1 Motivation and Introduction

Climate change produced by greater atmospheric CO_2 concentrations [1] from human activity has led to increased exposure to hazards worldwide and domestically: increased storm severity, rising sea levels, more extreme temperatures, hotter summers, and rising sea levels to name a few [2]. Without immediate action to reduce carbon emissions, these impacts will worsen [3]. Specifically, it is primarily our societal dependence on fossil fuels to support our expansive economies and energy systems that contributes the most to rising carbon dioxide levels (along with other greenhouse gases (GHGs)) [4]. Therefore, to achieve the almost universally shared goal of halting and reversing the effects of climate change [5], our globalized society must transition away from fossil fuels to clean energy technologies such as nuclear and renewable energy and switch our transportation systems to electric or hydrogen powered vehicles [6].

Naturally, the importance of modeling energy systems to gain insight and form strategies to achieve this transition has grown. Especially since the spatial and temporal complexities are also expected to grow with greater penetration of variable renewable energy (VRE), such as solar and wind energy — two energy sources that are spatially diffuse and temporally challenging to predict. A class of tools called energy system optimization models (ESOMs) are the most common method for understanding our energy systems. However, while climate change may be the most immediate existential threat to society [7], it is a focusing issue that brings challenges of equity and disproportional impacts to the fore. These latter challenges have been always been concomitant with our energy system, but energy system modeling has largely ignored the ways energy systems mediate socio-political power alongside transporting electrons and fuel. For example, fossil fueled power plants have always been associated with air pollution and worsened health for nearby communities — commonly poorer and black communities, which are already marginalized, evincing a violation of fairness and justice principles [8]. Studying these consequences of our energy choices historically belonged to domain of the environmental justice literature [9], [10] but has developed further into the discipline of energy justice [11].

The energy transition will require a great expansion of our energy infrastructure to build replace fossil-fueled energy with clean energy and additional transmission networks to carry electrons. Although the technology to accomplish this transition is mature, there is still local public opposition to many energy projects [12]. Particularly in empowered and affluent communities [13]. ESOMs cannot capture these "human dimensions" of energy systems despite some awareness of their importance [14]. This is because they only optimize a single objective — cost (or some other aggregated economic metric). People have and express preferences over many dimensions simultaneously. Further, even in the absence of climate change, incorporating social context into the practice of energy modeling remains beneficial since doing so will create substantively better decisions [15]. The solution for enclosing this feature of energy system design proposed in this thesis is two-fold. The first is to develop an ESOM capable of multi-objective optimization. The benefits of multi-objective optimization have been understood for some time, yet only recent advances in computing power have made them a practical method for energy modeling. Hobbs (1995) wrote:

> Multi-objective methods are more appropriately used to help people to understand the problem better, explore their feelings, form a coherent, defensible set of values, and understand the implications of those values for the decision. [...] In reality, people's values are often uncertain and incoherent. During the course of a planning exercise, people's attitudes will evolve in response to new information, interactions with other people, and viewing the problem from different perspectives [16].

This leads to the second major proposal for this thesis, which is to validate the multi-objective ESOM developed within by conducting a case study in the Champaign-Urbana region involving interviews with local energy planners and incorporating their feedback to develop a planning process that encourages greater participation by the community members. Altogether, this work will allow "non-technical" perspectives to be incorporated into a rigorous modeling framework leading to greater perceptions of legitimacy through an iterative articulation of values and priorities involving the public as key deliberators. The result is a step towards a holistic integration of energy justice and energy system engineering.

Every year, world leaders meet to discuss plans to address climate change at the COP summit. In 1995, world leaders established a set of targets with the Kyoto Protocol [17] and again with the 2016 Paris Climate Agreement [5]. Every few years, the United Nations releases a report from the International Panel on Climate Change (IPCC) assessing the current impacts of climate change and forecasting future scenarios. Most of the world understands that anthropogenic climate change is an existential threat to society. Indeed, many studies in the ESOM literature begin with a statement about the urgency of climate change. This chapter reviews the extant literature for both quantitative and qualitative analyses of the problem considered in this thesis — primarily bridging the gap between feasibility or planning studies to address the climate crisis and the current pattern of missed targets and growing carbon emissions. First, I draw from the risk assessment literature to characterize and situate the problem of climate change and demonstrate the necessity of a holistic analysis. Second, I build upon the central issue of disproportionality of climate change risk by reviewing the energy and environmental justice literature. Third, I develop an encompassing definition of an "energy system" using technical and social perspectives. Finally, I review the energy system literature for gaps in conventional modeling practices and identify previous attempts to incorporate social science and justice concepts into energy system models.

Energy justice is a conceptual and analytical tool regarding the ethical or normative dimensions of energy systems and addresses the systemic causes of burdens, and inequities [11].

There are many conceptions of justice; however, the most popular framework for understanding justice is a three-faceted approach originating from

David Schlosberg: distributional, recognitional, and procedural justice [18]. Distributional justice relates to the fair distribution of resources, burdens, and responsibilities. Studies on distributional justice seek to address the normative question: how should a just society distribute the benefits it produces and *the burdens required to maintain it* [19]. Additionally, distributional justice considers *how* poor distributions are created [18]. Procedural (in)justice is defined as the presence of (un)fair and (in)equitable institutional processes of the state [18]. In other words, how decisions of societal import are made and who is involved in those decisions. Sovacool and Dworkin (2015) outline four elements of procedural justice: transparency, meaningful participation, impartiality, and avenues for redress [11]. Justice of recognition is the vaguest of the three tenets of justice and is frequently reduced to a component of either distribution or procedural justice [18], [20]. A common argument for this consolidation is that recognition is a precondition for achieving distributional justice or that achieving procedural justice necessarily includes recognition [18]. However, recognition is unique from distributive and procedural justices because it is concerned with a different family of injustice, namely, *misrecognition* [20]. van Uffelen (2022) suggests a nuanced definition of recognition justice as "the adequate recognition of all actors through love, law, and the status order" [20]. Sovacool and Dworkin (2015) offer a framework for assessing energy policies from a justice perspective.

Although Sovacool & Dworkin do not explicitly discuss recognition justice, it is a unique aspect of justice that can still be useful for contextualizing their recommendations. For example, due to the psychological pressures introduced by a lack of access to energy, either due to infrastructure or cost, interrupts relational well-being and is an injustice [20]. Further, (un)sustainable policies may be considered a misrecognition of the humanity of future generations.

Next, I examine the specific ways the social science literature understands how energy systems and their infrastructure (artifacts) contribute to the distribution of burdens.

Previous work defined energy systems in purely technical terms as spatially, temporally, and topologically complex machines that coordinate the supply and demand of energy, especially electricity [21]. However, this definition neglects the ways energy systems may be used to construct and maintain power relations that contribute to inequitable distributions of burdens. Energy access is necessary to support complex modern economies and therefore possesses political power [22], [23]. The literature on the political economy of energy infrastructure locates this political influence in five distinct ways [23]. First, energy infrastructure affects competition and collaboration among nation-states in the geo-political sphere. The current situation in Ukraine makes this especially salient [24].

The second subset of the literature focuses on the process of energy infrastructure development and how these processes create social inequities. For example, energy policies that subsidize residential solar panels have not led to more equitable adoption of solar energy, with greater adoption in areas with higher income, among other social indicators [25]. Other popular arguments in favor of renewable energy assert that these energy sources are necessarily more egalitarian because the Sun and the wind cannot be (or have not yet been) privatized. Another is the urgency of climate change. Although these arguments have merit, they ignore or minimize the potential environmental and social consequences of energy planning that does not consider energy justice [22]. Large-scale energy projects in the Global South have already led to the dispossession of nearby indigenous communities and other key actors [26], [27].

Third, the development of energy infrastructure is not simply conducted via policy measures, but also in the manner governments activate the public imagination in favor of these policies [23], [28]. Jasanoff and Kim (2009) articulate this concept as 'socio-technical imaginaries,' which are simultaneously descriptive and prescriptive of possible energy futures established by governments in the national zeitgeist [28]. This concept is demonstrated by the discourse surrounding nuclear energy in the United States and South Korea [28] as well as in Japan [29]. Governments can employ 'grand narratives' related to national security, climate change, or modernization to enhance public support while minimizing genuine participation [23].

Fourth, the political power of energy infrastructure can be traced further to the cultural values and policy choices embedded in the design and operation of seemingly technical systems [23]. In other words, the design and implementation of energy infrastructure may be used as a vehicle for apparently unrelated agendas, a form of "policy-making by other means" [23], [30]. Edwards and Hecht (2010) refer to the co-constitution of technological and political order as '*technopolitics*,' demonstrating the tangible material and political outcomes of technological systems [31].

Finally, energy systems and their infrastructure possess a unifying quality through which new political identities may evolve [23].

From these various perspectives, we can observe that confining an energy system to its technical characteristics is woefully incomplete. I propose that an energy system is a spatially, temporally, and topologically complex machine that coordinates the supply and demand of energy and resources and acts as an important mediator of burdens that influence risks (such as risks from climate change). This thesis takes the important step of analyzing energy system planning and policy with this expanded definition.

ESOMs have broad utility, including forecasting future quantities, generating insight for policy development, or energy system planning for scheduling and acquisition [32], [33]. However, analyses using currently available ESOMs seldom consider the role of energy systems in creating and maintaining inequitable distributions of burdens. ESOMs vary significantly by the energy sectors they choose to model, the degree of physical detail, uncertainty quanitification, and forecasting capabilities.

Observing the dissonance between the awareness of anthropogenic climate change and policy actions to mitigate the effects of climate change is one of the key motivators for this work. Further, in instances where action is being taken — such as the construction of renewable energy projects following government subsidies, for instance — what drives public opposition? I will elucidate this question by incorporating literature from social movement theory [34], [35] into this thesis. Importantly, the literature shows that not-in-my-backyard (NIMBYism) is not the primary driver of public opposition to energy projects [36], rather, support for these energy projects is more strongly conditioned on genuine public participation in the decision-making process [27], [37]–[40]. For this proposed addition, I will develop a substantive theoretical basis for the argument I advance in this thesis — that a flexible and transparent ESOM is useful for improving procedural outcomes, whereas the current manner in which they are used and their results communicated further alienates the public [41] and delegitimizes energy planning processes

Open source multi-objective energy system framework (`Osier`)'s primary purpose is to translate policy preferences of the public into actionable energy visions for a given municipality. The idea is that if decision-makers used a tool like `Osier` to support their decisions and incorporate ideas from their constituents — ideas that may be distinct from the preconceptions of decision-makers themselves — then stronger actions toward addressing climate change may be taken with more just outcomes. Consider the following. If structural uncertainty is addressed by generating a set of solutions, either by searching the near-optimal space or considering the options along a Pareto Front, how should the ultimate solution be chosen? Answering this last question raises another source of normative uncertainty. Additionally, a result from social choice theory, Arrow's Impossibility theorem, states that one cannot construct a utility function that maps individual preferences onto a global preference order without violating principles of fairness [42]–[44]. Thus, the only way to address normative uncertainty produced by the process of deciding among equally valid alternatives, is to involve the public in a deliberative process [45]. Modelling energy systems with this understanding would allow energy system modelers to advance the causes of recognition and procedural justice, rather than hinder them. The last, and arguably most important, component of this thesis is to validate `Osier`'s usefulness in this regard. I propose validating `Osier`'s usefulness with a case study of the energy visioning processes of three municipalities: Urbana, Champaign, and the University of Illinois Urbana-Champaign (UIUC). The research question is then: "Do decision-makers or energy planners perceive that `Osier`, or tools like it, would be useful in enhancing collaboration between decision-makers and their constituents?" Although this case study focuses on a small sample, these paradigmatic cases could be used to generalize the usefulness of `Osier` to other locales [46]. The precise formulation of this research question (or questions) is subject to change between now and the beginning of this study. Since this research involves human participants it must be reviewed by an ethics board.

References

[1] R. P. Kane and E. R. de Paula, "Atmospheric CO2 changes at mauna loa, hawaii," *Journal of Atmospheric and Terrestrial Physics*, vol. 58, no. 15, pp. 1673–1681, Nov. 1, 1996, ISSN: 0021-9169. DOI: 10.1016/0021-

9169(95)00193-X. [Online]. Available: https://www.sciencedirect.com/science/article/pii/002191699500193X (visited on 12/20/2023).

[2] D. Reidmiller, C. Avery, D. Easterling, *et al.*, "Fourth national climate assessment," U.S. Global Change Research Program, United States, Volume II, 2018, p. 1526.

[3] Intergovernmental Panel on Climate Change, *Climate Change 2014 Mitigation of Climate Change: Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, 2014, ISBN: 978-1-107-41541-6. DOI: 10.1017/CBO9781107415416. [Online]. Available: http://ebooks.cambridge.org/ref/id/CBO9781107415416 (visited on 04/16/2020).

[4] EPA, "Inventory of u.s. greenhouse gas emissions: 1990 - 2021," U.S. Environmental Protection Agency, EPA 430-R-23-002, 2023. [Online]. Available: https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf (visited on 12/19/2023).

[5] U. Nations, *Paris agreement*, 2015. [Online]. Available: https://unfccc.int/sites/default/files/english_paris_agreement.pdf (visited on 01/02/2024).

[6] I. P. on Climate Change, "Climate change 2021: Summary for all," Intergovernmental Panel on Climate Change, Dec. 12, 2021. [Online]. Available: https://www.ipcc.ch/report/ar6/wg1/downloads/outreach/IPCC_AR6_WGI_SummaryForAll.pdf (visited on 01/27/2023).

[7] C. Hickman, E. Marks, P. Pihkala, *et al.*, "Climate anxiety in children and young people and their beliefs about government responses to climate change: A global survey," *The Lancet Planetary Health*, vol. 5, no. 12, e863–e873, Dec. 1, 2021, Publisher: Elsevier, ISSN: 2542-5196. DOI: 10.1016/S2542-5196(21)00278-3. [Online]. Available: https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00278-3/fulltext (visited on 01/02/2024).

[8] P. Mohai and R. Saha, "Which came first, people or pollution? assessing the disparate siting and post-siting demographic change hypotheses of environmental injustice," *Environmental Research Letters*, vol. 10, no. 11, p. 115 008, Nov. 2015, Publisher: IOP Publishing, ISSN: 1748-9326. DOI: 10.1088/1748-9326/10/11/115008. [Online]. Available: https://dx.doi.org/10.1088/1748-9326/10/11/115008 (visited on 01/12/2023).

[9] D. Schlosberg, "Reconceiving environmental justice: Global movements and political theories," *Environmental Politics*, vol. 13, no. 3, pp. 517–540, Sep. 1, 2004, Publisher: Routledge _eprint: https://doi.org/10.1080/0964401042000229025, ISSN: 0964-4016. DOI: 10.1080/0964401042000229025. [Online]. Available: https://doi.org/10.1080/0964401042000229025 (visited on 11/06/2023).

[10] P. Mohai, D. Pellow, and J. T. Roberts, "Environmental justice," *Annual Review of Environment and Resources*, vol. 34, no. 1, pp. 405–430, 2009. DOI: 10.1146/annurev-environ-082508-094348. [Online]. Available: https://doi.org/10.1146/annurev-environ-082508-094348 (visited on 01/12/2023).

[11] B. K. Sovacool and M. H. Dworkin, "Energy justice: Conceptual insights and practical applications," *Applied Energy*, vol. 142, pp. 435–444, Mar. 15, 2015, ISSN: 0306-2619. DOI: 10.1016/j.apenergy.2015.01.002. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0306261915000082 (visited on 01/12/2023).

[12] M. Wolsink, "Wind power implementation: The nature of public attitudes: Equity and fairness instead of 'backyard motives'," *Renewable and Sustainable Energy Reviews*, vol. 11, no. 6, pp. 1188–1207, Aug. 1, 2007, ISSN: 1364-0321. DOI: 10.1016/j.rser.2005.10.005. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1364032105001255 (visited on 12/26/2023).

[13] L. C. Stokes, E. Franzblau, J. R. Lovering, and C. Miljanich, "Prevalence and predictors of wind energy opposition in north america," *Proceedings of the National Academy of Sciences*, vol. 120, no. 40, e2302313120, Oct. 3, 2023, Publisher: Proceedings of the National Academy of Sciences. DOI: 10.1073/pnas.2302313120. [Online]. Available: https://www.pnas.org/doi/full/10.1073/pnas.2302313120 (visited on 09/26/2023).

[14] S. Pfenninger, A. Hawkes, and J. Keirstead, "Energy systems modeling for twenty-first century energy challenges," *Renewable and Sustainable Energy Reviews*, vol. 33, pp. 74–86, May 1, 2014, ISSN: 1364-0321. DOI: 10.1016/j.rser.2014.02.003. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1364032114000872 (visited on 01/16/2023).

[15] J. Wilsdon and R. Willis, *See-through science: why public engagement needs to move upstream*. London: Demos, 2004, OCLC: 60615114, ISBN: 978-1-84180-130-8.

[16] B. F. Hobbs, "Optimization methods for electric utility resource planning," *European Journal of Operational Research*, vol. 83, no. 1, pp. 1–20, May 18, 1995, ISSN: 0377-2217. DOI: 10.1016/0377-2217(94)00190-N. [Online]. Available: https://www.sciencedirect.com/science/article/pii/037722179400190N (visited on 12/26/2023).

[17] U. Nations, *KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE*, 1998. [Online]. Available: https://unfccc.int/resource/docs/convkp/kpeng.pdf (visited on 01/02/2024).

[18] D. Schlosberg, "2 distribution and beyond: Conceptions of justice in contemporary theory and practice," in *Defining Environmental Justice: Theories, Movements, and Nature*, D. Schlosberg, Ed., Oxford University Press, May 1, 2007, p. 0, ISBN: 978-0-19-928629-4. DOI: 10.1093/acprof:oso/9780199286294.003.0002. [Online]. Available: https://doi.org/10.1093/acprof:oso/9780199286294.003.0002 (visited on 01/12/2023).

[19] H. Brighouse, *Justice*. Polity, 2004, 188 pp., Google-Books-ID: 8XrVJJlQvEUC, ISBN: 978-0-7456-2595-9.

[20] N. van Uffelen, "Revisiting recognition in energy justice," *Energy Research & Social Science*, vol. 92, p. 102 764, Oct. 1, 2022, ISSN: 2214-6296. DOI: 10.1016/j.erss.2022.102764. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2214629622002675 (visited on 02/06/2023).

[21] S. G. Dotson, "The influence of temporal detail and inter-annual resource variability on energy planning models," Thesis, University of Illinois Urbana-Champaign, Urbana, IL, 2022, 99 pp. [Online]. Available: https://hdl.handle.net/2142/115793 (visited on 11/14/2022).

[22] C. F. Jones, "Building more just energy infrastructure: Lessons from the past," *Science as Culture*, vol. 22, no. 2, pp. 157–163, Jun. 1, 2013, ISSN: 0950-5431. DOI: 10.1080/09505431.2013.786991. [Online]. Available: https://doi.org/10.1080/09505431.2013.786991 (visited on 02/07/2023).

[23] G. Bridge, B. Özkaynak, and E. Turhan, "Energy infrastructure and the fate of the nation: Introduction to special issue," *Energy Research & Social Science*, Energy Infrastructure and the Fate of the Nation, vol. 41, pp. 1–11, Jul. 1, 2018, ISSN: 2214-6296. DOI: 10.1016/j.erss.2018.04.029. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2214629618302251 (visited on 01/12/2023).

[24] R. Figueiredo, M. Soliman, A. N. Al-Alawi, and M. J. Sousa, "The impacts of geopolitical risks on the energy sector: Micro-level operative analysis in the european union," *Economies*, vol. 10, no. 12, p. 299, Dec. 2022, Number: 12 Publisher: Multidisciplinary Digital Publishing Institute, ISSN: 2227-7099. DOI: 10.3390/economies10120299. [Online]. Available: https://www.mdpi.com/2227-7099/10/12/299 (visited on 02/07/2023).

[25] T. G. Reames, "Distributional disparities in residential rooftop solar potential and penetration in four cities in the united states," *Energy Research & Social Science*, vol. 69, p. 101 612, Nov. 1, 2020, ISSN: 2214-6296. DOI: 10.1016/j.erss.2020.101612. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2214629620301870 (visited on 04/25/2022).

[26] K. Yenneti, R. Day, and O. Golubchikov, "Spatial justice and the land politics of renewables: Dispossessing vulnerable communities through solar energy mega-projects," *Geoforum*, vol. 76, pp. 90–99, Nov. 1, 2016, ISSN: 0016-7185. DOI: 10.1016/j.geoforum.2016.09.004. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0016718515303249 (visited on 07/21/2022).

[27] S. J. Barragan-Contreras, "Procedural injustices in large-scale solar energy: A case study in the mayan region of yucatan, mexico," *Journal of Environmental Policy & Planning*, vol. 24, no. 4, pp. 375–390, Jul. 4, 2022, Publisher: Routledge _eprint: https://doi.org/10.1080/1523908X.2021.2000378, ISSN: 1523-908X. DOI: 10.1080/1523908X.2021.2000378. [Online]. Available: https://doi.org/10.1080/1523908X.2021.2000378 (visited on 11/23/2022).

[28] S. Jasanoff and S.-H. Kim, "Containing the atom: Sociotechnical imaginaries and nuclear power in the united states and south korea," *Minerva*, vol. 47, no. 2, pp. 119–146, Jun. 1, 2009, ISSN: 1573-1871. DOI: 10.1007/s11024-009-9124-4. [Online]. Available: https://doi.org/10.1007/s11024-009-9124-4 (visited on 02/07/2023).

[29] S. V. Valentine and B. K. Sovacool, "Energy transitions and mass publics: Manipulating public perception and ideological entrenchment in japanese nuclear power policy," *Renewable and Sustainable Energy Reviews*, vol. 101, pp. 295–304, Mar. 2019, ISSN: 13640321. DOI: 10.1016/j.rser.2018.11.008. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S1364032118307408 (visited on 07/27/2022).

[30] C. v. Clausewitz, "Chapter i: What is war?" In *On War*, trans. by J. Graham, New and Revised, vol. 1, 3 vols., Google-Books-ID: q4dZyNl0EukC, London: Kegan Paul, Trench, Trübner & Company, 1918, p. 23.

[31] P. N. Edwards and G. Hecht, "History and the technopolitics of identity: The case of apartheid south africa," *Journal of Southern African Studies*, vol. 36, no. 3, pp. 619–639, Sep. 1, 2010, Publisher: Routledge _eprint: https://doi.org/10.1080/03057070.2010.507568, ISSN: 0305-7070. DOI: 10.1080/03057070.2010.507568. [Online]. Available: https://doi.org/10.1080/03057070.2010.507568 (visited on 02/07/2023).

[32] J. F. DeCarolis, "Using modeling to generate alternatives (MGA) to expand our thinking on energy futures," *Energy Economics*, vol. 33, no. 2, pp. 145–152, Mar. 1, 2011, Publisher: Elsevier, ISSN: 0140-9883. DOI: 10.1016/j.eneco.2010.05.002. [Online]. Available: https://ideas.repec.org/a/eee/eneeco/v33y2011i2p145-152.html (visited on 05/22/2020).

[33] X. Yue, S. Pye, J. DeCarolis, F. G. Li, F. Rogan, and B. Gallachóir, "A review of approaches to uncertainty assessment in energy system optimization models," *Energy Strategy Reviews*, vol. 21, pp. 204–217, Aug. 2018, ISSN: 2211467X. DOI: 10.1016/j.esr.2018.06.003. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S2211467X18300543 (visited on 10/27/2021).

[34] D. McAdam, "Social movement theory and the prospects for climate change activism in the united states," *Annual Review of Political Science*, vol. 20, no. 1, pp. 189–208, 2017. DOI: 10.1146/annurev-polisci-052615-025801. [Online]. Available: https://doi.org/10.1146/annurev-polisci-052615-025801 (visited on 11/22/2022).

[35] D. McAdam and H. S. Boudet, *Putting Social Movements in Their Place: Explaining Opposition to Energy Projects in the United States from 2000-2005*. New York, New York: Cambridge University Press, 2012, 276 pp., ISBN: 978-I-I07-02066-5.

[36] D. M. Konisky, S. Ansolabehere, and S. Carley, "Proximity, NIMBYism, and public support for energy infrastructure," *Public Opinion Quarterly*, vol. 84, no. 2, pp. 391–418, Apr. 2, 2021, ISSN: 0033-362X, 1537-5331. DOI: 10.1093/poq/nfaa025. [Online]. Available: https://academic.oup.com/poq/article/84/2/391/5981974 (visited on 08/11/2022).

[37] P. Summers, E. Chao, P. McCoy, J. Perry, and S. D. Rhodes, "Influencing public transportation policy through community engagement and coalition building: Process and preliminary outcomes," *Progress in community health partnerships : research, education, and action*, vol. 14, no. 4, pp. 489–498, 2020, ISSN: 1557-0541. DOI: 10.1353/cpr.2020.0054. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8111683/ (visited on 07/15/2022).

[38] G. Ottinger, T. J. Hargrave, and E. Hopson, "Procedural justice in wind facility siting: Recommendations for state-led siting processes," *Energy Policy*, vol. 65, pp. 662–669, Feb. 1, 2014, ISSN: 0301-4215. DOI: 10.1016/j.enpol.2013.09.066. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0301421513009907 (visited on 01/30/2023).

[39] C. Walker and J. Baxter, "Procedural justice in canadian wind energy development: A comparison of community-based and technocratic siting processes," *Energy Research & Social Science*, vol. 29, pp. 160–169, Jul. 1, 2017, ISSN: 2214-6296. DOI: 10.1016/j.erss.2017.05.016. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S221462961730124X (visited on 01/30/2023).

[40] S. B. Gonyo, C. S. Fleming, A. Freitag, and T. L. Goedeke, "Resident perceptions of local offshore wind energy development: Modeling efforts to improve participatory processes," *Energy Policy*, vol. 149, p. 112 068, Feb. 2021, ISSN: 03014215. DOI: 10.1016/j.enpol.2020.112068. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S0301421520307795 (visited on 08/11/2022).

[41] B. Wynne, "Misunderstood misunderstanding: Social identities and public uptake of science," *Public Understanding of Science*, vol. 1, no. 3, pp. 281–304, Jul. 1, 1992, Publisher: SAGE Publications Ltd, ISSN: 0963-6625. DOI: 10.1088/0963-6625/1/3/004. [Online]. Available: https://doi.org/10.1088/0963-6625/1/3/004 (visited on 07/07/2023).

[42] K. J. Arrow, "A difficulty in the concept of social welfare," *Journal of Political Economy*, vol. 58, no. 4, pp. 328–346, 1950, Publisher: University of Chicago Press, ISSN: 0022-3808. [Online]. Available: https://www.jstor.org/stable/1828886 (visited on 12/17/2023).

[43] J. R. Kasprzyk, S. Nataraj, P. M. Reed, and R. J. Lempert, "Many objective robust decision making for complex environmental systems undergoing change," *Environmental Modelling & Software*, vol. 42, pp. 55–71, Apr. 1, 2013, ISSN: 1364-8152. DOI: 10.1016/j.envsoft.2012.12.007. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1364815212003131 (visited on 11/07/2023).

[44] M. Franssen, "Arrow's theorem, multi-criteria decision problems and multi-attribute preferences in engineering design," *Research in Engineering Design*, vol. 16, no. 1, pp. 42–56, Nov. 1, 2005, ISSN: 1435-6066. DOI: 10.1007/s00163-004-0057-5. [Online]. Available: https://doi.org/10.1007/s00163-004-0057-5 (visited on 11/07/2023).

[45] J. S. Dryzek, "The deliberative democrat's idea of justice," *European Journal of Political Theory*, vol. 12, no. 4, pp. 329–346, Oct. 1, 2013, Publisher: SAGE Publications, ISSN: 1474-8851. DOI: 10.1177/1474885112466784. [Online]. Available: https://doi.org/10.1177/1474885112466784 (visited on 12/31/2023).

[46] B. Flyvbjerg, "Five misunderstandings about case-study research," *Qualitative Inquiry*, vol. 12, no. 2, pp. 219–245, Apr. 1, 2006, Publisher: SAGE Publications Inc, ISSN: 1077-8004. DOI: 10.1177/1077800405284363. [Online]. Available: https://doi.org/10.1177/1077800405284363 (visited on 01/12/2023).