European Sustainable Phosphorus Platform

January 2016 n° 118

SCOPE NEWSLETTER

Bio-nutrients Circular Economy

ESPP General Assembly
Objective: bio-nutrient circular economy

ESPP work on policy proposals to support widespread nutrient recycling

European Union
Circular Economy Package

Nutrient recycling features strongly in EU Commission's new proposals and in responses to public consultation

Naantali Spa, Finland
Circular economy opportunities

EU EIP-AGRI workshop on agriculture and forestry circular economy case studies

Waste management industry
Circular Economy for C, nutrients and soil

International Solid Waste Association (ISWA) report: challenges and barriers to nutrient circular economy

Public policies

Switzerland
P-recovery made obligatory

Regulation approved makes P-recovery from sewage

Greece, Poland
Enforcement of EU sewage treatment law

Member States faces fines for not treating wastewater.

European Environment Agency (EEA)
Analysis of P resource taxation

Report for EEA assesses feasibility and impacts of resource taxation for iron/steel, copper and phosphorus

USA agriculture economics
Impacts of P taxation

Modelling impacts of externalities taxation or scarcity on P use, farmers' incomes, manure spreading

RISE ExpoMilano
Sustainable intensification and nutrients

Janez Potočnik and RISE launch study to identify obstacles, policies and incentives to develop nutrient recycling.

Resource recovery

IWA Compendium
State of the art

Report on water, energy and resource recovery

Ghent RR2015
IWA 1st Resource Recovery Conference

RR2015 presented R&D into recovery of minerals, nutrients and organic chemicals from waste waters.

ManuREsource
2nd international manure conference

Manure management, processing and recycling as organic or mineral fertiliser products

Summary table
Water resource recovery networks

The different networks, their objectives and roles.

Nano form calcium phosphates

Nano hydroxyapatite (HAP)
Safety of use in consumer products

Risk assessments of nano HAP in cosmetics and toothpastes

ESPP General Assembly minutes (2/12/2015) are now available on our website: administration, budget, actions, 2016 projects.

Sustainable Phosphorus Platform
International e-discussion group launched

Online exchange on P sustainability: use, impacts, resources and recycling, in agriculture, diet and nutrition, industry, chemistry, soil and water. ***Join now at:***

https://groups.google.com/d/forum/sustainablephosphorusplatform

The partners of the European Sustainable Phosphorus Platform

Bio-nutrients Circular Economy

ESPP General Assembly
Objective: bio-nutrient circular economy

The ESPP General Assembly, Brussels 2nd December 2015, launched discussions on what policies and tools are needed to enable widespread development of the bio-nutrient circular economy, not only in specific cases such as high nutrient excess regions or biological nutrient removal sewage works, but throughout agriculture and water treatment in Europe.

Six speakers presented policy assessments and proposals developed in different countries, **economic policies needed to make nutrient recycling generally competitive with mineral fertilisers**, and **synergies with sustainable organic carbon management** (biogas production, improving agricultural soil fertility and resilience).

Speakers slides are online
at www.phosphorusplatform.eu *under Downloads*

Chris Thornton, ESPP, outlined the challenge. Today sees a wide range of **success stories** in Europe, including innovative new P-recycling technologies producing mineral phosphate products (e.g. NuReSys, Ostara, Ecophos …see SCOPE Newsletters 115, 111) or organic fertilisers (e.g. COOPERL, Scope 114) to social innovation to enable high levels of recycling of organics (e.g. separative collection of food waste in Milan, REVAQ sewage biosolids certification in Sweden, SCOPE 111). However, **these are today driven by waste disposal costs or obligations, regional nutrient excesses, or specific water treatment operating conditions, but not by the economic value of the recovered nutrients**.

Removing regulatory barriers (e.g. revision of the EU Fertiliser Regulation) will facilitate emergence of such successful business cases in specific favourable contexts, but **will not enable a generalisation of nutrient recycling**.

Job creation in rural regions

Yet, the bio-nutrient circular economy offers **massive potential to generate distributed employment** (jobs in rural areas and small towns) and potential to contribute to farmers' incomes (see Ellen MacArthur "Growth Within" in SCOPE 114). However, this requires to address the cost difference between recycling (which is intensive in labour costs in processes, local logistics, management of variable and specific products) and mineral fertilisers (which despite price fluctuations, remain a relatively cheap commodity with high-volume logistics).

Katarina Svatikova, ***Trinomics***, presented conclusions of **assessments of fiscal policies and financial instruments** relevant to the circular economy, carried out for the Dutch and Scottish governments. A range of appropriate policy tools were identified as already in place, including R&D funding, grants and loans, tax credits, landfill tax, enhanced capital allowances, but these remain exceptional or marginal in their application to the circular economy. This makes **access to these tools difficult for operators, or perceived as difficult, in particular for SMEs.** Generally applicable policy tools (not requiring specific procedures) are needed, but these must also be targeted to be effective.

Fiscal and financial tools

Possible tools to support the bio-nutrient circular economy could include **innovation funds, reduced VAT for recycled products and services or a product levy on virgin minerals**.

Stephen Hinton, Swedish Sustainable Economy Foundation TSSEF, outlined how **fiscal approaches can modify the economic and financial drivers** in society, and so support the development of the circular economy. These conclusions are based on reports carried out for Sweden and Switzerland and on the European Environment Agency report on "resource taxation" (Oct 2015, see this SCOPE Newsletter).

Sweden: Teknikmarknad 2012-08-12 Norrköpings for a phosphorus resource neutral municipality
http://humlanviken.se/onewebmedia/Fosfor-och-kvaveneutral-kommun-v4-Norrkopings-kommun_2.pdf
Switzerland: "Experiences with price- and certificate based solutions to obtain environmental goals", not yet published

Externalities

Mr Hinton underlined the importance of **integrating externalities into mineral and fertiliser prices** (environmental impacts, resource consumption, but also export of jobs) and that this can only function if income from creation of jobs in Europe in recycling is redistributed, so that food price increases resulting from integrating externalities costs are affordable and acceptable.

The economic system is very complex and interactive, so that there is **no one simple solution**, and policies require monitoring, planning adjustment and communication.

Nicolas de la Vega, European Biogas Association (EBA), presented **synergies between circular economy policies for nutrients and biogas renewable energy produced by anaerobic digestion**. Electricity generation and heat production from biogas Europe is equivalent to supply of over 5 million households, and most of the input material comes from waste or by-product organic materials such as manures, sewage sludge, food waste, agri-food industry wastes, agricultural crop by products (non food parts of crop plants).

Biogas production is **geographically distributed**, both in urban settings (sewage works, food waste, green wastes), and in rural areas such as farms and in food production industries, generating thousands of distributed local jobs.

"**Digestate**", which is the stabilised residual after anaerobic digestion contains both nutrients and organic carbon, and can be a valuable fertiliser / soil amendment, in its untreated form but also in some cases after appropriate post-treatment (thickening or drying, composting).

Fertiliser products can also be recovered in **mineral forms**, e.g. by nitrogen-stripping from the anaerobic digester or by phosphate precipitation from the digestate.

EBA underline that the continuing development of biogas requires a **market system to ensure economic competitivity with fossil fuels** (e.g. ambitious new renewable energy directive targets, functioning carbon market, adequate support under European funds such as the ETS funds for Innovation and Modernisation). The challenges that renewable energies face in a fossil dominated energy market are many of the same as bio-nutrients compared to mineral fertilisers. Also, the regulatory context must be addressed to remove obstacles and facilitate the use of digestates as fertilisers: revisions of EU Fertilisers Directive, Waste Directive and Animal By-Products Regulation to foster recycling, exemption of digestates from REACH (see *http://phosphorusplatform.eu/regulatory*). The **greenhouse gas emissions reductions resulting from substituting the use of fossil fertilisers by digestate** need to be quantified and recognised, both in production and from soils.

Stefanie Siebert, European Compost Network (ECN), considers that there is a potential for recycling of 100 million tonnes/year of organic wastes (bio-wastes) in Europe, with a job creation potential of 20 – 50 000 jobs in e.g. separate collection, recycling.

ECN estimates the potential economic value of nutrients and organic carbon (humus) in these materials at around one billion and 0.5 billion €/year respectively.

Recycling of bio-wastes to digestates and composts reduces consumption of natural resources (mineral nutrients), reduces greenhouse emissions and **improves soil functionalities and productivity**. Composts and digestates can restore and increase soil organic carbon (humus). 45% of European soils are depleted in organic matter (COM(2006)231). Soil humus contributes to soil water retention and temperature regulation (climate change resilience), soil structure (limiting soil erosion) and to soil biological activity (nutrient availability and soil fertility).

ECN underlines that the **EU legal framework should better support separate collection of organic wastes, biological treatments and production and use of quality-assured composts and digestates**. Policy tools should include CAP reform to support carbon sequestration and agricultural use of recycled nutrients, enlarging the Renewable Energy Directive to take into account organic carbon in compost and digestate, and a "lead market initiative" for bio-based products (market incentives for recycled nutrient products).

Arthur ten Wolde, speaking on behalf of **Ecopreneur.eu**, presented a sustainable business perspective on circular economy development. Ecopreneur.eu is a new sustainable business association at the EU level representing five national associations including **De Groene Zaak**, with company members including 1500 SMEs.

He noted that many of the **models developed for circularity of consumer and industrial products** (e.g. pay per use, repair and refurbish, product design, take-back contracting …) may not applicable to most bio-materials. However, a number of Ecopreneur.eu proposals for the EU's circular economy policies are applicable:

- **binding targets for full use chain: reuse and recycling**
- **harmonisation** of EU legislation and guidelines for national action plants
- integration of recycling into **public procurement** (which represents 20% of EU GDP)
- **fiscal policies**: VAT differentiation on recycled products, tax burden shift from labour to resources (Green Deal). A clear price signal for consumers and producers is necessary.
- **extended producer responsibility**

- use of **Horizon 2020** and other specific funding for R&D, including into system and economic changes, development of quality criteria for secondary raw materials, and to support frontrunners

The EU Circular Economy Package published 6/12/2015 (see in this Newsletter) does not include targets beyond recycling, nor economic incentives for consumers or economic tax shifts, and these policies need to now be developed.

Bertrand Vallet, EUREAU, underlined that the water industry is interested to develop nutrient recycling, but faces difficulties. Recycling of reliable, high-quality products, and the logistics of distribution of recycled nutrients (from sewage works) imply **significant investment and operating costs, which at present farmers do not pay**. Side-benefits (improvements in sewage works operation in particular configurations, reductions in sludge disposal) do not generally cover these costs. Policies must ensure that the market for recycled nutrients is economically viable.

Farmers must be able to pass on costs

Discussion amongst participants confirmed that although there are **many innovative examples** of companies and local value chains already implementing nutrient recycling, **economic context changes are necessary for this to be generalised as standard practice rather than specific exceptions**.

A key obstacle is the **failure of agriculture to include waste treatment and externalities in price calculation, contrary to the "polluter pays" principle**.

This is because farmers cannot pass on these costs to the food industry and to supermarkets, and is contrary to the interests of farmers' incomes. Arthur ten Wolde remarked that **full transparency across the food and agriculture value chain**, which is considered a prerequisite by sustainable companies for a circular economy, seems a major challenge for the food cluster.

Francesco Presicce, European Commission DG Environment explained that EU environmental legislation (in particular, Nitrates Directive, Water Framework Directive), through Member States implementation, incites towards better use of fertiliser and to processing of manures to produce products which enable better nutrient management. **A difficulty with nutrients is that both emissions and impacts vary considerably with local conditions** (unlike e.g. greenhouse gases).

EPR – Extended Producer Responsibility

Arthur ten Wolde noted that **EPR (Extended Producer Responsibility) is generally best applied at the final use phase**, i.e. at end products.

Participants noted that **for nutrients, this could be at the level of the consumer, and should take into account the question of diet, for example with a "meat tax",** economically incentivising against foods with a high nutrient footprint. However, this poses major issues of political acceptability and economic redistribution to ensure societal fairness: "no government will increase the price of food".

Several participants underlined that economic tools such as EPR must, for nutrients, **take into account the complete agri-food industry chain, including farmers, food processors, retailers and consumers**.

How to move forward

Arnoud Passenier, ESPP President, summarised the general recognition that **deep policy changes are needed to modify the economic balance** between linear use of mineral fertilisers and a nutrient circular economy, based on use efficiency and recycling. This is in addition to the need to adapt the regulatory framework to address obstacles to sale and use of recycled nutrient products and the need for specific support for innovation, demonstration and collaboration. **Economic policies to widely develop nutrient recycling must involve the whole agri-food value chain**. This poses challenges to develop viable economic policies and acceptable political proposals.

ESPP proposes to continue to take forward the collaborative work started at this meeting, to develop circular economy policy proposals specifically adapted to bio-nutrient and organic carbon recycling. This should include economic, social and systems research; dialogue with agriculture, agri-food, industry, regulator and political stakeholders; and work with circular economy experts and organisations to integrate bio-materials into circular economy proposals currently developed around industrial and consumer goods.

ESPP General Assembly, 2nd December 2015, Science14, Brussels "Policies and tools for the bio-nutrient circular economy". Speakers' slides at: www.phosphorusplatform.eu *under Downloads.*

European Union

Circular Economy Package

The European Commission's new "Circular Economy Package" features strongly phosphorus and nutrient recycling, including confirming the EU Fertilisers Regulation revision to include recycled nutrients, integrating resource efficiency into BAT, and developing secondary raw materials data systems. Over half of replies to the EU public consultation referred to nutrients.

The European Commission published on 2nd December 2015 its new "Circular Economy Package" (see SCOPE Newsletter 114), replacing the previous EU Commission's Circular Economy Package COM(2014)398 published in 2014 (see SCOPE Newsletter 105).

Public consultation highlights nutrient recycling

The new Circular Economy Package follows an EU public consultation (closed 20th August 2015, see SCOPE Newsletter 113).

Of 1281 respondents to the consultation:

- **30% identified bio-nutrients as "secondary materials the EU should target first"** (Q5.3)
- In total, **54% cited bio-nutrients or phosphorus in their response (**all questions)

Bio-nutrients for fertiliser use was the third most cited target secondary raw material market in responses, just behind plastics and "critical raw materials" (which includes phosphates).

Respondents indicated that bio-nutrients offer a huge potential for the Circular Economy underlining the importance of nutrient cycles and the dependency of Europe on imported phosphates. They considered that bio-nutrient recycling could be implemented rapidly and provide a good example.

The public consultation identified as **key aspects to be addressed**, in order to develop bio-nutrient and materials recycling: improving quality, information, reliability and standards of recycled materials; increasing demand for recycled materials and addressing the cost differential with primary materials; regulatory obstacles and gaps at EU, national and regional levels; need for value chain cooperation and information and need for reliable data on secondary raw material flows.

Landfill targets

Public comment underlined that **landfill bans for recyclable materials and mandatory waste sorting schemes** across the EU are important to develop and render reliable secondary raw material flows. A number of organisations, in particular in the biogas sector, underlined the need to introduce **mandatory separate food waste collection**.

The EU Commission's proposals do not however include these measures. The **complete ban on landfilling of recyclable materials** (which would have effectively banned the landfilling of phosphorus-containing wastes such as sewage sludge incineration ash), proposed in the previous 2014 version, has been abandoned and the new 2015 package includes

- A common EU target for recycling 65% of municipal waste by 2030;
- A common EU target for recycling 75% of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10% of all waste by 2030;
- A ban on landfilling of separately collected waste.

The new package also drops food waste targets. European Commission First Vice-President Frans Timmermans has indicated that the Commission prefers to give precedence to **internationally agreed Sustainable Development Goals**, and to targets for resource efficiency.

Phosphorus recycling

The new Package confirms the revision of the EU Fertiliser Regulation "*to facilitate the recognition of organic and waste-based fertilisers in the single market and support the role of bio-nutrients.*"

"*Recycled nutrients are a distinct and important category of secondary raw materials, for which the development of quality standards is necessary. They are present in organic waste material, for example, and can be returned to soils as fertilisers. Their sustainable use in agriculture reduces the need for mineral-based fertilisers, the production of which has negative environmental impacts, and depends on imports of phosphate rock, a limited resource. … Water reuse in agriculture also contributes to nutrients recycling by substitution of solid fertilisers. The Commission will take a series of actions to promote the reuse of treated wastewater, including legislation on minimum requirements for reused water.*"

However, **specific proposals on phosphorus included in the 2014 Package have been deleted**, probably as part of the rewriting of the Package to delete parts which did not include directly operational legislative proposals. The 2014 text identified phosphorus is one of five materials and wastes specifically targeted for action and stated "*The Commission is considering developing a policy framework on phosphorus to enhance its recycling, foster innovation, improve market conditions and mainstream its sustainable use in EU legislation on fertilisers, food, water and waste*."

Nonetheless, the 2015 text includes "*The Commission will take a series of actions to encourage recovery of critical raw materials, and prepare a report including best practices and options for further action*" … "*Report on critical raw materials and the circular economy*" and "*Sharing of best practice for the recovery of critical raw materials from mining waste and landfills*", both for 2017. This will address amongst others **phosphorus**, which is on the EU Critical Raw Materials list (see SCOPE Newsletter n°104).

EU Fertilisers Regulation revision

The revision of the EU Fertilisers Regulation (see in the ESPP DONUTSS workshop summary report on *http://phosphorusplatform.eu/donutss*) is confirmed with the objective to "*facilitate recognition of organic and waste-based fertilisers in the single market and thus support the role of bio-nutrients in the circular economy*."

This was already confirmed in the **Fertilisers Regulation revision "Roadmap"** published October 2015, which specified that the revision process "*aims at establishing a regulatory framework enabling production of fertilisers from recovered bio-wastes and other secondary raw materials. This would boost domestic sourcing of plant nutrients which are essential for a sustainable European agriculture, including the critical raw material phosphorus … increase resource efficiency and decrease import dependency for raw materials essential to European agriculture, in particular phosphorus*".

This Roadmap noted the **contribution of ESPP** to this process: "*Phosphorus recovery and recycling has also been addressed by FP7 research projects, the results of which have been analysed during the workshop 'Circular approaches to phosphorus: from research to deployment', held in Berlin on 4 March 2015. One of the identified priorities is to revise the EU Fertiliser Regulation to extend its scope to nutrients from secondary sources (e.g. recycled phosphates) and organic sources*" see SCOPE Newsletter n°111.

The Roadmap also notes that nutrient "*Nutrient recovery from biobased waste streams and residues*" is included in the 2014 workplan of the **Bio-Based Industries Joint Undertaking** *http://bbi-europe.eu/sites/default/files/documents/BBI_JU_annual_Work_plan_2014.pdf*

To ESPP's understanding, **the draft text for the revised EU Fertiliser Regulation is expected to be published in January – February 2016**, covering inorganic and organic fertilisers, soil improvers, growing media, etc. This is expected to already include criteria for recovered nutrient products for composts and digestates. Criteria for struvite, ashes and biochar are expected to be added rapidly, and **first proposals have been published by ESPP** (struvite, ashes *http://www.phosphorusplatform.eu/regulatory*) after stakeholder consultation, or are under preparation by ESPP (biochar). Comments are welcome to ESPP. Work on draft criteria for mineral-type fertilisers recovered from manures could also be developed.

Data on raw material flows

Confirming the relevance of ESPP work on DONUTSS (Data on Nutrients to Support Stewardship) www.phosphorusplatform.eu/DONUTSS *the Circular Economy Package specifies that "The Commission will further develop the recently launched Raw Materials Information System and support EU-wide research on raw materials flows".*

EU Fertilisers Regulation revision Roadmap, "Revision of the Fertilisers Regulation (EC) No 2003/2003" October 2015
http://ec.europa.eu/smart-regulation/roadmaps/docs/2012_grow_001_fertilisers_en.pdf

Media coverage EU Circular Economy package
http://www.euractiv.com/sections/sustainable-dev/timmermans-defends-ambition-new-circular-economy-package-320049

EU Circular Economy webpage
http://ec.europa.eu/environment/circular-economy/index_en.htm

EU 2015 Circular Economy "package" (Communication from the Commission COM(2015)614/2 "Closing the loop - An EU action plan for the Circular Economy"), 2nd December 2015
http://ec.europa.eu/priorities/jobs-growth-investment/circular-economy/docs/communication-action-plan-for-circular-economy_en.pdf

Naantali Spa, Finland
Circular economy opportunities

The European Commission funded EIP-AGRI (European Innovation Partnership on Agricultural Productivity and Sustainability) workshop in Naantali Spa, Finland, discussed the transition to a circular economy in agriculture and forestry with presentations of concrete experiences and projects.

Tarja Haaranen, Finland Environment Ministry opened the workshop and presented Finland Government's programme and the key project "Breakthrough of a Circular Economy". **Finland has identified major circular economy opportunities in agriculture and forestry**. Objectives include phosphorus stewardship (Critical Raw material), energy footprint of nitrogen fertilisers, synergy between water quality protection and nutrient recycling and the potential for new business opportunities.

The Finland Government has fixed the objective of processing 50% of manure and sewage sludges in eutrophication 'Sensitive Areas' by 2025.

The economic potential of **pulp and paper industry by-products** in Finland is estimated at up to 240 million €/year, of which sludges and ashes 10 – 20 million €. In agriculture, 20 million tonnes of animal manures are produced annually, containing over 170 000 tonnes of phosphorus (P).

Local concentrations of livestock production result in the need to move manure nutrients, and so challenges of storage, transport and processing.

Finland already has a number of **exemplary local agriculture circular economy actions**:

- **Sybimar** *www.symbimar.fi*: equipment supplier for bioenergy and food production solutions with closed circulation, of waste, waste heat, nutrients and CO_2
- **Honkajoki Oy** *www.honkajokioy.fi*: producing protein feed, rendered fat and fertilisers, with waste heat recovery to heat greenhouses and return of recycled nutrients to the food chain in the form of animal feed, rendered fat, fertiliser and energy.
- **Palopuro agri-ecology symbiosis** *http://blogs.helsinki.fi/palopuronsymbioosi/english/*: Knehtilä Farm and Hyvinkää enterprise network, cooperative food production system based on energy and nutrient self-sufficiency.

The Finnish government is investing 300 million Euros in the bio-economy. **12.4 million Euros is specifically allocated to demonstration projects for nutrient recycling, agricultural symbiosis and biomass processing**. This programme will be officially launched early 2016.

Rob Peters, European Commission, DG AGRI (Agriculture and Rural Development), explained how the circular economy concept fits into current EU policies, within the overarching objectives of the EU 2020 strategy for **smart, sustainable and inclusive growth**. The EU communication and action plan on the Circular Economy (so called 'Circular economy package') planned for adoption on the 2nd of December this year (see in this Newsletter) includes **actions on food waste, biomass and bio-based products, including nutrient recycling and wastewater reuse**, amongst other. In addition to targeted actions, horizontal measures will accompany the transition to the circular economy. These include for example support to research and innovation through Horizon 2020 and, scaling-up technologies and processes thanks to EU funding programmes (e.g. LIFE+, EU structural funds including rural development).

The **revision of the EU Fertilisers Directive**, to take in recycled nutrient products, is now confirmed and the "Roadmap" for this revision is published *http://ec.europa.eu/smart-regulation/roadmaps/docs/2012_grow_001_fertilisers_en.pdf*

Fabio Cossu, European Commission DG AGRI, presented the tools in place to support innovation in agriculture, through the EIP-AGRI. EIP '*Operational Groups'*, for examples supported through rural development programmes will bringing together the relevant circular economy actors (farmers, foresters, advisors, bio-based businesses, etc.) to test innovative solutions on the field addressing concrete issues and opportunities.. Also, '*Focus Groups'* at the European level, bring together experts to define the state-of-the-art of research and practices to identify further research needs and gaps and prioritise innovative actions. Focus Groups *currently underway* relevant to the circular economy include among others: fertilisers' efficiency, water in agriculture, mixed farming systems.

EIP-AGRI Recycled Nutrients Focus Group

Mr Cossu confirmed that a new Focus Group will be launched in 2016 on the agronomic value of recycled nutrients. The scope and content of this Focus Group is currently under definition by the EU Rural Networks' Assembly (RN Assembly) Subgroup on Innovation, then a call for experts to constitute the group will be published by the EIP-AGRI.

SCOPE editor's note: *EIP-AGRI Focus Groups are brought together and secretariat ensured by the EIP-AGRI Service Point. The Focus Groups are tasked with assessing currently available knowledge and research needs and provide new and useful ideas to solve practical problems, provide ideas for EIP Operational Groups or research projects. They can eventually generate input for future Horizon 2020 research priorities, and do not imply funding for participants. ESPP, with support of nearly 60 different organisations, submitted the suggestion for establishing a Focus Group on "Agronomic use of recycled nutrients" replying to the EIP-AGRI call for proposals for ideas for Focus Groups in June 2015.*

Ben Allen, IEEP (Institute for European Environment Policy *www.ieep.eu*) explained the principles of the circular economy and its relationship to other related concepts, such as the bio-economy. He went on to describe how **agriculture and forestry are at the heart of the bio-economy** and that by integrating circular economy principles into these sectors they can be made more sustainable and profitable in the long-term. Through improved circularity, Europe can reduce pressure on land use, soil and water, reduce EU vulnerability to external commodity price risks, stimulate innovation and generate new income streams for farmers.

Circular economy in action

Dr Allen presented a number of exemplary cases of circular economy in action within the agriculture and forestry sectors. These included developments in paper recycling in Europe presented in a recent **CEPI** publication (*www.cepi.org*), where **already around 70% paper fibre recycling has been achieved**, remarkably high given that the feasible maximum is probably < 80% (some paper uses are non-recyclable, such as used hygienic tissues or newspaper used to light home chimneys …). These developments include the **production of paper fibres from agri-food industry waste streams such as lemon skins, nut shells, olive stones** (**Favini, Italy** *www.favini.com*); and **closed loop take-back recycling of hygienic tissues** (**Van Houtuum** *www.vanhoutum.nl*) amongst others.

Other **examples of circular economy activities in the agricultural and forestry sector** included: the production of organic compost from olive cake in Spain and Italy and waste wool to fertiliser in Italy, amongst other examples that were the focus of more detailed presentations throughout the remainder of the workshop.

Johan Vlaemynck, Tomato Masters, The Netherlands, presented this family farm development today producing 9 000 tonnes of no-soil greenhouse tomatoes per year with integrated circular nutrient and water cycling with **Aqua4C** fish production. Jade trout (an Australian species) are produced, with market value because of omega lipid content. The fish are fed with microalgae, currently 250 tonnes of fish per year (extension to 30 000 t underway) and the used aquaculture water is after microfiltration in the tomato greenhouses, **recycling both the water 30 t nitrogen, 15 t potassium and 5 t phosphorus per year** (one quarter of the nutrients needed for the tomato farm, worth 22 000 €/year).

Cogeneration (natural gas) is used to heat the greenhouses and produce electricity needed for the aquaculture, with 80% of the CO_2 used in the greenhouses. The tomatoes are sold via auction to international supermarket chains. A key challenge is levels of sodium in the used aquaculture water.

Research projects

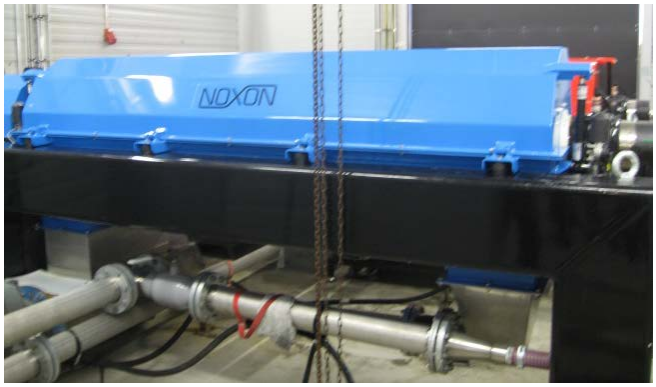
Michael Kornaros, University of Patras, Greece, presented a **research pilot biogas project** (INTEGRASTE). The intention is to use agri-food manufacturing by-products (olive mill wastes, cheese whey, pig manure …) to produce biogas to be burnt in cogeneration engines producing electricity and heat (used for the thermal needs of the biogas plant itself and other uses).

The project is looking at solid-liquid separation of the digestate, with the solid part going to composting and the liquid either to aerobic treatment or ultrafiltration, nanofiltration and reverse osmosis. The proposal is to use the treated digestate liquid to fertilise sweet sorghum cultivation on marginal land, to grow biomass for feeding the biogas digester when agro-waste streams are in shortage.

Site visit: BioVakka

Teija Paavola, Biovakka Suomi Ltd *www.biovakka.fi* (a BSAG Baltic Sea commitment company *http://www.bsag.fi/Pages/Commitment.aspx*) presented this cooperative of 21 farmers, which today owns and operates two biogas plants: Vehmaa, commissioned 2005, treating 90 000 tonnes/year (3/4 enzyme and food industry waste, 1/4 pig manures) and Turku, commissioned 2009, treating 75 000 tonnes/year of sewage sludge. **The Turku sewage sludge digestate is used partly on agricultural land, partly in landscaping**.

The workshop visited the BioVakka Vehmaa biogas plant. Here the input material is pasteurised at 70°C for one hour before digestion (to ensure sanitation). The biogas is burnt in cogeneration, producing electricity used onsite and partly fed to the grid (6 700 MWh/year), with heat being used both onsite and to heat greenhouses. The digestate is solid/liquid separated in centrifuges. The solid fraction is mainly used locally on farmland. The liquid fraction is



concentrated (vacuum evapo-concentration). **The concentrate (rich in nutrients) is sold to the paper industry, who need nutrients to 'feed' their wastewater treatment plants** (paper wastewater has high carbon and low nutrients). The condensate from the evaporator (which contains trace nutrients but near zero carbon and solids) is purified by reverse osmosis before discharge.

Nouchka De Craene, Millibeter, presented **pilot R&D in Belgium to use the larvae (maggots) of the black soldier fly (*Hermetia illucens*) to break down different bio-wastes**, and then harvest the larvae for use in e.g. aquaculture (fish feed) or in pet foods. This fly species does not eat when adult (cannot bite nor spread disease) and poses no threat to Belgian biodiversity in case of escape. Millibeter is also looking to further innovate by researching possible extraction of lipids, proteins and chitin from the larvae for higher value agro-food or chemical applications. There are regulatory obstacles to full-scale development because the flies/larvae are legally classified as 'farm animals', posing issues with waste and animal by-products regulations.

SCOPE editor's note: black soldier fly farms are already in full scale operation in e.g. Canada (Enterra, 36 000 tonnes/year www.enterrafeed.com *South Africa (Agriprotein, 40 000 tonnes/year* www.agriprotein.com*). Agriprotein have announced their intention to build a factory in the EU as soon as regulatory obstacles are resolved (20/2/2015* http://www.feednavigator.com/Regulation/Insect-feed-maker-AgriProtein-says-logic-will-win-out-in-the-EU*).*

Keijo Siitonen presented the AgroHubs project, Lapland, with the village of Kierinki and other villages, which aims to achieve full local energy balance, **using natural resources for biogas and cogeneration**, with local production ownership.

Forestry circular economy and wood ash

Felix Montecuccoli, Austrian Land and Forest Owners, indicated that **Austria produces some 250 000 tonnes/year of wood and straw ash**, around half of which currently goes to landfill and the rest to the cement industry, in both cases at a significant cost to the ash producers. He presented tests carried out into **valorisation of wood-energy ash as a fertiliser and for forest road construction** (binder / foundation material, replacing the use of limestone). The ash shows to be an effective fertiliser and liming agent in short-rotation coppice (production of willow as wood fuel), however there are issues regarding levels of **heavy metals**. Also, **wood ash is classified 'waste' in Austria, so cannot legally be used as fertiliser**.

***SCOPE editor's note:** this should be resolved through the currently underway revision of the EU Fertilisers Regulation, for which ESPP has proposed draft criteria for use of biomass ashes as fertilisers (*www.phosphorusplatform.eu/regulatory*).*

Challenges for valorisation of wood ashes include regulatory issues (legalisation of use as a fertiliser in Austria, REACH registration), acceptance in SFC (**Sustainable Forestry Certification**), heavy metal content, logistics, environmental impacts of leachates during storage, and lobbying from current operators to keep biomass ash classified as 'waste'.

Niklas von Weymarn, Metsä Fibre, presented **the circular economy in action at the company's new bio-product mill, being built in Äänekoski, central Finland**. The current mill produces 0.5 million tonnes/year of pulp fibres for graphic papers, boards, tissue paper and speciality fibre products. An investment of 1.2 billion € is underway to nearly triple production. As well as producing pulp fibres, the plant will be fully energy self-sufficient and will produce a variety of co-products, as well as bioenergy in various forms. In addition to the typical paper mill co-products tall oil and turpentine, the new mill will also include bark gasification to produce a gaseous biofuel and most likely also sulphuric acid and methanol. Additional co-products will follow.

Christer Segersteen, Södra, Sweden, indicated that Sweden is currently considering fixing an obligation to return ash to forest soil if branches are removed, in order to maintain fertility. However **heavy metals** are a challenge, in particular cadmium. This can be addressed by separating different materials in combustion, as barks have higher heavy metal levels. **Markuu Granander, Finland Forestry Centre**, indicated that wood ash is authorised and used as a forest fertiliser in Finland under specified conditions.

Simulation exercises

Interactive discussion of case studies presented at the workshop enabled participants to identify circular economy challenges and opportunities. Conclusions were presented by **Ludwig Hermann, Outotec, Hanna Marliere, Polish Chamber of Waste Management (PIGO)** and **Emma Berglund, Confederation of European Forest Owners (CEPF).**

Factors for success identified included:

- Key factor for uptake of recycled nutrients is **price**
- No one solution: bio-circular **economy solutions** need to be adapted to local and regional contexts
- Local **leadership** and sense of purpose are important, as are business partnerships and value chain contracts
- **Large potential** for water reuse, nutrient recycling, bio-based renewable energies
- **Short-chain agricultural product markets** can bring more added-value to farmers, rather than auction and supermarket intermediaries
- Need to **change shift in tax burden** from labour to resources, need for economic research to support this, taking into account the specific issues of farmers' incomes and rural employment
- **Market prices of mineral fertilisers are not a driver** for economically viable bio-nutrient recycling: policy tools are essential to ensure that recycled nutrients bring revenue to farmers and forestry
- **Importance of stable public policies**: long-term visibility for investors, farmers
- **Quality standards** for recycled products such as digestate are the basis of a real market
- **Public procurement** policies can be a leading incentive
- Need for **financial support for investments**
- **Rural Development Funds** should better integrate bio-based circular economy actions

A panel debate was led by **Cátia Rosas, CONFAGRI Portugal (National Confederation of Farming Cooperatives and Agricultural Cooperative Bank), Hilkka Vihinen, Natural Resources Institute Finland LUKE, Federico Grati, Biochemtex Italy, Christer Segersteen, Södra (Sweden forest owners' association), Geneviève Savigny, Via Campesina (international small farmers movement), Rob Peters** and **Ben Allen.** The panel noted that **both agriculture and forestry are traditionally and still today highly 'circular' in operation**, with important levels of reuse of energy, nutrients, carbon and materials.

New challenges

With **agriculture innovations and food safety legislation**, however, have come new challenges to address, so that promoting a strong network with research and equipment providers is a key to increase circularity. A rethink of agricultural and agro-industry value chains is needed, to make by-products into resources, not simply "treating wastes". **Changes to the economic system are needed to support farmers in redesigning ecological and local circular economy and bio-economy solutions**.

Considerable opportunities exist in developing new recycled nutrient products in regions with nutrient excesses and in producing higher value recovered products from agriculture or forestry by-products,

beyond energy uses, for e.g. chemicals, fibres, feed and food industry inputs.

Discussion with the workshop participants underlined the **importance of networking, stimulating innovation, exchanging good practices and knowledge exchange**: EIP-AGRI will continue to contribute to this, including with the new Focus Group on "Recycled Nutrients".

Interestingly, participants at the workshop put forward the **idea of setting up of a Horizon 2020 Thematic Network on bio-based circular economy**.

EIP-AGRI workshop 'Opportunities for Agriculture and Forestry in the Circular Economy', 28-29 October 2015, Naantali Spa, Finland. Workshop slides are available at https://ec.europa.eu/eip/agriculture/en/content/eip-agri-workshop-opportunities-agriculture-and-forestry-circular-economy

Waste management industry

Circular Economy for carbon, nutrients and soil

ISWA, the International Solid Waste Association, which brings together waste management companies and experts worldwide, has published 6 reports as conclusions of the ISWA Resource Management Task Force on the Circular Economy. These cover Circular Economy trends, tools, approaches and opportunities, with two thematic targeted assessments: carbon, nutrients & soil; energy & fuels.

Commodity prices

The first driver of the circular economy identified by ISWA is **raw material prices**. With a few exceptions, these fell 1-2% per year over the whole of the twentieth century, but this changed in the past decade, with considerable price increases.

Commodity prices, including oil, are however unpredictable, and have fallen again 30-40% over the last couple years. Companies respond to these price drops, making commodity prices an unreliable driver for recycling. Many economists expect prices to rise again pushed by growth and resource limitations.

Unpredictability may also be related to the current massive efforts engaged by OECD countries to secure and tie up future resource access.

The second major driver of the circular economy is identified as **environmental legislation**, including waste disposal limitations, recycling obligations, carbon reduction targets.

Environmental fiscality

Taxation is being increasingly used by OECD governments to push the circular economy. KPMG identified 30 new green taxes in 21 countries since 2011 (KPMG (2013) The KPMG Green Tax Index *https://home.kpmg.com/xx/en/home/insights/2013/04/kpmg-green-tax-index.html*).

These include **landfill taxes, incineration gate fees, accelerated asset depreciation, tax credits, VAT refunds** linked to secondary materials purchase, **reduced VAT or VAT refunds** on recycled goods (e.g. in China, South Korea).

The waste industry identifies six barriers to the circular economy:

- **Investment** in infrastructure alternatives to existing disposal routes
- A new "**regulatory construct**" is needed, moving from waste to materials management, adapted to reuse and recycling, rather than to use of virgin materials and waste disposal, including standards for secondary raw materials
- Opening of **commodity markets for secondary raw materials**, addressing information and price transparency, regulatory certainty
- **Data and information systems**, on both waste flows and secondary raw materials (c.f. ESPP's DONUTSS project)
- Development of specific necessary **skills** and **exchange of best practice**
- **International cooperation on markets, data, quality**

Carbon, nutrients and soil

The specific ISWA report on "Carbon, nutrients & soil" focuses on the **carbon and nutrient content of solid wastes**, and its important potential to produce high-quality products, contribute to agricultural food production, conserve resources and improve soils.

In OECD countries, an estimated 177 million tonnes of municipal organic waste (not including sewage biosolids, agricultural by-products, manures, food industry …) is produced annually, that is 27% of municipal solid wastes. Of this municipal organic solid waste, only 66 million tonnes is valorised in composting or anaerobic digestion. ISWA estimate that around 54 million tonnes additionally could feasibly be collected and valorised.

This total of 124 million tonnes potentially valorisable municipal organic waste contains 0.1 – 3 million tonnes of nitrogen (N, that is **up to 14% of total nitrogen fertiliser used in OECD countries**) and over 40 million tonnes of carbon (C).

The market value (based on inorganic fertiliser prices) of nutrients in this potentially collectable municipal organic waste is estimated at **121 million US$/year.** The stable carbon in composts and digestates has a total potential of 12 million tonnes/year, with potential to improve soil quality, improve crop productivity and buffer climate change.

ISWA notes that valorisation can take different routes, with total potential markets of billions of Euros:

- **Small volume, high added-value products**, e.g. for fine chemicals
- **Medium volume, medium value products**, such as bioplastics (e.g. PHB polyhydorybutryrate, PHA polyhydroxyalkanoate, PLA polylactic acid), commodity chemicals (e.g. phosphoric acid, in-butanol, acetone, lignin derivatives, humic acid derived surfactants, C5 and C6 sugars), carbon fibre, fibreboard and crystalline cellulose and cellulosic materials, biogas, struvite (mineral fertiliser)
- **High volume, low value products**, including composts, digestates, mulches, growing media constituents and soil improvers

Cost-effectiveness of operations can be improved by integrating different organic waste valorisation processes into "biorefineries", optimising production of a range of different value products from different input materials and facilitating "cascading" of resources according to quality.
Challenges for the waste industry

The World Economic Forum has estimated **global potential revenue from the biomass value chain at nearly US$ 300 billion** by 2020. The ISWA report includes a table of estimated financial value of nutrients in different types of compost, ranging for 4 to over 6 € per tonne (N, K and P).

ISWA identifies challenges faced by the waste sector in the move towards selective collection and treatment of organic wastes to manufacture valuable secondary products:

- **Relative cost of fossil fuels**. At present prices of crude oil, feedstock costs to produce commodity bulk chemicals from biomass can be 2 – 3 times higher than fossil fuel processes. To redress this, subsidies to fossil fuels must be ended and fiscal incentives to recycling put in place.
- **Legislative framework**, including waste legislation (transport, processing)
- **Quality standards and specifications** for secondary products, to ensure market confidence
- Development of **new infrastructure**
- **Service challenges**, including improving organic waste capture rates and improving selective collection to deliver clean, homogenous organic streams
- **Improving data and statistics** to quantify organic waste arisings and change in composition
- Developing necessary **competence and skills**

Quality control

ISWA underlines that quality standards and certification for composts and digestates are of "utmost importance" to ensure that only quality products are applied to soils. Separate collection of household and collective organic waste must be actively developed as the key starting point to ensure quality.

As well as providing nutrients (nitrogen, phosphorus, potassium), **compost and digestates provide organic carbon to soil**. This is positive, as there is a global trend to lose soil organic matter, which reduces soil resilience and function and releases CO_2 into the atmosphere.

Soil benefits of composts and digestates

Application of composts to soils is considered to offer the following potential advantages:

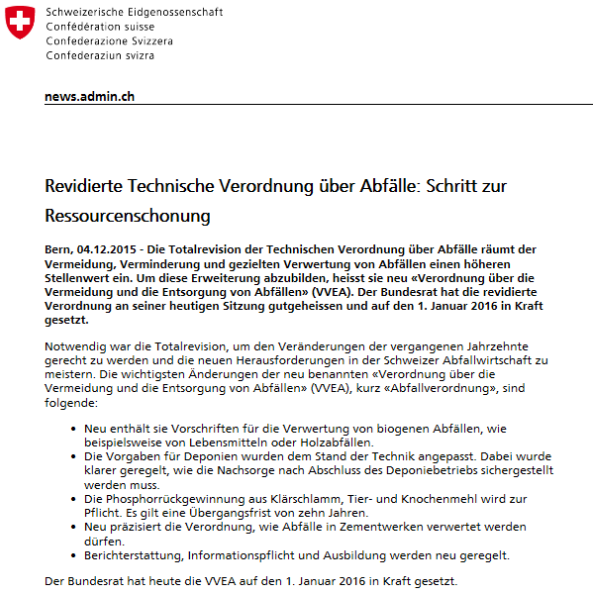
- **Increase 'stable' soil organic matter**, so reducing soil organic matter loss, reducing soil erosion and improving tillage
- **Improve nutrient retention**, so reducing runoff, by increasing cation exchange capacity
- **Improve water retention**, so drought resilience
- **Soil temperature regulation**
- **Increase soil biological activity**, so increasing carbon and nutrient availability for crops
- For some composts, **suppression of plant pathogens**
- **Reduce soil acidity**

The impacts of **digestate application have been less well studied**. Although the carbon in digestate is generally more labile than in compost (less stable humus), this can be improved by post-composting of digestate before application. Also, digestate probably increases soil biological activity, so stimulating in-soil humus carbon formation.

Quality criteria are essential for composts and digestates, to ensure that unwanted contaminants are not introduced to soil. The EU has draft standards with the JRC proposed End-of-Waste criteria for composts and digestates (see SCOPE Newsletter n°99) and also with ECN (European Compost Network) "Compost and Digestate Quality Assurance Scheme. The USA does not have national quality standards, whereas Australia has AS4454 and New Zealand NZS 4454-2005.

ISWA (International Solid Waste Association), ISWA European Group and ISWA Task Force on Resource Management "The Challenge of Circular Economy for the Waste Management Industry", conference Brussels, 3rd November 2015 and 6 reports at https://www.iswa.org/resourcemanagement

Public policies



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

news.admin.ch

Revidierte Technische Verordnung über Abfälle: Schritt zur Ressourcenschonung

Bern, 04.12.2015 - Die Totalrevision der Technischen Verordnung über Abfälle räumt der Vermeidung, Verminderung und gezielten Verwertung von Abfällen einen höheren Stellenwert ein. Um diese Erweiterung abzubilden, heisst sie neu «Verordnung über die Vermeidung und die Entsorgung von Abfällen» (VVEA). Der Bundesrat hat die revidierte Verordnung an seiner heutigen Sitzung gutgeheissen und auf den 1. Januar 2016 in Kraft gesetzt.

Notwendig war die Totalrevision, um den Veränderungen der vergangenen Jahrzehnte gerecht zu werden und die neuen Herausforderungen in der Schweizer Abfallwirtschaft zu meistern. Die wichtigsten Änderungen der neu benannten «Verordnung über die Vermeidung und die Entsorgung von Abfällen» (VVEA), kurz «Abfallverordnung», sind folgende:

- Neu enthält sie Vorschriften für die Verwertung von biogenen Abfällen, wie beispielsweise von Lebensmitteln oder Holzabfällen.
- Die Vorgaben für Deponien wurden dem Stand der Technik angepasst. Dabei wurde klarer geregelt, wie die Nachsorge nach Abschluss des Deponiebetriebs sichergestellt werden muss.
- Die Phosphorrückgewinnung aus Klärschlamm, Tier- und Knochenmehl wird zur Pflicht. Es gilt eine Übergangsfrist von zehn Jahren.
- Neu präzisiert die Verordnung, wie Abfälle in Zementwerken verwertet werden dürfen.
- Berichterstattung, Informationspflicht und Ausbildung werden neu geregelt.

Der Bundesrat hat heute die VVEA auf den 1. Januar 2016 in Kraft gesetzt.

Switzerland

P-recovery made obligatory

Switzerland is the first European country in the world to make phosphorus recovery and recycling from sewage sludge and slaughterhouse waste obligatory.

The new regulation (see also SCOPE n° 105 and n° 108) will **enter into force on the 1.1.2016 with a transition period of 10 years**. Switzerland banned direct use of sewage sludge on land in 2006, so that the new regulation will lead to **obligatory technical recovery and recycling in the form of inorganic products from all sewage sludge and slaughterhouse waste**.

Swiss sludge and slaughterhouse waste together represent an **annual flow of 9100 t of phosphorus** whereas technical recycling from the wastewater stream in Europe today totals of around 1000 t of phosphorus in the form of struvite.

In an **implementation guide** details such as required efficiency of the recovery process and plant availability of fertilizer is to be defined in collaboration with Swiss stakeholders.

https://www.news.admin.ch/message/index.html?lang=de&msg-id=59785

Greece, Poland

Enforcement of EU sewage treatment law

Greece faces fines for not treating sewage conform to EU 1991 regulations, and Poland has received a final warning from the European Commission.

Greece was fined 10 million € in October plus 20 000 € per day for failing to install adequate sewage collection and treatment in 6 areas (agglomerations > 15 000 pe), as required by the 1991 Urban Waste Water Treatment Directive 1991/271. The daily fine will run until compliance is achieved, depending on the number of areas still not in conformity.

The European Commission has now asked for an **additional 16 million € plus 35 000 € per day fine** for Greece's failure to collect and treat sewage discharged into the Gulf of Elefsina, in the area of Thriasio Pedio.

Greece was already **condemned by the European Court of Justice for this same area in 2004** and the Commission notes that still today only 28% of sewage is collected and treated.

Poland has also received a 'final warning' from the European Commission for failure to implement the EU Water Framework Directive 2000/2000, including failure to classify water bodies, large scale works carried out on rivers and unjustified exemptions to Good Quality Status objectives.

European Commission 19/11/2015 "Commission proposes fines and refers GREECE back to the Court of Justice of the EU over persistent poor waste water treatment. Greece facing fines over lack of urban waste water treatment" http://europa.eu/rapid/press-release_IP-15-6009_en.pdf

European Court of Justice, case C-167/14, 15/11/2015 "Because of its delay in implementing the directive on urban waste water treatment, Greece is ordered to pay a fixed sum of €10 million and a periodic fine of €3.64 million per semester of delay" http://curia.europa.eu/jcms/upload/docs/application/pdf/2015-10/cp150126en.pdf

European Environment Agency (EEA)
Analysis of P resource taxation

An 82 page report to the European Environment Agency (EEA) analyses the feasibility and expected environmental and economic impacts of different possible European resource taxation mechanisms for non-renewable (non-energy) resources, looking in detail at iron/steel, copper and phosphorus.

Resource (or raw material) taxation can be applied at different levels: extraction (mining), first industrial use (e.g. for P, fertiliser production) or final consumption (e.g. for P, fertiliser use).

In all cases, there are risks for any industry or use which is subject to international competition, because producers or users (mines, food production) outside Europe would not be subject to the tax. This can be neutralised through **"Border Tax Adjustment" (BTA).**

Avoiding penalising European industry or farmers

Although BTA "Border Tax Adjustment" might be relatively feasible for e.g. imported fertilisers and phosphorus containing industrial substrates (phosphate rock, phosphoric acid), because of the relatively small number of players and the homogeneous nature of the products concerned, it would be **much more complex for imported food and animal feeds** (difficulty of defining phosphorus content, large number and wide range of importing companies and operators).

The report notes the challenge that "*the agricultural sector faces strong international competition, that it is seen as a relevant economic sector, that it receives strong political support and many subsidies in most countries, and that it has a very strong lobby*".

Justification and advantages

The report identifies the following **reasons for action on phosphorus**:

- Non-substitutable in its main use, agriculture
- Considerable environmental impact
- Geopolitical issues related to reserve distribution in different countries in the world
- Tendency to mine lower grade rock
- Impurities in phosphate rock, e.g. cadmium, uranium
- EU is 92% dependent on imported phosphorus

It is noted that **overall use efficiency is low (only around 10% of mined P is effectively used)** and that use per hectare is highly variable between different European countries (from 3 to 13 kgP/ha/year).

A possible taxation scheme should therefore have as objectives

- To **secure long-term availability** and reduce import dependency
- To **reduce phosphorus losses** into surface waters
- To **close the phosphorus cycle** as far as possible, reducing inputs and outputs and developing recycling

In particular, the scheme should **provide incentives to recycling, to reduction of losses** from arable and animal farms, and to reduce the use of phosphate rock with high heavy metal contents.

Experience with phosphorus taxes

Experience from several EU states is summarised:

- **Finland**: tax on fertilisers 1976, then on P 1990, then P and N 1992, repealed 1994
- **Netherlands**: tax on farm N and P surpluses (MINAS Mineral Accounting System) 1998 – 2006
- **Denmark**: tax on P in animal feeds 2005 – still in place
- **Austria**: tax on fertilisers 1985 – 1994
- **Norway**: tax on N and P in fertilisers 1998 – 2000
- **Sweden**: tax and price regulation charge on fertilisers 1984 – 1994, replaced by a tax on cadmium content (still in place today)

Overall, analysis of these examples suggests that the **fertiliser taxes had little effect unless the level was quite high**. However, there was a long-term effect of better information and awareness of farmers.

The Netherlands MINAS tax on farm nutrient surpluses was considered effective, but had difficulties of administrative complexity, and has been replaced by regulatory policies using the same based (obligation for farm nutrient balances).

The Sweden tax scheme is considered effective, probably because the level of taxation is relatively high (3.3€ per g cadmium exceeding 5gCa/tonneP) and because it was accompanied by action programmes to reduce use.

The report notes that these experiences did not include BTA on imported products containing phosphorus, such as food products.

Stimulating innovation and efficiency

The report notes that the **prices of raw materials are often relatively low**, so that taxation would have to be at a very high level to modify use patterns sufficiently to significantly reduce resource consumption, environmental impact.

Phosphorus in fertiliser, however, offers a specific case, in that it is non-substitutable and essential for agricultural production. An appropriate level of taxation on virgin mineral phosphorus use could thus potentially stimulate both improvements in efficiency of use on farms and innovation and implementation of recycling (better use of or phosphorus recovery and recycling from organic sources such as sewage or manures).

Short-term price elasticity for phosphate fertilisers is cited as maybe -0.1 to -0.25, suggesting that **a 10-fold price increase would be needed to reduce use by 50%,** assuming that this can be substituted by phosphorus from organic streams (sewage, manure).

A **high potential for increasing phosphorus use efficiency** is identified throughout the use chain, not just in fertiliser use, but also in food production and dietary choice.

The report notes that **a tax on products implying high phosphorus use in their production (e.g. meat) could be more effective** than a tax on phosphorus fertilisers, but would pose implementation issues because of difficulties in calculating how much phosphorus is needed to produce one kilogramme of meat. Nonetheless, the current reduced rate of VAT on meat could be questioned.

The report concludes that probably no single tax tool could effectively target all uses of phosphorus and that **a phosphorus use tax should be part of a policy mix with other instruments**. In particular, the report notes that there are a number of tools in agricultural policy, including **bio-fuels policies and agricultural subsidies** which could be adjusted to incite phosphorus use efficiency, reduce phosphorus losses, reduce soil erosion, and encourage phosphorus recycling.

Policy effectiveness and acceptance

Söderholm and Christiernsson (2008) previously **analysed the effectiveness of taxation on mineral fertilisers, and economics, politics and obstacles to implementation**. They also present experience of fertiliser taxation in Europe in Austria, Denmark, The Netherlands (MINAS system), Norway and Sweden. They note that e.g. in Sweden fertiliser taxes do impose **competitive disadvantage for Swedish agricultural production**.

They conclude that although "**earmarking**" of such taxes is not theoretically desirable (not coherent with optimal use of revenue for the national good), it can help make such taxes more acceptable if revenues are directed to research and actions in partnership with relevant industries. They note the **difficulty of taxing close to environmental damage**, as this often necessitates specific monitoring. Also, it is complex to deal with **current damage resulting from past releases**. They also underline that tax implementation must be cost effective, and that **reduction of associated transaction costs** should be a priority.

"Material resource taxation, an analysis for selected material resources", October 2015, 82 pages, ETC/SCP, ETC/WMGE and EEA https://etc-wmge.vito.be/sites/etc-wmge.vito.be/files/ETC-working-paper-material-resource-taxation_final.pdf

F. Eckermann and M. Golde UBA; M. Herczeg, Copenhagen Resource Institute (CRI), Denmark; M. Mazzanti, Sustainability Environmental Economics and Dynamic Studies (SEEDS), Italy; R. Zoboli, SEEDS and Research Institute on Sustainable Economic Growth (IRCrES), Italy; S. Speck, European Environment Agency (EEA), Denmark.

"Policy effectiveness and acceptance in the taxation of environmentally damaging chemical compounds", Environmental Science & Policy 11 (2008), 240-252
http://www.sciencedirect.com/science/article/pii/S1462901107001189

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USA agriculture economics

Impacts of price increases on phosphorus fertiliser management

Possible impacts of taxing phosphorus fertilisers to internalise "externalities" (environmental costs) and P price increase (because of possible P depletion) are modelled for the US agriculture system: mineral fertiliser use, manure spreading, agricultural production, farmers' incomes and trade.

The paper **models impacts of different levels of a Pigovian type tax ("Phosphorus externalities tax")** and P sources depletion (increase in P prices) on mineral phosphorus fertiliser use, agricultural sector production, and consumer and producer surpluses. The modelling assumes that decreasing use of mineral P

fertiliser is substituted by use of livestock manures, at levels necessary to ensure crop phosphorus needs (no change in crop yield is therefore assumed), and with corresponding manure application costs for farmers. The authors note from USDA data that currently livestock manure is applied on only around 5% of US cropland, despite a very largely available potential supply, because of issues with transport cost and because of farmers' concerns about difficulty to define correct application rates, pathogen risks and odour. This results in environmental impacts from local excess applications around livestock production.

Manure phosphorus sources (USDA, data), region specific yield and crop simulated data from agro-ecosystem model (The EPIC, Williams 1995), **the cost of manure phosphorus fertiliser application in US** depending on manure type, receiving, region and destination (maximum 20 km) based on Ribaudo 2003 and external cost estimates (Dodds et al, 2009, see SCOPE Newsletter n° 72), are integrated in agricultural sector model (ASMGHG, Schneider 2007), to **estimate market and trade equilibriums in the USA and with foreign trading partners**.

To define the **monetary costs of phosphorus externalities** the authors adopt estimates from Dodds et al. of 3 billion dollars that is 3.62 /kg P applied on average (USDA, Crop data). For crops which currently show the highest P emissions (potatoes, corn INPI, P uptake data), this means over US $250 per acre (100 US $/ha). SCOPE editors' note: The costs are crop and region attributed, but eutrophication impacts are highly locally variable within regions and even within farms (see e.g. Sharpley in SCOPE Newsletter 114). To address uncertainty related to external cost estimates different levels of externalities taxation, covering 10%, 50% or 100% of estimated external cost are applied to the model.

***SCOPE editors' note**: the paper does not take into account the probably considerable transition costs for the fertiliser production and marketing industries for investments in new equipment and infrastructure to enable storage and transport of livestock manure, and for all concerned in training and knowledge in manure management and application. These transition costs would require appropriate economic support and enabling policies.*

Impacts of a mineral P fertiliser tax

Modelling results indicate that **substantial decreases in use of mineral phosphorus sources are possible if price / tax signals are strong enough**: a doubling of mineral P price only gives a use reduction of 1/6th whereas a 20x increase gives a 2/3 reduction. If the estimated external costs of using rock phosphate is fully internalized (100% tax), a 1/2 reduction of mineral phosphorous would require a 6x increase of P reference price (based on year 2000 P fertiliser prices, based on the assumption that this has already tripled by 2008 because of world market phosphate price increases). The marginal reduction in mineral P-use with price increase and level of external cost internalization is digressive while for higher P prices there is a significant decrease between zero and 10 to 50% tax, the changes between 50 and 100% taxation are fairly small.

Internalising externalities and food production and prices

Higher tax levels of P externality and increase in P prices do not have substantial impacts on agricultural markets and welfare. The changes in aggregated agricultural production are minor and would **result in an increase in aggregated agricultural commodity prices of c. 15%, but would not significantly impact trade in these commodities**. These price increases are mainly transferred from farmers to the final consumer. Farmers' revenue fall, in all the different tax scenarios, by <10%, but **farmers' net incomes increase because of higher crop prices**.

The authors conclude that P externality internalization may substantially increase the share of renewable organic phosphorous sources, while this will increase farmers' production cost, **farmers' income effects are positive** resulting from market price adjustments and associated welfare shifts from consumers to producers. The consumer surplus decreases by maximum 20 $ per capita per year.

"The impacts of higher mineral phosphorus prices and externality taxation on the use of organic phosphorus sources in US agriculture", Working Paper IETSR-1
http://www.researchgate.net/publication/267298768_The_impacts_of_higher_mineral_phosphorus_prices_and_externality_taxation_on_the_use_of_organic_phosphorus_sources_in_U.S._agriculture._Working_Paper_IETSR-1

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RISE ExpoMilano

Sustainable intensification and nutrient stewardship

The RISE Foundation (Rural Investment Support for Europe) has launched a 9-month study to assess the potential and challenges for nutrient recycling in European farming, to identify obstacles and propose policies to positive incentivise nutrient recycling.

The study was discussed at an **expert workshop in the EU Pavilion at ExpoMilano, 23rd September**, with keynote talk by **Janez Potočnik**. The study final report will be presented in March 2016. RISE invites input and comment.

The RISE workshop was opened by **Giancarlo Carati di Lanzacco, Head of the EU Pavilion at ExpoMilano "Feeding the Planet, Energy for Life"** and **Ambassador Corrado Pirizio-Biroli, CEO of RISE**.

Co-chair of the UNEP International Resource Panel, chair of the RISE Foundation and of the Forum for the Future of Agriculture, **Janez Potočnik** explained that in the face of a growing world population, "sustainable intensification" of agriculture is essential to achieve the **United Nations Sustainable Development Goal (SDG) to eliminate hunger and malnutrition by 2030** without putting further pressure on non-cultivated land, natural resources and biodiversity.

To achieve this, **the agri-food system must move towards the Circular Economy**, an economy designed to recirculate resources in the production and consumption cycle as long as possible.

Externalities

Janez Potočnik underlined that **the circular economy for bio-nutrients has the potential to develop economic growth and rural employment**. For this to happen, **we need to design externalities into the economic system**. Priority issues to address include regional nutrient inbalances, food wastes, nutrient use efficiency for both phosphorus and nitrogen on the farm and in the agri-food sector, nutrient recycling and dietary choices. This requires a coherent EU nutrient policy, stakeholder dialogue and awareness building.

Alan Buckwell, Institute of European Environmental Policy, indicated that RISE aims to provide a bridge between science, policy and farmers.

The RISE study on nutrient recycling will assess 6 issues: food and nutrition security, economic and environmental production sustainability, pollution, waste and losses (of food, natural resources), energy efficiency and consumption of finite resources. He underlined the **lack of reliable data on environmental nutrient losses, time series of phosphorus flow data, and on specific industry waste flows**.

Morton Rossé, McKinsey Center for Business and the Environment, noted that since 2010 global agricultural yield/ha has been increasing more slowly than world population. The circular economy is central to sustainable intensification needed to address this.

The Ellen MacArthur Foundation report Growth Within 2015 (see SCOPE Newsletter 116) shows that the **circular economy offers major opportunities for economic growth and employment**, and could save 3 000 € per year per household in Europe. "*Reinventing a regenerative food system*" is identified as one of four key targets for circular economy development in the this report, which underlines that **current lack of pricing of resources and externalities, which results in undervaluation of natural capital and prevents recovery of nutrients reaching large scale**. Other proposals include to reduce taxes on secondary materials such as recovered nutrients and to shift taxes away from labour to finite resources.

Marc Sutton, CEH and chair of the International Nitrogen Initiative and the UNECE Task Force on Reactive Nitrogen, explained that **without synthetic mineral fertilisers only around one half of the current world population could be fed**.

Nitrogen losses in the European Union already cost society 70 billion – 300 billion €/year, with over half of this cost resulting from agricultural activities. With climate change, agricultural ammonia emissions will increase. Three actions are priorities: **low-emission manure spreading**, **capture and recycling of nitrogen oxide emissions** and **food choice**. If the EU moved to a "Demitarian" diet (reducing meat consumption by 50%) nitrogen use efficiency would be doubled and environmental nitrogen losses cut by 40%.

Recycled bio-nutrient fertilisers

Nina Sweet, WRAP (now Waste and Resources Action Programme, UK): **bio-nutrient fertiliser products must be adapted to farmers' needs**, with

evidence and data on nutrient content and crop performance, with quality standards for products and production processes.

Laetitia Six, Fertilizers Europe: the European fertiliser industry wishes to develop the use of recycled materials to **reduce dependence on imports and to integrate the circular economy**, so ensuring social acceptability and license to operate. Innovation will involve composite products, combining organic and mineral content, to provide both organic carbon and the optimal nutrient ratio for crops. Secondary raw materials, such as struvite and biomass ashes are available, but industry needs the economics to be positive to implement.

Reinhard Büscher, Head of Unit Chemicals, EU Commission DG GROW: the revision of the EU Fertiliser Regulation, as part of the upcoming EU Circular Economy package, will **facilitate placing on the market of recycled nutrient products, whilst ensuring agronomic efficacy, quality and safety**. Challenges are to enable flexibility for innovation and new types of product, to avoid contaminant risks and the question of traceability.

Ruben Sakrabani, Cranfield University UK: challenges for nutrient recycling include public perception and heterogeneity of organic amendments. Opportunities include the vast availability of organic amendments in the EU – need to consider how to effectively use it locally and minimise transport. Need to use innovative approaches to 'mine' nutrients from organic amendments and deploy predictive methodologies to **increase reliability of how these amendments meet crop nutrient demand**.

Nutrient recycling in practice

Carl Dewaele, NuReSys: P-recovery as struvite, with installations up to 80 m^3/h operational on wastewaters from potato processing, cheese dairy, biomass anaerobic digestion, bio-oil production, metallurgy, slaughter houses and municipal sewage works. **The struvite product is used by fertiliser producers, blended to produce a nutrient-balanced product for farmers**. For example, **Timac Agro** has tested struvite as a starter fertiliser for maze in 4 test fields, achieving +10% yield compared to standard fertiliser.

Carl Dewaele noted that differences in national regulations (e.g. for fertilisers, pending the revision of the EU Fertilisers Regulation) or in **interpretations of EU regulations** (e.g. for REACH) pose obstacles to the roll-out of nutrient recycling.

Also **positive economic policies will be needed if implementation is to extend beyond the "low hanging fruit"** (where P-recovery offers specific operating benefits):

- **Internalisation of externalities**
- **Tax advantages** for nutrient recycling investment
- **Targets for P-recycling**
- **R&D funding of replication and not only researc**h

Sebastian Homo, Cooperl (Brittany, France, cooperative of 2 700 farmers): a combination of on-farm and centralised treatment of manure slurries and meat processing wastes (slaughterhouses, meat and bone meal ash MBMA) enables **energy optimisation, stabilisation, drying and production of a quality organic fertiliser products with nutrients specifically balanced for different crops**. Cooperl produces over 400 000 tonnes of these bio-nutrient fertilisers per year, recycling c. 500 tonnes N and c. 600 tonnes P per year.

Cooperl's TRAC piggery housing (see SCOPE Newsletter n° 114) with slatted floor and scraping system enables to reduce ammonia and NO_2 emissions by half, improve animal and worker welfare, separate solid/liquid (so improving N and P management) and increase biogas production by +40% (because the manure is moved faster from pig to digester). **This will enable Cooperl to nearly double the annual tonnages of P and N recycled to bio-nutrient fertilisers.**

Cooperl identifies as **factors of success**:

- **Farmers' cooperative model**
- **Small number of centralised, industrial plants** to treat the solid fraction of manures, with on-farm treatment of the liquid fraction
- **Possibility to renew piggeries buildings**, which have an average age of 30 years in Brittany whilst reducing operating costs for farmers

Aki Hainonen, Municipality of Punkalaiden, Finland: more than 50 000 tonnes of manure (wet weight) is produced within a 15 km radius. The studied process: before the dry plug flow anaerobic digestion process, pig manures solid concentration is increased by solid/liquid separation at farms so that the nitrogen-rich liquid can be used as fertilizer in local farms. Then the solid of pig manure is mixed with other manures and biomass like straw and grass, and a solid with a high C/N ratio improved biogas production. **Products of this digestion process are biogas and digestate for use as a fertilizer**.

Celia Bertholds, Käppala municipal waste water treatment plant, Sweden (see SCOPE Newsletter 111): **societal concern about contaminants in sewage** sludge pose challenges to maintaining recycling, after appropriate treatment, to agriculture, which is the optimal solution to recycle phosphorus, nitrogen, other nutrients and organic carbon. A farmer survey suggests that a third of farmers are favourable to using sewage sludges, but 70% have concerns, mainly relating to risk of receiving a lower price for the harvest.

Sewage sludge use restrictions are often not coherent: for example, the flour milling industry refuses grain on which sewage sludges have been used in Sweden, but does not apply this to imported grain. 95% of pharmaceuticals in sewage stay in the water in wastewater treatment, if not decomposed, and only 5% go to sewage sludge. There is a high level of breakdown of pharmaceuticals and other organic compounds by soil microbes. Sweden has a proposed target of 40% recycling of sewage P to farmland without undesirable contaminants and proposed limits for cadmium and silver could pose difficulties for Käppala wwtp. The REVAQ certification scheme works with stakeholder implication to develop confidence, and concerns both the quality of the sewage sludge product and also upstream action to reduce contaminants at source.

Aqua y Sole

The workshop participants visited the **Aqua y Sole Neorurale bio-nutrient recovery centre project** (Cassinazza, between Pavia and Milano). When operational soon, the site will anaerobically digest (55°C for 20 days in three in-series digesters) 120 000 tonnes/year (wet weight) of wastes, mainly separatively collected food wastes, but also manures and other biomass, to produce biogas (used to generate electricity). Ammonia will be stripped in the digesters and recovered as ammonium sulphate (15% concentration), used as a fertiliser in local tomato production.

The installation has cost c. 20 million € investment. The digestate will be delivered free to farmers in a c. 5 km radius (very intensive rice production region) and applied by injection at 10 cm (no till conservation agriculture). A key objective is to restore organic carbon in the intensive rice cultivation soils.

Participants also visited the **Neorurale project**, led by **Zeppi Natter**, where **300 hectares have been restored from intensive rice agriculture to wetlands, woodlands and meadows** over the last 15 years, resulting in a considerable biodiversity increase (documented +70% - +180% increases in numbers of species for birds, grasshoppers, dragonflies, lichens …). This is economically balanced by creation of housing and office jobs.

Workshop conclusions

The workshop expert panel, including **Chris Thornton, European Sustainable Phosphorus Platform**, and participant discussions identified challenges:

- **Potential of bio-nutrient circular economy** (which is employment-intensive) to generate distributed (rural) jobs and farmer income
- **Synergies** between nutrient recycling and biogas energy production, and between nutrient use efficiency and soil carbon reinforcement and soil conservation (erosion prevention)
- **Need for figures on costs of phosphorus losses** to water (eutrophication)
- **Need for data on bio-waste streams**, which are the raw material for nutrient recycling
- **Potential of "big data"** to support agricultural efficiency
- Except for some low-hanging fruit, there is not today an **economic business case** for nutrient recovery
- **Incentives** to cover costs and help farmers adapt
- Acknowledge **externalities** of nutrient losses and resource consumption, and integrate into costs
- Potential of **CAP (EU Common Agricultural Policy)** to push change
- **Specific local approaches**

Concluding the workshop, Alan Buckwell noted that although there are many ideas and operational solutions, **a better understanding of nutrients in agriculture sustainability is needed**.

In particular, the RISE study will look at the obstacles to bio-nutrient recycling: societal and farmer attitudes, economics to identify the right positive incentive systems.

RISE to launch new project on Nutrient Recycling and Reuse
http://www.risefoundation.eu/projects/nutrient-recycling-and-recovery

RISE (Rural Investment Support for Europe) expert workshop on the Sustainable Intensification (SI) of Agriculture and Nutrient Recycling and Recovery (NRR), ExpoMilano, 23rd September 2015

See also RISE report "Sustainable Intensification of Agriculture" in SCOPE Newsletter n° 107

Ghent

IWA Resource Recovery Conference

IWA's first Resource Recovery Conference (RR2015) brought together over 200 researchers and organisations involved in recovery of different values from waste water streams, with 60 presentations and 40 posters.

This event effectively launches the action of the **IWA Resource Recovery Cluster** (see SCOPE Newsletter 110).

The conference opening included an address by **Willy Verstraete (Ghent University),** explaining the need to move from "end of pipe" wastewater treatment to circular economy resource recovery combined with optimised energy recovery. A panel with **Peter Cornel (Technische Universitaet Darmstadt), Pablo Kroff (Suez), Patricia Osseweijer (TU Delft), Chris Thornton (European Sustainable Phosphorus Platform)** and **Ed McCormick (Water Environment Federation)**, addressed market implementation of resource recovery from wastewaters, concluding the need not only for R&D, but also for networking and value chain cooperation, for tools to accompany societal change, **modifying regulation to facilitate recycling whilst ensuring quality and safety and economic policy changes to support the circular economy**.

The official opening was made by **Kor Van Hoof, Flanders Environment Ministry**, who underlined that although water quality has considerably improved over recent decades, there is still a long way to go to meet **Water Framework Directive quality objectives**, so that new innovation will be needed beyond current BAT (best available technologies).

IWA Resource Recovery Best Practice Award

The winner of the ***first IWA Resource Recovery Best Practice Award*** was presented to **Waternet, Restoffenunie** and industrial companies **Ardagh Glass** and **Desso**, for work on **recycling calcium carbonate from wastewater as calcite** for use in three industrial processes. The calcite is respectively used as a seed material in drinking water softening (replacing sand), in backing materials for carpet tiles, and in glass production. These applications require recovery as a clean, pure product, and then specifically developed grinding and drying processes.

Young professionals' proposals

The IWA conference was preceded by a 2-day **workshop for young scientists and professionals**, which developed a number of **key messages to the conference**:

- ***Integration***
  - Wastes as opportunities, not only for a single industry, but for the local community (cooperation or market possibilities)
- ***Nutrients***
  - Legislation
  - Market?
- ***Scale***
  - For small companies, WATER is the product available
  - For big companies, heat an electricity (when organics) by AD
- ***Concentration***
  - Is the key point to make reuse feasible
- ***Economics***
  - Avoiding cost vs. profit
  - Transfer efficiency (e.g. aeration)
- ***Market (push vs pull)***
  - There is no value yet for a lot of products
  - The Green label does not create a market. Label should target purity
- ***Salts***
  - Don't forget them for REUSE
- ***Improve existing technologies***
- ***Keep it simple***

Today and tomorrow

Matteo Papa, University of Brescia, Italy, presented a survey of over 600 municipal wastewater treatment plants (wwtps) in Italy, covering around ¼ of total wastewater volume treated in Italy. **Over half of plants of all sizes send treated sewage sludge to agriculture and/or composting**. More than 60% of plants do not practice any other form of resource recovery. A significant number of plants reuse treated effluents internally, e.g. for washing filters. In smaller works, screenings are significantly used as a source of organic material. Some works recycle screened grit and stones to civil engineering and construction. Heat recovery and biogas production (anaerobic digestion) are present in a number of larger plants.

Jan Peter van der Hoek, Waternet, Amsterdam, explained how this regional public utility is **assessing possible strategies for developing resource recovery from wastewaters** via different routes and to different

time horizons. This is based on collection of material flow data and analysis of possible resource recovery products:

- **Cellulose**, e.g. for use in cardboard or textile production
- **Alginic acid**, which can be used in food and drink production, waterproofing and fire safety, textiles …
- **Bioplastics**, by recovering polymers or precursors
- **Phosphorus recovery**
- **Biogas** (anaerobic digestion)

Cellulose recovery can be implemented today. Bioplastics and alginic acid may be viable in a horizon of c. 10 years but compete. Methane production also competes for organic matter, but can be implemented on residuals. Thermal hydrolysis appears to be an optimal medium-term goal, combining biogas, alginic acid production and P-recovery. **Phosphorus recovery from sewage sludge incineration ash appears as a no-regrets option, compatible with all strategies**.

Ludwig Hermann, Outotec, presented a **vision for comprehensive resource recovery from wastewater**. Every citizen connected to a sewage works produces on average 28 kg sewage sludge containing around 160 kWh energy, 0.7 kg of phosphorus and 4 kg of nitrogen every year. **Nutrient and energy recovery can be efficient if combined in integrated processes to valorise waste heat, produce biogas, use efficient drying technologies** (see DeBugger project in SCOPE Newsletter 116) and recover nutrients both in liquor streams and from thermal conversion residues (ash). Such an integrated concept could enable recovery of nearly 100% of inflow P, 50% of inflow nitrogen (as ammonium sulphate or ammonium nitrate) and 70% net energy recovery.

Wastewater nutrient innovation

Daniel Puyol, University of Queensland, Australia, presented laboratory scale tests of **Purple Phototropic Bacteria (PPB), which can bio-accumulate phosphate (as polyphosphate) and also take up N in anaerobic conditions using light as an energy source** (whereas the bacteria usually developed in EBPR biological phosphorus removal wastewater treatment take up phosphate only in aerobic conditions). This property of PPB means that 'single tank' membrane photo-bioreactor sewage treatment systems can be developed to carry out both water purification (membrane) and phosphorus removal (to sludge, which can then go to anaerobic digestion for biogas production, releasing soluble phosphate for recovery).

Hiroshi Yamamura, Chuo University, Japan, presented laboratory scale experiments **cultivating eosinophilic microalgae to convert inorganic nitrogen in discharge waters from municipal sewage treatment to organic nitrogen, useable as fish food**. Under artificial light and continuous 1% carbon dioxide input, biomass production of up to 3g/m^2/day was achieved. Protein content, amino acid composition and heavy metal of the harvested microalgae were compatible with use as fish food, except for a possible sulphur deficit.

Ralph Lindeboom, Ghent University, presented an innovative "closed cycled" system, using **nano-filtration and reverse osmosis**, for water and nutrient recovery from urine which could be used in space travel life support systems: phosphate crystallisation upstream of nitrification (to reduce risks of scaling), biological urea -> nitrate conversion, recovery of nitrate by electrodialysis.

Laboratory research

Masanobu Takashima, Fukui University of Technology, Japan, presented experimental results for **recovery of calcium phosphate from sewage sludge** incineration ash by sulfuric acid leaching (pH 2-3), then iron chloride dosing to produce iron phosphate, then alkali leaching with sodium hydroxide (pH 13-14) and calcium phosphate precipitation. 70-90% P-recovery from the ash was achieved and the final calcium phosphate product had heavy metal levels below Japan fertiliser standards and <0.02% iron.

Several speakers presented different **research approaches to struvite and calcium phosphate precipitation for P-recovery from wastewaters**. **Cees Buisman, WETSUS,** presented a UASB-based processes to simultaneously recover methane (biogas for energy) and phosphate from domestic black water (mixed urine and faeces), by biologically induced calcium phosphate granule formation in the biofilm. **Sebastia Puig, Lequia – University of Girona**, presented laboratory work assessing the influence of the up-flow velocity as a control parameter on struvite precipitation particle size (within the ManureEcoMine project).

Roberta Hofman-Caris, KWR Netherlands, presented research into using **iron hydroxide sludge** from drinking water treatment as a phosphorus removal-recovery substrate. The sludge has been successfully pelletised by drying at 100°C and adding bentonite or CMC carboxymethyl cellulose. These pellets can be used to take up phosphate from surface

waters (low P concentrations) however regeneration to recover the phosphorus has not yet been tested. The pellets can also be used to remove H_2S from biogas, then regenerated to produce sulphur.

Full-scale nutrient recovery

Wilbert Menkveld, Nijhuis Water Technology BV, presented full-scale experience at **Bernard Mathews poultry processing factory** **recovering nitrogen as ammonium sulphate** by ammonium stripping from anaerobic digestates. Removing and recovery of ammonia can improve operating economics. Ammonia inhibition of mesophilic digestion is reduced, so increasing methane production. The Nijhuis Ammonium Recovery system (NAR) process combines a heat exchanger, CO_2 stripper, ammonia stripper (at 80°C using air and packing material to increase contact) and nitrogen recovery by scrubbing the stripped ammonium in sulphuric acid, producing 30 – 40% concentration ammonium sulphate. Total operating costs (CAPEX & OPEX) were 2.1 – 2.6 €/kgN, of which 0.4 €/kgN was recovered as value of the recovered ammonium sulphate (this price is regionally variable). Costs would be lower, down to 1 €/kgN for higher ammonium concentrations or if residual heat is available.

Angela Mañas, Véolia, presented the water industry's considerations for municipal waste water treatment of tomorrow, tested in the **CreativERU** demonstration plant (*www.anr-creativeru.fr*), a three-year collaborative project between **VERI (VEolia Research and Innovation)** and different universities, in the aim of demonstrating the impact of managing carbon and nutrient flows in municipal wwtps. The water industry is a low-income sector, and the prime objectives are to achieve discharge consent obligations and to reduce costs. Energy is typically around two thirds of wastewater treatment plant operating costs (not including sewage sludge disposal), and energy use varies considerably 0.3 - 2.1 kWh/m^3. The CreativERU plant uses **advanced pretreatment with biosourced polymers** to control ratios of COD/NTK to the secondary treatment. The primary sludge is digested to **produce acetate and propionate VFAs** (volatile fatty acids) which are partly recovered to feed the secondary treatment and improve denitrification. This configuration is compared with biogas production scenarios.

Adrien Marchi, Aquafin, presented **full-scale experiences at Leuven municipal sewage works recovering phosphate as struvite from sewage sludge liquors** (see SCOPE Newsletter 116). Pilot scale testing of the BioCrack® process, a continuous through-flow electroporation system (liquor flows through pipes with internal electrodes) has been performed. This can break open sludge organism cells, so making more phosphorus available for precipitation processes. This showed to increase soluble phosphate by +18% in sludge before digestion, +5% in sludge after digestion.

Also, full-scale tests of **struvite recovery from urine collected at a festival** were also successfully conducted with 99.5% phosphate precipitation efficiency at a molar ratio Mg/P-PO_4 of 1. However, 25% of the crystals recovered were smaller than 0.25 mm, which seem less interesting for the fertiliser industry than bigger crystals. Crystal size optimisation appears as an important operational aspect to guarantee a maximum recovery and a proper valorisation.

IWA Resource Recovery Cluster

During the conference took place the two first meetings of the IWA Resource Recovery Cluster (see SCOPE Newsletter 110), bringing together **some 30 participants to discuss what actions this Cluster should take forward**.

The Cluster is led by Willy Verstraete, Ghent University, Belgium and Peter Cornel, Technische Universitaet Darmstadt, Germany, and has established working groups:

- **Research**, led by Lars Angenent, Cornell University New York, and Aijie Wang, Harbin Institute of Technology, China
- **Market**, led by Olaf Van der Kolk, Reststoffenunie, Netherlands and Ludwig Hermann , Outotec
- **Outreach**, led by Korneel Rabaey, Ghent University, and Hong Li, IWA

The Cluster has published the "State of the art compendium report on resource recovery from water" (see in this Newsletter) and has fixed as objectives **to define 3-5 year resource recovery goals and regional roadmaps, including assessing regulatory obstacles**. In particular, links will be built with other sectors outside the water industry, potential user markets for resources recovered from waste water. The Cluster aims to renew this IWA Resource Recovery conference in 2 years' time.

IWA Resource Recovery Conference, 30th Aug – 2 Sept. 2015, Ghent http://www.iwarr2015.org/

IWA first Resource Recovery Best Practice Award (2015) http://www.iwa-network.org/news/flash-of-genius-recycles-water-waste-into-at-scale-industrial-applications

IWA Resource Recovery Cluster http://www.iwa-network.org/cluster/resource-recovery-from-water-cluster

IWA Compendium

State of the art of resource recovery from water

The IWA "*State of the art compendium report on resource recovery from water*" (42 pages) provides a summary of energy, water and different resource recovery from wastewaters, including technologies, social and regulatory aspects, innovation, adoption, good examples and identification of future trends.

IWA (International Water Association), with c. 10 000 individual and 500 corporate members, is the world's biggest water research and practitioners organisation.

The compendium was launched at IWA's first "Resource Recovery" conference, Ghent, 1-2 September 2015 – **see below** - and is presented as serving as "roadmap for IWA's cluster on resource recovery from water and for its activities" (see SCOPE Newsletter n° 110). The report is based on replies from 21 researchers and 12 practitioners to a survey.

The report summarises the **different resources which can be recovered from wastewaters**: water, energy, biogas, biosolids, heat, nutrients (phosphorus and nitrogen), metals, chemicals (e.g. polymers).

Importance of policy

The report underlines the **importance of policies (including global targets, national and regional regulations)** in encouraging innovation and adoption, encouraging good practice and discouraging unsuitable practices, but also in ensuring clarity (reliable regulations, protocols) and increasing public participation, as well as in removing obstacles to innovation and adoption. The importance of reliable data is emphasised, to support policy development, assess policy implementation and support innovation.

Four **good practices examples** are presented:

- **groundwater replenishment** using treated wastewater (Orange County, California)
- municipal **wastewater treatment energy optimisation**, using A/B biological treatment, DEMON biological deammonification, codigestion for biogas, combined heat and power CHP (Strass, Austria)
- **combined UASB, ANAMMOX, anaerobic digestion and Phospaq phosphorus recovery** as struvite (Oldburg, Netherlands)
- **Billund BioRefinery** Denmark (a SCOPE Newsletter article is currently pending data which is today not available from this site)

The report identifies the three following trends in resource recovery

- **Integrated resource recovery** (centralised IRR) policies, bringing together actions in different sectors (e.g. reducing drinking water infrastructure and operating costs through reduced demand, by using reclaimed water for non-drinking purposes)
- **Small-scale, decentralised water treatment** (e.g. within cities), facilitating local reuse of water, energy or resources
- **Sustainable wastewater treatment plant**, integrating energy saving/production and resource recovery

IWA Resource Recovery Cluster

The report concludes by defining the role of the IWA Resource Recovery Cluster in five points:

1. Provide a **sound science basis** and create awareness
2. Pull side: interact with the **market**
3. Identify consumer **profits from resource recovery**, develop platforms for interaction and consultation to highlight these
4. Develop a **network** for the circular economy
5. Encourage **appropriate policies** and legal frameworks for resource recovery

IWA (International Water Association) Resource Recovery Cluster "State of the art compendium report on resource recovery from water" (42 pages), published September 2015 http://www.iwa-network.org/cluster/resource-recovery-from-water-cluster

ManuREsource

2nd international manure conference

The second ManuREsource conference took place in Ghent, Belgium, 3-4 December 2015, with over 170 participants from 21 different countries. The conference addressed all aspects of management and valorisation of manure, including management of manure on the farm, the circular economy, manure processing technologies and the possibility of an "European manure market".

The conference gave an **extensive overview** in several parallel sessions looking at international research on fertilisation, energy production, technological innovations, nutrient recovery, environmental impact, quality of the recycled manure products.

Site visits

A visit was organised to the company **Fertikal**, located in the port of Antwerp. Fertikal is a manufacturer and seller of organic and organo-mineral NPK fertilizers worldwide. The company operates the **largest manure treatment plant in Belgium, processing around 180 000 tonnes (wet weight) of Flemish (Belgian) and Dutch manure into composted soil conditioner and granulated organic fertilizer** for both agricultural and horticultural markets. Solid fractions of separated slurry or solid manure are dried (thermal/biothermal) and pelletised in order to obtain exportable and concentrated products. The products are distributed to more than 25 countries including to Asia and to the Middle East.

Also, a demonstration was given by **D-Tec** of the company's **Near Infra-Red (NIR)** sensor system which enables to **register in real time the nutrient composition of manure in farmers' slurry tanks**, without sampling and laboratory analysis. The Dutch government is assessing whether this Near Infra-Red could be used as registration system for manure transports.

Need for international cooperation

Sibylle Verplaetse, Flemish Cabinet of the minister for environment, nature & culture, expressed the necessity for more cooperation concerning manure management.

Francesco Presicce of the European Commission (DG Environment) emphasised the **opportunities offered by the revision of the European Fertilizer regulation (EU 2003/2003)** for a more circular approach to nutrients and to enable a harmonised European market for organic fertilizers (e.g. processed manure and digestates).

Nitrates Directive definitions

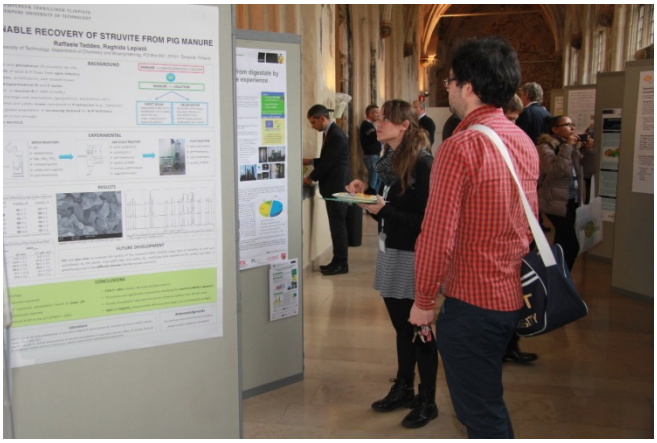
Participants raised the issue of **definitions of fertilisers in the Nitrates Directive**. This directive defines chemical fertilizer as a fertilizer manufactured by an industrial process (art. 2f) but also defines manure "*even in a processed form*" as still being manure. Participants suggested that this can lead to limits to manure application which can represent a barrier to the recovery of nutrients and do not reflect the technical progress in achieving organic fertilisers with better efficiencies.

In response, Mr. Presicce acknowledged that recycled products are improving in efficiency and have an important role in the circular economy. He emphasized that **the Nitrates Directive does not set any limits to the use of such fertilisers outside "nitrate vulnerable zones".** Limits, for both organic and mineral fertilisers, exist only in areas affected by nitrate pollution and are flexible, through the comitology procedure established by the Directive (Art.9), which **allows Member States to propose different values, provided that the risk of environmental losses does not endanger water quality**. He emphasised that the principle of balanced fertilisation embedded in the Directive has been an important driver encouraging innovation in the field of manure processing.

Member States actions

Conference participant comments underlined that **Member States have different approaches to manure management**. Some countries are confronted with high nutrient excesses, whereas in some regions the nutrient balance is in equilibrium or there is a need for nutrient input.

Sweden and **Poland** agriculture were presented, showing a demand for organic fertilisers.



Finland is developing manure legislation, and wants to include local authorities in a relocalisation of livestock and agriculture, to avoid local concentrations of manure production and so local nutrient excesses.

Wallonia does not have local manure excesses, strongly believes in recycling at the farm level, and wants to avoid external inputs where possible. However, if European regulation would foresee a harmonised manure market, Wallonia is prepared to revise the 'waste' statute of manure under certain conditions.

Need for data to support nutrient management

Flanders and the **Netherlands** are implementing systematic collection of data on fertilizer use, manure production and composition, including follow-up and tracing of transports. The German region **Niedersachsen** also intends to develop data collection. The conference panel members all agreed that numerous international manure transports make data exchange indispensable.

Fertilisers Regulation revision

The conference noted that the recent **EU 'Circular Economy Package'** second-version (see in this Newsletter), including the revision of the Fertilizer regulation, is a promising evolution for facilitating the marketing of organic fertilisers and bio-nutrients and to **enable a level playing field between fertilisers derived from animal manure and mineral fertilisers**.

The revision of the EU Fertilisers Regulation should **enable sufficient flexibility to determine the status of the fertiliser on the base of the plant availability of nutrients and of the product composition**. The characteristics and the composition of the fertiliser should determine its position on the market. However, it was noted that a lot of **work needs to be done, by researchers and policy makers to develop a sound scientific basis** about the characteristics of fertilisers generated from animal manure.

The third ManuREsource will take place in December 2017.

ManuREsource conference: www.manuresource2015.org

Contact info@vcm-mestverwerking.be

Sustainable Phosphorus Platform
E-Discussion Group

This is a newly-launched **international discussion group to exchange knowledge and experience on phosphorus sustainability**, covering phosphorus use, impacts, resources and recycling, in agriculture, diet and nutrition, industry, chemistry, soil and water. It has been initiated by the European Sustainable Phosphorus Platform (ESPP) www.phosphorusplatform.eu/ and is managed Arno Rosemarin (Stockholm Environment Institute *www.sei-international.org*), with collaboration of the North American Partnership for Phosphorus Sustainability (NAPPS) *https://sustainablep.asu.edu* and the Global Phosphorus Research Initiative (GPRI) *http://phosphorusfutures.net/*

The e-group will enable in particular **discussion of articles in SCOPE Newsletters**.

Join now !

Registration instructions and e-group address:

https://groups.google.com/d/forum/sustainablephosphorusplatform

Water resource recovery networks

Several different organisations enable networking and information exchange on resource recovery from waste waters. ESPP proposes a table summarising the different activities and content for each one. This overview has been prepared by ESPP. The networks concerned were consulted, but the final summary table is ESPP's responsibility.

		Geographical coverage	*Funding and organisation*	*Theme*	*Key objectives and actions*
ARREAU **Accelerating Resource Recovery from Water Cycle** *http://www.eip-water.eu/ARREAU*	EIP Water Action Group	Europe	European Innovation Partnership (EU R&D Horizon 2020 EIP Water)	Resource recovery from water	Define "Best Practice" Identify success factors, barriers Propose market and implementation plans for recovered resource value chains
WssTP **Resource Recovery Working Group** *http://wsstp.eu/*	WssTP	Europe	Industry members	RRWG covers recovery from water of nutrients, salts, metals, energy, organic chemicals	WssTP develops vision on water innovation Input to EU on R&D orientations Information about EU R&D funding opportunities R&D project brokerage
BioRefine Cluster *http://www.biorefine.eu/cluster*	BIOREFINE CLUSTER EUROPE	Europe	R&D project funding	Recycling of nutrients from bio-materials	Groups 20+ R&D projects to facilitate exchange and synergy, dissemination, interaction with regulators
WEF **Water Environment Federation** *www.wef.org*	Water Environment Federation the water quality people	Global (focus North America)	Research membership association + industry sponsors	No specific resource recovery 'sector' but activities on nutrient recycling from water, etc	Innovation dissemination
IWA Resource Recovery Cluster *http://www.iwa-network.org/cluster/resource-recovery-from-water-cluster*	IWA the international water association	Global	Membership association	Resource recovery from water	Promote concepts of resource recovery. Enable a bigger impact from the work of relevant IWA SGs on resource recovery through e.g., events, publications and working with external partners
Nutrient Platforms *www.phosphorusplatform.eu*	P	Global (GPNM) Europe (ESPP) N America (NAPPS) Japan (JPRC) National	Funded mainly by industry members, governments	Nutrients only, But full cycle (use, supply, recycling)	Networking Dissemination Regulatory dialogue

Nano forms of phosphates

Nano hydroxyapatite

Safety of calcium phosphate use in consumer products

A weight of evidence risk assessment of use of hydroxyapatite (tricalcium phosphate), including nano particles, in toothpaste concludes that use is safe. However, an Opinion of the EU SCCS (Scientific Committee on Consumer Safety) concludes that toxicological information available on nano forms of hydroxyapatite is insufficient to decide whether the material is safe but that there are concerns about potential toxicity of needle-shaped nano forms.

Hydroxyapatite (EINECS numbers 270-423-5, 215-145-7 and 235-330-6) is also known as "bone ash", tricalcium phosphate and pentacalcium hydroxide tris(orthophosphate). **It is widely present in living organisms, where it is the principal constituent in particular of bones and teeth**.

Nano forms are likely to be formed spontaneously in many natural, physiological or industrial hydroxylapatite production processes, in that the first small crystals will necessarily be of nano size (unless precipitation is entirely by growth onto larger seed crystals or surfaces).

See the EU definition of a "nanomaterial" at
http://ec.europa.eu/environment/chemicals/nanotech/faq/definition_en.htm

For memory, the **EU definition of a nano-material** is as follows: *"A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm – 100 nm. In specific cases and where warranted by concerns for the environment, health, safety or competitiveness the number size distribution threshold of 50 % may be replaced by a threshold between 1 and 50 %."*

The **Cosmetics Regulation** further specifies that only nano materials which are "insoluble or biopersistent" are considered.

The SCCS Opinion **does not justify that nano hydroxyapatite is either insoluble or biopersistent**, and indeed it is not clear how these terms are defined.

Integrated risk assessment

The 2011 **integrated weight-of-evidence risk assessment of hydroxyapatite use in toothpastes**, published by Scheel and Hermann of Henkel AG, looks at use of composites of hydroxyapatite (in different forms including nano rods and dull/needles) with gelatin (protein) in toothpastes (HCN composites, commercial name Nanit®), at contents up to 1%. HCN = 0.1% hydroxyapatite This product is used in toothpastes because it **reduces tooth sensitivity, by adsorbing onto dentine and inducing crystallisation of a thin protective layer**, so covering the dental tubuli which conduct paid stimuli to teeth nerves. Hydroxyapatite materials and composites are also used in medical applications as bone substitute materials or to cover implants, often including small particles down to nano size.

The assessment was based on in vitro testing including cell toxicity (macrophage, fibroblast MIT), mucous membrane irritation, eye irritation, inflammatory mediators and oxidative stress, as well as literature on hydroxyapatite and nano-hydroxyapatite medical and cosmetic uses and toxicity testing. The literature includes tests showing absence of mutagenicity and allergenic effects and indicates that small hydroxyapatite particles are taken into cells and dissolved in lysosomes. Data also included clinical tests of HPC with 180 volunteers, showing both effectiveness in reducing dental sensitivity and absence of negative health effects.

This paper concludes an absence of negative health effects and, taking into account exposure as used in toothpastes (risk assessment), safety for use.

SCCP opinion on nano hydroxyapatite

The **European Union's Scientific Committee on Consumer Safety (SCCS) Opinion on "Hydroxyapatite (nano)",** October 2015, assesses "*the safety of the nanomaterial Hydroxyapatite when used in oral cosmetics products including toothpastes, tooth whiteners and mouth washes with a maximum concentration limit of 10%, taking into account the reasonably foreseeable exposure conditions … (and) any further scientific concerns with regard to the use of Hydroxyapatite in nano form in cosmetic products*".

SCCS was mandated by the European Commission to assess these uses because **35 companies notified the use of nano forms of hydroxyapatite, including in toothpastes, tooth whiteners and mouth washes**, under Art. 16 of the *EU Cosmetics Regulation*

1223/2009 and the Commission identified possible concerns "*because of the potential for nanoparticles of hydroxyapatite to be absorbed and enter into cells*".

From the published SCCS Opinion, it would appear that this is based on **data submitted by only three (non named) companies, plus a literature search**.

In total, **some 40 studies and literature reports are assessed by SCCS**. For many of these studies and data presented, SCCS concludes that **reliable conclusions cannot be drawn** because methods were not standard OECD, data was incomplete or the (nano) material was insufficiently characterised. However, some studies do suggest that needle-shaped nano-sized hydroxyapatite particles may possibly have health effects including oxidative impacts

The study demonstrates that **needle-shaped nano-hydroxyapatite can penetrate into cells** and may lead to biochemical changes with indications of oxidative damage (Q. Chen 2014), **"slight" irritation to mucous membranes**, and unproven but possible systematic toxicity (possible effects on liver, kidney, lung), possible cell toxicity (osteoblasts) and possible genotoxicity.

SCCS concludes "*Based on the information available, SCCS considers that the safety of nano-hydroxyapatite materials … when used up to a concentration of 10% in oral cosmetic products, cannot be decided on the basis of the data submitted … and that retrieved from literature search. The available information indicates that nano-hydroxyapatite in needle form is of concern in relation to potential toxicity. Therefore, needle-shaped nano-hydroxyapatite should not be used in cosmetic products.*"

"Integrated risk assessment of a hydroxyapatite–protein-composite for use in oral care products: A weight-of-evidence case study", Regulatory Toxicology and Pharmacology 59 (2011) 310–323, http://dx.doi.org/10.1016/j.yrtph.2010.11.003

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Scientific Committee on Consumer Safety (SCCS) Opinion on "Hydroxyapatite (nano)", SCCS/1566/15, adopted 16 October 2015
http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_191.pdf

Updated events listing online at:

http://www.phosphorusplatform.eu/events/upcoming-events

To add your event, please contact
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Nutrient Platforms

Europe: ***www.phosphorusplatform.eu***

Netherlands: ***www.nutrientplatform.org***

Flanders (Belgium):
http://www.vlakwa.be/nutrientenplatform/

Germany: ***www.deutsche-phosphor-plattform.de***

North America Partnership on Phosphorus Sustainability NAPPS ***https://sustainablep.asu.edu***

Upcoming events

- 15-19 Jan. 2016, Arizona, **US P-RCN** (Sustainable Phosphorus Research Coordination Network) *https://sustainablep.asu.edu/*
- 25 - 26 January 2016, Rotterdam, **Towards a Circular Economy in Europe** *http://www.vlaamsmaterialenprogramma.be/sites/default/files/atoms/files/Unwrapping%20the%20Package.pdf*
- 10 Feb 2016, Leeuwarden Netherlands, **EIP Water Conference** *http://www.eip-water.eu/save-date-next-eip-water-conference-10-february-2016-leeuwarden*
- 15-16 Feb, Brussels, **Policy mixes promoting resource efficiency for a circular economy** *http://dynamix-project.eu/*
- 9-10 March, Berlin, Germany, **SUSCHEM – 2nd International Conference on Sustainable Phosphorus Chemistry** *www.susphos.eu*
- 13-15 March 2016, Paris, **Phosphates 2016** (the phosphate industry conference) *http://www.crugroup.com/events/phosphates/*
- 7-10 Mar. 2016, Berlin, **European Workshop on Phosphorus Chemistry** and 2nd **International Conference on Sustainable Phosphorus Chemistry (ICSPC2016)** *www.susphos.eu*
- 27-29 June, Guildford, UK, **SludgeTech 2016** *www.sludgetech.com*
- 16-20 Aug 2016, Kunming, Yunnan, China, 6th world **Sustainable Phosphorus Summit** *http://sps.ythic.com/*
- 5-9 Sept 2016., Windermere, Lake District, England, **International Organic Phosphorus Workshop 2016** *http://soilpforum.com/*
- 12-16 Sept 2016 Rostock, Germany, **8th International Phosphorus Workshop (IPW8),** Phosphorus 2020 – Challenge for synthesis agriculture & ecosystems *http://www.wissenschaftscampus-rostock.de/*