Going Green
CARE INNOVATION 2018

Conference Program &
Abstract Book

Towards a Circular Economy

7th International Symposium and Environmental Exhibition

An event to discuss future strategies, meet your clients and form strategic partnerships

November 26 - 29, 2018
Schoenbrunn Palace Conference Centre
Vienna, Austria

International Program Committee

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Conny Bakker, TU Delft
Miquel Ballester, Fairphone
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Thomas Fischer, Landbell
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Georg Fröhlich, Electrocycling
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Christian Hagelüken, Umicore
Carol Handwerker, Purdue University
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David Scuderi, amazon
Chris Slijkhuis, Müller-Guttenbrunn
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Elisabeth Smith, step initiative
Pia Tanskanen, Nokia
Aidan Turnbull, BOMcheck
Jan Visser, SIMS
Norbert Zonneveld, EERA

CARE Electronics

Advances in electronics have revolutionized the way in which we live and do business. However, today's technological advance and mass consumption has a subsequent impact on the global environment. CARE Electronics (= Comprehensive Approach for the Recycling and Eco-efficiency of Electronics) is a strategic initiative to understand the international and national implications of sustainability for the electr(on)ics industry in the future.
CARE Electronics is an independent, industrial R&D network with members from large and small companies and research organisations.

CARE Electronics

- forecasts products, technologies, services & societal expectations
- identifies and researches strategic issues
- provides a platform for dialogue with government, business, academia and society,
- initiates and supports a series of projects, which deliver sustainable solutions.

Message from the Chair

On behalf of the International Program Committee and the Organisers it is a pleasure to welcome you to the **Going Green – CARE INNOVATION 2018** conference and to Vienna.

With this four-days event we celebrate 20 years of CARE INNOVATION conferences in Vienna, Austria, always alternating with Electronics Goes Green in Berlin, Germany. **Going Green – CARE INNOVATION 2018** will provide a platform to discuss how the electronics and other innovative industries, science and politics approach the global environmental and social challenges.
An exciting Conference Program is offered including important and wide-ranging contributions. They cover state-of-the-art research results that address contemporary problems and provide new insights on our path *Towards a Circular Economy*.

The response to our *Call for Paper*s was overwhelming, attracting submissions from some 48 countries. The International Program Committee has arranged a Program that spans 32 sessions, organised in parallel streams, where delegates will deliver over 160 presentations and posters. International legislative actions, higher energy-efficiency, less resource consumption, and new approaches towards sustainable development and climate change will be some of the key topics.

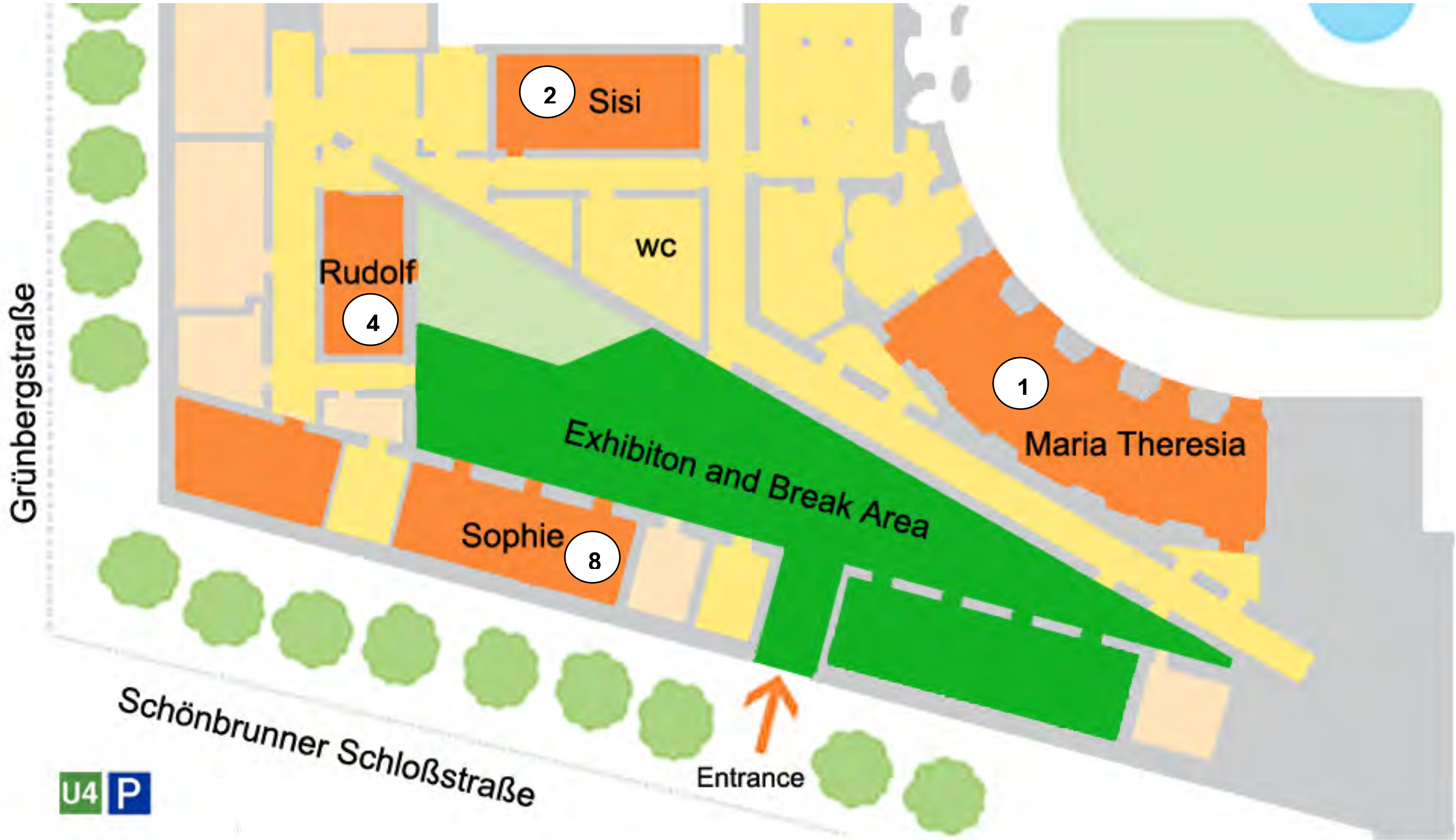
Additional workshops and special meetings address stimulating topics, delivered by professionals in the field. Along with the international congress, an environmental exhibition will take place.

To accelerate the networking between the huge numbers of participants, an extensive social program has been organized. It includes a Welcome Party, a Reception by the Mayor of Vienna in the magnificent, historical state rooms of the Viennese Town Hall and a Dinner at a typical “Heuriger” restaurant in Vienna.

Vienna – the bridge between East and West in the past and even more today – has been selected as the conference location to find synergies between economy and ecology.
I hope that in addition to attending the Technical Program, you will find time to explore and enjoy Vienna – the world famuous metropolis of music, art and culture – and if possible extend your stay to include a relaxing and memorable holiday.

I would like to express my appreciation to all the sponsors, workshop organizers, authors, session chairs, panellists, exhibitors, media partners and all participants for contributing to the success of the Conference and I am immensely grateful to the International Program Committee and my Organisation Team – especially Alexandra Linder, Andreas Jany and all the other *helping hands* – for making this unique event possible.

Schoenbrunn Palace Conference Centre



Program at a Glance

Monday, November 26, 2018

14.00 – 19.00	Registration				
18.00	Welcome Party & Opening of Environmental exhibition				

Tuesday, November 27, 2018

09.00 – 18.00	Registration				
10.30 – 12.30	Opening Ceremony & Panel Discussion “Towards a Circular Economy”				
12.30 – 14.00	Poster Session				
14.00 – 16.00	1.1 Circular Economy	1.2 EERA: WEEE recycling industry	1.3 Technologies & Materials	1.4 Closing the Loop	Environmental exhibition
16.30 – 18.30	1.5 Material Initiatives	1.6 New Business Models	1.7 Circular Economy in India	1.8 Products and Circular Economy	
19.30	Reception by the Mayor of Vienna in the City Hall				

Wednesday, November 28, 2018

08.00 – 18.00	Registration			
08.30 – 10.30	2.1 Circularity Assessment	2.2 Re-use & Repair	2.3 Closing the WEEE cycle	Environmental exhibition
11.00 – 13.00	2.4 Circularity Evaluations	2.5 Re-manufacturing & Repair	2.6 CROCODILE	
14.00 – 16.00	2.7 Information Management	2.8 C-SERVEES Workshop	2.9 Advanced Recycling Technologies	
16.30 – 18.30	2.10 Life Cycle Assessment	2.11 Market-driven Developments	2.12 FENIX	
19.30	Dinner at a Historical Viennese Heuriger			

Thursday, November 29, 2018

08.00 – 15.00	Registration			
08.30 – 10.30	3.1 Plastics Recycling	3.2 Legislation Updates	3.3 Circular Design of Mobile Devices	Environmental exhibition
11.00 – 13.00	3.4 Plastics Recycling	3.5 Legislation-driven Developments	3.6 Smartphones: 3R of Components	
14.00 – 16.00	3.7 StEP: solving the e-waste problem	3.8 Energy	3.9 iFixit Repairability Assessment Workshop	
16.00 – 17.00	Closing Session			

Friday, November 30, 2018

09.00 – 13.00	Technical Tour: (Semi-)automatic Disassembly of Mobile Devices (ProAutomation)

Going Green – CARE INNOVATION 2018

November 26 – 29, 2018
Schoenbrunn Palace Conference Centre, Vienna (Austria)

Monday, November 26, 2018

14.00 – 19.00	Registration (Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn, 1130 Vienna, nearest entrance: Schönbrunner Schloßstraße)
18.00	**Welcome Party & Opening of the Environmental exhibition** (Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn, 1130 Vienna)

Tuesday, November 27, 2018

09.00 – 18.00	Registration (Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn, 1130 Vienna, nearest entrance: Schönbrunner Schloßstraße)
10.30 – 12.30	**Opening Ceremony & Panel Discussion "Towards a Circular Economy"** (Room 1 – Maria Theresia)
	Welcome and Opening B. Kopacek, Conference Chair **Panel Discussion "20 years of CARE INNOVATION in Vienna – 20 years of electronics and the environment/Circular Economy"** M. Ballester, Fairphone, *NL* J. Krajewski, Microsoft, *US* J. Russinger, Siemens Healthcare, *DE* Y. Umeda, The University of Tokyo, *JP* J. Visser, Sims Recycling Solutions, *NL*
12.30 – 14.00	**Lunch Break & Poster Session**
	Geographies of e-waste flows in the EU M. Pietrzela, Leipzig University, *DE* **Self-organized Hierarchical Separation and Metal Recycling of Waste Printed Circuit Boards** J. He, B. Chen, Y. Xi, H. Ma, X. Zeng, Chinese Academy of Sciences, *CHN* Ivan Kaban, IFW Dresden, *DE* **Modularity in ICT co.project** S. Vaija, Orange, *FR* **Persuading People to become greener through Collaborative Activities** S. Koda, Tottori University of Environmental Studies, *JP*

Tuesday, November 27, 2018

	Room 1 – Maria Theresia	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	1.1. Circular Economy Chair: C. Hagelüken, Umicore, *DE*	**1.2. EERA: Present update and future outlook for the WEEE recycling industry** Chair: L. Stengs, EERA, *NL*	**1.3. New Technologies & Materials** Chair: B. Ferrari, Relight, *IT*	**1.4. Closing the Loop** Chair: T. Fischer, Landbell, *DE*
14.00 – 16.00	**Sustainability in Troubled times: SDGs as the driving force for corporates** H. Ohlsson, Epson Europe, *DE* **Will it go round in circles? Why circular economy is essential for emerging technologies – and how to get there** C. Hagelüken, Umicore, *DE* **Circular Economy Innovation at HP – business cases and challenges** B. Lahm, N. Hurst, J. Ortiz, HP, *DE* **Multiple facets of circular economy applied to telecommunications operator's activities** M. Vaija, E. Philipot, Orange Labs Networks, *FR* **Producer Responsibility in a Circular Economy** F. Mészáros, APPLIA, *HU*	**Recycling plastics from WEEE requires a sensible and practical approach on POPs** C. Slijkhuis, Müller-Guttenbrunn Group, *AT* **Recycling and Recovery Targets: Can WEEE reach them?** R. Widmer, H. Böni, Empa, *CH* **WEEE Recycling Economics - The shortcomings of the current business model** N. Zonneveld, EERA European Electronics Recyclers Association, *NL* **The Challenges of High-Energy Batteries in WEEE** M. Fahrner, Alba Group, *DE*	**Modular electronics – accessories as bridging technology?** M. Proske, K. Lang, Fraunhofer IZM/TU-Berlin, *DE* K. Schischke, N. Nissen, Fraunhofer IZM, *DE* **Equipment on access side of communication network aimed at energy and resource saving** M. Niwa, A. Sakurai, Y. Tanaka, NTT Network Technology Laboratories, *JP* **Building up a circular economy for electrical and electronic equipment through the development of the database of semiconductors and other components (DoSE)** L. Talens Peiró, X. Gabarrell i Durany, Universitat Autònoma de Barcelona, *ES* **Hyper-fine solder powders for further miniaturization of micro electronics** N. van Veen, M. Biglari, A. Kodentsov, L. Krassenburg, Mat-Tech, *NL* **Industry 4.0 solutions for boosting Circular Economy** R. Rocca, L. Fumagalli, P. Rosa, Politecnico di Milano, *IT*	**From waste management to stock and flow management: implementing closing the loop strategies in the Nordic countries** J. Hildenbrand, Swerea IVF, *SE* **Eco-Innovation Method by Integrating Biomimetic Concepts with TRIZ Scientific Effects and Mechanical Engineering Vocabulary** J. Chen, C. Fan, National Cheng Kung University, *TW* **Dealing approach in circular economy and industrial system as sustainable economic system** H. Hayashi, EcoDesign Promotion Network/Shibaura Institute of Technology, *JP* **Needs and Requirements for Environmental-friendly Product Development in Makerspaces – A Survey of German Makerspaces** A. Klemichen, I. Roeder, R. Stark, TU Berlin, *DE* J. Ringhof, Fab Lab Berlin, *DE* **Fostering of Environmental Leaders through Project Based Learning** K. Mishima, M. Afnan Bin Hajik Sardin, N. Mishima, Akita Univ., *JP*
16.00 – 16.30	**Coffee Break**			

Tuesday, November 27, 2018

	Room 1 – Maria Theresia	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	1.5. Material Initiatives Chair: T. Moriarty, Dell, *US*	**1.6. New Business Models** Chair: G. Brotto, Electrolux, *SE*	**1.7. Resource Efficiency and Circular Economy in India – Towards an Integrated Approach for Closed Loop ICT Industry** Chair: R. Prakash, GIZ, *IN*	**1.8. Products and Circular Economy** Chair: M. Piotrowski, Lenovo, *DE*
16.30 – 18.30	**A Protocol for Prioritizing Chemicals of Concern in the Electronics Industry** A. Fong, Apple, *US* A. Kokai, Apple/University of California, Berkeley, *US* **Material Impact Profiles – which materials to prioritize for a 100 recycled and renewable supply chain?** R. Maloney, I. Oswald, N. Santero, J. Lessard, W. Young, A. Orbach, C. Busch, S. Chandler, Apple, *US* **Closed-loop recycled gold in IT products** P. Shrivastava, S. Schafer, T. Moriarty, Dell, *US* **Conflict free/Responsible Gold – The Gold Convenant** A. Wittekoek, Coolrec, *NL*	**Circular Economy in action: uncovering the relation between Circular Business Models and their expected benefits** C. Sassanelli, P. Rosa, S. Terzi, Politecnico di Milano, *IT* **New Business Models for Circular Economy** M. Regenfelder, ReUse, *DE* R. Pamminger, TU Wien, *AT* **E-Businesses going circular – drivers, barriers and best practice examples of circular business models from the electronics sector** J. Emmerich, P. Chancerel, N. Nissen, K. Lang, TU Berlin, *DE,* R. Colley-Jones, M. Bates, University of Northampton, *UK,* G. Dimitrova, A. Berwald, Fraunhofer IZM, *DE* **A Community Based Social Marketing Approach for Increased Participation in WEEE Recycling** K. Casey, M. Lichrou, C. Fitzpatrick, University of Limerick, *IE* **Future Scenarios of Sustainable Consumption and Production: Comparative Analysis of Expert Workshops in Japan and Malaysia** Y. Kishita, E. Amasawa, A. Isoda, Y. Umeda, Univ. Tokyo, *JP,* A. Mohamed, Univ. Kebangsaan, *MYS,* M. Kojima, ERIA, *IDN,* B. McLellan, Kyoto Univ., *JP*	**Enabling a Circular ICT Industry in India through Extended Producer Responsibility** J. Hannak, M. Hemkhaus, adelphi, *DE* **Indigenous Technology to recycle Scrap Printed Circuit Boards** S. Chatterjee, Ministry of Electronics and Information Technology, *IN* P. Parthasarathy, E-Parisaraa, *IN* **Inclusive Action: Enabling Cooperation and Partnerships for Mainstreaming the Informal Sector** R. Arora, R. Prakash, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), *IN* **Greening Solar PV Value Chain in India** S. Bhattacharjya, S. Kapur, N. Arora, N. Nanda, S. Pandey, The Energy and Resources Institute (TERI), *IN*	**Research projects for a sustainable product and materials policy: lessons from two ongoing European Commission surveys** H. Eberl, European Commission **Hyperspectral Imaging for the On-line Identification and Classification of End-of-Life Lamps** A. Cicculo, Politecnico di Milano, *IT* M. Colledani, N. Picone, POLIMI/STIIMA-CNR, *IT* **Creating Systems for successful implementation of EPR and E-waste rules in India** P. Singhal, Karo Sambhav, *IN* **Regulatory Updates for E-Waste and Take Back Laws in Latin America** E. Perrier, Orbis Compliance, *US*
19.30	**Reception by the Mayor of Vienna at the City Hall** (Wappensaal, **Rathaus**, entrance: 1010 Vienna, Lichtenfelsgasse 2, Feststiege 2)			

Wednesday, November 28, 2018

08.00 – 18.00	Registration (Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn, 1130 Vienna, nearest entrance: Schönbrunner Schloßstraße)		
	Room 8 – Sophie	**Room 2 – Sisi**	**Room 4 – Rudolf**
	2.1. Circularity Assessment Chair: A. Turnbull, BOMcheck, *UK*	**2.2. Re-use & Repair** Chair: J. Visser, SIMS, *NL*	**2.3. Closing the WEEE cycle – Design, Dismantling, Recycling** Chair: K. Schischke, Fraunhofer IZM, *DE*
08.30 – 10.30	**A review of actions towards circular economy for business park´s governance** M. Le Tellier, L. Berrah, B. Stutz, Univ. Grenoble Alpes, *FR* J. Audy, S. Barnabé, Univ. du Québec à Trois-Rivières, *CAN* **Circularity Facts – Measuring performance in Circular Economy** W. Hoffmann III, C. Sheehy, A. Wain, UL Verification Services, *US* **Product circularity indicator using cumulative energy demand** N. Westerlund, Chalmers University of Technology, *SE* S. Shahbazi, A. Kristinsdottir, J. Hildenbrand, Swerea IVF, *SE* **Assessment of economic (LCC) and ecological (LCA) sustainability performance of power drive systems for producers and purchasers** A. Saraev, M. Gama, C. Herrmann, A. Busa, thinkstep, *DE* **Environmental Profit & Loss account Royal Philips** L. de Olde, H. van der Wel, Royal Philips, *NL* M. van Kampen, Philips Innovation Services, *NL*	**Increasing consumer acceptance of access-based PSS: Minimal personalisation of typical products** V. Tunn, R. Fokker, K. Luijkx, S. De Jong, J. Schoormans, Delft University of Technology, *NL* **Reuse of electrical and electronic devices: insights of an economic and environmental analysis in Switzerland** H. Böni, R. Hischier, Empa, *CH* **Circular economy in practice – how reuse is a part of the business model for the EPR company Norsirk in Norway** G. Husby, Norsirk, *NO* **Right to Repair** K. Wiens, iFixit, *US* **The emerging ‘Right to repair’ legislation in the EU and the US** S. Svensson, IVL Swedish Environmental Research Institute, *SE* J. Richter, C. Dalhammar, IEEE Lund University, *SE* E. Maitre-Ekern, University of Oslo, *NO* T. Pihlajarinne, University of Helsinki, *FI* A. Maigret, The European Consumer Organisation (BEUC), *BE*	**Recycling Information Centre – A platform to support manual e-waste recyclers to optimize their operations** K. Lenz, E. Smith, DRZ, *AT* T. Opsomer, M. Depypere, iFixit, *DE* **Advanced separation of bromine-free plastic fractions from WEEE streams: Design and development of a LIBS based continuous identification and sorting prototype** A. Asueta, P. Ereño, D. Iribarnegaray, S. Arnaiz, O. Salas, Fundación GAIKER, *ES,* A. Branderhorst, Coolrec, *NL* **PC/ABS and ABS recycling from un-used WEEE sources** M. Schlummer, F. Wolff, Fraunhofer IVV, *DE,* A. Sanchez, TECNALIA, *ES,* A. Rüdiger, Sitraplas, *DE,* A. Branderhorst, Coolrec Plastics, *NL* **Novel approach for Sb2O3 recovery from a WEEE-polymer recycling process** F. Wolff, M. Schlummer, Fraunhofer IVV, *DE* R. Schlüter, ARGUS Additive Plastics, *DE* **Compounding recycled plastics (from Electric and Electronic waste streams) and their application in E&E sector: mechanical and fire properties of Halogen Free Flame Retardant PC/ABS compounds** A. Sánchez, S. Villanueva, Tecnalia, *ES,* A. Rüdiger, Sitraplas, *DE,* A. Asueta, Gaiker, *ES* **Encouraging the uptake of recycled plastics from WEEE – the potential of ecolabels** G. Dimitrova, K. Schischke, A. Berwald, C. Walther, N. Nissen, Fraunhofer IZM, *DE*, P. Chancerel, K. Lang, TU Berlin, *DE*, A. Rüdiger, SITRAPLAS, *DE*
10.30 – 11.00	**Coffee Break**		

Wednesday, November 28, 2018

	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	2.4. Circularity Evaluations Chair: C. Handwerker, Purdue University, *US*	**2.5. Re-manufacturing & Repair** Chair: C. Fitzpatrick, University of Limerick, *IE*	**2.6. CROCODILE: first of a kind commercial Compact system for the efficient Recovery Of CObalt Designed with novel Integrated LEading technologies** Chair: B. Kopacek, ISL, *AT*
11.00 – 13.00	**Development of a method for measuring resource efficiency for product lifecycle** G. Miyake, N. Miyaji, Panasonic Corporation, *JP* A. Tajima, Panasonic Environmental Technology Solutions, *JP* K. Masui, M. Matsumoto, S. Kondoh, National Institute of Advanced Industrial Science and Technology (AIST), *JP* **Application of the Ostrom Framework to support a Circular Economy in Used Electronics** C. Handwerker, K. Frost, Purdue University, *US* W. Olson, Seagate, *US* G. Spencer, Geodis, *US* M. Schaffer, iNEMI, *US* **Is Disaggregation Always Sustainable?** K. Grobe, D. Stanaityte, ADVA Optical Networking, *DE* **A practical means for assessing circular economic value of an ICT product** L. Dender, IBM, *US* C. Gates, Microsoft, *US* N. Jackson, Metech, *US* T. Okrasinski, K. Wolenski, Nokia, *US* W. Rifer, GEC Emeritus, *US* G. O´Malley, M. Schaffer, iNEMI, *US* **Evaluating Energy-consumption Factors in Telecommunications Centers** T. Nagao, A. Sakurai, Y. Tanaka, NTT Network Technology Laboratories, *JP*	**More Aware through Repair: educating about critical raw materials** J. Richter, IEEE Lund University, *SE* M. Johnson, C. Fitzpatrick, University of Limerick, *IE* K. De Schepper, J. Peeters, KU Leuven, *BE* J. Rückschloss, Fraunhofer IZM, *DE* J. Gunter, Restart Project, *UK* **A Method to Assess the Repairability Incorporating the Ease of Disassembly (eDIM) Metric for Energy Related Products: Case studies for a washing machine, two vacuum cleaners and two laptops** J. Peeters, E. Bracquené, P. Tecchio, F. Ardente, P. Vanegas, D. Coughlan, F. Mathieux, W. Dewulf, J. Duflou, KU Leuven, *BE* **The World´s Most Advanced Electronic Component and Product Remanufacturing Facilities** D. Fitzsimons, European Remanufacturing Council, *BE* **Capabilities required to tackle Barriers to Remanufacturing** N. Boorsma, D. Peck, S. Fischer, C. Bakker, R. Balkenende, Delft University of Technology, *NL* **Remanufacturing workshops with professionals to overcome barriers – outcomes of two EU projects** N. Boorsma, D. Peck, S. Fischer, C. Bakker, R. Balkenende, Delft University of Technology, *NL*	**Introduction to CROCODILE** A. Siriwardana, Tecnalia, *ES* N. Akil, PNO Innovation, *BE* **Short overview on the supply** B. Ferrari, S. Sgarioto, Relight, *IT* **Introduction of the pre-treatment** V. Stein, Saubermacher, *AT* **Overview of the integrated chemical treatment processes** A. Siriwardana, Tecnalia, *ES* **Demonstration in the mobile plant** L. Baldassari, EcoRecycling, *IT* **Wrap up and future steps** A. Siriwardana, Tecnalia, *ES* N. Akil, PNO Innovation, *BE*
13.00 – 14.00	**Lunch**		

Wednesday, November 28, 2018

	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	2.7. Information Management Chair: M. Matsumoto, AIST, *JP*	**2.8. C-SERVEES Workshop: Is circularity possible in the EEE sector?** Chair: P. Leroy, WEEE Forum, *BE*	**2.9. Advanced Recycling Technologies** Chair: J. Chen, National Cheng Kung University, *TW*
14.00 – 16.00	**Requirements for product information flow to enhance WEEE urban mining** M. Matsumoto, K. Masui, National Institute of Advanced Industrial Science and Technology (AIST), *JP* **Benefits and challenges of acquiring a complete substance inventory for consumer electronics** K. Stumbaugh, C. Holmes, Microsoft, *US* **Integrating Lifecycle Assessment into Product-Level and Company-Level Environmental Activities** J. Dahmus, S. Smith, C. Arnold, N. Santero, Apple, *US* T. Ebert, Apple, *DE* **Exchange and Validation of Material Data – Linking different data formats and use of material assay data for compliance management** J. Strehlau, M. Riess, VDE Testing and Certification Institute, *DE* P. Müller, EntServ - DXC Technology, *DE* **An Operational Tool based on End-of-Life Treatment Data to support Electr(on)ic Equipment Design for Recycling** P. Assimon, L. Cuénot, ESR, *FR* **SustainHub – Exchange of upcoming sustainability related information in the supply chain – From FP7 to market requirements** A. Schiffleitner, iPoint-systems, *AT* K. Boehme, S. Dehlinger, A. Wahl, iPoint-systems, *DE*	**Introduction -The landscape and opportunities for developing the circular economy in the EEE sector** J. Horne, WEEE Forum, *BE* **Workshop: – debating the issues:** Some issues identified so far • Conflict between sales and the circular economy • Consumers do not know what the circular economy is • Circular economy is more than increasing reuse and improving recycling Questions to be addressed: • Can the e-sector adapt to circular economy thinking? • Why don't we see more examples of circular economy thinking in the e-sector? • Does circular economy work for all product categories in the e-sector? C. Cole, Loughborough University, *UK* K. Grobe, ADVA Optical Networking, *DE* **Summary, next steps and how to participate further in our work** P. Leroy, WEEE Forum, *BE*	**LCDVAL - separation of indium from LCDs** L. O'Donoghue, University of Limerick, *IE* **Analysis of a hydrometallurgical route to recover rare earths from fluorescent lamps** N. Ippolito, V. Innocenzi, I. De Michelis, M. Centofanti, F. Vegliò, University of L'Aquila, *IT* B. Kopacek, SAT, *AT* **Treatment of end of life Li primary batteries: cryo-mechanical and hydrometallurgical treatment** L. Baldassari, E. Moscardini, A. Del Gaudio, L. Toro, Eco Recycling, *IT* F. Padoan, P. Altimari, P. Schiavi, F. Pagnanelli, Sapienza University of Rome, *IT* F. Cornaggia, SEVal, *IT* **The future of waste NdFeB rare earth permanent magnets and their role in a circular economy** A. Bevan, D. Prosperi, C. Tudor, G. Furlan, M. Zakotnik, Urban Mining Company, *US* **An innovative hydrometallurgical process for spent NdBFe permanent magnets treatment** I. Birloaga, F. Vegliò, University of L'Aquila, *IT*
16.00 – 16.30	**Coffee Break**		

Wednesday, November 28, 2018

<table>
<tr><td rowspan="3">16.30 – 18.30</td><td>Room 8 – Sophie</td><td>Room 2 – Sisi</td><td>Room 4 – Rudolf</td></tr>
<tr><td>2.10. Life Cycle Assessment
Chair: C. Herrmann, thinkstep, DE</td><td>2.11. Market-driven Developments
Chair: P. Tanskanen, Nokia, FI</td><td>2.12. Circular Economy in practice: The FENIX project
Chair: B. Kopacek, SAT, AT</td></tr>
<tr><td>Life Cycle Assessment of First- and Second-Life Lithium-Ion Batteries: Implications from Existing Studies
M. Myllysilta, I. Deviatkin, S. Jenu, S. Tuurala, A. Hentunen, T. Pajula, VTT Technical Research Center of Finland, FI
I. Munne, Universitat Politècnica de Catalunya, ES

Are circular solutions environmentally sound solutions? Life cycle assessments of smartphones show a poor correlation between circularity and other impacts
N. Duque-Ciceri, C. Herrmann, thinkstep, DE
J. Vickers, thinkstep, NZ
A. Krishnan, thinkstep, US

More Lessons learnt from WDM LCA
K. Grobe, D. Stanaityte, ADVA Optical Networking, DE

Reducing the ecological footprint of household appliances: insights from the LCA of efficiency measures and expected trends
R. Hischier, Empa, CH
F. Reale, V. Castellani, S. Sala, European Commission - Joint Research Center, IT

Live LCA – New level of possibilities based on automated LCA – A user requirements point of view
A. Schiffleitner, A. Wahl, iPoint-Systems, AT
J. Hedemann, M. Prox, IFU Hamburg, DE</td><td>Circular economy in telecommunications – closing the loop
P. Tanskanen, S. Kallio, H. Scheck, Nokia, FI

Promotion of ICT abatement in companies -NTT group solution environmental labelling
M. Hara, Nippon Telegraph and Telephone West, JP

The IT Industry View On Ecolabels
N. Santos, HP, NL

International Harmonization of Environmental Assessment Criteria for Ecolabel Programs
W. Jager, ECD Compliance, CAN

RoHS: the global electronics regulation of our time as a cornerstone of the Circular Economy
L. Forrest, J. Costello, Compliance & Risks, IE</td><td>Introduction to FENIX
B. Kopacek, SAT, AT

Introduction of FENIX business models
P. Rosa, S. Terzi, Politecnico di Milano, IT

Reconfiguration and integration of pilot plants
Assembling/disassembling of products/wastes: P. Rosa, S. Terzi, Politecnico di Milano, IT
Bio-hydrometallurgical process: I. Birloaga, I. DeMichelis, F. Vegliò, University of L'Aquila, IT
3D additive manufacturing: J. Bonada, Fundació Centre CIM, ES

Use cases for value-added product-services
G. Smyrnakis, I3DU, GR
A. Bianchin, MBN nanomaterialia, IT</td></tr>
<tr><td>19.30</td><td colspan="3">Dinner at a Historical Viennese Heuriger (12 Apostelkeller, 1010 Vienna, Sonnenfelsgasse 3)</td></tr>
</table>

Thursday, November 29, 2018

08.00 – 15.00	Registration (Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn, 1130 Vienna, nearest entrance: Schönbrunner Schloßstraße)		
	Room 8 – Sophie	**Room 2 – Sisi**	**Room 4 – Rudolf**
	3.1. Plastics Recycling Chair: C. Slijkhuis, Müller-Guttenbrunn Group, *AT*	**3.2. Legislation Updates** Chair: M. Furkel, Lexmark, *DE*	**3.3. Circular Design of Mobile Devices** Chair: N. Nissen, Fraunhofer IZM, *DE*
08.30 – 10.30	**Polymer recycling from end of life display appliances** M. Schlummer, F. Wolff, Fraunhofer IVV, *DE* S. Grieger, W. Benner, Fraunhofer IWKS, *DE* **Evaluating the size distribution and color of mixed plastic recyclates using computer vision** H. Ramon, J. Peeters, C. Beerten, L. Antico, J. Duflou, W. Dewulf, KU Leuven, *BE* **Recycling of Plastics from Waste of Electrical and Electronic Equipment – Defining minimum requirements for the reapplication in injection moulded products** F. Wagner, J. Peeters, J. De Keyzer, J. Duflou, W. Dewulf, KU Leuven, *BE* **Design for Recycling: A priority plastics guide for WEEE recycling** A. Berwald, G. Dimitrova, N. Nissen, Fraunhofer IZM, *DE* A. Schwesig, MGG Polymers, *AT* P. Chancerel, J. Emmerich, K. Lang, TU Berlin, *DE* **Improve after use management of WEEE post-consumer plastics: current material flow and mass balances** A. Accili, N. Vincenti, L. Campadello, ECODOM – Consorzio Italiano Recupero e Riciclaggio Elettrodomestici, *IT*	**Effects and Challenges of the “Open Scope” Approach on WEEE Collection and Treatment procedures** S. Legler, 1cc, *DE* **Differences in implementation of “Open scope” of new WEEE Directive across EU Member States and comparison with non-EU e-waste regulations’ product scope** H. Stimpson, EC4P, *UK* **Promotion of Fair and Structural Reform of the Industrial Waste Management Contractors in Japan** S. Nagasawa, Waseda University, *JP* **Critical raw materials disclosure: a standardization perspective** S. Blaszkowski, Philips, *NL*	**Strategies for more Circularity in the Life Cycle of Mobile Information Technology** K. Schischke, M. Proske, J. Reinhold, Fraunhofer IZM, *DE,* M. Ballester, Fairphone, *NL,* K. Lang, TU Berlin, *DE,* M. Regenfelder, ReUse, *DE* **Modularization of Printed Circuit Boards through embedding technology and the Influence of highly integrated modules on the product carbon footprint of electronic systems** T. Kupka, G. Schulz, T. Krivec, AT&S, *AT* W. Wimmer, Vienna University of Technology, *AT* **The Sustainability Connection for Mobile Electronics** B. May, A. Santacreu, Circular Devices, *FI* N. Nissen, K. Schischke, Fraunhofer IZM, *DE* K. Lang, TU Berlin, *DE* **Designing an iameco D4R Tablet for Fab-Lab Level Production** J. Ospina, P. Maher, A. Galligan, MicroPro, *IE,* J. Gallagher, D. O’Donovan, GMIT Letterfrack, *IE,* G. Kast, ReUse, *DE,* K. Schischke, Fraunhofer IZM, *DE* **Guideline development to design modular products that meet the needs of Circular Economy** R. Pamminger, S. Glaser, W. Wimmer, Vienna University of Technology, *AT* G. Podhradsky, Speech Processing Solutions, *AT* **Technology Assessment of Wireless Charging using Life Cycle Tools** D. Sánchez, K. Schischke, N. Nissen, Fraunhofer IZM, *DE* K. Lang, TU Berlin, *DE*
10.30 – 11.00	**Coffee Break**		

Thursday, November 29, 2018

	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	3.4. Plastics Recycling Chair: T. Gil, HP, *ES*	**3.5. Legislation-driven Developments** Chair: R. Kühr, UNU, *DE*	**3.6. Smartphones: Repair, Remanufacturing and Reuse of Components** Chair: K. Schischke, Fraunhofer IZM, *DE*
11.00 – 13.00	**Where the shoe pinches – tackling current market challenges for recycling plastics from WEEE** N. Vincenti, L. Campadello, A. Accili, ECODOM – Consorzio Italiano Recupero e Riciclaggio Elettrodomestici, *IT* E. Wagner, P. Chancerel, J. Emmerich, TU Berlin, *DE* P. Liravi, University of Northampton, *UK* A. Berwald, G. Dimitrova, N. Nissen, K. Lang, Fraunhofer IZM, *DE* **Product Clustering for Improved Collection, Sorting and Recycling of Plastics** A. Boudewijn, J. Peeters, R. Dewil, D. Cattrysse, W. Dewulf, J. Duflou, KU Leuven, *BE* P. Chancerel, TU Berlin, *DE* **Collaboration between WEEE Take-Back Schemes and Recyclers: A way to face challenges by promoting new market for recycled plastics** A. Wittekoek, Coolrec, *NL* E. Carteron, ESR, *FR* **Plastic Close Loop in Electronic Products. Main drivers, challenges and key success factors** D. Miller, P. Gibbs, HP, *US* T. Gil, HP, *ES* **Sourcing RoHS-compliant high-quality recycled plastics from the informal sector: Experiences and challenges.** A. Almack, Plastics For Change, *IN* M. Gasser, Empa, *CH*	**Influence behaviours and enhance best practices to promote sustainability by demonstrating the impact and cost of non-sustainability: towards a model to evaluate the full cost of non-durable business practices, the research misconduct case** C. Gans-Combe, INSEEC, *FR* C. Kuszla, Université de Paris – Nanterre, *FR* **The impact of the EU geo-blocking regulation and the sales of goods directive on extended producer responsibility for electronic goods distance sellers** A. Campen, Landbell Group, *DE* **Enforcement actions and product withdrawals across Europe for non-compliance with RoHS, REACH and POPs substance restrictions** A. Turnbull, BOMcheck, *UK* **Defining Gold: An Examination of the New and Improved Elements of the IEEE 1680.1:2018 Standard** N. Gillis, E. Gately, Green Electronics Council, *US* C. Bocher, DEKRA, *DE* **Enforcement of California Proposition 65 substance regulations and using screening assessments to reduce the compliance burden** A. Turnbull, BOMcheck, *UK*	**Let´s Fix the Scoring of Reparability** B. Flipsen, M. Huisken, iFixit, *DE* **Implications of Circular Economy on Users Data Privacy: A Case Study on Android Smartphones Second-Hand Market** D. Nguyen, S. Martinez, M. Khramova, Blancco, *FI* **Analysis of data remanence after Factory Reset, and sophisticated attacks on memory chips** M. Khramova, S. Martinez, Blancco, *FI* **Battery Health in a Circular Economy: Embedding an Ageing Model in the Smart Battery System** C. Clemm, K. Marquardt, N. Dethlefs, K. Schischke, R. Hahn, N. Nissen, Fraunhofer IZM, *DE* K. Lang, TU Berlin, *DE* **Automated Identification and Sorting of Collected Smartphones** J. Reimers, Refind Technologies, *SE* **Automation of Smartphone Disassembly: Collaborative Approach** R. Ambrosch, E. Ambrosch, Pro Automation, *AT* R. Pamminger, S. Glaser, Vienna University of Technology, *AT* M. Regenfelder, ReUse, *DE* **Desoldering and remanufacturing of semiconductor components from electronic mobile devices.** J. Sitek, M. Koscielski, A. Arazna, K. Janeczek, W. Steplewski, Tele and Radio Research Institute, *PL* P. Ciszewski, P. Dawidowicz, Semicon, *PL* G. Podhradsky, Speech Processing Solutions, *AT* R. Ambrosch, Pro Automation, *AT*
13.00 – 14.00	**Lunch**		

Thursday, November 29, 2018

	Room 8 – Sophie	Room 2 – Sisi	Room 4 – Rudolf
	3.7. StEP: International E-waste management: now and in the future Chair: E. Smith, StEP Initiative, *AT*	**3.8. Energy** Chair: H. Hayashi, EcoDeNet, *JP*	**3.9. iFixit Repairability Assessment Workshop**
14.00 – 16.00	**Welcome and Introduction of the StEP Initiative** E. Smith, StEP Initiative, *AT* **Jobs and E-Waste** C. Fitzpatrick, University of Limerick, *IE* **Partnership models between the formal and informal sector** E. Gunsilius, GIZ, *DE* **Strategic Alliances for sustainable e-waste management** S. Adrian, US-EPA, *US* **E-Waste Visionary Paper** R. Kuehr, UNU, *DE* **E-Waste Recycling in Latin America** H. Böni, Empa, *CH* **Panel Discussion** E. Smith, StEP Initiative, *AT* C. Fitzpatrick, University of Limerick, *IE* E. Gunsilius, GIZ, *DE* S. Adrian, US-EPA, *US* R. Kuehr, UNU, *DE* H. Böni, Empa, *CH*	**EEPLIANT2 – overview of market surveillance efforts to ensure product compliance with the EU energy efficiency requirements** F. Zach, Austrian Energy Agency, *AT* I. Zlotila, ProSafe, *BE* **Reverse Logistics for Defective Li-Ion batteries and Li-Ion battery containing Devices** A. Zych, C. Krause, A. Bohnhoff, ERP/Landbell Group, *DE* **Including grid storage to increase the use of renewables – the case of an island in the North Sea** M. Zackrisson, J. Hildenbrand, Swerea IVF, *SE* **Evaluation of risk factors in wind energy systems in Akita prefecture** N. Mishima, Akita University, *JP* **UAV-based anti-smog monitoring of the quality of exhausts from private chimneys in urban areas** K. Cyran, M. Paszkuta, D. Myszor, W. Moczulski, SkyTech Products/Silesian Univ. of Technology, *PL* T. Rohn, T. Drosik, M. Adamczyk, SkyTech Products, *PL*	At iFixit, we believe that repair is crucial to extend the lifetime of consumer electronics, and thus slow down our consumption rate of precious materials. In our quest for more repairable products, we have devised a method to measure 'repairability' of mobile ICT products in a repeatable manner. We have also developed an online tool for conducting this assessment. In this workshop, we will introduce you to our approach and let you try out the tool for real. We'll provide smartphones for you to disassemble, in order to assess their repairability by yourself. **The places are limited!** **Special registration is necessary at https://register.eventcon.at/ci2018/event!**
16.00 – 17.00	**Closing Session** (Room 8 – Sophie)		

Friday, November 30, 2018

09. 00 – 13.00	**Technical Tour: (Semi-)automatic Disassembly of Mobile Devices** (ProAutomation, 1030 Vienna, Franzosengraben 10) Places are limited! Special registration is necessary at **https://register.eventcon.at/ci2018/event!**

Evening Program

Welcome Party

Monday, November 26, 2018 18.00

A Welcome Party will be held at the conference centre. Come and join the exhibitors, speakers, organizers and conference attendees for a buffet dinner.

Do not miss the opportunity to network with your colleagues!

Location: Schoenbrunn Palace Conference Centre, Schloss Schoenbrunn

Reception by the Mayor of Vienna in the City Hall

Tuesday, November 27, 2018 19.30

The Reception by the Mayor of Vienna will take place in the Vienna City Hall, one of the most splendid landmarks amongst the numerous monumental buildings along Vienna's Ring Road. Designed by Friedrich Schmidt (1825 – 1891), it was erected between 1872 and 1883. The architecture of the Ringstraße is dominated by Historicism. The City Hall was built in Gothic style, with a tower similar to Gothic cathedrals.

Today the City Hall is the head office of Vienna's municipal administration. More than 2000 people work in the building. Visitors are stunned by the magnificent appointments of the state rooms, which frequently provide an atmospheric backdrop to various events such as concerts or balls.

Location: Wappensaal, Rathaus
Entrance: 1010 Vienna, Lichtenfelsgasse 2, Feststiege II
Underground Station "Rathaus" (U2), Tram 2 "Rathaus", Tram 1, 71 or D "Rathausplatz/Burgtheater"

Dinner at a Historical Viennese Heuriger

Wednesday, November 28, 2018 19.30

Three basements up to 18-m depth protect monuments of the history. The origins of the history go back till the Romanesque and Gothic, it was already mentioned 1339. The masonry of the well cellar, with his for the distinguished constructions of the Romanesque to typical stone ashlars, comes from the years around 1100.

The mainly Gothic arched upper cellar still comes from the time before 1500. After his desctruction in 1561 the house was rebuilt, the well cellar received his early- baroque curvature and the foundation-stone with the chiseled annual number 1561. In times of war, as well as during to Turk´s sieges of Viena (1529 and 1683) these underground floor served as shelter sides.

In the years 1716 -1721 the baroque facade was formed by Viennese Master builder from Lucas von Hildebrand, one nicest in Vienna which got the building the name Hildebrandthouse and stands under conversations of monuments and historic buildings.

Famous artists, poets and painters have appeared in the course of the years since the existence of the Twelve Apostel - cellar in 1952 here and the magic of the past years and the romanticism which breathe in this old vault in himself allow to work.

Location: 12 Apostelkeller
Sonnenfelsgasse 3, 1010 Wien
Underground station "Schwedenplatz" (U1 and U4)

Abstract Book

1.1. Circular Economy

1.1.1. Sustainability in Troubled times: SDGs as the driving force for corporates

H. Ohlsson, Epson Europe, DE

The United Nations' Sustainable Development Goals (SDGs) are providing the much-needed framework to drive corporate social responsibility. While multinational companies are subject to different policies in the various geographies in which they operate, the SDGs provide an international standard, and companies are enthusiastically embracing these goals. However, industry experience suggests that companies are benchmarking progress against other industry competitors rather than reaching for game changing goals to generate a more fundamental impact. To ensure we are reaching our full potential, companies should ask themselves three important questions: How can we organise the business so that the SDGs are at the core? What can we learn from the world around us? How can we drive change throughout the entire value chain? By reviewing internal changes focused on CSR; learning from other countries, particularly Japan; and understanding the importance of the value chain, we can make a meaningful difference.

1.1.2. Will it go round in circles? Why circular economy is essential for emerging technologies – and how to get there

C. Hagelüken, Umicore, DE

The sustainable supply and use of metals is a key requirement for the successful implementation of many emerging low fossil carbon technologies. The concept of a circular economy as introduced by the EU Commission in 2015 can be a powerful enabler to unlock and boost the supply of secondary raw materials and hence contribute to fulfil the material requirements for technologies like electro-mobility. However, this requires fundamental changes in the way we design, sell, use and recycle our products. As a materials technology and recycling company, Umicore has gained extensive experience in the opportunities and challenges to close the metals loop, which are summarized in this contribution.

1.1.3. Circular Economy Innovation at HP – business cases and challenges

B. Lahm, N. Hurst, J. Ortiz, HP, DE

A shift to circular economy principles calls for radical change rather than incremental or gradual evolution. This paper would like to show some of HP's products and services enabling circular economy. It will also point out the challenges we faced while scaling these circular economy solutions.

1.1.4. Multiple facets of circular economy applied to telecommunications operator's activities

M. Vaija, E. Philipot, Orange Labs Networks, FR

Through the circular economy's principles, different domains such as life cycle assessment, eco-design, design for X (X standing for terms as repair, recycling, etc.) or material flow analysis (MFA) of critical raw materials are brought closer and explored by adding a business model angle. Among the diversity of goods that fuel our modern world electronic equipment hold a particular spot due to their fast technology evolution pace. As such these products are particularly challenging to apply alternative models regarding their repair rate, upgrade pace or to develop new recycling streams. For telecommunication operators involved in different fields, from small consumer devices as mobiles phones to large equipment powering Long term evolution (LTE) or Fiber-to-the-Home (FTTH) networks, circular economy offers a variety of opportunities for environmental footprint reduction and business strategy diversification.

1.1.5. Producer Responsibility in a Circular Economy

F. Mészáros, APPLIA, HU

This study is meant to present producer responsibility under the aegis of the circular economy, and the challenges manufacturers and legislators will face in the future in Hungary.

1.2. EERA: Present update and future outlook for the WEEE recycling industry

1.2.1. Recycling plastics from WEEE requires a sensible and practical approach on POPs

C. Slijkhuis, Müller-Guttenbrunn Group, AT

Recycling of WEEE plastics makes a lot of sense from an environmental perspective – it is a key activity towards a circular economy. Current proposals about thresholds to be set for POP BFRs imply a threat towards exactly this recycling industry. This paper calls for a sensible and practical approach. Decisions taken only one year ago by the EU to set REACH thresholds are both safe (environmentally, public health and toxicologically) and do-able for the recycling industry. This paper calls for support to develop rather than rules to stop recycling.

1.2.2. Recycling and Recovery Targets: Can WEEE reach them?

R. Widmer, H. Böni, Empa, CH

The ongoing discourse whether the output masses have to be measured at the entrance or at the exit of the final treatment should not deviate from the most urgent question: are the targets are achievable or not. Considering the increasing share of plastics in the WEEE stream, many of them still containing legacy substances; meeting the targets depends more and more on the condition that plastic recycling is exhausted. High variability of the input mix combined with devices depleted at collection exacerbates difficulties in reaching the targets.

1.2.3. WEEE Recycling Economics - The shortcomings of the current business model

N. Zonneveld, EERA European Electronics Recyclers Association, NL

The presentation will address the results of a study conducted by UNU in 2017 that was conducted among the EERA members. Subjects covered are cost of recycling, Scavenging of WEEE: environmental and economic consequences for society, the impact of non-compliant recycling and recommendations for next steps.

1.2.4. The Challenges of High-Energy Batteries in WEEE

M. Fahrner, Alba Group, DE

An estimated 50,000 tons of Lithium-Batteries are sold in Europe annually. This figure is to increase to 150,000 tons by 2025. Lithium- or High-Energy batteries cause serious hazards to the collection and treatment of waste electronics. As Li-on batteries - penetrate the EEE market, and more such batteries enter the automotive/transportation sector, problems have arisen with respect to their end-of-life management.

1.3. New Technologies & Materials

1.3.1. Modular electronics – accessories as bridging technology?

M. Proske, K. Lang, Fraunhofer IZM/TU-Berlin, DE; K. Schischke, N. Nissen, Fraunhofer IZM, DE

Modular electronics have been discussed over the last years including their potential environmental advantages through e.g. better repairability. The risks of additional material input for the modular design, potential impact on reliability or rebound effects are described. However, there is still no modular and upgradable smartphone on the mass market. Modular accessories could fill this gap. Add-on features do already exist and are – especially connected to better photography – comparably common. But also smartphones cases with additional functionality such as battery power, storage, etc. are available with a similar potential to increase the usetime of a device, thereby reducing the environmental impact. Addressing add-on modularity not as a specific product line, but as an accessory across several models and brands has the potential to reduce the development effort (add-on modules and interface, but not a completely new phone) and address a bigger market (users from established smartphone brands) at the same time.

1.3.2. Equipment on access side of communication network aimed at energy and resource saving

M. Niwa, A. Sakurai, Y. Tanaka, NTT Network Technology Laboratories, JP

For large-capacity and low-latency service, methods, such as edge computing, have been proposed. These methods involve placing multi-function and heat-generating equipment, such as cache servers, on the access side of a communication network, so air conditioning must be operated to cool the equipment, and buildings must be constructed to house it. Therefore, environmental load will most likely increase due to the increase in resources and energy being consumed for construction and air conditioning. We propose a method of installing information and communication equipment outside to prevent the increase in environmental load. As a result of comparing a conventional method and the proposed method, we found that the proposed equipment further reduces environmental load.

1.3.3. Building up a circular economy for electrical and electronic equipment through the development of the database of semiconductors and other components (DoSE)

L. Talens Peiró, X. Gabarrell i Durany, Universitat Autònoma de Barcelona, ES

To move towards a more circular economy of electrical and electronic equipment (EEE), information about their material composition and design shall be more widely available. This is particularly needed in the case of printed circuit boards (PCBs) which are virtually contained in all electrical and electronic devices. The Database of SEmiconductors and other components (DoSE) merges as a new database of electronic and electrical components mainly used in PCBs. The objective of DoSE is twofold: to help quantify the amount of materials contained in PCBs to allow a better environmental impact assessment of EEE and also to help estimate the economic value of such waste stream in order to optimize the recycling processes and reduce the losses of valuable materials. This paper explains how the DoSE is being developed to provide the material composition for the PCBs and fill the current gap in the assessment of EEE.

1.3.4. Hyper-fine solder powders for further miniaturization of micro electronics

N. van Veen, M. Biglari, A. Kodentsov, L. Krassenburg, Mat-Tech, NL

Ultimate miniaturization and ever increasing performance requirements favor linear technology vs circular technology. However, personalization of devices requires higher density interconnect. In the present work the status of present development work on ultrafine pitch solder paste is presented. It will be shown that work is well underway towards solder paste type 8, whereas the possibilities of reaching a type 9 paste look very promising as just a matter of time.

1.3.5. Industry 4.0 solutions for boosting Circular Economy

R. Rocca, L. Fumagalli, P. Rosa, Politecnico di Milano, IT

Industrial automation supported by the Industry 4.0 (I4.0) paradigm has become a driving force in production systems. According to current production trends requiring shorter product lifecycle and higher mass customization, I4.0 technologies, architectures and services offer a new perspective on automated and flexible production systems. Within this new industrial revolution, smart manufacturing represents a new way to produce goods and manage production processes, by making the classic Automation Pyramid (ISA-95) more flexible. Within the I4.0 Lab at Politecnico di Milano (https://www.industry40lab.org/home) an integrated use case for investigating how I4.0 technologies can support Circular Economy is under development through the H2020 FENIX project (http://www.fenix-project.eu/). The aim of the use case is to highlight how service orientation and integration, event-driven processing and information models available at the I4.0 Lab represent a technological boost for resources and products.

1.4. Closing the Loop

1.4.1. From waste management to stock and flow management: implementing closing the loop strategies in the Nordic countries

J. Hildenbrand, Swerea IVF, SE

The ongoing project “Circular Economy Integration in the Nordic Industry for enhanced sustainability and competitiveness” (CIRCit) aims to identify for companies from five countries in Northern Europe suitable recirculation strategies among options such as reuse, repair, remanufacturing, refurbishment, and material recycling for products and systems. The strategy shall be selected based on technical, market and sustainability characteristics. Moreover, guidance regarding the implementation shall be provided. As a requirement, conditions in the region need to be considered as well as properties of the products, components and materials that have reached the end of a utilization phase. To consider systems effects occurring on multiple levels and in multiple open and closed loops, a life cycle approach will be adopted. The approach will be further illustrated with cases from the CIRCit project.

1.4.2. Eco-Innovation Method by Integrating Biomimetic Concepts with TRIZ Scientific Effects and Mechanical Engineering Vocabulary

J. Chen, C. Fan, National Cheng Kung University, TW

This paper presents an eco-innovation method by integrating biomimetic concepts with TRIZ scientific effects and mechanical engineering vocabulary. In addition to using TRIZ inventive principles to link the biological cases, this paper provides another way by using 39 scientific effects of TRIZ method and arranges those scientific effects according to their “function”. This paper uses the supplementary keywords associated with each scientific effect to help the designer to search for enough biological cases. Furthermore, this paper reviewed the higher-frequency mechanical engineering vocabulary appears in index from textbooks of machine design and product design. With the biological resources analysis method and mechanical engineering vocabulary classification, this paper suggests designer a linking between mechanical engineering vocabulary and biological cases. An eco-innovation process for products by biomimetic concepts with TRIZ scientific effects and mechanical engineering vocabulary is proposed in this paper. Example is demonstrated to illustrate the capability of proposed method.

1.4.3. Dealing approach in circular economy and industrial system as sustainable economic system

H. Hayashi, EcoDesign Promotion Network/Shibaura Institute of Technology, JP

The economic activity is a perpetual cycling system in which values are created by human activity through exchanging goods (tangible or intangible). The circular economy is the concept of the sustainable economic system on recycling. It means that the system must circulate not only the material but money. The material value is increased by additional human work to purify and transform into the products consuming energy. The value is lost by degradation. The material is tangible, but the value is hiding behind the functionality of products. Even the software cannot be free from material by contraries as the material is the carrier of value or used in production mean. The same is the cause for the environmental impact. The value carried by the material cannot be retained even if it is recycled. This research shows the value-up mechanism of products by dealing approach and sustainable product supply in circular economy. The emotional factor is important.

1.4.4. Needs and Requirements for Environmental-friendly Product Development in Makerspaces – A Survey of German Makerspaces

A. Klemichen, I. Roeder, R. Stark, TU Berlin, DE; J. Ringhof, Fab Lab Berlin, DE

In order to meet the community’s demands for environmental-friendly product development in makerspaces and Fab Labs, a study has been conducted in Germany with around 158 makers covering current ways of product development processes, the general understanding of sustainability as well as the integration of sustainability criteria in their projects. Furthermore, experienced makers were asked about needs for supporting tools to improve their processes towards more environmentally friendly products. This study provides an overview of the state of the art regarding the integration of environmental factors in German makerspaces as a significant multiplier for knowledge transfer and best practices, with a special focus on environmental sustainability. Moreover, it gives an outlook towards promising measures for improving the level of implementation of environmental factors in makerspaces.

1.4.5. Fostering of Environmental Leaders through Project Based Learning

K. Mishima, M. Afnan Bin Hajik Sardin, N. Mishima, Akita Univ., JP

Currently in Japanese universities, educational method called Active Learning (AL) is being focused. Especially, one of the AL methods, project based learning (PBL) is said to be effective in enhancing self-motivated study for students. In finding solutions of problems that have no fixed and absolute answer. For example, for environmental problems that have many stake-holders and many trade-offs, this type of education is suitable to let the students think by themselves, investigate, negotiate and find solutions. Authors’ affiliation is taking this type of study in the curriculum. And it would be very effective in finding a solution for those complicated problems and fostering students who can have leadership in establishing a sustainable society.

1.5. Material Initiatives

1.5.1. A Protocol for Prioritizing Chemicals of Concern in the Electronics Industry

A. Fong, Apple, US; A. Kokai, Apple/University of California, Berkeley, US

Prioritizing potentially problematic chemical substances is integral to effectively focusing green chemistry efforts in electronics manufacturing. Existing scientific tools and policy frameworks, however, do not provide immediately applicable and transparent methods that companies can use to identify chemicals of concern. We have developed a Chemical Prioritization Protocol to systematically evaluate chemicals of interest and support Apple's Safer Materials Program. Electronics companies can use this Protocol to proactively identify chemicals that may warrant chemical management actions. Chemical prioritization can guide further efforts to make products and materials safer for manufacturing workers, customers, recyclers, and the planet. The Chemical Prioritization Protocol is a multi-criteria evaluation framework that synthesizes a wide range of relevant information about chemical hazard, use, exposure potential, and public concern into a simple set of quantitative indicators. This paper presents the design and application of the Protocol.

1.5.2. Material Impact Profiles – which materials to prioritize for a 100 recycled and renewable supply chain?

R. Maloney, I. Oswald, N. Santero, J. Lessard, W. Young, A. Orbach, C. Busch, S. Chandler, Apple, US

In this work, we present our material prioritization methodology for our ambition to make products without mining new materials. Using publicly available data, we comprehensively evaluated impacts in the value chains of 45 materials commonly used in consumer electronics, creating Material Impact Profiles (MIPs). Our analysis not only quantifies the generalized supply impacts of mined materials, but also the environmental and social impacts. We hope that this work will inspire others to comprehensively analyze impacts of materials for their products and begin their own work toward a 100 percent recycled and renewable supply chain.

1.5.3. Closed-loop recycled gold in IT products

P. Shrivastava, S. Schafer, T. Moriarty, Dell, US

Earlier in 2018, Dell proudly announced the launch of Closed Loop Gold Program, an industry-first pilot that integrates recycled gold from used electronics back into new computer motherboards. With this announcement Dell introduced a closed loop recycling supply chain for precious metals and demonstrated its successful integration. This innovation is as a result of Dell's ambitious initiative to advance the concepts of Circular Economy for electronics industry. In this presentation, we will share the challenges in the implementation of a closed-loop recycled gold program for IT products. An assessment of acceptable PCBA gold plating types and potential gold yield and quality was necessary to determine the feasibility of the program. A qualification plan was developed to meet stringent performance, reliability and quality metrics. Consideration was given to the existing Supply Chain and how it could be optimized to integrate the reclaimed gold into new products. We will also discuss the benefits of a gold reclamation process when compared with the traditional mined gold taking into consideration both environmental and social criteria.

1.5.4. Conflict free/Responsible Gold – The Gold Convenant

A. Wittekoek, Coolrec, NL

Mining and processing of gold has a heightened risk of violations of human rights, labour rights and environmental safeguards. There is a huge impact on natural environment, deforestation, mine waste, water management, chemicals (mercury), but also on working conditions, child labour, impact on local communities and the risk on smuggling and corruption, The Dutch Gold Agreement want to reach out to the WEEE Recyclers for the Urban Mine.

1.6. New Business Models

1.6.1. Circular Economy in action: uncovering the relation between Circular Business Models and their expected benefits

C. Sassanelli, P. Rosa, S. Terzi, Politecnico di Milano, IT

This research is aimed at developing Circular Business Models (CBMs) and industrial strategies for three novel supply chains, in order to enable value-added product-services. In a first stage, the existing CBMs were identified through a literature review, and their archetypes have been classified. In a second stage, a set of interviews with selected industrial partners allowed the identification of the most important benefits expected from the adoption of CBMs. Finally, the integration of these two views enabled the definition of the most suitable CBMs.

1.6.2. New Business Models for Circular Economy

M. Regenfelder, ReUse, DE; R. Pamminger, TU Wien, AT

For implementing circular economy, it is crucial to complement technological innovation by developing new circular business models. Therefore, the EU-funded Horizon2020 project sustainablySMART, aiming at more resource efficient product lifecycles of smart mobile electronic products, addresses new business models for mobile ICT products, such as smartphones and tablets. Closing the materials loop in this sector includes durability, repair, re-use and remanufacturing design strategies as well as new automatic re-/de-manufacturing processes for improving resource efficiency and enhancing product lifetime. Circular economy approaches change the structure of value creation, namely of value chains, systems and constellations. Transformation from linear to circular business models needs the assessment of this value creation structure: New actors, value creating activities, resources as well as links and interdependencies between them have to be considered. Focus is on how to create new business models for circular economy.

1.6.3. E-Businesses going circular – drivers, barriers and best practice examples of circular business models from the electronics sector

J. Emmerich, P. Chancerel, N. Nissen, K. Lang, TU Berlin, DE, R. Colley-Jones, M. Bates, University of Northampton, UK, G. Dimitrova, A. Berwald, Fraunhofer IZM, DE

Recovering post-consumer recycled (PCR) plastics from Waste Electric and Electronic Equipment (WEEE) could generate significant societal benefits by reducing the environmental impact by the factor 6-10. For this reason, it is essential that electronics companies implement business models which strive to close the material flows. Circular business models (CBMs) represent a chance for companies to design their business strategies in a more sustainable way and to gain a competitive advantage over market players remaining in linear business. This paper takes a closer look at the strategies of companies which have integrated PCR plastics into new high- tech applications, to better understand the drivers. Examining how persistent barriers can be overcome and how integrating recycled plastics can be a business case, aims to serve as a motivation for the Electrical and Electronic Industry.

1.6.4. A Community Based Social Marketing Approach for Increased Participation in WEEE Recycling

K. Casey, M. Lichrou, C. Fitzpatrick, University of Limerick, IE

Ireland is currently meeting the targets set by WEEE Directives. However, high collection rates occur predominantly in the categories of large household appliances and fridges/freezers. Collection rates for smaller WEEE are less successful by comparison. Worryingly, people tend to hoard obsolete and broken small WEEE at home. This study explored consumer experiences in relation to small WEEE recycling. Data collection consisted of 26 in-depth interviews with 30 participants, observations and casual conversations at a CA site and waste collection event, and participant observation at 25 retailers. Findings reveal that for consumers, electronic and electrical devices exist in fluid, in-between states of meaning and perceived value, from the time they enter one’s life until their disposition. WEEE disposal typically undergoes a four-stage journey, a process EEE typically goes through before divestment: a) Once EEE is no longer used it tends to be either consciously stored or abandoned in the home; b) A trigger prompts consumers to divest (critical moment); c) Provoked to action, consumers must decide what precisely to discard (transition from EEE to WEEE); d) Consumers decide to recycle or not (divestment).

1.6.5. Future Scenarios of Sustainable Consumption and Production: Comparative Analysis of Expert Workshops in Japan and Malaysia

Y. Kishita, E. Amasawa, A. Isoda, Y. Umeda, Univ. Tokyo, JP, A. Mohamed, Univ. Kebangsaan, MYS, M. Kojima, ERIA, IDN, B. McLellan, Kyoto Univ., JP

The use of natural resources and energy consumption has been increasing in accordance with rapid economic growth in Southeast Asia. When attempting to realize sustainable consumption and production (SCP), one critical challenge is to understand how locality or regional characteristics in each country will affect SCP. To analyze the influence of locality, we describe and compare SCP scenarios using a backcasting approach in Malaysia and Japan. For enabling the comparison, we express ideas generated in expert workshops in the form of logic trees, by which the causal relationship between goals for SCP and possible measures is clarified. The comparison shows that both scenarios in Malaysia and Japan include four key phrases as critical drivers for SCP, i.e., transformation of consumer behavior, circular production, sharing, and sufficient production.

1.7. Resource Efficiency and Circular Economy in India – Towards an Integrated Approach for Closed Loop ICT Industry

1.7.1. Enabling a Circular ICT Industry in India through Extended Producer Responsibility

J. Hannak, M. Hemkhaus, adelphi, DE

Developing long-term strategies for coping with the challenges of e-waste management and incorporating circular economy into the ICT sector, India builds on an established policy framework for electrical and electronic equipment. Operationalizing Extended Producer Responsibility (EPR), a key element of the strategy in this context, requires a more integrated collaboration of the concerned stakeholders. In the context of the Indian framework, special emphasis is put on fostering links between formal and informal actors in the e-waste management. Based on a comprehensive study developed under the European Union Resource Efficiency Initiative, India (EU-REI), the paper outlines the current situation and possible ways forward in facilitating the upscaling of EPR as well as complementing the roles and strengths of formal and informal sector in this context.

1.7.2. Indigenous Technology to recycle Scrap Printed Circuit Boards

S. Chatterjee, Ministry of Electronics and Information Technology, IN; P. Parthasarathy, E-Parisaraa, IN

Processing of electronics waste in informal sector is a challenge in developing countries due to unavailability and accessibility of cost-effective technology. The primitive methods used in this sector are unscientific, unhealthy, inefficient, non-environmentally friendly and release toxic emission. Foreign technologies are expensive and often not suited to the local needs in developing countries like India. This paper showcases the indigenous technology developed by Centre for Materials for Electronics Technology (Hyderabad) and its up-scaling efforts in India. This technology would be suitable for the informal sector to recover copper and precious metals exclusively from the scrap Printed Circuit Boards (PCBs) in a cost-effective, healthy and environment-friendly way.

1.7.3. Inclusive Action: Enabling Cooperation and Partnerships for Mainstreaming the Informal Sector

R. Arora, R. Prakash, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), IN

Presently nearly 95% of the e-waste in India is collected and processed by the informal sector. The network of informal sector workers caters to 30% household collection through door to door collection, intermediaries and repair market, and large proportion of the WEEE from the bulk consumers gets handled by the informal sector through auctions and illegal transfer of wastes. E-waste contains around 60 elements in complex forms with materials categorized as rare earths, hazardous and precious metals. The hazardous elements pose danger to human health and environment when handled in an improper and unsafe manner. The archaic methods employed for dismantling and recovery by the informal sector are damaging for their health, pollute the immediate environment and are inefficient forms of resource recovery. Thus, for effective and environmentally sound management of e-waste in India, mainstreaming of informal sector through empowering them with increased access to indigenous technologies will remain key.

1.7.4. Greening Solar PV Value Chain in India

S. Bhattacharjya, S. Kapur, N. Arora, N. Nanda, S. Pandey, The Energy and Resources Institute (TERI), IN

India is in the process of deploying an ambitious 100 GW capacity addition of solar power by 2022. However, achieving such a target is not free from challenges. Such challenges will include dedicated and affordable supply of materials for manufacturing solar PV technologies in India and ensuring environmentally benign end of life management of these products, among others. A resource efficient approach based on closed loop management along the life cycle stages will ensure reduced demand for primary materials through minimizing wastages, efficient and environmentally friendly recovery and recycling of key materials, and affordable access to PV technologies for consumers.

1.8. Products and Circular Economy

1.8.1. Research projects for a sustainable product and materials policy: lessons from two ongoing European Commission surveys

H. Eberl, European Commission

Projects for Policy (P4P) is an initiative which aims to use research and innovation project results to shape policy making. Research and innovation projects funded by EU Framework Programmes deliver invaluable results. These results are used for economic and social activities, as a basis for further research, or to develop new and better products and services. But project results can also provide evidence for policy development and design, highlight gaps or barriers in current policy frameworks or approaches and help develop new opportunities and innovative activities for any area of policy-making across Europe and the world. As such, they are an excellent tool for policy makers.

1.8.2. Hyperspectral Imaging for the On-line Identification and Classification of End-of-Life Lamps

A. Ciccullo, Politecnico di Milano, IT; M. Colledani, N. Picone, POLIMI/STIIMA-CNR, IT

The lighting market is expected to have revenues of over 100 billion euros in 2020. Despite the evident economical potentialities of this sector, the high products variability, complexity and the presence of materials with potential negative environmental impacts, make lamps recycling processes a challenging task. The Directive 2002/96/EC defines 80% as minimum recovery target for lamps containing mercury. Recovery processes currently adopted for End-Of-Life lamps treatment consist of a preliminary manual phase for sorting different lamp typologies, strictly correlated to the operator ability of recognize the lamps category. The present work proposes a new approach based on the application of hyperspectral vision systems for the automatic identification of End-of-Life lamps, aimed at optimizing recycling processes. These solutions could facilitate the securing of lamps containing hazardous materials, with the aim of maximizing the degree of purity of the recovered key metals and rare earths, stimulating potential secondary raw materials markets.

1.8.3. Creating Systems for successful implementation of EPR and E-waste rules in India

P. Singhal, Karo Sambhav, IN

In India, Extended Producer Responsibility (EPR) has been introduced as a baseline policy tool for E-waste (Management) Rules. The rules mandate the producers to do awareness programmes, set-up collection channels, collect e-waste as per targets, and ensure responsible recycling. This paper focuses on the efficacy of the PRO model for fulfilling these responsibilities for EEE producers in India. Karo Sambhav started as a PRO in 2017 with Apple, Dell, HP and Lenovo as founding members, and an active collaboration with International Finance Corporation (IFC). It has set up a grass-root level ecosystem for collection of e-waste in over 60 cities, consisting of thousands of informal waste pickers and aggregators, and repair shops. The PRO has enabled these players to become formal actors and grow their businesses in a safe and sustainable way. In the first year the PRO engaged over 500 offices, 1,500 schools covering 2,800 teachers and 600,000 students across India. Karo Sambhav has collected over 3200 tons of e-waste in the first twelve months. The biggest bottleneck in India for e-waste management is the very limited responsible recycling capacity. An effective PRO model in India requires strict enforcement of the E-waste Rules which can create a level playing field for producers, development of standards to cover the value chain, and introduction of recovery targets by the government to drive efficient and responsible recycling practices.

1.8.4. Regulatory Updates for E-Waste and Take Back Laws in Latin America

E. Perrier, Orbis Compliance, US

Latin America is one of the fastest growing regions in the world, with Brazil and Mexico rapidly progressing from emerging economies to developed countries. Manufacturers of electronic equipment and batteries need to carefully evaluate and plan their extended producer responsibility (ERP) programs, as they will have to be tailored to each country, keeping in mind the long run objective of running a single stewardship program based on the free movement of “resources” between countries. This presentation will concentrate on reviewing the current regulations in countries that are currently reforming and implementing laws such as Argentina, Brazil, Chile, Colombia, Peru, Paraguay, and Mexico.

2.1. Circularity Assessment

2.1.1. A review of actions towards circular economy for business park´s governance

M. Le Tellier, L. Berrah, B. Stutz, Univ. Grenoble Alpes, FR; J. Audy, S. Barnabé, Univ. du Québec à Trois-Rivières, CAN

A perfect example of business park aligned with circular economy is called ‘eco-industrial park’. However, all types of business parks, where co-locating companies can partake in synergetic relationships to reduce/recycle their resources, have a high potential to deploy circular economy. Like in any other organization, business park management could be considered as the definition of goals with the purpose of achieving them. This paper is a part of the creation of a decision-supporting tool for the business park’s governing body to accomplish its goals related to circular economy. A systemic model of the components of a business park is presented using the Unified Modelling Language (UML). From academic and grey literature, a review of business park’s governing body’s actions supporting the transition towards circular economy is given. The impacts of the reviewed actions are then analysed using the proposed systemic model.

2.1.2. Circularity Facts – Measuring performance in Circular Economy

W. Hoffmann III, C. Sheehy, A. Wain, UL Verification Services, US

The Circular Economy has been advanced as a framework for a more sustainable society, but there has been limited success in defining consolidated, systemic measures of current and continuous progress toward more circular systems. This paper explores how a new tool developed by UL addresses this gap by measuring product, facility, and corporate- level circularity. Circularity Facts tests one of the main hypothesis of circularity: that by making materials flows or material efficiency visible, we will be able to eliminate material loss and certain negative externalities of the current linear economic model. This paper describes Circularity Facts and explains how the tool may be expanded to include issues such as substances of concern, social issues, and GHG emissions. One case study will be presented to demonstrate how the system can be used to provide transparency information about a product and the manufacturing operations in the supply chain.

2.1.3. Product circularity indicator using cumulative energy demand

N. Westerlund, Chalmers University of Technology,SE; S. Shahbazi, A. Kristinsdottir, J. Hildenbrand, Swerea IVF, SE

This paper presents a tool to measure the circularity of a product and discusses how such a product circularity index can support decision making in early product development and design stage that has conclusive influence on the remainder of the product’s life, particularly on possibilities to extend product life and preserve or recover valuable resources. The calculation is constructed on a method presented by Linder (2017); however, the monetary value was replaced by cumulative energy demand (CED) as a basis for measuring product resource value and to establish a connection to environmental and resource use aspects. The circularity indicator calculates the ratio between the amount of CED saved by recirculating products, components or materials, and the total CED of the product produced from virgin and secondary resources. The tool presented has been developed in an action research-based approach and validated through multiple calculations of product circularity for different product concepts. In doing so, circularity indices for product concepts based on different re-strategies (i.e. reduce, reuse, repair, refurbishment, remanufacture and recycle) were investigated and compared to provide a preliminary evaluation of different re-strategies as promoted by the Ellen MacArthur Foundation. Insights are to be used in new product development and design efforts with regards to circular economy. The generic nature of the tool makes it applicable to be used for different products, components and companies.

2.1.4. Assessment of economic (LCC) and ecological (LCA) sustainability performance of power drive systems for producers and purchasers

A. Saraev, M. Gama, C. Herrmann, A. Busa, thinkstep,DE

Electric motors and power drive systems are responsible for around 40% of the electricity consumption worldwide. Even with the recent developments regarding energy efficiency and the corresponding laws and regulations, an increase can be expected: if no further measures are taken, this segment may become responsible for the double the energy consumption by 2030. On the other hand, an increased energy efficiency could lead to further demand of critical raw materials, e.g. dysprosium, neodymium in permanent magnets. The focus of the study is the analysis of power drive systems with different energy efficiencies, regarding the assessment of environmental and economic impacts, using Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) methodologies. An assessment of all components of the power drive system as well as the intended application must be considered to get meaningful results and guidance on the best options for the product design and optimization of the entire power drive system. This is only possible using a life cycle thinking approach. To support the practical application of the results, a tool was created, enabling different stakeholders, such as motor or power drive producers to do assessments of their own systems in an intuitive and user-friendly manner.

2.1.5. Environmental Profit & Loss account Royal Philips

L. de Olde, H. van der Wel, Royal Philips, NL; M. van Kampen, Philips Innovation Services, NL

Philips has a long sustainability history, stretching all the way back to its founding fathers. Providing transparency on the sustainability performance to stakeholders is key in gaining and sustaining trust in the company and its strategy. Underpinning Philips’ pioneering role in sustainability reporting Philips published an Environmental Profit & Loss (EP&L) account in its 2017 annual report which includes the environmental costs associated with Philips’ activities and products, from cradle to grave. The EP&L methodology is based on Life Cycle Assessment (LCA) methodology in which the environmental impacts, like climate change and toxicity, are expressed in monetary terms. Although an EP&L in itself is not new, the EP&L approach chosen by Philips is unique by the bottom up approach, the full cradle to grave scope and the fact that it relies on open source methodology only. The outcome provides transparency on the key contributors to Philips’ environmental footprint and provides valuable input where to focus the company’s sustainability program to reduce the environmental impact. This paper provides insight in the methodology and how the EP&L account supports Philips with their vision to make the world healthier and more sustainable through innovation.

2.2. Re-use & Repair

2.2.1. Increasing consumer acceptance of access-based PSS: Minimal personalisation of typical products

V. Tunn, R. Fokker, K. Luijkx, S. De Jong, J. Schoormans, Delft University of Technology, NL

This study suggests that minimal product personalisation can be used to lower barriers for acceptance of access-based product-service systems (AB-PSS). Minimal product personalisation is achieved by adding a personalised small product attribute to a typical product and thereby change the product personality, while limiting the sustainable impact. A 2x1 between subject design study (typical vs personalised product) was set-up to assess the effect of adding a personalised attribute to a typical product on the acceptance of leasing a product. Results indicate that respondents have a strong preference, as is widely recognised, for typical products in an AB-PSS. Acceptance further increases if the typical product is personalised with an add-on. These results can be used to think about ways in which design can enhance the acceptance of AB-PSS.

2.2.2. Reuse of electrical and electronic devices: insights of an economic and environmental analysis in Switzerland

H. Böni, R. Hischier, Empa, CH

Many consumers and politicians believe that, from an environmental point of view, reuse of electrical and electronic equipment (EEE) is preferable to recycling. But increases in energy efficiency, particularly for household appliances, have changed this picture in recent years. It therefore raises the question of where does the ecological limit lie – i.e. for what types of equipment and up to which age is such a reuse recommended from an environmental point of view? From an economic point of view, main question for a prospective purchaser of a used device is the purchase price (including repair) compared to the option of buying a new device. In this study here, the environmental and economic aspects of EEE reuse – considering as examples washing machines, refrigerators, LCD-televisions, smartphones and laptops – in Switzerland were investigated.

2.2.3. Circular economy in practice – how reuse is a part of the business model for the EPR company Norsirk in Norway

G. Husby, Norsirk, NO

Norsirk is a Norwegian extended producer responsibility (EPR) company. In 2017 Norsirk was responsible for more than half of the collected WEEEE in Norway, that is more than 68 000 metric tonnes. Since Norsirk absolutely is a company doing things, setting reuse in production, I believe it would be interesting for the conference to hear about what we are doing for the circular economy – how we are setting our customers, the producer in the re-use loop. Norsirk is the take back system in Europe working hardest to reach goals within reuse. Our goal is to reach a reuse percentage of 10 % in 2020. That means 6800 metric tons of WEEE turned into products again. That is a lot. To reach a goal like that – to do something that helps us, the municipalities, and the producers to step into circular economy.

2.2.4. Right to Repair

K. Wiens, iFixit, US

Viability of Repair and Modern Device Design We'll investigate the tradeoffs of extending the life of products versus energy efficiency. What are the downstream impacts of design on the recycling, reuse, and refurbishment sectors? What are the battery removability vs durability tradeoffs? We'll discuss the impacts of glued in batteries on recyclability and repairability. How are recyclers dismantling iPads and Microsoft Surface tablets? What design characteristics make some devices more difficult to repair and recycle? Presenters will also provide an in-depth analysis of the current state of Right to Repair legislation (pending in 18 US states) and concurrent efforts with the US Copyright Office Section 1201 exemptions to the DMCA, both essential to the repair and recycling ecosystem. The hidden costs of our throw-away society include dramatic social impacts on communities lacking access to modern technology. If the repair ecosystem is stifled and electronic lifespan is shortened, it will increase the digital divide. We'll discuss ways this is happening now, and efforts some companies like HP are taking to extend lifespans and maintain digital access.

2.2.5. The emerging 'Right to repair' legislation in the EU and the US

S. Svensson, IVL, SE; J. Richter, C. Dalhammar, IEEE Lund University, SE; E. Maitre-Ekern, University of Oslo, NO; T. Pihlajarinne, University of Helsinki, FI; A. Maigret, The European Consumer Organisation (BEUC), BE

The transition to a Circular Economy (CE) aims for more efficient use of resources and reconsideration of how products are designed and used, including promoting longer lifetimes through design and repair. However, several factors influence whether it is an option for the consumer to repair the product. These range from legal and market impediments to factors of cost, convenience, and consumer preference. In this paper, we examine the current state of right to repair and different stakeholder perspectives. We outline the fundamental barriers to accessing repair services for consumer electronics as well as current and proposed policies in both the EU and U.S. promoting access to repair. Following a comparison of initiatives, we conclude by discussing the need to balance stakeholder interests in defining the desired scope of Right to Repair (R2R) - distinguished from a fully open access to repair - within the context of CE goals.

2.3. Closing the WEEE cycle – Design, Dismantling, Recycling

2.3.1. Recycling Information Centre – A platform to support manual e-waste recyclers to optimize their operations

K. Lenz, E. Smith, DRZ, AT; T. Opsomer, M. Depypere, iFixit, DE

Objective 6 of the EU funded project "Close WEEE" aims at improving the flow of information to recyclers. DRZ in cooperation with iFixit and Fraunhofer Institute have developed the Recycler Information Centre (RIC), a web-based tool providing e-waste recyclers with detailed information to set-up an environmentally sound dismantling facility, to pursue this purpose. The main target group of the final platform are small manual e-waste dismantling facilities mainly in Latin America, Africa, Asia and Eastern Europe, who are in the process of establishing a manual treatment facility for e-waste. In addition to recyclers around the world also academia, government representatives as well as NGOs active in the field of e-waste management will be able to benefit from the tool as it provides a good basis for training and providing information to the concerned parties.

2.3.2. Advanced separation of bromine-free plastic fractions from WEEE streams: Design and development of a LIBS based continuous identification and sorting prototype

A. Asueta, P. Ereño, D. Iribarnegaray, S. Arnaiz, O. Salas, Fundación GAIKER, ES; A. Branderhorst, Coolrec, NL

The presence of additives such as Brominated Flame Retardants (BFRs) in EEEs is a critical factor in the recovery of WEEE plastics. Therefore, one of the main challenges for WEEE recycling is to obtain bromine free (< 0.1%) plastic fractions, which can be introduced again into the cycle of plastics as secondary raw materials. This paper looks at the challenge of bromine content identification present in ABS and PCABS plastic streams coming from TV set and PC monitor housings, using Laser Induced Breakdown Spectroscopy (LIBS). After the selection and calibration of the LIBS measurement head, the design and construction of a sorting prototype was carried out. The developed prototype is able to identify and classify the PC monitor and TV set housings according to their bromine content. The bromine content present in the Br-free plastic fractions is below the limit established by the Directive 2002/95/EC RoHS.

2.3.4. PC/ABS and ABS recycling from un-used WEEE sources

M. Schlummer, F. Wolff, Fraunhofer IVV, DE, A. Sanchez, TECNALIA, ES, A. Rüdiger, Sitraplas, DE, A. Branderhorst, Coolrec Plastics, NL

ABS (acrylonitrile butadiene styrene) and its blend with PC (Polycarbonate), PC/ABS, are common raw materials in a variety of EEE applications. While there is an increasing request for recycled PC/ABS and ABS this demand is currently not met, as quality and quantity specifications cannot be achieved by the state of the art recycling processes. The European CloseWEEE project addressed this issue and developed mechanical and solvent-based plastic recovery and subsequent compounding processes, all aiming at the recovery of high quality recycled ABS and PC/ABS grades applicable in advanced EEE application.
Recovery was based on SDA (small domestic appliances) and ICT (information and communication technology) waste polymers and processing included density separation and spectroscopic sorting with respect to mechanical treatment as well as the solvent based CreaSolv® Technology. Compounding with impact and gloss modifying agents improved properties to meet OEM specifications.

2.3.5. Novel approach for Sb2O3 recovery from a WEEE-polymer recycling process

F. Wolff, M. Schlummer, Fraunhofer IVV, DE; R. Schlüter, ARGUS Additive Plastics, DE

Antimony is used as a synergistic additive for flame retardant polymers. Although it is rated as a critical rare metal by the European Commission antimony is currently not recycled from end of life devices because of its low content in flame retarded polymers grades. Using the solvent based polymer recycling process CreaSolv® antimony trioxide (Sb2O3) was extracted from polymers of waste TV and monitor casings. After shredding and dissolution of the polymers in a solvent, a decanting centrifuge was used to extract particulate Sb2O3 into an intermediate, antimony-rich product. Further drying and pyrolysis eliminated residual polymers to receive a secondary Sb2O3 additive. This powder contained a Sb2O3 content of 66 % and was applied to completely substitute virgin antimony trioxide in flame retarded vapor barrier films (LD-PE). In edge ignition tests secondary Sb2O3 showed similar or even better flame retardancy than compounds with virgin Sb2O3.

2.3.6. Compounding recycled plastics (from Electric and Electronic waste streams) and their application in E&E sector: mechanical and fire properties of Halogen Free Flame Retardant PC/ABS compounds

A. Sánchez, S. Villanueva, Tecnalia, ES, A. Rüdiger, Sitraplas, DE, A. Asueta, Gaiker, ES

Flame retardant polycarbonate/acrylonitrile-butadiene-styrene blends (PC/ABS) are engineering polymers extensively used in the electric and electronic sector; mostly in electrical engineering where flame retardancy is a key property. Halogen-containing flame retardants have been commonly used to protect PC/ABS products. However, some EU regulations on electrical waste and increasing demand for smoke reduction in all sectors, combined with a discussion on the toxicity of release fumes, have progressively led to their replacement by halogen-free systems. In the present work, a second life for recycled PC/ABS from TV/PC monitors waste streams has been found. New halogen free flame retardant PC/ABS compounds have been developed achieving a compromise between mechanical and fire properties. The appropriate ratio of additives such as impact modifiers and phosphorous based flame retardants allow the production of post-consumer recycled based halogen free flame retardant PC/ABS compounds suitable for TV back cover application.

2.3.7. Encouraging the uptake of recycled plastics from WEEE – the potential of ecolabels

G. Dimitrova, K. Schischke, A. Berwald, C. Walther, N. Nissen, Fraunhofer IZM, DE, P. Chancerel, K. Lang, TU Berlin, DE, A. Rüdiger, SITRAPLAS, DE

In the electrical and electronics sector, a variety of legal and voluntary measures are in place, aiming at encouraging a transition to more durable, upgradable, repairable and recyclable products. In this respect, ecolabels play an important role, since they can help pull the market towards more sustainable products. Despite the fact that numerous life-cycle studies indicate that the use of recycled plastics from Waste Electric and Electronic Equipment (WEEE) can significantly decrease the environmental footprint of electrical and electronic products, specific criteria for the use of recycled plastics are absent in most ecolabels.
This paper offers a review and assessment of current ecolabelling criteria and the extent to which they incentivize higher recycling rates and better quality of recycled plastics. Based on a dismantling study of TV sets, interviews with actors and site visits, the paper emphasizes the current needs of the EOL sector. As a result, the paper provides recommendations on how ecolabels can help closing the gap between today's reality in the EOL sector and tomorrow's needs for better ecolabels.

2.4. Circularity Evaluations

2.4.1. Development of a method for measuring resource efficiency for product lifecycle

G. Miyake, N. Miyaji, Panasonic Corporation, JP; A. Tajima, Panasonic Environmental Technology Solutions, JP; K. Masui, M. Matsumoto, S. Kondoh, National Institute of Advanced Industrial Science and Technology (AIST), JP

In recent years, efficient use of material resources by circulating resources, for example by reuse, refurbishment, remanufacturing and recycling, is regarded as important globally. However quantitative measurement methods of resource efficiency for product life cycle have not been established. In this development, we built a framework of the measurement method, which has two features. The first feature is that it represents the changes of offering product value due to reuse, refurbish and remanufacturing products. The second feature is that it represents differences in environmental impact by material types. As a case study, we formulated five scenarios for refrigerated showcases. In the presentation, we first present a review of existing methods for measuring resource efficiency of products and present our proposing method. Then, we introduce the refrigerated showcase product business of Panasonic Corporation. Next, we present the product life cycle scenarios which we developed, and the application of our method. The effectiveness of the measurement method is discussed.

2.4.2. Application of the Ostrom Framework to support a Circular Economy in Used Electronics

C. Handwerker, K. Frost, Purdue University, US; W. Olson, Seagate, US; G. Spencer, Geodis, US; M. Schaffer, iNEMI, US

The iNEMI Project on Value Recovery from Used Electronics demonstrates how a multi- stakeholder circular economy for hard disk drives can be developed explicitly based on the Ostrom Framework for Socio-Ecological Systems (SES) for sustainable, self-management of common pool resources. By recognizing hard disk drives as a man-made common pool resource, all of the components of the Ostrom Framework were mapped first into the existing value recovery supply chain and then into a full circular economy supply chain, using key SES criteria to identify and fill critical gaps. The project is a model for understanding what the term "best practices" mean for the stakeholders in the context of an SES-based circular economy, how trusted relationships, information sharing, and collaborative demonstration projects make decisions towards circularity possible, and how quantifying the economics, logistics, environmental impacts, and the leverage points help the stakeholders identify current and future opportunities that depend on their working together to realize.

2.4.3. Is Disaggregation Always Sustainable?

K. Grobe, D. Stanaityte, ADVA Optical Networking, DE

Disaggregation is a new paradigm in telecommunications, aiming, for certain network function blocks, at mapping these blocks into quasi-standardized white boxes, and separating the respective hardware from the software. The goal is cost saving. However, disaggregation does not necessarily lead to better environmental performance of the resulting systems configurations. It can be shown that energy consumption, and hence GHG emissions, in most cases are slightly worse than those of the commonly used modular approach. The same is true for the resulting PCB size, which is another relevant environmental parameter. Interestingly, despite the fact that multiple white-box chassis must be used in more complex configurations, the contribution from the shelves themselves, metalwork, does not increase over the modular shelf approach. Therefore, disaggregation may have cost advantages in certain configurations, but with regard to environmental performance, it is a step back.

2.4.4. A practical means for assessing circular economic value of an ICT product

L. Dender, IBM, US; C. Gates, Microsoft, US; N. Jackson, Metech, US; T. Okrasinski, K. Wolenski, Nokia, US; W. Rifer, GEC Emeritus, US; G. O´Malley, M. Schaffer, iNEMI, US

A review of existing recyclability and reusability metrics revealed that the industry has limited means of practically assessing the circular economic value (recyclability, reusability, reparability and refurbish-ability) of an information and communication technology (ICT) product. Current mass-based metrics, in their most simplistic form, are deficient. The iNEMI Reuse and Recycling Metrics project team has been developing a practical means for assessing the circular economic value of an ICT product with the focus on incorporating score factors that assign reasonable impact value to product design features along with the ability to recover and return scrap value back to the market. The resulting system assesses the economic feasibility and physical practicality to separate and liberate the materials from ICT type products. The assessment is divided into three tiers: material choice, ease of liberation, and the available recycling technology. Regional factors have also been researched and incorporated in the assessment criteria. Additionally, the team reviewed the hierarchy of recovery (repair and reuse, parts harvesting, material recovery, or energy recovery/landfill), which impacts the ease of returning value to the market.

2.4.5. Evaluating Energy-consumption Factors in Telecommunications Centers

T. Nagao, A. Sakurai, Y. Tanaka, NTT Network Technology Laboratories, JP

Telecommunications centers consume a large amount of energy, so Japanese telecommunications centers need to reduce their energy consumption to contribute to climate change mitigation. The purpose of this research was to develop a method to efficiently reduce this energy consumption. To efficiently reduce energy consumption, energy-consumption factors need to be identified. However, identifying these factors is expensive and labor intensive due to the need to measure the energy consumption of each piece of communications, air-conditioning, and power-supply equipment in thousands of communication buildings. We propose a method of estimating these energy-consumption factors using a small amount of measured data. With this method, based on the assumption that the time variation in the movement of air-conditioning equipment differs between offices and machine rooms, a telecommunication building's energy consumption can be broken down into that of offices and that of machine rooms.

2.5. Re-manufacturing & Repair

2.5.1. More Aware through Repair: educating about critical raw materials

J. Richter, IEEE Lund University, SE; M. Johnson, C. Fitzpatrick, University of Limerick, IE; K. De Schepper, J. Peeters, KU Leuven, BE; J. Rückschloss, Fraunhofer IZM, DE; J. Gunter, Restart Project, UK

The issue of Critical Raw Materials (CRMs) and potential interruptions to their availability due to shortages, trade restrictions or other factors in their supply are topics that are relatively unknown to the general public. For this reason, education has been promoted as a key enabler of a circular economy. One key intervention point is the movement of electronic repair events. Repair events already exist throughout Europe and around the world; however, continuing innovation is needed to further enhance their ability to educate the public about complex issues such as CRMs. Raw Engagement for Electronics Repair (REFER) is a KIC Raw Materials project that seeks to educate wider society about CRMs through engagement in repair events. In this paper we explore the gap in awareness about CRMs and outline the process and initial outcomes of the REFER project in developing and evaluating potential awareness-raising approaches.

2.5.2. A Method to Assess the Repairability Incorporating the Ease of Disassembly (eDIM) Metric for Energy Related Products: Case studies for a washing machine, two vacuum cleaners and two laptops

J. Peeters, E. Bracquené, P. Tecchio, F. Ardente, P. Vanegas, D. Coughlan, F. Mathieux, W. Dewulf, J. Duflou, KU Leuven, BE

In prior research a method to assess the 'ease of disassembly' of products (eDIM) was developed and published by JRC in 2016. eDIM was developed to evaluate the ability or easiness with which components can be disassembled from products to facilitate repair, remanufacture and/or reuse. For this method, a database of disassembly tasks was built based on the Maynard Operation Sequence Technique (MOST), which provides values for elementary manual actions. The effectiveness of the quantification method was demonstrated by means of an LCD display case study. Results showed how the information about the disassembly sequence of a product (including types of fasteners and tools required) can be used in a spreadsheet to assess partial or complete disassembly, by means of the proposed ease of disassembly metric. In the presented research the eDIM method and database was further developed and the associated database was extended to improve its applicability to a wider range of products. The updated eDIM method allows now to evaluate both the ease of disassembly (eDIMD) and the ease of reassembly (eDIMR) metrics. The sum of the two metrics (eDIMD and eDIMR) allows the estimation of the overall effort needed for disassembling and reassembling one or more components. The improved eDIM methodology is explained by means of case studies for two recent laptops.

2.5.3. The World´s Most Advanced Electronic Component and Product Remanufacturing Facilities

D. Fitzsimons, European Remanufacturing Council, BE

Product durability can be demonstrated by offering one or more product life-extension options. The option with the most potential to add value - remanufacturing - is also one of the more complex. The remanufacture of components and whole products is established in many B2B sectors, yet overall it represents less than 3% of manufacturing sales. Numerous studies have highlighted the growth potential and resource efficiency of remanufacturing, sometimes comparing its growth potential to that of recycling in the 1990s when a recycling rate of just 5% was considered normal. One important constraint on growth, however, is the limited exchange of learning between product sectors. IBM's world class remanufacturing processes are unknown to the automotive or medical devices sectors. Syncreon's expertise in managing several different products for remanufacture in the same facility is unknown to those who specialise in single components. ALEC's use of specialised robots to disassemble and remanufacture electronic components is a mystery to the defence sector. GIT's take-back systems for imaging equipment and Lexmark's product design techniques to enable their printer cartridges to have as many as six life cycles are documented but rarely taught to the next generation of students.

2.5.4. Capabilities required to tackle Barriers to Remanufacturing

N. Boorsma, D. Peck, S. Fischer, C. Bakker, R. Balkenende, Delft University of Technology, NL

The transition towards a circular economy proposes to deliver sustainable, lower carbon opportunities to society, governments and companies. This paper focuses on finding barriers encountered during remanufacturing activities and interpreting the barriers by using a framework for dynamic capabilities. Dynamic capabilities enable companies to adjust to changes in their business activities. In the literature, remanufacturing is described as a process to restore used products to a 'as good as new' condition, through a series of steps. This paper discusses the analysis of in-depth interviews with a selection of five remanufacturing companies. The companies are from the following sectors: automotive, IT, photocopiers, industrial robots and building components. Results show they have a tendency to put technical capabilities at the core of their research, leaving 'softer' capabilities, such as sensing and learning, less developed.

2.5.5. Remanufacturing workshops with professionals to overcome barriers – outcomes of two EU projects

N. Boorsma, D. Peck, S. Fischer, C. Bakker, R. Balkenende, Delft University of Technology, NL

Remanufacturing is seen as a key strategy as part of the transition towards a circular economy. When looking at the available tools in literature to support companies to overcome barriers in this field, it can be concluded that only a few tools exist to serve this goal. This paper focuses on the development of a workshop for remanufacturing entrepreneurs and practitioners, which aims to overcome the barriers identified in two European Union KIC EIT Raw Materials funded projects. More widely, the outcomes aim to foster the further development and exploitation of remanufacturing practice.
The workshop was based on literature and case studies that highlighted barriers to remanufacturing. The workshop exercises support participants in developing company specific solutions, and simultaneously provides a framework for discussion. Based on participants' evaluations, exercises discussing product design, selecting a business model and planning reverse logistics were considered most insightful. Lower rated aspects, included offering more services around products and offering products as services.

2.6. CROCODILE: first of a kind commercial Compact system for the efficient Recovery Of CObalt Designed with novel Integrated LEading technologies

A. Siriwardana, L. Yurramendi, J. Hidalgo, Tecnalia, ES; L. Baldassari, E. Moscardini, P. Altimari, F. Pagnanelli, L. Toro, Eco Recycling, IT; S. Sgarioto, B. Ferrari, Relight, IT; N. Aki, PNO Innovation, BE; V. Stein, Saubermacher, AT

The CROCODILE project will showcase innovative metallurgical systems based on advanced pyro-, hydro-, bio-, iono- and electrometallurgy technologies for the recovery of cobalt and the production of cobalt metal and upstream products from a wide variety of secondary and primary European resources. CROCODILE will demonstrate the synergetic approaches and the integration of the innovative metallurgical systems within existing recovery processes of cobalt from primary and secondary sources at different locations in Europe, to enhance their efficiency, improve their economic and environmental values, and will provide a zero-waste strategy for important waste streams rich in cobalt such as batteries.
Additionally, CROCODILE will produce a first of a kind economically and environmentally viable mobile commercial metallurgical system based on advanced hydrometallurgical and electrochemical technologies able to produce cobalt metal from black mass containing cobalt from different sources of waste streams such as spent batteries and catalysts. The new established value chain in this project will bring together for the first time major players who have the potential of supplying 10,000 ton of cobalt annually in the mid-term range from European resources, corresponding to about 65% of the current overall EU industrial demand. Therefore, the project will reduce drastically the very high supply risk of cobalt for Europe, provide SMEs with novel business opportunities, and consolidate the business of large refineries with economically and environmentally friendly technologies and decouple their business from currently unstable supply of feedstocks.

2.7. Information Management

2.7.1. Requirements for product information flow to enhance WEEE urban mining

M. Matsumoto, K. Masui, National Institute of Advanced Industrial Science and Technology (AIST), JP

In today's recycling, only very limited amount of critical raw materials (CRM), especially minor metal CRMs, is recycled from waste electrical and electronic equipment (WEEE). This study addresses the question: what type information flow between original equipment manufacturers (OEMs) and recyclers is effective to enhance minor metal CRMs recycling from WEEE? The authors conducted interviews with 11 companies in Japan, which include OEMs and recyclers, and conducted a questionnaire survey to WEEE recyclers. The authors inquired: the current situations of information flow, the needs of recyclers on information of products to enhance recycling, and suggestions on eco-design to enhance recycling. The results of the survey are presented, and recommendations to enhance recycling are discussed.

2.7.2. Benefits and challenges of acquiring a complete substance inventory for consumer electronics

K. Stumbaugh, C. Holmes, Microsoft, US

In this paper we will discuss Microsoft's experience acquiring and maintaining an inventory of substances used in our consumer products, with a focus on the benefits and challenges associated with this endeavor. Maintaining a complete substance inventory enables comprehensive assessments of the potential impact of proposed substance restrictions, provides compliance documentation for components not analytically tested, and facilitates development of science-based approaches to supply chain risk assessment and strategy. A full substance inventory also supports voluntary activities including product environmental life cycle assessment (LCA), ecodesign programs, eco-certifications, and stakeholder communication. Challenges to maintaining a substance inventory include time, cost, organizational barriers, data management difficulties, maintaining confidentiality of proprietary information, and potential liability. Some challenges may be mitigated by technological developments such as cloud computing, Power BI, and improvements in tools designed for the management of substance inventories.

2.7.3. Integrating Lifecycle Assessment into Product-Level and Company-Level Environmental Activities

J. Dahmus, S. Smith, C. Arnold, N. Santero, Apple, US; T. Ebert, Apple, DE

Over the past decade, Apple's use of lifecycle assessment (LCA) to measure environmental impact has rapidly evolved. Initially, LCA models focused on a limited number of representative products, utilized industry-average data, and were conducted after products had been designed. Today, LCA models are developed for every product, major components and materials are modeled using data from Apple's own supply chains, and modeling begins early in the design process. These changes have led to an increased role for LCA in influencing design and manufacturing decisions at the product level. Moreover, this evolution has enabled Apple to make strategic decisions on corporate environmental initiatives that have led to meaningful reductions in environmental impact.

2.7.4. Exchange and Validation of Material Data – Linking different data formats and use of material assay data for compliance management

J. Strehlau, M. Riess, VDE Testing and Certification Institute, DE; P. Müller, EntServ - DXC Technology, DE

Product Manufacturers are demanded to consider material regulations of the markets where they want to sell their products. For different kind of markets (Electronic Industry, Automotive..) there exist different regulations even in one region (Automotive: ELV, RoHS 2019, REACH...). Customers ask for reporting in special formats (IPC, IEC) depending on what company internal systems are used. Therefore, the manufacturers face the challenge that they need data that allow statements on multiple regulations. This information needs to be complete, on time available and valid. Depending on who is asking the data need to be provided even in different file formats. There are two enabling tools that allow answering effectively, that means in short time and on reasonable costs: Database systems and material assay testing.

2.7.5. An Operational Tool based on End-of-Life Treatment Data to support Electr(on)ic Equipment Design for Recycling

P. Assimon, L. Cuénot, ESR, FR

ESR (Eco-systèmes and Récylum) is a collective take-back scheme accredited by the French authorities to develop, coordinate and organise the management of WEEE in France. To help manufacturers integrate end-of-life of their products in their ecodesign strategies, ESR has built on its position halfway between producers and treatment operators to create REEECYC'LAB, an ecodesign for recycling tool based on operational data of the recycling chain gathered from the field, combined and organised to meet products development teams' constraints.

This online tool releases eco-design for end-of-life feedbacks through qualitative information or recommendations and quantitative indicators. These two levels are complementary and both suit “experts” and “novices” in eco-design for end-of-life of EEE. Different aspects of end-of-life are analysed such as recyclability of the products, actions to improve the depollution and information on material which could be substituted by recycled materials to help identifying potential “closing the loop” opportunities.

2.7.6. SustainHub – Exchange of upcoming sustainability related information in the supply chain – From FP7 to market requirements

A. Schiffleitner, iPoint-systems, AT; K. Boehme, S. Dehlinger, A. Wahl, iPoint-systems, DE

An increasing amount of international and local regulations demand global operating companies to set up environmental compliance programs. Customers tend to request higher sustainability performance. Putting these responsibilities into practice requires managed data flow in the supply chain. A high quality of data exchange is needed in the supply chain as basis for developing products which have a higher level of sustainability, but this quality is usually not provided. This paper aims to describe an approach to a solution, which started as FP7 research project and is a productive tool now. SustainHub faces the complex requirements and quality needs by offering single entry to a wide range of compliance and sustainability applications, that access the same supplier information database. Designing SustainHub as open service platform enables third-party suppliers to provide their services as well. The paper characterizes the applications and delivers an outlook on the extension of the platform.

2.8. C-SERVEES Workshop: Is circularity possible in the EEE sector?

C. Cole, Loughborough University, UK; K. Grobe, ADVA Optical, DE; J. Horne, P. Leroy, WEEE Forum, BE

Waste electrical and electronic equipment (WEEE) is one the fastest growing waste streams in the EU; it is estimated that 12 million tonnes will be generated in 2020. The improvement of WEEE prevention, collection and recovery is essential to creating circular economies and enhancing resource efficiency. This will require new approaches in the design, manufacturing, use and end of life (EoL) treatment of electrical and electronic equipment (EEE).

C-SERVEES is a project funded under the H2020 Program (2018-2022) that aims to boost circular economic business models in the EEE sector. The business models will be developed through wide consultation with relevant stakeholders and their viability will be tested through demonstrations involving four target products: washing machines, toner cartridges, televisions and access link monitoring equipment used in telecoms. These products belong to EEE categories that together account for 77% of WEEE collected in the EU.

2.9. Advanced Recycling Technologies

2.9.1. LCDVAL - separation of indium from LCDs

L. O'Donoghue, University of Limerick, IE

LCD-Val aims to illustrate the indium value contented in LCDs via recovery techniques, therefore turning waste liquid crystal panel waste fractions into a resource for critical raw materials (CRMs). Liquid crystal glass panels are composed to two glass sheets with liquid crystal placed in between the sheets. indium is present in the form of a coating on the internal surfaces of the glass panels of the LCD and is combined in an alloy composition of indium Tin Oxide (ITO). The potential for indium recovery from LCD displays was investigated where pre-treatments were explored (to remove ITO) along with various hydrometallurgical techniques (to recover indium from the separated ITO). The pre-treatments considered for investigation including bulk grinding of the LCD panel glass with indium coating, surface grinding to remove the indium from LCD panel glass and a laser pre-treatment to evaporate off the indium coating. The output materials from the pre-treatment, indium containing powders in the case of bulk and surface ground techniques and indium on an absorption media in the case of the laser technique, then went through metallurgical testing to identify the parameters that would yield recovered indium with good quality and cost effectively.

2.9.2. Analysis of a hydrometallurgical route to recover rare earths from fluorescent lamps

N. Ippolito, V. Innocenzi, I. De Michelis, M. Centofanti, F. Vegliò, University of L'Aquila, IT; B. Kopacek, SAT, AT

The paper is focused on the recovery of rare earths from fluorescent powders of lamps by using hydrometallurgical treatments. According to the experimental results two different processes are proposed. The first one includes thermal treatment, leaching with sulfuric acid and precipitation of rare earths oxalates using oxalic acid. The final product has 98.62 % of purity in rare earths (as oxides). The second approach also includes selective separation for groups of rare earths by solvent extraction with (2-ethylhexyl) phosphoric acid (D2EHPA), stripping with acid and precipitation with oxalic acid. Two products can be recovered: the first is constituted by 98.8 % yttrium, 0.6% terbium and 0.6 % cerium (as oxides) and the second by 32.5 % europium, 17.9 % cerium, 17.1 % yttrium, 12.5 % lanthanum, 10.6 % terbium and 9.4 % gadolinium (as oxides). A preliminary economic comparison between the two processes was described.

2.9.3. Treatment of end of life Li primary batteries: cryo-mechanical and hydrometallurgical treatment

L. Baldassari, E. Moscardini, A. Del Gaudio, L. Toro, Eco Recycling, IT; F. Padoan, P. Altimari, P. Schiavi, F. Pagnanelli, Sapienza University of Rome, IT; F. Cornaggia, SEVal, IT

Li primary batteries are currently treated along with other Li batteries in few big pyrometallurgical plants in Northern EU countries. Pyrometallurgical processes present negative environmental impacts, while hydrometallurgical processing can potentially ensure the integral recovery of all materials in Li primary batteries. In this work, preliminary experimental findings obtained in LIFE-LIBAT project (LIFE16 ENV/IT/000389) about cryo-mechanical and chemical treatment of Li(0)-MnO2 batteries were reported. Representative samples of Li(0) batteries were characterized for type and composition. Batteries were stabilized in N2 bath and then crushed and sieved in pilot units. Separated fractions (external case and electrodic materials) were chemically characterized for target metal content (Li and Mn). Electrodic powder was then treated hydrometallurgically for Li and Mn extraction and their recovery as carbonate and hydroxide, respectively.

2.9.4. The future of waste NdFeB rare earth permanent magnets and their role in a circular economy

A. Bevan, D. Prosperi, C. Tudor, G. Furlan, M. Zakotnik, Urban Mining Company, US

NdFeB-based magnets have high magnetic energy densities (energy products) and, thus, are the most appropriate material of choice for the electronic industry, medical sector, or motors used within electric/hybrid vehicles, where permanent magnetic material must be as small, lightweight, and efficient as possible. Recent trends to move towards a greener economy (requiring the use of NdFeB), as well as increasing demand for the rare earths, have put additional stress in the available supply of materials to produce NdFeB-type permanent magnets. A serious effort to recycle NdFeB-type materials started around 2000, and commercial scale recycling NdFeB magnets via the magnet-to-magnet route is one method to mitigate large price fluctuations and material availability going forward. The manufacture of NdFeB magnets by the magnet-to-magnet process makes use of end-of-life 'waste' NdFeB as a feedstock material. The recycled magnets produced have been up-cycled from 'waste' NdFeB feedstock to new magnets with increased magnetic performance by the unique processing route and microstructure formed. One example is the performance of two nearly identical electric motors, which have been compared: one motor containing recycled NdFeB magnets produced via the magnet-to-magnet processing, and the other motor containing conventional NdFeB magnets made from virgin elements. The results demonstrate that flux linkage measured at open circuit and the torque measured at closed circuit are 7.0% and 6.4% higher, respectively, for the motor containing recycled magnets versus the motor containing conventional magnets. This was achieved despite the 15% lower Dy content of the recycled magnets as compared to conventionally produced magnets. This performance advantage demonstrates the viability of the magnet-to-magnet recycled NdFeB technology in real world applications.

2.9.5. An innovative hydrometallurgical process for spent NdBFe permanent magnets treatment

I. Birloaga, F. Vegliò, University of L'Aquila, IT

Within last two decades, due to their high magnetic fields and relative high level of Curie temperature, the commonly referred neodymium permanent magnets or the “rare earths” magnets have found applications (i.e. high tech and clean energy equipments). At the end of life of these equipments suitable technologies for their treatment and recovery of their content must be performed. Within this paper, the achieved results after application of a hydrometallurgical process on spent NdFeB permanent magnets of hard disk drives of personal computers are presented. The process consists of leaching of Nd, Pr and Fe from the powder achieved after a thermal and mechanical pre-treatment with a solution of citric acid. At the end of this chemical process, the solid residue with over 70% of Ni is achieved. The selective extraction of Nd and Pr from solution is achieved using the solvent extraction technology (Di-(2-ethylhexyl) phosphoric acid – DEHPA as extractant diluted in N-Heptane). Then, both rare earths elements are stripped from the organic solution by phosphoric acid. The citrate solution achieved after SX procedure is treated with oxalic acid to precipitate its iron content. At the end of the process, the global recovery yields for all four metals were larger than 95%. The purity of the final products (Nd and Pr phosphate and iron oxalate) was larger than 98%. Moreover, all the residual solutions have been reintegrated within the process and same recovery degrees have been achieved. Therefore, the current process has the advantage of achieving high recovery degrees with a minimal consumption of reagents and no solid or liquid waste generations.

2.10. Life Cycle Assessment

2.10.1. Life Cycle Assessment of First- and Second-Life Lithium-Ion Batteries: Implications from Existing Studies

M. Myllysilta, I. Deviatkin, S. Jenu, S. Tuurala, A. Hentunen, T. Pajula, VTT Technical Research Center of Finland, FI; I. Munne, Universitat Politècnica de Catalunya, ES

Repurposing automotive lithium-ion batteries, which have reached their end of life, for stationary applications, allows for significant extension of their lifetime compared to recycling. Life cycle assessment has been broadly applied to analyse the environmental performance of energy storage systems in both mobile and stationary applications. The impact of battery degradation on the battery's first life cycle was found to be significant. Furthermore, choices regarding the system boundaries, baseline scenario and the degradation ratio of the battery are found to have a pronounced contribution to the results. A fair comparison of the second-life batteries with the newly manufactured ones used for energy storage in stationary applications, such as residential households, requires allocation of the environmental burden associated with the batteries in their first life. The state of the degradation of a battery after its first life can serve as an allocation factor.

2.10.2. Are circular solutions environmentally sound solutions? Life cycle assessments of smartphones show a poor correlation between circularity and other impacts

N. Duque-Ciceri, C. Herrmann, thinkstep, DE; J. Vickers, thinkstep, NZ; A. Krishnan, thinkstep, US

This paper urges that improvements in material circularity must always be assessed alongside other life-cycle environmental performance metrics. Using smartphones as a case study, this paper demonstrates that there is very little correlation between an increase in the Material Circularity Indicator (MCI) of the Ellen MacArthur Foundation and a reduction in the product's environmental footprint as measured by other indicators (carbon footprint, water consumption and abiotic depletion of elements). This is because design changes to improve circularity focus mainly on the highest-mass components (i.e. mechanical parts and packaging), yet the majority of the smartphone's embodied footprint comes from a small number of relatively lightweight electronic components. The findings in this paper highlight the importance of taking a holistic approach using life cycle thinking to improve environmental performance – one that focuses on multiple environmental indicators.

2.10.3. More Lessons learnt from WDM LCA

K. Grobe, D. Stanaityte, ADVA Optical Networking, DE

Wavelength-Domain Multiplexing equipment is the backbone of the global ICT infrastructure. Due to massively increasing ICT bandwidths and long lifetime with always- on use mode, its environmental impact is dominated by emissions caused by use-phase electricity consumption. These and other impacts can be evaluated by Lifecycle Assessment. If this is done consistently across complete equipment portfolios, valuable guidance for economic ecodesign can be derived. This includes the identification of major pollutants, the components areas that need to be tackled following the focus on energy efficiency, aspects of the equipment usage in a network context that are not covered by LCA and hence need to be optimized by different approaches, and the fact that many components suppliers are not yet capable or willing to provide meaningful LCA data for their products.

2.10.4. Reducing the ecological footprint of household appliances: insights from the LCA of efficiency measures and expected trends

R. Hischier, Empa, CH; F. Reale, V. Castellani, S. Sala, European Commission - Joint Research Center, IT

The European Commission has been developing an assessment framework to monitor the evolution of environmental impacts associated to household consumption. Within this framework, the consumer footprint assesses potential environmental impacts of consumption in a specific area, based on the results of life cycle assessment calculations of representative products purchased and used in one year by an average European citizen. For its calculation, a Basket of representative Products (BoP) is built, based on statistics on consumption and stock of respective products – covering in the case of household appliances the most relevant types of such devices that an average citizen owns. Different scenarios for the situation in 2030 have been tested and compared with the respective impacts from a baseline scenario for the year 2010. The on-hand manuscript shows an excerpt of these results – focusing on four impact categories (global warming, ozone depletion, eutrophication, and ecotoxicity).

2.10.5. Live LCA – New level of possibilities based on automated LCA – A user requirements point of view

A. Schiffleitner, A. Wahl, iPoint-Systems, AT; J. Hedemann, M. Prox, IFU Hamburg, DE

This paper describes the activities during analysis of epic-level requirements for the new Life Cycle Assessment Solution Live LCA. Our recent work aims to break down complex and customer-specific conditions to a limited repertoire of requirements in order to generate relevant input for the programming part of the software development. An industrial interest group was involved to share knowledge on their pains and gains towards sustainability tasks. In addition, during interactive workshops we concentrated on artefact-based determination of requirements when collectively reflecting the hypothetical user roles (Personas) and use cases which we prepared. Results are specified user roles and use cases which form ground for detailed requirements engineering. Another discovery is the fact, that requirements towards the application are similar across target branches. As operational assessment tool for environmental impacts it should allow to address the cost perspective. As general requirement it should be easily integrated into existing management systems or even advance those.

2.11. Market-driven Developments

2.11.1. Circular economy in telecommunications – closing the loop

P. Tanskanen, S. Kallio, H. Scheck, Nokia, FI

Circular Economy and recycling are rapidly gaining interest in environmental organizations, standardization bodies, regulation and business. European standardization organizations are working on common terminology, definitions and methods to assess different circular economy aspects for ICT products and solutions. As circular economy requires the co-operation throughout the complete value chain, an agreement and common understanding of used terminology is fundamental. In this paper, we explain different aspects relevant for circular economy related discussions, like repair, upgrade, reuse, refurbishment, remanufacturing, and recycled material, in the context of Business to Business (B2B) telecommunication products installed in data centers or in telecommunication sites. Practical examples are presented throughout the product lifecycle (in product design, manufacturing, packaging, transport etc.) to demonstrate what are the main operational, financial, and technical challenges in closing the loop.

2.11.2. Promotion of ICT abatement in companies -NTT group solution environmental labelling

M. Hara, Nippon Telegraph and Telephone West, JP

Two comparative environmental impact assessments were conducted for two ICT solutions: “Field-Assistant” for assigning operators on-site and “Eco Megane” which automatically monitors the PV system. It was found that the two solutions were able to reduce Green House Gas (GHG) emission by as much as 37% and 43% more compared to the respective conventional methods. NTT Group has certified a Type II labelling named “Environmental Labelling System for solutions” to promote contribution to the abatement of GHG emission using ICT solutions.

2.11.3. The IT Industry View On Ecolabels

N. Santos, HP, NL

For the IT industry, product differentiation through environmental atributes has become an important business enabler. The use of Ecolabels has contributed to this product differentiation in the market, by helping to communicate on product sustainability features to consumers and procurement agents. Currently an ever increasing set of ecolabel criteria exist for the IT sector. Many of these target the similar (if not the same) atributes, geographies and product groups, leading to an increasing competing set of ecolabels. This could have the preverse effect of diluting the effectiveness of the communication.
Ecolabels will play an increasing role in Green Public Procurement in Europe, with the recent changes introduced with the EU Public Procurement Directive where under Article 43 specific ecolabels can now be required as means of proof against procurement sustainability requirements. However ecolabels ceritification cannot divert the focus from product attributes. Therefore a product meeting the environmental attributes of a specific ecolabel criteria should be considered in the same way, even if it is not certified to that ecolabel.

2.11.4. International Harmonization of Environmental Assessment Criteria for Ecolabel Programs

W. Jager, ECD Compliance, CAN

Variations in technical requirements and assessment methods among multiple ecolabel standards can lead to challenges when trying to implement environmental improvements. Unintentional biases can also appear in such standards. An opportunity to draw some requirements from a pool of harmonized criteria could alleviate some of the pressure and effort in developing these standards and lead to more consistent technical requirements.
A framework for harmonizing environmental assessment criteria and a database for storing and maintaining harmonized criteria is proposed. The harmonized criteria may be adopted for use in product-specific, ecolabel specific or voluntary standards. The approach recognizes and supports the need for differences in some technical details based on product type and geography; it sets common requirements where possible and enables product experts to set specific levels or technical details where necessary.

2.11.5. RoHS: the global electronics regulation of our time as a cornerstone of the Circular Economy

J. Costello, Compliance & Risks, IE

Since the release of its Circular Economy Action Plan in 2015, the EU is driving the current bid to transition to a circular economy, with its commitment to a package of regulatory measures imposing mandatory obligations on economic actors to underpin their product design and manufacturing processes with this precept.
This Presentation will show that RoHS serves as one of the cornerstones of this new economic model in supporting the effective recovery, reuse and recycling of EEE.
Addressing the seminal EU RoHS amendment, Directive (EU) 2017/2102, allowing the use and repair of used electrical and electronic equipment and halting the forced scrapping of functional appliances and the latest Pack 15 project to assess the possible restriction of a further seven substances, this Presentation will offer an overview of RoHS developments in terms of its steady evolution in the EU, emergence in new markets such as GCC and Brazil and ever-widening product scope.

2.12. Circular Economy in practice: The FENIX project

R. Ahlers, M. Lehne, BALance Technology Consulting, DE; C. Aionesei, Nicolae Stanescu, Greentronics, RO; A. Bianchin, MBN Nanomaterialia, IT; I. Birloaga, I. DeMichelis, F. Vegliò, University of L’Aquila, IT; J. Bonada, Centre CIM, ES; B. Kopacek, SAT, AT; K. Koutretsos, G. Smyrnakis, I3DU Technologies, GR; D. Ntalaperas, S. Pantelopoulos, SingularLogic, GR; M. Panou, A. Spiliotis, Hellenic Institute of Transport, GR; P. Rosa, S. Terzi, Politecnico di Milano, IT

Circular economy is a concept even more exploited by governments and companies to share green principles. However, its real adoption at industrial level remains limited to either small-scaled pilot plants or appositely constituted startups. The main aim of the FENIX project is the development of new business models and industrial strategies for three novel supply chains to enable value-added product-services. Through a set of success stories coming from the application of circular economy principles in different industrial sectors, FENIX wants to demonstrate in practice the real benefits coming from its adoption. In addition, Key Enabling Technologies (KETs) will be integrated within the selected processes to improve the efficient recovery of secondary resources.

3.1. Plastics Recycling

3.1.1. Polymer recycling from end of life display appliances

M. Schlummer, F. Wolff, Fraunhofer IVV, DE; S. Grieger, W. Benner, Fraunhofer IWKS, DE

The goal of DISPLAY - a European EIT raw material project - is to recover valuable raw material from end of life display devices. State of the art recycling is currently mostly done in smelting processes as the devices are too small for traditional recycling methods. Through a novel combination of separation techniques including electrohydraulic fragmentation (EHF) and automated sorting it was possible to separate display appliances into different fractions like displays, batteries and metals. These fractions where then treated by further downstream recycling processes. A polymer rich fraction was treated with the CreaSolv® Process, which is a solvent based recycling process for mixed polymer waste capable of recovering pure polymers from mixed plastic waste. By this process we successfully recovered high quality PA, PC/ABS and ABS from end of life display devices. These polymers where then analyzed by extensive material test including DSC, FTIR, TGA, XRF together with tensile and impact tests. Results show that the recovered polymers are well comparable with virgin polymers.

3.1.2. Evaluating the size distribution and color of mixed plastic recyclates using computer vision

H. Ramon, J. Peeters, C. Beerten, L. Antico, J. Duflou, W. Dewulf, KU Leuven, BE

Better information about plastic recyclates originating from waste of electrical and electronic equipment (WEEE) will lead to improved closing of the material loops. Therefore an innovative method is presented for automated identification of the size and colour of plastic flakes and to create an information sheet . The method relies on colour images that are assessed using computer vision. Computer vision algorithms to calibrate, filter the background, achieve contour recognition, and determine the pixel colours inside the contour flakes are used for this purpose. Several validation batches have been analysed to evaluate the developed method. The size characterization has been validated by comparing the results of the developed program with sieving tests, using different sieve sizes. The presented results show that the developed program effectively allows determining the size and colour of plastic flakes and can provide valuable insights for recycling companies to evaluate the value of mixed plastic recyclates.

3.1.3. Recycling of Plastics from Waste of Electrical and Electronic Equipment – Defining minimum requirements for the reapplication in injection moulded products

F. Wagner, J. Peeters, J. De Keyzer, J. Duflou, W. Dewulf, KU Leuven, BE

The recycling of plastics from Waste Electrical and Electronic Equipment and the application in injection moulded products remains a challenge due to the complexity of this waste stream and quality requirements of the products. In this paper a method to define minimum requirements for the communication between recycler and OEMs is proposed. The formulation of a shortlist of requirements for the screening in a material selection process shows that many requirements are too specific to be communicated by a general and standardized set of tests on a datasheet level. In addition, two case studies investigate the minimum requirement for the application of recycled PC/ABS with phosphorous flame retardants in thin-walled, injection moulded products and show that colour requirements are considered relevant while many recycled plastics are often limited in possible colour changes.

3.1.4. Design for Recycling: A priority plastics guide for WEEE recycling

A. Berwald, G. Dimitrova, N. Nissen, Fraunhofer IZM, DE; A. Schwesig, MGG Polymers, AT; P. Chancerel, J. Emmerich, K. Lang, TU Berlin, DE

Waste electrical and electronic equipment (WEEE) is one of the fastest growing waste streams in the European Union (EU), expected to grow at a rate of 3–5 % per year. Recycling of post-consumer WEEE plastics still represents a major challenge from a technical and economic point of view. According to the European Commission (EC), more than 80% of a product’s environmental impact is determined at the design stage. For a product to be properly recycled at its end of life, it is therefore key that the initial product design matches the recyclers’ requirements. This concept is known as design for recycling. The objective of this paper is to help closing the information gap between product designers and WEEE plastics recyclers by establishing a priority plastics guide to be used by designers of electrical and electronic equipment (EEE) at the conception stage. Based on an overview of today’s plastic composition of EEE, the analysis of the plastics recycling value chain and the most common mechanical and chemical recycling technologies, major mismatches between the quality of today’s Electronics Shredder Residue (ESR) received by recyclers as a feedstock and an “ideal state” were identified to develop a priority plastics guide. The guide consists of recommendations related to the avoidance of toxics (hazardous substances and components) and material purification as well as less material variety (choice of polymers and non-hazardous additives). The guide is supported by industrial partners within the H2020 PolyCE project.

3.1.5. Improve after use management of WEEE post-consumer plastics: current material flow and mass balances

A. Accili, N. Vincenti, L. Campadello, ECODOM – Consorzio Italiano Recupero e Riciclaggio Elettrodomestici, IT

To significantly enhance the use of recycled PCR WEEE plastics in new electronics applications, the first step is redesigning the recycling and recovery chain of WEEE. This research investigates the current WEEE value chain with attention to material flows and mass balances. It provides an organic overview and identifies the crucial nodes of the WEEE chain. The adopted methodology includes the evaluation of the quantity of plastic put on the market, closely linking it with the amount of EEE POM. The availability of PCR e-plastic is instead correlated with the WEEE collection dimension. Therefore, WEEE in input and plastic in output from WEEE treatment facilities have been calculated. Qualitative assessment has been performed developing a matrix showing the plastic content of the actual EEE and WEEE flows at polymers level. The specificity of different WEEE streams has been taken into account and the correspondent supply chains compared.

3.2. Legislation Updates

3.2.1. Effects and Challenges of the “Open Scope” Approach on WEEE Collection and Treatment procedures

S. Legler, 1cc, DE

The open scope approach brings changes and potential improvements to national WEEE collection and recycling activities. This paper gives a summary of the current transposition status of open scope legislation in various EU countries. Despite harmonization efforts throughout the EU, we will see individual changes made to the national reporting systems and to the WEEE (sub-) categories applied. The switch from 10 defined equipment categories to the open scope approach will also impact operational compliance and treatment procedures, as for example the input material mix is changing.

3.2.2. Differences in implementation of “Open scope” of new WEEE Directive across EU Member States and comparison with non-EU e-waste regulations’ product scope

H. Stimpson, EC4P, UK

This presentation provides an overview of EU Member States national WEEE Regulations to implement the WEEE Recast Directive 2012/19/EU Article 2 ‘Open Scope’ requirements and the transition to Annex 3 six new product categories by the Directive deadline of 15 August 2018. The presentation highlights some of the key differences in how the new Open Scope and new six product category requirements are being implemented in national WEEE Regulations in the 28 EU Member States. Selected examples contrast the differences in implementation in European countries and provide practical guidance on how product sales and recycling data must be reported differently in each country. The presentation also compares product scope for selected non-European countries which have recently implemented their own e-waste legislation for collection, recycling and reporting of products at end-of-life.

3.2.3. Regulatory Update on Extended Producer Responsibility Legislations for E-waste in Middle East and Africa

O. Varga, 1cc, US

With growing volumes of E-waste, either from local sources through a growing economy or from ewaste entering the country legally and/or illegally, the countries in these regions understand their needs to implement a (mandatory) infrastructure to collect and recycle -waste with a minimum (less) impact on the environment. This results in an increasing number of e-waste legislations being introduced or already implemented in this region.
By addressing different implementations of the EPR principles, and by discussing various perspectives of involved stakeholders, this presentation offers support to manage a compliant EPR approach in Middle East and Africa.

3.2.4. Promotion of Fair and Structural Reform of the Industrial Waste Management Contractors in Japan

S. Nagasawa, Waseda University, JP

In this paper, we present the meaning of the ‘evaluation system for the industrial waste disposer superiority’ (old system) and the ‘accreditation system for excellent contractors in industrial waste disposers’ (new system) propounded by the Ministry of Environment. We describe its significance and the issues stemming from it from the standpoint of the author who has played central roles in developing the ‘accreditation system’ (new system) as advanced by the Ministry of the Environment.

3.2.5. Critical raw materials disclosure: a standardization perspective

S. Blaszkowski, Philips, NL

Raw materials are at the core of concepts such as resource efficiency and circular economy, which are crucial to the European economy and essential to maintaining and improving the quality of life. Securing reliable and unhindered access to certain (critical) raw materials is a growing concern within the European Union and across the globe. The electrical and electronic equipment sector in Europe depends on a variety of raw materials including for example antimony, beryllium, cobalt, indium, and rare earth elements. However, the information of the exact use is scarce.
In this context, the aspect of how standards can contribute to the improvement of the circularity of critical raw materials is central. In this paper, the challenges and barriers associated with the definition, preparation and implementation of standards and their uptake is discussed. In particular, the process of transfer of information on critical raw materials through, rather complex, supply chains, and also how “static” standards can cope with fast changes in product design and digitalization, are addressed.

3.3. Circular Design of Mobile Devices

3.3.1. Strategies for more Circularity in the Life Cycle of Mobile Information Technology

K. Schischke, M. Proske, J. Reinhold, Fraunhofer IZM, DE; M. Ballester, Fairphone, NL, K. Lang, TU Berlin, DE; M. Regenfelder, ReUse, DE

The EU funded Horizon2020 project sustainablySMART develops technological and business innovations along the lifecycle of mobile information and communication technology devices with the aim to enhance circularity in this fast-paced and highly innovative sector. This includes aspects for enhanced end-of-life performance, re-use and remanufacturing design strategies as well as new automatic re-/de-manufacturing processes for improved resource efficiency.

3.3.2. Modularization of Printed Circuit Boards through embedding technology and the Influence of highly integrated modules on the product carbon footprint of electronic systems

T. Kupka, G. Schulz, T. Krivec, AT&S, AT; W. Wimmer, Vienna University of Technology, AT

Greenhouse gas (GHG) emission knowledge of company own production processes will be a necessary future asset, independently of the respective industry. To meet future environmental goals, the knowledge of greenhouse gas emissions related to products is critical. This can be assessed using a product carbon footprint (PCF) approach, assessing the greenhouse gas emissions of a product over its product life cycle. The production of electronic systems, which include active or passive components as well as printed circuit boards (PCB), is characterized by the use of emission intensive materials such as precious metals, polymeric dielectrics or organic process chemicals. Available data show that the product carbon footprint of those electronic systems is mainly determined by the amount and type of materials used to build up the system. Increasing the degree of integration of an electronic system, by means such as embedding of active or passive dies into the PCB build-up, allows achieving a significant reduction of the size of the system or module. Thus, the integration of separate functions into an integrated module is considered as one promising way to improve the PCF of electronic systems. The presented study deals with the comparison of an electronic system based on surface mount technology with a highly integrated functional module, which is produced applying embedding technologies. Process flows were investigated in detail and documented. Assessment was done following ISO 14067 - "Carbon Footprint of Products" in which the inventory (energy, materials, waste, transportation) was gathered and the impact was calculated using emission factors from Ecoinvent 3.4 database. Results of the study show a large impact of type and amount of used materials as well as a significant potential to improve the PCF by size reduction of the system, which favors embedding technology over the traditional manufacturing approach.

3.3.3. The Sustainability Connection for Mobile Electronics

B. May, A. Santacreu, Circular Devices, FI; N. Nissen, K. Schischke, Fraunhofer IZM, DE; K. Lang, TU Berlin, DE

Modularity has been identified as a prerequisite to achieve a more circular economy in electronics. In particular it would help to match reusable modules and subassemblies of connectivity enabled products during reuse and repair efforts to keep functional units in active use - concentrating on those, which caused the highest environmental impact during the initial production. This paper introduces the missing link enabling an efficient reuse and customization of more standardized electronic devices. An ecosystem of compatible modules will enable smaller production runs and smaller companies to participate in constantly updated electronic functionalities while concentrating on their unique customized parts of the product (or on software apps and services, as may be the focus of the company).

3.3.4. Designing an iameco D4R Tablet for Fab-Lab Level Production

J. Ospina, P. Maher, A. Galligan, MicroPro, IE; J. Gallagher, D. O'Donovan, GMIT Letterfrack, IE; G. Kast, ReUse, DE; K. Schischke, Fraunhofer IZM, DE

MicroPro Computers has been working in the design and manufacture of computer equipment based on circular economy principles over the past 20 years. In sustainablySMART (H2020 – FoF) MicroPro is working with GMIT Letterfrack and other partners, to adapt the design of a green computer (the iameco D4R tablet) for digital design and manufacture, using equipment typically found in a FabLab or similar non-commercial manufacturing environment. The aim of developing this approach is to enable viable and replicable commercialization of green tablets for an initially small but potentially growing market. Combining a localized smart manufacturing approach with robust green credentials could allow for higher margins, as well as flexibility in terms of production numbers and costs, and provide an important model for the green electronics sector.

3.3.5. Guideline development to design modular products that meet the needs of Circular Economy

R. Pamminger, S. Glaser, W. Wimmer, Vienna University of Technology, AT; G. Podhradsky, Speech Processing Solutions, AT

The intended paper presents the development of a guideline on how to design a modular product concept for smart mobile devices to meet the needs of Circular Economy.

First the D4R-Modularity was defined. Usually, smart mobile devices get obsolete caused by a failure or dam- age of only one single part, although all other parts are still working. These parts could serve more than one product lifetime. To continue the reuse of those parts, mixing different end-of-life strategies in one product is needed. The resulting design process shown in the guideline is divided into five tasks: The definition of an adequate main CE-strategy of the product, the development of an appropriate business model, the definition of CE-strategies of subassemlies, parts the definition and the actual design of modules. For these steps useful tools and methods are given to support the development of a product concept.

The case study in this paper is a "Phillips Digital Voice Recorder". The modular product concept of the digital voice recorder, together with a circular business model, aims at extending the lifetime of the whole product, the lifetime of different modules and supports efficient material recycling. The case study indicates that economic advantages as well as reduced environmental impacts can be achieved with applying the proposed guideline for modular products.

3.3.6. Technology Assessment of Wireless Charging using Life Cycle Tools

D. Sánchez, K. Schischke, N. Nissen, Fraunhofer IZM, DE; K. Lang, TU Berlin, DE

Smartphone market has experienced an exponential growth in the last decade. Numerous studies have modelled and characterised the energy consumption of smartphones using many approaches such as inner component consumption, network connection consumption or recharging process consumption. On the latter, extensive study has been carried out around conventional technologies of charging, but in the late years wireless inductive charging method has been increasingly popular, while little attention has been paid to it. This study aims to provide an overall insight into this technology by analysing its energy use and environmental impacts. For that, a life cycle approach is assumed, focusing in two areas: the chargers themselves as electronical devices and the impact that wireless charging compatibility has in smartphone design. As an outcome, the results characterize the environmental performance of this technology, opens up space for further investigation and suggests possible routes to improvement.

3.4. Plastics Recycling

3.4.1. Where the shoe pinches – tackling current market challenges for recycling plastics from WEEE

N. Vincenti, L. Campadello, A. Accili, ECODOM, IT; E. Wagner, P. Chancerel, J. Emmerich, TU Berlin, DE; P. Liravi, University of Northampton, UK; A. Berwald, G. Dimitrova, N. Nissen, K. Lang, Fraunhofer IZM, DE

As one the fastest growing waste streams in the EU, waste of electrical and electronic equipment (WEEE) growing at 3-5% per year, with an estimated generation above 12 million tonnes for 2020, has emerging and urgent potential for recycling. This paper gathers information on the current recycling market challenges, takes a look on weaknesses and needs of the secondary market for post-consumer recycled (PCR) plastics. On one side, barriers currently preventing or making the use of PCR plastics unfavourable and on the other side drivers pushing the application of post-consumer plastics in industrial sectors are investigated. The outcomes of the investigations were categorized to underline technical/technological, economic and legal.

3.4.2. Product Clustering for Improved Collection, Sorting and Recycling of Plastics

A. Boudewijn, J. Peeters, R. Dewil, D. Cattrysse, W. Dewulf, J. Duflou, KU Leuven, BE; P. Chancerel, TU Berlin, DE

Plastics are commonly used in electric and electronic devices for a variety of reasons. Consequently, the abundance of plastics in electric and electronic equipment results in a large presence of plastics in waste electric and electronic equipment (WEEE). In this paper, data is gathered regarding material density of the main plastic constituents of WEEE. Data concerning the material composition of back covers of CRT monitors, CRT televisions, LCD monitors and LCD televisions is subsequently collected in a distinct data set. The number of clustering and separation options is too large to manually determine a (near) optimal separation method. A computational framework for optimizing the use of density separation in material recovery facilities is therefore developed. In particular, a simulated annealing algorithm is presented that determines the optimal density values at which density separation should take place, as well as the order in which the separation steps should take place. This algorithm is applied to different partitions of the four products, indicating that separating monitors from televisions in a preprocessing step may substantially improve the profits of a WEEE recovery plant.

3.4.3. Collaboration between WEEE Take-Back Schemes and Recyclers: A way to face challenges by promoting new market for recycled plastics

A. Wittekoek, Coolrec, NL; E. Carteron, ESR, FR

Take-back schemes and recyclers play a major role in the WEEE sector to foster a new market for recycled plastics and develop a real circular economy. A take-back scheme collects important volumes of WEEE, sorts them by streams (large cooling appliances, small household appliances, ...) and sends them to specific processes of recycling handled by dedicated operators (recyclers), under control of the take-back scheme. Thanks to long term contracts, recyclers benefit from a visibility of WEEE volumes enabling them to invest in increasingly efficient processes and become real waste-to-product suppliers. Finally, some take-back schemes (as ESR) help EEE producers structuring an integration process of recycled plastic by facilitating collaboration between producers needs and recyclers capacities.

3.4.4. Plastic Close Loop in Electronic Products. Main drivers, challenges and key success factors

D. Miller, P. Gibbs, HP, US; T. Gil, HP, ES

Plastics can be considered one of the most important discoveries of the last century. Due to their tremendous advantages such as ease of manufacturing, versatility, durability and low cost, plastics have become the “new metals” in electronics manufacturing and other sectors. However, plastic has also become a growing environmental issue due to its petroleum based (non- biodegradable) baseline.

Conscious of the environmental impact, the implementation of open loop recycling solutions (although more environmentally friendly) were still far from being the holistic solution. More recently, aligning with the circular economy trend, closed-loop plastics recycling initiatives (in which post-consumer plastic is collected, recycled, cleaned and compounded to make new consumer products), addressed the issue definitively. At HP Inc., our experience in closed-loop recycling with ink cartridges started 14 years ago, but more recently we established a commitment and challenged ourselves to expand this process to the Hardware space.

The plastics closed-loop system is a complex puzzle which requires high focus in all stages including; channel partner relationships, take-back schemes from customers, conscientious consumers and recycling partners, recycling, compounding, molding, product design, qualification and manufacturing. HP joined partners with the same vision to develop of an end- to- end solution. Like any other complex industrial process, the solution must define and scale up an economically beneficial outcome for all partners involved. This paper highlights the drivers, challenges, success factors, and the continued learnings of this innovative, groundbreaking process.

3.4.5. Sourcing RoHS-compliant high-quality recycled plastics from the informal sector: Experiences and challenges.

A. Almack, Plastics For Change, IN; M. Gasser, Empa, CH

In most developing countries, the informal sector is responsible for 80-90% of recycling activities. The informal sector infrastructure lacks the advanced processing technology needed to create high quality recycled plastic pellets. As a result, it is difficult for the formal industry to source consistent supplies of high quality recycled plastic. We have developed a low cost process for SMEs in developing regions to create a high quality recycled ABS plastic source stock that complies with RoHS standards. This approach enables the informal stakeholders to implement responsible recycling practices without the large capital investment needed to establish advanced recycling facilities. It also allows a global market access for materials, as long as social and ethical sourcing requirements can be fulfilled through means such as a web based assurance platform and contributes to the vision of a clean, circular and sustainable economy.

3.5. Legislation-driven Developments

3.5.1. Influence behaviours and enhance best practices to promote sustainability by demonstrating the impact and cost of non-sustainability: towards a model to evaluate the full cost of non-durable business practices, the research misconduct case

C. Gans-Combe, INSEEC, FR; C. Kuszla, Université de Paris – Nanterre, FR

The ongoing H2020 European research project "DEFORM: Determine the global and financial impact of Research Misconduct" includes within its objectives to work on a cost model to give a value to non-sustainable practices in research and innovation, this to make visible the full costs of short term malpractices in such fields. In order to do so, the project has deployed a number of innovative decision -making IT tools including the deployment of an international database intending to provide a comprehensive definition of what is the perimeter as well as predictors of research & innovation misconduct to enhance/ease such adverse practices detection and mitigation by creating new models of responsible research governance and processes. The present paper presents the results achieved by the project during its first operational phase.

3.5.2. The impact of the EU geo-blocking regulation and the sales of goods directive on extended producer responsibility for electronic goods distance sellers

A. Campen, Landbell Group, DE

The European Internal Market provides equal access to services and goods to all residents in the EU, not discriminating them based on their country of residence or nationality. Implementation of extended producer responsibility however is still regulated on national markets rather than on the internal market of the EU. The Geo-blocking regulation and the revision of the Sales of Goods Directive try to tackle barriers to cross- border sales, but not take into account barriers for traders imposed by waste legislation.

3.5.3. Enforcement actions and product withdrawals across Europe for non-compliance with RoHS, REACH and POPs substance restrictions

A. Turnbull, BOMcheck, UK

This presentation discusses enforcement actions and product withdrawals across Europe for non-compliance with RoHS, REACH and POPs substance restrictions.

3.5.4. Defining Gold: An Examination of the New and Improved Elements of the IEEE 1680.1:2018 Standard

N. Gillis, E. Gately, Green Electronics Council, US; C. Bocher, DEKRA, DE

Personal Computers and Displays have evolved since the first IEEE Standard for Environmental Assessment of Personal Computer Products, Including Notebook Personal Computers, Desktop Personal Computers, and Personal Computer Displays standard was introduced in 2009. The new IEEE Standard for Environmental and Social Responsibility Assessment of Computers and Displays, published in early 2018, brings a wide range of new topic areas. One major difference between the two standards is that the original standard had an environmental focus while the new standard has both an environmental and social responsibility focus. New criteria include topics such as new hazardous substance restrictions, chemical assessment and selection, requesting and receiving substance inventory, long life rechargeable batteries, increasing product longevity, bulk packaging, corporate carbon footprint, greenhouse gas emissions from product transport, corporate reporting by suppliers, energy management systems, renewable energy use, social responsibility, and conflict minerals.

3.5.5. Enforcement of California Proposition 65 substance regulations and using screening assessments to reduce the compliance burden

A. Turnbull, BOMcheck, UK

This presentation discusses the new product labelling requirements for California Proposition 65 substance regulations which takes effect from 30 August 2018, enforcement activities and using screening assessments to reduce the compliance burden.

3.6. Smartphones: Repair, Remanufacturing and Reuse of Components

3.6.1. Let´s Fix the Scoring of Reparability

B. Flipsen, M. Huisken, iFixit, DE

3.6.2. Implications of Circular Economy on Users Data Privacy: A Case Study on Android Smartphones Second-Hand Market

D. Nguyen, S. Martinez, M. Khramova, Blancco, FI

Modern electronic devices, particularly smartphones, are characterised by extremely high environmental footprint and short product lifecycle. Every year manufacturers release new models with even more superior performance, which pushes the customers towards new purchases. As a result, millions of devices are being accumulated in the urban mine. To tackle these challenges the concept of circular economy has been introduced to promote repair, reuse and recycle of electronics. In this case, electronic devices that previously ended up in landfills or households are getting the second life, therefore, reducing the demand for new raw materials. Smartphone reuse is gradually gaining wider adoption partly due to the price increase of flagship models, consequently, boosting circular economy implementation. However, along with reuse of communication device, circular economy approach needs to ensure the data of the previous user have not been "reused" together with a device. This is especially important since modern smartphones are comparable with computers in terms of performance and amount of data stored. These data vary from pictures, videos, call logs to social security numbers, passport and credit card details, from personal information to corporate confidential data. To assess how well the data privacy requirements are followed on smartphones second-hand market, a sample of 100 Android smartphones has been purchased from IT Asset Disposition (ITAD) facilities responsible for data erasure and resell. Although devices should not have stored any user data by the time they leave ITAD, it has been possible to retrieve the data from 19% of the sample. Applied techniques varied from manual device inspection to sophisticated equipment and tools. These findings indicate significant barrier in implementation of circular economy and a limitation of smartphone reuse. Therefore, in order to motivate the users to donate or sell their old devices and make electronic use more sustainable, data privacy on secondhand smartphone market should be significantly improved. Presented research has been carried out in the framework of sustainablySMART project, which is part of Horizon 2020 EU Framework Programme for Research and Innovation.

3.6.3. Analysis of data remanence after Factory Reset, and sophisticated attacks on memory chips

M. Khramova, S. Martinez, Blancco, FI

Considering the amount of data stored on smartphones, it is critical that none of the user information is retrievable in case of device resell or disposition. Data security on disposed devices is one of the key enablers for device lifetime extension and, consequently, for making electronics more sustainable. Factory Reset, being default data wipe solution offered by Android, has already been challenged by researchers from University of Cambridge back in 2015. That has been the first comprehensive study and probably one of the most recognized works on evaluation of Android Factory Reset performance. The study proved that default erasure process is failing to securely sanitize the storage on Android versions from Gingerbread to Jelly Bean (v.2.3 – 4.3). However, despite frequent updates of Android OS, there was no further research conducted to reexamine Factory Reset reliability on newer devices and OSes. Our study has brought this line of research to the new level and investigated the changes of Factory Reset effectiveness over the past years. In addition, we have evaluated the robustness of in-built Android sanitization against attacks of different degree of sophistication including chip-level data read on one of the best-selling smartphones in history Samsung Galaxy S4 (80 Million units). The results show that Android Factory Reset logical sanitization has generally improved making user data more difficult to recover. However, default erasure process is still failing to irretrievably erase the data, which allowed us to retrieve the user data directly from the NAND flash bypassing the controller. Considering the share of smartphones running on Android Lollipop and below, over one third of Android devices (from Lollipop (5.0) and earlier) are vulnerable to improper storage sanitization. The magnitude of failing Factory Reset data sanitization is huge and despite the improvements the number of Android smartphones that may not properly sanitize the storage has grown by over 50% between 2015 and 2018. This means that over 770 million devices, that are currently circulating in the second-hand market, may still store previous owners' sensitive information, which represents serious security risk.

3.6.4. Battery Health in a Circular Economy: Embedding an Ageing Model in the Smart Battery System

C. Clemm, K. Marquardt, N. Dethlefs, K. Schischke, R. Hahn, N. Nissen, Fraunhofer IZM, DE; K. Lang, TU Berlin, DE

To enable continued use of used batteries and battery-powered devices through reuse, refurbishment, and remanufacturing, information on the state of health (SoH) of batteries is a crucial element. To date, various models for SoH prediction exist with varying degrees of certainty. A new empirical ageing modelling and monitoring for Li-ion batteries was developed, in which event counters for damaging events are integrated directly into the battery management system. The most relevant damaging events can be accounted for, such as cold charge, over-temperature, high currents, and particularly high or low average voltage. Reading out tracked data from a used battery may facilitate a quick and easy way to estimate the battery's health condition. As a result, a decision can be derived to determine whether a battery can still be used in a given application or whether it does no longer serve a useful purpose. Additionally, existing models may predict SoH more precisely using the tracked data.

3.6.5. Automated Identification and Sorting of Collected Smartphones

J. Reimers, Refind Technologies, SE

As part of the Horizon2020 project sustainablySMART, Refind Technologies have developed and built a phones sorting equipment using machine learning software technology. The demonstrator result and the possible integration downstream scenarios are described in this paper.

3.6.6. Automation of Smartphone Disassembly: Collaborative Approach

R. Ambrosch, E. Ambrosch, Pro Automation, AT; R. Pamminger, S. Glaser, Vienna University of Technology, AT; M. Regenfelder, ReUse, DE

The existing recycling technologies for electronics scrap focus on shredding devices into smaller fractions for recovery of prevailing valuable materials from integrated printed circuit boards (PCBs). By using metallurgic processes, many low volume materials such as rare earths metals and valuable still functioning integrated circuits (ICs) are lost during treatment.

The approach developed in the sustainablySMART project implies a collaborative disassembly unit which can be re-arranged and adapted to different types of mobile phones and combines less invasive technology with manual labor. In the sustainablySMART project, a demonstrator was developed and tested using different smartphones.

The paper presents research results obtained during the development of a collaborative disassembly cell for mobile phones and shows the possibilities of the newest automation technology. Additionally, the environment impact of the disassembly cell will be assessed and it is outlined to which business models and value chains the developed technology contributes to.

3.6.7. Desoldering and remanufacturing of semiconductor components from electronic mobile devices.

J. Sitek, M. Koscielski, A. Arazna, K. Janeczek, W. Steplewski, Tele and Radio Research Institute, PL; P. Ciszewski, P. Dawidowicz, Semicon, PL; G. Podhradsky, Speech Processing Solutions, AT; R. Ambrosch, Pro Automation, AT

The paper presents results of investigation obtained during desoldering process development leading to elaboration of machinery concept of automatic disassembly of electronic components from mobile and communication devices. The possibilities of different desoldering techniques and their limitations in automatic desoldering processes of components was presented. Next the issue regarding remanufacturing process of BGA semiconductor components for reuse was showed. The carried out investigations showed the best remanufacturing technique and confirmed an acceptable quality and reliability level of remanufactured BGA components for reuse in less demanding applications.

3.7. StEP: International E-waste management: now and in the future

E. Smith, StEP Initiative, AT; C. Fitzpatrick, University of Limerick, IE; E. Gunsilius, GIZ, DE; S. Adrian, US-EPA, US; R. Kuehr, UNU, DE; H. Böni, Empa, CH

StEP is an international initiative comprised of manufacturers, recyclers, academics, governments and other organizations. It envisions to be an agent and steward of change, uniquely leading global thinking, knowledge, awareness and innovation in the management and development of environmentally, economically and ethically-sound e-waste resource recovery, re-use and prevention.
Against this StEP strongly supports strategic approaches towards sustainability such as e.g. circular economy and zero waste/emissions. It also addresses especially UN Sustainable Development Goals 12 “Responsible Consumption and Production”.
During the last year StEP defined four focus projects to be at the core of StEPs work. The projects highlight different angles of e-waste management in developing as well as in industrialized countries. The potentials for job creation along the e-waste management chain under different framework conditions is analysed as well as models that can be created to facilitate partnerships between the formal and informal sector.
In order to successfully implement E-waste management solutions on a global level strategic alliances are of high importance. Within the StEP project potential alliances between existing national, regional and global networks are analysed, initiated and supported.
Further StEP looks into the future and produces a high level paper on the vision of the E-Waste management in 2050. New concepts, ownership models as well as demographic developments are taken into account in order to develop various scenarios.
One region showing major progress in terms of developing sustainable solutions for E-waste management is Latin America. Therefore, StEP has developed a regional working group for the region in order to facilitate cooperation and coordination between actors active in the region.

3.8. Energy

3.8.1. EEPLIANT2 – overview of market surveillance efforts to ensure product compliance with the EU energy efficiency requirements

F. Zach, Austrian Energy Agency, AT; I. Zlotila, ProSafe, BE

The key objective of the EEPLIANT2 project is to help deliver the intended economic and environmental benefits of the EU Energy Labelling and Ecodesign Directives by increasing the rates of compliance with the energy efficiency requirements. Seventeen Market Surveillance Authorities (MSAs) and a national agency from fifteen EU Member States work jointly to coordinate their monitoring, verification and enforcement actions.
The consortium of EEPLIANT2 is designing, carrying out and evaluating coordinated market surveillance actions across three different product sectors - participants review the product documentation and test energy performance of household and professional refrigerating appliances and the energy consumption resulting from appliances on network standby. In case of any non-compliance found, MSAs take appropriate enforcement action. A common way of dealing with non-compliant products shall be established. Circumvention issues are being addressed too, in order to make sure that all the intended energy savings are being achieved.
The EEPLIANT2 Action is a project coordinated by PROSAFE and funded by the European Union under the Horizon 2020 framework. It started in September 2017 and will last for 30 months.

3.8.2. Reverse Logistics for Defective Li-Ion batteries and Li-Ion battery containing Devices

A. Zych, C. Krause, A. Bohnhoff, ERP/Landbell Group, DE

Thanks to high efficiency in converting chemical energy into electrical current, which also allows to make them light and small, Lithium-Ion batteries are considered the best technology for powering portable devices. But this energy source has also some drawbacks: there is a significant risk of self-ignition attached, which rightfully makes such batteries subject to several provisions of the ADR regulation. The electronic and logistics industries have successfully designed the product distribution supply chain. However, the reverse supply chain and recycling are far more challenging and thus the solutions are still unmatured.
This paper and case study illustrate key challenges for critical Li-Ion battery transportation and recycling from the perspective of 2 global producers of notebooks who need to implement a battery recall program in the EMEA region.

3.8.3. Including grid storage to increase the use of renewables – the case of an island in the North Sea

M. Zackrisson, J. Hildenbrand, Swerea IVF, SE

Utilization of renewable energy supply is limited by fluctuations and lack of alignment with demand. Including storage technology in the grid can increase self-consumption of renewable energy in local applications as well as reduce peaks in supply and demand for local low voltage grids with a high share of renewable energy input. The project NETfficient, funded by the European Union under the Grant Agreement 646463, explores requirements and effects of storage solutions in a grid on different levels. On the island of Borkum in the North Sea, a variety of grid-connected use cases is installed and tested in pilot studies. This paper focusses on homes equipped with photovoltaic panels for harvesting energy and two different storage solutions. The research addresses the resource demand and emissions due to novel components and the potential to decrease resource demand during the use phase, applying a life cycle perspective for components and systems. Data from the project as well as from LCA databases are collected and used to calculate environmental impacts for three different systems or applications: Stand alone photovoltaic (PV) panels, PV panels and customized Li- Ion-batteries and PV panels with a disused Li-Ion battery from an electric vehicle. The results indicate that the customized or dedicated Li-Ion battery in combination with PV panels have a larger climate impact avoidance than the other systems.

3.8.4. Evaluation of risk factors in wind energy systems in Akita prefecture

N. Mishima, Akita University, JP

In accordance with the nation-wide promotion of renewable energy, Akita prefecture is strongly focus on wind energy systems. These years, annual increase of capacity is the largest in the area. However, in the Sea of Japan side of Northeast region of Japan, weather condition is special. For efficient operation and maintenance (O&M) of the wind energy systems in the area, such conditions should be considered. This paper focuses on special weather conditions and industrial backgrounds of the area and evaluates severity of different failure modes of wind energy systems in Akita prefecture. Based on the evaluation, the paper clarify which failure modes should be focused, in the O&M in the area.

3.8.5. UAV-based anti-smog monitoring of the quality of exhausts from private chimneys in urban areas

K. Cyran, M. Paszkuta, D. Myszor, W. Moczulski, SkyTech Products/Silesian Univ. of Technology, PL; T. Rohn, T. Drosik, M. Adamczyk, SkyTech Products, PL

The paper presents how properly designed UAVs can be used to efficiently control the quality of exhausts from private chimneys. Supervising the unmanned platform by virtual teleportation technology is presented together with types of sensors required for collecting the appropriate data. Monitoring with the use of such platforms is important step toward cleaner sky, because constant air monitoring reveals around 10-fold increase in concentration of PM10 and most hazardous for human life PM2.5 particles between summer and winter in southern Poland. By using proposed system, a systematic control of exhausts from private chimneys can be performed by municipal services with a goal of improving the quality of winter air.

3.9. iFixit Repairability Assessment Workshop

B. Flipsen, M. Huisken, iFixit, DE

At iFixit, we believe that repair is crucial to extend the lifetime of consumer electronics, and thus slow down our consumption rate of precious materials. In our quest for more repairable products, we have devised a method to measure ‘repairability’ of mobile ICT products in a repeatable manner. We have also developed an online tool for conducting this assessment. In this workshop, we will introduce you to our approach and let you try out the tool for real. We’ll provide smartphones for you to disassemble, in order to assess their repairability by yourself.

As places are limited, only for attendees with prior special registration!

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EU - H2020

CROCODILE

Recovering cobalt

CHALLENGE

Improve the economic and environmental values of recovery processes of cobalt in Europe.

SOLUTION

Provide a zero-waste strategy for important waste streams rich in cobalt such as batteries.

CROCODILE

TARGETED FEEDSTOCKS

The targeted primary and secondary raw materials are laterite mines, catalysts and batteries.

FACTS

Horizon 2020 - Grant Agreement No. 776473
EC contribution: 11 625 289€
4 years: from June 2018 to May 2022
Coordinated by Tecnalia, Spain

Please join our session on Wednesday 11.00-13.00 (Room 4 Rudolf)

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776473

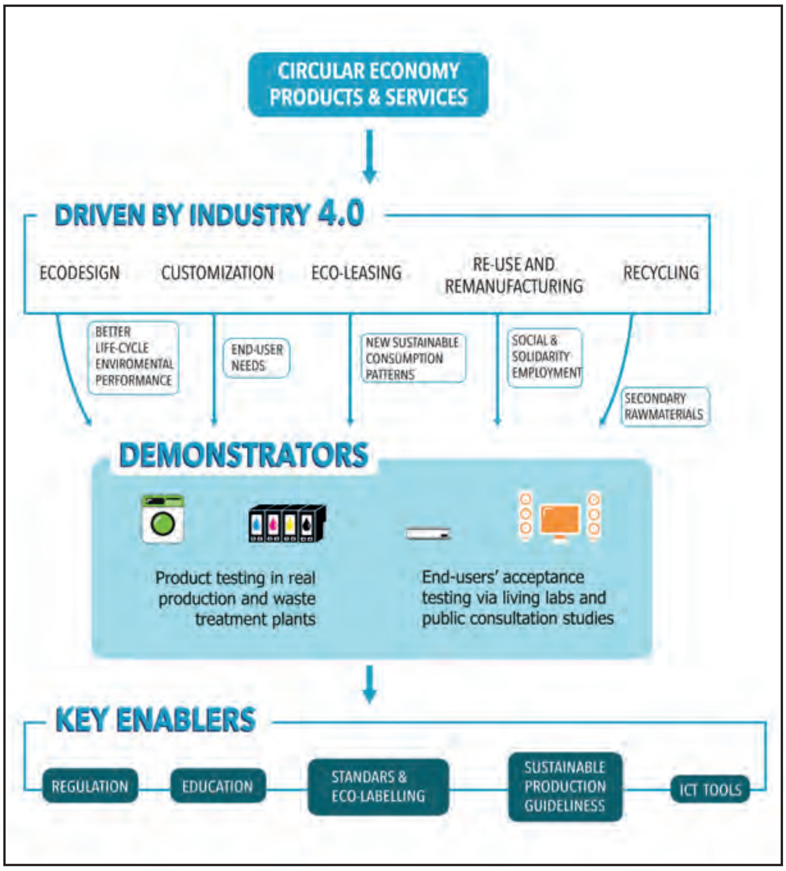
C SERVEES

Activating Circular Services in the Electric and Electronic Sector

C-SERVEES aims to boost a resource-efficient circular economy in the E&E sector through development, testing, validation and transfer of new circular economic business models based on systemic eco-innovative services.

www.c-serveesproject.eu

**But is circularity actually possible in the EEE sector?
Come to our workshop on Wednesday 14.00-16.00 (Room 2 Sisi) and debate this important question!**



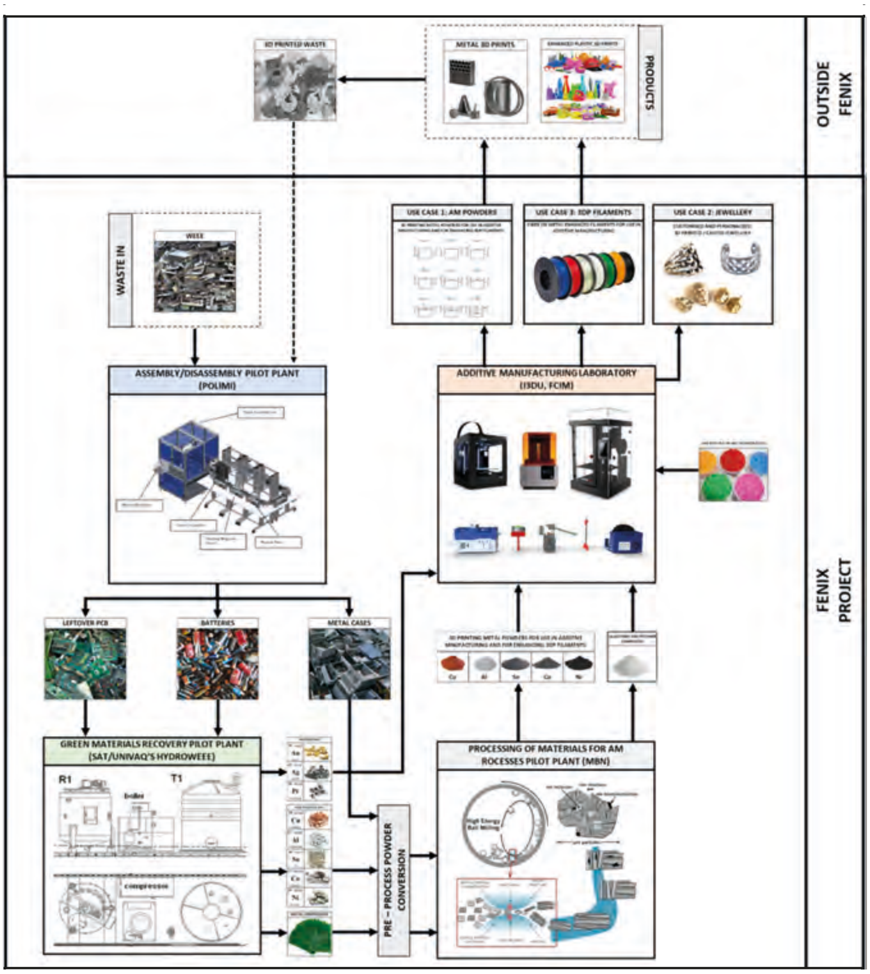
This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776714

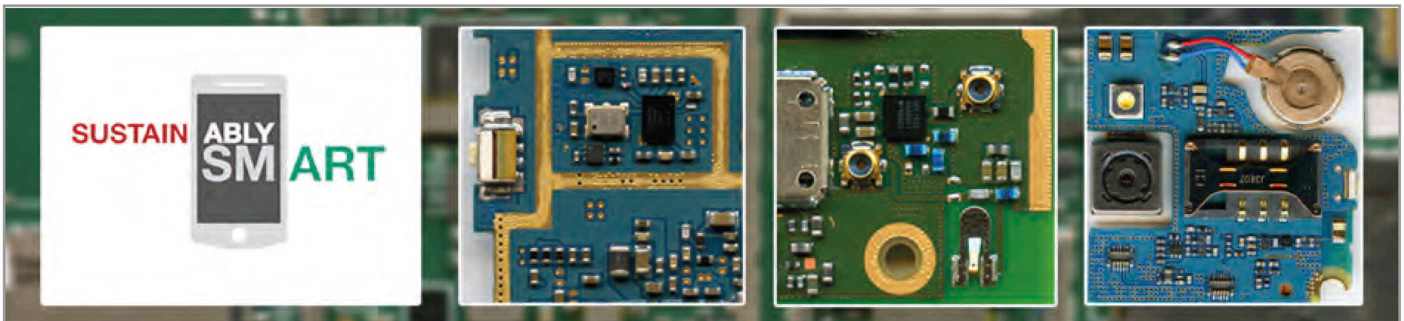
FENIX will demonstrate how three completely different industrial sectors (e.g. WEEE management, jewellery and 3D printing equipments) could be linked together in a more sustainable and networked supply chain able to cope with overcapacity issues, adopt industry 4.0 principles and exploit social media benefits in industrial systems.

www.fenix-project.eu

Please join our session on Wednesday 16.30 - 18.30 (Room 4 Rudolf) and visit us at our booth.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 760792.





Sustainable Smart Mobile Devices Lifecycles through Advanced Re-design, Reliability, and Re-use and Remanufacturing Technologies

www.sustainably-smart.eu

Please join the programme of sustainablySMART:

Tuesday, Nov 27, 2018
13:00 Booth Demo - Desktop grader by Refind
16:00 Booth Demo - Test services by Grant4Com

Wednesday, Nov 28, 2018
10:30 Booth-Demo - Component re-use by ITR and Semicon
13:30 Booth-Demo - Puzzlephone prototype by Circular Devices
16:00 Booth-Demo - Embedded modules by AT&S, Speech and Fraunhofer IZM

Thursday, Nov 29, 2018
08:30-10:30 sustainablySMART Session (Room 4 Rudolf)
11:00- 13:00 sustainablySMART Session (Room 4 Rudolf)
10:30 Booth-Demo - Data erasure from Blancco
13:30 Booth-Demo - D4R tablet by MicroPro
14:00-16:00 iFixit´s Repairability Assessment Workshop (Room 4 Rudolf) *

Friday, Nov 30, 2018
09:00-13:00 Live demonstrations of the automatic sorting and disassembly of smart mobile devices during the Technical Excursion at ProAutomation *

* Special registration required.

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 680604.

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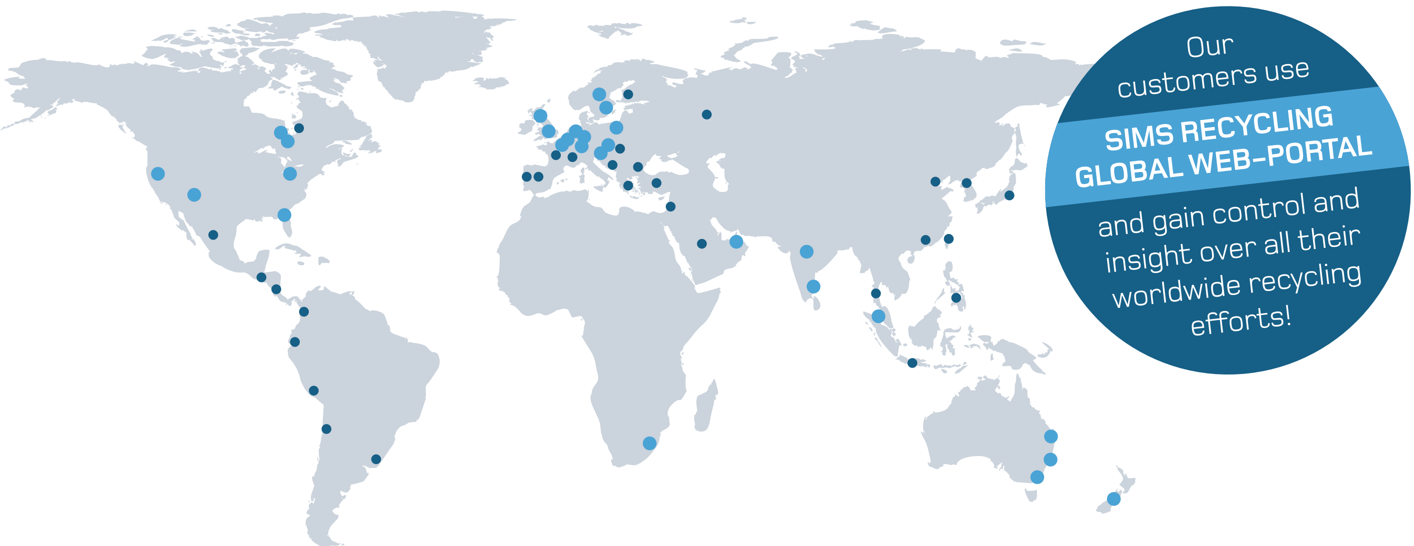

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