SS 1: Targets, indicators, and benchmarks for resource use

Time: Monday, 12 October 2015 (8:00 – 9:50)

Location: Flüela

Session Chair: Dr. Sonia Valdivia, World Resources Forum, Switzerland

Session Chair: Dr. Xiaoyue Du, EMPA, Switzerland

On the road to a resource efficient Europe – Recent findings from POLFREE research

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Concerning the use of natural resources in terms of raw materials, water, land and soil as well as with regards to CO2 emissions, the European Union (EU) aims at achieving ambitious targets (European Commission 2011). It is rather unambiguous that a socio-economic transition is needed in order to achieve these objectives, but to which extent? – For an illumination of this topic, the POLFREE project arranged simulation studies by means of the global economy-energy-environment model GINFORS. GINFORS represents an environmentally extended dynamic Multi-Region Input-Output (MRIO) model (for methodological details see Meyer et al. 2013). In order to assure a comprehensive modelling of biotic resource categories like land use or water, GINFORS was linked with the global vegetation model LPJmL in these studies (see, e.g., Popp et al. 2011 for a previous implementation of LPJmL to an integrated modelling framework). This integrated assessment approach facilitates the linked modelling of biotic resource availabilities and global economic developments under alternating climate regimes.

Experiences of Small Electronics Companies to Underpin Circular Economy Approaches by Means of Simplified Life Cycle Indicators

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The term “Circular Economy” gains ground currently not only among large companies but also among small and medium-sized enterprises (SMEs). Suitable metrics are required to address circular economy effects in the product design process or for communication purposes towards consumers and clients. Simplified Life Cycle Assessment (LCA) calculations can help to quantify environmental effects throughout a product’s life cycle, to educate consumers and clients and to communicate business strategies. More than 120 SMEs from a range of industrial sectors received mentoring on simplified LCAs. Experiences from this interaction with SMEs are an invaluable source of insights into the current status of implementing circular economy approaches among small European companies.

The paper analyzes the LCA requirements among companies from the electronics sector, including the various perspectives of product manufacturers, suppliers, and information technology refurbishing companies, given the limitations among these companies regarding environmental know-how, influence on supply chains, and resources to engage in LCAs. The experiences of the SMEs are illustrated on the example of three case studies. Drivers and barriers for using Key Environmental Performance Indicators are analyzed.

Historic Move of Current Global Flow of Strategic Metals

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Current trend of the global flow of strategic metals are analysed by use of visual mapping of trade flow. In many cases, each global flow of metal is changing from the trilateral structure of U.S., EU and Japan in the later 20th century into the convergence to China as “the factory of the world”. It distributes materials and products to developing countries to become world average GDP per capita up to $10,000. This development caused the historic price peak of metals and prepare the next stage of resource issue. Metal consumption per capita v.s. GDP per capita are traced from 1998 to 2013. Some kind of metals such as Cu and Au shift the growth from rapidly developing stage to moderate stage which have weak dependence on GDP per capita. However, the moderated level of metal consumption per capita is still high, considering the population growth. Several times of amount of resource will be required up to 2100. Recycling should be strongly promoted from now.

VDI framework guideline on resource efficiency: Towards the standardization and reduction of natural resource use in the industrial sector

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In 2011, the German Association of Engineers (VDI) started working on a set of guidelines towards increased resource efficiency. These guidelines represent a framework that defines resource efficiency and outlines considerations for the producing industry. A special guideline for SMEs is included as well as guidelines on methodologies for evaluating resource use indicators, such as the cumulative raw material demand of products and production systems. Resource efficiency, defined here as the ratio of specific quantifiable use to natural resource consumption, can be evaluated by defining a function which expresses the specific use and quantifies the resource requirements through a set of indicators (use of raw materials, energy, water, land and ecosystem services including sinks).

The results from this also depend on the system boundary parameters and the allocation rules for by-products and waste treatment options. Optimising resource use is possible at all stages of a product's or production system's life cycle chain (raw material extraction, production and manufacturing, use and consumption, and the end-of-life stage). VDI guidelines are widely accepted across Germany's industrial sector and therefore represent an important means of mainstreaming resource efficiency in this target area. As well as providing a methodological framework, the guidelines describe strategies and measures towards increasing resource efficiency, and they enable industrial producers and service providers to identify potential areas of improvement. The full article presents an overview of the methodology and contents of these guidelines and discusses their impact in achieving absolute reductions in the industrial use of natural resources.

The Distribution of Solar Radiation across Nations

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This paper presents the distribution of solar radiation resources across the geographically larger 171 countries of the world, and compares this to the distribution of other energy resources, such as crude oil, natural gas and coal, using oil-equivalent measures. The insolation incident on each country is calculated using the NASA Surface Meteorology and Solar Energy (SSE) Data, which provides estimates of the solar radiation for each quadrilateral of one degree latitude by one degree longitude, making 64,800 (180×360) data points. With a range of world mapping resources, these are used to calculate the solar power available to each nation. The table for every country is currently being completed. Solar reserves are a continuous, constantly replenished flow, while, fossil fuels have finite stocks, limited world resources. Thus, the oil and gas industry now explores in more and more highly remote areas, using technologies that equally mean that almost any land area could have a solar power installation, including areas at sea. The difficulty for solar energy is that solar is 'live' energy. Hence, a key factor is the distance the electricity has to be transmitted. Energy in oil and gas is stored (trapped) until it is burnt (albeit with possibly disastrous consequences). The socioeconomic policy implications for different nations in this new era of solar power are immense. The less developed countries, that could gain dramatically from investing in solar power, are identified.

Accelerating the circular economy: outcome on Resources of the Springtij Forum 2015 in the Netherlands

Arthur ten Wolde

Springtij Forum, The Netherlands

On September 24-26, the Springtij Forum 2015 “Reinventing the Future” holds a series of 5 master classes in the Netherlands on the Circular Economy in the track on “Resources”. Springtij is the annual Dutch forum on sustainability with ca 350 participants from governments, industry, NGOs, science and finance to discuss and work on the issues of climate, biodiversity, energy, economics and leadership. The track on Resources focuses on how to accelerate and mainstream the circular economy.

The outcome of this track will be reported in this session. The presentation will cover company examples of circular business models, obstacles, government and EU policy, the business Manifesto “More prosperity, new jobs”, Netherlands Hotspot Circular Economy, local approaches, societal benefits, and the latest developments on LCA implementation and circular ecnonomy indicators. What do companies encounter? What government policies are needed, and at what level? What is the North Sea Resources Roundabout? What does a local circular economy look like and what are frontrunning cities doing to get things going? How can the level of circularity be measured and pgroess be monitored? These are some of the questions that will be addressed.

SS 2: Technological innovation, business and finance

Time: Monday, 12 October 2015 (8:00 – 9:50)

Location: Schwarzhorn

Session Chair: Dr. Franz Georg Simon, BAM Federal Insitut for Materials Research, Germany

Session Chair: Dr. Mathias Schluep, World Resources Forum, Switzerland

Can a Circular Economy provide a backbone for a more sustainable, fair and social market economy in Europe?

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Most of us would readily subscribe the statement that our planet needs a transition towards a circular economy decoupling raw material use from economic growth. In a circular economy deserving this label, pressure on our earth's natural resources will definitely be reduced. But – what about the economy? Will political and economic decision makers really manage to return to relevant economic growth rates or will the ecological footprint be reduced because of a constantly stagnating or even contracting economy? If a stagnating economy is the inevitable price for more sustainability, who will pay the salaries and pensions of those who already live in precarious conditions? According to the EU employment statistics, 35.5-53.8% of the population aged 15-24 was jobless in Portugal, Croatia, Italy, Greece and Spain in July 2014.

This paper raises many questions and has no real answer. In the economic areas overseen by the author, technologies for processing minerals, metals and fuels, a symbiosis of economic growth and circular economy is conceivable: mining and processing of natural resources can be replaced by urban mining and processing; fossil energy carriers can be replaced by renewable resources. The market, however, will not be a driver due to mining and processing of renewable resources being currently more expensive than processing ores and consuming fossil fuels. This will not change, as long as the economy is not picking up. Without a strong demand, prices for commodities tend to go down and new approaches may be even less competitive in the foreseeable future than today.

The paper aims at fueling the discussion about the appropriate economic and societal framework and the research needed to come to a realistic and convincing judgment on the potential of the Circular Economy as a pillar for a fair and sustainable social market economy in Europe.

Case studies of circular economy business models

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The contemporary economy is mainly based on linear business models, where the products are sold to the consumer. With such business models producers cannot fully benefit from their design for a circular economy, such as the use of materials in multiple cycles, modular design for refurbishing, longevity, easy disassembly and so forth. As soon as the product is sold, someone further down the value chain will cash in on those qualities. There is no incentive for producers to invest into circular economy design.

Circular economy business models like leasing and service models have the ability to transfer circular qualities of a product into additional earnings. They close the gaps of a segmented value chain. Through that, values that cannot be capitalized in the selling model, reach the producer as additional direct income. The experience of the companies presented in the case studies show that circular economy and circular design can be profitable areas of business.

The stimulation of circular business models (CBM) will in turn stimulate the development of a circular economy. This happens because in leasing and service models, the economic success is directly linked to circular design. In such models the company is very interested in qualities like longevity or that your product is easily serviceable. Through the economic optimization within their business model, companies will naturally invest in circular design and more resource efficient products will be released to the market.

Business Plan Calculation Tool for Manual Dismantling Facilities

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Waste Electrical and Electronic Equipment (WEEE), or e-waste, is the fastest growing waste stream and can cause harm to human health and the environment when not treated properly. Especially in developing countries e-waste is often treated under critical health conditions and inadequate technologies are causing negative environmental impacts. Without proper legal framework conditions and control mechanisms specialized formal and informal recyclers are using rudimentary methods focusing mainly on reclaiming valuable recycling fractions, like ferrous and non-ferrous metals, while dumping the hazardous ones. To improve this situation effective e-waste management strategies are required.

The StEP-Business-Plan-Calculation-Tool supports entrepreneurs to set up an economic viable e-waste recycling business in an environmental sound manner. It can be further helpful for policy makers to understand the present economic framework conditions for e-waste recycling in their region. This paper gives an introduction into the design and structure of the calculation tool explaining its features. Further, possible use and benefits are illustrated.

Business model innovation as core enabler to accelerate adoption of a circular economy

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The economic value creation potential in a circular economy is rooted in the ability to preserve and create more value by keeping products, components and materials in productive use for longer and at a higher quality than compared to a classical linear take-make-dispose economy. In addition improvements in the resource effectiveness during the use period, esp. for consumables, energy carrying matter, etc. can further drive resource productivity over the total usage cycle(s) of products, components and materials. In most instances the potential list of ideas and levers to transform existing linear value chains into circular ones or to set-up circular ones up from scratch is long and frequently easy to implement from a technical point of view. However most companies and institutions struggle to identify business models, which allow them to capture and redistribute the created value along their partnership network. The reason for this is the observation, that in a market- transaction, sales based approach only the value add of the upstream activities (i.e. the assembly of products) is commercialized. However benefits for superior resource productivity during use and for revalorization cannot easily be added into the pricing or extracted at end of use. As a result many companies and institutions are incentivized to forgo implementation of more resource productive solutions and services to comply with their profit (i.e. return on capital employed (ROCE)) maximising mandate. To realign incentives (i.e. value capture and redistribution along the partnership network) towards more resource productive circular economy value chains, it is essential to design the business model innovation (value capture and redistribution) so that it fits with the technical solution (value creation).

Creating a Competing Demand for Waste Resources: A Strategy for Waste Minimization in Nigeria

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Solid waste management in Nigeria is a social and public health concern. Nigerian municipal waste has organic biodegradables 50 to 70%, hard plastics/ plastic film 15 to 20%, metal scrap 10% and others mixed such as glass, ash, batteries, etc. depending on the culture, occupation, and other community activities. The waste generated (0.5 to 0.7 kg/capita), has a density of about 250kg/m3, wet, and often mixed with non-biodegradables and hazardous components. Itinerary waste collectors parade the dumping yards for scavenging recyclable components in the waste which have a value. State and local governments tried various methods of disposal e.g. communal dustbins, house to house collection, curbside collection, private sector participation, open dumping and incineration. None of these methods yielded sustainable results, rather, cities became dirtier.

We introduced waste segregation, buy back and recycling activities in selected communities in Ibadan and Lagos and developed a “Competing Demand Model”. Here, when we add value to a particular component of the waste, that component will reduce or disappear from the waste stream. The generator will take adequate care to segregate such components and keep aside for economic gains. We introduced waste to wealth schemes, e.g. fertilizer from market and abattoir wastes, ferrous and non-ferrous metal recycling, paper, conversion of hard and film plastics and pet bottles into industrial feedstock. Communities started looking at these as a way of earning extra income. For this model to succeed, government, private entrepreneur or an individual may act as drivers and initiate community based small or medium scale entrepreneurship (e.g. recycling industry or collection kiosks) and pay some money in exchange for the resource, waste. This model yielded encouraging results with significant reduction of metals, paper and certain types of plastics from the waste stream with youth employment opportunities.

SS 3: Lifestyles and Education

Time: Monday, 12 October 2015 (12:30 – 14:20)

Location: Schwarzhorn

Session Chair: Dr. Harald Mattenberger, tba, Austria

Session Chair: Dr. Lewis Akenji, Institute for Global Environmental Strategies, Japan

Developing a low-resource society – frameworks and scenarios towards a decoupled future

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Resource-focused research on sustainability has revealed insights into the techno-economic aspects of living and working. Approaches that develop concrete pictures of societies in the future that are ready, able and willing to live and strive in a low-resource way are as a rule much scarcer or very abstract. However, without such approaches low-resource practices are not likely to be established on a broader scheme. On the other hand, a society that has made low resource-living a central institution will not only cater for less resource use, it will also make it a positive, socially accepted and beneficial experience for its members. Creating solutions for this challenge is thus mandatory for successful long-term policies towards new, low-resource systems. The question however remains what such a future society may look like. Our contribution will address this issue by outlining a concept for a low-resource society and by introducing five explorative scenarios that delineate such a society. Firstly, the term low-resource society is presented in more detail. From this onset, five scenarios have been developed in workshops with experts and pioneers of low-resource living. These scenarios are distinct with respect to underlying assumptions on basic values and drivers, leading to very diverse narratives. They will be presented in brief and discussed in order to illustrate potential pathways and derive needs for further research.

Ecological lifestyles: Benefits of second-hand products sold through Internet platforms

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Environmental-friendly lifestyles are becoming more and more popular throughout society. Part of this trend is also connected to the second-hand articles being resold over various Internet platforms. In order to figure out what this could mean in terms of reductions in CO2e-emissions, tutti.ch asked myclimate to perform a study on the environmental benefits of purchasing second-hand products compared to the production of new goods. On the basis of the assessment of 41 products in the 8 product categories furniture, toys, sport articles, small household appliances, large household appliances, electronics, baby/child and clothes/accessories, the total CO2e-emissions saved by the reuse of all the sold products over one year are calculated. The data inventory includes the raw materials, the production processes, as well as the packaging and transport of new products. The Swiss database ecoinvent was applied for background data. In most cases, producer information, end-of-life studies and Environmental Product Declarations (EPDs) served as primary data source. The received total GHG-emissions for the 5 most sold products in each category were extrapolated to the overall emissions of each category, with a safety margin of 33%. The results show that more than 50% of the CO2e-emissions are caused by the category furniture, followed by electronics. The entire GHG-emissions saved by the tutti platform in a year add up to approximately 47'600 t CO2e. The study concludes that the saved CO2e-emissions by the tutti Internet platform are remarkable. The avoided purchase of new products not only helps climate protection, but also resource and energy efficiency, as less natural resources and energy carriers are being consumed for the production and transport. A lifestyle that fosters the use of a product up to its functional end-of-life therefore makes a lot of sense and does not affect the standard of living.

Learning Factory – Transfering Resource Efficiency in Practical Implementation – An example of flood coolant in machining processes

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Decoupling of resource use and economic growth is an aim with future global relevance (UNEP 2011) and also one target within the German sustainability strategy. Further, in the German resource efficiency programme (ProgRess) (FME 2012) one focus lies on the resource efficiency within production processes. However, its implementation in companies is slightly rare (UBA 2014). With the idea of a learning factory, resource efficiency is transferred in practical implementation with the focus on flood coolant use in machining processes. The focus of the research project 'TU Darmstadt

learning factory–resource efficiency in production–pilot project-machining processes‘ lies in two areas of research: First, the term ‘resource efficiency’ is not clearly defined. Second, companies do not know, how resource efficiency can be assessed, and which technological measures have an efficiency influence of the use of resources. The methodological approach includes three main parts: Assessment of resource efficiency, identification of technological processes and development of training concept. As selected processes drilling and milling processes with different tool sizes are chosen. Further the materials cast, steel and aluminium are investigated. For assessing resource efficiency an assessment matrix is developed. This matrix includes assessment parameters – economic, natural resources and practicability. These are described by defined indicators. Relevant control variables and seven technological approaches are identified. For the training concept ‘Learning Factory of Resource Efficiency’ three main parts are appointed: 1) Theoretical knowledge of resource efficiency as well as state of the art (of) technology development 2) Practical implementation of machining processes and own measurements 3) Evaluation of measurements and determination of resource efficiency potential Using the assessment matrix for evaluation of possible technological measures provides comprehensive information on resource efficiency. This knowledge is implemented directly in the practice by training courses offered for companies. This concept displays a new approach for an extended application of resource efficiency in production processes.

Households resource consumption: impact and potentials of social practices

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The transformation of society to sustainable consumption and production patterns is a future key challenge. Households play a major role in this transformation process. This paper describes results of a resource consumption analysis at household level, conducted in Germany as part of the Living Lab research in the EU-project SuslabNWE (Sustainable Living Lab North West Europe, www.suslabnwe.eu). The project explores social and technological innovations in the field of heating and develops strategies for sustainable household consumption. To analyse the resource consumption of households a methodology for assessing households’ material consumption and consumption patterns was derived. The analysis intended to identify the impact of social practices on resource consumption. Therefore, households’ (n=16) natural resource consumption was calculated in different fields of activity. The direct consumption of resources was taken into account as well as their life-cycle wide impact. Finally, it was possible to compile consumption roadmaps together with seven of the involved households. In the course of the road mapping process, the households developed different options in a short, medium or long term frame collaboratively with researchers to reduce resource consumption in the fields of actions. Results show the applicability of the methodology,

possibilities for further development, the transformational potential for changing behaviour as well as for product-service design (PSS). For example, it is possible to derive a less detailed questionnaire for assessing households' resource consumption that can be used and integrated in an online tool, developed for calculating individual resource consumption (www.ressourcen-rechner.de). The resulting resource profiles show that next to technical options there is a high potential for structural changes and social innovations materialized in low resource PSS. The road mapping process showed the high motivation of the households for changing social practices and the need for adapted PSS and infrastructures.

Future Households: Smaller Footprint, Better Life

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The paper presents a project on how to achieve future household consumption already today. The project calculated lifestyle material footprint, developed household-specific roadmaps for halving material footprints by 2030, tested relevant measures towards a one-planet material footprint of 8 tonnes per person in a year, and developed mainstreaming options in co-operation between service and infrastructure providers and households. We concentrate on the material footprint as an aggregated indicator for the overall use of material resources. According to transition methodologies, the methodology was extended from just measuring household resource use to developing roadmaps, conducting experiments, as well as learning and upscaling, all of which contribute to the Transition-Enabling Cycle. The results of the experimental phase were encouraging. During that period, the households decreased their material footprint already close to the 2030 targets in their roadmaps. The participants thus showed that it is possible to achieve a significant dematerialisation of con-sumption by relatively few changes in everyday living already today. However, a part of the services used in the experiments had to be simulated because they were not yet available in the area where the project took place. Thus, achieving a one-planet level of resource use also requires systemic changes. While changing their lifestyles in the experimental phase of the project, several households noticed that their quality of life even increased. As a conclusion, we state that relevant and positive changes in household behaviour and activities can be achieved even soon. Thus there is no need for waiting until systemic changes have happened but households can make powerful improvements immediately, thus encouraging other actors to offer more sustainable solutions on the market.

SS 4: Targets, indicators, and benchmarks for resource use

Time: Monday, 12 October 2015 (12:30 – 14:20)

Location: Flüela

Session Chair: Marilyn J. Mehlmann, Global Action Plan International, Sweden

Session Chair: Dr. Patrick Wäger, Empa, Switzerland

Criticality of water – aligning water and mineral resources assessment

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ETH Zurich, Chair of Ecological System Design, Switzerland

The concept of criticality has been used to assess whether a resource may become a limiting factor to economic activities. It has been primarily applied to non-renewable resources, in particular to metals. However, renewable resources such as water may also be overused and become a limiting factor. We therefore developed a water criticality method that allows for a new, user-oriented assessment of water availability and accessibility. Comparability of criticality across resources is desirable, which is why the presented water criticality method is based on a metal criticality method (Graedel et al. 2012). Its basic structure with three dimensions is maintained: 1) the supply risk addresses the physical availability as well as regulatory and geopolitical risks; 2) the environmental implications account for impacts of resource use on human health and the environment; 3) aspects of vulnerability (e.g. dependency on water for economic production) and adaptation to supply restrictions (e.g. production of desalinated water and water storage) of affected economies are taken into account. With respect to the necessary adaptations to the water context, a transparent water criticality framework is proposed that may pave the way for future integrated criticality assessment of metals, water and other resources. Water criticality scores were calculated for 159 countries subdivided into 493 geographic units for the year 2000. Amongst the most critical regions are Northern Africa (Egypt, Libya) and Central and South Asia (e.g. Afghanistan, Turkmenistan, Northern India). Results allow for a detailed analysis of criticality profiles, revealing locally specific characteristics of water criticality (e.g. low water stress but high vulnerability). This is useful for the screening of sites and their related water criticality, for indication of water related problems and possible mitigation options and water policies, and for future water scenario analysis.

Assessing sustainable limits for meals – first results from the project NAH_Gast: Developing, Testing and Dissemination of concepts for sustainable production and consumption in the food service sector

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The food industry belongs to the most significant economic sectors worldwide. Regarding resource use, human nutrition is responsible for about 30 % of global resource consumption. In order to decrease resource consumption to a level in line with planetary boundaries, it is suggested to reduce the resource use of the nutrition sector by factor 2. In view of about 40 % market share in the total nutrition market in Germany, the restaurant and catering sector presents a large untapped potential to increase resource efficiency and improve consumers' health status. In the light of the above, the current project NAH_Gast aims at initiating, supporting and promoting transformation processes for sustainable business in the hospitality sector. Therefore the project will promote the concept of a resource-efficient and socially inclusive economy through the development and testing of instruments for sustainable product innovations, which should be integrated in hospitality settings so actors will be able to measure and assess foodstuff and menus from the viewpoint of sustainability and health. By now, already existing indicators and assessment methods, e.g. Carbon and Material footprinting, or already targeted concepts such as the Nutritional Footprint or SusDISH have to be compared and analyzed. The aim is to provide a comparison of existing concepts and their adaption to reach the overall goal towards a deeper understanding of sustainable catering and food procurement. The paper may be seen as the conceptional and methodological part of the general framework of the NAH_Gast project.

The Good Growth Plan farm network – Monitoring resource efficiency of crop production systems

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The FAO estimates that food supplies need to increase by 70% to feed a growing population of 9 billion people by 2050. The changes in agricultural practices required to grow more tend to exert higher demand on resources and put eco-system services at risk of degradation. Syngenta, a global company selling agrochemicals and seeds, invests in research and development of agricultural innovations that help farmers produce more with less. In 2013, Syngenta launched The Good Growth Plan and set global targets to be met by 2020 with regard to resource efficiency and other indicators. A global monitoring and evaluation system was set up to track progress on these targets. To measure improvements of farm resource efficiency, a global network of over 3500 farms in 41 countries was established. The network covers 23 different crops in different market segments, including smallholder farms in developing countries. The sample includes reference and benchmark farms. While reference farms are real customers selected by Syngenta, benchmark farms were randomly selected within the

same market segments. In 2014, the baseline farm surveys were carried out by Market Probe, an independent agricultural market research company. Data on resource efficiency will be collected annually until 2020. With more years of data available, panel techniques and time series analysis will be used to assess trends and determinants of resource efficiency.

Resource efficiency and sustainable management of natural resources and raw materials: the need for a common understanding of the terminology in policy making

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Policy makers set out a range of initiatives with the buzzwords ‘natural resources’, ‘raw materials’, ‘resource efficiency’, and ‘sustainable management’ of natural resources and raw materials. An analysis of the practice highlights that there are quite different interpretations of the terminology used. In this contribution, we bring proposals for coherent definitions of ‘natural resources’ and ‘raw materials’, a systematized framework for ‘resource efficiency indicators’ and a holistic set of sustainability concerns to understand the coverage and positioning of assessment methods for ‘sustainable management’ of raw materials production and supply.

Applicability of environmental impact assessment indicators on the use of natural resources in the built environment

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The paper addresses the outcomes of a study on the analysis of state-of-the-art indicator-based approaches for the environmental impact assessment of the usage of natural resources. Life cycle based assessment methods are applied on the case of construction materials, construction products and entire buildings. The study has been conducted on behalf of the city of Zurich to support their strategy towards the 2000 Watt society with consideration of the potential trade-off situation between energy efficiency and renewable energies, greenhouse gas reduction potentials and the responsible use of (natural) resources. Some environmental impact assessment methods claiming to consider natural resources in their assessment and impact framework combining energetic and natural resources, which are detected or reported partly as separate parameters. A few methods use naturally-material resources as an input parameter, whereas other approaches consider mass flows in relation to suspected reserves or the willingness of the market to pay a price for a resource or a product. An expert survey among the advisory group members has also shown that the recyclability of a material resource and the avoidance of dissipative losses should be reflected within a reliable resource-specific ecological assessment method and an appropriate indicator. To meet these requirements, the combination of different evaluation methods to assess the use of (natural) resources and their environmental impacts can be carried out without any further methodological development. The disadvantages are that the existing methods today do not meet all the requirements of a sustainable use of resources. Furthermore the comprehensive results cannot be sensibly aggregated into a single number to support decision making processes.

Destroying circular economy in order to save it

Elmer Rietveld

TNO, The Netherlands

The Circular Economy concept by the Ellen MacArthur foundation (EMF) could be threatened by opportunists, fundamentalists or romantics. Basically anyone with an aversion to try to clarify the present state of the planet, society or economy. Concepts might therefore be in need of destruction or salvation. The eloquent display of the Circular Economy concept by the EMF has undoubtedly captured the imagination of many entrepreneurs, researchers and policy makers. Many organizations highlight their interest in a circular economy, which poses the risk of the concept being a victim of its own success. If everything is deemed important, nothing is. What's worse: a scattered focus takes

away the awareness of menacing challenges that are at the heart of the Circular Economy. This manuscript aims to discuss three challenges to the circular economy framework that we consider most threatening to the concept in the long term. First, the fact that publicly available data have stark limitations. Databases lack level of detail, geographical coverage and accuracy. This means that in decision making, conceptual thinking is overpowering verifiable fact-finding. Second, the absence of an answer to the question: how we should express circularity, even if we would have the data? Although propositions for indicator frameworks are available, (notably the “measuring circularity” report of the EMF from 2015) there is still no agreement among experts. Third, the inability to establish a framework of welfare optimization, even if we would have a clear definition of circularity. The need for corporate secrecy, the need for personal privacy, the lack of recognition of negative externalities, the nature of disruptive innovations The result is an unbalanced focus on mandates of public authorities, along with an allocation of resources to solutions that have little to do with ideas based on a Circular Economy concept.

SS 5: Circular economy and decoupling

Time: Tuesday, 13 October 2015 (8:00 – 9:50)

Location: Schwarzhorn

Session Chair: Prof. Arnold Tukker, Leiden University and TNO, The Netherlands

Session Chair: Prof. Kiichiro Hayashi, Nagoya University, Japan

Modelling the future secondary resource availability and recycling potential of aluminium in Austria

Hanno Buchner, David Laner, Helmut Rechberger, Johann Fellner

Vienna University of Technology

Production of secondary aluminium (Al) currently represents about 70% of total European Al production with a still rising trend and about 50% European final Al demand. The utilization of anthropogenic Al resources as secondary raw materials is therefore a core aspect of moving towards a circular economy, from an ecological as well as from a raw material supply perspective. With respect to Al resource management, dynamic material flow models can be used to understand patterns of Al use, the evolution of Al stocks, and the future availability of Al scrap. In this study, a dynamic aluminium flow model is developed in order to investigate Austrian Al consumption, in-use stocks and post-consumer (old scrap) flows during the last five decades, from 1964 to 2012. It is found, that during the past 20 years Austrian Al in-use stocks have more than doubled up to the level of 360 kg/capita in 2012. Almost two thirds of the Al stock are contained in buildings and transport applications. In recent years, total old scrap generation amount to almost 50% of final Al consumption. Based on the historic Al model and projections of Al consumption until 2050, the future development of in-use stocks and old scrap generation is estimated. An increase of 130% in total old scrap generation is expected compared to the current levels. Modelled trends on scrap generation are finally contrasted with end-use Al demand as well as with industrial scrap demand in order to display the potential for future Al self-supply in Austria. Since improved recycling is a major aspect of European resource policy, opportunities and limits of increasing the domestic supply with domestic Al scrap, through increased collection rates, are shown.

Circular Economy and Life Cycle Assessment (LCA): how to make circular economy happen

Soledad Contreras, Mark Goedkoop

PRé Consultants, The Netherlands

Circular Economy has positioned as an important vision that is mobilizing business and governments, drawing the big picture and showing the connections (flows and feedbacks) between systems.

However, while inspiring there is no clear view if the concepts developed by circular economy thinking are also reducing the environmental impacts. Twenty-five years of experience in LCA have shown that closing loops is not always the best idea, and can even have negative consequences. Therefore what circular economy thinking is missing is a methodology in order to assess the benefits and trade-offs, and there life cycle assessment (LCA) can be the tool to fill the gap. The paper will introduce how through LCA is possible to test impacts of the circular business models, validating its assumptions and giving feedback to them. We will present a few do's and don'ts that we have learned from LCA, from cases where closing loops makes sense and where it does not, or how, with the same investments or even bigger cost saving much more effective measures can be taken. Second, we will introduce how LCA can help to define targets and indicators to measure impacts of the circularity of products and services and in order to allow a practical implementation in organizations.

The regional resource flow model for promoting circular economy at the regional level

Joonas Hokkanen, Riina Känkänen, Heikki Savikko, Ari Sirkiä

Ramboll Finland Ltd, Finland

The regional resource flow model is applicable for examining the resource efficiency on the region level and on different scales varying from regions to urban areas and also smaller local development project areas. Jyväskylä region has been the first in Finland to study the availability of regional resource information, to examine the use of natural resources and to develop a model to illustrate the actual material flows. The regional resource flow model was valid for Jyväskylä region and now it has been expanded to cover also other regions in Finland. It has also clear potential to globally use. The model gives a reliable representation about the interaction between industries in the region, the use of natural resources, the efficiency of regional economy, the employment impacts, the added value and the environmental impacts. The model provides new perspectives and application possibilities to promoting the bioeconomy and circular economy and to the impact assessments of national, regional and local level plans, programs and projects. The model can be used to recognize the importance of companies to the regional economy, employment and environment as well as the role of companies in promoting the circular economy. Resource flows are built into the model based on the regional material flow analysis and environmentally expanded input-output method. The economic and other social benefits can be simulated and made measurable with the model. The life cycle based environmental impact assessment included in the model gives a general view on regional and global impacts, direct point source emissions and indirect impacts that actualize outside the region (life cycle emissions).

Substitution of metals in times of potential supply limitations: What are the mitigation options and limitations?

Kristin Vala Ragnarsdottir[1], Harald Sverdrup[1], Deniz Koca[2]

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Global production rates of metals vary from iron at 1.4 billion ton per year to platinum with 200 ton per year. Resource scarcity starts to manifest itself in rising prices and supply limitations, and metal substitution has been a major argument among economists when putting considerations of resource scarcity aside. Here we investigate the potential limits to metal substitution. Present consumption, recycling and irreversible loss rates, as well as the metal balances and properties are examined. Our findings suggest that the major limitations and issues to substitution are: (1) Physical limitations in terms of metal available; it can only take place by a more abundant metal taking partly the place of a metal produced in smaller amounts; (2) Functional limitations based of differences in physical and chemical properties; and (3) By considering substitution options often more energy is needded and larger CO2 emissions occur. Substitution of metals is therefore not going to take the threat of scarcity away; it can only delay us in adapting to the level of sustainable use. The longer we wait, the more we risk squandering resources before we properly conserve our resources from becoming scarce.

Finding and offering resource efficient technologies with the Enterprise Europe Network

Ernst-Jan van Hattum

Euresearch, Switzerland

Background EASME, EEN and Euresearch: The Enterprise Europe Network helps ambitious SMEs innovate and grow internationally in the EU and beyond; it is the world's largest support network for SMEs with close to 600 member organisations in over 53 countries. It supports also other organisations, services are often free of charge and it exists since 2008. The network is organised in sector groups like Environment, Intelligent Energy, Sustainable Construction. The EEN is managed by the EASME. The Executive Agency for Small and Medium-sized Enterprises has been set-up by the European Commission to manage on its behalf several EU programmes, including the EEN, but also many environmental, societal or climate funding actions within H2020. In Switzerland, Euresearch and Switzerland Global Enterprise offer professional support services to find technology partners or market your innovation. Euresearch has several examples on resource efficient technologies offers and needs. Finding resource efficient or circular economy related technologies: The first step is to check the EEN cross-sectorial Technology Database with more than 6000 Technology and knowhow Offers, Technology Requests and Research Requests. Technology Offers can be outcomes of EU and national funding schemes. All profiles are tagged with 330 Technology Keywords. If one does not find the wished technology, an own – anonymous – Technology Request can be made with the local EEN.

After dissemination of the resource efficient technology need to the other network countries, one will receive the expression of interests via the local EEN to start business as usual. Offering resource efficient or circular economy related innovations: The first step is to check the EEN Technology Database. If one does not find a fitting request, an own (anonymous) Technology Offer can be made. After dissemination of the innovative technology, one will receive the expression of interests via the local EEN to start business as usual.

Cool life cycle thinking. Mainstreaming trends and opportunities for national life cycle initiatives creation and expansion

Sonia Valdivia[1], Guido Sonnemann[2], Sanjeevan Bajaj[3]

[1]World Resources Forum, Switzerland; [2]University of Bordeaux; [3]The Federation of Indian Chambers of Commerce and Industry

Life cycle thinking (LCT) is gaining global recognition as guiding principle for policy development at Governmental and business level. At Rio+20 (2012) Heads of State agreed that Sustainable Consumption and Production (SCP) is a cornerstone of sustainable development and an important contributor to poverty alleviation and the transition to low-carbon and green economies. This agreement led to the establishment of the 10-Years Framework of Programmes to support the development of national SCP action plans to be based on LCT (UNEP 2012). At business level, there is a growing implementation of LCT to evolve from linear business models, in which products are discarded at the end of their lives, to circular economies models where smart design results in products being repaired, reused, returned and recycled (WorldSteel 2014). The question remains whether LCT is already mainstreaming or not. Based on a global survey commissioned by the UNEP/SETAC Life Cycle Initiative in 2014, the report (UNEP/SETAC 2015) describes the opportunities for national life cycle (LC) initiatives to mainstream LCT. A special focus is given to 18 selected rapidly growing and emerging economies. The study discusses the levels of LCT mainstreaming conditions based on four criteria: existence of training activities on life cycle assessment (LCA), local capacities, national LC networks, and LCA studies and databases. In case of favorable conditions, signals of growing markets for LC approaches, tools and professionals as well as an increasing uptake of LCT in policies design and circular economy based regulations are perceived. First results show that capacities in industrialized countries are available and in a number of emerging economies are beginning to consolidate, but especially in the latter they remains insufficient. Based on the results, a roadmap for improving the mainstreaming conditions especially in the rapidly growing and emerging economies is proposed.

SS 6: Lifestyles and Education

Time: Tuesday, 13 October 2015 (8:00 – 9:50)

Location: Dischma

Session Chair: Dr. Lewis Akenji, Institute for Global Environmental Strategies, Japan

Session Chair: Dr. Harald Mattenberger, tba, Austria

Untying the Gridlocks: Changing our Hermeneutics to Bifurcate for Good

Carlos Alvarez-Pereira

INNAXIS Foundation, Spain

This contribution uses metaphors originated in the Dynamical Systems Theory to describe the potential pathways in the evolution of human societies and how, through the accumulation of tensions at critical points, bifurcations can emerge, for the good or the bad. Making the bifurcation go in the right way is no easy task, and it requires changing our framework of interpretation, by backcasting from desirable futures.

Developing more impactful, effective and sustainable sustainability programs – An integrated systems model based approach.

Himanshu Ardawatia

EnSensa Labs, Norway; Grow Movement, UK

With increasing uncertainties around resource and energy availability and environmental concerns in the world, sustainability issues are being addressed at national level and organization / business level. To address these issues, development of diverse initiatives and programs around sustainability is one of the key focus area that is being pursued in countries and businesses. Success, impact and sustainability itself of such sustainability programs vary. The key drivers around different aspects such as costs, resources, value, partners etc. to create systemic value across the value chain are often not harnessed optimally. They also seem to be hindered by unforeseen, but completely avoidable, constraints. Further, they are unable to surmount the silo-effect and often key internal and external stakeholder engagement is left wanting. Due to lack of insights into feedback mechanisms, behaviour of such programs is ill anticipated. Eventually, impact and effectiveness of such sustainability initiatives, programs and strategies are limited and often not replicable or scalable over the years. As a result, a lot of time, effort, money and resources can be wasted without desirable impact and value creation for stakeholders. This work presents an integrated systems model based approach towards developing effective, impactful and sustainable sustainability programs. Fundamental issues around sustainability programs and strategies are investigated and the intergrated solution is presented using

systemic model approach. First, key aspects of the model based approach are discussed and key parameters and their feedback structure-behaviour relationships are presented starting from idea stage to execution stage. Second, case studies are presented to discuss how this approach can help develop sustainable, inclusive and effective sustainability programs. Finally, key lessons from data and model based insightful strategies for developing successful, high impact, sustainable and replicable program are discussed.

Food System Transition towards Sustainability: Individuals Engaging in Change

Katariina Koistinen[1], Satu Teerikangas[2], Mirja Mikkilä[1], Lassi Linnanen[1]

[1]Lappeenranta University of Technology, Finland; [2]University College London

Food security is currently one crucial topics of the sustainability science. Agricultural land occupies proximately one third of the earth's land surface, and it is stated that about one third of the environmental impact of EU is caused by the current food system. Further, feeding the world's increasing population is a mounting challenge. To achieve a sustainable food system, a holistic change is required. Whereas past research has focused on macro-led sustainable change, in this study turn the focus on individuals and we emphasize the importance of micro-change. We hypothesize that change agents are in a significant position in implementing sustainable change. Therefore we want to discover individuals' inducements in accepting the sustainable change and reasons why individuals stay engaged in change in the framework of a Finnish food system. We present a qualitative study in which 26 individuals involved in the Finnish agricultural value chain were interviewed. We conclude that individual's intrinsic motivation and ethical stances are playing key roles in change acceptance and engagement. We also identified that different forms of change agency exist. Our findings further bear important implications to the emerging study of micro-led sustainable change. When the appreciation of micro-level change increases, sustainable transformation is more likely to become institutionalized.

Radical Crowd based Open Innovation and Design for Sustainability

Ursula Tischner

econcept, Germany

Collaborative "crowd" based open innovation and design as well as funding activities, websites, platforms and projects are becoming increasingly popular. These combine the creativity of people with new enabling technologies like online platforms, rapid prototyping machines, simple Computer Aided Design (CAD) software to design and produce individualised products and services. However, very often these methods and tools are used to produce fun but unsustainable "stuff". How these new Internet and crowd based methods and tools can be used to create technological and social innovation

and design that actually leads to more sustainable life styles has been explored and is demonstrated by the Sustainability Maker project, www.sustainabilitymaker.org, and its open innovation for sustainability platform www.innonatives.com, partly funded by the European Life+ Environment programme. The platform innonatives.com connects actors that have identified and/or suffer from sustainability related problems with actors who have found or would like to contribute to generating solutions for such problems. The platform systematically enables the creation of very divers open sustainability innovation and design solutions through crowd-sourcing, crowd-voting, crowd-testing, and helps to implement them through crowd-funding, an online marketplace for sustainable solutions, an expert system, and educational activities. Success and failure factors, other research findings, as well as the quality and type of solutions that can be generated by crowd based open innovation for sustainability platforms are discussed in this paper.

Multidimensional Assessment of Sustainability: Harmony vs the Turning Point

Stanislav Shmelev

Environment Europe Ltd, United Kingdom

Multidimensional assessment of sustainability is a way to reconcile the need for simultaneous consideration of various indicators of progress beyond GDP growth with a policy focused visualization of multi-dimensional trends in clear and transparent manner. The various composite measures used for sustainability assessment often hide the trade-offs between economic, social and environmental dimensions of sustainability. This chapter discusses indicators used for sustainability analysis at the macro scale and offers a multi-criteria sustainability assessment framework. It discusses results that were obtained in sustainability assessments for the USA, Brazil, China, France, Germany, Britain and Russia. The Multicriteria Decision Aid tool, Aggregated Preference Index System (APIS) is used for the assessment with the following three headline indicators: GDP per capita; CO2 emissions and Life Expectancy at birth. The indicators represent economic, environmental and social dimensions respectively. The multidimensional assessment is designed with two different policy priorities: priority of economic over environmental and social dimension versus priority of environmental and social dimensions over economic. Results help to identify countries, where economic development happened at the expense of environmental and social dimension and lead to policy conclusions.

SS 7: Targets, indicators and benchmarks for resource use

Time: Tuesday, 13 October 2015 (8:00 – 9:50)

Location: Flüela

Session Chair: Heinz Böni, Empa, Switzerland

Session Chair: Dr. Xiaoyue Du, Empa, Switzerland

Renewable Energy (RE) for the Mining Industry: Case Studies, Trends and Developments, and Business Models

Kateryna Zharan

TU Bergakademie Freiberg, Germany

RE for the mining industry has perspectives for implementation and development. The European Union is concentrating on increasing the capacity of RE generation and consumption according to the Directive on the promotion of the use of energy from Renewable Energy Sources. The specific objective of this paper is to explore contributions to to the implementation of electrical energy supply from RE sources to the mining industry. Within this study the following aspects are dealt with. Firstly, a comparative analysis of levelized costs of electricity from RE sources and fossil one in European countries is presented. Secondly, an cost evaluation analysis of RE for transmission and distribution systems into the mining industry is considered. Thirdly, we investigate the technological possibilities for the penetration of RE into the mining industry. Finally, a guideline for the development of a business model for the implementation for European mining companies is created.

Resource Demand of Pathways towards Electric Mobility: Analyzing material demand, critical resources and emissions

Ole Soukup, Katrin Bienge, Michael Ritthoff, Peter Viebahn

Wuppertal Institute for Climate, Environment and Energy, Germany

In 2009, the German Federal Government published its National Development Plan Electric Mobility. Therein, it highlights the strategic relevance of the electrification of motorized private transport. The Development Plan stresses the potential of electric drivetrains to reduce the dependency on crude oil as well as local emissions of carbon dioxide and air pollutants. Up to now, strategies that strive for the implementation of electric mobility in Germany and worldwide, mainly focus on the political goals to reduce greenhouse gas emissions and dependencies on fuel imports. However, within the scope of an environmental lifecycle assessment of vehicle technologies and possible development pathways, it is necessary to take into account further ecological criteria. The resource demand in the focus of this

paper is regarded as one of these additional criteria. On the one hand, the quantification of the resource demand of vehicle technologies along transport scenarios can be regarded as a general environmental impact indicator: The higher the amount of raw material extraction from the ecosphere, the higher the expected environmental impact. On the other hand, it gives insight into the demand development of certain “critical” resources that might affect their long-term security of supply (long-term availability of the raw materials, supply situation, recyclability and the environmental conditions governing their extraction). Based on the combined methods of Material Intensity Analysis and scenario analysis this paper presents comprehensive research concerning the aforementioned aspects of resource demand. The paper presents the cumulative demand for material and energy resources as well as greenhouse gas emissions caused by different electric mobility strategies for private motorized transport up to the year 2050. The results are compared to a reference development solely based on conventional combustion vehicles. The cumulative material demand serves as a basis to identify critical materials relevant for the entire lifecycle of passenger cars.

Responsible and sustainable mineral production – what does it mean?

Karen Hanghøj, Per Kalvig

Geological Survey of Denmark and Greenland, Denmark

All societies depend on mineral resources, but in the western world there is a disproportionate relationship between consumption and production. For example, the European Union consumes 20-30 % of all mineral resources produced globally, but produces only 3-4 %. Most of Europe’s mineral exploration and extraction takes place in northernmost Europe and Greenland, Regions that have in common that they are endowed with rich mineral resources have low population densities, arctic climates and fragile eco systems and societal structures. At the same time, responsible and sustainable development in the Arctic has never been higher on the global agenda. The Arctic is one of the remaining frontier regions and is seen as an area of significant potential for resources, including minerals, oil and gas, renewable energy and living resources. Land-use changes through mining, energy production and tourism, is likely to intensify in the future putting pressure on the Arctic environment. Climate change may bring additional challenges to the Arctic environment, but perhaps also brings new opportunities. The resistance to mining rests mainly on land-use management issues and a strong opposition to host mining in many communities. To promote sustainable raw materials production globally, society must take responsibility for consumption by ensuring that extraction is done in the best possible manner – and perhaps that is in our backyard. In that context, the northern and Arctic regions in general have a strong local support for developing extractive industries, although they also have unique vulnerabilities to mining. While mineral resources are non-renewable in the sense that once they are extracted they will not come back, we need to think about sustainability in different terms. A sustainable mineral production can be thought of as an industry that is

technologically innovative, environmentally responsible, socially responsible, and economically sustainable in a long-term global perspective.

Cross-border electricity infrastructures and efficient use of renewable energy sources

Karolis Gudas

Swiss National Center of Competence in Research, Trade Regulation, Switzerland

Long-distance renewables' integration projects emerge as feasible option for the decarbonization of the electricity sector and efficient use of resources. The paper provides an overview of the large-scale cross-border projects being implemented in the electricity sector, which among their objectives aim at integrating renewable energy sources. It reviews the role of multilateral regimes in the development of cross-border transmission links, outlines the challenges, and makes policy recommendations for regulatory developments in the international system.

Integrating anthropogenic material stocks and flows into modern resource classification frameworks

Andrea Winterstetter[1], David Laner[1,2], Helmut Rechberger[2], Johann Fellner[1]

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This study investigates how anthropogenic resources could fit into the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009). Compared to geogenic resources, anthropogenic deposits are more heterogeneous and often more decentralized. Further, the human impact on production, consumption and disposal, combined with significantly shorter time spans of renewal are major differences. Factors influencing the classification of anthropogenic material deposits include various aspects such as technological developments, market prices, laws, and ecological and social considerations. They can be systemized according to their role during the individual phases of resource classification, namely prospection, exploration and evaluation. The prospection phase is determined by 1) the deposit's status of availability for mining, discriminating between "in-use stocks", "obsolete stocks" and "waste flows", 2) by the specific condition of handling and potential mining (push vs. pull situation), and 3) the system variables, which determine the potentially extractable amount of materials. System variables (e.g. technological options) also play a major role during the exploration phase and can potentially be varied in a scenario analysis. For the socioeconomic evaluation modifying factors with direct impact on the project's economics are investigated. The influencing factors of mining anthropogenic resources from 1) an old

landfill, 2) waste electrical and electronic equipment (WEEE) and 3) wind turbines are analyzed. To map such different types of anthropogenic materials within the three UNFC-2009 axes “knowledge on composition”, “field project status and technical feasibility” and “socioeconomic viability”, specific guidelines are still to be defined and need to be demonstrated via case studies. Ultimately, this will allow for a meaningful comparison of anthropogenic with geogenic mineral resources, promoting efficient resource use.

Socio-metabolic graphs and socio-metabolic tables: tools for the design of policies for circular economic systems

Stefan Pauliuk

University of Freiburg, Germany

The transition to a more sustainable metabolism of modern societies will entail repercussions in the entire system, including energy supply and the material, food, and water cycles. Under a strong regulatory or incentive-driven regime towards a circular economy, individual industrial and end-use sectors need to be seen as part of a larger system; they cannot develop in isolation or be considered as driven by final demand only. Scientific analysis of society’s biophysical basis increases our understanding of the coupling and feedback mechanisms in the system, and researchers can use these insights to assist policy makers and to inform the general public. One step towards better interaction between research on socioeconomic metabolism and those groups who could utilize scientific insight is to visualize the linkages between the different elements and layers of socioeconomic metabolism based on existing quantitative information. Powerful visualization complements accounting frameworks and quantitative methods like material flow analysis and input-output analysis. First, I present the state of the art of visualizing society’s biophysical basis and identify shortcomings. I then present a graphical representation of flows and stocks in society’s metabolism that incorporates information from the material and energy layers, and can be readily extended to the water and emissions layer. Each graph is equivalent to an accounting table, which establishes a formal link and compatibility between common accounting frameworks and the graphical approach. Here, I present the principle and during the conference, I show first examples of the new graphical approach to understanding society’s biophysical basis.

SS 8: Circular economy and decoupling

Time: Tuesday, 13 October 2015 (12:30 – 14:20)

Location: Flüela

Session Chair: Dr. Michal Miedzinski, Technopolis Group, Belgium

Session Chair: Prof. Kiichiro Hayashi, Nagoya University, Japan

Challenges to the transition to a circular economy: understanding of the web of constraints to more efficient use of resources

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The concept of the circular economy has attracted the attention of policy makers and businesses in recent years. However, changing current patterns of resource use is a complex task. This paper aims to shed some light on the understanding of why resources are being used inefficiently and the factors that contribute to explain patterns of resource use. Based on the research undertaken under FP7 project on Policy Options for Resource Efficiency (POLFREE), the authors propose to move from the concept of barrier to resource efficiency, that seems to point to some concrete single factor that impedes more optimal use of resources, to the notion of 'web of constraints', that highlights the complex web of interlinked factors that interact with each other dynamically and simultaneously. To illustrate how different factors interact and feedback loops are generated leading to inefficient use of resources, the authors have selected two main areas from where to draw conclusions: buildings and mobility. In both cases, they represent areas of intensive use of resources and, where the feedback loops and interaction of supply and demand contribute to create conditions that drive and/or hamper resource efficient practices. Based on the analysis of the web of constraints, the paper draws some conclusions on the role of policy in tackling inefficient use of resources in these two sectors.

Dynamic interaction of market and behavioural barriers in the transition towards a circular economy:a heterogeneous-agent approach

Saeed Moghayer, Hettie Boonman, Trond Husby

Netherlands Organisation for Applied Scientific Research (TNO), The Netherlands

In this paper we analyse transition towards circular economy as an complex adaptive system focusing on the market and behavioral barriers. We investigate the conditions for successful introduction of a new production which is appropriate for a circular economy, 'circular' product with a focus on the contribution of underlying demand-side behavioral factors. To do that, we develop a heterogeneous agent model in which consumers are modeled to choose between two varieties of a consumer good/service in the market: a 'circular' product/service type and a 'non-circular' t type. The results and methods developed in this paper is applied to a use case of recycling of rubbers in the Netherlands.

Putting Circular Economy principles into practice

Jonathan Perry[1], Markus Stutz[2]

[1]Dell, United Kingdom; [2]Dell, Germany

Circular economies produce virtually no waste, as materials are re-used and recycled continuously. It's a dramatic shift from the current linear economy in which we take, make, consume and dispose – drawing regularly on natural resources to create products that eventually end up as waste. Dell supports the principles and practice of the circular economy model and over the past two years has been transforming its approach to the supply chain and business models to become more circular in nature. Dell has created a closed loop supply of plastics where obsolete IT products are collected, disassembled and sorted. After a shredding and purification process it is compounded to produce plastic pellets. This plastic is then moulded into plastic parts such as the back panel or stand of an All-in-One computer, a display or a front bezel of a desktop. Closed loop plastics are now being used in 35 Dell products at a volume of 1,800 tons with the aim of further growth in the near future. Dell has incorporated the use of wheat straw from rural China in its packaging. Instead of being burned on the field it is purchased and broken down before being mixed with recycled content cardboard to be used as corrugate or pulped cushion material. This process views another's waste as a resource, reduces air pollution, and uses less energy and water. Smart sourcing and recycling are only a part of the circular economy. We need to continue to incubate innovation to unlock the economic potential that can bring increased value and new jobs with it. To transition to a true circular economy, collaboration within and across industries and borders is essential, it is not something anyone can do alone.

The Zero Waste Approach to Resource Management

Richard Anthony

Zero Waste International Alliance, United States of America

A Zero Waste system is a resource management system. The process of wasting resources is against nature. In a zero waste system everything has a place before, during and after use. There is no away. In the best-designed system, the dismantling or demanufacturing would be designed into the product. The system of extraction, manufacturing, use, and disposal to incinerators or landfill will be replaced with systems that capture the material and recycle them into a closed loop system of reuse, repair, recycle/compost and redesign. Raw materials will be used as reserves.

Students Are Learning Circular Economy with Companies in the REISKA Project

Sakari Autio[1], Katerina Medkova[1], Kirsti Cura[1]

[1]Lahti University of Applied Sciences, Finland

The "REISKA – New business using resource efficiency" project represents an example of how an educational institution can contribute to a local and regional change towards circular economy and support the local companies. In the REISKA project, university students of engineering will analyze the material use and efficiency of hundreds of companies in several industrial areas in the Lahti region. The REISKA project supports the change of surplus materials, energy, heat and space into a profitable asset, raw material or energy for other companies of the region. In addition to surplus screening, REISKA will support multiple workshops, where the companies can develop partnerships, match the demand and supply. The REISKA project is carried out in 2015-2017 by Lahti University of Applied Sciences and Lappeenranta University of Technology with the support of the European Regional Development Fund. REISKA aims at supporting new circular economy business models that would enhance the resource efficiency and follow the philosophy of industrial symbiosis in the Päijät-Häme region located in Southern Finland. During the REISKA pre-assessment phase in 2014, 12 regional industrial locations were screened and tens of companies were contacted by the engineering students. The experiences have been encouraging and the project will continue in 2015 with a deeper analysis of a hundred companies, a GIS application and surplus workshops. This process can increase the amount of discussion and understanding about the circular economy and resource efficiency in Lahti and the Päijät-Häme region. According to a government survey, the better resource efficiency through circular economy would bring a potential growth of 1.5 -2.5 billion Euros by 2030 to the Finnish national economy (MOTIVA 2015). This can be supported locally by student's' efforts in contacting companies, gathering and managing the information and match making exchange of surplus materials and energy between the companies.

Using life cycle approaches for regional sustainable development in the context of a circular economy

Guido Sonnemann[1], Fritz Balkau[2], Stefania Massari[3]

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Life cycle thinking is increasingly common in the private and public sectors, invoking concepts, programmes and tools that put holistic ideas into practice and relate to resource efficiency and circular economy policies. Multinational companies have been among the principal users of such approaches in their quest for sustainable product development and marketing. An aspect that has been less addressed in the literature is the potential role that life cycle sustainability can play to foster also more sustainable forms of regional development. To fill this gap this paper describes the current state of life cycle management discussions and how to strengthen sustainability in regional socio-economic development processes based on the four summer courses organized on that topic in the period of 2012-2015. It is shown that life cycle approaches can be used successfully for sustainable regional development in the context of a circular economy. A combination of first mover projects for sustainable innovation and building capabilities using a maturity model seem to be a good way forward. To this end a case study from Northern France is presented. The information collected was considered so interesting by an editor that it will become part of a resource book on that topic. The paper concludes with an outline of the resource book under development and principles for applying life approaches to sustainable regional development in order to foster circular economy for economic growth and human wellbeing.

SS 9: Circular Economy and decoupling

Time: Tuesday, 13 October 2015 (12:30 – 14:20)

Location: Dischma

Session Chair: Dr. Nick Harley Florin, University of Technology Sydney, Australia

Session Chair: Eliette Johana Restrepo Gomez, Empa, Switzerland

Municipal Water/Wastewater Agency Services: Shifting from Linear to Circular

Steven E. Sherman

East Bay Municipal Utility District, United States of America

Municipal water/wastewater agencies play an essential role in community well-being. Traditionally, municipal water/wastewater agencies have followed a linear ("take, make, dispose") mode of thinking based on resource extraction. Often, the model follows this form: a public agency transports water (frequently over great distances) and delivers it inexpensively and without restrictions to customers, who use it liberally once and then discharge it to the wastewater treatment facility, where the public agency treats and discharges it (often without further economic use). Among other issues, water/wastewater agencies use enormous amounts of energy. Drinking water and wastewater systems account for nearly 4% of U.S. energy usage, and emit 45 million tons of greenhouse gases annually. These core service providers must transition to circular economy modes of thinking and programming in order to meet emerging 21st century needs. Some leading municipal water/wastewater agencies in the U.S., notably the East Bay Municipal Utility District (EBMUD) in California, where the author works, have begun the long shift toward a more circular approach. EBMUD's wastewater operation has gone from being a major purchaser of electricity to becoming North America's first publicly-owned wastewater treatment facility that is a net producer of renewable energy, using anaerobic digestion of food waste and conversion of biogas to electricity. In addition, it produces soil products, nine million gallons per day of recycled water, and offers a way (through acceptance of brine wastewater) for California's key agricultural production area (the Central Valley) to begin to manage the harmful build-up of salt in the region's soil. Traditional key service providers, such as water/wastewater agencies, can better address 21st century needs by extensively incorporating circular approaches to the definition of issues, articulation of goals, identification of opportunities, and development of feedback loop-based programs that support environmental and economic sustainability.

Policy Mixes for Resource Efficiency – Theoretical and practical challenges

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Based on an on-going research project called “Policy options for a resource efficient Europe” (POLFREE), this paper analyses potential policy instruments and their interdependencies in a policy mix for resource efficiency. It focuses on fundamental trade-offs in such a mix and identifies three generic challenges based on an empirical analysis of 27 specific instruments. The innovative aspect of the paper is to go beyond another long list of potential instruments or a mix of instruments, but to analyse them with regard to the theoretical requirements for coherence and consistency. To this end, the paper explores possibilities to go beyond single instruments and integrate them into a consistent and coherent policy mix with relevant synergies between its single elements. It discusses specific instrument design features such as stringency, profitability, predictability, flexibility, differentiation and depth, which are not only of particular relevance in order to analyse their innovation effect, but also as an indication for the effectiveness and efficiency of the instruments as such and the requirements for the analysis of instrument interactions.

Prospecting Secondary Raw Materials in the Urban Mine and Mining Wastes (ProSUM)

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A compositional characterisation of the urban mine is a necessary prerequisite to optimise the recovery of critical raw materials (CRM). However, existing data is scattered amongst a variety of institutions including government agencies, geological surveys, universities, non-governmental organisations (NGOs) and industry. In addition, where data relates to the composition of products and waste fractions, different sampling, sample preparation and chemical analysis approaches may have been used, which makes it challenging to aggregate and compare data. In the EU Horizon 2020 project “Prospecting Secondary raw materials from the Urban mine and Mining wastes” (ProSUM) a comprehensive, standardised and harmonised inventory of CRM stocks and flows will be constructed at national and regional levels across Europe. The scope of the project, which is being carried out from January 1, 2015 to December 31, 2017 by a consortium of 17 partners representing research institutes, geological surveys and industry, addresses particularly relevant sources of secondary CRMs: electrical and electronic equipment, vehicles, batteries and mining wastes, such as processing tailings. As an important part of the project, an EU information network that includes potential data providers and users has recently been launched.

Cost-benefit analysis of WEEE Recycling in Germany – Case study of mobile phones and smartphones

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Scarcity of natural resources and supply chain risks represent one of today's most vital topics. This issue very much applies to the context of electrical and electronic equipment (EEE) sector as well, as its production requires a mixture of various different kinds of raw materials, metals and precious metals, partly classified as critical by the European Commission.The paper analyzes the monetary value of precious and critical metals in selected electronic equipment sold during 2004-2014 in Germany and at global level, as well as the value of the metals stock which is not being put to use. The stocks of critical and precious metals inside mobile phones and smartphones are assessed on the basis of sales volumes. Initially a literature review on the definition of critical metals is being provided, followed by an analysis of the critical and precious metal stock content and monetary value for selected electrical and electronic equipment (EEE). Overall, for the selected EEE, a total stock of 5.6 thousand tonnes of critical and precious metals can be estimated, with a total monetary value of more than € 558 million. However, the short life-cycle of these products combined with their inappropriate disposal leads to a major loss of these metals. Moreover, a cost benefit analysis of the end of life management of mobile phones and smartphones is being realized reaching the conclusion that the potential revenues from recycling these products can be quite significant. Furthermore, the issues and challenges in the German WEEE Management System are also being analyzed with a closer look at mobile phone and smartphone waste streams with the goal of identifying the potential of closing the resources loop.

Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers

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Small and medium-sized enterprises (SMEs) are increasingly aware of the benefits of closing loops and improving resource efficiency, such as: saving material costs, creating competitive advantages and accessing new markets. At the same time, however, various barriers pose formidable challenges to small businesses in their transition to a circular economy, including lack of financial resources and lack of technical skills. The aim of this paper is to increase knowledge and understanding about the

barriers and opportunities experienced by SMEs when implementing circular economy business models. It first investigates the barriers that prevent SMEs from realising the benefits of the circular economy. This is done on the basis of a literature review and analysis of SME circular economy business models that are featured on the GreenEcoNet (www.greeneconet.eu) EU-funded web platform. Drawing on this review, the paper identifies key areas for continuous improvement in order to better promote circular economy business models among SMEs.

SS 10: Lifestyles and Education

Time: Tuesday, 13 October 2015: (16:30 – 18:20)

Location: Schwarzhorn

Session Chair: William Anthony Worrell, San Luis Obispo County Integrated Waste Management Authority, United States of America

Session Chair: Richard Anthony, Zero Waste International Alliance, United States of America

Greenhouse Gas Emissions: Correlations to Income and Environmental Concern

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ETH Zurich, Switzerland

Switzerland, like many other countries, has set targets to reduce greenhouse gas (GHG) emissions. Private households play an important part in achieving these aims. Therefore, it is important to know which factors are related to emissions. So far, most studies have focused on income, household size and other structural factors while neglecting the potential relevance of attitudinal variables such as environmental concern. Those studies that did examine environmental attitudes mostly were based on "intent-oriented" measures of behavior instead of actual GHG emissions. The aim of the present study is to bring these lines of research together by analyzing the relationship between GHG emissions, income and environmental attitudes within a framework of multivariate analysis. Furthermore, three specific emission domains – mobility, housing and food – are analyzed separately. All analyses are based on data from a large representative general population survey, the Swiss Environmental Survey 2007 (n = 3,369; Diekmann & Meyer, 2008), and a subsequent life cycle assessment calculated with support from the Swiss Federal Laboratories for Materials Science and Technology (cf. Notter, Meyer, & Althaus, 2013). The results indicate that higher income as well as lower levels the environmental concern are both associated with higher GHG emissions. Furthermore, overall emissions are higher for younger, male respondents with higher education, living in smaller households with cars. For emissions by mobility, being economically active is a further predictor of higher emissions. For housing, the pattern is slightly different in that females and older respondents are attributed higher emissions. In the case of food, however, there is no clear-cut association between emissions and income. In conclusion, this study clearly indicates that next to income, environmental concern is an important predictor of GHG emissions even when controlling for the effects of income.

Supporting sustainable lifestyles by communicating benchmarks for resource consumption with help of a novel environmental accounting system

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According to UNEP, household consumption is responsible for 60 % of the total life cycle impacts of final consumption in most countries. Therefore, the transition to a more sustainable society can only be achieved by changing current consumption and production patterns. There are two basic problem which need to be solved in order to reach this goal: The first problem is the lack of environmental information for products. The second problem is that even if information exists, it might be to abstract to incorporate and transform it into action. Based results of environmental psychology and a model for individual change, we analyse this problem and postulate that by setting system knowledge and target knowledge in relation meaningful benchmarks can be derived. Those benchmarks can help to create transformation knowledge, lead to a successful benchmarking process and therewith promote the transition to sustainable consumption. To develop such benchmarks the following questions are addressed in the paper: 1) How is the current information base of target knowledge? 2) What information is interesting for specific target groups? 3) What are target group specific benchmarks and how should they be communicated? The paper presents results of the project myEcoCost (www.myecococst.eu), funded by the European Commission. Within the project, a software system is developed that automatically calculates resource consumption and emissions along a product value chain using company data from the companies accounting systems. The results are shown as ecoCosts and can be provided via smartphone app to the consumer. Therewith the system can help solving the problem of missing system knowledge of economic actors and serve as basis for benchmarking.

A Roadmap of Resource Education as a key factor for implementation of Resource Preservation and Efficiency

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Natural resources, especially raw materials, are key production factors and therefore fundamental for our prosperity. A conserving and efficient treatment of natural resources will have to be a key competence of future societies. An important step to more resource efficiency is fostering public awareness and establishing a corresponding culture to protect resources. Under the basic idea of “Education for Resource Preservation and Efficiency“, a large research project in Germany called “BilRess” aims to contribute to the goals of resource policy through an educational strategy. The main objective is to develop an “Educational Roadmap for Resource Conservation and Resource Efficiency (R&R)” in interaction with relevant actors in the educational system, describing steps to integrate the topic in all important educational contexts in the future. Therefore, an inventory of educational

materials, interviews and focus groups with several actors were conducted and the BilRess-Network was established in 2014 (by now including 130 members). Results show that resource education is not yet established in the educational system in Germany. The paper will present intermediary results of the roadmap for the different areas of education (school, apprenticeship, further education, university/college) – including specific comprehensive requirements. Important factors include: Raising public awareness for sensible resource handling through campaigns, carving out practical relevance of R&R within all educational areas, strengthen networks between relevant actors, increasing awareness of institutions through further training sessions, establishing the idea of material resources in framework curricula, examination regulations, syllabi and teaching modules, further developing educational materials, media and teaching concepts for all educational areas, establishing learning platforms as well as extending qualification of teachers. In order to put these ideas into practice and foster resource preservation in education, including communication and education activities through political measures (e.g. ProgRess, German national resource efficiency programme), a political promotion scheme for the idea itself is required.

Challenges of Implementing the Environmental Protection Laws in Sri Lanka

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The object of this research paper is to analyze the challenges of implementing the environmental protection laws in contemporary Sri Lanka. It is generally expected that environmental police unit in Sri Lanka will work for the environmental protection while ordinary people will follow the environmental laws of country. However, there is a wide gap between these two groups when it comes to implementation of environmental protection laws. This wide gap is a result of the lack of environmental police officers, lack of continues awareness programmes for police officers and lack of reformation of colonial laws from the legal sides. Moreover, lack of media intervention, and changes of production patterns have become the impediments for environmental friendly behaviour. However, when it comes to ordinary peoples' side, even though people are aware of the environmental pollution as well as legal punishments, it has been a real challenge for them to maintain the environmental friendly behaviour due to lack of land, population density, urbanization, commercialization, and changes of consumption patterns and lifestyle. This research paper presents the preliminary results of an ongoing quantitative research which is been conducted since February, 2015. Colombo urban council area in Sri Lanka was selected as the research site, while 60 environmental police officers and 200 people were selected for the sample from the research site. Questionnaire, interviews and observation methods were employed to collect primary data. This research paper further suggests that even though there are legal officers and laws for the environmental protection, it is difficult to implement, or have an environmental friendly behaviour as there are no social, economic, political and environmental

supportive factors for the environmental friendly behaviour. Therefore, it is necessary to look at the wider social, cultural, environmental, political, and economic context than just looking at the legal aspects of the country.

Climate-KIC Innovation Framework: Addressing the Barriers to Innovation in the Circular Economy

Katherine Foster

EIT Climate-KIC, Switzerland

This paper presents the innovation framework of Climate-KIC one of the Knowledge and Innovation Communities (KICs) created in 2010 under the European Institute of Technology but the European Union. The cross-sectoral partnership approach to Climate-KIC's innovation projects, education programming and start-ups focus on identifying and addressing the barriers to innovation and the scalability of technologies, products and services that address climate change adaptation and mitigation.

The presentation of a series of case studies of Climate-KIC innovation projects, educational offerings and start-ups will be used to demonstrate the range of stakeholders, resources, sectors, value chains and geographic areas collaborating within the framework and with the aims of improving cross-industry resource efficiency and sustainability and of turning waste – including food waste and CO2- into resources.

The case studies will also illustrate the challenge of demonstrating potential scalability of different elements of industrial symbiosis and circular economy projects including the business model replicability, is discussed. Finally the Climate-KIC framework and approach to addressing the barriers to scalable economic, market, social and climate impact in the new Sustainable Production Systems (SPS) theme is presented.

SS 11: Circular Economy and decoupling

Time: Tuesday, 13 October 2015 (16:30 – 18:20)

Location: Dischma

Session Chair: Prof. Helga Weisz, Potsdam Institute for Climate Impact Research (PIK), Germany

Session Chair: Dr. Cecilia Matasci, World Resources Forum, Switzerland

Towards responsible prosperity: progressing a circular economy in Australia

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In China, Japan and Europe circular economy concepts are being adopted as a mechanism for utilising resources to support long term economic, social and environmental benefit. Australia's unique economic environment will affect the way circular economy concepts are implemented to build responsible prosperity. To date, the circular economy concept is yet to achieve a transformative effect and a new local narrative is needed to promote the benefits in the context of the current economic circumstances, as an extractive economy. Based on a review of international initiatives and discussion with stakeholders, the key enabling factors for progressing circular economy in Australia have been prioritised. Awareness raising and building networks were identified as most achievable to create change in the short-term and strong policies including regulations and targets, alongside innovation in business models, were identified as having the most impact. A coordinated and collaborative effort across all sectors and stakeholders will be required to successfully progress circular economy in Australia.

Innovation in finance to unlock the full potential of a circular economy

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Returnity Partners, Germany

The structural shift towards a circular economy will result as well as require shifts in determining the value of stock of resources, components and materials and the resulting management of these values in the financial system. In a linear economic model relying on a take–-make–-dispose value chain the value of resources is first increased (largely driven by demand–-supply market mechanisms and adding the additional value–-add for extraction, refinement and commercialization of resources) and then after integration into the final component and or product unit of usage/consumption rapidly depreciated, sometimes towards a negative value (i.e. the cost of disposal). In a circular economy model relying on different forms of reuse the value of resources is likely to remain high for longer (or even increase over time) as after each usage cycle the products, components and their embedded resources exhibit (a market price) as input for further value adding activities. In addition to this fundamental revalorization of resources along their value chain/cycle in a circular economy a number of other underlying concepts and practices with profound impact on the financial management are likely to change (e.g. the establishment of registers of resources/products will create collateral to de–-risk lending, the increase in performance based contracts will require funding of more working capital, the shift in the distribution of value adding activities along the value chain/cycle will require re–-balancing the underlying capital asset base, the transition towards a more circular economy will require new investments and open up alternative funding and revenue streams, ….). The objective of this paper is to identify the most likely and most relevant discontinuities in the financial management of resources for companies and institutions as the shift towards a circular economy unfolds.

Cradle to Cradle® – Parquet for Generations

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Working with wood means assuming a responsibility. Wood is the most important naturally re-growing raw material and it is considered to be the construction material of the future. However treated with chemicals (adhesives, lacquers) the resource wood becomes waste. Having adopted a new technology under the name of “Silente”, Bauwerk Parquet, based in Switzerland, is breaking new grounds. Silente products follow the Cradle to Cradle® design principle. Cradle to Cradle® stands for a closed raw material cycle and a respective quality assurance process. Bauwerk parquet is designed to last. It should never become a waste product or consume unnecessary or environmentally harmful energy. Raw materials are preserved and the resource water is treated with consideration. Bauwerk acts in a fair and socially responsible manner, both within the company and in public. EPEA

Switzerland is assisting Bauwerk in its implementation of the Cradle to Cradle® vision. Raw materials and ingredients from up to 36 suppliers are assessed on material health, reutilization, environmental impact and traced back to their origins. The “Silente” Bauwerk Parquet products are Cradle to Cradle Certified™ at GOLD level. Bauwerk floors that incorporate the new Silente technology can easily be dismantled and returned to the company. Thanks to the new “Silente-Mat”, the parquet can be taken up without being destroyed. All components can be either reconditioned or recycled for new products. Bauwerk products that incorporate the Silente technology are made exclusively from materials that are safe for both humans and the environment. Thanks to this closed cycle, Bauwerk conserves the valuable resource wood and acts in the interest of future generations. • The use of healthy, non-hazardous materials • The subsequent use of all materials in a closed cycle • The validation of renewable energy • Environmentally compatible water management • Social responsibility

Towards companies that perform within the earth’s regenerative capacity

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The latest Living Planet Report of WWF shows that we used the regenerative capacity of 1.5 planets in 2010 at present consumption levels. An increasing number of companies set targets to lower the impact of their activities on the environment, but such targets do not inform if the company performs within the limits of the earth’s regenerative capacity. Inspired by the concept of planetary boundaries of Rockström et al. (2009), we aim to link corporate activities to global, regional and local boundaries. In this paper we introduce a methodological framework in which we link midpoint indicators of Life Cycle Assessment (LCA) to scientifically established boundaries at global, regional and local level. The methodological framework consists of three steps: 1) quantify environmental impacts at product level, 2) define scientific boundaries at global, regional and local level and 3) set targets at sector and product level. The methodological framework has been applied to Eneco, an energy company in the Netherlands striving for sustainable energy for everyone, to set targets for climate change (within the 2 degrees pathway) and particulate matter (below the WHO concentration target) in their power generation and supply. The methodological framework should be seen as a first step towards absolute boundary setting for companies.

Urban Metabolism as framework for Circular economy design for cities

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Chalmers University of Technology, Sweden

The circular economy (CE) concept was defined in 1966 from insights about living systems and formulated as an economic model. In the CE concept, all resources need to be managed more efficiently throughout their life cycle. CE boundaries range from substances to products, from individual supply chains to cities to countries. To design CE, a system approach is needed to describe and analyze the current situation and to model and implement the needed transformations. The Urban Metabolism (UM) concept, also based on insights from living systems, study resource consumption and environmental pressure of urban areas in a systemic way. UM has become increasingly important in the last two decades, developing applications for Sustainability Indicators, Policy Analysis, Design and Material Flow Accounting. The UM research field contains the characteristics to support the design of CE in cities. The UM group at Chalmers is developing the methods and tools that cover the three steps: description, analysis and scenarios design. At the description level, the UMAn model allows the accounting of material flows disaggregated in 1000 product groups and 28 material types. Work is being developed to connect material flows with life cycle impacts and provide multidimensional information for a proper analysis of the urban system. Based on the existing information, understanding the drivers of material flows, in terms of lifestyles, economic conditions and typologies of cities is being conducted. Finally, modeling policies effects on material flows and CE strategies such as industrial symbiosis and urban mining is being developed for which the outcomes will provide an understanding of the effectiveness of the strategies in the overall urban system. In summary, the UM field ensures completeness in materials and allows the modeling of the needed changes towards CE providing the best framework to investigate the pathways to circularity at the urban level.

SS 12: Targets, indicators and benchmarks for resource us

Time: Wednesday, 14 October 2015: 8:00 – 9:50

Location: Flüela

Session Chair: Prof. Daniel Beat Müller, NTNU, Norway

Session Chair: Dr. Cecilia Matasci, World Resources Forum, Switzerland

Sustainable Development and Resource Efficiency as Drivers for the Circular Economy – The Case of the Swiss Building Sector

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Compared to ecology, the circular economy is not a “perfect” cycle. Although economic activities applying the concepts of circular economy try to mimic nature, they are still rejecting waste and pollution, harming humans and nature alike. Circular economy has to become more sustainable. This implies among the first measures, committing to and effectively applying efficiency and replacing energy based on fossil fuels by renewable energy. The Swiss building stock is responsible for almost half of Switzerland’s primary energy demand, cumulating expenses of nearly 16 billion CHF every year. The SIA (the Swiss Society of Engineers and Architects) works to find ways to reduce energy consumption induced by buildings over their whole life cycle by half before 2050. This goal can only be met following clear long term political targets such as the “2000W and 1 ton CO2 society” and by using simple holistic tools like SIA’s “Energy Efficiency Path” – SIA 2040. Applying the theories of the circular economy to the building sector can yield improvements in resources efficiency. An innovative Swiss project shows how to link buildings together in an area energy grid. Indeed, there is much more potential to improve energy efficiency by connecting buildings with different usages in a grid than the sum of all energy efficiency potentials of the individual buildings. A second example exposes newly developed colourful and even perfectly white nanofilms for solar cells that allow 100% architectural integration in building facades. The technical knowledge to achieve the previously mentioned ambitious goals and prime examples for such efficient and sustainable technologies, buildings and grids exist. If we can reach a large commitment to building standards and planning processes based on these concepts, resources efficiency can be largely improved and climate change impacts reduced accordingly.

Direct and Indirect Uses of Urban Forest Resources –case in Nagoya, Japan–

Kiichiro Hayashi

Nagoya University, Japan

Urban forest has an important role for carbon stock in a city. Also citizen utilizes urban forest resources directly and indirectly in many ways. In this study, the direct and indirect uses of forest resources were studied based on a simple on-site field survey to grasp the role of urban forest for human society as a case in Nagoya City, Japan. The survey topics include not only ecological research items but also cultural aspects of citizen's use of urban forest. As a result, deciduous broadleaf forest was dominant followed by evergreen broadleaf forest both in area and carbon stock. Per hectare carbon stock was high especially in historical shrines. Some of recreational function had relatively high correlation with carbon stock.

Intensity assessment and global accounting for non-metallic minerals used for construction

Alessio Miatto[1], Tomer Fishman[1], Hiroki Tanikawa[1], Heinz Schandl[2]

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Both developed and developing countries are showing a constant accumulation of material in society. The development of new buildings and roads requires not only cement and steel, but also aggregate, including sand, gravel, and crushed stone. Construction materials are low economic value-high volume material flows, and despite being absolutely essential for the development of buildings and infrastructure, they are often poorly accounted and even omitted from official statistics. Empirical accounting methods for aggregates in material flow analysis (MFA) studies have relied on simplistic and generalised assumptions without taking into account the technological complexity and engineering knowledge of concrete, roads, and brick production. Thus, even though published country-level MFA accounts seem to be in the correct order of scale, aggregate consumption is arguably the material flow category with the highest uncertainty. The objective of this research is to increase the precision of construction material flow accounting on the global scale for the past 40 years and compare it with economic growth to assess whether decoupling is happening or not. This interdisciplinary research aims to obtain realistic data for the material intensities of production of concrete, roads, and bricks through the analysis of construction codes and consultations with engineering and construction experts. Crossing aggregate intensity data obtained from construction codes with cement, bitumen, and bricks production figures reveals the underlying consumption levels of raw construction materials. This enables us to identify aggregate consumption and obtain statistics, which can give a good sense of the uncertainty and variance in the extraction and production of construction materials between world regions. This research will help improve the accuracy and robustness of one of the most under-explored data areas in MFA, and may assist in managing the extraction, usage, recycling, and disposal of sand, gravel, and crushed stones in a sustainable way.

Thanatia and thermodynamic rarity: assessment of mineral resource depletion

Antonio Valero, Alicia Valero

Fundación CIRCE – Universidad de Zaragoza, Spain

Thanatia theory is a new application of the Second Law of Thermodynamics. In an intuitive way, it stands that a mine, a glacier or a river are abiotic resources clearly distinguishable from a resource-exhausted reference planet. Such theoretical state of the Earth, coined Thanatia, can be likened to an ultimate landfill where all resources eventually end up and are irreversibly dispersed, besides that all fossil fuels were burnt. The quantitative representation of Thanatia's crust is composed by the nearly 300 most abundant minerals found in the crust, with corresponding composition and average concentrations. Thanatia is the ideal "dead state" reference environment for assessing the exergy of any mineral deposit on Earth. Moreover, the exergy cost of recovering any commodity from Thanatia, i.e. its Thermodynamic rarity (in GJ/ton) can be assessed for minerals and chemical substances. This revolutionary approach entails a drastic paradigm shift in the way resources could be globally managed in the future. It shows a thoughtful attempt to demonstrate that the Second Law of Thermodynamics can be applied in a quantitative way for assessing the rate of loss of Mineral Capital on Earth and evaluate the mineral Aging of the Planet.

Concept and development of a factor four building in Inden (D)

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In the community of Inden (Germany) a residential area is currently being developed as a pilot-project, in which the resources of the houses to be built is limited. In an holistic approach ecological rucksacks, embodied energy and global warming potential will be reduced at least by a factor of two. In this residential area, a reference house is being constructed, which over a lifecycle of 50 years only needs a quarter of the resources compared to the resource consumption of a conventional building. Another challenge is a design of the house that allows prefab manufacturers an industrial production of the house for a competitive price.

Polluting Water with a Veritable Source of Energy: the Situation in the Urban City of Lagos-Nigeria.

Timothy Oluwagbenga Ajayi[1], Godwin Ikechukwu Chinemerem[2], Grace Jadesola Ajayi[3]

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Introduction and Objectives Lagos is the commercial nerve centre of Nigeria experiencing rapid urbanisation. It is one of the mega cities of the world with an estimated population of 17.5 million. The

Lagos Lagoon which is a notable water body in Lagos state has been a sewage disposal site for the past fifty years and the quantity of sewage wastes disposed daily into the Lagoon has greatly increased due to rapid population growth. The Lagoon serves as the major source of sea foods in Lagos and also confers beauty to the city. Like some other highly populated and sewage rich cities, Lagos state is yet to utilise her abundant sewage resources in scaling-up her energy supply instead of polluting her Lagoon. The aim of this paper is to elucidate the effects of disposing sewage waste into the Lagos Lagoon and the potential of the state generated sewage waste in meeting her formidable energy challenge. Methodology and Approaches Water samples from ten different stations in the Lagos Lagoon were analysed for the presence of pathogenic organisms using Sedimentation, Microscopy and Culture techniques. The Biochemical Oxygen Demand (BOD) and pH of the water samples were tested with the aid of BOD test apparatus and pH meter respectively. The daily average numbers of sewage tankers offloaded in all the sewage disposal sites were recorded and the average daily volume of sewage wastes disposed calculated.

SS 13: Technological innovation, business and finance

Time: Wednesday, 14 October 2015 (8:00 – 9:50)

Location: Schwarzhorn

Session Chair: William Anthony Worrell, San Luis Obispo County Integrated Waste Management Authority, United States of America

Session Chair: Eliette Johana Restrepo Gomez, Empa, Switzerland

The economic, environmental and local employment benefits of remanufacturing (a case study)

Nicolas Schnebelen[1], Guillaume Moënne-Loccoz[2], Adrian Ronald Tan[1]

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Remanufacturing is one of key approaches in a circular economy. Remanufacturing is the process of restoring a used product to a state that provides at least the same functionality and performance as when it was first produced. This typically involves collection of products at their end-of-life; reverse logistics; inspection; disassembly; cleaning, repairing or replacing parts; reassembling and testing before being sold again. Under the right conditions remanufacturing can prove to be a profitable, more resource efficient and less environmentally harmful approach to doing business. The key factors that determine the economic and environmental benefits of remanufacturing are the product's design, its residual value, labour costs, the business model, the pricing strategy and the reverse logistics system. These factors are often interdependent and it is a real challenge for companies to find the right balance when setting up a remanufacturing business. This paper presents a case study of how a postal equipment manufacturer, Neopost, established their remanufacturing business by first redesigning their postage (franking) machines; then developing the reverse logistics chain across the commercial organisation by providing financial incentives throughout their supply chain; and, finally, framing the remanufactured product's price position on the market. The history of how remanufacturing was developed in the company and the steps made to ensure that all the key factors vital to ensure the profitability and environmental benefits of remanufacturing was analysed. The paper also presents the economic, environmental and local employment benefits of remanufacturing compared with a conventional linear business model. This case study provides important lessons to how companies can systematically develop profitable remanufacturing businesses by ensuring all the key factors for success are aligned.

Recovery of Precious Metals from Incineration Bottom Ash

Roland Weippert

LAB GmbH, Switzerland

Incineration bottom ash (IBA), the final solid residues from Energy of Waste Facilities (EfW), holds a huge potential for recovery of valuable metals and a complete reuse of the residual mineral matter. Modern treatment technologies allow for a recovery of lumpy metals to the greatest possible extend and the production of a homogeneous secondary construction material. Over the last two years, LAB Geodur has developed a new approach for IBA treatment: Based on its existing dry treatment process for wet-discharged and matured IBA, known under the name of RecuLAB® NF, a wet processing for fresh IBA has been developed, which allows to directly treat wet-discharged IBA. This process, called RecuLAB® AU, is designed to treat IBA without any upfront storage or maturation. RecuLAB® AU is a modular concept, which can be installed on the premises of an EfW plant or at an existing IBA treatment site. Given the wet processing, both the metal recovery yield as well as the metal qualities are importantly improved. Besides further value creation from additionally recovered metals down to 0.03 mm, a sand-like secondary aggregate is produced, opening up new application possibilities. The mineral fraction additionally benefits from an improved visual appearance and from further reduced contamination. Process water is kept in a closed loop, enabling a residue-free treatment technology. Due to the wet processing, typical dust issues from IBA treatment can be completely solved. With this, not only the mode of operation is simplified, the environmental and working conditions are massively improved, too.

Material stocks and well-being: connecting steel use and services

André Cabrera Serrenho, Julian Allwood

University of Cambridge, United Kingdom

Recent literature on material flow analysis has been focused on quantitative characterisation of past and prospective material in-use stocks that result from the accumulation of flows over time. These analyses often neglect the quality of those stocks and their capacity to deliver services. We explore how enhanced knowledge on in-use stock performance can be useful to understand the decoupling between services and material throughput. This is accomplished by characterising the size, composition and service delivery of the iron and steel in-use stocks of cars in Great Britain from 2002 to 2012. The results provide evidence of decoupling material use from service delivery and give us insights on the urgent focus of environmental policies aimed at preserving material stocks. In this period the stock mass has increased and transportation service delivery has decreased. The service provided by in-use iron and steel stock has decreased, due to stock aging and a shift in material composition of cars. The promotion of service delivery of old cars is critical in limiting the loss of iron and steel stock performance and may contribute for the lifetime extension.

Moving three industrial parks towards eco-industrial parks in Vietnam

Heinz Leuenberger

UNIDO, Switzerland

Abstract: Moving three industrial parks towards eco-industrial parks in Vietnam Vietnam has undergone rapid economic growth over the last ten years driven mainly by the processing and manufacturing sectors. To facilitate the emergence of new industries, the government has established so-called industrial zones (IZ) with the provision of infrastructure such as utilities, water and effluent treatment. The industrial growth in Vietnam has however brought about adverse impacts on the environment, as well as on human health in neighbouring communities: ♣ By the end of 2013, 92 IZs have failed to construct wastewater treatment plants. The wastewater from some IZs is directly discharged without any treatment; ♣ Air pollution is concentrated in IZs, with enterprises using obsolete technologies or lacking air emission treatment systems; and, ♣ The volume of solid waste increased significantly, 20% of it being hazardous. To tackle these issues, MPI and UNIDO jointly developed a project with the objective to introduce and implement an eco-industrial park (EIP) management system to reduce and/or eliminate greenhouse gasses (GHGs), water consumption, water pollution, persistent organic pollutants (POPs) and other chemicals of global concern. The system also aims to demonstrate innovative clean and low-carbon technologies and practices in industry. In the presentation, the different project components will more outlined in more detail, and the concept of eco-industrial parks will be subject to further analysis.

Mining of rare earth metals from hydro mineral resources in Siberia: trends and prospects

Olga Ulanova

Irkutsk National Research Technical University, Russian Federation

Siberian scientists showed by their scientific investigations that brines of Siberian Platform are a very important hydro mineral resource for economical development of the East Russia. Prospects for the integrated mining of the hydromineral resources in Russia remain low. This is caused by the absence of efficient and environmentally friendly processing technologies. The necessity of resolving these problems relates to the perspectives of developing a source of raw materials in Russia for extracting strategic rare earth metals and rather alkaline and alkaline-earth elements (lithium, rubidium, cesium, strontium etc.) from unconventional sources of mineral raw materials. The unique property of the brines is their industrially profitable concentrations: by 20-25 times on lithium, by 5-10 times on rubidium, by 3 times on cesium, by 10 times on strontium. Great resources of rare-earth metals and rather alkaline and alkaline-earth elements (in industrially profitable concentrations) are concentrated in Angaro-Lensky and Oleneksky artesian basin on all lithological horizons. On the basis of theoretical studies and pilot researches revealed conditions of the selective extraction of strontium, lithium and

rubidium from highly concentrated natural brines during the ion exchange. Technological schemes were developed to extraction of rare earth metals and rather alkaline and alkaline-earth elements from brines and various compositions of quarry waters of iron-ore and diamond deposits in Siberia.

SS 14: Circular Economy and decoupling

Time: Wednesday, 14 October 2015 (8:00 – 9:50)

Location: Dischma

Session Chair: Dr. Franz Georg Simon, BAM Federal Insitut for Materials Research, Germany

Session Chair: Dr. Michal Miedzinski, Technopolis Group, Belgium

Wood products as resource-saving circulary products

Nikolaus Lienbacher

Ressourcen Forum Austria, Austria

It all starts with sustainable forest management which has been practiced in Austria for centuries. Active forest management and tending strategies require forests with a wide range of species and structures. Such well-structured forests fare better in the face of climate change conditions than those left to their own devices. From trees in the forest to the product cycle of wood as a construction material, wood in form of paper and the recycling of residues, followed by the thermal utilisation at the end of the cycle, wood is an unique sustainable material. The use of bark and by-products for energy purposes in the wood, wood panelling and paper industry is globally regarded as 'best practice' and improves the national climate balance enormously. The various forms of use are based on a highly complex cycle of timber in which combined production and cascading use play key roles within the value chain. At the end of the product lifecycle, recycling of wood enables further binding of CO2 in products. The wood composite industry can make a positive contribution in achieving a positive CO2-balance through the repeated material use of wood waste in addition to the significant effect of using fresh wood. Keywords: Cascading, Cycle of timber, Forest Management, Recycling References FHP, Commitment to cascading use across the value chain at forest based industries (2014) Republic of Austria, Federal Ministry of Agriculture, Forestry, Environment and Water Management (2008), Austrian Forest Report (2008) 9-11 RiskRe, Economica, Boku Wien, i.A. Ressourcen Forum Austria (2015), Potentiale von NAWAROS im Forst- und Holzsektor

How the energy budget scheme contributes to decoupling and deep decarbonisation

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Resource use is increasing globally, and four of nine planetary boundaries have now been crossed due human activities, out of which climate change and biosphere integrity are "core boundaries", implying a risk of driving the Earth system into a new state. While technological advances, policy changes and burden shifting from developed to developing countries have led to decoupling in many countries, this does not change the negative trends globally and address the main drivers behind. In

the case of climate change deep decarbonisation of the global economy would be required resulting in radical emissions reductions. The objective of this paper is to analyse the main reasons of the rift between what climate science requires and what current climate policies can deliver with the currently applied policies, and how an international energy budget scheme can tackle these problems. The energy budget scheme builds on initiatives like the energy entitlement scheme and the Tradable Energy Quotas (TEQs), which gained considerable political recognition in Hungary and in the UK respectively, building on substantial scientific research. The energy budget scheme puts a hard cap on energy use, and links this with incentive schemes to deliver tightening national and international targets. The annual entitlements for energy use for households and all other public and private consumers ensure the needed reductions in greenhouse gas emissions, while the trade in entitlements among consumers on national level and countries on international level contributes to value change, global energy transition and puts Common but Differentiated Responsibilities (CBDR) into practice. The transition fund provides a financing scheme for driving investment and technological innovation, where the payback rate is linked to improvements in decarbonisation and made through unused entitlements. The dedicated market for environmental products and services operates with quota currency realised from entitlement savings, and boosts the green economy.

Decoupling of economic growth and environmental impacts in Germany

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The paper highlights in which regard economic growth has been decoupled from environmental impacts in Germany. It is based on extensive desk research and six expert interviews. The answer to the question if Germany can serve as an example for successful and absolute decoupling is not unambiguous. Germany has succeeded in stopping the growth of material and energy use. However, absolute decoupling is happening only when natural resource use and other environmental impacts are decreasing in absolute terms. This has, so far, not happened to natural resource use in general but only to specific emissions that can be regulated by technical means. Total Material Requirement and Total Material Consumption (TMR and TMC), as well as carbon footprint and ecological footprint have not increased nor decreased during this century in Germany. Water footprint and land use for food production have increased, as well as domestic land use for infrastructure and settlements, and biodiversity decline. Absolute decoupling, i.e. the constant decrease of environmental impacts while the economy is growing, could not be stated for any indicator that takes into account also the environmental impacts of imports. However, the development within Germany's borders cannot be considered sufficient while both economy and material flows are subject of constant globalisation. As a conclusion, general absolute decoupling cannot yet been found in Germany. However, Germany has been politically active in decreasing natural resource use and other environmental impacts. This is visible, for instance, in strongly increasing activities of states and companies in the field of resource efficiency. However, so far we are not yet able to claim general evidence that economic growth generally could be decoupled from resource use and other environmental impacts when potential burden-shifting through imported goods is taken into account.

Modelling the copper, zinc and lead mining rates and co-extraction of dependent metals, supply, price and extractable amounts using the BRONZE model

Harald Ulrik Sverdrup[1], Kristin Vala Ragnarsdottir[2], Deniz Koca[3]

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The total resources form copper, zinc and lead was estimated from a reworking of the literature. The data was used as input to the integrated systems dynamics model BRONZE, and used to estimate the global supply of these metals and the by-products antimony, indium, germanium, tellurium, cadmium, bismuth and selenium. The runs show that copper, zinc and lead go through peak production around

2050 and declines as the resources run out some time after 2100, and with them the metals produced as by products become unavailable.

Sustainable Industrial Areas: The Place for Circular Economy

Detlef Wolfgang Schreiber, Katrin Gothmann, Philip Jain

GIZ, Germany

For many emerging economies the creation of economic zones and industrial areas constitute a cornerstone of their industrialization strategies. Hundreds of them are planned right now. They could become the breeding ground for circular economy. However, creating successful industrial networks which use resources in a highly efficient way is an enormous management task. Companies need to communicate with each other in a new manner, exchanging information about material flows, previously considered confidential. The proximity of distinctive resource providers and recipients becomes more relevant. Currently, the management of these industrial zones is in most cases unable to coordinate exchange between companies; even less the planned location of enterprises necessary to establish industrial symbiosis. In many parts of the world industrial areas are dirty places with crumbling infrastructure, environmental pollution and inadequate working conditions. Yet this is where large parts of the world's production take place. Before these industries become hotbeds for circular economy fundamental Services must be implemented. As service provider for Technical Cooperation with developing countries and emerging economies, GIZ gives advice on planning and operation of sustainable industrial areas with special regard to circular economy. Practical work includes planning of new industrial areas, upgrading of existing ones as well as advice to governments on suitable framework conditions, standards and incentives. Experience of Technical Cooperation indicates that industrial areas must be managed by service-oriented companies or administrative units, which have more duties than selling plots of land and providing basic infrastructure. They must provide well-planned infrastructure, control compliance with environmental regulations, care for social facilities and exchange with local communities. In order to enhance circular economy, the management unit of an industrial area must act as facilitators of material flows between companies. Our thesis is therefore "Well-managed industrial areas are a success factor for Circular Economy".

SS 15: Technological innovation, business and finance

Time: Wednesday, 14 October 2015 (12:00 – 13:50)

Location: Schwarzhorn

Session Chair: Prof. Helga Weisz, Potsdam Institute for Climate Impact Research (PIK), Germany

Session Chair:

Exploring the potential of e-mobility to improve resource efficiency through scenario building

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The transport sector is the second largest emitter of GHG emissions in the EU and about two thirds of the emissions are generated from road transport. More importantly, while emissions from other sectors have shown a consistent decreasing trend, GHG emissions from transport have continued to rise and were 20.5% above 1990 levels in 2012, despite important improvements in vehicle efficiency. The electrification of the car float using vehicles running on plug-in electricity for their primary energy or e-mobility, has been considered a central option to improve the environmental efficiency of the transport sector and a key element to achieve the required Transport White Paper target of 60% decrease of GHG emissions by 2050. Although important innovations have been made in recent years, the requirements for e-mobility and also its implications are not always well understood. This papers uses a combination of Life Cycle Assessment (LCA) and scenario modeling to explore the energy and resource implications of e-mobility and helps to understand the contribution of e-mobility to the transport sector GHG reduction target but, more generally, to resource efficiency. Based on a comprehensive LCA, which covers e-cars from cradle to grave – i.e. manufacturing, use and disposal/recycling, the analysis builds three differentiated scenarios of e-mobility for 2050, based on different assumptions with regards to road transport use, e-car share and energy mix, as well as powertrain efficiency and recycling rate. Environmental impacts, energy savings and resource implications are analyzed for each of these scenarios. Based on these findings, the paper draws conclusions about policy mixes to promote resource efficiency in the transport sector and the role of e-mobility in a resource efficient economy.

Are metal resources under severe pressure from E-mobility?

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Electric vehicles (EV) as an alternative to fossil fuel based cars play an important role for a more sustainable development of the transport sector. Traction batteries such as Lithium-ion Batteries (LIB) represent the vital part of this technology and could face a significantly increasing demand bringing about also a growing need for the contained materials. Therefore it should be evaluated if a strong and fast increase in use of battery materials through EV might pose a threat for long-term availability of raw materials required for LIB production. Starting with the example of lithium for EV-batteries we could show that the contribution of recycling to reduce the need for primary resources seems to be lower than often assumed, especially as long as demand is growing fast. Additional challenges for an effective recycling of EV-batteries are the low selectivity of battery recycling technologies complicating the recovery of certain valuable materials and also the dependency of the recycling rate on the efficiency of the whole recycling chain. Furthermore, supply risks could rise through high demand for primary raw materials as the dependency on reserves in critical countries increases when the smaller amount of reserves in stable countries is depleted.

Integrating environmental and resource efficiency issues in the investment decisions of institutional investors

Adrian Ronald Tan, Caroline Delerable, Antoine Helouin
Ernst & Young (EY), France

While it is possible to manage resources more sustainably and use them more efficiently to improve productivity, competitiveness, growth and job creation, this requires a long-term view and significant initial investments. Finance and securing investments in resource efficiency is a fundamental component to achieve sustainable growth and make a shift towards a resource-efficient, low-carbon economy. One issue that has been identified as a barrier to investment in resource efficiency is the responsibility of institutional investors through fiduciary duty. Fiduciary duty has been traditionally interpreted narrowly as focusing solely on maximising the financial returns often through short- and medium-term investments. Today, 10 years after the first UNEP Financial Initiative's Freshfields report on the integration of environmental, social and governance (ESG) issues into fiduciary duties and the UN supported Principles of Responsible Investment (PRI) initiative, the inclusion of environmental and resource efficiency issues in the investment decision-making process of institutional investors is not considered a breach of fiduciary duties in the EU or any of its Member States. Although the inclusion of environmental factors into fiduciary duties is compatible with the legal framework, there is still scope to further develop and advance the integration of environmental and resource efficiency issues in the investment decisions of institutional investors. This paper provides an overview of the state of play on the inclusion of environmental and resource efficiency issues into fiduciary duties. It examines the arguments for and against including sustainability issues into the fiduciary duties of institutional

investors and proposes actions for how such issues could be more explicitly integrated into investment decision-making to encourage long-term investments to promote resource efficiency and sustainable and inclusive growth in Europe.

An innovation promoting sustainable construction in developing countries aims at changing the market EDGE brings together the Construction & Financial Sectors in Central America

Ana Quiros1, Jose Cordero1, Mario Quiros2, Philip Strothman3

1Green Building Council Costa Rica, Costa Rica; 2ALCALA, Association for LCA in Latin America; 3FSLCI, Berlin Germany

Recognizing the importance the construction sector has on the economy as well as the impact it has on resource consumption there have been several evaluating and certification systems that have been developed with the over-arching objective to steer market along the sustainability path. One of such systems with global reach is LEED appears to respond mainly to the higher end of the construction value chain offering the opportunity for the application of more affordable evaluating tools. EDGE (Excellence in Design for Greater Efficiencies) is an IFC World Bank innovation aiming at transforming the market with a simple, user-friendly, free of charge evaluating system. The tool gathers information from more than 100 emerging economies and may be tailored to country specific conditions -climate, prices and construction practices. South Africa, Costa Rica (first in LA), Vietnam, Indonesia, India, have launched or are in the process of launching EDGE country-specific platform. Colombia, Ecuador, Perú, Panamá and Honduras have expressed interest.

A recount of LEED application in CA and as it compares to recent EDGE launch in Costa Rica, shows the effectiveness of the new online tool to help developers and homeowners find efficient ways to reduce building´s energy and water consumption, lower the GHG emissions and provides information on investment, pay-off terms and reduction on monthly electricity and water bills all with CF assessment. Furthermore GBC-CR supports green credits and other financial instruments for projects with EDGE certification. Private and public banks are implementing such financial instruments and the availability of this simple yet robust, competitive evaluating system proves its effectiveness..

The experiences show EDGE complements evaluating systems to mainstream resource-efficient buildings in developing countries bringing together governments, green building councils, financial institutions, developers and in general all actors of the construction value chain, for the sought market transformation towards a green economy.

Linking decoupling to social progress and global solidarity

Klara Hajdu

CEEweb for Biodiversity, Hungary

While global resource consumption is steeply on the rise, fuelling just a moderate global economic growth, this has not eliminated social inequalities, hunger or poverty globally. Today we face growing global competition over resources, and rising prices which tend to hurt the poorest, both globally and within nations. Poverty, unsustainable production and consumption patterns, access to modern energy and climate change together with financing are in the centre of political attention at the negotiations on Sustainable Development Goals and a climate change agreement. However, current policy efforts aim to give sectoral responses to these challenges, often also locked in to the same approaches due to historical responsibilities and institutional structures. The ignorance of the deeply underlying drivers behind these problems and the failure to address their relationships endangers though the effective delivery of the common global goals. The European Resource Cap Coalition has set on to examine the challenge of resource overuse with the full consideration of social justice and the equitable sharing of benefits from the use of resources. The Coalition has studied a number of policy tools and advocates for an international energy budget scheme, which is a complex set of tools to apply on national and international levels. This paper analyses why current policy responses cannot effectively deliver social, environmental and economic goals at the same time, focusing specifically on the global dimension of resource allocation, benefit sharing and access to technologies. Then it examines how the energy budget scheme can contribute to delivering an ambitious climate change agreement as well as several Sustainable Development Goals and targets, linking the core features of decoupling to social progress and global solidarity. The energy quota, the secondary market and the revolving fund, the three key components of the scheme are analysed from this perspective.

SS 16: Circular Economy and decoupling

Time: Wednesday, 14 October 2015 (12:00 – 13:50)

Location: Dischma

Session Chair: Dr. Cornis Van der Lugt, Centre for Corporate Governance in Africa, Stellenbosch University Business School, South Africa

Session Chair: Dr. Nick Harley Florin, University of Technology Sydney, Australia

Estimating critical extraction rates for the main metals for a sustainable society within the planetary limits

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The critical rates of extraction of some metals was explored using a methodology based on the thinking behind critical loads for sulphur and nitrogen deposition developed in Europe 1990-2010. With a long term sustainability view in mind, critical rates based on 5,000 and 10,000 years were estimated and found to widely exceed the present extraction rates. Huge advances in recycling, as well as a significant contraction of metal demand would be required to reach no exceedence of the critical rates.

Modelling the global primary extraction, supply, price and depletion of the extractable geological resources using the COBALT model

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The global supply of cobalt was simulated by combining 3 different system dynamics models; BRONZE, PGM and STEEL. The present use of cobalt shows a low degree of recycling and systemic losses are significant. The reserves of cobalt are not very large (20-25 million ton extractable) as compared to metals like copper, zinc or iron, and after 2170 cobalt will have run out under a business-as-usual scenario. The present business-as-usual for cobalt use in society is in no way sustainable.

Closing the Loop in the Automotive Sector in India: The Role of End-of-life Vehicles

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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, India

India’s rapid economic growth has made it one of the largest consumers of materials in the world with consequences for the environment and economy as demand increases further in future. The fast growing automotive sector is one of the most resource intensive with high potential for future growth. Reusing material from end-of-life vehicles (ELVs) in the production chain can significantly benefit the resource needs of the sector. This study was conducted in cooperation between GIZ, Central Pollution Control Board (CPCB), and the NGO Chintan to gain a better understanding of the conditions of this sector in India and the challenges faced by it. The study carried out detailed surveys in six major automotive hubs across India interviewing a wide range of stakeholders. ELV recycling is carried out mostly in the informal sector in India and the sector consequently faces a range of problems including lack of space, poor environmental performance and working conditions, lack of access to finance, technology and capacity development. Rapidly changing technology and manufacturing standards used by vehicle manufacturers in recent years has become a challenge for the ELV sector due to limited capacity for upgrading. All stakeholders of the ELV sector are eager to move towards formalisation, which is seen as instrumental to achieve higher environmental and material efficiency standards. Legislative and regulatory void, including the absence of a systematic procedure for licensing ELVs, is the primary reason for poor performance of the sector. Based on this study, a clear regulatory mechanism and a supportive policy framework is recommended for rejuvenation of the ELV sector in India.

Policy packaging in support of absolute decoupling– a conceptual model

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Ecologic Institute, Germany

Global resource consumption has seen marked increases in the last century, in particular since the 1950s. In transforming these materials into products, food, infrastructure and energy functions for mobility and housing, significant environmental impacts are generated: ecosystems becomes ever more degraded, some 50 GtCO2e are emitted annually, and the global ecological footprint of human activities already requires more than 1.4 planet Earths. Through systematic literature review, we identified a number of relevant drivers that lock unsustainable resource use in at European and global level, such as: – consumption-based lifestyles (linked to social norms, increasing advertising efforts and rising aspirations) – short-term product and consumption cycles fuelling a take-make-dispose mentality – infrastructure design and planning locking in fossil fuel based structures and mobility decisions – volatile resource prices, which are (still) mostly ignorant of the true external costs of the resources' use We need to improve our understanding of the complex linkages between different trends and drivers in order to enable forward-looking decision-making. This requires thinking in terms of policy mixes, i.e. combining different policy measures, targeting different or the same trends and drivers. As knowledge on policy packaging is only starting to build up, we will develop a conceptualisation for resource policy packaging and roadmapping. This conceptualisation will have to take into account a) the need to investigate and mitigate potential negative consequences of policy measures aiming at achieving main environmental objectives. b) A time-dynamic roadmapping of policies, i.e. policy instruments packed in chronological order allowing for a transition pathway towards more ambitious resource policies. We will present the conceptual model for policy mixing, learning from the results of ongoing qualitative and quantitative ex-ante assessment of policy mixes, which will be completed until November 2015 in ongoing FP7-research (DYNAMIX, http://dynamix-project.eu/).

The climate impacts of feebate on cars in future scenarios

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The ongoing EU FP7 project DYNAMIX aims to develop and assess dynamic policy mixes that achieve absolute decoupling between resource use and well-being. One of the policy instruments we assess is a feebate scheme for selected product categories. This instrument combines a fee for the environmentally worst products in the category and an economic incentive to choose the best products. France has such an instrument for cars.

We modelled the carbon footprint of the future European car fleet with and without an effective, EU-wide feebate scheme. The calculations were carried through in the context of the different background

scenarios developed in the DYNAMIX project. These scenarios are based on different assumptions on the future rate of innovation and the degree of materialism in the economy. In a materialistic society with a high rate of innovation, the feebate system is likely to affect the share of electric cars rather than the size of the car. In a non-materialistic society with a low rate of innovation, the feebate system is likely to affect mainly the size of the car. In a non-materialistic society with a high rate of innovation, the feebate system is likely to affect both the size and the technology of the car. Using different assumptions on the future European electricity system, the calculation results indicate that a shift to electric cars, or other technological improvements, is more important for the climate than a shift to smaller cars.