



**Universiteit  
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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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### **Citation**

Chen, Z. (2026, January 14). *Material demand and sustainability challenges of key infrastructures in emerging energy and digital technologies under the low-carbon transition*. Retrieved from <https://hdl.handle.net/1887/4289526>

Version: Publisher's Version

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# Stellingen

## Behorende bij het proefschrift

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

1. Strengthening the regulatory framework for decommissioning submarine and underground cables would improve the sustainability and material governance of future electrical grids (This thesis, Chapter 2).
2. A mixed pathway with battery electric light-duty vehicles and fuel-cell heavy-duty vehicles can deliver a more balanced combination of material demand and environmental impacts than either technology on its own (This thesis, Chapter 3).
3. Large-scale deployment of green hydrogen electrolysis may shift climate ambitions into new resource constraints if critical-metal requirements and material-efficiency strategies are not explicitly integrated into hydrogen scenarios (This thesis, Chapter 4).
4. As computational demand accelerates, the upstream material footprint of data center IT hardware will become an increasingly important constraint on the sustainability of digital infrastructure (This thesis, Chapter 5).
5. Low-carbon energy systems inevitably rely on metal-intensive infrastructures whose expansion requires more mining, making recycling, substitution and careful device design essential components of climate strategy rather than optional add-ons (Vidal et al., 2013).
6. Although ICT-based ‘smart’ solutions have a high potential to reduce energy and material flows, there is no guarantee that they are sustainable; each application may or may not be beneficial depending on whether its own footprint outweighs the savings it enables elsewhere (Hilty et al., 2014).
7. Sustainable AI consists of two complementary dimensions: using AI to advance sustainability goals and ensuring that AI systems themselves operate within sustainable material and energy limits (Aimee van Wynsberghe., 2021).
8. Climate mitigation pathways that rely on rapid deployment of renewable and low-carbon technologies must confront the social and environmental harms of mineral extraction, rather than treating them as a secondary issue to decarbonization (Sovacool et al., 2020).
9. Consistency is a more reliable driver of scientific progress than inspiration, because most breakthroughs begin with incremental work.
10. In the age of AI-assisted research, critical thinking has become more important than technical skill, because tools can automate analysis but not judgment.

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Leiden, The Netherlands, 12 September 2025