

Summary Curriculum Vitae Prof. dr. Arnold Tukker (2023.01.02)

Education

- Ph.D. Policy Sciences, LCA and toxic risk assessment, Tilburg University, Netherlands (1996-1998). Supervisor: prof. dr. J.M Cramer
- M.Sc. Chemistry, Utrecht University, Netherlands (1978-1987, including teaching license)

Current appointments

- 2014.04-present Chair of the Board, *Leiden-Delft-Erasmus Centre for Sustainability* (300 involved researchers; focus on systems analysis, technology and design, business models and behavior, and governance for a circular economy) via triple helix innovation hubs of science, business, and government
- 2013.10-present Scientific director (until 2022.09, maximum 8 year term) and Professor of Industrial Ecology, Institute of Environmental Sciences (CML), Faculty of Science, *Leiden University*, Netherlands (>150 staff; 80%), a globally leading institute in Life cycle assessment, Material Flow Analysis, Input-Output analysis, environmental systems analysis, and biodiversity/ecosystem research.
- 2013.10-present Senior scientist, *TNO*, Netherlands (20%)

Previous appointments

- 2010.04-2014.09 Professor II, Industrial Ecology Program/Institute of Product Design, *NTNU*, Trondheim, Norway (20%)
- 1990-2013.10 Various positions including Business Line Manager Societal Innovation and Economy, *TNO*, Netherlands
- 1988-1990 Policy official, Environment Inspectorate, *Environment Ministry*, Netherlands

Scientific achievements and related recognitions

- 191 papers in the peer reviewed, scientific literature. Citations: 10700 (Scopus); 22500 (Google scholar); H-index: 44 (Scopus); 64 (Google scholar);
- >150 invited/keynotes lectures including for the EU Parliament, COP21 (Paris) and COP22 (Marrakech), Benelux Parliament, International Society for Industrial Ecology, Gordon research conference on Industrial Ecology, etc.
- About 15 graduated PhDs, over 25 ongoing.
- Honorary doctorate, Linköping University, November 2022
- Highly Cited Researcher 2019-2022, Clarivate/Web of Science Group (top 0.1% globally)
- Elected as Fellow of the Paris Institute of Advanced Study, year 2022/23
- Elected as Member of the European Academy of Sciences, 2018
- Awarded about 40 Mio Euro in project grants during his career.

Education experience

- Teaching courses at BSc. and MSc. level on Life cycle assessment, Input-output analysis, and a general introduction to sustainable development; supervision of over 10 MSc students
- Initiating the development of a MSc. Governance of Sustainability and a BSc. in sustainability
- University Teaching Qualification (2016)

Coverage of subjects in environmental sciences

In his career, Prof. Tukker showed an in-depth interest in different aspects of sustainability, reflected

by high impact projects, reports and publications in the following scientific fields:

- Socio-economic and environmental assessment of production-consumption systems (Material flow analysis, LCA, input-output databases/models, resource-efficiency and circularity assessments)
- Sustainable technology and sustainable product design
- Sustainable, circular business models and sustainable consumption
- Governance and policies related to sustainable transitions

He applied these approaches for research into food and agricultural systems, the built environment, transport systems, electrical and electronic equipment, waste management, production of chemicals and related toxicity risks, material supply systems and the circular economy, and energy/climate.

Services to society and interaction with policy, business and civil society

Prof. Tukker worked for a long time at TNO, a not for profit research organization. Projects invariably were in interaction with policy, business, and/or civil society and aimed at co-creation of or advising on sustainability strategies. In this context he worked frequently with EU DG's (including Climate Action, Environment and Industry), DG JRC, EEA, Eurostat, US EPA, OECD, UN Statistical Division, UN Environment Program, UN Economic and Social Commission for Asia and the Pacific (ESCAP) and many organizations in Europe and beyond including Yale University, Tsinghua University, IIASA, Universitas Indonesia, Padjadjaran University, Tokyo University, and many others. Some illustrations:

- Member, Scientific Advisory Board, MISTRA-REES project, led by Linköping University
- Co-chair, European Rare Earth Competence Network, 2014, set up by DG Industry
- Member, European Innovation Partnership Raw Materials, 2016-now
- Member, Circular Economy 100 Network, Ellen MacArthur Foundation, representing Leiden University as one of the 20 universities involved world wide
- PI, Marie Curie Innovative Training Network on a Circular Economy ('Circeuit'), with a.o. TU Delft, NTNU, Grenoble INP, and Leiden, Cranfield, Aston, and Linköping University (15 PhDs)
- Member, Director's Supervisory Board, Program Monitoring Circular Economy, led by the Netherlands Environmental Assessment Agency (PBL), Netherlands (2020-now)
- Member, Scientific Advisory Board, Circularity Gap Report. Published annually by Circle Economy at the World Economic Forum, Davos.
- Co-lead Author, Sustainable Industry chapter, Green Economy Report, UNEP (2009-2010)
- Member, Core Team Dutch Knowledge Network on System Innovations (KSI, 2003-2008)

Management, organizational and other skills

Prof. Tukker developed over time skills and insights of how to manage large organizations depending on external finances, and that have to operate in complex, networked contexts and have to balance inputs of stakeholders with different interests. Illustrations include:

- A large number of scientific network projects aimed at organizing a science field, between 2000 and 2010 (e.g. SusProNet on sustainable business models, SCORE! on sustainable consumption)
- Taking over the management of the Institute of Environmental Sciences (CML) at Leiden University in 2013 after a period of reorganizations, and growing it with support of staff and other management to a vibrant institute tripled in size by 2022 (>150 staff, 9 Mio turnover, external acquisition 10 Mio Euro in 2022 mainly by mid-career staff and from very diverse sources)
- Setting up the Leiden-Delft-Erasmus Centre for Sustainability and the Leiden University Liveable Planet program, both networked programs/centres working via bottom-up coordination of over 20 scientific groups of the different universities, business partners, and government representatives.

Full Curriculum Vitae Prof. dr. Arnold Tukker

Personal details

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Annex 1: Education

- Ph.D. (1996.12-1998.11) Tilburg University, Ph.D. Thesis 'Frames in the toxicity controversy- Risk assessment and Policy Analysis related to the Dutch Chlorine Debate and Swedish PVC Debate (published as a book by Kluwer, Dordrecht, Netherlands, 1999, 480 p.). Supervisor : Prof. Dr. J.M. Cramer. Subjects covered:
- Philosophy of science
 - Policy sciences and governance of complex/controversial decision making
 - Substance flow analysis, LCA, and Risk analysis of toxic substances
 - Assessment of economic and social implications of radical innovations
- M.Sc. (1978-1987) University of Utrecht, Utrecht, the Netherlands.
- Main subject: analytical chemistry.
 - Secondary subjects: economics; pedagogy and didactics
- Various
- Academic leadership (2016), Dedicated Leiden University leadership course
 - Development of Inspiring Leadership (2007-2009), BonSpirit. Breda. Dedicated TNO leadership course
 - De Vlerick Leuven-Gent Management School, 1999: Dedicated TNO Research management course
 - Colegio Estudios Hispánicos, Salamanca, Spain, 1987: Spanish.
 - Various other courses in the field of journalism, computer science, etc.

Annex 2: Current appointments

- 2014.04-present Chair of the Board, *Leiden-Delft-Erasmus Centre for Sustainability* (300 involved researchers; focus on systems analysis, technology and design, business models and behavior, and governance for a circular economy). The three universities in South Holland, Leiden University (UL), Delft University of Technology (DUT), Erasmus University Rotterdam (EUR), set up a strategic collaboration via joint research centres. I was asked to set up LDE CfS, focusing on resource-efficiency and a circular economy. Position and achievements:
- Establishment of triple helix innovation hubs on circular Industry, Cities and Agro-Food with authorities and business, that acquired by now 8-10 Mio Euro research funding via EU H2020, the EIT KIC Raw Materials, National science foundations, the provincial circularity acceleration program ACCEZ, Dutch Top sectors, municipalities, next to management funding via the LDE fund
 - Bundling/aligning 5 MSc programs as 'circular economy' education, with >300 graduations per year (Industrial Ecology, Materials technology, Circular design, Global business & sustainability, Governance of sustainability)
 - Evaluated as 'good, if not best practice' within LDE, and selected by the three Boards of directors for a next round of management support funding from 2019-2024

- 2013.10-present Scientific director (until 2022.09, maximum term of 8 years) and Professor of Industrial Ecology, Institute of Environmental Sciences (CML), Faculty of Science, *Leiden University*, Netherlands (>150 staff; 80%), a globally leading institute in Life cycle assessment, Material Flow Analysis, Input-Output analysis, environmental systems analysis, and biodiversity and ecosystems research.
- Tripling the size of the institute from 40-50 staff (including PhDs) and a budget of 2.5 Mio Euro in 2013 to over 150 staff and 9 Mio Euro in 2022.
 - Expanding CML's education program by doubling student numbers in a Minor Sustainable Development, expanding the MSc Industrial Ecology, and initiating a new MSc Governance of Sustainability and a BSc Sustainability Science
 - Positioning CML in an institutionally stable, strong and valued position within Leiden university, reflected by CML's leadership role in Leiden University's 'Liveable Planet' stimulation research program that supported 4 new professors since 2019
- 2013.10-present Senior scientist, *TNO*, Netherlands (20%)

Annex 3: Previous appointments

- 2010.04-2014.09 Professor II, Industrial Ecology Program/Institute of Product Design, *NTNU*, Trondheim, Norway (20%). Research and PhD supervision, program development, fund raising, teaching. Contributions to NTNU's MSc. and PhD. teaching programs.
- 1990-2013.10 Various positions including Business Line Manager Societal Innovation and Economy, *TNO*, Netherlands. Main activities:
- Managing acquisition, operations and knowledge investments in the field of sustainable system innovation, policy impact assessment and interactive policy making, and environmental/resource/economic accounting and modelling (4.5 Mio Euro annually within TNO, corresponding with a workforce of 40-50 people, mainly permanent staff).
 - Managing 3-4 major projects per year. Combined budgets 5-10 Mio Euro, up to 20 researchers per project, up to 30 legal entities as partners.
 - Representing TNO with key international policy makers (EU DG Environment,; EEA; DG JRC IPTS; UNEP, various national ministries) and professional network organizations in this field (e.g. IS41E, ERSCP, PREPARE, SETAC, IHDP-IT); fostering collaboration of TNO with around 50 research institutes globally (including Wuppertal Institute, Yale University, New Jersey Institute of Technology, Lund University/II IEE, SERI, NTNU, Cardiff University, University of Surrey, VITO, VTT, etc.). Co-Lead author of the Industry chapter of the UN's Green Economy Report.

- Contributing to TNO's image of excellence and impact by 8-10 invited keynotes per year on major international conferences, high profile international projects such as for the UN Resource Panel and Green Economy Initiative, frequent scientific publications, and press interviews in international newspapers such as the Washington Post. The TNO units mainly funded via his Business Line were evaluated as 'Internationally Leading' in TNO's Scientific Assessment Exercise of November 2012

1988-1990

Policy official, Inspectorate for the Environment, *Ministry of Environment*, Netherlands

- Secretariat of the Enforcement Co-ordination Committee of Dutch Hazardous Waste Legislation
- Supporting the Ministry's Waste management Directorate with development of improved hazardous waste legislation
- Developing (with RIVM) technical support tools for enforcement specialists (waste sampling manuals, waste analysis methodologies, company auditing check lists and industry background manuals)

Annex 4: Scientific achievements and related recognitions

Summary of publications and recognitions

- 191 papers in the peer reviewed, scientific literature. Citations: 10700 (Scopus); 22500 (Google scholar); H-index: 44 (Scopus); 64 (Google scholar)
- >150 invited/keynotes lectures including for the EU Parliament, Benelux Parliament, International Society for Industrial Ecology, Gordon research conference on Industrial Ecology
- Organisation of 2 side events during the COP 21 in Paris (2015) and the COP22 in Marrakech (2016) on Consumption based carbon accounting the EU and OECD pavilion, respectively.
- Editor of 8 special issues of peer-reviewed journals and 6 books. This included a Special Issue of a key climate journal, *Climate Policy*, on Consumption-Based Carbon Accounting and Policies (Volume 20, 2020, Supplementary issue
- Over 200 technical research reports
- Honorary doctorate, Linköping University, November 2022
- Highly Cited Researcher 2019-2022, Clarivate/Web of Science Group (top 0.1% globally)
- In the top 2500 of the 200.000 (2%) most impactful researchers globally in 2021 as evaluated by Stanford University/Elsevier (method developed by prof. Ioannidis, based on a citation analysis that emphasizes single, first and last authored papers). Top 25 globally and top 2 nationally in the sub-field of Environmental Sciences.
- Elected as Fellow of the Paris Institute of Advanced Study, year 2022/23
- Elected as Member of the European Academy of Sciences, 2018

Links to full publication lists (Scopus, Google Scholar):

- <https://www.scopus.com/authid/detail.uri?authorId=6701524162>
- <https://scholar.google.nl/citations?user=kG-dn38AAAAJ&hl=nl>

Selected publications

1. Jiang, M., P. Behrens, Y. Hang, W. Zhou, B. Zhu, A. Tukker (2022). Different material footprint trends between China and the World in 2007-2012 Explained by Construction and Manufacturing associated investment. *One Earth* 5, 109-119
2. Sun, Z., Scherer, L., Tukker, A., Spawn-Lee, S.A., Bruckner, M., Gibbs, H.K., Behrens, P. Dietary change in high-income nations alone can lead to substantial double climate dividend. (2022) *Nature Food*, 3 (1), pp. 29-37.
3. Zhong, X., Hu, M., Deetman, S., Steubing, B., Lin, H.X., Hernandez, G.A., Harpprecht, C., Zhang, C., Tukker, A., Behrens, P. Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060 (2021) *Nature Communications*, 12 (1), 6126.
4. Aguilar, G.A., [...] J.F. Rodrigues, A. Tukker (2019). The circularity gap of nations. A multiregional analysis of waste generation, recovery and stock depletion in 2011. *Resources Conservation Recycling*, 151 104452
5. Marques, A., Martins, I.S., Kastner, T., Plutzer, C., Theurl, M.C., Eisenmenger, N., Huijbregts, M.A.J., Wood, R., Stadler, K., Bruckner, M., Canelas, J., Hilbers, J.P., Tukker, A., Erb, K., Pereira, H.M. (2019). Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth. *Nature Ecology and Evolution*, 3 (4), pp. 628-637
6. Behrens, P., J.K. de Jong, T. Bosker, J.F.D. Rodrigues, A. de Koning, A. Tukker (2017). Evaluation the environmental impacts of dietary recommendations. *PNAS*, December 19, 2017, 114, p. 51 <https://doi.org/10.1073/pnas.1711889114>
7. Tukker, A., T. Bulavskaya, S. Giljum, A. de Koning, S. Lutter, M. Simas, K. Stadler, R. Wood (2016). Environmental and resource footprints in a global context: Europe's structural deficit in resource endowments. *Global Environmental Change* 40 (2016) 171–181
8. Tukker, A. 2015, "Product services for a resource-efficient and circular economy - A review", *Journal of Cleaner Production*, vol. 97, pp. 76-91.
9. Tukker, A. and E. Dietzenbacher (2013). Global multiregional input-output frameworks: an introduction and outlook. *Economic Systems Research* 2013 25 (1)
10. Tukker, A., de Koning, A., Wood, R., Hawkins, T., Lutter, S., Acosta, J., Rueda Cantuche, J.M., Bouwmeester, M., Oosterhaven, J., Drosdowski, T., Kuenen, J. (2013). Exiopol – Development and illustrative analyses of a detailed global MR EE SUT/IOT. *Economic Systems Research*, 25 (1), pp. 50-70.
11. Tukker, A., & Jansen, B. (2006). Environmental impacts of products: A detailed review of studies. *Journal of Industrial Ecology*, 10(3), 159-182.
12. Tukker, A. (2004). Eight types of product-service system: Eight ways to sustainability? experiences from Suspronet. *Business Strategy and the Environment*, 13(4), 246-260.

Books

1. Tischner, U., E. Sto, U. Kjaernes and A. Tukker (eds.). 2010. *System Innovation for Sustainability II. Case Studies in Sustainable Consumption and Production: Food and Agriculture*. Greenleaf Publishing, Sheffield, UK
2. Tukker, Arnold, Martin Charter, Carlo Vezzoli, Eivind Sto and Maj Munch Andersen (eds., 2008). *System Innovation for Sustainability 1: Perspectives on Radical Changes to Sustainable Consumption and Production* Greenleaf Publishing, Sheffield, UK (480 p)
3. Tukker, A. and U. Tischner (eds; 2006). *New Business for Old Europe: Product-services as a means*

- to enhance competitiveness and eco-efficiency. Greenleaf Publishing, Sheffield, UK (400 p)
4. Bruijn, T. de and A. Tukker (eds.). 2002. Partnership and Leadership: Building alliances for a Sustainable Future. Kluwer Academic Publishers, Dordrecht/Boston/London, 300 p.
 5. Tukker, A. 1999. Frames in the Toxicity Controversy. Risk Assessment and Policy Analysis related to the Dutch Chlorine Debate and the Swedish PVC Debate. Kluwer Academic Publishers, Dordrecht/Boston/London, 400 p.
 6. Klostermann, J.E.M. and A. Tukker (eds.) 1998. Product Innovation and Eco-efficiency. Twenty-three industry efforts to reach the Factor 4. Kluwer Academic Publishers, Dordrecht/Boston/London, 300 p.

Invited keynote presentations

Prof. Tukker held over 150 invited conference presentations, and over 100 presentations based on accepted abstracts during his career. Some examples:

- 13 June 2022. Bottom-Up and Top-Down Approaches for Circularity Assessments. Gordon Research Conference in Industrial Ecology, Newry, ME, US (keynote)
- 18 March 2020. Measuring SDGs with Global Input Output Tables. Green Growth Knowledge Platform ‘What’s your footprint’ (virtual)
- 15 October 2019, On the Circular Economy. European Roundtable on Sustainable Consumption and Production, Barcelona (keynote)
- 17 April 2018. Sustainable Consumption and Production – relevance for SDGs. Conference organized for the book launch ‘SDGs in Indonesia’, by prof. Armida Alisjahbana, former Minister of National Development and current SG UN ESCAP, Jakarta, Indonesia
- 23 March 2018. The Circular Economy – some policy suggestions. Lecture for the Benelux Parliament, 1e Kamer, Den Haag, Netherlands
- 30 June 2017. Norms and standards for a circular economy. World Materials Forum, Nancy.
- 24 November 2016 ‘The Circular Economy – Challenges and Opportunities’. Indonesian Cleveringa Lecture, Erasmushuis, Jakarta, Indonesia
- 7 September 2016 ‘Digitizing Europe’s Industry – Environmental and Economic Opportunities and Challenges’. Conference: Digitizing Europe’s Industry – Are we on the right track? Europarlament, organized by The Greens, Brussels
- 22 April 2016: ‘Towards an EU Materials Intelligence System’. European Resources Intelligence – A conference under the Dutch 2016 EU presidency. Den Haag, Netherlands
- 30 November 2015: Organization Side event ‘Consumption based carbon accounting’, EU Pavilion, COP21, Paris

PhD supervision (ongoing, with support of various co-supervisors)

1. Bertram de Boer (2016-2023) – Unintended international effects of national environmental policies.
2. Dian Armanda (2016-2023) – Urban farming in Indonesia and its environmental impacts
3. Carlos Siguenza (2017-2023) – Impacts of changes to circularity with LCA – with case studies on electrical and electronic equipment and automotive
4. Suzanne v.d. Brink (2017-2023) – Transparency in supply chains of critical minerals
5. Michelle Wagner (2017-2024) – Material flow analysis of critical metals
6. Franco Donati (2017-2023) – Assessment tool for measuring changes in the carbon, material, land

- and water footprint related to circular economy scenarios
7. Natalya Tsoy (2017-2023) – Ex ante LCA of the use of CO₂ as raw material chemicals production
 8. Jana Enking (2018-2023) – Ex-ante LCA of remanufacturing strategies
 9. Chen Tang (2018-2023) – Dynamic MFA of Li batteries in the context of an EU transition to e-mobility
 10. Xioyang Zhong (2018-2023) – Assessing carbon, material and land footprints of current and future global use of building and construction materials
 11. Teun Verhagen (2018-2023) – The energy transition and implications for resource use in the build environment
 12. Levon Amatuni (2019-2023) – Towards a detailed, global integrated economic/physical stock-flow database (PANORAMA project with EIT KIC Raw Materials aligned with RMIS of EU DG JRC)
 13. Tales Yamamoto (2019-2024) – Idem
 14. Irlan Aditya Rum (2019-2023) - Indonesian palm oil production and global trade
 15. Jinhui Zhou (2019-2023) – Global nitrogen flows and impacts
 16. Janneke van Oorschot (2019-2023) – Material stocks and circularity implications for the Netherlands
 17. Sander van Nielen (2019-2023) – Ex-ante LCA of re-use of NdBFe magnets
 18. Miranda Xicotencatl (2019-2023) – Dynamic MFA of secondary magnets
 19. Milou Derks (2020-2023) – Networked business models supporting a low carbon energy transition
 20. Oscar Rueda Gonzales (2020-2024) – Carbon capture and storage
 21. Carina Harpprecht (2020-2024) - Major metals production and carbon neutrality
 22. Nicolas Navarre (2020-2024) – Environmental impacts of microplastics
 23. Marc van der Meide (2021-2025) – Circular building and construction materials
 24. Stephanie Cap (2021-2025) – Sustainable consumption related to the 1.5 degree target
 25. Antoine Coundard (2021-2025) – Environmental impacts of food waste
 26. Anniek Kortleve (2021-2025) – Detailed spatially explicit carbon footprint analyses
 27. Mike Slootweg (2021-2025) – Environmental and biodiversity implications of PV and green rooftops in an urban environment

PhDs (graduated)

1. Chengjiang Xu (2018-2022.12) – Future carbon emissions, energy storage potential and material requirements related to global production and use of Electric Vehicle Batteries
2. Yi Jin (2018-2022.06) – Water use of energy technologies in China
3. Xining Yang (2018-2022.06) – Estimating building stocks with LCA & Building Information Management Systems
4. Viktor Firmana (2016-2022.06) – Environmental and economic accounts for Indonesia
5. Chungbo Zhang (2017-2021) – Eco-efficiency assessment of innovative building and construction materials and the trade-off between renovation for energy neutrality and material use
6. Sebastiaan Deetman (2015-2021) – Scenarios on the use of raw materials in view of the global energy and mobility transition
7. Zhongxiao Sun (2017-2021) – Spatially Explicit Environmental Input Output Analysis of global biotic material flows and implications for carbon sequestration
8. Glenn Aguilar (2016-2021) – Environmental, economic and social impacts of changes to circularity with environmental input output analysis

9. Dong Di (2017-2021) – China and the global copper cycle
10. Coen van der Giesen (2013-2020) – Towards a methodology for ex-ante LCA
11. Juan Wang (2019) – Potential for carbon emission reductions in the industrial sector in China
12. Angelica Mendoza Beltran (2018) – Uncertainty in LCA, with case studies on fish farming
13. Rong Yuan (2018) – Energy efficiency and spillovers in China
14. Arjan de Koning (2018) – Input-output analysis for sustainability scenarios
15. David Font Vivanco (2016) – Rebound effects of eco-efficient transport systems
16. Ida Nilstadt Pettersen (2013) – Sustainable consumption practices and design, at NTNU
17. Saartje Sondejker (2008)- Transition management in health care, at EUR

PhD examiner/opponent

Next to being opponent in some 25 PhD ceremonies at Leiden University between 2013 and now, prof. Tukker was examiner or opponent in the following PhD evaluations outside Leiden:

1. 28 October 2022, Magnus Schulz-Mönnighoff, Aalborg University (Battery repurposing)
2. 11 June 2021, Marianna Lena Kambanu, Linköping University (Circular business modelling)
3. 29 January 2021, Albert Kwame Osie-Owusu, Aarhus University (Footprints of Danish food consumption)
4. 6 October 2020, Vivian Tunn, Delft University of Technology (Circular business models for consumer markets)
5. 5 September 2019, Yan Xu, Groningen University (Environmental degradation, trade, input-output analysis)
6. 3 July 2017, Michiel Zijp, Radboud University Nijmegen (Solution focused sustainability assessments)
7. February 2017, Samantha Moutoor, University of Mauritius (Waste and circularity in Mauritius)
8. December 2016, Piyanon Kaenchan, King Mongkut's University of Technology, Thailand
9. 30 September 2016, Simon Mair, Surrey University (Impact assessment of fair wages in the textile industry assessed with input output analysis)
10. 23 September 2016, Barbara Kölbl, Utrecht University (Macro-economic impacts of CCS)
11. 4 February 2016, Wouter Spekking, Erasmus University Rotterdam (Innovation dynamics in eco-industrial parks)
12. 27 November 2015, Anne Owen, Leeds University (Comparative evaluation of the Eora, GTAP and WIOD Input-Output databases)
13. May 2015, Yun Lan, University of Sydney (Structural decomposition analysis of energy footprints)
14. 3 July 2014, Maaike Bouwmeester, Groningen University (Economics and environment - modeling global linkages)
15. 5 September 2012, René Kleijn, Leiden University (Materials requirement of the energy transition)
16. 16 March 2011, Li Shen, Utrecht University (LCAs of chemicals)
17. 1 March 2011, Hogne Nersund Larsen, NTNU (Carbon footprint of Norwegian municipalities)
18. 18 May 2010, MingMing Hu, Leiden University (Dynamic MFA of building materials in China)
19. 16 September 2004, Oksana Mont, Lund University (Product service systems)

Project grants and Principal investigator positions

Prof. Tukker acquired over 40 Mio Euro in research grants during his career, see below. For most of these projects he served as Principal Investigator, in other instances he handed over the project management to colleagues.

Budget (Euro)	Name	Period	Funding sources
5.0 Mio	Circular Circuits (towards a circular electronics chain)	2022-2027	Dutch Science Foundation
2.0 Mio	MultiGreen (towards an green, biodiverse urban environment; collaborative project with the Chinese Academy of Sciences)	2021-2025	Dutch Science Foundation
2.0 Mio	PANORAMA (global material stock flow database)	2019-2022	EIT KIC RM
5.0 Mio	ACCEZ (Accelerating the Circular Economy in South Holland), a joint program of LDE, Wageningen University, VNO-NCW, Province of South Holland	2018-2023	Province of South Holland, NL
1.5 Mio	RamaSCENE, Circu MAT, Criticalc (assessment tools and life long learning programs on circular material use)	2017-2021	EIT KIC RM
4,0 Mio	CircEuit (Circular European Economy Training Network, 15 PhDs)	2016-2020	MC ITN
3,0 Mio	Carbon-CAP (consumption based carbon accounts)	2013-2016	EU FP7
3,0 Mio	DESIRE (System of indicators for resource efficiency)	2012-2016	EU FP7
3,0 Mio	CREEA (Environmental and economic accounts)	2011-2013	EU FP7
1,5 Mio	BrainPOOL (Beyond GDP)	2011-2013	EU FP7
5,0 Mio	EXIOPOL (externalities, accounting; with Anil Markandya)	2007-2011	EU FP6
0,2 Mio	SCOPE2 (Sustainable Consumption)	2006-2007	EU FP6
0,9 Mio	SCORE! (Sustainable Consumption)	2005-2008	EU FP6
1,5 Mio	SusProNet (Sustainable Product Development Network)	2002-2005	EU FP5
> 35 Mio	<i>Subtotal</i>		
>3 Mio	Participant in major projects such as BAREENERGY, CRISP, EMINIMM, POLFREE, COMPLEX, SCRREEN, ORAMA, RESOURCE, Getting the Data Right, Knowledge Network on Sustainable System Innovation and Transitions, NL-China Smart Industrial Park project, other	2000-2017	Dutch Science Funding, Swedish EPA, EU FP's, private foundations
>2 Mio	Smaller grants, including grants for the Dutch Chlorine Chain Study (0.5 Mio), the Swedish PVC chain study (0.2 Mio), various Eurostat studies (0.5 Mio), Dutch and Irish Waste management plans (0.3 Mio)	1990-2015	Various public and private parties
>40 Mio Euro	TOTAL		

Editorial board memberships

1. Frontiers of Engineering Management (2023-2026)
2. Journal of Circular Economy and Sustainability (2020-now)
3. Journal of Cleaner Production (2016-now)
4. Sustainability: Science, Practice and Policy (2016-now)
5. Resources (2013-now)
6. Sustainability (2013-now)
7. Journal of Industrial Ecology (2004-now)
8. International Journal of Life cycle assessment (2000-now)
9. Journal of Sustainable Product Design (2000-2006)
10. Book Series Editor Eco-efficiency & Industry, Springer (1998-2014)

Roles as evaluator and similar

1. Reviewer for a broad range of journals, including Science, the Nature family of journals, Journal of Industrial Ecology, Ecological Economics, Environmental Science & Technology, Resources, Conservation, Recycling, International Journal of Life Cycle Assessment, Global Environmental Change, Science of the Total Environment, and many others
2. Reviewer of project proposals submitted to the EU's Framework programs, and National Science Foundations and similar of a.o. Belgium, Switzerland, Austria, Norway, Sweden, Finland, UK, Ireland etc.
3. Scientific board memberships of conferences of the International Society of Industrial Ecology (2019, 2017, 2015, 2013 and others) World Resources Forum (2019, 2017, 2015), European Roundtable on Sustainable Consumption and Production, and many others
4. Evaluation of professorial appointments in China, Denmark, Sweden, Netherlands

Membership of professional societies

1. International Society of Industrial Ecology (Inaugural chair of the Input-output section)
2. Society for the European Roundtable on Sustainable Consumption and Production (ERSCP; Inaugural chair)
3. International Input Output Association

Annex 5: Teaching experience

- Obtained the University Teaching Qualification (2016)
- Development of a 4 ECTS basic LCA course for 3rd year BSc students at Leiden University College. Teaching this course in 2014, 2015 and 2017
- Development of a 4 ECTS Introduction to Sustainability course in the CML Minor in Sustainable Development, given to 3rd year BSc students. Teaching this course since Fall 2014
- Variety of guest lectures in the Leiden/Delft MSc Industrial Ecology, and the Leiden MSc Governance of sustainability
- Initiating the development of a MSc on Governance of Sustainability and a BSc on Sustainability Science at Leiden University. Operational development and accreditation was taken over by other CML staff.
- Supervision of over 10 MSc students

Annex 6: Coverage of subjects in environmental sciences

In his career, Prof. Tukker showed an in-depth interest in different aspects of sustainability, reflected by high impact projects, reports and publications in the following scientific fields:

- Socio-economic and environmental assessment of production-consumption systems (Material flow analysis, LCA, input-output databases/models, resource-efficiency and circularity assessments)
- Sustainable technology and sustainable product design (including the EU MC ITN Circuit project executed with Leiden University, TU Delft, NTNU, Grenoble INP, Cranfield University, Aston University, Linköping University)
- Sustainable, circular business models and sustainable consumption
- Governance and policies related to sustainable transitions

He applied these approaches for research on food and agricultural systems, the built environment, transport systems, electrical and electronic equipment, waste management, production of chemicals and related toxicity risks, material supply systems and the circular economy, and energy systems. Illustrations of projects are given below.

Topic	Illustrative projects, publications or activities
Social, economic and environmental performance of regional, national and global production-consumption systems	<ul style="list-style-type: none"> • PI of the development of EXIOBASE, the most detailed environmental input output model used for environmental footprinting (160 sector, >43 country, 1995-2015); maps economic, material and energy flows world-wide, and that expresses impacts in a variety of indicators, such as ecological footprint, material flow indicators, LCA themes, and external costs. Funded via EU Framework projects such as EXIOPOL: 6 Mio Euro; CREEA: 3.5 Mio Euro; DESIRE: 3 Mio Euro; Carbon CAP: 3 Mio Euro. Teams consist of the global leadership in EEIO. Work is executed in close co-operation with the European Environment Agency, EU DG JRC IPTS, Eurostat, DG ENV and various national statistical offices world-wide. The projects provide major support to the EU's Resource Efficiency Flagship under the EU 2020 strategy . • Editor, Report on Impacts of Products and Resources, UN International Resources Panel (2010); downloaded >500.000 times • Manager, 3 Eurostat projects on Data Centres on Products and Resources , and Environmentally Extended Input Output Analysis (2009-2013)
Sustainable design	<ul style="list-style-type: none"> • Ecodesign: European State of the Art (2000, 400 pages). Project manager/final editor of this ESTO project (150 days) executed in co-operation with VITO, TNO, VDI and CfSD. With country studies for EU-15. For DG JRC, Sevilla • Ecodesign: Strategies for Dissemination to SMEs (2000, 400 pages). Overall project manager. For EU/JRC/IPTS, with VITO , CfSD, VDI, TNO, DTU. EUR 19583 EN, DG JRC IPTS, Seville, Spain. With country studies for EU-15
Sustainable and circular business models	<ul style="list-style-type: none"> • Manager Sustainable Product Development Network (www.suspronet.org ; 2002-2004) .1.5 Million Euro Thematic Network within the 5th Framework Programme of the EU, involving about 30-40 key EU industries and research institutes . Formed the central node of the scientific community dealing with Product Service Systems (PSS) . <i>Key outcome: Eight types of product-service system: Eight ways to sustainability? Business Strategy and the Environment, 13(4), 246-260. With over 1300 citations this paper is in the top 15 out of the 24.000 peer-reviewed publications on business modelling in SCOPUS (March 2022)</i>
Sustainable consumption	<ul style="list-style-type: none"> • Co-ordinator of the Sustainable Consumption Research Exchanges network (www.score-network.org; October 2005 - July 2008) . EU funded Network of 30 directly involved institutes and some 200 researchers. Contributed directly to the UN 10 Year Framework of Programs on Sustainable Consumption and Production as agreed upon in the World Summit on Sustainable Development in 2002 in Johannesburg , and played a key role in the efforts of the UN, OECD, EU and national member states in this field. <i>Key outcome: a community of SCP specialists, later consolidated in the SCORAI network and the ERSCP.</i>
Governance for sustainable system innovations and transitions	<ul style="list-style-type: none"> • PI of the Marie Curie ITN CircEuit (Circular European Economy Training Network), 15 PhDs, 4 Mio Euro, 6 EU partners including LiU, looking at the circularity transition from a business, consumer, design, logistics and environmental and economic systems perspective, with partners like the Ellen MacArthur Foundation and others (2016-2020) • Lead Author, Sustainable Industry chapter of the Green Economy Initiative/Green New Deal Report written for the UN (2009-2010) • PhD thesis, on conflict resolution and governance of chlorinated substances ('Frames in the Toxicity Controversy', published with Kluwer/Springer, 1998) • Core group member of the 10 Million Euro Knowledge Network on Sustainable System Innovations and Transitions, granted by Dutch Government, led by Rotmans, Grin and Schot). Manager project "Integrated systems analysis and foresight for transition management" (2005-2009 ; 600.000 Euro; 1 Ph.D., co-executed with Rotterdam University) .

Application areas	Illustrative projects, publications or activities
Food systems	<ul style="list-style-type: none"> • PI, IMPRO-Food on environmental impact reductions of diet change. For EU DG JRC, 2011 • Behrens, P., J.K. de Jong, T. Bosker, J.F.D. Rodrigues, A. de Koning, A. Tukker (2017). Evaluation the environmental impacts of dietary recommendations. PNAS, December 19, 2017, 114, p. 51 https://doi.org/10.1073/pnas.1711889114 • Sun, Z., Scherer, L., Tukker, A., Behrens, P. Linking global crop and livestock consumption to local production hotspots (2020) Global Food Security, 25, art. no. 100323 • Sun, Z., Scherer, L., Tukker, A., Spawn-Lee, S.A., Bruckner, M., Gibbs, H.K., Behrens, P. Dietary change in high-income nations alone can lead to substantial double climate dividend (2022) Nature Food, 3 (1), pp. 29-37.(calculating carbon sequestration due rewilding of land freed up by changes to low-meat diets)
Build environment	<ul style="list-style-type: none"> • Various PhDs (Mark Meijde, Chunbo Zhang, Teun Verhagen, others) • Jiang, M., Behrens, P., Wang, T., Tang, Z., Yu, Y., Chen, D., Liu, L., Ren, Z., Zhou, W., Zhu, S., He, C., Tukker, A., Zhu, B. Provincial and sector-level material footprints in China (2019) Proceedings of the National Academy of Sciences of the United States of America, 116 (52), pp. 26484-26490. • Zhang, C., Hu, M., Dong, L., Gebremariam, A., Mirand-Xicotencatl, B., Di Maio, F., Tukker, A. Eco-efficiency assessment of technological innovations in high-grade concrete recycling (2019) Resources, Conservation and Recycling, 149, pp. 649-663. • Yang, X., Hu, M., Tukker, A., Zhang, C., Huo, T., Steubing, B. A bottom-up dynamic building stock model for residential energy transition: A case study for the Netherlands (2022) Applied Energy, 306, art. no. 118060 • Zhong, X., Hu, M., Deetman, S., Steubing, B., Lin, H.X., Hernandez, G.A., Harpprecht, C., Zhang, C., Tukker, A., Behrens, P. Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060 (2021) Nature Communications, 12 (1), art. no. 6126 • Zhang, C., Hu, M., Laclau, B., Garnesson, T., Yang, X., Tukker, A. Energy-carbon-investment payback analysis of prefabricated envelope-cladding system for building energy renovation: Cases in Spain, the Netherlands, and Sweden (2021) Renewable and Sustainable Energy Reviews, 145, art. no. 111077
Transport system	<ul style="list-style-type: none"> • Various PhDs., e.g. • Xu C. et al. Future material demand for automotive lithium-based batteries, Nature Communications Materials, doi.org/10.1038/s43246-020-00095-x • Tang, C., Sprecher, B., Tukker, A., Mogollón, J.M. The impact of climate policy implementation on lithium, cobalt and nickel demand: The case of the Dutch automotive sector up to 2040 (2021) Resources Policy, 74, art. no. 102351
Electrical & electronic equipment	<ul style="list-style-type: none"> • Various PhDs, e.g. Deetman, S., Pauliuk, S., Van Vuuren, D.P., Van Der Voet, E., Tukker, A. Scenarios for Demand Growth of Metals in Electricity Generation Technologies, Cars, and Electronic Appliances (2018) Environmental Science and Technology, 52 (8), pp. 4950-4959.
Waste management systems	<ul style="list-style-type: none"> • PI, studies for two Dutch National Hazardous Waste Management Plans, 1992 and 1995, Dutch Environment Ministry • Co-PI, study for the Irish National Hazardous Waste Management Plan, 1998, Irish EPA • Co-PI, study on waste management for the Buenos Aires Province, Argentina, 1996 • PI, Chemical recycling of plastics waste, 2000, EU DG Environment • PI, LCA study on battery recycling technologies, 2002, for ADEME, France • Member, Peer review committee on LCA of recycling techniques for packaging waste, for DSD, Germany, 1996 • PI, various Life cycle assessments and peer reviews on waste management of various waste streams including plastics, packaging, etc.
Production of chemicals and related toxicity risks	<ul style="list-style-type: none"> • PI, Chlorine chain study and risk assessment of emissions of chlorinated substances in the Netherlands (1995), Dutch Environment Ministry • PI, PVC chain study and risk assessment of emissions of substances from the PVC chain (1997), Norsk Hydro, Sweden • PI, Study on risk reduction of the use of plasticisers in PVC, Dutch Environment Ministry (2000) • PI, Study on the risks of dichloromethane, DG Environment, 1999 (led to a ban on DCM use in consumer products) • PI, Study on the risks of use of lead in products, DG Environment, 2000

Application areas	Illustrative projects, publications or activities
Materials supply systems	<ul style="list-style-type: none"> • Co-chair, European Rare Earth Competence Network, 2014, set up by DG Industry • Member, European Innovation Partnership Raw Materials, 2016-now • Member, Director's Supervisory Board, Program Monitoring Circular Economy in the Netherlands, 2019-now • van den Brink, S., Kleijn, R., Sprecher, B., Tukker, A. Identifying supply risks by mapping the cobalt supply chain (2020) <i>Resources, Conservation and Recycling</i>, 156, art. no. 104743 • Li, C., Mogollón, J.M., Tukker, A., Dong, J., von Terzi, D., Zhang, C., Steubing, B. Future material requirements for global sustainable offshore wind energy development (2022) <i>Renewable and Sustainable Energy Reviews</i>, 164, art. no. 112603 • Liang, Y., Kleijn, R., Tukker, A., van der Voet, E. Material requirements for low-carbon energy technologies: A quantitative review (2022) <i>Renewable and Sustainable Energy Reviews</i>, 161, art. no. 112334
Energy systems and climate policy	<ul style="list-style-type: none"> • Wood, R., Grubb, M., Anger-Kraavi, A., Pollitt, H., Rizzo, B., Alexandri, E., Stadler, K., Moran, D., Hertwich, E., Tukker, A. Beyond peak emission transfers: historical impacts of globalization and future impacts of climate policies on international emission transfers (2020) <i>Climate Policy</i>, 20 (sup1), pp. S14-S27. • Mendoza Beltran, A., Cox, B., Mutel, C., van Vuuren, D.P., Font Vivanco, D., Deetman, S., Edelenbosch, O.Y., Guinée, J., Tukker, A. When the Background Matters: Using Scenarios from Integrated Assessment Models in Prospective Life Cycle Assessment (2020) <i>Journal of Industrial Ecology</i>, 24 (1), pp. 64-79. • Wang, J., Rodrigues, J.F.D., Hu, M., Behrens, P., Tukker, A. The evolution of Chinese industrial CO₂ emissions 2000–2050: A review and meta-analysis of historical drivers, projections and policy goals (2019) <i>Renewable and Sustainable Energy Reviews</i>, 116, art. no. 109433 • Harpprecht, C., Naegler, T., Steubing, B., Tukker, A., Simon, S. Decarbonization scenarios for the iron and steel industry in context of a sectoral carbon budget: Germany as a case study (2022) <i>Journal of Cleaner Production</i>, 380, art. no. 134846 • Li, C., Mogollón, J.M., Tukker, A., Steubing, B. Environmental Impacts of Global Offshore Wind Energy Development until 2040 (2022) <i>Environmental Science and Technology</i>, 56 (16), pp. 11567-11577. • Yuan, R., Rodrigues, J.F.D., Wang, J., Tukker, A., Behrens, P. A global overview of developments of urban and rural household GHG footprints from 2005 to 2015 (2022) <i>Science of the Total Environment</i>, 806, art. no. 150695 • Jin, Y., Scherer, L., Sutanudjaja, E.H., Tukker, A., Behrens, P. Climate change and CCS increase the water vulnerability of China's thermoelectric power fleet (2022) <i>Energy</i>, 245, art. no. 123339, • Rueda, O., Mogollón, J.M., Tukker, A., Scherer, L. Negative-emissions technology portfolios to meet the 1.5 °C target (2021) <i>Global Environmental Change</i>, 67, art. no. 102238. • Organisation of 2 side events during the COP 21 in Paris (2015) and the COP22 in Marrakech (2016) on Consumption based carbon accounting in the EU and OECD pavilion, respectively. • Editor of a Special Issue of a key climate journal, <i>Climate Policy</i>, on Consumption-Based Carbon Accounting and Policies (Volume 20, 2020, Supplementary issue)

Annex 7: Services to society and interaction with policy, business and civil society

Prof. Tukker worked for a long time at TNO, a not for profit research organization. Projects invariably were in interaction with policy, business, and/or civil society and aimed at co-creation of or advising on sustainability strategies. In this context he worked frequently with EU DG's (including Climate Action, Environment and Industry), DG JRC, EEA, Eurostat, US EPA, UN Statistical Division, UN Environment Program, UN Economic and Social Commission for Asia and the Pacific (ESCAP) and many research institutes and organizations in Europe and beyond including Yale University, Tsinghua University, Tokyo University, and many others. Many of his projects were done in complex, controversial or politically tense contexts where science diplomacy and conflict resolution were crucial to complete the mission successfully:

- Member, Climate Advisory Board, Elsevier Publishers (2021-now)
- Member, Scientific Advisory Board, Norwegian Institute for Sustainability Research (NORSUS),

Frederikstad, Norway (2021-now)

- Member, Scientific Advisory Board, MISTRA-REES program on a circular economy, led by Linköping University (2019-)
- Co-chair, European Rare Earth Competence Network (2014), set up by DG Industry
- PI, Marie Curie Innovative Training Network on a Circular Economy ('Circeuit'), with a.o. TU Delft, NTNU, Grenoble INP, Leiden University, Cranfield University, Aston University, and Linköping University (15 PhDs in total)
- Member, European Innovation Partnership Raw Materials (2016-now)
- Member, Circular Economy 100 Network, Ellen MacArthur Foundation, representing Leiden University as one of the 20 universities involved worldwide (2019-now)
- Member, Director's Supervisory Board, Program Monitoring and Steering Circular Economy, led by the Netherlands Environmental Assessment Agency (PBL), Netherlands (2020-now)
- Member, Scientific Advisory Board, Circularity Gap Report. Published annually by Circle Economy at the World Economic Forum, Davos (2019-now).
- Editor, report on Priority Products and Materials of the UN International Resources Panel (2011)
- Co-lead Author, Sustainable Industry chapter of the Green Economy Report, UN Environment Program (2009-2010)
- Member, Core team Dutch Knowledge Network on Sustainable System Innovations and Transitions (led by Jan Rotmans, Johan Schot, and John Grin; 2003-2008)
- Advisor, development of the UN Ten Year Framework of Programs on Sustainable Consumption and Production (2008)

Annex 8: Management, organizational and other skills

Prof. Tukker developed over time skills and insights of how to manage large organizations depending on external finances, and that have to operate in complex, networked contexts and have to balance inputs of stakeholders with different interests. Illustrations include:

- A large number of scientific network projects aimed at organizing a science field, between 2000 and 2010 (e.g. SusProNet on sustainable business models, SCORE! on sustainable consumption)
- Taking over the management of the Institute of Environmental Sciences (CML) at Leiden University in 2013 after a period of reorganizations, and growing it with support of staff and other management to a vibrant institute tripled in size by 2022 (>150 staff)
- Setting up the Leiden-Delft-Erasmus Centre for Sustainability and the Leiden University Liveable Planet program, both networked programs/centres working via bottom-up coordination of over 20 scientific groups of the different universities, business partners, and government representatives.
- Extensive experience in an international and inter-cultural context. CML hosts over 30 nationalities including scientists with an origin from e.g. China, Russia, Indonesia, Latin-America, etc. Several collaborative projects with institutes in such regions.

Prof. Tukker is a native Dutch speaker. He is fluent in English and has good command of German, Spanish and French.

Leiden/Den Haag, 02.01.2023