P01 Can consequential LCA stimulate sustainable decision-making? A case study from the recycling of a steel production residue. A. Di Maria, KU Leuven / MTM; K. Van Acker, KU Leuven. Effective policy instruments must be put in place to incentivize industrial symbiosys (IS) Choosing the most environmentally efficient and economically cost-effective policy measure can prove to be challenging, as decision-making involves trade-offs between economic and environmental aspects. Therefore decision-making should be supported by tools able to combine the environmental and economic consequences of new IS practices. Within the LCA framework, the effectiveness of the attributional approach in evaluating new IS strategies has been discussed. The attributional LCA is based on the underlying assumption that the process involved in the life cycle are operated under steady-state conditions and the investigated life cycle is not connected with other markets. This intrinsic limitation makes attributional approach debatable for tackle IS issues, since the fundamental role of policy related question and interconnections between different markets In this paper, the attributional and consequential analysis of IS between the steel and concrete sector is presented. In particular, Stainless Steel Slag (SSS) is a residue occurring during the production of stainless steel. Today, SSS is must be chemically stabilized before its disposal in landfill or its recoverering as low quality aggregates. However, since SSS contains valuable metallic oxides, it could be chemically activated to produce new construction materials. The scope of the study is therefore to evaluate and compare the results of an A-LCA and a C-LCA for a relevant case of IS strategy implementation, represented by the recycling of stainless steel residues to produce new construction materials. The A-LCA results describes the environmental impacts directly related to the recycling process, indicating the more sustainable solution among the possible recycling routes. C-LCA enlarged the analysis on the environmental consequences of the supply of new recycled products from SSS, indicating that the changes in the construction blocks market are the driving the final results of the whole system, while almost no environmental benefits are achieved if SSS are only recycled as low quality aggregates. These results can support a more informed policy making process, aiming at increasing an environmentally sustainable synergy between steel and concrete sectors

P02 Circular economy: Recycling glass fiber reinforced composites (GRP) V. Vladimirov, HOBAS; I. Bica, Technical University of Civil Engineering Bucharest. Glass reinforced plastic composites (GRP) are used by a wide range of major industrial sectors (including construction, automotive, electronic, renewable energy). With increased use of GRP material across the industries, the amount of generated waste has also been on a rise. Additionally, environmental legislation in Europe is becoming increasingly restrictive, accelerating demand for industrial scale recycling solutions. Recycling of GRP has specific challenges, as the material cannot be reshaped again by heating once cured in production. However, due to its long life-span, the end-of-life disposal has not been a major issue to-date. Landfilling and incineration remain the simplest and most used disposal methods. At the same time, as the need for recycling solutions increases, there are limited resources that provide comparative insight into environmental impacts among available waste management methods. The present study starts from a GRP product (GRP pipe) and analyzes the environmental impacts through application of Module D (recycling) per EN15804 by applying various scenarios: landfilling, incineration (including energy recovery), co-processing, mechanical (i.e. concrete block, plastic foil, ceramic sink, wooden elements, pavement stone) and thermal reclaiming. Due to recent efforts to bring clarification to this field (i.e. Product Environmental Footprint PEF developed by the European Commission), most of the existing methodologies can now be unified by using the “integrated formula”, employed as backbone by the PEF pilots. The EN 15804 with Module D approach is mathematically identical and the sum of the results of the modules is identical to that of the “integrated formula”. The results provide valuable understanding of recycling GRP, including design choices such as using recycled content or recycled raw materials.

P03 Consequential and attributional LCA of LNG production K. Boonen, A. Vercalsteren, VITO. In many countries, associated natural gas, extracted together with petroleum, is flared. One of the reasons is the difficulty to transport it to potential users. In this LCA, the production of liquefied natural gas (LNG) from associated natural gas, the distribution to consumers in remote locations and the use for industrial heating is investigated. This is done from a consequential and an attributional perspective. It is found that the LNG production is expected to have a positive effect on the environment for all impact categories considered, except one. The sign of the effect is equal for the consequential and attributional approach; however, the magnitude varies greatly. The environmental savings are generally much larger for the consequential model, for two reasons. First, in the case of the consequential LCA model, the benefits of the avoided flaring are given entirely to the investigated system, while in the case of the attributional model, part of these benefits are allocated to the co-extracted petroleum. Also the impact of the combined extraction is partly allocated to the natural gas extraction. Second, taking into account the impacts avoided thanks to the use of the by-products is more favourable than allocating only part of the impact of the production process to the main product, LNG.

P05 Consequential or attributional LCA in support of policy making? Strengths and limitations of both approaches to tackle the urban scale N. Mirabella, K. Allacker, KU Leuven / Department of Architecture. To date, cities are increasing in number and dimensions worldwide at an unprecedented rate. Half of global population is residing in cities and this share is expected to reach up to 66% by 2050 [1]. In addition to this, they are complex and dynamic entities, that concentrate the majority of services and economic activities. Urban systems consume a great amount of materials and energy, and produce waste and pollutants [2]. Furthermore, cities are part of larger networks and are often dependent on the surroundings, especially in a context of *glocal* economy, their influence goes well beyond their territorial or administrative boundaries. This is particularly true for the environmental burdens associated to all the activities responsible to sustain urban life, e.g. consumption goods produced in one country but purchased and used in another. Thanks to their density in terms of people and energies, scientists and policy makers consider cities as the priviliged hub of interventions in favour of sustainability [3]. Notwithstanding, the holistic accounting of urban environmental impacts is still immature [4]. The Life Cycle Thinking approach is promising in accomplishing this task, and Life Cycle Assessment (LCA) plays an important role, as it can provide support to policy-makers towards more transparent and evidence-based decisions [5]. However, several issues are still open and basic methodological refinements (e.g. system boundaries, functional unit, allocation procedures, etc.) are necessary. Last but not least, if an LCA-based method is used, it is relevant determining whether an attributional (A-LCA) or a consequential LCA (C-LCA) is most appropriate. Indeed, a C-LCA is designed to generate information on the consequences of actions [6] and can be more accurate and comprehensive in evaluating the effect of a policy and/or scenarios at the urban scale [5]. Neverthless, applications of LCA at the urban scale are missing and studies conducted at territorial level stressed that a C-LCA is suggested only if the territory support strategical activities at a higher (e.g. regional) level, otherwise an A-LCA is recommended [7]. The aims of the present contribution are: i) providing insights in the current state of art of environmental assessment at the urban scale; ii) presenting strong and working points for the application of A-LCA and C-LCA; iii) defigning a proposal based on the emerged possibilities and limits offered by both approaches.

P06 Dynamic LCA of stationary battery systems in a renewable-based decentralized grid M.J. Baumann, Karlsruhe Institute of Technology (KIT) / Institute for Technology Assessment and Systems Analysis; J.F. Peters, Helmholtz Centre Ulm / Resources, Recycling, Environment and Sustainability; M. Weil, Karlsruhe Institute of Technology KIT / Institute for Technology Assessment and Systems Analysis ITAS. A major challenge for hybrid micro grids is the

fluctuating generation behavior of decentralized sources as photovoltaics and wind turbines that correlate only poorly with loads. Energy storage is becoming increasingly important for decentralized electricity systems, and batteries are considered as one of the key technologies for this purpose. However, their production is costly and associated with significant environmental impacts, why continuous efforts are made in order to decrease them. Furthermore, different battery technologies are available, each with its specific advantages and disadvantages. Conventional LCA are not able to consider the dynamic load and charging conditions of different applications and thus only give a very simplified picture of the true environmental impacts of a battery for a given application. The load profile has a fundamental impact of the depth of discharge of the batteries and therefore on their lifetime, determining the required battery replacements over the lifetime of the application. Thus, the consideration of application-specific dynamic operation profiles increases considerably the significance of life-cycle assessments of stationary battery systems. We apply a combination of techno-economic assessment, energy system optimization and size optimization to determine life-cycle costs and environmental impacts of different battery technologies in a decentral application. Different renewable energy sources with dynamic load profiles are considered in order to point out the importance of choosing the appropriate battery for this specific application. The size optimization determines the best trade-off between battery oversizing and increased battery replacements under economic aspects. It turns out that battery life is a determining factor for the overall environmental performance. This is not only due to the amount of battery replacements required, but also due to oversizing needed for battery types with low cycle lives in order to reduce degradation effects. Most lithium-ion batteries, but also the sodium nickel chloride battery show a good performance, while valve regulated lead acid batteries seem to be less recommendable due to low cycle life and low charge-discharge efficiency. For redox flow batteries, a high dependency on the desired application field can be pointed out.

P07 Dynamic Life Cycle Inventories: coupling experimental design and LCA for the eco-design of an extrusion process. R. Julio, J. Albet, INP-ENSIACET; D. Medrano, Universidad Nacional de Lanús / DESARROLLO PRODUCTIVO Y TECNOLOGICO; C. Sablayrolles, INP-ENSIACET. Fossil resources and rare metals rarefaction involve drastic changes in our production ways. Modern industries need to apply an innovative system based on sustainable development and circular economy. Developing biorefineries is crucial, to promote processes using and valorizing renewable resources. Nevertheless, it is necessary to determine the best set of operating conditions for the eco-design of chemical and biorefinery processes. The main limit to eco-design such processes is certainly the lack of specific data. To face this issue, it is possible to couple the fields of process modelling and simulation with Life Cycle Assessment. Indeed, simulating a process can lead to obtain detailed mass and energy balances. Thereby, these balances can be used to perform an environmental Life Cycle Assessment, but also an economic assessment and an improvement of the production yields. This integrated assessment of a process through economic, environmental and technological considerations can be a powerful tool based on Life Cycle Thinking for decision support. This methodology and its associated tools have been tested on an extrusion process. Indeed, to valorize agricultural wastes, wheat bran and straw have been extruded in order to recover hemicelluloses, which could then be used to produce biofilms. The second order polynomial equation model used to simulate extrusion process is obtained thanks to experimental design methodology. The semi-empirical model is based on specific experiments and can predict flowrates, production yields, detailed biomass composition or the required energy, in function of some operating parameters such as raw materials ratio, or screw rotation speed for instance. Coupling process modelling and simulation to LCA could lead to perform dynamic Life Cycle Inventories, and so to have a better understanding of links between elementary flows and environmental impacts categories. Moreover, this methodology permits to work with more specific, precise and reliable foreground data. By predicting specific data with semi-empirical models especially developed for the assessed process, a significant progress can be performed in the data quality. Thus, it also can develop the integration of two paramount concepts in the decision making process: (1) Life Cycle Thinking and (2) Sustainability with simultaneous assessments of economic viability, environmental performance and productivity of a process.

P08 Eco-efficiency of Second Life Applications of Lithium Ion Traction Batteries H. Schmidt, Esslingen University of Applied Sciences / Institute of Sustainable Energy Technology and Mobility; M. Flad, W. Guth, Esslingen University of Applied Sciences. Second Life (SL) applications for used Lithium Ion Traction Batteries (LITBs) could be a possible concept to reduce battery related costs and environmental impacts and therefore improve the eco-efficiency of LITBs. Eco-efficiency describes the combination of ecological and economic evaluation criteria to enable a holistic assessment of products, processes or technologies and to identify optimization potentials. For the ecological assessment, preliminary analyses of the study will be completed with comparative Life Cycle Analysis (LCA) of different application scenarios. From the economic point of view, the study analyses whether LITBs can be applied economically such that the Total Cost of Ownership (TCO) of a Battery-electric Vehicle (BEV) can be improved. Profitable second life (SL) applications include, amongst others, provision of primary control and house storage systems in combination with a photovoltaic system. A potential economic value for the use of SL batteries against new batteries can be found. The success factors for SL applications are: *i)* A high share of the battery costs compared to the total investment costs, *ii)* A long operating time of the SL battery (SLB), and *iii)* Low absolute SLB costs. A TCO reduction potential (with profitable SL applications) of 3.4% is determined along with comparable reductions of the acquisition costs of a BEV with, e.g., 7.3% for a Nissan Leaf Visia. Compared to recycling, the economic SL applications are preferred because recycling is currently not economically feasible. The reuse of a LITB can reduce the TCO of a BEV and, thereby, support a faster market penetration of BEVs – however, potential effects on the TCO are limited. To identify the most eco-efficient applications and the range of the possible improvements, next steps include detailed analyses based on not only real options valuation but also LCA.

P09 Energy demand and greenhouse gases emissions assessment of PV panels recycling process in Spain I. Herrera, CIEMAT / Energy Dpt Energy Systems Analysis Unit; I. Istrate, Universidad Rey Juan Carlos / Environmental Engineering; D. Garrain, CIEMAT / Energy Dpt Energy Systems Analysis Unit; Y. Lechon, Energy Dpt Energy Systems Analysis Unit / Energy. PV power capacity installed will increase considerably in the next decades and the sustainability of this source of energy will depend on the end-of-life management of PV panels. It is expected that the high potential environmental benefits encourage the consolidation of the circular economy principles in the PV industry. Within this context, the objective of this study was to analyse GHG emissions and primary energy demand of a recycling process of mc-Si PV modules in Spain and to compare with the manufacturing step. The process is based on mechanical (disassembly and shredding) and thermal (separation of EVA; with energy recovery) treatments. Aluminium, glass and copper are treated in specific recycling plants, while polymers (back-sheet and junction box) are incinerated for energy recovery. Recycling of mc-Si cells has been excluded, and finally, solar cells are disposed of in a sanitary landfill. Through the analysis of the end-of-life approach, relevant reduction of both GHG emissions and primary energy demand of the whole life cycle of mc-Si PV modules are observed due to the recycling integration.

P10 Environmental performance of SIAM technology under Mediterranean climatic conditions Y. Lorenzo, CETaqua, Water Technology Centre / Environment and Socioeconomics; M. Ruiz Mateo, I. Gutierrez-Prada, M. Calvet, A. Silva, CETaqua, Water Technology Centre; D. Marin, CETaqua, Water Technology Centre / Environment and Socioeconomics. Anaerobic biological processes are environmentally friendly due to the production of biogas and lower

waste sludge production than the conventional processes using aerobic processes. Nevertheless, some issues should be resolved in order to broad the use of anaerobic processes for treating sewage at ambient temperatures in mild climates: i) The low temperature of sewage may impede the completion of the process; ii) The difficulty of nitrogen removal, and iii). The presence of dissolved methane in their effluents, which represents an important environmental problem in terms of greenhouse gas (GHG) emissions.A very interesting approach, which could be used to reduce both nitrogen content of the wastewater and GHG emissions of anaerobic processes, might be based on the use of biological methane oxidation coupled with denitrification processes. The LIFE SIAMEC project proposes the use of an integrated anaerobic-aerobic membrane novel technology called SIAM that also produces high quality that could be easily reused. This study intends to evaluate the environmental benefits of the proposed technology in comparison with the existing WWTP of Cabezo Beaza (Murcia, Spain). To do so, life cycle assessment (LCA) was the selected methodology to quantify the environmental burdens of the prototype and the full scale WWTP. Special focus has been put on GHGs emissions monitoring and minimization opportunities. The availability of experimental GHG emissions data allowed to obtain an accurate carbon footprint of the novel technology and to provide a benchmark in comparison with the existing alternatives. The results obtained throughout the analysis of both systems suggest that even though the indirect carbon footprint of SIAM technology is slightly higher, mainly due to the higher energy use (pilot scale), the overall footprint of the prototype is lower. The impact of direct GHGs emissions in the real WWTP, mainly N_2O produced in the biological reactor (nitrification-denitrification processes), cause its elevated overall carbon footprint. With respect to the eutrophication impact category, ENEI indicator has been used to cast light on the environmental benefits of both wastewater treatments alternatives. The results showed that the performance of the SIAM technology was lightly superior than the one obtained by the real WWTP.

P11 Electricity from biogas in Italy: Environmental consequences related to the elimination of economic subsidies j. bacenetti, State University of Milano / Departiment of Environmental Science and Policy; G. Falcone, Università degli Studi Mediterranea di Reggio Calabria / Dipartimento di Agraria. The Anaerobic Digestion (AD) is recognized as one of most viable way to produce bioenergy, also contributing to reduce the GHG emissions and the amount of wastes above all if livestock husbandry secondary products and crop residues are used. In the last decade, several studies dealt with the biogas production via AD from an environmental point of view, deepen the burdens strictly linked to life cycle of biogas production but underestimating the multi-functional role that biogas-to-electricity systems could play in the agricultural sector. AD can be realized using different feeding mix, chosen, primarily in function of maximization of profit according to technical and economical feasibility of process. The granting of national incentives for the increasing of share of renewable energies, pushed several entrepreneurs to undertake the biogas production activity, making partnerships with farmers in order to displace ordinary cultivated land management to energy crops. In Italy, in the last 20 years, above all in the norther regions, thanks to a favorable subsidy framework, around 1800 AD plants fed with agricultural feedstock were built. Despite the higher supply cost, due to the level of subsidy (280 €/MWh of electricity fed into the national grid for plants built before the 2013), several plants are fed mainly with dedicated crops and the maize silage is the most used biomass. The future scenarios of bioenergy production could change considerably when the incentives will cease. In fact, for all bioenergy plants fed with dedicated crops, revenues could not cover supply costs for feeding and then the suspension of incentives could cause the cessation of activities. The aim of this study is to analyze the consequences related to a change in the actual subsidy framework for renewable energies and, in particular, the elimination of the grants for biogas production. More in details, to evaluate the environmental effects related to (i) the substitution of renewable energy with non-renewable energy or (ii) the maintenance of plants fed with dedicated crops by substituting the feeding mix with pig and cow slurry a consequential life cycle assessment (cLCA) was performed. The effects of future scenarios were evaluated with a partial equilibrium model. The achieved results can support the decision of policy makers in order to drive the future towards more sustainable direction.

P12 Improved modeling of substitution in consequential LCA by the use of market prices D. Schrijvers, University of Bordeaux; P. Loubet, CyVi-ISM / ISM CyVi; G. Sonnemann, University of Bordeaux / ISM CyVi. Substitution is a modeling technique that is inseparably linked with consequential LCA. We model effects of substitution when we produce co-products, by-products, or recycled materials. In other words: when a dependent co-product is produced. There has been an ongoing discussion on how to improve the modeling of substitution effects. Advanced methods often use price elasticities, but these data are often unavailable or do not represent the level of detail or the time horizon that is required for the LCA, and the effects that price elasticities represent are limited. We propose a procedure that uses market-price ratios to model the effects of substitution in consequential LCA. The market-price ratio (*A*) is calculated between the dependent co-product and the material or product that it substitutes. If these products have the same price (i.e. $A = 1$), full substitution is modeled, according to the end-of-life recycling method. If the price is different (i.e. A ? 1), the following possible reasons must be evaluated: 1) A product is displaced in a different market segment due to a reduced functionality, quality, or a different image, 2) downstream drawbacks and/or benefits take place, which should be integrated into the calculation of the market-price ratio, and 3) if the user of the dependent co-product experiences a financial benefit, the demand for the dependent co-product is (partly) constrained. The latter implies that there is a surplus of the material and alternative waste treatment is affected. It is demonstrated that this simple approach improves the modeling of recycled glass, plastics, and even rare earth elements that do not have a direct substitute, such as europium. Factor *A* shows several benefits over the use of price elasticities: market prices are often available for different material grades and can be determined on a case-by-case basis. Market prices can represent products that are directly traded between two actors, as in this situation demand constraints can be relevant as well. Besides, the market-price ratio stimulates the modeling of downstream effects caused by the use of a dependent co-product in the life cycle inventory, which is often neglected in practice. Finally, this approach provides the perspective to put a price on externalities, which would improve the representation of factor *A*.

P13 Interpreting LCA results in models with high variability and potential scenarios - the wider impact of the AQUAVALENS project C. Torres, Universitat Rovira i Virgili; F. Castells, Universitat Rovira i Virgili / Chemical engineering department; M. Figueras, Universitat Rovira i Virgili. Life Cycle Assessment (LCA) can be applied to a variety of activities, services and products, giving rise to new challenges in the assessment and interpretation phase due to the peculiarities of each system: data availability, uncertainty, temporal and geographical resolution, sensitivity to unsettled parameters, etc. In the presented study we show an example on how the mentioned features can be managed in the interpretation of the results. The systems to be evaluated are the novel platforms developed under the project AQUAVALENS for the detection of pathogens in drinking water. The aim of the project is to enable the water system managers, to better control the safety of water supplies by using these newfangled technologies. Carbon Footprint (CFP) is calculated using as Functional Unit (FU) the processing (preparation and detection of specific microorganism i.e. virus, E. coli etc) of one water sample. The sources of primary data are the project partners thus the data collection and feedback strategies must be tailored to overcome the communication barriers and ensure the understanding of the findings to non-expert audience. Three types of detection platforms designed and manufactured by the producer partners are tested experimentally in suix European locations by different end-user partners. Parametric uncertainty derived from the variation and stochastic errors of the input data in the model is

analysed. Besides two secenario analyses are conducted considering type of vehicle in the sampling transport and electricity mix production for the energy consumption. In the whole life cycle of the product, the use phase is by far the major contributor in constrast with the manufacturing phase. AQUAVALENS methods would reduce approximately 65% the CFP of the conventional methods for the analysis of pathogens from the three kingdoms in a sample (a set of especies of bacteria, parasites and viruses). The Relative Standard Deviations indicate that AQUAVALENS platforms scores have higher uncertainty than conventional procedures since they are more dependent on the input with the highest variability that is the transport. The estimated reduction of the CFP considering the parametric uncertainty and the potential scenarios (two alternatives in type of vehicle in sampling transport and the three alternatives in electricity production mix) would be 66.2% as central value (mode) in the range [58.7 % - 73.7 %].

P14 Investigating mitigation opportunity of switching to organic rice paddy production from traditional method using CLCA A. Jimmy, North South University / Environmental Science and Management; M. Sujauddin, North South University; M. Hossain, Chalmers University of Technology. Rice production in Bangladesh is large – sitting at fourth position in the top producers of rice in the world, the nation is pushing the 40 million metric ton mark in total rice production. Hence there is a dire need to improve the overall performance of rice paddy production in Bangladesh, in context to environment. A consequential life cycle assessment will give a holistic picture of influence, a decision can have on the product system chain, for example how the product system will be influenced due to a change in decision, such as switching from traditional agricultural practice to organic agricultural practice to grow the paddy rice. The benefits that arise from avoided use of fertilizers and chemicals are evident from this alternative scenario analysis is evident as most of the indicators show significant decrease in burden. From the absence of urea application alone, almost 10% of global warming potential burden can be reduced. This is due to resulting decrease in production of Urea, as a consequence of the decision to stop its application. Given the difficulty in applying CLCA in a developing country due to unstable economy and unpredictable demand, this study is the first of its kind from this region.

P15 LCA as tool to direct research in the water cycle T. van den Brand, KWR Watercycle Research Institute / Water systems and technology; R. Hofman-Caris, KWR Watercycle Research Institute; A. Butkovskyi, Wageningen University WUR Univ of Valencia UV; B. Hofs, Evides. In the water sector much research is conducted regarding environmental issues; such as resource recovery and lowering the total (CO_2) footprint. A life cycle assessment (LCA) analysis can be performed to evaluate the environmental impact of a new process or scenario in which resources are recovered, without having to invest in intensive and expensive technical research. This LCA study demonstrated that research should be focussed on the baricum concentration in the wastewater for the shale gas wastewater treatment process and for the recovery of flocculant is should be focussed on the quality of the recovered flocculant. In this study LCA has shown to be an effective tool to evaluate the direction of research within the water sector, evaluate possibilities for resource recovery and determine environmental impacts of processes.

P16 LCA of magnesium recovery processes for decision support in REMAGHIC EU-project M.I. González Hernandez , Fundación CIDAUT / Material Producto Proceso; J. Garcia, Grupo Antolin. REMAGHIC (New Recovery Processes to produce Rare Earth - Magnesium Alloys of High Performance and Low Cost, in the frame of SPIRE project) is focused on contributing to Europe's rare earth recovery and magnesium recycling technologies, improving the efficiencies of these processes and advancing the technology readiness levels for a new generation of industrial processes that will produce sustainable competitive alloys for automotive and aeronautics industries, and biomedical sector. The main objective of this work was the environmental assessment of the new technologies for recovering magnesium (Mg) developed in REMAGHIC. The evaluation of the effective environmental performance of this new recovery technology supported the decision making process of selecting the most promising routes to be applied in the upscaling process of the new production of Mg+REE alloying ingots (this activity is still under development). The scope of the Mg recovery technologies developed within REMAGHIC was the assessment of the environmental profile of the production of a one kilogram ingot of recovered magnesium, to be alloyed with rare earth, from the available types of Mg wastes in Grupo Antolin facilities. The magnesium recovery process, were based on remelting technologies. The waste streams were rejected parts, Biscuits & Gates, overflows; and dross & sludges. In the project, a recovery system is being defined to obtain high quality secondary Mg ingots, from magnesium wastes. Through LCA models, footprint of different technical options have been analyzed and taken into account for decision making. That allows studying the impact that alternative technical solutions within REMAGHIC Mg recovery system, in order to properly define the pilot plant where validate the developed process. Scenario analysis was implemented in order to assess how the results of the LCA vary if the model is set up in different ways: a) employment of different composition for refining salts, b) varying the balance of wastes as raw materials, c) varying the energy sources to provide the thermal energy needed; d) varying the stirring system in the melting crucible, and e) selecting different configuration of cover gases to use in different stages within the recovery system. The LCA assessments were carried out following the standard ISO 14040/14044

P17 Life-cycle assessment of table grapes in Austria - three case studies B. Mairinger, University of Natural Resources and Life Sciences Vienna; I. Kral, AlpS GmbH; A. Gronauer, University of Natural Resources and Life Sciences Vienna / Division of Agricultural Engineering; G. Piringer, University of Natural Resources & Life Sciences / Dpt. of Sustainable Agricultural Systems. Table grapes are beginning to be grown in Austria, but no life-cycle assessments (LCA) on table grapes has been found in literature. The objective of this work was an estimate of the potential environmental impacts of producing 1 kg of table grapes and the development of impact mitigation options. It used a "cradle-to-gate" LCA (from vine planting to primary consumer) to study three naturally or organically managed case study vineyards in Eastern Austria, and one hypothetical reference vineyard. The global warming potential (GWP100) of the four vineyards ranged from 0.30 to 1.05 kg CO2-eq/kg grape, with a strong dependency on annual grape yield. The main contributing processes varied between vineyards, including machinery use, the production of packaging materials and mineral fertilizer production. Options to reduce the impacts of table grape production in the vineyards studied here include the use of modern, efficient machinery, a less material-intensive packaging system and optimal fertilizer use. In the vineyard with the highest total GWP100, just replacing the old tractor with a modern model would reduce the grapes' total carbon footprint by 38.5%.

P18 Managing uncertainty in LCA of innovative processes to recover rare earth elements in REMAGHIC project A. Salles, Fraunhofer Institute for Chemical Technology ICT; S. Sgarioto, Relight italia; L. Yurramendi, Tecnalia Research Innovation; F. Forte, Katholieke Universiteit Leuven; M.I. González Hernandez , Fundación CIDAUT / Material Producto Proceso. The REMAGHIC (New Recovery Processes to produce Rare Earth - Magnesium Alloys of High Performance and Low Cost, in the frame of SPIRE program) project aims at contributing to Europe's rare earth recovery and magnesium recycling technologies, improving the efficiency of these processes and advancing the technology readiness levels of a new generation of industrial processes to produce new and more sustainable alloys for the automotive, aeronautical, and biomedical industries. The main objective of this work was the environmental assessment of the new technologies developed in REMAGHIC for recovering rare earth elements (REE). The evaluation of the effective environmental performance of these new recovery technologies supported the decision-making process of

selecting the route to be applied in the upscaling process of the new production of Mg+REE alloying ingots (this activity is still under development). The environmental assessment was carried out following the ISO 14040/14044 standard. The rare earth recovery processes developed within REMAGHIC, with focus on Yttrium, Cerium and Lanthanum, were based on hydrometallurgical (Relight), pyrometallurgical (Tecnalia), ionometallurgical and solvometallurgical (KUL) technologies. The waste streams were fluorescent lamp phosphors, Cathode Ray Tube, and Nickel Metal Hydride batteries. Modelling LCIs that assured robust results proved challenging, due to uncertainties about the quality of the data, mainly because some project partners were working in innovative processes (i.e. low TRL). Most uncertainties stemmed from partners working in different TRL in a same process route and from the consumption of specific chemicals, for which the obtainment processes were not found in the available LCA databases. One solution for these issues was to have the partners with higher TRL support those with lower TRL, with their knowledge and experience, in extrapolating their information (e.g. resource consumption). In addition, the unavailable obtainment processes for the chemicals were created based on literature research. Finally, every decision regarding the extrapolation/estimation of data was supported by chemical experts and owners/suppliers of the relevant equipment. This approach reduced the uncertainties of the inputs/outputs from the processes developed within REMAGHIC and will allow its LCA group to assess the up-scaling process of Mg+REE alloying ingots while still assuring a good data quality.

P19 Marginal energy carriers - a Swedish perspective T. Ekvall, IVL Swedish Environmental Research Institute Ltd; I. Adolfsson, A. Fråne, M. Hagberg, IVL Swedish Environmental Research Institute; M. Wråke, Energiforsk; L. Youhanan, IVL Swedish Environmental Research Institute. We discuss how to model the production of energy carriers (fossil fuel, renewable fuel, waste as fuel, residual heat, district heat, and electricity) affected by a marginal increase in their use in Sweden. Much of the discussion is valid also for energy use in other countries, since many energy carriers are traded on an international or global market. Marginal fossil fuel can simply be modelled as the average fossil fuel extracted at the time horizon of the LCI. Modelling renewable fuel is more complicated. Unprocessed solid biofuel are currently traded on a regional market. A marginal increase in demand can affect the quantity of unused forest residues or produced energy crops depending on the regional land use. Refined solid biofuel, and possibly future unprocessed biofuel, can be transported far and the marginal production has to be identified on an international marke. A marginal change in the use of waste as fuel in Swedish waste incinerators is likely to affect the import of waste. A marginal increase in the import is likely to affect a mix of landfilling of primary or secondary waste, biological treatment, and waste incineration in other European countries. In the future, it might also affect materials recycling. The impact of a change in the use of district heat can be complex and strongly depends on the local district-heating (DH) system. It also varies with the outdoor temperature, which, in turn, varies with time and local climate. Short-term impacts of a well-defined marginal change in heat demand can be estimated through the use of energy models, if the DH system(s) affected is known. The marginal impacts are highly uncertain, however, when effects on DH investments are taken into account or when the DH system affected is not known. A marginal Swedish increase in electricity use is currently not likely to affect investments in new power plants, due to existing overcapacity in the North European electricity system. With some exceptions it is instead likely to affect the utilization of fossil fuel in existing plants. It can possibly affect also decisions to shut down old power plants. An increase in future electricity demand is likely to affect utilization and production capacity in a complex mix of technologies. This mix is highly uncertain, but some aspects of it can be investigated through the use of dynamic optimising energy models.

P21 Socio-economic analysis based on a life cycle perspective: the comparison of existing and emerging production process for trimethyl phosphite B. Brunklaus, S. Stahl, RISE Research Institute of Sweden / Energy and Circular EconomySustainable Society Energy and Environmental Systems Analysis; K. Lorentzon, RISE Research Institute of Sweden; J. Berlin, RISE Research Institute of Sweden / Energy and Circular EconomySustainable Society Energy and Environmental Systems Analysis. Socio-economic analysis (SEA) is a methodology developed for chemical risk management and decision making, derived from tools like the Cost benefit analysis, or the Multi-criteria analysis. Since the latest ECHA guideline for SEA in 2011, a number of studies have been performed, while seldom with a life cycle perspective and seldom on production processes. This socio-economic analysis (SEA) is based on earlier Life cycle assessment on the production process of trimethyl phosphite (TMPi) including risk of fire/explosion and life lost. Trialkyl phosphites are important intermediates in the chemical industry in a large variety of applications, including crop protection, flame-retardants and plastics production. Among the existing technologies for the production process of TMP there are the tertiary amine process (TEA) and the transesterification process. Among the new innovative technologies, there are the TRYALKYL process, part of the EU Life project TRIALKYL. In this SEA study, the existing TEA production process is compared with the new TRIALKYL process for the production of TMP. The current evaluation is based on laboratory data and design of the pilot line, while the final evaluation will be based on industrial data on pilot line. The evaluation includes mainly economic, health, environmental and social impacts in accordance to the latest ECHA guidelines for SEA. The results of the SEA analysis are economic benefits and risk presented as scenarios, such as the “non-use scenario” for the Trialkyl production process and the “applied for use scenario” for the TEA production process. The results have shown that socio-economic analysis based on life cycle perspective and the inclusion on fire/explosion and life lost are useful for the health and environmental assessment and beneficial for the understanding of chemical risk management and decision making. So far, the results have shown that despite the cost of a new production plant, the EU society benefits significantly from the shift to the Trialkyl process due to the improved benefits within human health and the environment.

P22 Stochastic modelling using the Monte Carlo simulation for life cycle inventory of the rare earth elements (REEs) in beneficiation rare earth waste from Covas mining site, Portugal case study B. Bieda, AGH University of Science and Technology / Management; K. Grzesik, AGH. This paper deals with the stochastic modeling based on the Monte Carlo (MC) simulation, used to the life cycle inventory (LCI), in order to evaluate uncertainty of the inventory of the rare earth elements (REEs) recovery from the secondary materials processes production applied to the tailings from COVAS mining site located in Portugal, case study. In this study uncertainty analysis is conducted using Oracle Crystal Ball® (CB) software for performing MC simulation. Chemical elements used in this study are: cerium(Ce), lanthanum (La), neodymium (Nd) and tungsten (W), based on the results in the production of a concentrate and tailing.[1]. Uncertainty was modeled using probability distributions. The probability distribution for the Ce, La, Nd and W were considered to be log-normal, according to the criteria proposed by Sonnemann et al. [2].The output report provided by CB, after 10,000 runs, is reflected in the frequency charts and summary statistics [3]. As a result of the MC simulation, confidence intervals estimating the values of the Ce, La, Nd and W elements have been formed. The aim of the study is to present the performance of MC simulation by using CB for LCI applied to rare earth elements (REEs). Probabilistic technic based on the log-normal distributions is presented. The results of this study could be used as the first step in performing a full LCA of the REEs recovery process chain. Also the results can improve current procedures and can help practitioners and decision makers in the REEs beneficiation processes management. [1] Menard Y, Magnaldo A. 2017. ENVIREE – Deliverable 2.1 - Report on the most suitable combined pre-treatment, leaching and purification processes. http://www.enviree.eu/fileadmin/user_upload/ENVIREE_D2.1.pdf. Accessed 10 July 2017. [2] Sonnemann G, Castells F, Schumacher M. 2004. Integrated Life-Cycle And Risk Assessment For Industrial

Processes. London, New York, Washington, DC, GB, USA: Lewis Publishers Boca Raton. 362 p. [3] Bieda B. 2012. Stochastic Analysis in Production Process and Ecology under Uncertainty. Heidelberg Berlin, Germany: Springer-Verlag) 168 p. *Acknowledgement* - This publication and research was completed within ENVIREE project (ENVIronmentally friendly and efficient methods for extraction of Rare Earth Elements from secondary sources) funded by NCBR, within the 2nd ERA-NET ERA-MIN Joint Call Sustainable Supply of Raw Materials in Europe 2014.

P24 Water-Energy-Food-Climate Nexus approach for food waste management decision: the case study of the fish canning industry

J. Laso, Universidad de Cantabria / Chemical and Biomolecular Engineering; M. Margallo; I. García-Herrero, Universidad de Cantabria / Chemical and Biomolecular Engineering; P. Fullana, A. Bala, Universitat Pompeu Fabra UPF / UNESCO Chair in Life Cycle and Climate Change Escola Superior de Comerç Internacional ESCI; C. Gazulla, Lavola Cosostenibilidad; I. Vázquez-Rowe, Pontificia Universidad Catolica del Peru / Civil Engineering; A. Irabien, Universidad de Cantabria / Chemical and Biomolecular Engineering; R. Aldaco, University of Cantabria. Increasing awareness is being worldwide addressed in recent years to food security. Food systems depend heavily on land, water and energy resources and contribute sifnifincantly to greenhouse gas (GHG) emissions and other environmental impacts. In particular, food systems have been estimated to be responsible for 20-30% of the anthropogenic GHG emissions. Moreover, over 1.3 billion metric tons of supplied products are wasted or lost annually throughout the food supply chain (FSC) that are equivalent to about one-third of the total global food production and produce 3.3 Gtonnes of CO2 eq. The reduction and/or management these food losses is one of the main concerns of the European legislation. The Waste Framework Directive 2008/98/EC established a mandatory management principle for municipal waste, the so-called “waste hierarchy”. According to this classification, waste prevention is the most preferable option, while landfilling leads to the last resort waste treatment. However, waste prevention is not always possible, adopting other management measures such as disposal, incineration and valorisation. The latter is directly linked with the circular economy approach that enables economic growth while optimizing the consumption of natural resources. This concept aims to keep the added value in products, materials and resources for as long as possible and minimizing waste generation. Proper food losses (FL) management and how quatify the consumption of natural resources and the environmental impacts generated are a concern that has been studied in the last years. However, this work aims to go further proposing a new approach to assess different FL management alternatives based on the nexus water, energy, food and climate systems by means of an integrated Water-Energy-Food-Climate Nexus Index (WEFCNI). This index, which allows a more integrated planning, development, policy-making, monitoring and evaluation of different sectors, can be applied to any sector. In this case, the case study is focused on the FL management of the anchovy canning industry. In particular, three management alternatives were analysed: valorisation using FL as animal feed by means of valorisation, incineration and landfilling.