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Success story

Thermal hydrolysis biogas and fertiliser from food waste, Oslo

The Romerike Biogas Plant (RBA) operated by the Oslo urban authority since 2012, produces over 100 000 t/y fertiliser from food waste digestate. The plant takes in separately sorted and collected household food waste and commercial and industry food waste. It includes optical and mechanical sorting (magnetic separator, bio-separator, sieve, sifters), shredding, thermohydrolysis (THP) at 130°C – 4 bars to render organics better available for digestion, then biogas production (anaerobic digestion at 38°C for c. 24 days). Biogas is compressed and used to fuel the city's buses (1 kg food waste gives 0.13 l diesel equivalent). The digestate is solid liquid separated and distributed as liquid fertiliser (90 000 t/y of N₁₀ P₂ K₆ at c. 4.5% DM or 15% after concentration) and solid fertiliser (15 000 t/y at 28% DM).

Nils Finn Lumholdt, City of Oslo: "AD in Oslo - Production of Liquid Biomethane from Sorted Household Waste", AD Europe 2014
https://asiakas.kotisivukone.com/files/biolaitosyhdistys.palvelee.fi/23_nils_finn_lumholdt.pdf and "Green Energy from Waste" DAKOFA 24/8/2016
http://www.mita.lt/uploads/documents/food_waste_recycling.pdf

Regulation and policy

EU to further restrict dental mercury

The EU has agreed a text to ban mercury in dental amalgam for children under 15, pregnant and breastfeeding women. This will enable continuing reductions in mercury levels in sewage sludge, of which amalgam is the largest source, because of daily wear of mercury amalgam in people's teeth. This is significant for safe nutrient reuse through biosolids spreading or through P-recovery. The text has been agreed by the three EU institutions (Commission, Parliament, Council of Member States). It also requires Member States to set a national plan for reducing amalgam and for the Commission to report (by 2020) on the feasibility of a complete phase out of mercury amalgam by 2030. Environmental NGO European Environment Bureau (EEB) [welcomed](#) the agreement as placing Europe as a world leader in implementation of the 2013 Minamata International Convention on mercury, but regretted that the complete ban on mercury amalgam is not yet confirmed. The European water industry EurEau has also taken [position](#) for a ban on mercury amalgam, considering that mercury separators at dental clinics only partly reduce mercury losses. EurEau estimate that dental mercury going to sewage from teeth reduces



by 20% the part of sewage biosolids which can be recycled to farmland, thus resulting in an annual additional cost of around 128 million € per year (EU) for incineration costs, as well as additional CO₂ emissions due to the use of fossil fuels to support sludge incineration.

EurEau position 13/6/2016: <http://eureauwaternews.tumblr.com/post/151926522998/eureau-welcomes-european-parliament-vote-on-dental-EEB-position-8/12/2016> <http://www.eeb.org/index.cfm/news-events/news/eeb-welcomes-strengthening-of-eu-mercury-laws/>

Circular Economy standard proposed

The British Standards Institute (BSI) has [published online for comment](#) a draft standard for implementing the circular economy in organisations, the first such standard to be proposed. For the purpose of this standard, the following definition of Circular Economy is proposed "systemic approach to the design of business models, enabling the sustainable management of resources in products and services". The introduction notes that unprecedented uncertainty is expected over coming decades, implying price volatility for raw materials, and proposes the circular economy as a systemic approach to business redesign to address this. Relations between circular economy, resource efficiency, zero waste, bioeconomy and lean thinking are discussed. The proposed standard includes a detailed section of definitions, an approach to optimising value creation through circularity, an overview of circular economy business models and implementation tools including an eight-stage framework and a needs-based navigation tool.

British Standards Institute draft "Framework for implementing the principles of the circular economy in organizations – Guide" BS8001 <https://drafts.bsigroup.com/Home/Details/59265>

Netherlands approves Circular Economy 2050 strategy

On 5th October, The Netherlands national Circular Economy programme to 2050 was presented to Parliament. The programme fixes an interim objective of 50% reduction in raw materials use (minerals, metals, fossil fuels) by 2030, and an objective of 100% sustainable, non polluting use of raw materials by 2050. 'Biomass and food' is one of the five priority areas identified in the programme. Under this priority, the programme indicates commitment to the Netherlands Nutrient Platform and to European action through ESPP (European Sustainable Phosphorus Platform). Actions specified to address the 'Biomass and food' priority include reducing food waste, sustainable agri- food- and biomass value chains, development of alternative protein sources, recycling of food industry residues, soil quality and increasing soil carbon, precision farming and closing the loop for nutrients.

"A Circular Economy in the Netherlands by 2050" Government-wide Programme for a Circular Economy, Netherlands Minister for Environment and Minister for Economic Affairs, 72 pages, launched 14th September 2016 <https://www.government.nl/documents/policy-notes/2016/09/14/a-circular-economy-in-the-netherlands-by-2050>

France, Spain face European Court actions for failure to treat sewage

France has been condemned by the European Court of Justice for failure to adequately treat sewage (absence of secondary treatment) for 11 small agglomerations with 2 000 to 15 000 person equivalents. These 11 towns are those for which sewage was still not being adequately treated at the date of the European Commission's legal procedure (8 of these are since considered to be treated by the Commission), out of some 551 agglomerations initially cited by the European Commission's action launched against France in 2009. The Commission has also engaged European Court of Justice (ECJ) proceedings against Spain for failure to implement adequate waste water treatment in 17 cities (1.4 million population in total), out of 37 for which Spain was already condemned by the ECJ in 2011. This concerns failure to ensure secondary treatment sufficient to avoid risks to health from pollution of water bodies. The Commission is requesting a 46.5 million € fine on Spain, plus 171 000 € daily fine until conformity is ensured.

Judgement of the European Court of Justice, 23rd November 2016, failure of France to implement the Urban Waste Water Directive 91/271/CEE Art. 4, paragraphs 1 & 3, secondary treatment or equivalent <http://curia.europa.eu/juris/document/document.jsf?text=&docid=185543&pageIndex=0&doclang=FR&mode=req&dir=&occ=first&part=1&cid=2213788>
European Commission "November infringements package: key decisions" 17th November 2016 "SPAIN faces fines for not complying with judgment from 2011 over poor waste water collection and treatment" http://europa.eu/rapid/press-release_MEMO-16-3644_en.htm

German proposed sludge ordinance in English

As indicated in ESPP eNews n°5, Germany has notified to Europe its proposed new sewage sludge ordinance (AbfKlärV), which will make phosphorus recovery obligatory for most of Germany's sewage. The text has now been translated and is [published](#) by the EC in English. The proposal, which is expected to enter into force in 2018, will ban land use of sewage sludge from all sewage works > 50 000 p.e. (over 100 000 p.e. if the sludge has <2%P DM) and will update and harmonise contaminant limits, monitoring obligations and procedures (including quality assurance) where sludge is used in agriculture. For larger sewage works, phosphorus recovery will be obligatory (11 years after entry into force) wherever sludge contains >2% phosphorus (dry matter DM) and in this case at least 50% of the P must be recovered (and sludge P reduced to <2%)* if operating in the sewage works, or at least 80% of the P from incineration ash or other carbon residues (see p75). Implementation of the proposed ordinance is expected to cost 94-119 million €/year.

* ESPP note: if this wording is not modified this will effectively exclude struvite recovery as currently implemented. This could be resolved by changing "and" to "or" here.

European Commission Notification Detail Ordinance reorganising sewage sludge recovery (Sewage Sludge Ordinance)

Notification Number: 2016/514/D (Germany) <http://ec.europa.eu/growth/tools-databases/tris/en/search/?trisation=search.detail&year=2016&num=514>

Germany ammonia emissions taken to court

Two environmental NGOs ([ClientEarth](#) and [Deutsche Umwelthilfe](#)) have engaged a court case against the state of Germany (at Cologne administrative court) for failure to respect Germany's ammonia emissions limit under the revised National Emissions Ceilings [Directive](#) which entered into force on 31st December 2016. This requires Germany to reduce its ammonia emissions by 5% by 2020 and 29% by 2030 (vs. 2005 levels). The NGOs state that Germany has exceeded its 2010 target under the previous NECD Directive by 17-22% from 2010 – 2015 and that its national air pollution plans as defined at present will not ensure compliance with the new NECD. Ammonia air pollution generates fine particles in the atmosphere and particulate air pollution is estimated to cause nearly 50 000 premature deaths per year in Germany. Over 90% of ammonia emissions come from agriculture, in particular manure management, so that pressure to reduce emissions will incite to nitrogen recovery installation.

"Legal action against German government for ammonia breaches", [ClientEarth](#), 4th January 2017 <http://www.clientearth.org/legal-action-german-government-ammonia-breaches/>

Policy for the circular economy

Germany UBA proposes reduced VAT on resource efficient products

The German environment agency UBA has proposed that EU tax regulations should be modified to allow reduced-rate VAT (Value Added Tax) on resource efficient products, as well on services such as repairs. Modification to EU VAT rules requires unanimous decision of all Member States. UBA has also called for binding environmental and social standards throughout the value chain with mandatory certification. UBA also proposes specifying minimum recycled product contents in certain products.

"Resource-efficient products should be cheaper" <http://www.umweltbundesamt.de/en/press/pressinformation/resource-efficient-products-should-be-cheaper>
Umweltbundesamt Germany 11th November 2016 and resources report www.umweltbundesamt.de/resourcesreport2016

Regulatory barriers to circular economy wealth creation

In a report for the European Commission (DG GROW), 10 case studies are presented where removing regulatory barriers could facilitate development of the circular economy, including two relevant to nutrients: nutrient recycling from manure and food waste in the hospitality sector. For food waste, VAT regulations tax food donations and strict Member State implementation of the 2004 EU Regulation on Food Hygiene result in throwing food away. Regulation and VAT changes could result in savings of 4 billion €/year for the hospitality sector. For manure nutrients, the report identifies five regulatory barriers to recycling:

- EU Fertilisers Regulation does not at present cover organic fertilisers (NOTE: this is being addressed through the EU Fertiliser Regulation revision)
- The Animal By-Products Regulation does not take into account the sanitisation ensured by various manure processing methods (NOTE: this should be addressed by the EU Fertilisers Regulation revision, but is not at present)
- Waste Framework Directive labels anaerobic digestion as "recovery" (energy production) instead of recycling (NOTE: so "forgetting" the nutrient value of digestate and the potential for nitrogen recovery by ammonia stripping)
- Absence of End-of-Waste criteria for manure derived products (NOTE: as above, this should be addressed by the EU Fertiliser Regulation revision)
- REACH (EU chemical regulation) application to manure derivatives (for which this Regulation may not be adapted)

Other non-regulatory barriers to manure nutrient recycling identified by the report are:

- Benefits of organic fertilisers not recognised
- Inconsistent quality of manure derived products
- Manure processing is more expensive than field spreading or than mineral fertilisers
- Legal uncertainty around manure processing discourages investments

The report estimates that if 20% of EU manure is currently wasted, rather than being reused in agriculture, then this represents a loss of over 1.1 billion €/year for phosphorus and nitrogen fertiliser value. The report also notes that manure processing is labour intensive, with a "reasonable" job creation potential of 200 000 full-time equivalents across the EU.

Technopolis, Wuppertal Institute, Thinkstep and Fraunhofer ISI "Regulatory barriers for the Circular Economy. Lessons from ten case studies" 13th July 2016
<http://ec.europa.eu/DocsRoom/documents/19742> and European Commission DG GROW website http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8986&lang=en&tpa_id=1040

Report confirms potential of tax shift from labour to consumption

A new report for the Ex'tax project, by Cambridge Econometrics, Deloitte, EY, KPMG and Price Waterhouse shows that transferring tax burden from labour to consumption would increase GDP by +2% and employment by +3% in Europe, and deliver 5 – 9% reductions in energy use, water use and carbon emissions. At present, around 50% of Europe's national tax revenues come from taxation of labour, compared to just 6% from taxes on resources and consumption. The Ex'tax proposal shifts taxation from the payroll (social contributions and income tax), to carbon, water and electricity (bulk users not households), and possibly also other green taxes on e.g. metals and



minerals, travel and traffic, waste, building materials, air pollution emissions, toxic chemicals, plastics, biodiversity, as well as a small increase in VAT (but zero VAT for maintenance and repair) with tax credits for job creation and for circular economy innovation.

"New era. New plan. Europe. A fiscal strategy for an inclusive, circular economy", published 15/12/2016, Ex'tax project 2016 <http://www.newernewplan.com/>

Media

ICL Fertilisers: the world must consume less raw materials

In an interview published with Springer Professional, Kees Langeveld, vice president of business development of the international chemical company Israel Chemicals Ltd. (ICL) explains that phosphorus recycling is part of the company's engagement for environmental and social change, and the circular economy, and also contributes to maintaining ICL's production factories in The Netherlands and Germany. As well as ICL's use of struvite in fertiliser production, Mr Langeveld cites ICL's project, using the RecoPhos technology, to recover elemental P₄ (white phosphorus, a key raw material for flame retardants, lubricants, and other applications) from sewage sludge ash, and production of phosphoric acid using ashes and hydrochloric acid.

Springer Professional "Less raw materials must be extracted", 12th January 2017 <https://www.springerprofessional.de/recycling/nachhaltigkeit/-weniger-neue-rohstoffe-muessen-gewonnen-werden-11926228>

Aqua Strategy: P recovery update

The water sector professional magazine Aqua Strategy published in its December issue a summary of current developments in phosphorus recycling technology installation worldwide, covering current installations and underway projects using technologies of Ostara (Pearl), NuReSys, Colsen (Anphos), Véolia (Struvia) and Mephrec (Nuremburg pilot). More detailed presentations of Outotec's work to develop a recovered calcined phosphate product (improved AshDec process) adapted to farmers needs, and of the Budenheim ExtraPhos process (P extraction from sewage sludge at ambient temperature using CO₂, Mainz-Mombach pilot).

"Aqua Strategy review: Process progress with sewage phosphate recovery" cover story, December 2016 <https://www.aquastrategy.com/article/aqua-strategy-review-process-progress-sewage-phosphate-recovery> and feature article "Budenheim pilots its process to meet German wastewater phosphate recovery requirements" <https://www.aquastrategy.com/article/budenheim-pilots-its-process-meet-german-wastewater-phosphate-recovery-requirements>

Toilet Board Coalition: Circular Economy could accelerate global sanitation

The Toilet Board Coalition, a platform of hygiene brand companies, NGOs and development organisations, has published a study concluding that the circular economy could speed up implementation of global sanitation. The study concludes that valorising resources derived from toilet wastewater can create a self-sustaining sanitation business, accelerating sanitation investment, reducing need for public funding and creating business opportunities for both multinationals and innovative SMEs – but not without risk. Resources recoverable from toilets are identified as (today) energy, agricultural products [compost, organic fertilisers and soil conditioners], water and (potentially) innovative products/raw materials and health data. Challenges to address are seen as contaminants and pathogens (safety), public perception ("yuk factor"), smell, security/ quality of supply, maintenance, development of new products, fit with existing instruments and operators and failure to monetarise externalities.

"Sanitation in the Circular Economy" Transformation to a commercially valuable, self-sustaining, biological system, November 2016 http://www.toiletboard.org/media/17-Sanitation_in_the_Circular_Economy.pdf

Science

Healthy diet, diet P and food sustainability

A systematic review (Nelson et al. 2016) identified 23 studies relating diet quality to environmental impact (for developed countries). Analysis of this data concludes that dietary patterns which are higher in plant-based foods and lower in animal-based (especially red meat) and lower in energy content, are both healthier and have a lower environmental impact. Meier & Christen 2013 is the only study cited as specifically addressing phosphorus, showing lower P use with healthier, more plant-based diets. Another study (Peltner & Thiele 2017) looks at nutrients in the Healthy Eating Index – 2010 concluding that densities (nutrient content/energy content) of nutrients (P, Ca, K, Mg, Fe and others) are higher in the high quality diet (67 mgP/100 kcal) than the low quality diet (53 mgP).

"Alignment of Healthy Dietary Patterns and Environmental Sustainability: A Systematic Review" M. Nelson et al., *Adv Nutr* 2016, 7 1005–25, <http://dx.doi.org/10.3945/an.116.012567>

"Association between the Healthy Eating Index-2010 and nutrient and energy densities of German households' food purchases", J. Peltner & S. Thiele, *European J. Public Health*, 2017, <http://dx.doi.org/10.1093/eurpub/ckw247>

Phosphorus losses from mains water leakages

A new study suggests that phosphorus losses from mains (drinking) water leakages is nearly one quarter of P discharged from sewage works in the Thames river catchment, England. The study estimates phosphorus losses from mains water pipes at 90 tP/y, compared to

380 tP/y from sewage works and 560 tP/y from agriculture. Phosphates are dosed to drinking water in the UK to prevent lead and copper dissolving into water and posing health problems – this is not the case in most of the rest of Europe. A previous study (Ascott et al. 2016, summarised in [SCOPE Newsletter n°119](#)) estimated phosphorus leakage out of mains water supply pipes at 1 200 tP/y, total England and Wales, of which around 70% into surface waters.

"Mainswater leakage: Implications for phosphorus source apportionment and policy responses in catchments", D. Goody, M. Ascott et al., *Science of the Total Environment* 2016 <http://dx.doi.org/10.1016/j.scitotenv.2016.11.038>

Phosphorus recovery potential, Sofia, Bulgaria

Phosphorus recycling potential of Sofia, Bulgaria, waste water treatment plant is assessed. This is Bulgaria's biggest sewage works, serving a population of over 1.3 million (14% of Bulgaria's sewage), p.e. not specified. Bulgaria's 2014-2020 National Sludge Management Strategy anticipates an increase in sewage sludge production to nearly 125 000 tonnes DM per year, with upgrading of sewage works to respect EU water legislation. Currently around half of Bulgaria's sludge goes to landfill or temporary storage, both of which must be stopped, and the remainder farmland or soil restoration. Phosphorus in the Sofia sewage works inflow is c. 2.9 mgP_{total}/l and 0.9 mgP_{total}/l in discharge. The authors estimate that around 70% of inflow phosphorus could thus potentially be recovered from either sludge or sludge incineration ash, that is 170-250 tP/year.

"Phosphorus recovery potential in Sofia WWTP in view of the national sludge management strategy, I. Ribarova et al., *Resources, Conservation and Recycling* 116 (2017) 152–159 <http://dx.doi.org/10.1016/j.resconrec.2016.10.003>

Risk assessment and fertiliser regulations

A first-approach risk [assessment](#) is presented of contaminants in mineral fertilisers and a number of possible recycled nutrient products (including sewage sludge, recovered struvite and sewage sludge ash derived products), covering risk to humans (food via crops, farmers), to soil organisms and to surface water. It is concluded that cadmium and zinc may be of concern for some endpoints: possible cadmium risk to surface waters on acidic soil, zinc risk to soil organisms from sewage sludges or sludge incineration ash products. Chromium and copper may also potentially be significant contaminants, comparative to atmospheric deposition, in some recycled fertiliser products. Struvite shows the lowest contaminant levels and no identified risks. For the persistent organic contaminants considered (dioxins, poly aromatic hydrocarbons) recycled nutrient product input is low compared to atmospheric deposition and does not contribute significantly to risk. Risk to humans are considered low for all fertiliser materials considered (levels higher than PNEC Predicted No Effect Concentration).

"Risk Assessment and Fertilizer regulation – A valuation with respect to recycled phosphorus materials from wastewater", F. Kraus, C. Kabbe, W. Seis, Berlin 17 Nov. 2016, paper prepared within the EU-FP7 Project P-REX and updated in 2016. http://p-rex.eu/uploads/media/Kraus_Kabbe_Seis_Risk_Assessment_and_Fertilizer_regulation_-_A_valuation_with_respect_to_recycled_phosphorus_materials_from_wastewater.pdf An enhanced version with better consideration of these uncertainties and a quantitative sensitivity analysis is planned for mid-2018

Cost assessment of struvite recovery from digestate

[COWI](#), at the [Nordic Phosphorus Conference](#), October 2016, presented a preliminary study of costs of possible struvite recovery from a biogas plant treating sewage sludge and sorted household organic wastes (OFMSW). The Grodaland biogas plant, Norway, currently being built, will treat 89 000 t/y of municipal sewage sludge and 41 000 t/y OFMSW, that is a total of nearly 23 000 t/y dry solid content. Cost estimates, based on different struvite process supplier technologies, ranged from 13 to 18 €/kgP recovered. Cost differences were not considered pronounced, but costs for struvite recovery were around half of costs for evaporation processes (but these could also recover nitrogen and potassium). Possible operation cost savings resulting from phosphorus recovery were not considered.

Line Blytt, COWI, "Solutions and costs for public facilities, example from an evaluation of technologies for nutrient recovery at Grødaland biogas plant in Rogaland, Norway" https://dakofa.com/fileadmin/user_upload/1100_Line_Blytt_Danielsen_COWI.pdf

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