



Universiteit  
Leiden  
The Netherlands

## **The energy and material related impacts of the transition towards low-carbon heating: a case study of the Netherlands**

Verhagen, T.J.

### **Citation**

Verhagen, T. J. (2023, February 1). *The energy and material related impacts of the transition towards low-carbon heating: a case study of the Netherlands*. Retrieved from <https://hdl.handle.net/1887/3514615>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/3514615>

**Note:** To cite this publication please use the final published version (if applicable).



# References

## References

- Adam, P., & Heunemann, F. (2020). *Hydrogen infrastructure - the pillar of energy transition*. <https://assets.siemens-energy.com/siemens/assets/api/uuid:3d4339dc-434e-4692-81a0-a55adb-caa92e/200915-whitepaper-h2-infrastructure-en.pdf>
- An, T., Zheng, S., Peng, H., Wen, X., Chen, L., & Zhang, L. (2017). Synergistic action of hydrogen and stress concentration on the fatigue properties of X80 pipeline steel. *Materials Science and Engineering: A*, 700, 321-330. <https://doi.org/10.1016/j.msea.2017.06.029>
- Ayres, R. U., & Ayres, L. (Eds.). (2002). *A handbook of industrial ecology*. Edward Elgar Pub.
- Baars, M. (2020, March 2). *Personal communication with demolition company about the processing of demolition waste* [Telephonic interview].
- Basosi, R., Bonciani, R., Frosali, D., Manfrida, G., Parisi, M. L., & Sansone, F. (2020). Life Cycle Analysis of a Geothermal Power Plant: Comparison of the Environmental Performance with Other Renewable Energy Systems. *Sustainability*, 12(7), 2786. <https://doi.org/10.3390/su12072786>
- Berenschot. (2020a). *Het warmtescenario*. [https://www.berenschot.nl/media/352kcpid/cases-het\\_warmtescenario.pdf](https://www.berenschot.nl/media/352kcpid/cases-het_warmtescenario.pdf)
- Berenschot. (2020b). *Klimaatneutrale energiescenario's 2050*. [https://www.berenschot.nl/media/hl-4dygfg/rapport\\_klimaatneutrale\\_energiescenario\\_s\\_2050\\_2.pdf](https://www.berenschot.nl/media/hl-4dygfg/rapport_klimaatneutrale_energiescenario_s_2050_2.pdf)
- Bergsdal, H., Brattebø, H., Bohne, R. A., & Müller, D. B. (2016). Dynamic material flow analysis for Norway's dwelling stock. *Building Research & Information*, 35(5), 557-570.
- Bianco, V., Scarpa, F., & Tagliafico, L. A. (2017). Estimation of primary energy savings by using heat pumps for heating purposes in the residential sector. *Applied Thermal Engineering*, 114, 938-947. <https://doi.org/10.1016/j.applthermaleng.2016.12.058>
- Blagoeva, D. T., Dias, P. A., Marmier, A., & Pavel, C. C. (2016). *Assessment of potential bottlenecks along the materials supply chain for the future deployment of low-carbon energy and transport technologies in the EU*.
- Bokhoven, T., & D. (2018). *Uitwerking overige hernieuwbare energie*. RVO. <https://www.energieakkoord-ser.nl/~media/files/energieakkoord/nieuwsberichten/2014/20141218-uitwerking-overige-hernieuwbare-energie.ashx>
- Broadbent, C. (2016). Steel's recyclability: Demonstrating the benefits of recycling steel to achieve a circular economy. *The International Journal of Life Cycle Assessment*, 21(11), 1658-1665. <https://doi.org/10.1007/s11367-016-1081-1>
- Buffat, R., Schmid, L., Heeren, N., Froemelt, A., Raubal, M., & Hellweg, S. (2017). GIS-based Decision Support System for Building Retrofit. *Energy Procedia*, 122, 403-408. <https://doi.org/10.1016/j.egypro.2017.07.433>
- CBS. (2019a). *Characteristics per zipcode* [Webpagina]. Centraal Bureau voor de Statistiek. <https://www.cbs.nl/nl-nl/dossier/nederland-regionaal/geografische-data/wijk-en-buurtkaart-2019>
- CBS. (2019b). *Energy per zipcode* [Webpagina]. Centraal Bureau voor de Statistiek. <https://www.cbs.nl/nl-nl/maatwerk/2019/11/energielevering-aan-woningen-en-bedrijven-naar-postcode>
- CBS. (2021). *Bevolking* [Webpagina]. Centraal Bureau voor de Statistiek. <https://www.cbs.nl/nl-nl/maatschappij/bevolking>
- CBS. (2021). *Woningen; hoofdverwarmingsinstallaties, regio* [Webpagina]. Centraal Bureau voor de Statistiek. <https://www.cbs.nl/nl-nl/cijfers/detail/84948NED?q=gemeenten>
- CE Delft. (2016). *MKBA Warmte Zuid-Holland*. CE Delft. [https://www.ce.nl/publicatie/mkba\\_warmte\\_zuid-holland/1500](https://www.ce.nl/publicatie/mkba_warmte_zuid-holland/1500)

- Cerniauskas, S., Jose Chavez Junco, A., Grube, T., Robinius, M., & Stolten, D. (2020). Options of natural gas pipeline reassignment for hydrogen: Cost assessment for a Germany case study. *International Journal of Hydrogen Energy*, 45(21), 12095-12107. <https://doi.org/10.1016/j.ijhydene.2020.02.121>
- Cetinay, H., Kuipers, F. A., & Van Mieghem, P. (2018). A Topological Investigation of Power Flow. *IEEE Systems Journal*, 12(3), 2524-2532. <https://doi.org/10.1109/JSYST.2016.2573851>
- Cetinay, H., Soltan, S., Kuipers, F. A., Zussman, G., & Van Mieghem, P. (2018). Analyzing Cascading Failures in Power Grids under the AC and DC Power Flow Models. *ACM SIGMETRICS Performance Evaluation Review*, 45(3), 198-203. <https://doi.org/10.1145/3199524.3199559>
- Chen, W.-Q., & Graedel, T. E. (2012). Anthropogenic Cycles of the Elements: A Critical Review. *Environmental Science & Technology*, 46(16), 8574-8586. <https://doi.org/10.1021/es3010333>
- Cossu, R., & Williams, I. D. (2015). Urban mining: Concepts, terminology, challenges. *Waste Management*, 45, 1-3. <https://doi.org/10.1016/j.wasman.2015.09.040>
- CRI. (2014). *Resource efficiency in the building sector*. <https://ec.europa.eu/environment/eussd/pdf/Resource%20efficiency%20in%20the%20building%20sector.pdf>
- Deetman, S., de Boer, H. S., Van Engelenburg, M., van der Voet, E., & van Vuuren, D. P. (2021). Projected material requirements for the global electricity infrastructure – generation, transmission and storage. *Resources, Conservation and Recycling*, 164, 105200. <https://doi.org/10.1016/j.resconrec.2020.105200>
- Deetman, S., Marinova, S., van der Voet, E., van Vuuren, D. P., Edelenbosch, O., & Heijungs, R. (2020). Modelling global material stocks and flows for residential and service sector buildings towards 2050. *Journal of Cleaner Production*, 118658. <https://doi.org/10.1016/j.jclepro.2019.118658>
- Deetman, S., Pauliuk, S., van Vuuren, D. P., van der Voet, E., & Tukker, A. (2018). Scenarios for Demand Growth of Metals in Electricity Generation Technologies, Cars, and Electronic Appliances. *Environmental Science & Technology*, 52(8), 4950-4959. <https://doi.org/10.1021/acs.est.7b05549>
- Delmastro, C., Mutani, G., & Schranz, L. (2016). The evaluation of buildings energy consumption and the optimization of district heating networks: A GIS-based model. *International Journal of Energy and Environmental Engineering*, 7(3), 343-351. <https://doi.org/10.1007/s40095-015-0161-5>
- Di Maria, A., Eyckmans, J., & Van Acker, K. (2018). Downcycling versus recycling of construction and demolition waste: Combining LCA and LCC to support sustainable policy making. *Waste Management (New York, N.Y.)*, 75, 3-21. <https://doi.org/10.1016/j.wasman.2018.01.028>
- ECN, & CBS. (2017). *Nationale energieverkenning 2017*. [https://www.cbs.nl/-/media/\\_pdf/2017/42/nationale%20energieverkenning%202017.pdf](https://www.cbs.nl/-/media/_pdf/2017/42/nationale%20energieverkenning%202017.pdf)
- Ecofys. (2018). *Collectieve warmte naar lage temperatuur*. <https://www.ecofys.com/files/files/collectieve-warmte-naar-lage-temperatuur.pdf>
- Ecolnvent. (2010). *Natural gas production\_CA-AB\_2010\_Undefined*. <https://v38.ecoquery.ecoinvent.org/Home/Index>
- Ellen McArthur Foundation. (2016). *Circularity in the built environment*. <https://www.ellenmacarthur-foundation.org/assets/downloads/Built-Env-Co.Project.pdf>
- Elshkaki, A. (2019). Materials, energy, water, and emissions nexus impacts on the future contribution of PV solar technologies to global energy scenarios. *Scientific Reports*, 9(1), 19238. <https://doi.org/10.1038/s41598-019-55853-w>
- Elshkaki, A., & Graedel, T. E. (2013). Dynamic analysis of the global metals flows and stocks in electricity generation technologies. *Journal of Cleaner Production*, 59, 260-273. <https://doi.org/10.1016/j.jclepro.2013.07.003>
- Ensoc, & RVO. (2018). *De rol van stadsverwarming bij verduurzaming van de warmtevoorziening in de gebouwde omgeving*. <https://www.ensoc.nl/files/de-rol-van-stadsverwarming-in-de-energietransitie-def.pdf>
- EU. (2016). *Emissions cap and allowances* [Text]. Climate Action - European Commission. [https://ec.europa.eu/clima/policies/ets/cap\\_en](https://ec.europa.eu/clima/policies/ets/cap_en)
- European commission. (2017). *Circular Economy Action Plan*. [https://ec.europa.eu/environment/circular-economy/implementation\\_report.pdf](https://ec.europa.eu/environment/circular-economy/implementation_report.pdf)
- European Industrial Gases Association. (2004). *Hydrogen transportation pipelines*. [https://h2tools.org/sites/default/files/Doc121\\_04%20H2TransportationPipelines.pdf](https://h2tools.org/sites/default/files/Doc121_04%20H2TransportationPipelines.pdf)
- Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2), 219-245. <https://doi.org/10.1177/1077800405284363>
- Francisco Pinto, J., & Carrilho da Graça, G. (2018). Comparison between geothermal district heating and deep energy refurbishment of residential building districts. *Sustainable Cities and Society*, 38, 309-324. <https://doi.org/10.1016/j.scs.2018.01.008>
- Graedel, T. E. (2019). Material Flow Analysis from Origin to Evolution. *Environmental Science & Technology*, 53(21), 12188-12196. <https://doi.org/10.1021/acs.est.9b03413>
- Graedel, T. E., Allwood, J., Birat, J.-P., Buchert, M., Hagelüken, C., Reck, B. K., Sibley, S. F., & Sonnemann, G. (2011). What Do We Know About Metal Recycling Rates? *Journal of Industrial Ecology*, 15(3), 355-366. <https://doi.org/10.1111/j.1530-9290.2011.00342.x>
- Greenhome. (2017). *Bodem-water warmtepomp, warmte uit de bodem*. <https://kennis.greenhome.nl/warmtepomp/bodem-water-warmtepomp/>
- Greening, B., & Azapagic, A. (2012). Domestic heat pumps: Life cycle environmental impacts and potential implications for the UK. *Energy*, 39(1), 205-217. <https://doi.org/10.1016/j.energy.2012.01.028>
- Guinée, J. B., Heijungs, R., Huppes, G., Zamagni, A., Masoni, P., Buonamici, R., Ekvall, T., & Rydberg, T. (2011). Life Cycle Assessment: Past, Present, and Future. *Environmental Science & Technology*, 45(1), 90-96. <https://doi.org/10.1021/es101316v>
- Harris, D., Bazelon, C., Humphreys, B., & Dickson, P. (2020). *Report for the Ministry of Economic Affairs, Agriculture and Innovation by the Brattle Group*. 121.
- Harrison, G. P., Maclean, E. (Ned). J., Karamanlis, S., & Ochoa, L. F. (2010). Life cycle assessment of the transmission network in Great Britain. *Energy Policy*, 38(7), 3622-3631. <https://doi.org/10.1016/j.enpol.2010.02.039>
- Heeren, N., & Fishman, T. (2019). A database seed for a community-driven material intensity research platform. *Scientific Data*, 6(1), 23. <https://doi.org/10.1038/s41597-019-0021-x>
- Heeren, N., & Hellweg, S. (2018a). Tracking Construction Material over Space and Time: Prospective and Geo-referenced Modeling of Building Stocks and Construction Material Flows. *Journal of Industrial Ecology*, 0(0). <https://doi.org/10.1111/jiec.12739>
- Heeren, N., & Hellweg, S. (2018b). Tracking Construction Material over Space and Time: Prospective and Geo-referenced Modeling of Building Stocks and Construction Material Flows. *Journal of Industrial Ecology*. <https://doi.org/10.1111/jiec.12739>
- Heeren, N., Jakob, M., Martius, G., Gross, N., & Wallbaum, H. (2013). A component based bottom-up building stock model for comprehensive environmental impact assessment and target control. *Renewable and Sustainable Energy Reviews*, 20, 45-56. <https://doi.org/10.1016/j.rser.2012.11.064>
- Heeren, N., Mutel, C. L., Steubing, B., Ostermeyer, Y., Wallbaum, H., & Hellweg, S. (2015). Environmental Impact of Buildings—What Matters? *Environmental Science & Technology*, 49(16), 9832-9841. <https://doi.org/10.1021/acs.est.5b01735>

- Hendriks, C. F., & Pietersen, H. S. (2000). *Report 22: Sustainable Raw Materials: Construction and Demolition Waste - State-of-the-Art Report of RILEM Technical Committee 165-SRM*. RILEM Publications.
- Hermkens, R. J. M., Colmer, H., & Ophoff, H. A. (2018). *MODERN PE PIPE ENABLES THE TRANSPORT OF HYDROGEN*. 12.
- Hormaza Mejia, A., Brouwer, J., & Mac Kinnon, M. (2020). Hydrogen leaks at the same rate as natural gas in typical low-pressure gas infrastructure. *International Journal of Hydrogen Energy*, *45*(15), 8810-8826. <https://doi.org/10.1016/j.ijhydene.2019.12.159>
- Hu, M., Pauliuk, S., Wang, T., Huppel, G., van der Voet, E., & Müller, D. (2010). Iron and steel in Chinese residential buildings: A dynamic analysis. *Resources, Conservation and Recycling*, *54*(9), 591-600. <https://doi.org/10.1016/j.resconrec.2009.10.016>
- Hu, M., van der Voet, E., & Huppel, G. (2010). Dynamic Material Flow Analysis for Strategic Construction and Demolition Waste Management in Beijing. *Journal of Industrial Ecology*, *14*(3), 440-456. <https://doi.org/10.1111/j.1530-9290.2010.00245.x>
- IEA. (2020). *Energy Technology Perspectives 2020*. [https://iea.blob.core.windows.net/assets/7f8aed40-89af-4348-be19-c8a67df0b9ea/Energy\\_Technology\\_Perspectives\\_2020\\_PDF.pdf](https://iea.blob.core.windows.net/assets/7f8aed40-89af-4348-be19-c8a67df0b9ea/Energy_Technology_Perspectives_2020_PDF.pdf)
- IEA. (2021). *Heating - tracking report*. IEA. <https://www.iea.org/reports/heating>
- IEEE. (2020). *Resources - IEEE PES Test Feeder*. <https://cmte.ieee.org/pes-testfeeders/resources/>
- Intergovernmental Panel on Climate Change, & Edenhofer, O. (Eds.). (2014). *Climate change 2014: Mitigation of climate change: Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://www.ipcc.ch/report/ar6/wg1/>
- IRP. (2011). *Recycling Rates of Metals*. <https://www.resourcepanel.org/reports/recycling-rates-metals>
- IRP. (2016). *Global material flows and resource productivity*. [www.resourcepanel.org/file/423/download?token=Av9xJsGS](http://www.resourcepanel.org/file/423/download?token=Av9xJsGS)
- Isaac, M., & van Vuuren, D. P. (2009). Modeling global residential sector energy demand for heating and air conditioning in the context of climate change. *Energy Policy*, *37*(2), 507-521. <https://doi.org/10.1016/j.enpol.2008.09.051>
- Jiménez Rivero, A., Sathre, R., & García Navarro, J. (2016). Life cycle energy and material flow implications of gypsum plasterboard recycling in the European Union. *Resources, Conservation and Recycling*, *108*, 171-181. <https://doi.org/10.1016/j.resconrec.2016.01.014>
- Jorge, R. S., Hawkins, T. R., & Hertwich, E. G. (2012). Life cycle assessment of electricity transmission and distribution—part 2: Transformers and substation equipment. *The International Journal of Life Cycle Assessment*, *17*(2), 184-191. <https://doi.org/10.1007/s11367-011-0336-0>
- Kadaster. (2018). *BAG Nederland*. <https://bagviewer.kadaster.nl/lvbag/bag-viewer/index.html>
- Kadaster. (2021). *BAG*. <https://www.kadaster.nl/zakelijk/registraties/basisregistraties/bag>
- Kleemann, F., Lederer, J., Rechberger, H., & Fellner, J. (2017). GIS-based Analysis of Vienna's Material Stock in Buildings. *Journal of Industrial Ecology*, *21*(2), 368-380. <https://doi.org/10.1111/jiec.12446>
- Kleijn, R., & van der Voet, E. (2010). Resource constraints in a hydrogen economy based on renewable energy sources: An exploration. *Renewable and Sustainable Energy Reviews*, *14*(9), 2784-2795. <https://doi.org/10.1016/j.rser.2010.07.066>
- Kleijn, R., van der Voet, E., Kramer, G. J., van Oers, L., & van der Giesen, C. (2011). Metal requirements of low-carbon power generation. *Energy*, *36*(9), 5640-5648. <https://doi.org/10.1016/j.energy.2011.07.003>
- KNMI. (2020). *Aardbevingen door gaswinning*. <https://www.knmi.nl/kennis-en-datacentrum/uitleg/aardbevingen-door-gaswinning>
- Koezjakov, A., Urge-Vorsatz, D., Crijns-Graus, W., & van den Broek, M. (2018). The relationship between operational energy demand and embodied energy in Dutch residential buildings. *Energy and Buildings*, *165*, 233-245. <https://doi.org/10.1016/j.enbuild.2018.01.036>
- Krook, J., Carlsson, A., Eklund, M., Frändegård, P., & Svensson, N. (2011). Urban mining: Hibernating copper stocks in local power grids. *Journal of Cleaner Production*, *19*(9), 1052-1056. <https://doi.org/10.1016/j.jclepro.2011.01.015>
- Liang, Y., Kleijn, R., Tukker, A., & van der Voet, E. (2022). Material requirements for low-carbon energy technologies: A quantitative review. *Renewable and Sustainable Energy Reviews*, *161*, 112334. <https://doi.org/10.1016/j.rser.2022.112334>
- Love, J. A., Smith, A. Z. P., Watson, S., Oikonomou, E., Summerfield, A., Gleeson, C., Biddulph, P., Chiu, L., Wingfield, J., Martin, C., Stone, A., & Lowe, R. (2017). The addition of heat pump electricity load profiles to GB electricity demand: Evidence from a heat pump field trial. *Applied Energy*, *204*, 332-342.
- Lund, H., Werner, S., Wiltshire, R., Svendsen, S., Thorsen, J. E., Hvelplund, F., & Mathiesen, B. V. (2014). 4th Generation District Heating (4GDH). *Energy*, *68*, 1-11. <https://doi.org/10.1016/j.energy.2014.02.089>
- Ma, L., & Spataru, C. (2015). The use of natural gas pipeline network with different energy carriers. *Energy Strategy Reviews*, *8*, 72-81. <https://doi.org/10.1016/j.esr.2015.09.002>
- Marinova, S., Deetman, S., van der Voet, E., & Daioglou, V. (2020a). Global construction materials database and stock analysis of residential buildings between 1970-2050. *Journal of Cleaner Production*, *119*146. <https://doi.org/10.1016/j.jclepro.2019.119146>
- Marinova, S., Deetman, S., van der Voet, E., & Daioglou, V. (2020b). Global construction materials database and stock analysis of residential buildings between 1970-2050. *Journal of Cleaner Production*, *247*, 119146. <https://doi.org/10.1016/j.jclepro.2019.119146>
- Mastrucci, A. (2017). *Geospatial characterization of building material stocks for the life cycle assessment of end-of-life scenarios at the urban scale*. <https://doi.org/10.1016/j.resconrec.2016.07.003>
- Miatto, A., Schandl, H., Forlin, L., Ronzani, F., Borin, P., Giordano, A., & Tanikawa, H. (2019). A spatial analysis of material stock accumulation and demolition waste potential of buildings: A case study of Padua. *Resources, Conservation and Recycling*, *142*, 245-256. <https://doi.org/10.1016/j.resconrec.2018.12.011>
- Miatto, A., Schandl, H., & Tanikawa, H. (2017). How important are realistic building lifespan assumptions for material stock and demolition waste accounts? *Resources, Conservation and Recycling*, *122*, 143-154. <https://doi.org/10.1016/j.resconrec.2017.01.015>
- Milieu centraal. (2018). *Isoleren en besparen*. MilieuCentraal.nl. <https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/isoleren-en-besparen/>
- Milieu centraal. (2019). *Energietarieven 2019*. MilieuCentraal.nl. <https://www.milieucentraal.nl/energie-besparen/snel-besparen/grip-op-je-energierekening/energierekening-2019/>
- Mohajerani, A. (2017). *Practical recycling applications of crushed waste glass in construction materials: A review | Elsevier Enhanced Reader*. <https://doi.org/10.1016/j.conbuildmat.2017.09.005>
- Moreno-Benito, M., & Agnolucci, P. (2016). *Towards a sustainable hydrogen economy: Optimisation-based framework for hydrogen infrastructure development | Elsevier Enhanced Reader*. <https://doi.org/10.1016/j.compchemeng.2016.08.005>
- Moss, R. L., Tzimas, E., Kara, H., Willis, P., & Kooroshy, J. (2013). The potential risks from metals bottlenecks to the deployment of Strategic Energy Technologies. *Energy Policy*, *55*, 556-564. <https://doi.org/10.1016/j.enpol.2012.12.053>

- MRA, & TNO. (2017). *De duurzaamheid van warmtenetten*. <http://warmteiscool.nl/wp-content/uploads/sites/17/2017/07/20170298-Brochure-A4-los1.pdf>
- Mukherjee, U., Elsholkami, M., Walker, S., Fowler, M., Elkamel, A., & Hajimiragha, A. (2015). Optimal sizing of an electrolytic hydrogen production system using an existing natural gas infrastructure. *International Journal of Hydrogen Energy*, 40(31), 9760-9772. <https://doi.org/10.1016/j.ijhydene.2015.05.102>
- Müller, D. (2006). Stock dynamics for forecasting material flows-Case study for housing in The Netherlands. *Ecological Economics*, 59(1), 142-156. <https://doi.org/10.1016/j.ecolecon.2005.09.025>
- Municipality of Leiden. (2019). *Strategie duurzaam Leiden*. [https://www.gagoed.nl/uploads/1904034\\_GD\\_ECWD\\_Circulaire-economie-Leiden-2020-2023\\_web.pdf](https://www.gagoed.nl/uploads/1904034_GD_ECWD_Circulaire-economie-Leiden-2020-2023_web.pdf)
- NEDU. (2020). Verbruiksprofielen. NEDU. <https://www.nedu.nl/documenten/verbruiksprofielen/>
- Netbeheer Nederland. (2018). *Toekomstbestendige gasdistributienetten*. [https://www.netbeheernederland.nl/\\_upload/Files/Toekomstbestendige\\_gasdistributienetten\\_133.pdf](https://www.netbeheernederland.nl/_upload/Files/Toekomstbestendige_gasdistributienetten_133.pdf)
- Netbeheer Nederland. (2020). *Energie in Cijfers | Hoofdstuk 1: Kerngegevens energienetten*. <https://energiecijfers.info/hoofdstuk-1/>
- Netbeheer Nederland. (2021). *Grijs gietijzeren gasleidingen onder de loep-Netbeheer Nederland*. <https://www.netbeheernederland.nl/nieuws/grijs-gietijzeren-gasleidingen-onder-de-loep-1291>
- Nord, N. (2016). *Possibilities for Transition of Existing Residential Buildings to Low Temperature District Heating System in Norway*. [https://www.researchgate.net/publication/306364685\\_Possibilities\\_for\\_Transition\\_of\\_Existing\\_Residential\\_Buildings\\_to\\_Low\\_Temperature\\_District\\_Heating\\_System\\_in\\_Norway](https://www.researchgate.net/publication/306364685_Possibilities_for_Transition_of_Existing_Residential_Buildings_to_Low_Temperature_District_Heating_System_in_Norway)
- Nouvel, R., Mastrucci, A., Leopold, U., Baume, O., Coors, V., & Eicker, U. (2015). Combining GIS-based statistical and engineering urban heat consumption models: Towards a new framework for multi-scale policy support. *Energy and Buildings*, 107, 204-212. <https://doi.org/10.1016/j.enbuild.2015.08.021>
- Nyers, J., & Nyers, A. (2011). COP of heating-cooling system with heat pump. In *EXPRES 2011-3rd IEEE International Symposium on Exploitation of Renewable Energy Sources, Proceedings* (p. 21). <https://doi.org/10.1109/EXPRES.2011.5741809>
- Ogden, J., Jaffe, A. M., Scheitrum, D., McDonald, Z., & Miller, M. (2018). Natural gas as a bridge to hydrogen transportation fuel: Insights from the literature. *Energy Policy*, 115, 317-329. <https://doi.org/10.1016/j.enpol.2017.12.049>
- Oliver-Solà, J., Gabarrell, X., & Rieradevall, J. (2009a). Environmental impacts of natural gas distribution networks within urban neighborhoods. *Applied Energy*, 86(10), 1915-1924. <https://doi.org/10.1016/j.apenergy.2008.11.029>
- Oliver-Solà, J., Gabarrell, X., & Rieradevall, J. (2009b). Environmental impacts of the infrastructure for district heating in urban neighbourhoods. *Energy Policy*, 37(11), 4711-4719. <https://doi.org/10.1016/j.enpol.2009.06.025>
- Ortlepp, R., Gruhler, K., & Schiller, G. (2018). Materials in Germany's domestic building stock: Calculation model and uncertainties. *Building Research & Information*, 46(2), 164-178. <https://doi.org/10.1080/09613218.2016.1264121>
- Ostermeyer, Y., Nägeli, C., Heeren, N., & Wallbaum, H. (2018). Building Inventory and Refurbishment Scenario Database Development for Switzerland. *Journal of Industrial Ecology*, 22(4), 629-642. <https://doi.org/10.1111/jiec.12616>
- Pauliuk, S. (2018). *dynamic\_stock\_model: Python class for efficient handling of dynamic stock models (1.0)* [Python; MacOS]. [https://github.com/stefanpauliuk/dynamic\\_stock\\_model](https://github.com/stefanpauliuk/dynamic_stock_model)
- Pauliuk, S., & Heeren, N. (2020). ODYM-An open software framework for studying dynamic material systems: Principles, implementation, and data structures. *Journal of Industrial Ecology*, 24(3), 446-458. <https://doi.org/10.1111/jiec.12952>
- PBL. (2014). *Op weg naar een klimaatneutrale woning*. [https://www.pbl.nl/sites/default/files/downloads/pbl-2014-op-weg-naar-een-klimaatneutrale-woningvoorraad-in-2050-achtergrond\\_1333\\_1.pdf](https://www.pbl.nl/sites/default/files/downloads/pbl-2014-op-weg-naar-een-klimaatneutrale-woningvoorraad-in-2050-achtergrond_1333_1.pdf)
- PBL. (2019). *Achtergronddocument Effecten Ontwerp Klimaatkoord: Elektriciteit*. <https://www.pbl.nl/publicaties/achtergronddocument-effecten-ontwerp-klimaatkoord-elektriciteit>
- PBL. (2021, January 19). *Integrale Circulaire Economie Rapportage (ICER)* [Text]. PBL Planbureau voor de Leefomgeving. <https://www.pbl.nl/monitoring-circulaire-economie/icer>
- Pellegrino, S., Lanzini, A., & Leone, P. (2017). Greening the gas network - The need for modelling the distributed injection of alternative fuels. *Renewable and Sustainable Energy Reviews*, 70, 266-286. <https://doi.org/10.1016/j.rser.2016.11.243>
- Persson, U., & Werner, S. (2015). *Quantifying the Heating and Cooling Demand in Europe: Work Package 2, Background Report 4*. <http://urn.kb.se/resolve?urn=urn:nbn:se:hh:diva-35236>
- Petrović, S. N., & Karlsson, K. B. (2016). Residential heat pumps in the future Danish energy system. *Energy*, 114, 787-797. <https://doi.org/10.1016/j.energy.2016.08.007>
- Planbureau voor de Leefomgeving. (2019). *Trends in global CO2 and total greenhouse gas emissions: 2019 Report*. [https://www.pbl.nl/sites/default/files/downloads/pbl-2020-trends-in-global-co2-and-total-greenhouse-gas-emissions-2019-report\\_4068.pdf](https://www.pbl.nl/sites/default/files/downloads/pbl-2020-trends-in-global-co2-and-total-greenhouse-gas-emissions-2019-report_4068.pdf)
- Province of Zuid-Holland. (2018). *Warmte-Warmterotonde* [Webpagina]. Provincie Zuid-Holland. <https://www.zuid-holland.nl/onderwerpen/energie/productie-duurzame/warmte-warmterotonde/>
- Reck, B. K., & Graedel, T. E. (2012). *Challenges in Metal Recycling*. <https://doi.org/10.1126/science.1217501>
- Reyna, J. L., & Chester, M. V. (2015). The Growth of Urban Building Stock: Unintended Lock-in and Embedded Environmental Effects. *Journal of Industrial Ecology*, 19(4), 524-537. <https://doi.org/10.1111/jiec.12211>
- Rijksoverheid. (2017). *Energierapport-Transitie naar duurzaam*. <https://www.rijksoverheid.nl/documenten/rapporten/2016/01/18/energierapport-transitie-naar-duurzaam>
- Rijksoverheid. (2018a). *IBO kostenefficiëntie CO2-reductiemaatregelen*. <https://zoek.officielebekendmakingen.nl/blg-725127.pdf>
- Rijksoverheid. (2018b). *Nederland circulair in 2050*. <https://www.circulair economienederland.nl/rijksbreed+programma+circulair+economie/default.aspx>
- Rijksoverheid. (2018c). *Warmtepomp*. <https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/energiezuinig-verwarmen-en-warm-water/warmtepomp-combi-en-hybridwarmtepomp/>
- Rijksoverheid. (2021). *Jaarplan Staatstoezicht op de Mijnen 2021*. [www.rijksoverheid.nl/2Fbinaries%2Frijksoverheid%2Fdocumenten%2Fjaarplannen%2F2021%2F06%2F15%2Fjaarplan-staatstoezicht-op-de-mijnen-2021%2Fbijlage-jaarplan-staatstoezicht-op-de-mijnen-2021.pdf](http://www.rijksoverheid.nl/2Fbinaries%2Frijksoverheid%2Fdocumenten%2Fjaarplannen%2F2021%2F06%2F15%2Fjaarplan-staatstoezicht-op-de-mijnen-2021%2Fbijlage-jaarplan-staatstoezicht-op-de-mijnen-2021.pdf)
- RVO. (2014). *Overzicht afleversets voor warmtelevering*. <https://www.rvo.nl/sites/default/files/2014/11/ENG2014-010%20Overzicht%20afleversets%20voor%20warmtelevering%20%281%29.pdf>
- RvO. (2018). *Rapport verkennende studie tool aardgasvrije woningen*. [https://www.rvo.nl/sites/default/files/2018/06/Rapport%20verkennende%20studie%20tool%20aardgasvrije%20woningen\\_0.pdf](https://www.rvo.nl/sites/default/files/2018/06/Rapport%20verkennende%20studie%20tool%20aardgasvrije%20woningen_0.pdf)
- Sayegh, M. A., Jadwiszczak, P., Axcell, B. P., Niemierka, E., Bryś, K., & Jouhara, H. (2018). Heat pump placement, connection and operational modes in European district heating. *Energy and Buildings*, 166, 122-144. <https://doi.org/10.1016/j.enbuild.2018.02.006>
- Schiller, G., Müller, F., & Ortlepp, R. (2017). Mapping the anthropogenic stock in Germany: Metabolic evidence for a circular economy. *Resources, Conservation and Recycling*, 123, 93-107. <https://doi.org/10.1016/j.resconrec.2016.08.007>
- Seck, G. S., Hache, E., Bonnet, C., Simoën, M., & Carcanague, S. (2020). Copper at the crossroads: Assessment of the interactions between low-carbon energy transition and supply limitations. *Resources, Conservation and Recycling*, 163, 105072. <https://doi.org/10.1016/j.resconrec.2020.105072>

- Serrano-Jimenez, A., Barrios-Padura, A., & Molina-Huelva, M. (2017). Towards a feasible strategy in Mediterranean building renovation through a multidisciplinary approach. *Sustainable Cities and Society*, 32, 532-546. <https://doi.org/10.1016/j.scs.2017.05.002>
- Shamsudin, S., Lajis, M., & Zhong, Z. W. (2016). Evolutionary in Solid State Recycling Techniques of Aluminium: A review. *Procedia CIRP*, 40, 256-261. <https://doi.org/10.1016/j.procir.2016.01.117>
- Spath, P. L., & Mann, M. K. (2000). *Life Cycle Assessment of a Natural Gas Combined Cycle Power Generation System* (NREL/TP-570-27715, 776930; p. NREL/TP-570-27715, 776930). <https://doi.org/10.2172/776930>
- Sprecher, B., Daigo, I., Spekkink, W., Vos, M., Kleijn, R., Murakami, S., & Kramer, G. J. (2017). Novel Indicators for the Quantification of Resilience in Critical Material Supply Chains, with a 2010 Rare Earth Crisis Case Study. *Environmental Science & Technology*, 51(7), 3860-3870. <https://doi.org/10.1021/acs.est.6b05751>
- Sprecher, B., & Kleijn, R. (2021). Tackling material constraints on the exponential growth of the energy transition. *One Earth*, 4(3), 335-338. <https://doi.org/10.1016/j.oneear.2021.02.020>
- Sprecher, B., Verhagen, T. J., Sauer, M. L., Baars, M., Heintz, J., & Fishman, T. (2021). Material intensity database for the Dutch building stock: Towards Big Data in material stock analysis. *Journal of Industrial Ecology*. <https://doi.org/10.1111/jiec.13143>
- Stimular. (2016). *CO2 Footprint-Milieubarometer website*. <https://www.milieubarometer.nl/CO2-footprints/co2-footprint/actuele-co2-parameters-2016/>
- Sullivan, J. (2010). *Life-cycle analysis results of geothermal systems in comparison to other power systems*. OSTI. <https://www.osti.gov/biblio/993694-wlvuul/>
- Tam, V. W. Y., & Tam, C. M. (2006). A review on the viable technology for construction waste recycling. *Resources, Conservation and Recycling*, 47(3), 209-221. <https://doi.org/10.1016/j.resconrec.2005.12.002>
- Tang, C., Sprecher, B., Tukker, A., & Mogollón, J. M. (2021). The impact of climate policy implementation on lithium, cobalt and nickel demand: The case of the Dutch automotive sector up to 2040. *Resources Policy*, 74, 102351. <https://doi.org/10.1016/j.resourpol.2021.102351>
- Tanikawa, H., Fishman, T., Okuoka, K., & Sugimoto, K. (2015). The Weight of Society Over Time and Space: A Comprehensive Account of the Construction Material Stock of Japan, 1945-2010. *Journal of Industrial Ecology*, 19(5), 778-791. <https://doi.org/10.1111/jiec.12284>
- Tanikawa, H., & Hashimoto, S. (2009). Urban stock over time: Spatial material stock analysis using 4d-GIS. *Building Research & Information*, 37(5-6), 483-502. <https://doi.org/10.1080/09613210903169394>
- Technische Unie. (2018). *Levensduur warmtepomp*. <https://www.technischeunie.nl/categorie/levensduur-warmtepomp>
- TNO. (2017). *Warmteladder warmtenetwerken*. <http://warmteiscool.nl/wp-content/uploads/sites/17/2017/07/Warmteladder-voor-MRA.pdf>
- UN Environment. (2017). *Global Status Report 2017*. [https://www.worldgbc.org/sites/default/files/UNEP%20188\\_GABC\\_en%20%28web%29.pdf](https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf)
- Ürge-Vorsatz, D., Cabeza, L. F., Serrano, S., Barreneche, C., & Petrichenko, K. (2015). Heating and cooling energy trends and drivers in buildings. *Renewable and Sustainable Energy Reviews*, 41, 85-98. <https://doi.org/10.1016/j.rser.2014.08.039>
- US EPA, O. (2021, April 16). *Impacts of Climate Change* [Overviews and Factsheets]. <https://www.epa.gov/climatechange-science/impacts-climate-change>
- van Oorschoot, J., Sprecher, B., Roelofs, B., van der Horst, J., & van der Voet, E. (2022). Towards a low-carbon and circular economy: Scenarios for metal stocks and flows in the Dutch electricity system. *Resources, Conservation and Recycling*, 178, 106105. <https://doi.org/10.1016/j.resconrec.2021.106105>
- van Oorschoot, J., van Straalen, V., & Delahaye, R. (n.d.). *Voorraden in de maatschappij: De grondstoffen-basis voor een circulaire economie*. 119.
- Verhagen, T. J., Cetinay, H. I., van der Voet, E., & Sprecher, B. (2022). Transitioning to Low-Carbon Residential Heating: The Impacts of Material-Related Emissions. *Environmental Science & Technology*. <https://doi.org/10.1021/acs.est.1c06362>
- Verhagen, T. J., Sauer, M. L., van der Voet, E., & Sprecher, B. (2021). Matching Demolition and Construction Material Flows, an Urban Mining Case Study. *Sustainability*, 13(2), 653. <https://doi.org/10.3390/su13020653>
- Verhagen, T. J., Voet, E. van der, & Sprecher, B. (2020). Alternatives for natural-gas-based heating systems: A quantitative GIS-based analysis of climate impacts and financial feasibility. *Journal of Industrial Ecology*, n/a(n/a). <https://doi.org/10.1111/jiec.13047>
- Vestas. (2019). *Life cycle assessment of electricity production from an onshore V117-3.45 MW wind plant*. 137.
- Vrancken, K. C., & Laethem, B. (2000). Recycling options for gypsum from construction and demolition waste. In G. R. Woolley, J. J. M. Goumans, & P. J. Wainwright (Eds.), *Waste Management Series* (Vol. 1, pp. 325-331). Elsevier. [https://doi.org/10.1016/S0713-2743\(00\)80045-8](https://doi.org/10.1016/S0713-2743(00)80045-8)
- Walraven. (2020). *Buisafmetingen en -gewichten*. Walraven Nederland. <https://www.walraven.com/nl/technische-informatie/buisafmetingen-en-gewichten/>
- Wang, W., Jiang, D., Chen, D., Chen, Z., Zhou, W., & Zhu, B. (2016). A Material Flow Analysis (MFA)-based potential analysis of eco-efficiency indicators of China's cement and cement-based materials industry. *Journal of Cleaner Production*, 112, 787-796. <https://doi.org/10.1016/j.jclepro.2015.06.103>
- Weinzettel, J., Reenaas, M., Solli, C., & Hertwich, E. G. (2009). Life cycle assessment of a floating offshore wind turbine. *Renewable Energy*, 34(3), 742-747. <https://doi.org/10.1016/j.renene.2008.04.004>
- Werner, S. (2018). *District heating and cooling in Sweden*. [https://ac.els-cdn.com/S0360544217304140/1-s2.0-S0360544217304140-main.pdf?\\_tid=b939b589-aef3-4c61-96b6-5fdc742f9509&acdnat=1529060937\\_6c52922e76c2e978c1cf801d19ab7ddd](https://ac.els-cdn.com/S0360544217304140/1-s2.0-S0360544217304140-main.pdf?_tid=b939b589-aef3-4c61-96b6-5fdc742f9509&acdnat=1529060937_6c52922e76c2e978c1cf801d19ab7ddd)
- Xining, Y., & Steubing, B. (2021). *Potential GHG emission reductions in the Dutch residential building stock - pathways to 2050*. Under revision
- Yanan, L., Kleijn, R., Tukker, A., & Voet, E. van der. (2022). Material requirements for low-carbon energy technologies: A quantitative review. *Renewable and Sustainable Energy Reviews (under Review)*.
- Yang, X., Hu, M., Heeren, N., Zhang, C., Verhagen, T., Tukker, A., & Steubing, B. (2020). A combined GIS-archetype approach to model residential space heating energy: A case study for the Netherlands including validation. *Applied Energy*, 280, 115953. <https://doi.org/10.1016/j.apenergy.2020.115953>
- Zhang, C., Hu, M., Dong, L., Gebremariam, A., Miranda-Xicotencatl, B., Di Maio, F., & Tukker, A. (2019). Eco-efficiency assessment of technological innovations in high-grade concrete recycling. *Resources, Conservation and Recycling*, 149, 649-663. <https://doi.org/10.1016/j.resconrec.2019.06.023>
- Zhang, C., Hu, M., Sprecher, B., Yang, X., Zhong, X., Li, C., & Tukker, A. (2021). Recycling potential in building energy renovation: A prospective study of the Dutch residential building stock up to 2050. *Journal of Cleaner Production*, 301, 126835. <https://doi.org/10.1016/j.jclepro.2021.126835>
- Zhang, C., Hu, M., Yang, X., Amati, A., & Tukker, A. (2020). Life cycle greenhouse gas emission and cost analysis of prefabricated concrete building façade elements. *Journal of Industrial Ecology*, n/a(n/a). <https://doi.org/10.1111/jiec.12991>