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Material demand and sustainability challenges of key infrastructures in emerging energy and digital technologies under the low-carbon transition

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List of publications

Publications related to this thesis

Chen, Z., Kleijn, R., Lin, H.X., 2023. Metal Requirements for Building Electrical Grid Systems of Global Wind Power and Utility-Scale Solar Photovoltaic until 2050. *Environ. Sci. Technol.* 57, 1080–1091.

Chen, Z., Kleijn, R., Zhang, C., Lin, H.X., 2026. Fuel cell and electric vehicles: Resource use and associated environmental impacts. *Resour. Conserv. Recycl.* 226, 108646.

Chen, Z., Kleijn, R., Lin, H.X., Integrating resource constraints into green hydrogen scenarios: material demand and mitigation pathways for electrolyzer metals (under review by the journal *Renewable Energy*).

Chen, Z., Kleijn, R., Cao, Z., Yao, Y., Chen, W., Wei, S., Peng, P., Lin, H.X., Material efficiency key for decarbonizing global data centers (under review by the journal *Nature Communications*).

Other publications

Zhang, L., **Chen, Z.**, Yang, C., Xu, Z., 2022. Global supply risk assessment of the metals used in clean energy technologies. *J. Clean. Prod.* 331, 129602.

Yang, C., Zhang, L., **Chen, Z.**, Gao, Y., Xu, Z., 2022. Dynamic material flow analysis of aluminum from automobiles in China during 2000–2050 for standardized recycling management. *J. Clean. Prod.* 337, 130544.

Chen, Z., Zhang, L., Xu, Z., 2020. Analysis of cobalt flows in mainland China: Exploring the potential opportunities for improving resource efficiency and supply security. *J. Clean. Prod.* 275, 122841.

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Niu, B., **Chen, Z.**, Xu, Z., 2017e. Method for recycling tantalum from waste tantalum capacitors by chloride metallurgy. *ACS Sustain. Chem. Eng.* 5, 1376–1381.

Invention Patents

Xu, Z., Niu, B., **Chen, Z.**, 2016. Method and technical process for producing ultrafine Ta₂O₅ from spent tantalum capacitors (一种利用废旧钽电容器制备超细氧化钽的方法). Patent No. CN106186066A.

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Xu, Z., Niu, B., **Chen, Z.**, 2016. Process for synthesizing tantalum oxynitride (TaON) photocatalysts from spent tantalum capacitors (利用废旧钽电容器制备氧氮化钽光催化材料的方法). Patent No. CN106276827A.

<https://patents.google.com/patent/CN106276827A/zh>

Conferences

Chen, Z., Kleijn, R., Lin, H.X., 2023. Global material demand and associated climate impact for servers and storage of data centers and mitigation strategies to 2050. International Conference on Resource Sustainability (icRS 2023). University of Surrey, Guildford, United Kingdom. (Oral presentation)

Chen, Z., Kleijn, R., Lin, H.X., 2022. Mineral resource demands for building power transmission grids associated with wind and solar PV plants by 2050 under the energy

transition. International Conference on EcoBalance. Japan Institute of Life Cycle Assessment, Fukuoka, Japan. (Poster presentation)

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Curriculum Vitae



Zhenyang Chen (陈振洋) was born in 1993 in Wuwei, Gansu Province, China. She completed her bachelor's degree in Environmental Engineering and Science at the School of Metallurgy and Environment, Central South University. During her undergraduate years, she worked on several research projects that focused on improving environmental sustainability in the metal smelting industry. Part of this work received the national first prize in the “National University Student Energy Conservation and Emission Reduction Social Practice and

Technology Competition” organized by China’s Ministry of Education.

Her excellent academic performance earned her direct entry to the master’s program in Environmental Engineering and Science at Shanghai Jiao Tong University, a track reserved for top undergraduates. During her master’s studies, she focused on developing resource-recovery and recycling technologies for waste electrical and electronic equipment (WEEE), while also examining the management policies that shape how WEEE is handled in practice. Her research resulted in two national technological invention patents in China and earned her an Outstanding Thesis Award. She completed her master’s degree with distinction in June 2018.

In September 2019, Zhenyang moved from China to the Netherlands and joined the Institute of Environmental Sciences (CML) at Leiden University, where she began her PhD under the supervision of Prof. Hai Xiang Lin and Prof. René Kleijn. As her work developed, her research shifted toward studying the material demand and environmental impacts of key renewable and digital technologies in the global low-carbon energy transition.

Zhenyang is now based in New Haven, USA, where she is carrying out her postdoctoral research at Yale University. Outside of work, she finds joy in playing the piano, boxing, going for hikes, and seeking out good spicy food.

