

Foreword

The circular economy is gaining increasing currency as a strategy in the pursuit of global sustainability. China enacted a law for the promotion of the circular economy in 2008, the Ellen MacArthur Foundation has played a pivotal role in engaging the business community, and the European Union is formulating a circular economy strategy as a socio-economically promising means to achieve resource efficiency.

In contrast to the take-use-dispose paradigm in a traditional linear economy, in a circular economy, resources are kept in use for as long as possible, extracting their maximum value. Products and materials are recovered and renewed, leveraging business models designed to support this regenerative activity.

There are many conferences and discussions about business opportunities and the policy potential for the circular economy. Discussion, however, about the actual environmental dimensions of this framework has been limited. For two and half decades the field of industrial ecology has examined the cycling of materials and energy at all scales. It may hence provide a scientific foundation and many insights for understanding and quantifying the extent of the environmental benefits to be obtained and the pitfalls to be avoided.

Scientists at **Vrije Universiteit Brussels (IES/VUB)**, **Yale University**, the **University of Cambridge**, the **Norwegian University of Science & Technology** and **INSEAD** under the auspices of the International Society for Industrial Ecology have organized a day-long event to explore environmental and resource dimensions of the circular economy. The event will present examples of research—along with commentary by stakeholders—that can illuminate what industrial ecology can contribute to the beneficial development of the circular economy.

Organizing Committee:

Anders Hammer Strømman, The Norwegian University of Science and Technology

Harri Kalimo, Vrije Universiteit Brussel

Reid Lifset, Yale University

Kieren Mayers, INSEAD

Jonathan Cullen, The University of Cambridge

Helen Ann Hamilton, The Norwegian University of Science and Technology

Chris Kennedy, The International Society for Industrial Ecology

Chair, Speaker and Panel Members Biographies

Chris Bayliss

Chris, Deputy Secretary General for the International Aluminium Institute, has nearly fifteen years of experience in the aluminium industry, as part of the International Aluminium Institute team. In that time his work and interests have developed, as has the industry's, from a "licence to operate" focus to one that addresses increasing "licence to market" issues. He is involved in all aspects of the Institute's sustainability activities, from data collection and analysis to communication and has played a leading role in collaborative projects to develop, among other things, the industry's greenhouse gas accounting protocols, occupational health performance measurement tools, the global aluminium mass flow model and The Aluminium Story (www.thealuminiumstory.com). Chris holds Masters degrees from the University of Cambridge and the University of London and has conducted fieldwork around the globe, with a particular focus on China, India and Pakistan.

Silke Conrad

Silke Conrad has been working in her current position within the Daimler Representative office in Brussels since 2010, focusing on environmental and sustainable energy issues and on transport policies, chemical legislation and resource efficiency in relation to the automotive industry. Recently she has developed a particular interest in sustainable transport solution within the circular economy. Prior to this, she has been working in different positions within the Daimler group in Brussels. She studied communication and PR and has gained her degree in Economics in 2001. She is a German citizen and currently lives with her partner and two children just outside Brussels.

Jonathan Cullen

Jonathan is a University Lecturer in Energy, Transport and Urban Infrastructure at the University of Cambridge and a Fellow of Fitzwilliam College. He studied at Cambridge for the MPhil in Engineering for Sustainable Development. Following this, Jonathan completed a PhD before taking up the role of Research Associate for the WellMet2050 research programme. Jonathan's research interests include whole energy systems, energy and material demand reduction and low-carbon energy technologies. His energy research aims to characterise physical efficiency limits for energy devices, systems and services and provide consistent frameworks for evaluating energy demand reduction options and emissions abatement strategies. Jonathan also works on novel material efficiency options for reducing demand for energy intensive materials as an alternative carbon abatement strategy for industry. This work is described in the book, *Sustainable Materials: with both eyes open* (available for free download from www.withbotheyesopen.com).

Roland Geyer

Roland Geyer is assistant professor at the Bren School of Environmental Science and Management. Prior to this appointment, he held positions as research fellow at the Centre for Environmental Strategy, University of Surrey, UK; research associate at the Centre for the Management of Environmental Resources, INSEAD, France; and consultant in financial risk management for AMS (now part of CGI) in Germany. In his research, he uses the approaches and methods of industrial ecology, such as life cycle assessment and material flow analysis, to assess pollution prevention strategies based on recycling, reuse, and material and technology substitution. Dr. Geyer also combines these approaches with research methods from operations management and other fields in order to study the relationship between environmental performance, economic viability, and technical and operational feasibility of pollution prevention strategies.

Willi Haas

Willi Haas, DI, Dr.; is a graduated engineer in mechanical engineering and management and holds a doctoral degree in philosophy/subject sociology. He is a senior researcher and lecturer at the Institute of Social Ecology, Vienna. His research focuses on society-nature interactions at various scales including their interdependencies. He studies local communities to better understand both how global (environmental) change affects the local and how local action contributes to global problems and/or improvements. His further research interest is in socio-ecological transitions in the past as well as in future as discussed under the heading of transition pathways. In this context, he studies the numerous interrelations between societal energy use and human labour with a long-term perspective. He also deals with the link between sustainability and health with a special focus on health co-benefits.

Stefanie Hellweg

Stefanie Hellweg is full professor for ecological systems design at the Institute of Environmental Engineering of ETH Zurich (Switzerland). After completing her Ph.D. on the environmental assessment of thermal waste treatment processes she worked as a post-doc and senior scientist at the Institute for Chemical and Bioengineering at ETH Zurich. Between 2004 and 2005 she was a visiting scientist at Lawrence Berkeley National Laboratory and in 2013 at Yale University. Since 2006 she holds the Chair for Ecological Systems Design at ETH Zurich. Her main research interests are the environmental assessment of products and processes, e.g. food products, chemicals and waste treatment technologies. Since 2011 she is member of the National Research Council of the Swiss National Science Foundation.

Christoph Herrmann

Prof. Dr.-Ing. Christoph Herrmann is a university professor for Sustainable Manufacturing & Life Cycle Engineering and co-director of IWF, Institute of Machine Tools and Production Technology, Technische Universität Braunschweig. Since 2009 he co-leads the Joint German-Australian Research Group on "Sustainable Manufacturing and Life Cycle Management". From August 2009 to February 2013 he was scientific director and member of the NFF (Niedersächsisches Forschungszentrum Fahrzeugtechnik / Automotive Research Center Lower Saxony), Germany. Professor Herrmann has conducted various industry and research projects in the context of life cycle engineering and sustainable manufacturing on national and international level. He was chairman of the international conference series Eco-X in 2005 and 2007 in Vienna and chairman of the 18th CIRP Conference on Life Cycle Engineering held in Braunschweig in 2011. He has published more than 200 papers and book publications as author, co-author and editor. Professor Herrmann is member of the International Academy for Production Engineering (CIRP) and the International Society for Industrial Ecology (ISIE).

Johan Holmqvist

Johan Holmqvist is Director of Sustainability at Sony Mobile Communications (a business unit within Sony Corporation). He has also been Senior Environmental Specialist within Sony Mobile and globally responsible for "Design for Environment" and environmental compliance. Before he joined ITC industry he was a senior environmental risk assessor and eco-toxicologist. Johan has a Ph.D. in Biogeochemistry from Lund University in Sweden where he studied the dynamics of macronutrients in soil and trees/plants. He is also a member of; the steering group in the multi-stakeholder project on chemicals in products (CiP) led by UNEP/UN, ChemSec business group (ChemSec is a International Chemical Secretariat, a non-profit organisation working towards a toxic free environment) and BOMcheck steering group.

Harri Kalimo

Dr. Harri Kalimo a Research Professor at and the Acting Academic Director of the Institute for European Studies at the Vrije Universiteit Brussel. Trained as a lawyer and an economist, he is also the Director of IES's post-graduate programmes in European and international law ("PILC"), as well as in political science and economics ("EuroMaster"). Prof. Kalimo works in the IES research clusters on Environment and Sustainable development and on European Economic Governance. His research focuses on areas where European, American and/or international economic and environmental laws and policies interact, notably in the areas of circular economy (in particular Extended Producer Responsibility, WEEE and renewable energy), environment-and-trade issues and policy instruments. Before his academic career, Prof. Kalimo held managerial and legal positions in Nokia Corporation.

Christopher Kennedy

Christopher currently serves as President of the *International Society for Industrial Ecology*. Additionally, he is a Professor at the University of Victoria in the Civil Engineering department. In his research, he applies the principles of Industrial Ecology to challenges of developing sustainable cities and global infrastructure systems. He also draws upon qualifications in Civil Engineering, Economics and Business to advise on policies and planning for sustainable infrastructure. Clients have included the governments of Canada, China, Saudi Arabia; UAE, and the UK, as well as the World Bank, Ontario Ministry of Finance, and others. In 2011/12, he was seconded to the OECD in Paris, to work on Cities, Green Growth and Policies for Encouraging Investment in Low Carbon Infrastructure. He has been a visiting professor at Oxford University and ETH Zürich. He is also a Senior Fellow at the *Global Cities Institute* and author of *The Evolution of Great World Cities: Urban Wealth and Economic Growth*.

Jacquetta Lee

Dr Lee is a Mechanical/Materials engineer and holds a PhD in Environmental Systems Analysis from Cranfield University. Prior to joining the Centre for Environmental Strategy at the University of Surrey in she worked for Rolls-Royce plc in their Environmental Strategy department, specialising in Life Cycle Analysis and Design for Environment. On joining academia in 2003, she spent two years as a Leverhulme Special Research Fellow, investigating the potential for television to influence environmental behaviour of consumers. She has over 20 years' experience in sustainable systems analysis across many industrial sectors including aerospace, electronics, construction and agriculture. Her current areas of research interests include the operationalisation of 'absolute sustainability' and the development of social LCA approaches. She is the Director of the Practitioner Doctorate Programme in Sustainability, at the University of Surrey.

Reid Lifset

Reid Lifset is a Research Scientist and Resident Fellow in Industrial Ecology on the faculty of the School of Forestry & Environmental Studies at Yale University. He is the founder and Editor-in-Chief of the *Journal of Industrial Ecology*, an international peer-reviewed bi-monthly headquartered at and owned by Yale University and published by Wiley-Blackwell. In addition, he serves as the Associate Director of the Industrial Environmental Management Program. Mr. Lifset's research focuses on the application of industrial ecology to novel problems and research areas, the evolution of extended producer responsibility (EPR), and the characterization of global metal cycles. He is a member of the governing council of the International Society for Industrial Ecology (ISIE) and the editorial advisory board for the Springer book series on Eco-efficiency in Industry & Science. He has served on the U.S. Environmental Protection Agency's Science Advisory Board, the managing board of the *American Journal of Science*, and the advisory board for the Q Collection in New York City.

Kieren Mayers

Dr. Kieren Mayers is an academic practitioner working as Head of Environment and Technology Compliance at Sony Computer Entertainment Europe, based in London. He is also an Executive in Residence at INSEAD Social Innovation Centre in Fontainebleau, France, through which he has authored a number of articles on industrial ecology in practice. He has over 20 years' experience in environmental, waste, and sustainability management within IBM, Xyratex, HP, Geodis, and Sony, and was previously a Research Affiliate at Yale School of Forestry and Environmental Management. Kieren graduated with an Engineering Doctorate in Environmental Technology from Brunel University, London.

Christina Meskers

Christina Meskers is senior manager and leading the Market Intelligence and Business Research team at Umicore Precious Metals Refining in Hoboken, Belgium after completing her PhD in metallurgy at Delft University of Technology in 2008. She is responsible for monitoring and assessing medium and long term market, supply chain and policy developments, and for collaborative (research) projects in this domain. Part of her activities is bringing Umicore's ideas and expertise on closed loop material cycles, recycling and sustainability forward in numerous interactions with stakeholders in industry, research and government. Among others Christina co-authored the United Nations' International Resource Panel report "Metal Recycling - Opportunities, Limits, Infrastructure" (2012), besides numerous conference and journal publications. Christina currently serves as member of the TMS (The Minerals Metals & Materials Society) Extraction & Processing Division council, the Materials & Society Committee and the Public and Government Affairs Committee. In 2008 she was a recipient of the TMS Young Leader Award of the Extraction and Processing Division of TMS.

Daniel Müller

Daniel B. Müller is a professor in Industrial Ecology and director of the International MSc Programme in Industrial Ecology at the Norwegian University of Science and Technology (NTNU). Prior to his appointment at NTNU, he was a post-doc at TU Delft and an associate research scientist at Yale University. In 2014, he was a visiting professor at the Chinese Academy of Sciences (CAS). He has served on a variety of committees and institutions, such as the U.S. National Research Council and the Swiss National Research Programme, and The Intergovernmental Panel on Climate Change (IPCC), where he was a lead author of the Fifth Assessment Report, WG III (Mitigation). He is a council member of the International Society for Industrial Ecology (ISIE), and was the founding chair of ISIE's section "Material Flow Analysis – ConAccount" (today "Socio-Economic Metabolism"). His main research interests evolve around the understanding of the socio-economic metabolism to enable high qualities in built and natural environments.

Antti Peltomäki

Mr. Antti Peltomäki is Deputy Director-General of the Internal Market, Industry, Entrepreneurship and SMEs Directorate-General since February 2012. In this function, Mr. Peltomäki is responsible for Industrial transformation and Advanced value chains; Consumer, Environmental and Health Industries; and Innovation and Advanced Manufacturing Directorates. Mr. Peltomäki is also the Commission representative at the Management Boards of the European Chemicals Agency (ECHA). Before that, Mr. Peltomäki was Deputy Director-General in the Information Society and Media Directorate General where he was firstly responsible for research cooperation in the context of the seventh research framework (2007-2013) and thereafter for regulatory policy in the telecommunications, media and internet fields. Mr. Peltomäki has also worked as Head of the Commission's representation in Helsinki in 2006 – 2007. Prior to joining the Commission in 2006, Mr. Peltomäki worked for almost ten years in the office of the Prime Minister of Finland, initially as State Under-Secretary, then State Secretary for EU affairs. A lawyer by training, Mr. Peltomäki began his career as a coordinator of international research and training courses at the Helsinki University of Technology.

Umberto Raiteri

Umberto Raiteri is the President and CEO of European Recycling Platform (ERP). In this role Raiteri is responsible for the management of ERP's activities across Europe; in eight years he has driven the growth of ERP to reach 100M€ turnover, 2500 member Companies and operations in 17 countries. He works closely with ERP's local management teams to develop and enhance ERP's position as the key player in the WEEE compliance market in Europe. Raiteri has 28 years of leadership experience in the European business environment, covering different responsibilities at local and European level within the Electrolux Group, where he held various senior managerial positions before being appointed as General Manager for ERP Ireland in 2005. Under his leadership, he guided the creation and start-up of the first ERP local entity, and consequently in August 2006 he's been appointed responsible for ERP in Europe. During his tenure, ERP Europe saw its turnover and membership quadruple in size and its credibility being established as a leading stakeholder of the WEEE business in Europe.

Helmut Rechberger

Helmut Rechberger is a full professor for Resource Management at Vienna University of Technology since 2003. He received his professional education in Vienna, at ETH Zurich, and at Yale. His research interests are: further development of evaluation methods and concepts in waste and resource management including statistical entropy; introduction of mathematical-statistical tools to Material Flow Analysis to consider data uncertainty; resource accounting; investigation on morphological and chemical composition of urban stocks including dynamics; recovery of valuable substances from ashes and slag; waste characterization.

Robert Rivett

Dr. Robert M. Rivett joined Emerson Electric Co. in August 1993 is now Corp. Tech. VP and head of the global operations for the Emerson Advanced Design Center. EADC is responsible for solving technical problems at Divisions or suppliers anywhere in the world and conducting Design Reviews on key products. Besides leading the ADC, he is responsibilities include, but are not limited to:

- Developing relationships with Universities and Institutes internationally
- Leading product environmental conformance efforts (i.e, RoHS, WEEE, etc.)
- Developing Emerson's long term material strategies

Vera Susanne Rotter

Vera Susanne Rotter holds a degree in Environmental Engineering. After working for the German Technical Control Board (TÜV) in Hannover (Germany) in the field of process control in nuclear power plants and radio-active waste treatment, she became, in 2003, junior professor for Solid Waste Management at Berlin Technical University. In 2009, she was visiting professor at UNESCO-IHE Institute for Water Education, Delft, The Netherlands. In 2010, she was appointed as full professor at the TU Berlin for Solid Waste Management (since 2016: Circular Economy and Recycling Technology). Her main fields of research are on product-centric recovery strategies and recycling technologies. She is appointed member of the expert panel "R²- Innovative Technologies for Resource Efficiency" (R²- Innovative Technologien für Ressourcen Effizienz) for the German Federal Ministry for Research and Education (BMBF). In 2009 and 2011 she was invited participant of the working group on Recycling of International Panel for Sustainable Resource Management, under the United Nations Environmental Programme (UNEP) and contributed to two reports "Recycling Rates of Metals" and "Metal Recycling: Opportunities, Limits, Infrastructure".

Cesar Santos

Cesar Santos is a policy analyst in the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs, where he oversees the implementation of the Ecodesign Directive. The main focus of his career as a Commission official has been on industrial policy. Before joining DG Enterprise in 2001, he was an IT consultant in the private sector in Madrid and London. Cesar holds a MSc in Telecommunications Engineering from the Universidad Politécnica in Madrid.

Hugo Schally

After working for UNDP, the Austrian Ministry for Foreign Affairs and the Organisation for Security and Co-operation in Europe (OSCE) in Vienna Hugo-Maria Schally joined the European Commission in 1998 and has been Head of Unit in the Directorates General "External relations", "Development" and "Environment" since 1998. Moreover, since 1st June 2014, Hugo has been Head of Unit in the Directorate General "Environment" of the European Commission dealing with eco-innovation and circular economy. In this function he is entrusted with the coordination of the preparation of the new EU package on circular economy and the development and implementation of EU policies and instruments in support of the transition to a circular economy.

Anders Hammer Strømman

Professor Strømman is the Director of the Industrial Ecology Programme at the Norwegian University of Science and Technology, which was the first institution worldwide to award both master and PhD degrees in industrial ecology. In addition to educational responsibilities, Strømman oversees the programmes' research portfolio covering all key methodological domains of industrial ecology applied to a multitude of sectors. The current group numbers are around 40 research staff and 5 professors. Professor Strømman is an author of 80 journal publications covering development and integration of methods in industrial ecology as well as applied analysis related to the environmental assessment of energy, transport, bio-resource systems as well as climate land use interactions. In 2011, Professor Strømman was awarded the Laudise medal in Industrial Ecology in recognition of his research. He was a contributing author to WGIII of the 5th assessment report of the IPCC and a member of the Norwegian Academy of Sciences.

Arnold Tukker

Arnold Tukker is a Professor of Industrial Ecology and Director of the Institute of Environmental Sciences (CML) at Leiden University. Until then he was Business line manager Societal Innovation and Economy at TNO, a large not for profit research organization in the Netherlands, where he retains a 30% position as senior researcher. Arnold set up prominent EU projects in the field of sustainable product design (SusProNet) and sustainable consumption and production (SCORE!) and was core member of the 10 Million Euro Dutch Knowledge Network on Sustainable System Innovations. He currently co-ordinates a string of major programs worth 15 million Euro with some 20 key European research institutes in the field of resource-efficiency, a.o. constructing the world's most ambitious and detailed global energy/resource/economic input-output databases and models (EXIOBASE). He authored 6 books, 60 refereed papers and 7 special issues on sustainability research. He has been engaged with work of the UN on the Green Economy Initiative, the Resources Panel, the Ten Year Framework of Programs on Sustainable Consumption and Production, and Sustainable Development Goals.

Kees Veerman

Project leader in Circular economy at the Netherlands Ministry of infrastructure and the environment. Now more than 26 years working on environmental policy making, from waste management to circular economy. Looking for improving the environment by cooperation between policy, business and knowledge.

Carsten Wachholz

Carsten is responsible for EU policies on sustainable consumption and production at the EEB. He advocates for the EU to match its rhetoric on resource efficiency and circular economy with ambitious measures in the areas of eco-design, labelling and the related fields of product policy. Before coming to Brussels, Carsten was deputy head of the department for environmental protection at the headquarters of German NGO NABU, where he worked on climate change, energy policy and sustainable development. He also gained expertise as a consultant in facilitating stakeholder communications, public participation and conflict resolution. Carsten is German and speaks English and German as well as some Swedish and French.

Luk van Wassenhove

Professor Van Wassenhove's research and teaching are concerned with operational excellence, supply chain management, quality, continual improvement and learning. His recent research focus is on closed-loop supply chains (product take-back and end-of-life issues) and on disaster management (humanitarian logistics). He is senior editor for *Manufacturing and Service Operations Management* and departmental editor for *Production and Operations Management*. In 2005, Professor Van Wassenhove was elected Fellow of the Production and Operations Management Society (POMS). In 2006, he was the recipient of the EURO Gold Medal for outstanding academic achievement. In 2009 he was elected Distinguished Fellow of the Manufacturing and Services Operations Management Society (MSOM), and received the Lifetime Achievement Faculty Pioneer Award from the European Academy of Business in Society (EABIS) and the Aspen Institute. In 2013 he became Honorary Fellow of the European Operations Management Association (EUROMA). He is a member of the Royal Flemish Academy of Sciences. At INSEAD he holds the Henry Ford Chair of Manufacturing. He currently leads INSEAD's Humanitarian Research Group.

Norbert Zonneveld

Mr. Norbert Zonneveld is currently partner at GrinwisZonneveld - Business Consultants and is the Executive Secretary of the European Electronics Recycling Association (EERA) since 2004. Among others, he has worked as the CEO of MIREC, part of the waste services division of SUEZ, the French-quoted conglomerate. Mr. Zonneveld holds a M.Sc. in Biology and Business Administration, from the Wageningen University and Erasmus University. His organization is based in The Netherlands.