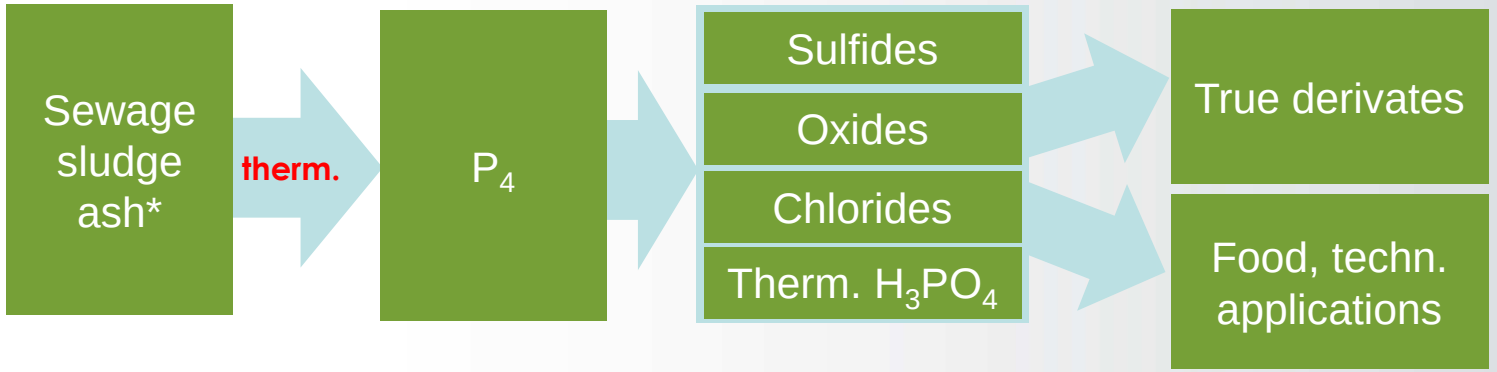
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## Value chain - RecoPhos

Raw material → End product




From sewage sludge ash to elementary P as raw material for industrial applications!

* ~300.000 t/a in Germany

# Thermal Phosphorus – Market Overview

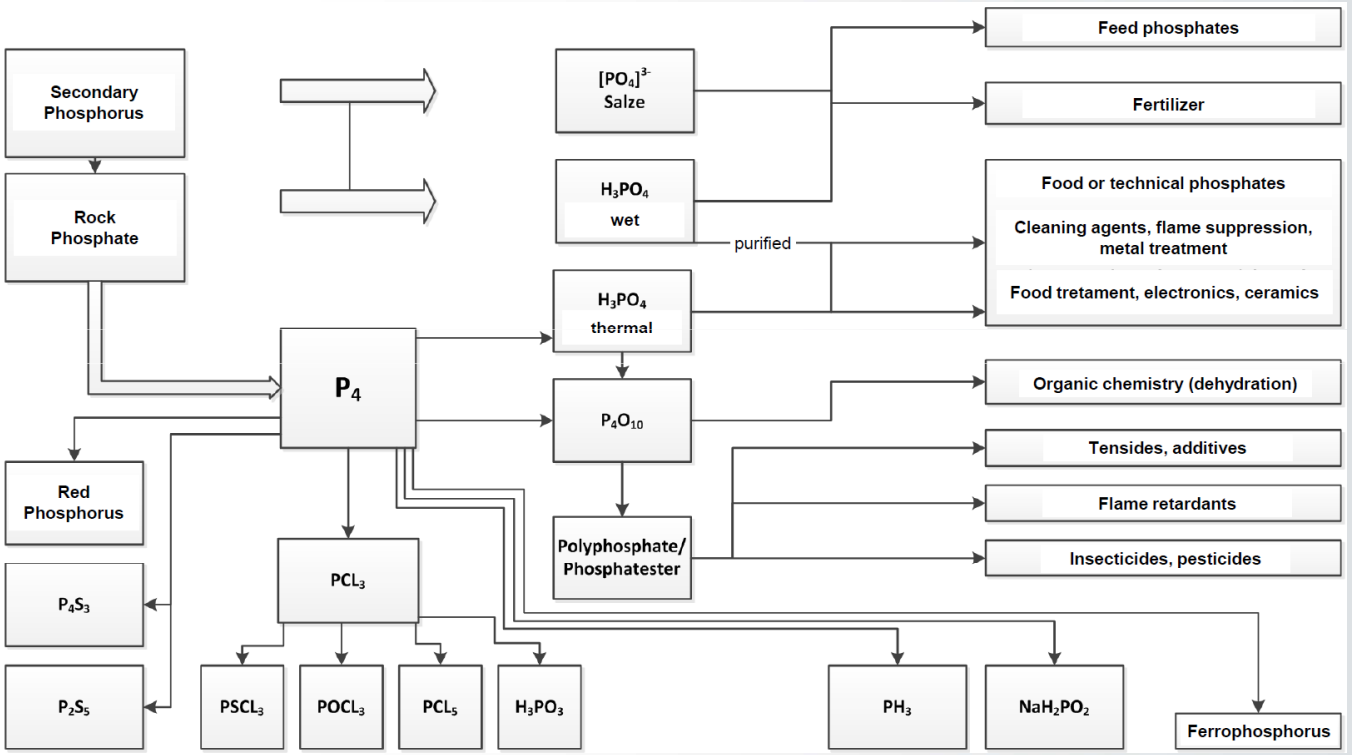
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## White Phosphorus Product Tree




Further applications of elementary phosphorus include (but are not limited to) flame retardants, additives in chlorinating, batteries, herbicides, pesticides, catalysts, chemical synthesis, disinfection, plastic production, reduction, pyrotechnics, bleaching, lubricants, corrosion protection, water treatment, doping, matches, etc.



**References:**

Gantner, Schipper, Weigald, “Technological use of phosphorus: the non-fertilizer, non-feed and non-detergent domain”, Appendix 8, in: Sustainable Phosphorus Management: A Global Transdisciplinary Roadmap (Scholz et. al.), 2014

# Thermal Phosphorus – Market Overview

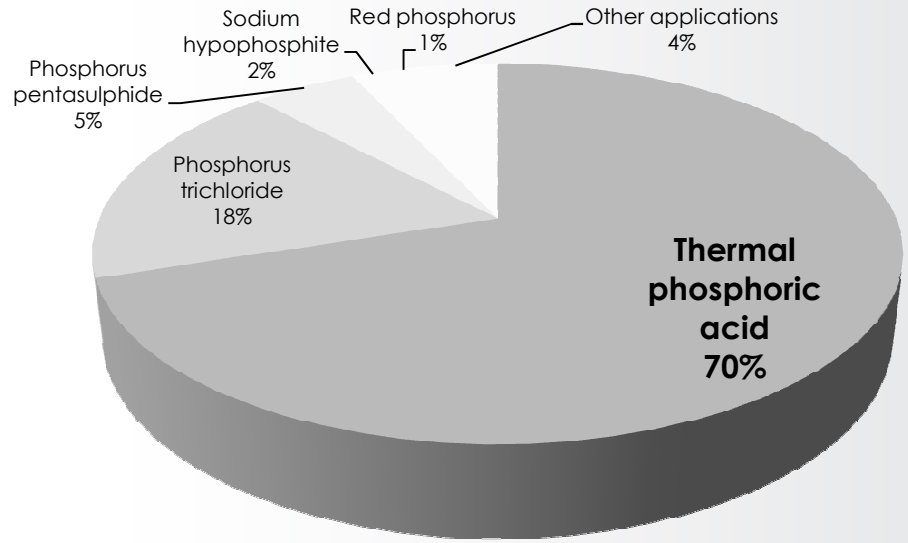
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## Annual production of elementary P ~850.000mt /a




China, US, Kazakhstan and Vietnam cover most of the world production.

EU market for thermal phosphorus ~ 80.000 - 100.000mt/a

P production of a typical submerged arc furnace ~25.000mt/a



**References:**
http://www.essentialchemicalindustry.org/chemicals/phosphorus.html

# Summary

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- Germany largest producer of sewage sludge ashes in Europe
- Sewage sludge ash as the main input material for the thermo-reductive RecoPhos process
- Production of elementary phosphorus for applications outside the fertilizer industry
- All process by-products are economically valuable

# Thanks a lot!!!

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