Spatiotemporal building stock modeling for residential decarbonization in the Netherlands

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References

[1]   EASAC. Decarbonisation of buildings: for climate, health and jobs. 2021.

[2]   Heeren N. Modelling environmental impacts of buildings – energy, material, and dynamics. ETH Zürich, 2017. doi:10.3929/ethz-a-010853498.

[3]   IRP. Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future. 2020. doi:10.5281/zenodo.3542680.

[4]   González A, Sendra C, Herena A, Rosquillas M, Vaz D. Methodology to assess the circularity in building construction and refurbishment activities. Resour Conserv Recycl Adv 2021;12:200051. doi:https://doi.org/10.1016/j.rcradv.2021.200051.

[5]   United Nations Environment Programme. 2020 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector. Nairobi: 2020.

[6]   Wit M de, Ramkumar JHS, Douma HFA. The Circularity Gap Report - An analysis of the circular state of the global economy. 2018.

[7]   Krausmann F, Lauk C, Haas W, Wiedenhofer D. From resource extraction to outflows of wastes and emissions: The socioeconomic metabolism of the global economy, 1900–2015. Glob Environ Chang 2018;52:131–40. doi:https://doi.org/10.1016/j.gloenvcha.2018.07.003.

[8]   Iyer-Raniga U, Huovila P. Global State of Play for Circular Built Environment. 2021.

[9]   United Nations Environment Programme. 2021 Global Status Report for Buildings and Construction: Towards a zero-emissions, efficient and resilient buildings and construction sector. Nairobi: 2021.

[10]   Mastrucci A, van Ruijven B, Byers E, Poblete-Cazenave M, Pachauri S. Global scenarios of residential heating and cooling energy demand and CO2 emissions. Clim Change 2021;168:14. doi:10.1007/s10584-021-03229-3.

[11]   CE Delft. Zero carbon buildings 2050. 2020.

[12]   Streicher KN, Berger M, Panos E, Narula K, Soini MC, Patel MK. Optimal building retrofit pathways considering stock dynamics and climate change impacts. Energy Policy 2021;152:112220. doi:https://doi.org/10.1016/j.enpol.2021.112220.

[13]   Grubler A, Wilson C, Bento N, Boza-Kiss B, Krey V, McCollum DL, et al. A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies. Nat Energy 2018;3:515–27. doi:10.1038/s41560-018-0172-6.

[14]   Anu R, G. RA, J. CP, Rahul SK, Emani K. Meta-principles for developing smart, sustainable, and healthy cities. Science (80-) 2016;352:940–3. doi:10.1126/science.aaf7160.

[15]   IEA (International Energy Agency). Net Zero by 2050 A Roadmap for the Global Energy Sector. 2021.

[16]   Sun Z, Ma Z, Ma M, Cai W, Xiang X, Zhang S, et al. Carbon Peak and Carbon Neutrality in the Building Sector: A Bibliometric Review. Build   2022;12. doi:10.3390/buildings12020128.

[17] IRP. The Weight of Cities: Resource Requirements of Future Urbanization. 2018.

[18] Ramaswami A, Tong K, Canadell JG, Jackson RB, Stokes E (Kellie), Dhakal S, et al. Carbon analytics for net-zero emissions sustainable cities. Nat Sustain 2021;4:460–3. doi:10.1038/s41893-021-00715-5.

[19] Hamida MB, Jylhä T, Remøy H, Gruis V. Circular building adaptability and its determinants – A literature review. Int J Build Pathol Adapt 2022;ahead-of-p. doi:10.1108/IJBPA-11-2021-0150.

[20] Yang X, Hu M, Wu J, Zhao B. Building-information-modeling enabled life cycle assessment, a case study on carbon footprint accounting for a residential building in China. J Clean Prod 2018;183:729–43. doi:10.1016/j.jclepro.2018.02.070.

[21] Ibn-Mohammed T, Greenough R, Taylor S, Ozawa-Meida L, Acquaye A. Operational vs. embodied emissions in buildings—A review of current trends. Energy Build 2013;66:232–45. doi:https://doi.org/10.1016/j.enbuild.2013.07.026.

[22] Parkin A, Herrera M, Coley DA. Net-zero buildings: when carbon and energy metrics diverge. Build Cities 2020;1:86–99. doi:10.5334/bc.27.

[23] Odyssee-Mure. Energy efficiency trends in buildings in the EU. 2018.

[24] Göswein V, Dinis Silvestre J, Habert G, Freire F. Dynamic Assessment of Construction Materials in Urban Building Stocks: A Critical Review. Environ Sci Technol 2019;53:9992–10006. doi:10.1021/acs.est.9b01952.

[25] Azari R, Abbasabadi N. Embodied energy of buildings: A review of data, methods, challenges, and research trends. Energy Build 2018. doi:10.1016/j.enbuild.2018.03.003.

[26] Sandberg NH, Sartori I, Vestrum MI, Brattebø H. Using a segmented dynamic dwelling stock model for scenario analysis of future energy demand: The dwelling stock of Norway 2016–2050. Energy Build 2017;146:220–32. doi:10.1016/J.ENBUILD.2017.04.016.

[27] Yang X, Hu M, Heeren N, Zhang C, Verhagen T, Tukker A, et al. A combined GIS-archetype approach to model residential space heating energy: A case study for the Netherlands including validation. Appl Energy 2020;280:115953. doi:10.1016/j.apenergy.2020.115953.

[28] Roca-Puigròs M, Billy RG, Gerber A, Wäger P, Müller DB. Pathways toward a carbon-neutral Swiss residential building stock. Build Cities 2020;1:579–93. doi:10.5334/bc.61.

[29] Röck M, Baldereschi E, Verellen E, Passer A, Sala S, Allacker K. Environmental modelling of building stocks – An integrated review of life cycle-based assessment models to support EU policy making. Renew Sustain Energy Rev 2021;151:111550. doi:https://doi.org/10.1016/j.rser.2021.111550.

[30] Hietaharju P, Pulkkinen J, Ruusunen M, Louis J-N. A stochastic dynamic building stock model for determining long-term district heating demand under future climate change. Appl Energy 2021;295:116962. doi:https://doi.org/10.1016/j.apenergy.2021.116962.

[31] Göswein V, Silvestre JD, Monteiro C, Habert G, Freire F, Pittau F. Influence of materials choice, renovation rate, and electricity grid to achieve a Paris agreement-compatible building stock: A Portuguese case study. Build Environ 2021:107773. doi:https://doi.org/10.1016/j.buildenv.2021.107773.

[32]   Röck M, Saade MRM, Balouktsi M, Rasmussen FN, Birgisdottir H, Frischknecht R, et al. Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. Appl Energy 2020;258:114107. doi:10.1016/J.APENERGY.2019.114107.

[33]   Hertwich EG, Ali S, Ciacci L, Fishman T, Heeren N, Masanet E, et al. Material efficiency strategies to reducing greenhouse gas emissions associated with buildings, vehicles, and electronics—a review. Environ Res Lett 2019;14:043004. doi:10.1088/1748-9326/ab0fe3.

[34]   Zhong X, Hu M, Deetman S, Steubing B, Lin HX, Hernandez GA, et al. Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060. Nat Commun 2021;12:6126. doi:10.1038/s41467-021-26212-z.

[35]   Pauliuk S, Heeren N, Berrill P, Fishman T, Nistad A, Tu Q, et al. Global scenarios of resource and emission savings from material efficiency in residential buildings and cars. Nat Commun 2021;12:5097. doi:10.1038/s41467-021-25300-4.

[36]   Huang T, Shi F, Tanikawa H, Fei J, Han J. Materials demand and environmental impact of buildings construction and demolition in China based on dynamic material flow analysis. Resour Conserv Recycl 2013;72:91–101. doi:10.1016/J.RESCONREC.2012.12.013.

[37]   Deetman S, Marinova S, van der Voet E, van Vuuren DP, Edelenbosch O, Heijungs R. Modelling global material stocks and flows for residential and service sector buildings towards 2050. J Clean Prod 2020;245:118658. doi:10.1016/J.JCLEPRO.2019.118658.

[38]   Sorace C, Hurst W. China's Phantom Urbanisation and the Pathology of Ghost Cities. J Contemp Asia 2016;46:304–22. doi:10.1080/00472336.2015.1115532.

[39]   OECD. Global Material Resources Outlook to 2060. OECD; 2019. doi:10.1787/9789264307452-en.

[40]   Jiang M, Behrens P, Yang Y, Tang Z, Chen D, Yu Y, et al. Different Material Footprint Trends between China and the World in 2007-2012 Explained by Construction- and Manufacturing-associated Investment. One Earth 2022;5:109–19. doi:https://doi.org/10.1016/j.oneear.2021.12.011.

[41]   Anastasiades K, Goffin J, Rinke M, Buyle M, Audenaert A, Blom J. Standardisation: An essential enabler for the circular reuse of construction components? A trajectory for a cleaner European construction industry. J Clean Prod 2021;298:126864. doi:https://doi.org/10.1016/j.jclepro.2021.126864.

[42]   Kim J. Construction and demolition waste management in Korea: recycled aggregate and its application. Clean Technol Environ Policy 2021;23:2223–34. doi:10.1007/s10098-021-02177-x.

[43]   Zhang C, Hu M, Yang X, Miranda-Xicotencatl B, Sprecher B, Di Maio F, et al. Upgrading construction and demolition waste management from downcycling to recycling in the Netherlands. J Clean Prod 2020;266:121718. doi:10.1016/j.jclepro.2020.121718.

[44]   Verhagen TJ, Sauer ML, van der Voet E, Sprecher B. Matching Demolition and Construction Material Flows , an Urban Mining Case Study. Sustainability 2021;13. doi:10.3390/su13020653.

[45]   Tavares V, Gregory J, Kirchain R, Freire F. What is the potential for prefabricated buildings to decrease costs and contribute to meeting EU environmental targets? Build Environ

2021;206:108382. doi:https://doi.org/10.1016/j.buildenv.2021.108382.

[46]   O'Grady T, Minunno R, Chong H-Y, Morrison GM. Design for disassembly, deconstruction and resilience: A circular economy index for the built environment. Resour Conserv Recycl 2021;175:105847. doi:https://doi.org/10.1016/j.resconrec.2021.105847.

[47]   Vandervaeren C, Galle W, Stephan A, De Temmerman N. More than the sum of its parts: Considering interdependencies in the life cycle material flow and environmental assessment of demountable buildings. Resour Conserv Recycl 2022;177:106001. doi:https://doi.org/10.1016/j.resconrec.2021.106001.

[48]   Fiorito F. Trombe Walls for Lightweight Buildings in Temperate and Hot Climates. Exploring the Use of Phase-change Materials for Performances Improvement. Energy Procedia 2012;30:1110–9. doi:https://doi.org/10.1016/j.egypro.2012.11.124.

[49]   Liu Z, Hou J, Meng X, Dewancker BJ. A numerical study on the effect of phase-change material (PCM) parameters on the thermal performance of lightweight building walls. Case Stud Constr Mater 2021;15:e00758. doi:https://doi.org/10.1016/j.cscm.2021.e00758.

[50]   Miller SA, Habert G, Myers RJ, Harvey JT. Achieving net zero greenhouse gas emissions in the cement industry via value chain mitigation strategies. One Earth 2021;4:1398–411. doi:https://doi.org/10.1016/j.oneear.2021.09.011.

[51]   Heeren N, Mutel CL, Steubing B, Ostermeyer Y, Wallbaum H, Hellweg S. Environmental Impact of Buildings—What Matters? Environ Sci Technol 2015;49:9832–41. doi:10.1021/acs.est.5b01735.

[52]   Alina G, Maliki M, Alexander H, Sébastien L, Bruno S, Guillaume H. Bio-based materials as a robust and optimal solution for building renovation. CEES 2021, 2021. doi:10.3929/ethz-b-000515477.

[53]   Habert G. Fast-Growing Bio-Based Materials Can Heal the World. Build Cities 2021. https://www.buildingsandcities.org/insights/commentaries/cop26-biobased-materials.html (accessed January 7, 2022).

[54]   Pomponi F, Hart J, Arehart JH, D'Amico B. Buildings as a Global Carbon Sink? A Reality Check on Feasibility Limits. One Earth 2020;3:157–61. doi:https://doi.org/10.1016/j.oneear.2020.07.018.

[55]   Cao Z, Myers RJ, Lupton RC, Duan H, Sacchi R, Zhou N, et al. The sponge effect and carbon emission mitigation potentials of the global cement cycle. Nat Commun 2020;11. doi:10.1038/s41467-020-17583-w.

[56]   Ren L, Zhou S, Peng T, Ou X. A review of CO2 emissions reduction technologies and low-carbon development in the iron and steel industry focusing on China. Renew Sustain Energy Rev 2021;143:110846. doi:https://doi.org/10.1016/j.rser.2021.110846.

[57]   Creutzig F, Niamir L, Bai X, Callaghan M, Cullen J, Díaz-José J, et al. Demand-side solutions to climate change mitigation consistent with high levels of well-being. Nat Clim Chang 2021. doi:10.1038/s41558-021-01219-y.

[58]   John Barrett, Steve Pye, Sam Betts-Davies, Nick Eyre, Oliver Broad, James Price, Jonathan Norman, Jillian Anable, George Bennett, Christian Brand, Rachel Carr-Whitworth, Greg Marsden, Tadj Oreszczyn, Jannik Giesekam, Alice Garvey PR and KS. The role of energy

demand reduction in achieving net-zero in the UK. 2021.

[59]   Knobloch F, Pollitt H, Chewpreecha U, Daioglou V, Mercure J-F. Simulating the deep
         decarbonisation of residential heating for limiting global warming to 1.5 °C. Energy Effic
         2019;12:521–50. doi:10.1007/s12053-018-9710-0.

[60]   Milieu Centraal. Step-by-step plan for natural gas-free living n.d.
         https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/wonen-zonder-
         aardgas/stappenplan-aardgasvrij-wonen/ (accessed October 26, 2020).

[61]   EPBD. Directive 2010/31/EU of the European Parliament and of the Council of 19 May
         2010 on the energy performance of buildings 2010.

[62]   Ahmed A, Ge T, Peng J, Yan W-C, Tee BT, You S. Assessment of the renewable energy
         generation towards net-zero energy buildings: A review. Energy Build 2021:111755.
         doi:https://doi.org/10.1016/j.enbuild.2021.111755.

[63]   Langevin J, Harris CB, Satre-Meloy A, Chandra-Putra H, Speake A, Present E, et al. US
         building energy efficiency and flexibility as an electric grid resource. Joule 2021;5:2102–28.
         doi:10.1016/j.joule.2021.06.002.

[64]   Hainsch K, Löffler K, Burandt T, Auer H, Crespo del Granado P, Pisciella P, et al. Energy
         transition scenarios: What policies, societal attitudes, and technology developments will
         realize the EU Green Deal? Energy 2022;239:122067.
         doi:https://doi.org/10.1016/j.energy.2021.122067.

[65]   Gassar AAA, Cha SH. Review of geographic information systems-based rooftop solar
         photovoltaic potential estimation approaches at urban scales. Appl Energy 2021;291:116817.
         doi:https://doi.org/10.1016/j.apenergy.2021.116817.

[66]   Lu X, Chen S, Nielsen CP, Zhang C, Li J, Xu H, et al. Combined solar power and storage as
         cost-competitive and grid-compatible supply for China's future carbon-neutral electricity
         system. Proc Natl Acad Sci 2021;118:e2103471118. doi:10.1073/pnas.2103471118.

[67]   Mi P, Zhang J, Han Y, Guo X. Operation performance study and prediction of photovoltaic
         thermal heat pump system engineering in winter. Appl Energy 2022;306:118071.
         doi:https://doi.org/10.1016/j.apenergy.2021.118071.

[68]   TABULA. National Building Typologies 2013. http://episcope.eu/building-typology/
         (accessed October 10, 2019).

[69]   Grossmann WD, Grossmann I, Steininger KW. Distributed solar electricity generation across
         large geographic areas, Part I: A method to optimize site selection, generation and storage.
         Renew Sustain Energy Rev 2013;25:831–43. doi:https://doi.org/10.1016/j.rser.2012.08.018.

[70]   Broersen S, Van den Berg N, Van Deutekom C, van Erk R, Hompes M, Lijding K, et al.
         State of the State report Solar panels could provide half of Dutch electricity demand. 2018.

[71]   Eshraghi H, Rodrigo de Queiroz A, Sankarasubramanian A, DeCarolis JF. Quantification of
         climate-induced interannual variability in residential U.S. electricity demand. Energy
         2021;236:121273. doi:https://doi.org/10.1016/j.energy.2021.121273.

[72]   Magrini A, Lentini G, Cuman S, Bodrato A, Marenco L. From nearly zero energy buildings
         (NZEB) to positive energy buildings (PEB): The next challenge - The most recent European
         trends with some notes on the energy analysis of a forerunner PEB example. Dev Built

Environ 2020;3:100019. doi:https://doi.org/10.1016/j.dibe.2020.100019.

[73]   Khanna TM, Baiocchi G, Callaghan M, Creutzig F, Guias H, Haddaway NR, et al. A multi-country meta-analysis on the role of behavioural change in reducing energy consumption and CO_2 emissions in residential buildings. Nat Energy 2021. doi:10.1038/s41560-021-00866-x.

[74]   Verhagen TJ, der Voet E, Sprecher B. Alternatives for natural-gas-based heating systems: A quantitative GIS-based analysis of climate impacts and financial feasibility. J Ind Ecol 2021:jiec.13047. doi:10.1111/jiec.13047.

[75]   Nasir U, Chang R, Omrany H. Calculation Methods for Construction Material Stocks: A Systematic Review. Appl Sci 2021;11. doi:10.3390/app11146612.

[76]   Blok M. Urban mining and circular construction - what, why and how it works n.d. https://www.metabolic.nl/news/urban-mining-and-circular-construction/ (accessed February 12, 2022).

[77]   Arora M, Raspall F, Cheah L, Silva A. Buildings and the circular economy: Estimating urban mining, recovery and reuse potential of building components. Resour Conserv Recycl 2020;154:104581. doi:https://doi.org/10.1016/j.resconrec.2019.104581.

[78]   Kloostra B, Makarchuk B, Saxe S. Bottom-up estimation of material stocks and flows in Toronto's road network. J Ind Ecol 2022;n/a. doi:https://doi.org/10.1111/jiec.13229.

[79]   Soonsawad N, Martinez RM, Schandl H. Material demand, and environmental and climate implications of Australia's building stock: Current status and outlook to 2060. Resour Conserv Recycl 2022;180:106143. doi:https://doi.org/10.1016/j.resconrec.2021.106143.

[80]   Mastrucci A, Marvuglia A, Popovici E, Leopold U, Benetto E. Geospatial characterization of building material stocks for the life cycle assessment of end-of-life scenarios at the urban scale. Resour Conserv Recycl 2017. doi:10.1016/j.resconrec.2016.07.003.

[81]   Guo Z, Hu D, Zhang F, Huang G, Xiao Q. An integrated material metabolism model for stocks of urban road system in Beijing, China. Sci Total Environ 2014;470–471:883–94. doi:10.1016/J.SCITOTENV.2013.10.041.

[82]   Arbabi H, Lanau M, Li X, Meyers G, Dai M, Mayfield M, et al. A scalable data collection, characterization, and accounting framework for urban material stocks. J Ind Ecol 2021;n/a. doi:https://doi.org/10.1111/jiec.13198.

[83]   Peled Y, Fishman T. Estimation and mapping of the material stocks of buildings of Europe: a novel nighttime lights-based approach. Resour Conserv Recycl 2021;169:105509. doi:https://doi.org/10.1016/j.resconrec.2021.105509.

[84]   Heeren N, Fishman T. A database seed for a community-driven material intensity research platform. Sci Data 2019;6:23. doi:10.1038/s41597-019-0021-x.

[85]   Yang D, Guo J, Sun L, Shi F, Liu J, Tanikawa H. Urban buildings material intensity in China from 1949 to 2015. Resour Conserv Recycl 2020;159. doi:10.1016/j.resconrec.2020.104824.

[86]   Fu C, Zhang Y, Deng T, Daigo I. The evolution of material stock research: From exploring to rising to hot studies. J Ind Ecol 2021;n/a. doi:https://doi.org/10.1111/jiec.13195.

[87]   Swan LG, Ugursal VI. Modeling of end-use energy consumption in the residential sector: A review of modeling techniques. Renew Sustain Energy Rev 2009;13:1819–35. doi:10.1016/J.RSER.2008.09.033.

[88]   Probst B, Touboul S, Glachant M, Dechezleprêtre A. Global trends in the invention and diffusion of climate change mitigation technologies. Nat Energy 2021;6:1077–86. doi:10.1038/s41560-021-00931-5.

[89]   Duan H, Chen S, Song J. Characterizing regional building energy consumption under joint climatic and socioeconomic impacts. Energy 2022;245:123290. doi:https://doi.org/10.1016/j.energy.2022.123290.

[90]   Yamaguchi Y, Kim B, Kitamura T, Akizawa K, Chen H, Shimoda Y. Building stock energy modeling considering building system composition and long-term change for climate change mitigation of commercial building stocks. Appl Energy 2022;306:117907. doi:https://doi.org/10.1016/j.apenergy.2021.117907.

[91]   Wong CHH, Cai M, Ren C, Huang Y, Liao C, Yin S. Modelling building energy use at urban scale: A review on their account for the urban environment. Build Environ 2021;205:108235. doi:https://doi.org/10.1016/j.buildenv.2021.108235.

[92]   Sandberg NH, Sartori I, Heidrich O, Dawson R, Dascalaki E, Dimitriou S, et al. Dynamic building stock modelling: Application to 11 European countries to support the energy efficiency and retrofit ambitions of the EU. Energy Build 2016;132:26–38. doi:10.1016/j.enbuild.2016.05.100.

[93]   Hong T, Chen Y, Luo X, Luo N, Lee SH. Ten questions on urban building energy modeling. Build Environ 2020;168:106508. doi:10.1016/j.buildenv.2019.106508.

[94]   Zhong X, Hu M, Deetman S, Rodrigues JFD, Lin H-X, Tukker A, et al. The evolution and future perspectives of energy intensity in the global building sector 1971-2060. J Clean Prod 2021:127098. doi:https://doi.org/10.1016/j.jclepro.2021.127098.

[95]   Heeren N, Jakob M, Martius G, Gross N, Wallbaum H. A component based bottom-up building stock model for comprehensive environmental impact assessment and target control. Renew Sustain Energy Rev 2013;20:45–56. doi:https://doi.org/10.1016/j.rser.2012.11.064.

[96]   Abbasabadi N, Mehdi Ashayeri JK. Urban energy use modeling methods and tools: A review and an outlook. Build Environ 2019;161:106270. doi:10.1016/J.BUILDENV.2019.106270.

[97]   Wang Z, Srinivasan RS. A review of artificial intelligence based building energy use prediction: Contrasting the capabilities of single and ensemble prediction models. Renew Sustain Energy Rev 2017;75:796–808. doi:10.1016/J.RSER.2016.10.079.

[98]   Buffat R, Froemelt A, Heeren N, Raubal M, Hellweg S. Big data GIS analysis for novel approaches in building stock modelling. Appl Energy 2017;208:277–90. doi:https://doi.org/10.1016/j.apenergy.2017.10.041.

[99]   Johari F, Peronato G, Sadeghian P, Zhao X, Widén J. Urban building energy modeling: State of the art and future prospects. Renew Sustain Energy Rev 2020;128:109902. doi:https://doi.org/10.1016/j.rser.2020.109902.

[100]   Nägeli C, Camarasa C, Delghust M, Fennell P, Hamilton I, Jakob M, et al. Best practice reporting guideline for building stock energy models. Energy Build 2022;260:111904. doi:https://doi.org/10.1016/j.enbuild.2022.111904.

[101]   Ferrando M, Lavagna M, Causone F. Life cycle assessment approaches applied to energy

modelling of urban building stocks: a literature review. n.d.

[102]   Malhotra A, Bischof J, Nichersu A, Häfele K-H, Exenberger J, Sood D, et al. Information modelling for urban building energy simulation—A taxonomic review. Build Environ 2021:108552. doi:https://doi.org/10.1016/j.buildenv.2021.108552.

[103]   Reinhart CF, Cerezo Davila C. Urban building energy modeling – A review of a nascent field. Build Environ 2016;97:196–202. doi:https://doi.org/10.1016/j.buildenv.2015.12.001.

[104]   Fennell PJ, Ruyssevelt PA, Mata É, Jakob M. A Review of the Status of Uncertainty and Sensitivity Analysis in Building-stock Energy Models. Proc. Build. Simul. 2019 16th Conf. IBPSA, 2019, p. 3353–60.

[105]   Ali U, Shamsi MH, Hoare C, Mangina E, O'Donnell J. Review of urban building energy modeling (UBEM) approaches, methods and tools using qualitative and quantitative analysis. Energy Build 2021;246:111073. doi:https://doi.org/10.1016/j.enbuild.2021.111073.

[106]   Langevin J, Reyna JL, Ebrahimigharehbaghi S, Sandberg N, Fennell P, Nägeli C, et al. Developing a common approach for classifying building stock energy models. Renew Sustain Energy Rev 2020;133. doi:10.1016/j.rser.2020.110276.

[107]   Oraiopoulos A, Howard B. On the accuracy of Urban Building Energy Modelling. Renew Sustain Energy Rev 2022;158:111976. doi:https://doi.org/10.1016/j.rser.2021.111976.

[108]   B. Müller D. Stock dynamics for forecasting material flows—Case study for housing in The Netherlands. Ecol Econ 2006;59:142–56. doi:https://doi.org/10.1016/j.ecolecon.2005.09.025.

[109]   Bergsdal H, Brattebø H, Bohne RA, Müller DB. Dynamic material flow analysis for Norway's dwelling stock. Build Res Inf 2007;35:557–70. doi:10.1080/09613210701287588.

[110]   Hu M, Bergsdal H, Van Der Voet E, Huppes G, Muller DB. Dynamics of urban and rural housing stocks in China. Build Res Inf 2010;38:301–17. doi:10.1080/09613211003729988.

[111]   Hu M, Van Der Voet E, Huppes G. Dynamic Material Flow Analysis for Strategic Construction and Demolition Waste Management in Beijing. J Ind Ecol 2010;14:440–56. doi:10.1111/j.1530-9290.2010.00245.x.

[112]   Heeren N, Hellweg S. Tracking Construction Material over Space and Time: Prospective and Geo-referenced Modeling of Building Stocks and Construction Material Flows. J Ind Ecol 2019;23:253–67. doi:10.1111/jiec.12739.

[113]   Wiedenhofer D, Fishman T, Plank B, Miatto A, Lauk C, Haas W, et al. Prospects for a saturation of humanity's resource use? An analysis of material stocks and flows in nine world regions from 1900 to 2035. Glob Environ Chang 2021;71:102410. doi:https://doi.org/10.1016/j.gloenvcha.2021.102410.

[114]   Lanau M, Liu G, Kral U, Wiedenhofer D, Keijzer E, Yu C, et al. Taking Stock of Built Environment Stock Studies: Progress and Prospects. Environ Sci Technol 2019;53:8499–515. doi:10.1021/acs.est.8b06652.

[115]   Augiseau V, Barles S. Studying construction materials flows and stock: A review. Resour Conserv Recycl 2017;123:153–64. doi:https://doi.org/10.1016/j.resconrec.2016.09.002.

[116]   Müller E, Hilty LM, Widmer R, Schluep M, Faulstich M. Modeling Metal Stocks and Flows: A Review of Dynamic Material Flow Analysis Methods. Environ Sci Technol 2014;48:2102–13. doi:10.1021/es403506a.

[117] Guo D, Huang L. The State of the Art of Material Flow Analysis Research Based on Construction and Demolition Waste Recycling and Disposal. Buildings 2019;9. doi:10.3390/buildings9100207.

[118] Allesch A, Brunner PH. Material Flow Analysis as a Decision Support Tool for Waste Management: A Literature Review. J Ind Ecol 2015;19:753–64. doi:https://doi.org/10.1111/jiec.12354.

[119] Wang D, Landolt J, Mavromatidis G, Orehounig K, Carmeliet J. CESAR: A bottom-up building stock modelling tool for Switzerland to address sustainable energy transformation strategies. Energy Build 2018;169:9–26. doi:10.1016/J.ENBUILD.2018.03.020.

[120] McKenna R, Merkel E, Fehrenbach D, Mehne S, Fichtner W. Energy efficiency in the German residential sector: A bottom-up building-stock-model-based analysis in the context of energy-political targets. Build Environ 2013;62:77–88. doi:10.1016/J.BUILDENV.2013.01.002.

[121] Yang D, Dang M, Sun L, Han F, Shi F, Zhang H, et al. A System Dynamics Model for Urban Residential Building Stock towards Sustainability: The Case of Jinan, China. Int J Environ Res Public Health 2021;18:9520. doi:10.3390/ijerph18189520.

[122] Francis A, Thomas A. A framework for dynamic life cycle sustainability assessment and policy analysis of built environment through a system dynamics approach. Sustain Cities Soc 2022;76:103521. doi:https://doi.org/10.1016/j.scs.2021.103521.

[123] Tang S, Zhang L, Hao Y, Chang Y, Liu G, Liu Q, et al. System dynamics modeling for construction material flows of urban residential building: A case study of Beijing, China. Resour Conserv Recycl 2021;168:105298. doi:https://doi.org/10.1016/j.resconrec.2020.105298.

[124] Zhao F. AGENT-BASED MODELING OF COMMERCIAL BUILDING STOCKS FOR ENERGY POLICY AND DEMAND RESPONSE ANALYSIS. 2012.

[125] Nägeli C, Jakob M, Catenazzi G, Ostermeyer Y. Towards agent-based building stock modeling: Bottom-up modeling of long-term stock dynamics affecting the energy and climate impact of building stocks. Energy Build 2020;211:109763. doi:10.1016/J.ENBUILD.2020.109763.

[126] Ebrahimi B, Rosado L, Wallbaum H. Machine learning-based stocks and flows modeling of road infrastructure. J Ind Ecol 2022;n/a. doi:https://doi.org/10.1111/jiec.13232.

[127] Mulero-Palencia S, Álvarez-Díaz S, Andrés-Chicote M. Machine Learning for the Improvement of Deep Renovation Building Projects Using As-Built BIM Models. Sustain 2021;13. doi:10.3390/su13126576.

[128] Nägeli C, Jakob M, Catenazzi G, Ostermeyer Y. Policies to decarbonize the Swiss residential building stock: An agent-based building stock modeling assessment. Energy Policy 2020;146:111814. doi:10.1016/j.enpol.2020.111814.

[129] Mastrucci A, Marvuglia A, Leopold U, Benetto E. Life Cycle Assessment of building stocks from urban to transnational scales: A review. Renew Sustain Energy Rev 2017;74:316–32. doi:https://doi.org/10.1016/j.rser.2017.02.060.

[130] Kurvinen A, Saari A, Heljo J, Nippala E. Modeling Building Stock Development.

Sustainability 2021;13. doi:10.3390/su13020723.

[131]   Steubing B, De Koning D, Haas A, Mutel CL. The Activity Browser-An open source LCA software building on top of the brightway framework. Softw Impacts 2020;3:100012. doi:10.1016/j.simpa.2019.100012.

[132]   Hollberg A, Kiss B, Röck M, Soust-Verdaguer B, Wiberg AH, Lasvaux S, et al. Review of visualising LCA results in the design process of buildings. Build Environ 2021;190:107530. doi:https://doi.org/10.1016/j.buildenv.2020.107530.

[133]   Varun, Bhat IK, Prakash R. LCA of renewable energy for electricity generation systems—A review. Renew Sustain Energy Rev 2009;13:1067–73. doi:https://doi.org/10.1016/j.rser.2008.08.004.

[134]   Helena DSG, Silvia D. Model for Life Cycle Assessment (LCA) of buildings. 2018. doi:10.2760/10016.

[135]   Life Cycle Initiative. Interactive map of lca databases n.d. https://www.lifecycleinitiative.org/applying-lca/lca-databases-map/ (accessed January 11, 2022).

[136]   Piacenza JR, Tumer IY, Seyedmahmoudi SH, Haapala KR, Hoyle C. Comparison of Sustainability Performance for Cross Laminated Timber and Concrete 2013. doi:10.1115/DETC2013-12267.

[137]   Mao R, Bao Y, Duan H, Liu G. Global urban subway development, construction material stocks, and embodied carbon emissions. Humanit Soc Sci Commun 2021;8:83. doi:10.1057/s41599-021-00757-2.

[138]   Wernet G, Bauer C, Steubing B, Reinhard J, Moreno-Ruiz E, Weidema B, et al. The ecoinvent database version 3 (part I): overview and methodology. Int J Life Cycle Assess 2016;21:1218–30. doi:10.1007/s11367-016-1087-8.

[139]   Mutel C. Brightway: An open source framework for Life Cycle Assessment. J Open Source Softw 2017;2:236. doi:10.21105/joss.00236.

[140]   Moschetti R, Mazzarella L, Nord N. An overall methodology to define reference values for building sustainability parameters. Energy Build 2015;88:413–27. doi:10.1016/J.ENBUILD.2014.11.071.

[141]   IKE. eFootprint LCA software n.d. http://www.ike-global.com/#/ (accessed January 11, 2022).

[142]   Steubing B, de Koning D. Making the use of scenarios in LCA easier: the superstructure approach. Int J Life Cycle Assess 2021. doi:10.1007/s11367-021-01974-2.

[143]   Zimmermann RK, Bruhn S, Birgisdóttir H. BIM-Based Life Cycle Assessment of Buildings—An Investigation of Industry Practice and Needs. Sustain 2021;13. doi:10.3390/su13105455.

[144]   Potrč Obrecht T, Röck M, Hoxha E, Passer A. BIM and LCA Integration: A Systematic Literature Review. Sustain 2020;12. doi:10.3390/su12145534.

[145]   Obrecht TP, Röck M, Hoxha E, Passer A. The challenge of integrating Life Cycle Assessment in the building design process – a systematic literature review of BIM-LCA workflows. IOP Conf Ser Earth Environ Sci 2020;588:32024. doi:10.1088/1755-

1315/588/3/032024.

[146] Llatas C, Soust-Verdaguer B, Passer A. Implementing Life Cycle Sustainability Assessment during design stages in Building Information Modelling: From systematic literature review to a methodological approach. Build Environ 2020;182:107164. doi:https://doi.org/10.1016/j.buildenv.2020.107164.

[147] Sprecher B, Verhagen TJ, Sauer ML, Baars M, Heintz J, Fishman T. Material intensity database for the Dutch building stock: Towards Big Data in material stock analysis. J Ind Ecol 2021;n/a. doi:https://doi.org/10.1111/jiec.13143.

[148] Zhang C, Hu M, Sprecher B, Yang X, Zhong X, Li C, et al. Recycling potential in building energy renovation: A prospective study of the Dutch residential building stock up to 2050. J Clean Prod 2021;301:126835. doi:https://doi.org/10.1016/j.jclepro.2021.126835.

[149] Pauliuk S, Heeren N. ODYM—An open software framework for studying dynamic material systems: Principles, implementation, and data structures. J Ind Ecol 2020;24:446–58. doi:https://doi.org/10.1111/jiec.12952.

[150] Yücel G. Extent of inertia caused by the existing building stock against an energy transition in the Netherlands. Energy Build 2013;56:134–45. doi:10.1016/J.ENBUILD.2012.09.022.

[151] Mastrucci A, Baume O, Stazi F, Leopold U. Estimating energy savings for the residential building stock of an entire city: A GIS-based statistical downscaling approach applied to Rotterdam. Energy Build 2014;75:358–67. doi:10.1016/J.ENBUILD.2014.02.032.

[152] Wang CK, Tindemans S, Miller C, Agugiaro G, Stoter J. Bayesian calibration at the urban scale: a case study on a large residential heating demand application in Amsterdam. J Build Perform Simul 2020;13:347–61. doi:10.1080/19401493.2020.1729862.

[153] Filippidou F, Nieboer N, Visscher H. Are we moving fast enough? The energy renovation rate of the Dutch non-profit housing using the national energy labelling database. Energy Policy 2017;109:488–98. doi:10.1016/j.enpol.2017.07.025.

[154] Liu W, Best F, Crijns-Graus W. Exploring the pathways towards a sustainable heating system – A case study of Utrecht in the Netherlands. J Clean Prod 2021;280:125036. doi:https://doi.org/10.1016/j.jclepro.2020.125036.

[155] Government of the Netherlands. A circular economy in the Netherlands by 2050. 2016.

[156] Ouden B den, Kerkhoven J, Warnaars J, Terwel R, Coenen M, Verboon T, et al. Nederland klimaatneutraal in 2050: vier scenario's (The Netherlands will be climate neutral in 2050: four scenarios). 2020.

[157] Dutch government. National Climate Agreement - The Netherlands. 2019.

[158] European Commission. Financing the energy renovation of buildings with Cohesion Policy funding 2014. https://ec.europa.eu/regional_policy/en/information/publications/guides/2014/financing-the-energy-renovation-of-buildings-with-cohesion-policy-funding (accessed October 9, 2019).

[159] Delmastro C, Gargiulo M. Capturing the long-term interdependencies between building thermal energy supply and demand in urban planning strategies. Appl Energy 2020;268:114774. doi:https://doi.org/10.1016/j.apenergy.2020.114774.

[160] Ma W, Fang S, Liu G, Zhou R. Modeling of district load forecasting for distributed energy

system. Appl Energy 2017. doi:10.1016/j.apenergy.2017.07.009.

[161] Johansson T, Olofsson T, Mangold M. Development of an energy atlas for renovation of the multifamily building stock in Sweden. Appl Energy 2017;203:723–36. doi:https://doi.org/10.1016/j.apenergy.2017.06.027.

[162] Kavgic M, Mavrogianni A, Mumovic D, Summerfield A, Stevanovic Z, Djurovic-Petrovic M. A review of bottom-up building stock models for energy consumption in the residential sector. Build Environ 2010;45:1683–97. doi:https://doi.org/10.1016/j.buildenv.2010.01.021.

[163] Nutkiewicz A, Yang Z, Jain RK. Data-driven Urban Energy Simulation (DUE-S): A framework for integrating engineering simulation and machine learning methods in a multi-scale urban energy modeling workflow. Appl Energy 2018. doi:10.1016/j.apenergy.2018.05.023.

[164] Chen Y, Hong T, Piette MA. Automatic generation and simulation of urban building energy models based on city datasets for city-scale building retrofit analysis. Appl Energy 2017;205:323–35. doi:10.1016/J.APENERGY.2017.07.128.

[165] Mata É, Sasic Kalagasidis A, Johnsson F. Building-stock aggregation through archetype buildings: France, Germany, Spain and the UK. Build Environ 2014;81:270–82. doi:10.1016/J.BUILDENV.2014.06.013.

[166] Sokol J, Cerezo Davila C, Reinhart CF. Validation of a Bayesian-based method for defining residential archetypes in urban building energy models. Energy Build 2017;134:11–24. doi:10.1016/J.ENBUILD.2016.10.050.

[167] Froemelt A, Hellweg S. Assessing Space Heating Demand on a Regional Level: Evaluation of a Bottom-Up Model in the Scope of a Case Study. J Ind Ecol 2016;21:332–43. doi:10.1111/jiec.12438.

[168] Bianchi C, Zhang L, Goldwasser D, Parker A, Horsey H. Modeling occupancy-driven building loads for large and diversified building stocks through the use of parametric schedules. Appl Energy 2020;276:115470. doi:https://doi.org/10.1016/j.apenergy.2020.115470.

[169] Lim H, Zhai ZJ. Review on stochastic modeling methods for building stock energy prediction. Build Simul 2017;10:607–24. doi:10.1007/s12273-017-0383-y.

[170] van den Brom P, Meijer A, Visscher H. Performance gaps in energy consumption: household groups and building characteristics. Build Res Inf 2018;46:54–70. doi:10.1080/09613218.2017.1312897.

[171] Hall LMH, Buckley AR. A review of energy systems models in the UK: Prevalent usage and categorisation. Appl Energy 2016. doi:10.1016/j.apenergy.2016.02.044.

[172] BAG. Basisregistratie Adressen en Gebouwen (Basic registration Addresses and Buildings) 2018. https://www.geobasisregistraties.nl/basisregistraties/adressen-en-gebouwen (accessed October 10, 2019).

[173] KNMI (the Royal Netherlands Meteorological Institute). Weather data of the Netherlands n.d. https://www.knmi.nl/home (accessed October 8, 2019).

[174] Ministry of the Interior and Kingdom Relations. Figures about Housing and Construction 2013 (Cijfers over Wonen en Bouwen 2013). 2013.

[175]   García-Pérez S, Sierra-Pérez J, Boschmonart-Rives J. Environmental assessment at the urban level combining LCA-GIS methodologies: A case study of energy retrofits in the Barcelona metropolitan area. Build Environ 2018;134:191–204. doi:10.1016/J.BUILDENV.2018.01.041.

[176]   TABULA Project Team. TABULA Calculation Method – Energy Use for Heating and Domestic Hot Water. Institut Wohnen und Umwelt GmbH; 2013.

[177]   Filogamo L, Peri G, Rizzo G, Giaccone A. On the classification of large residential buildings stocks by sample typologies for energy planning purposes. Appl Energy 2014;135:825–35. doi:10.1016/J.APENERGY.2014.04.002.

[178]   Vasallo A, Vallejo E, Massa G, Macía A, Pablos L, Criado C, et al. The District Energy-Efficient Retrofitting of Torrelago (Laguna de Duero – Spain). IOP Conf Ser Earth Environ Sci 2019;290:012138. doi:10.1088/1755-1315/290/1/012138.

[179]   Milieu Centraal. Stappenplan aardgasvrij wonen (Natural gas-free living step-by-step plan) n.d. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/wonen-zonder-aardgas/stappenplan-aardgasvrij-wonen/ (accessed October 18, 2019).

[180]   International Organization for Standardization. Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790:2008). Brussels: 2008.

[181]   Soheil Alavirad. Robust energy-retrofit strategy for dutch archetypes：A demand reduction approach. Technische Universiteit Eindhoven, 2018.

[182]   Het Centraal Bureau voor de Statistiek (CBS). Energielevering aan woningen en bedrijven naar postcode (Energy supply to homes and businesses by postcode) 2015. https://www.cbs.nl/nl-nl/maatwerk/2019/11/energielevering-aan-woningen-en-bedrijven-naar-postcode (accessed October 9, 2019).

[183]   Majcen D, Itard LCM, Visscher H. Theoretical vs. actual energy consumption of labelled dwellings in the Netherlands: Discrepancies and policy implications. Energy Policy 2013;54:125–36. doi:10.1016/J.ENPOL.2012.11.008.

[184]   Brøgger M, Bacher P, Madsen H, Wittchen KB. Estimating the influence of rebound effects on the energy-saving potential in building stocks. Energy Build 2018;181:62–74. doi:10.1016/j.enbuild.2018.10.006.

[185]   Heat Transition Atlas (Warmte transitie atlas) n.d. http://pzh.maps.arcgis.com/apps/MapJournal/index.html?appid=4c8e61a776eb4a6e8aaec99653d22b62# (accessed October 14, 2019).

[186]   Li W, Zhou Y, Cetin K, Eom J, Wang Y, Chen G, et al. Modeling urban building energy use: A review of modeling approaches and procedures. Energy 2017;141:2445–57. doi:10.1016/J.ENERGY.2017.11.071.

[187]   Majcen D, Itard L, Visscher H. Actual and theoretical gas consumption in Dutch dwellings: What causes the differences? Energy Policy 2013;61:460–71. doi:10.1016/J.ENPOL.2013.06.018.

[188]   D'Oca S, Hong T. Occupancy schedules learning process through a data mining framework. Energy Build 2015;88:395–408. doi:10.1016/J.ENBUILD.2014.11.065.

[189]   Kragh J, Wittchen KB. Development of two Danish building typologies for residential

buildings. Energy Build 2014;68:79–86. doi:10.1016/J.ENBUILD.2013.04.028.

[190]   Ballarini I, Corgnati SP, Corrado V. Use of reference buildings to assess the energy saving potentials of the residential building stock: The experience of TABULA project. Energy Policy 2014;68:273–84. doi:10.1016/J.ENPOL.2014.01.027.

[191]   Magalhães SMC, Leal VMS. Characterization of thermal performance and nominal heating gap of the residential building stock using the EPBD-derived databases: The case of Portugal mainland. Energy Build 2014;70:167–79. doi:10.1016/j.enbuild.2013.11.054.

[192]   van den Brom P, Hansen AR, Gram-Hanssen K, Meijer A, Visscher H. Variances in residential heating consumption – Importance of building characteristics and occupants analysed by movers and stayers. Appl Energy 2019;250:713–28. doi:10.1016/J.APENERGY.2019.05.078.

[193]   Österbring M, Camarasa C, Nägeli C, Thuvander L, Wallbaum H. Prioritizing deep renovation for housing portfolios. Energy Build 2019;202:109361. doi:10.1016/J.ENBUILD.2019.109361.

[194]   Rogeau A, Girard R, Abdelouadoud Y, Thorel M, Kariniotakis G. Joint optimization of building-envelope and heating-system retrofits at territory scale to enhance decision-aiding. Appl Energy 2020;264:114639. doi:https://doi.org/10.1016/j.apenergy.2020.114639.

[195]   Chang M, Thellufsen JZ, Zakeri B, Pickering B, Pfenninger S, Lund H, et al. Trends in tools and approaches for modelling the energy transition. Appl Energy 2021;290:116731. doi:https://doi.org/10.1016/j.apenergy.2021.116731.

[196]   Shimoda Y, Sugiyama M, Nishimoto R, Momonoki T. Evaluating decarbonization scenarios and energy management requirement for the residential sector in Japan through bottom-up simulations of energy end-use demand in 2050. Appl Energy 2021;303:117510. doi:https://doi.org/10.1016/j.apenergy.2021.117510.

[197]   Bui D-K, Nguyen TN, Ghazlan A, Ngo TD. Biomimetic adaptive electrochromic windows for enhancing building energy efficiency. Appl Energy 2021;300:117341. doi:https://doi.org/10.1016/j.apenergy.2021.117341.

[198]   Cao Z, Liu G, Duan H, Xi F, Liu G, Yang W. Unravelling the mystery of Chinese building lifetime: A calibration and verification based on dynamic material flow analysis. Appl Energy 2019;238:442–52. doi:10.1016/J.APENERGY.2019.01.106.

[199]   Sandberg NH, Sartori I, Brattebø H. Using a dynamic segmented model to examine future renovation activities in the Norwegian dwelling stock. Energy Build 2014;82:287–95. doi:10.1016/J.ENBUILD.2014.07.005.

[200]   Wiedenhofer D, Steinberger JK, Eisenmenger N, Haas W. Maintenance and Expansion: Modeling Material Stocks and Flows for Residential Buildings and Transportation Networks in the EU25. J Ind Ecol 2015;19:538–51. doi:10.1111/jiec.12216.

[201]   Ostermeyer Y, Nägeli C, Heeren N, Wallbaum H. Building Inventory and Refurbishment Scenario Database Development for Switzerland. J Ind Ecol 2017;22:629–42. doi:10.1111/jiec.12616.

[202]   Coffey B, Borgeson S, Selkowitz S, Apte J, Mathew P, Haves P. Towards a very low-energy building stock: Modelling the US commercial building sector to support policy and

innovation planning. Build Res Inf 2009;37:610–24. doi:10.1080/09613210903189467.

[203]   Pauliuk S, Sjöstrand K, Müller DB. Transforming the Norwegian Dwelling Stock to Reach the 2 Degrees Celsius Climate Target: Combining Material Flow Analysis and Life Cycle Assessment Techniques. J Ind Ecol 2013;17:542–54. doi:10.1111/j.1530-9290.2012.00571.x.

[204]   Vásquez F, Løvik AN, Sandberg NH, Müller DB. Dynamic type-cohort-time approach for the analysis of energy reductions strategies in the building stock. Energy Build 2016;111:37–55. doi:10.1016/J.ENBUILD.2015.11.018.

[205]   Koezjakov A, Urge-Vorsatz D, Crijns-Graus W, van den Broek M. The relationship between operational energy demand and embodied energy in Dutch residential buildings. Energy Build 2018;165:233–45. doi:10.1016/J.ENBUILD.2018.01.036.

[206]   Miatto A, Schandl H, Tanikawa H. How important are realistic building lifespan assumptions for material stock and demolition waste accounts? Resour Conserv Recycl 2017;122:143–54. doi:10.1016/j.resconrec.2017.01.015.

[207]   Klimaatakkoord. Climate Agreements for Built Environment n.d. https://www.klimaatakkoord.nl/gebouwde-omgeving (accessed October 30, 2020).

[208]   Visscher H. Innovations for a carbon free Dutch housing stock in 2050. IOP Conf Ser Earth Environ Sci 2019;329. doi:10.1088/1755-1315/329/1/012003.

[209]   Milieu Centraal. Double glass, HR ++ glass and triple glass n.d. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/isoleren-en-besparen/dubbel-glas-hr-glas-en-triple-glas/ (accessed October 8, 2021).

[210]   TABULA Project Team. TABULA WebTool 2017. https://webtool.building-typology.eu/#bm (accessed October 8, 2021).

[211]   Koezjakov A. The Effect of an Increase in Energy Efficiency on Embodied Energy use: a scenario analysis for Dutch residential buildings. Utrecht University, 2017.

[212]   Gernaat DEHJ, de Boer H-S, Dammeier LC, van Vuuren DP. The role of residential rooftop photovoltaic in long-term energy and climate scenarios. Appl Energy 2020;279:115705. doi:https://doi.org/10.1016/j.apenergy.2020.115705.

[213]   Bódis K, Kougias I, Jäger-Waldau A, Taylor N, Szabó S. A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union. Renew Sustain Energy Rev 2019;114:109309. doi:10.1016/J.RSER.2019.109309.

[214]   Ende E van den. A revolution: The Netherlands kisses gas goodbye – but will it help the climate? Energypost 2017. https://energypost.eu/a-revolution-the-netherlands-kisses-gas-goodbye-but-will-it-help-the-climate/ (accessed October 26, 2020).

[215]   IPCC. IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 2013.

[216]   Mendoza Beltran A, Cox B, Mutel C, van Vuuren DP, Font Vivanco D, Deetman S, et al. When the Background Matters: Using Scenarios from Integrated Assessment Models in Prospective Life Cycle Assessment. J Ind Ecol 2018;24:64–79. doi:10.1111/jiec.12825.

[217]   PBL. Integrated Assessment of Global Environmental Change with IMAGE 3.0 - Model description and policy applications. 2014.

[218] O'Neill BC, Kriegler E, Riahi K, Ebi KL, Hallegatte S, Carter TR, et al. A new scenario framework for climate change research: the concept of shared socioeconomic pathways. Clim Change 2014;122:387–400. doi:10.1007/s10584-013-0905-2.

[219] The Energy Agreement for sustainable growth (Energieakkoord voor duurzame groei) 2013. https://www.ser.nl/nl/thema/energie-en-duurzaamheid/energieakkoord/domeinen/01 (accessed October 26, 2020).

[220] Rijksoverheid. The Netherlands circular in 2050 (Nederland circulair in 2050) 2018. https://www.rijksoverheid.nl/onderwerpen/circulaire-economie/nederland-circulair-in-2050 (accessed February 28, 2021).

[221] CBS. Population forecast of the Netherlands 2018. https://www.cbs.nl/en-gb/news/2018/51/forecast-18-million-inhabitants-in-2029#id=undefined (accessed November 8, 2020).

[222] RVO. Energieprestatie-BENG (Energy performance-NZEB) 2021. https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels/nieuwbouw/energieprestatie-beng (accessed July 21, 2021).

[223] Milieu Centraal. Complete heat pump n.d. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/energiezuinig-verwarmen-en-warm-water/volledige-warmtepomp/ (accessed November 7, 2020).

[224] CBS. Emissions to air by the Dutch economy-national accounts 2020. https://opendata.cbs.nl/#/CBS/en/dataset/83300ENG/table?searchKeywords=CO2 (accessed April 13, 2021).

[225] Kong M, Hong T, Ji C, Kang H, Lee M. Development of building driven-energy payback time for energy transition of building with renewable energy systems. Appl Energy 2020;271:115162. doi:https://doi.org/10.1016/j.apenergy.2020.115162.

[226] Mata É, Wanemark J, Nik VM, Sasic Kalagasidis A. Economic feasibility of building retrofitting mitigation potentials: Climate change uncertainties for Swedish cities. Appl Energy 2019;242:1022–35. doi:10.1016/j.apenergy.2019.03.042.

[227] Milieu Centraal. Low temperature heating n.d. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/energiezuinig-verwarmen-en-warm-water/lage-temperatuur-verwarming-ltv/ (accessed November 11, 2020).

[228] Heat network without natural gas n.d. https://www.milieucentraal.nl/energie-besparen/energiezuinig-huis/wonen-zonder-aardgas/warmtenet-verwarmen-zonder-aardgas/ (accessed November 1, 2020).

[229] Municipality of Leiden. Heat vision Leiden VERSION FOR PARTICIPATION FINAL. 2017.

[230] Wei M, Lee SH, Hong T, Conlon B, McKenzie L, Hendron B, et al. Approaches to cost-effective near-net zero energy new homes with time-of-use value of energy and battery storage. Adv Appl Energy 2021;2:100018. doi:https://doi.org/10.1016/j.adapen.2021.100018.

[231] He Z, Hong T, Chou SK. A framework for estimating the energy-saving potential of occupant behaviour improvement. Appl Energy 2021;287:116591.

doi:https://doi.org/10.1016/j.apenergy.2021.116591.

[232] CBS. Living space in the Netherlands 2018. https://www.cbs.nl/nl-nl/achtergrond/2018/22/woonoppervlakte-in-nederland (accessed November 12, 2020).

[233] Galvin R. Making the 'rebound effect' more useful for performance evaluation of thermal retrofits of existing homes: Defining the 'energy savings deficit' and the 'energy performance gap.' Energy Build 2014;69:515–24. doi:10.1016/J.ENBUILD.2013.11.004.

[234] Rijksoverheid. Construction Transition Agenda (Transitieagenda Bouw) 2018. https://www.rijksoverheid.nl/onderwerpen/circulaire-economie/documenten/rapporten/2018/01/15/bijlage-4-transitieagenda-bouw (accessed June 10, 2021).

[235] Chen Y, Deng Z, Hong T. Automatic and rapid calibration of urban building energy models by learning from energy performance database. Appl Energy 2020;277:115584. doi:https://doi.org/10.1016/j.apenergy.2020.115584.

[236] Xiao T, Xu P, He R, Sha H. Status quo and opportunities for building energy prediction in limited data Context—Overview from a competition. Appl Energy 2022;305:117829. doi:https://doi.org/10.1016/j.apenergy.2021.117829.

[237] Sun H, Kporsu AK, Taghizadeh-Hesary F, Edziah BK. Estimating environmental efficiency and convergence: 1980 to 2016. Energy 2020;208:118224. doi:https://doi.org/10.1016/j.energy.2020.118224.

[238] Stephan A, Athanassiadis A. Towards a more circular construction sector: Estimating and spatialising current and future non-structural material replacement flows to maintain urban building stocks. Resour Conserv Recycl 2018;129:248–62. doi:10.1016/J.RESCONREC.2017.09.022.

[239] Babí Almenar J, Elliot T, Rugani B, Philippe B, Navarrete Gutierrez T, Sonnemann G, et al. Nexus between nature-based solutions, ecosystem services and urban challenges. Land Use Policy 2021;100:104898. doi:https://doi.org/10.1016/j.landusepol.2020.104898.

[240] Zabek M, Hildebrand L, Brell-Cokcan S, Wirth M. Used building materials as secondary resources – Identification of valuable building material and automized deconstruction. J Facade Des Eng 2017;5:25–33. doi:10.7480/jfde.2017.2.1684.

[241] Koutamanis A, van Reijn B, van Bueren E. Urban mining and buildings: A review of possibilities and limitations. Resour Conserv Recycl 2018;138:32–9. doi:10.1016/J.RESCONREC.2018.06.024.

[242] Di Maria A, Eyckmans J, Van Acker K. Downcycling versus recycling of construction and demolition waste: Combining LCA and LCC to support sustainable policy making. Waste Manag 2018;75:3–21. doi:https://doi.org/10.1016/j.wasman.2018.01.028.

[243] Akbarieh A, Schäfer M, Waldmann D, Teferle FN. Post-Urban Mining Automation and Digitalisation for a Closed- Loop Circular Post-Urban Mining Automation and Digitalisation for a Closed- Loop Circular Construction. Proc. 38th Int. Conf. CIB W78, Luxembourg: 2021.

[244] Tanikawa H, Fishman T, Okuoka K, Sugimoto K. The Weight of Society Over Time and Space: A Comprehensive Account of the Construction Material Stock of Japan, 1945–2010.

J Ind Ecol 2015;19:778–91. doi:10.1111/jiec.12284.

[245]   Kleemann F, Lederer J, Rechberger H, Fellner J. GIS-based Analysis of Vienna's Material Stock in Buildings. J Ind Ecol 2017;21:368–80. doi:10.1111/jiec.12446.

[246]   Mao R, Bao Y, Huang Z, Liu Q, Liu G. High-Resolution Mapping of the Urban Built Environment Stocks in Beijing. Environ Sci Technol 2020;54:5345–55. doi:10.1021/acs.est.9b07229.

[247]   Lanau M, Liu G. Developing an Urban Resource Cadaster for Circular Economy: A Case of Odense, Denmark. Environ Sci Technol 2020;54:4675–85. doi:10.1021/acs.est.9b07749.

[248]   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. Appl Energy 2022;306:118060. doi:10.1016/j.apenergy.2021.118060.

[249]   Meglin R, Kytzia S, Habert G. Regional circular economy of building materials: Environmental and economic assessment combining Material Flow Analysis, Input-Output Analyses, and Life Cycle Assessment. J Ind Ecol 2021;n/a. doi:https://doi.org/10.1111/jiec.13205.

[250]   Tanikawa H, Hashimoto S. Urban stock over time: spatial material stock analysis using 4d-GIS. Build Res Inf 2009;37:483–502. doi:10.1080/09613210903169394.

[251]   Schiller G, Gruhler K, Ortlepp R. Continuous Material Flow Analysis Approach for Bulk Nonmetallic Mineral Building Materials Applied to the German Building Sector. J Ind Ecol 2017;21:673–88. doi:10.1111/jiec.12595.

[252]   Schebek L, Schnitzer B, Blesinger D, Köhn A, Miekley B, Linke HJ, et al. Material stocks of the non-residential building sector: the case of the Rhine-Main area. Resour Conserv Recycl 2017;123:24–36. doi:10.1016/J.RESCONREC.2016.06.001.

[253]   Lederer J, Gassner A, Kleemann F, Fellner J. Potentials for a circular economy of mineral construction materials and demolition waste in urban areas: a case study from Vienna. Resour Conserv Recycl 2020;161. doi:10.1016/j.resconrec.2020.104942.

[254]   Lismont A, Allacker K. Turning the existing building stock into a resource mine: Proposal for a new method to develop building stock models. IOP Conf Ser Earth Environ Sci 2019;323. doi:10.1088/1755-1315/323/1/012070.

[255]   Bogoviku L, Waldmann D. Modelling of mineral construction and demolition waste dynamics through a combination of geospatial and image analysis. J Environ Manage 2021;282:111879. doi:https://doi.org/10.1016/j.jenvman.2020.111879.

[256]   Aaron O'Neill. Netherlands: Degree of urbanization from 2009 to 2019. Statista 2019. https://www.statista.com/statistics/276724/urbanization-in-the-netherlands/ (accessed July 2, 2021).

[257]   UNEP. Recycling Rates of Metals - A Status Report. A Report of the Working Group on Global Metal Flows to the International Resource Panel. 2011.

[258]   Potrč Obrecht T, Jordan S, Legat A, Passer A. The role of electricity mix and production efficiency improvements on greenhouse gas (GHG) emissions of building components and future refurbishment measures. Int J Life Cycle Assess 2021;26:839–51. doi:10.1007/s11367-021-01920-2.

[259] Hart J, D'Amico B, Pomponi F. Whole-life embodied carbon in multistory buildings: Steel, concrete and timber structures. J Ind Ecol 2021;25:403–18. doi:https://doi.org/10.1111/jiec.13139.

[260] Sun H, Edziah BK, Kporsu AK, Sarkodie SA, Taghizadeh-Hesary F. Energy efficiency: The role of technological innovation and knowledge spillover. Technol Forecast Soc Change 2021;167:120659. doi:https://doi.org/10.1016/j.techfore.2021.120659.

[261] Tsydenova N, Becker T, Walther G. Optimised design of concrete recycling networks: The case of North Rhine-Westphalia. Waste Manag 2021;135:309–17. doi:https://doi.org/10.1016/j.wasman.2021.09.013.

[262] Nußholz JLK, Nygaard Rasmussen F, Milios L. Circular building materials: Carbon saving potential and the role of business model innovation and public policy. Resour Conserv Recycl 2019;141:308–16. doi:https://doi.org/10.1016/j.resconrec.2018.10.036.

[263] Vegter D, van Hillegersberg J, Olthaar M. Supply chains in circular business models: processes and performance objectives. Resour Conserv Recycl 2020;162:105046. doi:https://doi.org/10.1016/j.resconrec.2020.105046.

[264] Hart J, Adams K, Giesekam J, Tingley DD, Pomponi F. Barriers and drivers in a circular economy: the case of the built environment. Procedia CIRP 2019;80:619–24. doi:https://doi.org/10.1016/j.procir.2018.12.015.

[265] Huo T, Xu L, Feng W, Cai W, Liu B. Dynamic scenario simulations of carbon emission peak in China's city-scale urban residential building sector through 2050. Energy Policy 2021;159:112612. doi:https://doi.org/10.1016/j.enpol.2021.112612.

[266] Arceo A, Tham M, Guven G, MacLean HL, Saxe S. Capturing variability in material intensity of single-family dwellings: A case study of Toronto, Canada. Resour Conserv Recycl 2021;175:105885. doi:https://doi.org/10.1016/j.resconrec.2021.105885.

[267] Zhang C, Hu M, Di Maio F, Sprecher B, Yang X, Tukker A. An overview of the waste hierarchy framework for analyzing the circularity in construction and demolition waste management in Europe. Sci Total Environ 2022;803:149892. doi:https://doi.org/10.1016/j.scitotenv.2021.149892.

[268] IEA. Energy Technology Perspectives 2020. 2020. doi:10.1787/ab43a9a5-en.

[269] Xi F, Davis SJ, Ciais P, Crawford-Brown D, Guan D, Pade C, et al. Substantial global carbon uptake by cement carbonation. Nat Geosci 2016;9:880–3. doi:10.1038/ngeo2840.

[270] United Nations Population Division. World Urbanization Prospects 2018. 2018.

[271] GlobalABC, IEA, UNEP. GlobalABC Roadmap for Buildings and Construction 2020-2050. Glob Status Rep 2020:110. http://globalabc.org/our-work/forging-regional-pathways-global-and-regional-roadmap (accessed July 12, 2021).

[272] Saheb Y. COP26: Sufficiency should be first. Build Cities 2021.

[273] Bocken NMP, Niessen L, Short SW. The Sufficiency-Based Circular Economy—An Analysis of 150 Companies. Front Sustain 2022;3:1–18. doi:10.3389/frsus.2022.899289.

[274] European Commission. COM 662 final. A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. 2020.

[275] Kullmann F, Markewitz P, Stolten D, Robinius M. Combining the worlds of energy systems and material flow analysis: a review. Energy Sustain Soc 2021;11:13. doi:10.1186/s13705-021-00289-2.

[276] Fathi S, Srinivasan R, Fenner A, Fathi S. Machine learning applications in urban building energy performance forecasting: A systematic review. Renew Sustain Energy Rev 2020;133:110287. doi:https://doi.org/10.1016/j.rser.2020.110287.

[277] Akbarnezhad A, Xiao J. Estimation and Minimization of Embodied Carbon of Buildings: A Review. Buildings 2017;7. doi:10.3390/buildings7010005.

[278] Filippidou F. Energy performance progress of the Dutch non-profit housing stock: a longitudinal assessment. TU Delft, 2018.

[279] Municipality of Leiden. Op weg naar een circulair Leiden (Towards a circular Leiden) 2019:1–76. https://www.gagoed.nl/op-weg-naar-een-circulair-leiden/ (accessed June 20, 2021).

[280] Yang X, Hu M, Zhang C, Steubing B. Urban mining potential to reduce primary material use and carbon emissions in the Dutch residential building sector. Resour Conserv Recycl 2022;180:106215. doi:https://doi.org/10.1016/j.resconrec.2022.106215.

[281] Takano A, Hafner A, Linkosalmi L, Ott S, Hughes M, Winter S. Life cycle assessment of wood construction according to the normative standards. Eur J Wood Wood Prod 2015;73:299–312. doi:10.1007/s00107-015-0890-4.

[282] Bronsvoort E, Veldboer T, te Slaa A, Kaptein T. Bouwen aan een houten toekomst-Scenario's voor bouwen met klimaatpositieve materialen (Building a wooden future-Scenarios for building with climate-positive materials). 2020.

[283] Municipality of Leiden. 2020-2050 Bevolkingsprognose Leiden (Leiden population forecast). 2020.

[284] PAW. Transition vision heat n.d. https://aardgasvrijewijken.nl/themas/regieenorganisatie/transitievisie+warmte2/default.aspx (accessed May 1, 2021).

[285] Lombardi F, Rocco MV, Belussi L, Danza L, Magni C, Colombo E. Weather-induced variability of country-scale space heating demand under different refurbishment scenarios for residential buildings. Energy 2022;239:122152. doi:10.1016/j.energy.2021.122152.

[286] Buffat R, Heeren N, Froemelt A, Raubal M. Impact of CH2018 Climate Change Scenarios for Switzerland on today's Swiss building stock. J Phys Conf Ser 2019;1343:12004. doi:10.1088/1742-6596/1343/1/012004.

[287] Royal Netherlands Meteorological Institute. 14 climate scenarios for the Netherlands 2015. https://www.knmiprojects.nl/projects/climate-scenarios/documents/publications/2015/01/01/folder-knmi14-climate-scenarios (accessed October 26, 2021).

[288] Romainsacchi. Use examples of premise n.d. https://github.com/romainsacchi/premise/blob/master/examples/examples.ipynb (accessed December 1, 2021).

[289] Joshi KK, Kono T. Optimization of floor area ratio regulation in a growing city. Reg Sci

Urban Econ 2009;39:502–11. doi:https://doi.org/10.1016/j.regsciurbeco.2009.02.001.

[290] Guest G, Cherubini F, Strømman AH. Global Warming Potential of Carbon Dioxide Emissions from Biomass Stored in the Anthroposphere and Used for Bioenergy at End of Life. J Ind Ecol 2013;17:20–30. doi:https://doi.org/10.1111/j.1530-9290.2012.00507.x.

[291] Walter T, Mathew P. GHG policy impacts for Seattle's buildings: targets, timing, and scope. Build Cities 2021;2:283–301. doi:10.5334/bc.81.

[292] Müller A. Energy Demand Assessment for Space Conditioning and Domestic Hot Water: A Case Study for the Austrian Building Stock [Dissertation]. 2015.

[293] Reyna JL, Chester M V. The Growth of Urban Building Stock: Unintended Lock-in and Embedded Environmental Effects. J Ind Ecol 2014;19:524–37. doi:10.1111/jiec.12211.

[294] Bernstein S, Hoffmann M. Climate politics, metaphors and the fractal carbon trap. Nat Clim Chang 2019;9:919–25. doi:10.1038/s41558-019-0618-2.

[295] de Oliveira Fernandes MA, Keijzer E, van Leeuwen S, Kuindersma P, Melo L, Hinkema M, et al. Material-versus energy-related impacts: Analysing environmental trade-offs in building retrofit scenarios in the Netherlands. Energy Build 2021;231:110650. doi:https://doi.org/10.1016/j.enbuild.2020.110650.

[296] Vahidi E, Kirchain R, Burek J, Gregory J. Regional variation of greenhouse gas mitigation strategies for the United States building sector. Appl Energy 2021;302:117527. doi:https://doi.org/10.1016/j.apenergy.2021.117527.

[297] Lausselet C, Lund KM, Brattebø H. LCA and scenario analysis of a Norwegian net-zero GHG emission neighbourhood: The importance of mobility and surplus energy from PV technologies. Build Environ 2021;189:107528. doi:https://doi.org/10.1016/j.buildenv.2020.107528.

[298] Luderer G, Pehl M, Arvesen A, Gibon T, Bodirsky BL, de Boer HS, et al. Environmental co-benefits and adverse side-effects of alternative power sector decarbonization strategies. Nat Commun 2019;10:5229. doi:10.1038/s41467-019-13067-8.

[299] Rijkswaterstaat. The climate monitor n.d. https://klimaatmonitor.databank.nl/jive (accessed December 2, 2021).

[300] Streicher KN, Berger M, Chambers J, Schneider S, Patel MK. Combined geospatial and techno-economic analysis of deep building envelope retrofit. J. Phys. Conf. Ser., vol. 1343, Institute of Physics Publishing; 2019. doi:10.1088/1742-6596/1343/1/012028.

[301] Galimshina A, Moustapha M, Hollberg A, Padey P, Lasvaux S, Sudret B, et al. What is the optimal robust environmental and cost-effective solution for building renovation? Not the usual one. Energy Build 2021:111329. doi:https://doi.org/10.1016/j.enbuild.2021.111329.

[302] Zuberi MJS, Chambers J, Patel MK. Techno-economic comparison of technology options for deep decarbonization and electrification of residential heating. Energy Effic 2021;14:75. doi:10.1007/s12053-021-09984-7.

[303] Directorate-General for Energy. Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU. Final report. 2019. doi:10.2833/14675.

[304] RIVM. Circular economy in the Dutch construction sector - A perspective for the market and

government. 2015.

[305]   Zhang C, Hu M, Laclau B, Garnesson T, Yang X, Li C, et al. Environmental life cycle costing at the early stage for supporting cost optimization of precast concrete panel for energy renovation of existing buildings. J Build Eng 2021;35:102002. doi:https://doi.org/10.1016/j.jobe.2020.102002.

[306]   Wang H, Chen D, Duan H, Yin F, Niu Y. Characterizing urban building metabolism with a 4D-GIS model: A case study in China. J Clean Prod 2019;228:1446–54. doi:https://doi.org/10.1016/j.jclepro.2019.04.341.

[307]   Passe U, Dorneich M, Krejci C, Koupaei DM, Marmur B, Shenk L, et al. An urban modelling framework for climate resilience in low-resource neighbourhoods. Build Cities 2020;1:453–74. doi:10.5334/bc.17.

[308]   Cerezo Davila C, Reinhart CF, Bemis JL. Modeling Boston: A workflow for the efficient generation and maintenance of urban building energy models from existing geospatial datasets. Energy 2016;117:237–50. doi:10.1016/J.ENERGY.2016.10.057.

[309]   Mastrucci A, Marvuglia A, Benetto E, Leopold U. A spatio-temporal life cycle assessment framework for building renovation scenarios at the urban scale. Renew Sustain Energy Rev 2020;126. doi:10.1016/j.rser.2020.109834.

[310]   Verellen E, Allacker K. Inventory of the existing residential building stock for the purpose of environmental benchmarking. IOP Conf Ser Earth Environ Sci 2019;323:12029. doi:10.1088/1755-1315/323/1/012029.

[311]   Ali U, Shamsi MH, Bohacek M, Purcell K, Hoare C, Mangina E, et al. A data-driven approach for multi-scale GIS-based building energy modeling for analysis, planning and support decision making. Appl Energy 2020;279:115834. doi:10.1016/j.apenergy.2020.115834.

[312]   Reimer F, Kral U. The Viennese Building Stock from 1920 to 2018: a Prototype Model. Real Corp 2020, 2020. doi:10.5281/zenodo.5109660.

[313]   TABULA Project Team. Typology Approach for Building Stock Energy Assessment 2017. http://episcope.eu/index.php?id=97 (accessed October 6, 2019).

[314]   Cabeza LF, Ürge-Vorsatz D. The role of buildings in the energy transition in the context of the climate change challenge. Glob Transitions 2020;2:257–60. doi:https://doi.org/10.1016/j.glt.2020.11.004.

[315]   Liu G, Ye K, Tan Y, Huang Z, Li X. Factors influencing homeowners' housing renovation decision-making: Towards a holistic understanding. Energy Build 2022;254:111568. doi:https://doi.org/10.1016/j.enbuild.2021.111568.

[316]   Bianco V, Sonvilla PM, Gonzalez Reed P, Villoslada Prado A. Business models for supporting energy renovation in residential buildings. The case of the on-bill programs. Energy Reports 2022;8:2496–507. doi:https://doi.org/10.1016/j.egyr.2022.01.188.

[317]   Rabbat C, Awad S, Villot A, Rollet D, Andrès Y. Sustainability of biomass-based insulation materials in buildings: Current status in France, end-of-life projections and energy recovery potentials. Renew Sustain Energy Rev 2022;156:111962. doi:https://doi.org/10.1016/j.rser.2021.111962.

[318] Palumbo M, Lacasta AM, Giraldo MP, Haurie L, Correal E. Bio-based insulation materials and their hygrothermal performance in a building envelope system (ETICS). Energy Build 2018;174:147–55. doi:https://doi.org/10.1016/j.enbuild.2018.06.042.

[319] He W, King M, Luo X, Dooner M, Li D, Wang J. Technologies and economics of electric energy storages in power systems: Review and perspective. Adv Appl Energy 2021;4:100060. doi:https://doi.org/10.1016/j.adapen.2021.100060.

[320] Așchilean I, Cobîrzan N, Bolboaca A, Boieru R, Felseghi R-A. Pairing solar power to sustainable energy storage solutions within a residential building: A case study. Int J Energy Res 2021;n/a. doi:https://doi.org/10.1002/er.6982.

[321] Li H, Wang Z, Hong T, Piette MA. Energy flexibility of residential buildings: A systematic review of characterization and quantification methods and applications. Adv Appl Energy 2021;3:100054. doi:https://doi.org/10.1016/j.adapen.2021.100054.

[322] Martin-Roberts E, Scott V, Flude S, Johnson G, Haszeldine RS, Gilfillan S. Carbon capture and storage at the end of a lost decade. One Earth 2021;4:1569–84. doi:10.1016/j.oneear.2021.10.002.

[323] Chatterjee S, Oreggioni G, Stavrakas V, Aryandoust A, Ürge-Vorsatz D, Staffell I, et al. Model development to match models to the user needs 2021. doi:10.5281/ZENODO.5915372.

[324] Shinde R, Peng S, Vijay S, Hellweg S, Froemelt A. Data mining for evaluating the rebounds-associated emissions due to energy-related consumer behavioural shifts in Switzerland. J Phys Conf Ser 2021;2042:12127. doi:10.1088/1742-6596/2042/1/012127.

[325] Guerra Santin O. Occupant behaviour in energy efficient dwellings: evidence of a rebound effect. J Hous Built Environ 2013;28:311–27. doi:10.1007/s10901-012-9297-2.

[326] Frithjof Laubinger. A bottom-up analysis of household energy consumption in Amsterdam Resolving policy barriers in the residential building sector. VU University Amsterdam, 2015.

[327] Morseletto P. Restorative and regenerative: Exploring the concepts in the circular economy. J Ind Ecol 2020;24:763–73. doi:https://doi.org/10.1111/jiec.12987.

[328] Green Building Store. Understanding windows: U values, Psi values and g values. Green Build Store 2018. https://www.greenbuildingstore.co.uk/understanding-windows-u-values-psi-values-g-values/ (accessed October 8, 2021).

[329] Groengas Nederland. What is green gas? n.d. https://groengas.nl/groen-gas/wat-is-groen-gas/ (accessed April 22, 2021).

[330] Energie Vergelijken. Green gas in the Netherlands n.d. https://www.energievergelijken.nl/duurzame-energie/groen-gas (accessed April 22, 2021).

[331] Green Gas Forum. Green gas roadmap. 2014.

[332] Jim van der Kooij A. Environmental impact of the materials used in the Dutch heat transition. 2018.

[333] Borg AA. The Environmental Impact of Ventilation Systems in a Norwegian Office Building from a Life Cycle Perspective. Norwegian University of Science and Technology, 2016.

[334] Fonseca JA, Nguyen T-A, Schlueter A, Marechal F. City Energy Analyst (CEA): Integrated

framework for analysis and optimization of building energy systems in neighborhoods and city districts. Energy Build 2016;113:202–26. doi:10.1016/J.ENBUILD.2015.11.055.

[335]   Milieu Centraal. Solar water heater 2021. https://www.milieucentraal.nl/energie-besparen/duurzaam-warm-water/zonneboiler/ (accessed August 12, 2021).

[336]   Hinckley M. What is the Life Span of a Water Heater? n.d. https://www.hunker.com/12151423/what-is-the-life-span-of-a-water-heater (accessed August 12, 2021).

[337]   Milieu Centraal. How Do Solar Panels Work? n.d. https://www.milieucentraal.nl/energie-besparen/zonnepanelen/hoe-werken-zonnepanelen/ (accessed August 13, 2021).