European Sustainable Phosphorus Platform

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SCOPE NEWSLETTER

EU agriculture policy

Draft EU BAT reference
Intensive poultry & pigs

European Commission publishes draft Best Available Practice legal reference document (BAT BREF) for intensive animal production, introducing ammonia emissions and animal P and N excretion limits.
Any comments to ESPP by 5th October 2015

EMAS Agriculture
EU Best Environmental Management Practice (BEMP) published

The European Commission JRC has published the BEMP report (Final Draft) for the agriculture sector, crop and animal production

EU Joint Research Centre (JRC)
EMAS best practices for agriculture presented at Expo2015 Milan

JRC, the European Commission's in-house science service, presents EMAS Best Environmental Management Practices (BEMP) for agriculture

EU water policy

European Court of Auditors (ECA)
Call to tighten EU sewage and sludge Directives

ECA report recommends tightening EU wastewater and sewage sludge Directives and compliance monitoring, improving sewage reuse with energy and P recovery and improving water pricing

ESPP General Assembly

Action plan, election of Board & budget, overview of dossiers underway: Circular Economy, Fertiliser Regulation inc. struvite and ashes, agricultural BEMPs, standards …
To participate: please indicate your name AND EMAIL at http://doodle.com/poll/9tzibixznvidfctc and also contact info@phosphorusplatform.eu

Circular economy and nutrient recycling

Skellefteå, Sweden
Outotec presents DeBugger sludge dryer prototype

Steam-drying technology may open new routes for biosolids nutrient recycling

Leuven Belgium
Struvite precipitation and sludge dewaterability

Better sludge dewaterability may be a positive result of struvite recovery

UK water industry
P-recycling policy tool

Thesis proposes "Phosphorus Recycling Obligation" to address UK P resource scarcity

Locminé, Brittany
Green energy and bio-nutrients from agro-food wastes

60 000 tonnes/year of wastes and manures will produce methane, heat, electricity and recycled nutrient fertiliser digestate.

Phosphorus flows and P in soil

Phosphorus flows
Low P use efficiency of New Zealand

P SFA (substance flow analysis) shows high P consumption and low efficiency in New Zealand.

Switzerland
Available soil phosphorus related to agricultural land use

Soil analysis at 245 sites shows soil P forms related to land use rather than landscape site characteristics

The partners of the European Sustainable Phosphorus Platform

EU agricultural policy

Draft EU BAT reference
Intensive poultry & pigs

European Commission has published, for consultation, the draft legal reference document (BAT BREF) **Best Available Technology** for **intensive animal production (pigs & poultry).** Under the Industrial Emissions Directive (IED), all new installations in Europe have to respect the BAT BREF specifications, and all existing plants have four years to become compliant after its adoption. The BAT-BREF specifies operational criteria including best available technologies and emissions limits.

The BAT BREF for intensive pig and poultry production (850 pages) was published on the EU (JRC) website on 14/8/15 and will be discussed at the IED consultative committee on 19th October, of which ESPP is a member.
http://eippcb.jrc.ec.europa.eu/reference/irpp.html
select "Download the BREF document (Final Draft)"

New requirements: ammonia emissions, P and N excretion limits

The proposed draft would introduce important new binding environmental obligations for all intensive pig and poultry farms above the applicable sizes (40 000 places for poultry, 2 000 places for production pigs > 30kg, 750 places for sows – that is in total some 19 000 farms in Europe):

- **Ammonia emissions**
- **Nitrogen and phosphorus excretion limits** per animal per year
- **Fully slatted floors** (obligatory for new installations only)
- Plus a range of other BAT specifications including water use, energy consumption, noise, dust, odour.

ESPP notes that these BAT requirements will have positive impacts in reducing environmental impacts of large livestock farms, and should help move towards better nutrient use efficiency, but also notes that **it is important that farmers can pass on implementation costs to supermarkets and consumers**, particularly in the current context of high pressure on farm incomes, including as a result of competition with imported food products which do not respect such production quality requirements.

Implications for phosphorus management

This BAT BREF has direct relevance to phosphorus management

- In **animal feed use** (feed intake levels, nutrient levels in feed, enzyme use …)
- **Nutrient emission levels** (nutrient levels in manures, emissions in housing, manure storage, spreading …)
- In **manure collection** (including animal housing), manure treatment, manure spreading

Manure treatment processes specified include: mechanical separation, biological treatment, anaerobic digestion, composting, drying, acidification, combustion of poultry litter, ammonia stripping, phosphorus separation by gypsum based precipitate, electro-oxidation/electro-coagulation and struvite precipitation.

Animal nutrition, phytase, feed phosphates

Reference data is provided for poultry and pig feeding. Poultry feed phosphorus levels are indicated as 0.3 – 0.85% P for poultry and 0.4 – 0.75% P for pigs (multiphase feeding). Also, a range of different data is provided for manure production and manure nutrient content /annual nutrient excretion for different poultry and pigs, in different production systems.

Good management practices presented for **nutrient management in feed** are:

- **reducing crude protein level** by formulating a balanced diet based on net energy for pigs and metabolisable energy for poultry
- formulating diet adapted to specific requirements of production phases (**multiphase feeding**)
- improving feed characteristics through using e.g. amino acids to reduce crude protein, **phytase** to reduce P levels, zootechnical additives, highly digestible feed raw materials.

Phytase use is indicated as improving P digestibility of plant material in diet by 15 – 40% for pigs and 20 – 30% for poultry. Advantages of phytase use are indicated as including:

- no loss of growth, feed conversion rates, egg production, compared to high P diets
- improved protein digestibility
- reduced use of mineral P feed additives, so reducing P resource consumption

- lower P levels in manures: a reduction of 0.1%P in poultry feed using phytase can result in a 20% reduction in manure P content

Inorganic (mineral) feed phosphate additives are also cited as offering advantages of predictable P content and high digestibility. The total phosphorus levels in animal diets can thus be reduced by using mineral feed phosphates, resulting in reduced phosphorus losses in manures.

Other feed additives assessed include other enzymes (proteases, which can improve nitrogen balance, xylanases, glucanases …), non-antimicrobial growth enhancers, microorganisms (e.g. *Lactobacillus Bacillus, Enterococcus* …), organic acids (e.g. benzoic acid which can reduce ammonia emissions in animal housing), phytogenic feed additives (improve animal health by fostering intestinal bacteria).

BAT for "Nutritional Management" is specified for nitrogen (BAT 3) as: reducing crude protein content through a balanced diet, multiphase feeding, addition of amino acids and use of feed additives which reduce nitrogen excretion. BAT-associated total nitrogen excreted varies from 1.5 to 30 kgN/animal place/year for pigs and 0.2 – 2.3 kgN for poultry.

BAT for "Nutritional Management" is specified for phosphorus (BAT 4) as: multiphase feeding, feed additives which reduce phosphorus excreted (e.g. phytase), use of inorganic feed phosphates. BAT-associated total phosphorus excreted varies from 1.2 to 15 kgP/animal place/year and 0.05 – 1.0 kgP for poultry.

Manure processing

BAT information relevant to manure production and processing includes animal housing systems (including manure / litter / liquid separation), reduction of emissions from manure storage to air and to soil/water, on-farm processing of manure, reduction of emissions from land application of manure, monitoring.

Techniques for on-farm manure processing assessed are:

- **mechanical separation**: screw press, auger, decanter-centrifuge, coagulation-flocculation, sieve, filter presses
- **biological treatment**: aerobic digestion (aeration, serial tank), nitrification-denitrification
- **composting**, co-compositing of poultry manure with green wastes, composting with biological inoculum
- **anaerobic digestion** to produce biogas. It is indicated that this improves N crop availability, and so fertiliser use.
- **anaerobic lagoon**
- **evaporation and drying**, external tunnel drying, belt drying
- **acidification**
- **combustion** of poultry manure for energy recovery. It is noted that the resulting ash can be used a fertiliser because it is rich in P and K
- **ammonia stripping**
- **manure additives**: masking and neutralising, absorbents, urease inhibitors, pH regulators, oxidising agents, flocculants, disinfectants and antimicrobials, biological agents

Different **conditions in which one or more of these manure treatment techniques must be applied in new or existing farms are specified** in BAT 19:

- mechanical separation is only specified where nutrient reduction is required due to limited land available for spreading or where manure cannot be economically transported for spreading
- anaerobic digestion for biogas is specified as "may not be generally applicable due to the high implementation cost" and anaerobic digestion of slurry is only specified where pathogen and odour reduction is required
- nitrification-denitrification, external tunnel dryer and composting are specified as only required in specific circumstances

Emerging techniques

Four processes are identified as "emerging techniques" for manure processing:

- **combined biological treatment with ammonia stripping**, indicated as combined with phosphate precipitation, to produce both a phosphate fertiliser and ammonium sulphate nitrogen fertiliser
- **phosphorus separation by using gypsum** (calcium sulphate) and magnesium oxide, producing a slurry which can be separated (by settling) and used as a phosphate fertiliser
- **electro-oxidation / electro-coagulation**: application of an electrical current with iron and aluminium electrodes can oxidise material in suspension, float off small particles and enable iron-led coagulation, enabling removal of organic matter and nitrogen compounds and improved solid – liquid separation (phosphorus is settled with solids)

- **struvite precipitation for phosphorus recovery**: issues noted are the need to pretreat pig manure to solubilise the phosphorus and the need to add magnesium and often alkali (pH adjustment) chemicals. The potential to recover potassium struvite is not mentioned which is logical as this is more applicable to calf manure, which has high K concentrations.

Other emerging techniques identified are: low-litter floor systems for poultry; slatted ventilated floors and scrapers for piggeries; sequential feeding for poultry; NZES (near zero emission stall) systems for piggeries; PigSAFE Piglet and Sow Alternative Farrowing Environment pens; titanium oxide paints which can photocatalytically degrade ammonia; P-index for soils to manage manure spreading.

"Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs", Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control), European Commission JRC, "Final draft" August 2015 http://eippcb.jrc.ec.europa.eu/reference/irpp.html *select "Download the BREF document (Final Draft)"*

You are welcome to transmit comments on this document to ESPP please: deadline for submission to EU = 5th October 2015

EMAS Agriculture

EU Best Environmental Management Practice (BEMP) published

The European Commission has published the **BEMP (Best Environmental Management Practice)** SRD (Sectoral Reference Document) report (Final Draft) for the agriculture sector, crop and animal production, developed according to the EU EMAS (Eco-Management and Audit Scheme) regulation (see article in this Newsletter above). The 612 page document presents a scientific and economic assessment of agriculture's key environmental impacts, then identifies and details 47 BEMPs targeting different agricultural sectors or cross-cutting for different themes and environmental challenges.

For each of the proposed 47 BEMPs, the report specifies **benchmarks of excellence, environmental performance indicators, reference publications**. These are summarised in the 7-page Table 13.1 Overview of the key environmental performance indicators and benchmarks of excellence, pages 604-610. For some BEMPs, case studies are also provided.

Nutrient Management BEMPs from Table 13.1
Overview of the key environmental performance indicators and benchmarks of excellence

BEMP	*Benchmarks of excellence*	*Key environmental performance indicators*
5.1. Field nutrient budgeting	The maximum fertiliser nutrients applied do not exceed those required to achieve the agronomic optimum crop yield, after fully accounting for crop-available nutrients supplied by: a. organic amendments, b. soil nutrient supply and c. crop residues. Nutrient surplus or nutrient use efficiency is estimated for nitrogen, phosphorus and potassium for individual crop- or grassland- management parcels	Field nutrient surplus (kg/ha/yr) Nitrogen use efficiency (%) N balance (kg N/ha) Regular soil fertility testing
5.2. Crop rotation for efficient nutrient cycling	All grassland and crop rotations include at least one legume crop and one break crop over a five year period	Integrate legumes and break crops into rotation for N and C cycling Number of break crops (ley, legume, oilseed in a rotation) Length of rotation/years
5.3. Precision nutrient application	Nutrient surplus or nutrient use efficiency is estimated for nitrogen, phosphorus and potassium for individual crop- or grassland- management parcels	NUE from synthetic inputs Apply the 4Rs: right fertiliser, right time, right rate, right method. Use GPS technology to optimise nutrient delivery Apply nutrients to coincide with plant demand
5.4. Select lower impact synthetic fertilisers	Mineral fertiliser used in the enterprise must not have given rise to manufacturing emissions exceeding 3 kg CO_2e per kg N, which must be demonstrated in an openly reported calculation provided by the supplier Employ low ammonia emission application of fertilisers	Certified fertiliser carbon footprint (kg CO_2 e/kg N) Source synthetic fertilisers with lower embodied (upstream) GHG emissions and energy and with lower post application ammonia and GHG emissions Percentage of (%) fertilisers produced in factories implementing best available technology (BAT) as defined in the European Industrial Emissions Directive

It is indicated that Table 13.1 can be used stand-alone, and the lines for the four **Nutrient Management BEMPs are reproduced abive**.

Four nutrient management BEMPs

The SRD report identifies four BEMPs for nutrient management, applicable to all farm types:

- 5.1 Field nutrient budgeting
- 5.2 Crop rotation for efficient nutrient cycles
- 5.3 Precision nutrient application
- 5.4 Select lower impact synthetic fertilisers

Also, a short **introduction to nutrient management** is provided (6 pages), underlining that although considerable nutrient use efficiency improvements have been achieved for both phosphorus and nitrogen since the 1980s-1990s, there is still "*an urgent need to develop joined-up approaches to optimize the planet's nutrient cycles for delivery of our food and energy needs, while reducing threats to climate, ecosystem services and human health*.".

In particular, potential for **greenhouse gas emission reductions** through **optimised manure and fertiliser handling** and **point and source nutrient pollution** from agriculture are highlighted as important issues, including EU Nitrates Directive and Water Framework Directive implementation (cross-compliance).

Nutrient Management Plans are identified as key to enabling farms to optimise yield and optimise use of fertilisers and organic manures.

Manure BEMPs

The SRD report identifies **seven BEMPs for manure and livestock slurry management**:

- 9.1 **Efficient housing**
- 9.2 **Anaerobic digestion** of organic waste
- 9.3 **Slurry and digestate separation** (Key Environmental Performance Indicators identified include Nutrient surplus N and P kg/ha/year and Nutrient use efficiency N and P %)
- 9.4 Appropriate **slurry processing and storage** systems (Benchmarks of Excellence include optimisation with respect to farm nutrient management planning)
- 9.5 Appropriate **solid manure storage**
- 9.6 **Injection slurry application** and manure incorporation, in **accordance with nutrient requirement** of the crop (Key Environmental Performance Indicators identified include avoided fertiliser requirement and timing of slurry applications in relation to crop nutrient requirements)
- 9.7 **Injection slurry application to grassland**, in accordance with nutrient requirement of the crop (Key Environmental Performance Indicators identified include nutrient surplus N and P kg/ha/year and nutrient use efficiency N and P %)

The report notes the **links to the Industrial Emissions Directive (IED) BAT BREF (Best Available Technologies document) for intensive poultry and pig production**. This was published in 2003 but is currently under revision (the revised draft was published in August 2015 at *http://eippcb.jrc.ec.europa.eu/reference/irpp.html* [select "Download the BREF document (Final Draft)"]. ESPP is a member of the IED Forum, consulted for such BAT BREF proposals. See article in this Newsletter.

The report underlines that also **for dairy farms, manure management is environmentally important**, contributing (in animal housing and manure storage) 10 – 50% of farm greenhouse gas, eutrophication and acidification emissions.

Other nutrient relevant BEMPs

Two BEMPs addressing "**animal husbandry**" directly concern nutrient management:

- 8.2 **Nutrient Budgeting** on livestock farms
- 8.3 **Dietary reduction of N excretion** (ruminants and monogastric)

Furthermore, a number of other BEMPs will significantly contribute to improved nutrient management, although this is not identified directly, for example:

- 3.1 Strategic **Farm Management Plan**
- 3.3 **Landscape water quality management** (Key Environmental Performance Indicators identified include soil nutrient concentrations (mg/kg) and width of buffer strips)
- 3.6 **Waste Management** (Key Environmental Performance Indicators identified include % organic waste sent to digestion or composting)
- 4.1 Assess **soil physical condition**
- 4.2 Maintain/improve **soil organic matter** on cropland (identified Benchmarks of Excellence include account for all organic nutrient inputs in nutrient management plans)
- 4.3 Maintain **soil structure** (avoid erosion and compaction)
- 6.3 Mitigate **tillage impacts**

- 6.4 **Crop rotations** as one measure for soil protection
- 6.5 Establish **cover/catch crops**
- etc.

Information provided includes the case study (8.2.1) "**Nutrient cycling in BPM 'pilot' commercial dairy farms, Netherlands**", presenting the Dairyman project which has 16 commercial farms as pilots for managing nutrients efficiently and reducing surpluses,

"Best environmental management practice for the agriculture sector - crop and animal production" – Final Draft – August 2015 https://ec.europa.eu/jrc/en/research-topic/best-environmental-management-practice *and direct link* http://susproc.jrc.ec.europa.eu/activities/emas/documents/AgricultureBEMP.pdf

EU Joint Research Centre (JRC) European Commission's in-house science service

EU best practices for agriculture in the framework of EMAS

On 6th July, the European Commission (Joint Research Centre JRC, the Commission's in-house science service), presented its work on BEMPs (Best Environmental Management Practices) for agriculture (crop and animal production), which will be the basis for producing an EMAS Sectoral Reference Document (SRD) on Best Environmental Management Practice for the agriculture sector. Including, among others, chapters on nutrient management, soil quality and irrigation, this comprehensive report is now published at:

https://ec.europa.eu/jrc/en/research-topic/best-environmental-management-practice *"Best environmental management practice for the agriculture sector - crop and animal production" – Final Draft – August 2015* http://susproc.jrc.ec.europa.eu/activities/emas/documents/AgricultureBEMP.pdf

The document, summarised in a separate article in this Newsletter, is the result of 2 years of cooperation with an expert working group involving farmers, industry and stakeholders led by the European Commission's Joint Research Centre (JRC).

Separate work is underway on a parallel report for the food and beverage manufacturing sector.

The BEMP reports lead to the production of shorter **EMAS Sectoral Reference Documents (SRD)** on Best Environmental Management Practice which are officially adopted by the European Commission and should be taken into account by organisations registering with EMAS but can also be referred by industry in regulatory schemes, by regulators or by standards organisations.

EMAS (EU Eco-Management and Audit Scheme) is a European voluntary framework and environmental management system to evaluate, report and improve the environmental performance of an organisation/company. It is open to all kind of companies and other organisations willing to take serious steps in making their activities more environmentally sustainable.

Expo 2015

The European Commission presented the agriculture EMAS BEMP work at a conference on "*Best practices in improving the sustainability of agriculture*", at the EU Pavilion in Expo2015, Milan (the international exhibition on "Feeding the Planet – Energy for Life").

Paolo Canfora, European Commission Joint Research Centre (JRC), presented the BEMP process, with the objective of identifying environmental practice frontrunners then facilitating generalisation to the sector. Key aspects are providing **practical guidance, defining operational indicators of environmental performance and identifying benchmarks of excellence**.

As an example, the defined **BEMP (Best Environmental Management Practice) for fertiliser management** provides guidance on how to produce and use a farm nutrient management plan, selection of fertilisers with lower environmental impact, and application when and where fertiliser is required. The benchmark is that the application of fertiliser is not greater than the requirement for economic optimum crop production and that nutrient budgeting/fertiliser application is calculated field by field.

BEMP cost benefits

Sebastian Paquot, European Commission DG Environment, indicated that implementation of EMAS can bring **benefits including cost savings (resource efficiency), respect of regulation, better management and improved public image**. The importance of nutrient management in agriculture's environmental impacts has also been underlined: mineral fertiliser use represents 2% of society's total greenhouse gas emissions and less than 20% of total nitrogen input into EU agriculture actually reaches food crops and livestock products.

Katarina Hedlund, Lund University Sweden, underlined the **need to restore soil organic carbon**, which is under pressure from intensive agriculture and from biomass use. On top of soil organic carbon, better management of soil quality is important for soil biological activity, biotic resistance, reducing soil erosion, compaction and salinisation. BEMP proposals include farms to have a **5-year soil management plan**, with analysis of soil carbon every five years and actions to improve soil quality such as specifying tonnage/ha of straw to be returned to soil. A benchmark of excellence is for all arable fields to receive organic matter from crop residues, manures, composts or digestates, or catch/cover crops every year.

David Styles, Bangor University UK, explained that nutrient management is cross-cutting in different agriculture BEMPs and critical to sustainable intensification. Nutrient management BEMPs include the following criteria:

- Accounting for **organic nutrients applied** (manures, crop residues) and soil nutrient availability when calculating fertiliser application rates at the field level
- Calculation of the **whole-farm nutrient balance** for livestock farms, accounting for fertiliser and animal feed inputs and manure application onto pastures …
- **Limiting nutrient 'surplus'** (total net input minus crop/livestock offtakes) to 100 kgN/ha/yr and 10 kgP/ha/yr for livestock farms
- **Adapted animal housing** (slatted floors, scraping), covered manure storage, and anaerobic digestion of manures to reduce manure management emissions of methane and ammonia, and to conserve N
- **Appropriate application of manures**: right time, right place, right equipment (e.g. trailing shoe or injection) to minimise nutrient losses to air and water)

Daniele Massa, CRA-VIV (Italian Council for Research and Economic Analysis of Agriculture), presented environmental challenges related to agricultural irrigation, **BEMP techniques to improve water use efficiency (WUE)** and reduce water loss. He noted that regulatory drivers are necessary because the cost of water is generally low whereas the equipment and energy costs of precision irrigation can be significant. However, the monitoring of crop water requirements through direct (sensors) and indirect (models) measurements is a key factor for optimising irrigation.

Need for dissemination

The conference concluded with the **need to disseminate and communicate the content and recommendations of the BEMP report**, to farmers and to different organisations supporting or advising farmers: agricultural outreach services, catchment management bodies, decision makers, agricultural supply-chain…

ESPP indicated the Platform's interest in combining the EMAS BEMP recommendations into the objective of **updating and republishing the existing (COST) sets of Fact Sheets on Best Management Practice for nutrients** (see SCOPE Newsletter n° 115), in partnership with **NAPPS** and **SERA17** in North America.

The presentations of the event are available at: https://ec.europa.eu/jrc/en/event/conference/best-practices-improving-sustainability-agriculture

European Commission poster "Go Green with Best Environmental Management Practices" https://ec.europa.eu/jrc/sites/default/files/jrc-infographic-bemp-agriculture-emas.pdf

For further information: European Commission's JRC website on EU Eco-Management and Audit Scheme (EMAS) BEMP reports: https://ec.europa.eu/jrc/en/research-topic/best-environmental-management-practice

General EMAS website: http://www.emas.eu

Infographics on Best Environmental Management Practices (BEMP) for agriculture: *https://ec.europa.eu/jrc/sites/default/files/jrc-infographic-bemp-agriculture-emas.pdf*

EU water policy

European Court of Auditors (ECA)

Call to tighten EU sewage and sludge Directives

An European Court of Auditors special report (pursuant to art. 287(4) TFEU) makes a number of ambitious recommendations concerning EU wastewater treatment and sewage sludge Directives, compliance monitoring, sewage sludge management (including proposing to condition of EU subsidies on sewage sludge use) and water pricing to consumers. The European Commission is indicated to have so far rejected the Auditors' proposals to tighten sewage works discharge limits and sewage sludge spreading rules (proposed revisions of the EU Urban Waste Water Treatment and Sludge Directives).

The Auditors cite **energy production and phosphorus recovery from sewage sludge** as areas where development possibilities should be explored ($115e).

8 billion € EU subsidies

The European Court of Auditors Special Report 2015 n°2 (Chamber II, structural policies, transport and energy) looked at 28 waste water treatment plants in four 'Accession' countries in the Danube basin (Czech Republic, Hungary, Romania, Slovakia), countries where the EU has spent nearly 8 billion € in subsidies to wastewater treatment 2000-2013 (EU Cohesion Fund, European Regional Development Fund). From assessment of this EU spending and these 28 cases, with assessment of other relevant studies and publications, the Auditors derive a number of **strategic recommendations for European waste water and sewage sludge policies**.

The overall conclusion of the report is that the EU money has been effective, in that EU subsidies were the main funding for the sewage plants assessed and the **EU funding "*has played a key role in bringing forward waste water collection and treatment*" in the region studied**. However, progress made has not been sufficient to meet the EU Directive deadlines and requirements for waste water treatment. Also, one third of the sewage works looked at are considered as oversized, often relating to problems of groundwater entry into sewerage networks, resulting in treatment of diluted sewage.

Sewage sludge

The Auditors looked at handling of sewage sludge from the subsidised waste water treatment plants, concluding that it was in most cases appropriate, except in Romania where significant amounts of sewage sludge are still going to landfill.

The Auditors note that national limits for pollutants in sewage sludge used, after treatment, on agricultural land, are often stricter than the **EU Directive 86/278/EEC "Sewage sludge used in agriculture",** and also that this directive fixes no limits for sludge used in other applications (forestry, land reclamation, …), concluding that this directive should be updated (contaminants covered, limit levels, monitoring requirements) to take into account current knowledge on sewage sludge contaminants and their fate.

The European Court of Auditors propose ($117a) that **EU subsidies to sewage works should include specific clauses requiring appropriate reuse of sewage sludge**. *SCOPE Editors Note: such policies already exist elsewhere, for example Rhône-Méditerranée Water Agency in France gives +10% higher subsidy rates to sewage works if sludges are going to specified treatments http://www.eaurmc.fr/aides-et-redevances/redevances-et-primes/prime-de-performance-epuratoire-des-systemes-dassainissement-collectif.html*

European Court of Auditors also recommends ($115e) to *"explore and disseminate information on the possibilities of cost savings such as by using the energy production potential of sewage sludge or by **using sewage sludge as valuable raw material for phosphorus recovery**"*.

Water pricing: financial sustainability

The Auditors note that **in nearly 90% of cases assessed, water pricing (waste water tariffs) do not enable full recovery of waste water collection and treatment costs**, and will not enable accumulation by utilities of sufficient funds to ensure replacement or renewal of infrastructure at end of life.

This is despite the fact that the current tariffs are consistently below the "**4% affordability**" threshold proposed by EU Commission guidance (2006), that is water service costs should not exceed 4% of household income.

European Court of Auditors Recommendations

- **Revise the EU Urban Waste Water Treatment Directive** (91/271/EEC) to take into account technological progress (tighter discharge consents, in line with stricter requirements already in place in a number of Member States)
- **Revise the EU Sewage Sludge Directive** 86/278/EEC, e.g. to tighten limits for contaminants, specify limits for contaminants currently not covered (are cited perfluoralkyl substances), tighten and enforce robust monitoring requirements, enlarge to cover application of sewage sludge in non-agricultural land or as an input material for compost production
- Ensure that **water / wastewater tariffs** cover the full cost of waste water collection and treatment, including both maintenance and renewal of infrastructure "with tariffs no lower than the 4 % affordability level" (water rates 4% of household income)
- Include **conditions in EU subsidies** for waste water treatment requiring appropriate valorisation of sewage sludge

- Implement **legal obligations for household connection to sewerage networks** in all EU Member States and improve reporting on this
- Tighten Urban Waste Water Treatment Directive **reporting requirements** for Member States and accelerate compliance procedures, verify Member State reporting of numbers of agglomerations > 2 000 p.e., implement reporting for the "appropriate treatment" (UWWT Directive art. 7) requirement for agglomerations < 2 000 p.e., improve sewage treatment and reporting into river basin management plans
- Explore and disseminate information on **energy production and phosphorus recovery** from sewage sludges ($115e)
- Develop and implement indicators and **benchmarking for resource efficiency** in waste water treatment ($71)

"Audit calls for sewage sludge law update", V. Flynn, ENDS Europe 13th July 2015 http://www.endseurope.com/42253/audit-calls-for-sewage-sludge-law-update

European Court of Auditors press release, 13th July 2015 "Treatment plants in Danube basin often oversized and unsustainable say EU Auditors" http://www.eca.europa.eu/Lists/News/NEWS1507_13/INSR_DANUBE_RIVER_EN.pdf

European Court of Auditors special report 2015 n°2 "EU-funding of Urban Waste Water Treatment plants in the Danube river basin: further efforts needed in helping Member States to achieve EU waste water policy objectives" http://www.eca.europa.eu/Lists/ECADocuments/SR15_02/SR_DANUBE_RIVER_EN.pdf

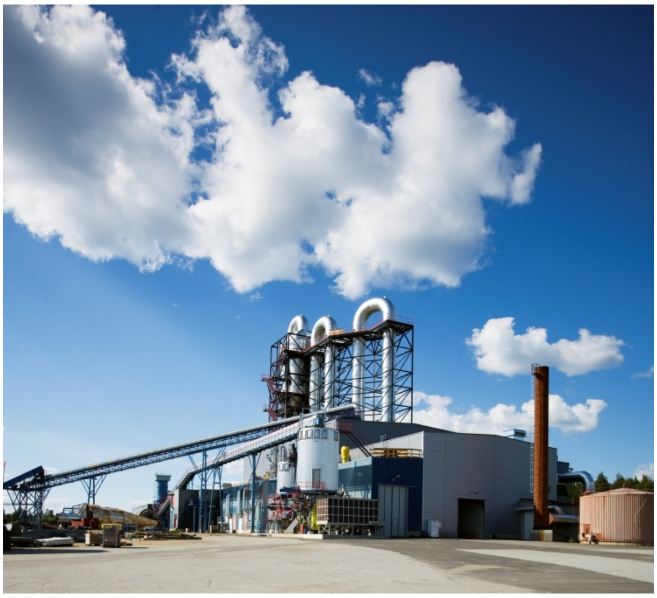
Circular economy and nutrient recycling

Skellefteå, Sweden

Outotec presents DeBugger sludge dryer prototype

The LIFE+ Conference, Skellefteå, Sweden, 15-16 June 2015, visited Outotec's new 6 tonnes/day (evaporation capacity) DeBugger steam dryer, which will be tested for sewage sludge and other biosolids. This high energy efficiency technology opens possible new routes for nutrient recovery from sewage sludges or manures, by drying to produce directly an organic nutrient product or upstream of further processing to extract phosphorus.

Jan Nilssen, Outotec (Managing Director Outotec (Sweden) AB), **Andreas Orth** (Vice-President, Energy) of **Outotec** and **Christian Müller, CEO of KIC Energy**, opened the conference, underlining the international group's commitment to resources efficiency, energy efficiency and recycling.



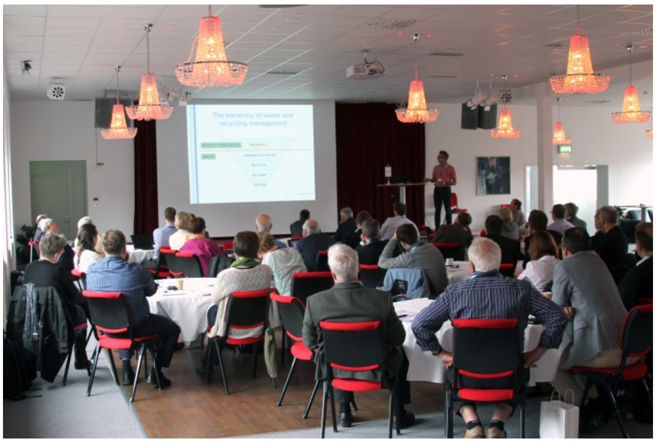
Outotec steam dryer at Storuman Combined Heat and Power and Pellet Plant

Willy Verstraete, University of Ghent, presented a vison of the future where **wastewater is considered a resource, for recovery of energy, nutrients and other materials**. He underlined the inherent inefficiency of agriculture in transforming nutrient inputs into protein, and proposed to use sewage directly to produce protein for animal food and mineral nitrogen in out-of-ground systems, producing single-cell proteins to process into food.

Oliver Gantner, University of Augsburg, Chair of Resource Strategy, explained that information available about world phosphate rock reserves and about mines operating today is incomplete and not reliable. **Currently, major investments in increased phosphate rock production are being made or are planned**, particularly in Morocco (OCP) but also in Australia, China, Brazil, the USA. Further significant phosphate rock reserves exist, but are not economic with current beneficiation technologies.

Business opportunities

Kimo van Dijk underlined the **opportunities for efficiency improvements in nutrient management**. Crop production is currently around 60% efficient for phosphorus, and animal production 20-30% P-efficient.



Most EU countries have around four times more P in the food supply than is needed, around half is lost (not consumed, e.g. food waste) and current diet contains around twice the phosphorus our bodies actually need. Furthermore, the potential for phosphorus recycling is probably around one third to one quarter of current EU mineral P fertiliser consumption.

Mathias Bergman, BSAG (Baltic Sea Action Group) considers that the key to saving the Baltic Sea water quality is the **transition to a Circular Economy**. The Baltic is currently highly impacted by hazardous substances and (eutrophication) nutrients, leading to anoxic "dead" zones. Phosphorus release from sediments is around 10 times land run-off, so projects to treat the sea sediments to remove or immobilise phosphorus represent a major business potential.

Last winter (Dec. 2014 – January 2015) **an exceptional "push" caused nearly 200 km^3 of North Sea water to enter the Baltic**, bringing 2 million tonnes of oxygen. This could significantly accentuate eutrophication this summer.

Sweden's recycling quality objectives

Anders Finnson, Swedish Water and Wastewater Association, presented the vision that Sweden should have quality drinking water, clean lakes and seas and access to long-term ecologically and economically sustainable water services. Today **96% of total sewage works inflow phosphorus and 20% of nitrogen are removed in sewage works in Sweden** and transferred to sludge (most of the rest of the nitrogen is lost to the air). He called for clear political targets for recycling and reuse of different nutrients.

Sweden EPA's current policy proposal, submitted to government and consultation, is the **objective to recycle 40% of sewage phosphorus and 10% of nitrogen to agriculture** whilst avoiding contaminant risks. Sewage sludge incineration is seen in Sweden as losing the objective of upstream contaminant control at source ("non toxic environment") and as delaying the path to recycling of nitrogen and organics.

The **REVAQ sewage works certification system** is a key tool for improving sludge quality, reducing upstream contaminants, ensuring monitoring and transparency, and so facilitating agricultural reuse of sewage biosolids products. Over half of Sweden's waste water is today REVAQ certified.

Important actions in Sweden aim to **reduce contaminants in sewage sludge**:

- Push to extend EU REACH "Candidate Substance" list
- Push to ban cadmium in amateur artists paints
- ChemSec SIN List of problematic contaminant chemicals *http://chemsec.org/what-we-do/sin-list*
- Education of retailers
- Nordic EcoLabel chemical specifications
- Public / consumer education for not putting chemical products into drains

Christian Adam, BAM, presented different **phosphorus recovery technologies** (see also P-REX conference summary in SCOPE Newsletter 115). He underlined that a range of technologies exist today, some operational at full scale, others tested at pilot scale or full-scale plants now planned or under construction. P-recovery from sewage sludge incineration ash offers the advantages of high potential P-recovery rates and elimination of contaminants, but (current processes) are only compatible with "mono-incineration" (incineration of sewage sludge not mixed with domestic solid refuse) and still have to optimise energy and chemical demand (can maybe addressed by integration into incineration installations). LCA studies in P-REX proved that P-recovery from sludge and ashes can have positive environmental impacts. P-recycling routes need to develop to use existing infrastructure and to ensure optimised energy efficiency.

Soil phosphorus

Andreas Muskolus, Humbold University Berlin, explained the complexity of phosphorus plant availability in soil. 90% of soil P is not readily plant available. **Fertiliser efficiency can be significantly improved by better application**, for example in trials 25% of root-injected fertiliser P was taken up by crops in the first year, compared to only 13% surface spread.

He noted that in a long-term trial in Germany, over 50 years, **zero phosphorus fertiliser application did not result in any loss of yield**. During the following 20 years "only" an average 10-20% production loss was found. (*SCOPE editor's note: farmers may not consider this not significant*).

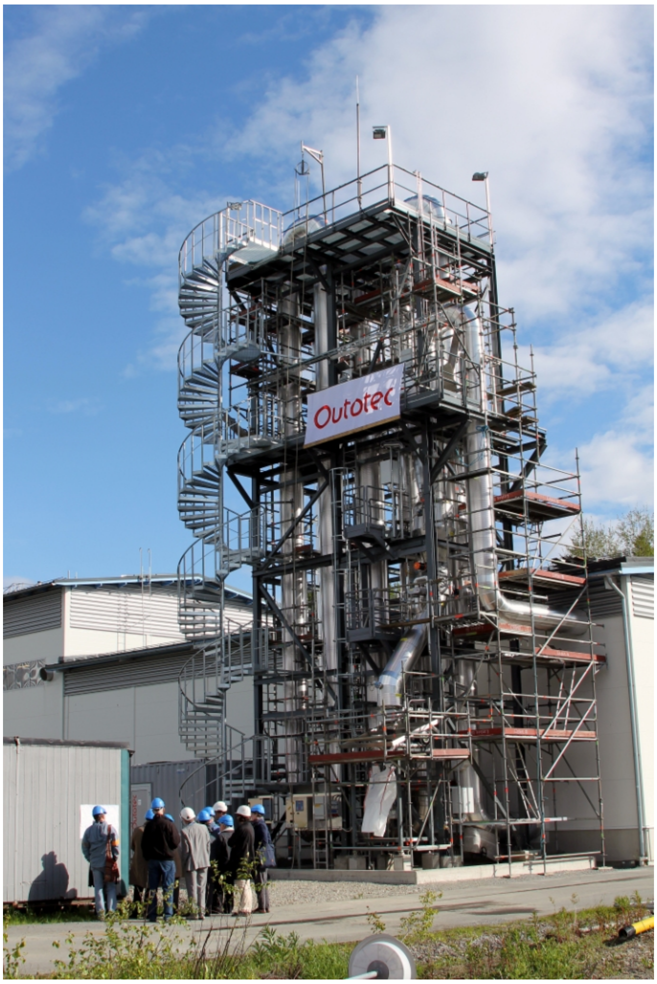
Liisa Pietola, MTK (Finland Central Union of Agricultural Producers and Forest Owners) and chair of **COPA-COGECA Environment Committee**, underlined the **importance of recycling not only nutrients but also organic carbon** (e.g. in crop residues), to enhance soil structure, limit erosion, improve soil nutrient recycling and soil fertility. Reductions in acid rain mean that sulphur is now a key nutrient requirement, as well as others: magnesium (>1 kg/ha generally needed), Ca, B, Mo, Cu, Fe, Mn, Zn. However, trace element requirements are specific and local, so soil analysis is needed. On the other hand, it must be ensured that xeno-organic contaminants in recycled bionutrients are removed.

Outotec steam dryer

Robert Johansson, Outotec (R&D Coordination), presented the **Outotec biosolids pilot dryer at Skellefteå sewage works** (see photos), visited by the conference participants, which will be able to treat sewage sludge (at c. 25% dry matter) or other biosolids (e.g. manure). The installation is a full-scale pilot, with a capacity of c. **6 tonnes water evaporation per d**ay, drying to 90% dry matter, approx. length of dryer tube = 280m, internal diameter 0.3m, installation height 30m. The investment cost of design and construction has been c. 3 million € (funded with EU LIFE+ (40%) and KIC InnoEnergy (20%) support), not including the costs for operating as a pilot test installation. The dryer is now commissioned and will start operation in August 2015.

The dryer is heated by superheated steam (150 – 200°C, 20 bar into dryer, 5 bar out), which is fed into the dryer mixed with the biosolids, moisture is then separated out as condensate and solids are discharged using a cyclone.

The use of steam for the dryer is reliable (few components), safe (non ATEX, no explosive dusts) and is both highly energy efficient and enables energy integration with e.g. biosolids or waste incineration facilities which generate steam as output of electricity generation and/or use of the condensate steam for e.g. district heating or energy recovery.



Outotec Skellefteå biosolids dryer prototype

The Outotec steam dryer achieves an **efficiency of c. 400 kW/tonne water evaporated, compared to 1 200 – 800 for standard energy efficient dryers**. The dryer is a closed process (no emissions gases).

The Skellefteå biosolids dryer prototype follows nearly **20 years' experience of steam dryers installed by Outotec in Sweden**, operating for example for sawdust and wood chip drying in wood-pellet production installations. The DeBugger prototype will allow full-scale testing of the dryer on sewage sludge and other biosolids, testing energy efficiency, feed systems, reliability and properties of the dried biosolids. Its operation will enable to identify which contaminants are transferred to the steam condensate and which remain in the dried biosolids, and similarly for nitrogen and potassium.

Ludwig Hermann, Outotec (Senior Consultant Energy), explained the potential **business case for the DeBugger steam dryer for phosphorus recovery from sewage sludge**, where regulatory or societal pressure pushes for P-recovery and where thermal valorisation of the dryer downstream heat is possible, by combining the steam dryer with steam gasification of the biosolids. The objective is to eliminate organic contaminants and separate the energy carrier (syngas) from nutrient rich ash, allowing for using the energy in a power, cement or MSW plant and the ash as a phosphatic raw material for any ash based P-recovery process. He noted the potential for specific added value of recovered phosphorus products, for example through content of micronutrients (e.g. zinc).

Andreas Orth, Outotec (Vice-President, Energy), explained that the company can offer an integrated biosolids solution, where **drivers such as geographical population concentration or concerns about organic contaminants (pharmaceuticals) push for sewage sludge incineration**. Outotec also offers a gasification solution, for sludges, biomass and wastes, which generates a gas (to which contaminants are transferred) useful for energy-consuming industries (cement, alumina) and an ash suitable for P-recovery.

Mika Saariaho, Outotec (Senior Vice-President Energy & Water), concluded the conference by underling that **the economics of phosphorus recycling will be driven by incentives and policies**, and that these are necessary to release the potential positive impacts on employment and on quality of life.

Info http://www.outotec.com/en/About-us/Research-and-technology/EU-Life-Environment-Demonstration-Project/

Leuven Belgium

Struvite precipitation and sludge dewaterability

Struvite precipitation from bio-P sewage works sludge digestate can result in significant operating benefits (see e.g. Berlin Wasser SCOPE Newsletter 111, 101, Thames Water SCOPE 111, 99). One possible benefit is the improvement of sludge dewatering. This has been documented to occur when the struvite precipitation is installed upstream from the sludge dewatering, e.g. Amsterdam Waternet (SCOPE Newsletter 115). This paper shows that this improved dewatering does not occur in all circumstances, as it is a function of the properties of the polymer used and of the quantity of divalent and monovalent cations which need to be carefully adjusted to obtain the expected dewaterability.

The authors present results from a **full scale struvite recovery process in the municipal WWTP of Leuven city (Belgium, 120, 000 people equivalent, operated by Aquafin).**

The struvite precipitation is operated on the sludge digester outflow, upstream of a buffer tank where the sludge is held and mixed with sludges from other Aquafin sewage works, before then entering the plant's dewatering (centrifuge).

The struvite precipitation unit is **NuReSys** technology (see SCOPE Newsletter n°115), c. 8 m^3/h flow, using aeration (CO_2 stripping), $MgCl_2$ (magnesium addition) and NaOH dosing (pH control), and is operational since March 2013.

Struvite recovery

The authors present data for the phosphorus levels in the treated sludge digestates, for quality of struvite recovered, for the recovery of precipitated struvite from the sludge liquor and for sludge dewatering, for the first year of operation.

A **second paper by the same authors** (Geerts et al. 2015) provides discussion of **economics** based on this data and on modeling, including cost benefit of this process configuration (struvite unit upstream compared to downstream of the sludge dewatering) with economic sensitivity analysis.

The struvite process **reduced the phosphate load from the sludge dewatering centrate** (measured downstream of the centrifuges, that is after addition of external sludges) by half (from 15 to 7.5 % of the plant load) and orthophosphate concentration from 179 mg P/l to 29 mg P/l. Because this centrate is returned to the inflow of the sewage works, this can be expected to improve the performance of the plant's biological phosphorus removal process and reduce nuisance phosphate precipitations (but these impacts were not measured in this paper). The decrease of the N load in the centrate was negligible.

The **purity of struvite** recovered was determined by checking its composition using inductively coupled plasma-atomic emission spectroscopy and X-Ray diffraction spectrometry. It was found to be of high purity with a total carbon content of 0.3 % (low inclusion of organic matter) and very low heavy metal levels (highest value was 22 ppm for zinc). Concentrations of organic pollutants or pathogens were not reported.

The authors note however that difficulties were encountered in recovering the formed struvite from the sludge digestate stream, with the struvite unit harvester only effectively recovering c. 25 % of the precipitated struvite (4 % of the plant influent phosphorous), based on the reduction in orthophosphate in the struvite installation. It is noted that **this problem is largely avoided in configurations where struvite precipitation is installed downstream of the sludge dewatering**.

Factors impacting sludge dewatering

Data is provided for four comparative dewatering experiments: 1 m^3 sludge samples were taken both upstream and directly downstream of the struvite unit in spring (3 samples), summer, autumn and winter (each 2 samples). Dewatering was tested using a mobile filter press.

The first tests (spring) showed deteriorated dewatering (after struvite precipitation) but this was attributed to not **changing the dewatering polymer used**, whereas the addition of the monovalent chloride ion (in $MgCl_2$) is thought to result in a more cationic polymer being appropriate.

In the next tests (summer), the appropriate polymer was used, but dewaterability was nonetheless marginally worse downstream of the struvite precipitation. The authors suggest this may be because at this time **high NaOH dosing was being used in the struvite reactor** (low CO_2 stripping intensity).

In the 3rd and 4th tests (autumn, winter), **sludge dewaterability showed better results downstream of the struvite unit** (dry matter increase from respectively 24 to 27 %dm in autumn and 23 to 24 %dm in winter).

However, in none of the four test sets was the change of dewaterability statistically significant (ANOVA $P > 0.05$). Also, the tests did not directly reflect the sewage works configuration but rather a general configuration likely to be found in other works: a filter press was used for dewatering in the tests (the Leuven sewage works uses a centrifuge), and the tests were carried out directly downstream of the struvite unit (the Leuven centrifuge is after a buffer tank and mixing with sludges from other Aquafin sewage works).

The **polymer dosing levels** are not given, but the authors have confirmed that these were defined to not influence the dewatering results reported.

The sewage works operators confirmed the overall results of the dewatering tests, that the struvite installation appeared to improve sludge dewatering in autumn and winter, but deteriorate in spring and summer.

The authors discuss **possible mechanisms for modification of dewaterability by struvite precipitation**, e.g. divalent cation bridging theory, whereby addition of magnesium (divalent) cations creates bridges between the negatively loaded sludge particles. They suggest that high levels of NaOH dosing may deteriorate dewatering due to the negative effect of monovalent cations (Na^+) on coagulation supplanting the effect of divalent cations.

This study suggests that struvite precipitation can improve sludge dewaterability and that this can have a significant economic benefit for the sewage works, but that there remain uncertainties regarding the impacts on sludge dewaterability of struvite precipitation, installed either upstream or downstream of dewatering, and on how to optimise struvite precipitation parameters (CO_2 stripping, pH or NaOH dosing, magnesium dosing).

Also, the authors note that **it is important to re-select dewatering polymers to optimise sludge dewatering** after struvite precipitation installation.

"Full-scale phosphorus recovery from digested waste water sludge in Belgium - part I: technical achievements and challenges", Water Sci. Technol. 71 (4), pp. 487–494, 2015 http://dx.doi.org/10.2166/wst.2015.023

A. Marchi, S. Geerts, M. Weemaes, S. Wim, V. Christine S. Geerts, Aquafin nv, Dijkstraat 8, Aartselaar 2630, Belgium sam.geerts@aquafin.be

See also "Full-scale phosphorus recovery from digested wastewater sludge in Belgium - part II: economic opportunities and risks", S. Geerts, A. Marchi, M. Weemaes, Water Sci. Technol. 71 (4), pp. 495–502, 2015 http://dx.doi.org/10.2166/wst.2014.509

Summary initially prepared by WETSUS www.wetsus.nl *for ESPP SCOPE Newsletter.*

UK water industry
P-recycling policy tool

This thesis includes a Phosphorus Substance Flow Analysis (P-SFA) for the UK, summarised in SCOPE Newsletter n° 113. It also proposes a phosphorus recycling target and Phosphorus Recycling Obligations (PRO), as possible policy tools for obliging phosphorus recycling from sewage whilst optimising the cost-effectiveness between operators.

The author's UK phosphorus flow analysis (SCOPE Newsletter n° 113) shows that **of around 55 000 tonnes P entering sewage in the UK, c. 23 000 tP are currently recycled to farming (agricultural spreading of treated biosolids),** c. 24 000 tP are discharged to surface water* and c. 7 000 tP are lost to landfill and other disposal routes.

** SCOPE Editor's note: of which around 43 % is discharged from sewage works to marine water where phosphorus removal is not required because the receiving water is not "eutrophication sensitive": DEFRA Clarification on Aspects of DLCP Impact Assessment, 20th January 2010*
http://webarchive.nationalarchives.gov.uk/20130822084033/http://www.defra.gov.uk/corporate/consult/detergents-regs2005/clarification-for-IA.pdf

P-recovery target

The thesis suggests that **a water industry 80% P-recycling target by 2050 would be realistic** (% of total P in sewage recycled, including via agricultural use of treated biosolids) and proposes a "**Phosphorus Recycling Obligation" (PRO)** tool to achieve this, based on experience with carbon certificates (climate change policy), assessing the possible response of the water industry. This target is considered realistic in reference to e.g. CIWEM 2012 (see SCOPE Newsletter n° 88).

The proposed PRO scheme would involve an industry-wide (total) recycling target to be fixed each year, consistent with a pathway to the 80% target for 2050. Based on this annual target, a target for phosphorus recycling would be then calculated for each UK water company, proportional to connected population. 1 kg of phosphorus recycled would earn 1 PROC (**Phosphorus Recycling Obligation Certificate**).

P-recycling Certificates

Water companies which do not achieve their annual P-recycling target would have to either purchase PROCs from other companies or pay a fixed annual buy-out fee per kg phosphorus. **Companies recycling more phosphorus than their target could sell PROCs on the market or receive a fixed surplus fee at the end of year**. This trading mechanism is intended to enable the most cost-effective investments in P-recycling to be made whilst ensuring that the overall target is achieved and is based on the experience with renewable energy, initially Renewable Obligations (RO), now being replaced by Contracts for Difference (CfD) scheme.

The **fixed buy-out and surplus fees should be fixed over significant time horizons** (e.g. five years) by the regulator authority (e.g. OFWAT in the UK) to limit financial volatility of the PROCs market, so setting minimum/maximum prices, and so enabling a relatively stable long-term visibility for investment in phosphorus recycling. The thesis did not attempt to calculate levels of these fees necessary to balance investments for P-recycling at least cost.

Buy-out fee income would be used to finance the scheme administration costs and to contribute to provide a fund for paying surplus fees. Excess surplus fees beyond this fund availability would be financed by a cross-industry levy.

The thesis proposes that the scheme could be adapted by "banding": that is **giving additional PROCs (per kg phosphorus recycled) for P-recycling from selected technologies** which regulators might wish to develop (new technologies).

Effects on different water companies

The different UK water companies face **varying operating conditions**, such as average size of sewage works, proportion of population currently subject to P-removal obligations (discharge into eutrophication "Sensitive Areas"), biological vs. chemical P-removal technologies installed today, availability of agricultural land for biosolids recycling … Currently, only c. 21 million p.e. (population equivalent) in the UK is served by sewage works with phosphorus removal obligations, out of a total of c. 71 million p.e. (see comment above regarding discharge to the sea).

Current % sewage P recycling as calculated below (2012) is estimated to vary between the 12 UK water companies from 26% to 71%, with an overall total of 47% (compared to an initial PROC target of 44% for 2012 and 50% for 2020).

Taking an illustrative figure of UK£0.75 PROC trading fee and UK£0.50 surplus fee, this situation would result in a UK£1.4 million PROC income for the most benefiting water company, UK£ 0.7 million PROC purchase costs for the least benefiting, and an **overall surplus fee cost of UK£0.9 million** (which would have to be passed on to the water companies as an overall levy). Similar illustrative calculations are carried out for 2025 and 2050.

The thesis concludes that there is **significant potential for developing phosphorus recycling in the UK water industry**, with possibly synergy with investments to improve phosphorus removal towards EU Water Framework Directive objectives, and that a financial scheme such as PROCs would improve cost-sharing between water companies and between sewage works of different sizes and configurations.

Indicators

The thesis also includes the detailed **phosphorus substance flow analysis (P-SFA)** for the UK and a proposal for **national indicators for sustainable phosphorus management performance** (see SCOPE Newsletter n° 113):

- **Net P imports** (national SFA)
- **Agricultural P efficiency** (P outputs / P inputs)
- **Mineral fertiliser consumption**
- **Rate of P-recycling** (from wastewater)
- **Rate of P losses** (to water bodies and to landfill)

Specific phosphorus performance indicators for the water industry are also proposed:

- P into sewage works
- P in final effluent
  → **sewage works P removal efficiency**
- sewage sludge P reused on land
- P recovered from wastewater (struvite, other processes)
- P recovered via thermal destruction processes (e.g. from ash)
  → **total P recovered or recycled**
    → **% sewage P recycled**

The thesis also includes (Table 3) a useful **summary of phosphorus recovery technologies**, covering Ostara Pearl, P-ROC, Phostrip, Phospaq, Crystalactor, Unitika Phosnix, ProPhos, Kurita, AirPrex, NuReSys, Seaborne/Gifhorn, Budenheim, Wasstrip, Prisa, Heatphos, Suschka, Mephrec, Susan/AshDec, Thermphos, Sesal-Phos, Sephos, Bio-Con, bioleaching, PASH.

"Managing phosphorus in the UK water industry to increase national resource security", J. Cooper thesis (supervisor: C. Carliell-Marquet), University of Birmingham (Civil Engineering), October 2014 http://etheses.bham.ac.uk/5764/

Locminé, Brittany

Green energy and bio-nutrients from agro-food wastes

Locminé, Brittany, France, a town of 4 400 population, is investing 15 million Euros in the local bio-nutrient circular economy, in a project recognised by French Environment Minister as exemplary of the country's "energy transition" objectives.

The public private company (SEM) LIGER (Locminé Inovation and Management of Renewable Energies) site will treat **60 000 tonnes/year of organic agricultural wastes, agri-food processing industry wastes and piggery manures** to produce electricity, methane, local heat and will recycle nutrients in the digestates as bio-fertilisers.

Wastes treated will come from an industrial meat and sausage processor (**Jean Floc'h**, processing c. 2 million pigs/year), vegetable and crop processors (e.g. tops of root vegetables), abattoirs and around ten pig farms (manures), from up to around 10 km from the site. These will be **anaerobically digested to produce biogas** (methane), which will be partly burnt to generate electricity and heat for local heating, and partly used to fuel vehicles (equivalent to 300 000 litres of diesel per year), after processing to remove CO_2 and sulphur and compression to 200 bar, sold under the brand Karrgreen as Vehicle Natural Gas, for adapted vehicles for the municipality or local industry fleets.

The digestate will be sold as a bio-fertiliser (brand **Douargreen**), and this processing of the bio-nutrients will enable a reduction of 2 000 hectares in the area used for spreading manure, helping to address eutrophication and nitrates issues.

Additionally, the site already includes a wood-burning boiler, fed with saw mill offcuts and forestry waste cuttings, which already feeds into the local heating network. Also, **half the 4 hectare site is wetland, which is managed by the bird protection society**.

"Locminé veut se chauffer et rouler avec ses déchets", Le Monde, 21-22 June 2015
http://www.lemonde.fr/planete/article/2015/06/20/locmine-veut-se-chauffer-s-eclairer-et-rouler-avec-ses-dechets_4658431_3244.html

"Locminé : Une unité de méthanisation comme locomotive", ServicePublic.FR 10/10/2014
http://servirlepublic.fr/article.php?ID=1542

Phosphorus flows

Low P use efficiency of New Zealand

Phosphorus SFA (substance flow analysis) was conducted to distinguish and quantify different phosphorus (P) flows within New Zealand (NZ). This shows that P consumption for intensive agriculture is high and use efficiency low compared to other countries. Over half of imported phosphorus is either lost or accumulated in soil.

Principal components analysis (PCA) was used to show the different New Zealand P utilization efficiency on a global scale. Phosphorus flows between eleven compartments in New Zealand were assessed based on available data, with balancing where data was not available. A system mass balance was used to calculate the potential values of flows with information from previous literature and estimated via other means.

Phosphorus imports

New Zealand imports nearly 250 000 tonnes of phosphorus per year (250 ktP/y), nearly ¾ as phosphate rock and nearly ¼ as fertiliser, plus smaller amounts in natural precipitation/soil weathering and in animal feedstuffs. Only 46 ktP/y are exported in food products and 43 ktP/y in non-food products (timber and pulp).

Around 60% of imported P is either lost (c. 28 ktP/y to water and 40 ktP/y to landfill) or accumulated in agricultural soils (c. 90 ktP/y).

Approximately 10% (4.1 ktP/y) of the P passing through waste & water treatment facilities in NZ annually was discharged into water bodies (with a further 23 ktP/y reaching waterbodies from agricultural land). The other **90% (36.9 ktP/y) ends up in landfill sites**, and the authors indicate that this can threaten the environment with potential leachate problems.

The authors consider that world P rock reserves are estimated to run out within the next 70-140 years. **The average P fertilizer consumption per hectare in NZ is two times larger than Australia, three times larger than the world average, and seven times larger than Europe**. It is thus important to investigate the P consumption structure and utilization efficiency within NZ.

Market vulnerability

The authors conclude that Phosphorus (P) consumption in **New Zealand (NZ) is heavily dependent on imports** and thus is more vulnerable to international market changes. Comparison between NZ and other countries suggests that the P consumption structure in NZ exhibits **lower P utilization efficiency than other countries**.

To improve the NZ P utilization efficiency, P recovery from both waste water treatment facilities and landfill sites could be enhanced.

The PCA analysis shows that the difference between NZ and the more phosphorus utilization efficient countries (or SBC) is driven by differences in the P recovery, total imports, total exports, exported food and landfill. The P recovery ratio from waste in New Zealand is quite low in waste water treatment plants (WWTP). Thus **point sources of pollution at landfills**, **as well as WWTP**, **offer an accessible resource for recovery activities**.

"Substance flow analysis of phosphorus within New Zealand and comparison with other countries", Science of The Total Environment, 2015, 527, 483 – 492.
http://www.sciencedirect.com/science/article/pii/S0048969715005112

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Switzerland

Available soil phosphorus related to agricultural land use

Full soil analysis (total P and different forms of extractable P) data from 245 agricultural sites in a wide range of altitude and soil types in Fribourg canton Switzerland show that available phosphorus is highest in croplands and lowest in mountain pastures, whereas total P is higher in permanent pasture grasslands and lowest in croplands. Landscape site variables such as altitude, slope, wetness, and soil type all impact much less the levels of available P.

Soil analysis was carried out at **250 sites in Fribourg canton, Switzerland, over a period of 5 years** (each site analysed once). In each case, 25 collected soil samples were combined into one composite pooled sample. 5 sites were excluded as outliers (very high soil organic matter). The sites covered a wide range of altitude (430 – 1600 m) and other soil characteristics.

Different forms of soil P analysed were: total P, organic P, inorganic P, P-H_2O (water extractable, 16 hours), P-CO_2 (CO_2 saturated water, pH 3.5-4, 1h, 1 bar), AAE-P (0.5 M ammonium acetate + 0.5M acetic acid + 0.02M EDTA), P-$NaHCO_3$ (0.5M $NaHCO_3$ at pH 8.5), soil P saturation (ratio of ammonium oxalate extraction of P, Fe, Al).

Available phosphorus in croplands

The different indicators of available P (P-H_2O, P-CO_2, P-AAE, P-$NaHCO_3$) were all **correlated to inorganic phosphorus**, providing equivalent results.

Soil available P was significantly higher in croplands, then in permanent grassland, and lowest in mountain pastures (mean cropland 2.1 / permanent grass 1.9 / mountain pasture 0.7 mg P-CO_2/kg soil).

Total soil P, on the other hand, was higher in permanent grassland, then mountain pastures, and lowest in croplands (mean permanent grass 1190 / mountain pasture 1040 / cropland 940 mg total-P/kg soil).

"Spatial variability of soil phosphorus in the Fribourg canton, Switzerland", Geoderma 217–218 (2014) 26–36
http://dx.doi.org/10.1016/j.geoderma.2013.11.001

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Summary prepared by Kirsty Ross, Lancaster University, for ESPP SCOPE Newsletter.

Blog

Sustainable P Initiative blog

http://www.phosphorusplatform.eu/blog.html

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

- 18 Sept. Milan (San Rocco wwtp) **Resource Recovery in Wastewater Treatment Plants** *www.metropolitanamilanese.it*
- 15-16 September, Toledo, Spain **REFERTIL** EU FR7 project final meeting *http://www.refertil.info*
- 16-17 Sept, Padeborn, Germany "**Sewage sludge handling**", 17 Sept. P recovery workshop (in German) *www.vdi.de/klaerschlamm*
- 17-18 September, Toledo, Spain REFERTIL **Advanced compost and biochar processing solutions for P-recovery** *http://www.refertil.info*
- 23 Sept, Milan EXPO, **RISE Sustainable Intensification and Nutrient Recovery and Reuse in Agriculture** *http://www.risefoundation.eu/news/135-expo-conference-nutrient-recycling-2*
- 28-30 Sept, Wexford, Ireland, **Catchment Science 2015** *http://www.teagasc.ie/agcatchments/catchmentscience2015.asp*
- 1-2 October, Vienna University of Technology, "**Mining the Technosphere**: Potentials and Challenges, Drivers and Barriers" *http://iwr.tuwien.ac.at/mining-the-technosphere/home.html*
- 5-6 October, Frankfurt, **Energy from Chemical Fuels**, session on P-recovery and use *http://www.kic-innoenergy.com/event/energy-from-chemical-fuels-2015/*
- 5-8 October, Karlsruhe, Germany, **CMM (Materials Processes Systems)** DPP P-recovery session (8/10) *www.cmm.kit.edu*

- 5-9 October, Berlin, IFDC-IFA **Phosphate Fertiliser Production Technology** *http://ifdc.org/training/2015-training-programs/*
- 11-14 October 2015, Ithaca, New York, USA, 2nd International Conference on **Global Food Security** *www.globalfoodsecurityconference.com*
- 12-13 October, Manchester UK, 9th European **Waste Water Management Conference** *http://www.ewwmconference.com/*
- 19 October, Brussels, European Sustainable Phosphorus Platform **ESPP Board and strategy working group**. To participate contact *info@phosphorusplatform.eu*
- 20 October, Liège, Belgium, **CEBEDEAU workshop phosphorus** in sewage treatment *http://www.citemiroir.be/activite/le-phosphore-de-la-fosse-lamphore*
- 30 October 2015, Berlin. **DPP German national phosphorus plan meeting**. *www.deutsche-phosphor-plattform.de*
- 2-3 November, The Hague, **Conference Planetary Security** Peace and Cooperation in Times of Climate Change and Global Environmental Challenges (Netherlands Ministry of Foreign Affairs) *http://www.planetarysecurity.nl/*
- 2-6 Nov, **Amsterdam International Water Week**. 3 Nov. morning Netherlands Nutrient Platform / ARREAU P-recovery workshop *http://internationalwaterweek.com/*
- 9-11 Nov, Manchester UK, 20th **European Biosolids & Organic Resources** Conference *www.european-biosolids.com*
- 10-12 Nov. Jacksonville, Florida, **Fertilizer Outlook and Technology** Conference *http://www.firt.org/*
- 15-18 Nov. Minneapolis, US **ASA-CSSA-SSSA-ESA soil science meetings** *www.acsmeetings.org* including session 'Tracking Legacy Phosphorus in Lakes and Rivers' *https://scisoc.confex.com/scisoc/2015am/webprogrampreliminary/Session14624.html*
- 18-19 November, Minneapolis, **SERA-17** promoting promote innovative solutions to minimize phosphorus losses from agriculture *http://www.cvent.com/events/2015-sera-17-meeting/event-summary-4eb969f0be224a25821b4372c54c34a5.aspx*
- 25-26 Nov., Berlin, Germany, **Global BioEconomy Summit 2015** *http://gbs2015.com*
- 2-4 Dec 2015, Ghent, Belgium, **ManuResource II** (manure valorisation) *http://www.manuresource2015.org/*
- 14-18 December, San Francisco, AGU (Am. Geophysical Union) Conference, Workshop **'Human alteration of the P cycle'** *https://agu.confex.com/agu/fm15/preliminaryview.cgi/Session8517*
- 15-19 Jan. 2016, Arizona, **US P-RCN** (Sustainable Phosphorus Research Coordination Network) *https://sustainablep.asu.edu/*
- 10 Feb2016, Leeuwarden Netherlands, **EIP Water Conference** *http://www.eip-water.eu/save-date-next-eip-water-conference-10-february-2016-leeuwarden*
- 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** (**SUSPHOS**) *www.susphos.eu*
- 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/*

Updated events listing online at:
http://www.phosphorusplatform.eu/events/upcoming-events
To add your event, please contact info@phosphorusplatform.eu

ESPP General Assembly

Action plan, election of Board & budget, overview of dossiers underway: Circular Economy, Fertiliser Regulation inc. struvite and ashes, agricultural BEMPs, standards …
***To participate**: please indicate your name AND EMAIL at* http://doodle.com/poll/9tzibixznvidfctc *and also contact* info@phosphorusplatform.eu