

En-ROADS and C-ROADS in the Literature

The following list (alphabetical order, by author last name) contains research on the impact of the En-ROADS and C-ROADS simulators, co-developed by Climate Interactive and MIT Sloan, as well as other research conducted using the simulators.

Is your published research not listed here? Let us know at climatepathways@mit.edu.

1. Acen, C., Bamisile, O., Cai, D., Ukwuoma, C. C., Obiora, S., Huang, Q., ... & Adun, H. (2024). The complementary role of carbon dioxide removal: A catalyst for advancing the COP28 pledges towards the 1.5° C Paris Agreement target. *Science of The Total Environment*, 947. <https://doi.org/10.1016/j.scitotenv.2024.174302>
2. Akpan, J., & Olanrewaju, O. (2024, September). Recent Tools and Their Roles Towards High-Share Renewable Energy in the Climate-Changing World. In *Trends in Clean Energy Research: Selected Papers from the 9th International Conference on Advances on Clean Energy Research (ICACER 2024)* (pp. 65-81). Cham: Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-67987-2_7
3. Akpan, J., & Olanrewaju, O. (2024, September). The Transition to 100% Renewable Energy Versus the Global Temperature Scenarios: A Perspective Analysis. In *Trends in Clean Energy Research: Selected Papers from the 9th International Conference on Advances on Clean Energy Research (ICACER 2024)* (pp. 151-166). Cham: Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-67987-2_15
4. Alfredo, C., & Christiani, A. (2024, September). Innovative Climate Solutions: Simulating the Future with En-ROADS. In *2024 2nd International Conference on Technology Innovation and Its Applications (ICTIIA)* (pp. 1-5). IEEE. <https://doi.org/10.1109/ICTIIA61827.2024.10761725>
5. Anzalone, J., Vázquez Jacobus, M., Joseph, L., & Buck, B. (2024). From Knowledge to Action: How Climate Education Shapes Youth Engagement. https://digitalcommons.library.umaine.edu/rural_issues/53/
6. Ardh, K. F., & Fujii, H. (2022). Report from Japan. *Promoting Teacher Education for Climate Change Education through Collaboration between Asian Centres of Excellence for Education for Sustainable Development (ATECCE)*, 32. <http://ceteesd.ed.okayama-u.ac.jp/pdf/220817.pdf#page=34>
7. Armijos Romero, O. E., & Dután Duque, M. J. (2022). *Metodología STEAM para contribuir a la motivación y el rendimiento académico en Biología para tercero de Bachillerato, Unidad Educativa "Herlinda Toral"* (Bachelor's thesis, Universidad Nacional de Educación). <http://repositorio.unae.edu.ec/handle/56000/2348>

in collaboration with:

8. Bonino, Roberto, En-ROADS: un gemello digitale del pianeta per salvare il clima. (2025, January 27). Agenda Digitale.
<https://www.agendadigitale.eu/smart-city/en-roads-un-gemello-digitale-del-pianeta-per-salvare-il-clima/>
9. Burger, J., Clark, R., Preece, D., & Webb, H. (2023). Simulated climate solutions: using the EN-ROADS simulator. *Teaching Geography*, 48(3), 114-116.
<https://www.proquest.com/docview/3102956705>
10. Cembalest, M. (2023). Growing Pains: The Renewable Transition in Adolescence. *2023 Eye on the Market Energy Paper*. JP Morgan.
<https://assets.jpmprivatebank.com/content/dam/jpm-wm-aem/campaign/energy-paper-13/growing-pains-renewable-transition-in-adolescence.pdf>
11. Chaudhry, A. (2024). The Power of Simulation for Climate Action: En-ROADS.
<https://journals.aom.org/doi/abs/10.5465/amle.2023.0187?journalCode=amle>
12. Cheney, Lucia. "Associations Between Interactive Climate Policy Interventions With En-ROADS and Other Factors on Climate Change-Related Public Communications of Politicians." Master's thesis, University of Massachusetts Lowell, 2024.
13. Creutzig, F., & Kapmeier, F. (2020). Engage, don't preach: Active learning triggers climate action. *Energy Research & Social Science*, 70, 101779.
<https://doi.org/10.1016/j.erss.2020.101779>
14. Di Benedetto, A., Wieners, C.E., Dijkstra, H.A., von der Heydt, A.S. (2025). Political processes affect the feasibility of climate policy in Integrated Assessment Models. *npj Clim. Action* 4, 88.
<https://doi.org/10.1038/s44168-025-00298-3>
15. Drevenšek, M. (2023). *Strengthening energy and climate literacy with microlearning and open educational resources* (Doctoral dissertation, University of Nova Gorica, Faculty of Engineering and Management).
<http://193.2.120.22/IzpisGradiva.php?id=8304&lang=eng>
16. Eker, S., Siegel, L., Jones, C., Sterman, J., Kapmeier, F., Fiddaman, T., Homer, J., Rooney-Varga, J., Franck, T. and Jones, A. (2021, April). Public outreach and interactive learning with En-ROADS global energy and climate simulator. In *EGU General Assembly Conference Abstracts*.
<https://ui.adsabs.harvard.edu/abs/2021EGUGA..23.7334E/abstract>
17. Faranda, D., Taligrot, L., Yiou, P., and Caud, N.: ClimarisQ: *What can we learn from playing a game for climate education?*, *Geosci. Commun.*, 9, 115–125,
<https://doi.org/10.5194/gc-9-115-2026>, 2026.

in collaboration with:

18. Fischer, H., Boschert, E., Böhnisch, A., Abele, L., & Huff, M. (2026). Communicating complex climate dynamics with the En-ROADS simulator: Comparing graph-based and animated environments for learning, metacognition, and motivation. *PsychArchives* (pre-print).
<https://doi.org/10.23668/psycharchives.21634>
19. Garcia, C.A., Savilaakso, S., Verburg, R.W., Stoudmann, N., Fernbach, P., Sloman, S.A., Peterson, G.D., Araújo, M.B., Bastin, J.F., Blaser, J. and Boutinot, L. (2022). Strategy games to improve environmental policymaking. *Nature Sustainability*, 5(6), 464-471.
<https://doi.org/10.1038/s41893-022-00881-0>
20. Garman, A. N., Andersen, A., Armbruster, R. Born, K., Watts, C. A. (2026). Leveraging experiential learning for a more environmentally sustainable future: Early experiences from the Healthcare Management Consortium on Planetary Health. *Journal of Health Administration Education*, 42(3), 497-504.
<https://www.ingentaconnect.com/contentone/aupha/jhae/2026/00000042/00000003/art00013>
21. Hensel, M., Bryan, J., McCarthy, C., McNeal, K. S., Norfles, N., Rath, K., & Rooney-Varga, J. N. (2023). Participatory approaches enhance a sense of urgency and collective efficacy about climate change: Qualitative evidence from the world climate simulation. *Journal of Geoscience Education*, 71(2), 177-191.
<https://doi.org/10.1080/10899995.2022.2066927>
22. Holz, C., Siegel, L. S., Johnston, E., Jones, A. P., & Sterman, J. (2018). Ratcheting ambition to limit warming to 1.5 C-trade-offs between emission reductions and carbon dioxide removal. *Environmental research letters*, 13(6).
<https://doi.org/10.1088/1748-9326/aac0c1>
23. Howell, T. (2022). A Climate Policy Primer.
<https://rdw.rowan.edu/oer/28/>
24. Jedd, T., Sattich, T. M., Bekebrede, G., Schreurs, M., Van de Graaf, T., & Scholten, D. (2024). Sparking Students' Interest: Teaching About International Climate Negotiation with a Renewable Energy Transition Simulation Game. *Journal of Political Science Education*, 1-23.
<https://doi.org/10.1080/15512169.2024.2442612>
25. Johnson, C. R. (2025). *Using climate simulators to facilitate peacebuilding: A study of practice*. In *Factis Pax: Journal of Peace Education and Social Justice*, 19(1), 213–243.
<https://openjournals.utoledo.edu/index.php/infactispax/article/view/1467/1058>
26. Judson, E., Ostman, R., & Weller, N. A. (2025). Effects of designing a narrative-based video game on high school students' climate change perspectives. *Journal of Science Education and Technology*. <https://doi.org/10.1007/s10956-025-10250-z>

in collaboration with:

27. Kapmeier, F., Greenspan, A., Jones, A., & Sterman, J. (2021). Science-based analysis for climate action: how HSBC Bank uses the En-ROADS climate policy simulation. *System dynamics review: the journal of the System Dynamics Society*, 37(4), 333-352.
<https://publikationen.reutlingen-university.de/frontdoor/index/index/docId/3411>
28. Kapmeier, F., Rooney-Varga, J., Sterman, J., Fracassi, E., Kurker, V., Johnston, E., Jones, A., & Rath, K. World climate: Understanding climate change through play – acting sustainably: Behavioral change through simulation-based role play. *In: On becoming: developmental dynamics in nature and society; perspectives of a future-oriented culture of values in the dialogue between science, art and education*. (2019). Editor: Beatrice Voigt. 178-189.
<https://publikationen.reutlingen-university.de/frontdoor/index/index/docId/2734>
29. Kapmeier, F., Sterman, J., Siegel, L., Eker, S., Fiddaman, T., Homer, J., Rooney-Varga, J. and Jones, A. (2021, April). En-ROADS: A global energy and climate simulator to support strategic thinking and public outreach. In *EGU General Assembly Conference Abstracts*.
<https://doi.org/10.5194/egusphere-egu21-7608>
30. Khademolhosseini, M. S. (2023). Impacts of global warming on the whole environment and suggestions for solving them by EN-ROADS Model. *Environmental Engineering & Management Journal (EEMJ)*, 22(3).
<http://doi.org/10.30638/eemj.2023.033>
31. Killingsworth, J. (2022) En-ROADS: Using the Climate Interactive Tool for Designing and Planning. *In: Proceedings of Relating Systems Thinking and Design*, RSD11, 3-16 Oct 2022, Brighton, United Kingdom.
<https://openresearch.ocadu.ca/id/eprint/4221/>
32. Kühner, C., Will, F., & Goodwin, B. (2023). Evaluationsbericht zur Klimasimulation En-ROADS, 18.02.-26.02. 2023, *Science Communication Lab, Deutsches Museum*.
<https://doi.org/10.5282/ubm/epub.103597>
33. Landmann, H., Ziegler, W., & Gaschler, R. (2024). Simulating climate policies influences how laypersons evaluate the effectiveness of climate protection measures. *Environment, Development and Sustainability*, 1-15.
<https://doi.org/10.1007/s10668-024-05028-z>
34. Law, B. E., Moomaw, W. R., Hudiburg, T. W., Schlesinger, W. H., Sterman, J. D., & Woodwell, G. M. (2022). Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States. *Land*, 11(5), 721.
<https://doi.org/10.3390/land11050721>
35. Ledley, T. (2024, February). Climate Action Simulation: UN Role-Playing Game with En-ROADS. In *2024 AAAS Annual Meeting*. AAAS.
<https://aaas.confex.com/aaas/2024/meetingapp.cgi/Session/32909>

in collaboration with:

36. Ledley, T. (2021, December). Exploring the Complexity of Developing a Suite of Climate Change Solutions with the Energy Rapid Overview and Decision Support (En-ROADS) Systems Dynamics Model. In *AGU Fall Meeting Abstracts* (Vol. 2021, pp. ED45C-0748).
<https://ui.adsabs.harvard.edu/abs/2021AGUFMED45C0748L/abstract>
37. Lenk-Ostendorf, B., Thaller, A., Brudermann, T. and Krusche, S. (2026). Decoding climate policy acceptance: contrasting the influence of simulation and text-based information. *Environmental Research Communications*, 8(7).
<https://doi.org/10.1088/2515-7620/ae7fdd>.
38. Lincoln, P. (2023). Using the En-ROADS future climate simulator. *The Physics Teacher*, 61(6), 540-541.
<https://doi.org/10.1119/5.0167002>
39. Machen, R. (2024). Digital Fractures. *Digital Technologies for Sustainable Futures: Promises and Pitfalls*.
40. Marhraoui, M. A. (2022, May). Smart Education–A Case Study on a Simulation for Climate Change Awareness and Engagement. In *International Conference on Advanced Intelligent Systems for Sustainable Development* (pp. 354-363). Cham: Springer Nature Switzerland.
https://doi.org/10.1007/978-3-031-26384-2_31
41. McNicholas, R. (2023). Climate Change Proposal: Coupling Equity and Scientific Rigor in Facing Global Warming.
<https://doi.org/10.15760/honors.1340>
42. Meyerson, E., Francon, O., Sargent, D., Hodjat, B., & Miikkulainen, R. (2024). Unlocking the Potential of Global Human Expertise.
<https://doi.org/10.48550/arXiv.2411.00156>
43. Miani, L., De Zuani Cassina, F., & Levrini, O. (2025). Raising awareness on the complexity of decision-making through climate change education. *Research in Science Education*.
<https://doi.org/10.1007/s11165-025-10266-w>
44. Miller, H. I. (2022). “Statistical Murder”?; By depriving communities of wealth, ill-conceived climate-change proposals will lead to worse health outcomes. *City Journal*, NA-NA.
<https://www.city-journal.org/article/statistical-murder>
45. Hildén, M., Kułakowska, M., Magnuszewski, P., Obermeister, N., Sivonen, M. H., (2024). Arctic Institute of North America. *Arctic*, 77(2), 104–196.
<https://journalhosting.ucalgary.ca/index.php/arctic/issue/view/5321>.
46. Möller, J., & Kapmeier, F. (2025). Climate action simulation: Which solutions against climate change have the greatest impact – and work in time? *SEMINAR*, 45(1), 101–107.
<https://doi.org/10.3278/SEM2501W013>

in collaboration with:

47. Molthan-Hill, P. "The En-ROADS way to tackling climate change." (2023).
<https://irep.ntu.ac.uk/id/eprint/49470/>
48. Molthan-Hill, P., Blaj-Ward, L., Leigh, J. S., & Kapmeier, F. (2023). Climate change mitigation education in business schools: now it is time to save the day!. In *Sustainable Management* (pp. 42-78). Routledge.
<https://www.taylorfrancis.com/chapters/edit/10.4324/9781003294665-5/>
49. Molthan-Hill, P., Blaj-Ward, L., Mbah, M. F., & Ledley, T. S. (2022). Climate change education at universities: Relevance and strategies for every discipline. In *Handbook of climate change mitigation and adaptation* (pp. 3395-3457). Cham: Springer International Publishing.
https://doi.org/10.1007/978-3-030-72579-2_153
50. Mukherjee, I. (2023). Optimizing Climate Policy through C-ROADS and En-ROADS Analysis. *arXiv preprint arXiv:2311.03546*.
<https://doi.org/10.48550/arXiv.2311.03546>
51. Naumov, S., Keith, D. R., & Sterman, J. D. (2023). Accelerating vehicle fleet turnover to achieve sustainable mobility goals. *Journal of Operations Management*, 69(1), 36-66.
<https://doi.org/10.1002/joom.1173>
52. Nicholas, K. (2021). *Under the Sky We Make: How to Be Human in a Warming World*. G.P. Putnam's Sons.
<https://lup.lub.lu.se/search/publication/1293dcff-8dbd-4c89-af54-9789062c7c1e>
53. Olasehinde, D.O., Bamisile, O., Acen, C., Ejiyi, C., Huang, Q. and Obiora, S. (2026). Evaluating pathways to meet the Paris Agreement using the En-ROADS model: Balancing fossil fuel mitigation and carbon dioxide removal. *Carbon Capture Science & Technology*, 18, 100590.
<https://doi.org/10.1016/j.ccst.2026.100590>
54. Padwick, A., Hocking, E.P., Shimwell, J., Davenport, C., Bourne, J., Ransome, K., Baxter, C., Ramsay, A. & Blazey, E. (2025). It's In Our Hands: facilitating agency, personal connections and collective cohesion in climate education through board game play. *J Environ Stud Sci*.
<https://doi.org/10.1007/s13412-025-01045-0>
55. Rayhan, M. (2022). Climate change and sustainable development–Public awareness measure with climate simulator En-ROADS (Master's thesis, University of South-Eastern Norway).
<https://openarchive.usn.no/usn-xmlui/handle/11250/3106709?show=full>
56. Rooney-Varga, J.N., Coleman, R.L., Jones, A.P., Kapmeier, F., Newsome, P., Noiseux, K., Patten, B., Rath, K., & Sterman, J. D. (2025). Interactive role-play with climate policy simulation can motivate evidence-based climate action. *Commun Earth Environ* 6, 769.
<https://doi.org/10.1038/s43247-025-02744-w>

in collaboration with:

57. Rooney-Varga, J.N., Fracassi, E., Franck, T., Kapmeier, F., McCarthy, C., McNeal, K.S., Norfles, N., Rath, K. and Sterman, J.D. (2021). A simulation game that motivates people to act on climate. In *World Scientific Encyclopedia of Climate Change: Case Studies of Climate Risk, Action, and Opportunity Volume 3* (pp. 231-243).
https://doi.org/10.1142/9789811213960_0029
58. Rooney-Varga, J. N., Franck, T., Jones, A., Sterman, J., & Sawin, E. (2013, December). Merging Energy Policy Decision Support, Education, and Communication: The 'World Energy' Simulation Role-Playing Game. In *AGU Fall Meeting Abstracts* (Vol. 2013, pp. ED12B-07).
<https://ui.adsabs.harvard.edu/abs/2013AGUFMED12B..07R/abstract>
59. Rooney-Varga, J.N., Hensel, M., McCarthy, C., McNeal, K., Norfles, N., Rath, K., Schnell, A.H. and Sterman, J.D. (2021). Building consensus for ambitious climate action through the world climate simulation. *Earth's Future*, 9(12). <https://doi.org/10.1029/2021EF002283>
60. Rooney-Varga, J. N., Kapmeier, F., Henderson, C., & Ford, D. N. (2024). Community-based propagation to scale up educational innovations in sustainability. *Nature Sustainability*, 1-11.
<https://www.nature.com/articles/s41893-024-01446-z>
61. Rooney-Varga, J. N., Kapmeier, F., Sterman, J. D., Jones, A. P., Putko, M., & Rath, K. (2020). The climate action simulation. *Simulation & Gaming*, 51(2), 114-140.
<https://doi.org/10.1177/104687811989064>
62. Rooney-Varga, J. N., Sterman, J. D., Fracassi, E., Franck, T., Kapmeier, F., Kurker, V., ... & Rath, K. (2018). Combining role-play with interactive simulation to motivate informed climate action: Evidence from the World Climate simulation. *PloS one*, 13(8).
<https://doi.org/10.1371/journal.pone.0202877>
63. Ryder, M., Evro, S., Brown, C., & Tomomewo, O. S. (2023). Multi-Model Approach of Global Energy Model Validation: Times and EN-ROADS Models. *Am. J. Energy Res*, 11, 63-81.
<https://pubs.sciepub.com/ajer/11/2/2/>
64. Sanchez, P., & Perez, D. (2022). *The role of nuclear energy in the fight against climate change* (No. INIS-MX--3648). Sociedad Nuclear Mexicana (SNM), Ciudad de Mexico (Mexico).
<https://inis.iaea.org/records/0sz6h-z1582>
65. Sterman, J., Moomaw, W., Rooney-Varga, J. N. (2018). Reply to comment on 'Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy.' *Environmental Research Letters*, 13(12), 128-138.
<https://doi.org/10.1088/1748-9326/aaf354>
66. Sterman, J., Moomaw, W., Rooney-Varga, J. N. (2018). Does replacing coal with wood lower CO2 emissions? Dynamic lifecycle analysis of wood bioenergy. *Environmental Research Letters*, 13(1), 128-138.
<https://doi.org/10.1088/1748-9326/aaa512>

in collaboration with:

67. Sterman, J., Siegel, L., Rooney-Varga, J. N., & Siegel, L. (2022). Does wood bioenergy help or harm the climate?. *Bulletin of the Atomic Scientists*, 78(3), 128-138.
<https://doi.org/10.1177/1046878113514935>
68. Thiele-Eich, I. (2020). *En-ROADS-Können wir die Erderwärmung auf 1.5° C begrenzen?* (No. DKT-12-71). Copernicus Meetings.
<https://meetingorganizer.copernicus.org/DKT-12/DKT-12-71.html>
69. Vervoort, J.M., Milkoreit, M., van Beek, L., Mangnus, A.C., Farrell, D., McGreevy, S.R., Ota, K., Rupprecht, C.D., Reed, J.B. and Huber, M. (2022). Not just playing: The politics of designing games for impact on anticipatory climate governance. *Geoforum*, 137, 213-221.
<https://doi.org/10.1016/j.geoforum.2022.03.009>
70. Womack, C. B., Giani, P., Eastham, S. D., & Selin, N. E. (2025). Rapid emulation of spatially resolved temperature response to effective radiative forcing. *Journal of Advances in Modeling Earth Systems*, 17(1).
<https://doi.org/10.1029/2024MS004523>
71. Wyatt, S. N., Sullivan-Watts, B. K., Watts, D. R., & Sacks, L. A. (2022). Facilitating Climate Change Action in the Ocean Sciences Using the Interactive Computer Model En-ROADS.
<https://doi.org/10.1002/lob.10504>
72. Yan, Min-Ren (2022). Handbook of Sustainable System Development for Strategic Management and Business Innovation. [ISBN 978-986-06857-1-8](https://doi.org/10.1002/lob.10504).
73. Zimmermann, N., Pluchinotta, I., Salvia, G., Touchie, M., Stopps, H., Hamilton, I., Kesik, T., Dianati, K. and Chen, T. (2020). Moving online: reflections from conducting system dynamics workshops in virtual settings. *System Dynamics Review*, 37(1), 59.
<https://doi.org/10.1002/sdr.1667>
74. Rooney-Varga, J.N., Cheney, L., Coleman, R.L. *et al.* Interactive simulation with En-ROADS spurs climate action among decision-makers. *npj Clim. Action* 5, 36 (2026).
<https://doi.org/10.1038/s44168-026-00348-4>
75. Kapmeier, F., A. P.Jones, and J. D.Sterman. 2026. "Designing for Impact: Engaging Stakeholders With System Dynamics Models." *System Dynamics Review* 42, no. 2: e70024.
<https://doi.org/10.1002/sdr.70024>.

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