Hydrogen justice

Franziska Müller*, Johanna Tunn and Tobias Kalt
University of Hamburg, Hamburg
* Author to whom any correspondence should be addressed.
E-mail: franziska.mueller@uni-hamburg.de

Keywords: hydrogen, energy justice, water justice, energy governance

Abstract
For a rapid energy transition to renewable energy, green hydrogen is increasingly considered a solution to a myriad of challenges: climate neutrality, clean energy supply, and decoupling of growth and carbon emissions. However, whether the global hydrogen transition will indeed be a just transition is far from certain. This paper introduces the concept of hydrogen justice as an analytical toolkit to help examining justice challenges of the global hydrogen transition. Placing hydrogen justice at the nexus of energy, water and climate justice, and incorporating crucial insights from political ecology and decolonial studies we highlight potential hydrogen injustices and suggest a six-dimensional concept of hydrogen justice: procedural, distributive, restorative, relational, recognitional and epistemological justice. Our research explores socio-ecological, political and economic conditions in hydrogen target countries and examines emerging hydrogen projects and partnerships. Hydrogen injustices may manifest around issues of energy access in countries with high rates of energy poverty, water access in arid regions, as well as forced displacements, impairments of Indigenous livelihoods and the strengthening of authoritarian rule. We conclude that hydrogen injustices result from the interplay of global hydrogen governance and local conditions in producing countries. We illustrate this with examples from transnational hydrogen projects situated in Morocco and Namibia. Finally, we suggest strategies for redressing hydrogen injustices by integrating justice principles at all scales of hydrogen governance.

1. Introduction
For a rapid energy transition to renewable energy (RE), green hydrogen is increasingly considered a solution to a myriad of challenges: climate neutrality, clean energy supply, and decoupling of growth and carbon emissions\(^1\). Unsurprisingly, the EU, Germany and other industrial countries cherish green hydrogen. The global hydrogen production market is expected to grow by up to 9.2% annually throughout 2030 (ETC 2021), with green hydrogen projected to play a major role in fostering decarbonization in hard-to-abate sectors, such as heavy industries and transport (FMTE 2020). While Germany and the EU are able to provide hydrogen technologies that cover the entire value chain, a lack of physical resources for domestic generation (Hank et al 2020) means that countries in Africa, Latin America and the Middle East have been identified as export production sites for Europe's future hydrogen economy. However, there is a huge gap between technological euphoria and the potential socio-ecological consequences of large-scale hydrogen production. Indeed, the emerging hydrogen economy relies on unequal power relations and interventions in socio-ecological systems in countries of the Global South in order to reach European climate and energy goals. Hydrogen generation, hydrogen infrastructure and hydrogen governance are associated with several socio-ecological and political risks (Koj et al 2019), which have so far not been sufficiently considered.

We look at hydrogen risks through a justice lens (see also Dillman and Heinonen 2022). Hydrogen production may interfere with environmental Water justice analyses and politicizes justice if land rights, water distribution and marine ecosystems are affected. Energy justice may be at stake in terms of

\(^1\) This piece was developed in cooperation with the members of the H2POLITICS research project. For comments, data collection, and critique we thank Nina Glätzer and Imeh Ituen.
issues of energy access, distribution and decision-making over energy policies. Likewise, water justice is targeted regarding access to clean water, unjust pricing structures and privatized infrastructure. From a global justice perspective, hydrogen supply chains contribute to unequal ecological exchange by extracting and transferring energy resources from south to north (Hickel et al 2022). Furthermore, the focus on market readiness creates the risk that insufficient attention is paid to establishing hydrogen governance frameworks according to sustainability and human rights criteria, public participation opportunities, technology and knowledge transfer, and global/domestic policy alignment. Considering that these aspects have not been sufficiently addressed in the existing environmental justice literature, we introduce ‘hydrogen justice’ as a concept for analyzing and addressing socio-ecological injustices associated with newly emerging hydrogen regimes.

To delineate our understanding of hydrogen justice, we first recapture environmental, energy, water and climate justice debates. We then explore how the turn towards a green hydrogen economy may require reconceptualization to address new justice challenges. Placing hydrogen justice at the nexus of energy, water and climate justice, we highlight potential hydrogen injustices and suggest a six-dimensional concept of hydrogen justice. We illustrate this with examples from transnational hydrogen projects situated in Morocco and Namibia. Finally, we suggest strategies for redressing hydrogen injustices by integrating justice principles at all scales of hydrogen governance.

2. The case for hydrogen justice

Rooted in the Black Radical Tradition and the US civil rights movement of the 1960s and 1970s (Pulido and de Lara 2018, Galvin 2020), environmental justice refers to the uneven distribution of environmental costs and benefits along the lines of race, gender and class. Coining the term ‘environmental racism’, Bullard explored how environmental injustice manifests and how these inequalities can be addressed and eventually overcome (2005).

Based on these transformative heuristics, the environmental justice debate has since expanded to specific dimensions of environmental problems, resulting in concepts such as climate justice, energy justice and water justice (Jenkins et al 2016, Sultana 2018, 2022). Environmental justice scholars have drawn on liberal justice theory (Rawls 1971/1991, Fraser 1999, Sen 2009) to develop the concept further. However, this has severed the concept from its social movement roots. Drawing on the experience of environmental justice movements, Schlosberg (2004) expanded the concept of environmental justice to include recognition of differences and plurality of participation. Current debates in political ecology and decolonial theory seek to strengthen social movement connections (Pulido and de Lara 2018; Svarstad and Benjaminsen 2020). To grasp the justice controversies along the hydrogen production chain, we draw on energy, water and climate justice because their foci closely relate to the major challenges of water- and energy-intensive hydrogen production for a global market.

Energy justice highlights the socio-ecological dimensions, power struggles and transformative qualities of energy systems. Based on liberal justice theory, Kirsten Jenkins and her co-authors consider energy justice a threefold concept combining distributive, recognitional and procedural justice (Sovacool and Dworkin 2015, Jenkins et al 2016). Distributive justice refers to the distributional effects of transition processes; that is, access to RE, affordability of RE and fair cost/benefit-sharing. Recognitional justice asks whether transition strategies recognize, reflect and respect the needs of vulnerable groups; for example, by co-designing community-based RE projects. Procedural justice focuses on democratic issues of political participation. Recent conceptual advancements include a more nuanced understanding of justice adapted to post-colonial realities. Heffron and McCauley (2017) expand the energy justice concept by adding the dimension of restorative justice. This encourages decision-makers to engage with (historical) injustices caused by energy projects and allows drawing a line to forms of energy colonialism (Lehman 2019, Dunlap 2021). Brato et al (2018) and Barthel (2019) underscore that the energy justice debate needs to reflect on the coloniality of energy transitions both in epistemic terms by privileging Western transition knowledge and material terms by restricting access to technology and finance. Furthermore, Sovacool et al (2017) critically assessed the liberal-cosmopolitan norm set that pervades current understandings of energy justice and seek to pluralize and provincialize energy justice by linking the concept to norms stemming from Southern cosmovisions. Water justice also stems from environmental justice debates (Harris et al 2015) but is closely connected to human rights traditions (Mirosa and Harris 2012), given water’s essential role for human and ecosystem survival. Water justice analyses and politicizes fundamental questions of water use, supply and governance (Boelens et al 2018). In contrast to the energy justice debate, the water justice literature is more scattered, combining elements from political ecology, critical geography, political science and decolonial approaches. Drawing on political ecology and political philosophy, Zwarteeven and Boelens (2014, p 154) develop a multifaceted conceptualization of water justice that considers its material and economic dimensions (‘redistribution’) and its cultural and political dimensions (‘recognition’
and ‘participation’). Empirical work on water justice engages with the established model of integrated water resource management and points to its shortcomings and depoliticizing effects due to its neglect of repercussions of scarcity and privatization (Allan 2006, Neal et al 2014). Joy et al (2014) underscore that water justice needs to reflect the characteristics of water as a fundamental source of life, pay attention to vital issues of water access, rights and equity, and contribute to repoliticising water governance. Indigenous water justice perspectives underscore this by centering on the right to self-determination, referring to the United Nations Declaration on the Rights of Indigenous Peoples. The right to cultural and political self-determination requires that Indigenous Peoples’ decisions on water use and Indigenous human–water relations need to be respected (Robinson et al 2017, pp 852–7). To unlock the transformative potential of research on water justice for struggles for water justice, Grafton et al (2022, p 1) suggest concentrating on a set of questions that assess how water injustices occur (to whom, when and where) and explain their causes (why) to identify concrete pathways towards achieving water justice.

Thirdly, climate justice informs our approach. Global climate justice focuses on historically uneven impacts, vulnerabilities, adaptive capacities and responsibilities in the climate crisis, thus claiming climate debt and compensation for loss and damage (Sultana 2022), and criticizing techno-managerial solutions to climate change. In addition, climate justice scholars examine how green transitions reproduce global inequalities and create carbon/green colonialism (Dunlap 2021) visible in the appropriation of land and resources in the Global South for carbon offsets and for green technologies, such as agrofuels, lithium batteries and solar panels (Zografos and Robbins 2020).

We develop the concept of hydrogen justice against the background of the current push for green hydrogen that may significantly impact the global energy transition due to the large expansion of RE capacities for hydrogen production. With estimates that in 2050 hydrogen could meet up to 12% of global energy consumption (IRENA 2022, p 10), this has repercussions for energy access, land and resource use, RE policies, and global energy governance. As hydrogen megaprojects require large amounts of land, energy and water, typical injustices related to the expansion of RE, such as displacements, unfair pricing structures or land-use conflicts (Rule 2014, Lehman 2019, Dunlap 2021) may also become a common feature of the hydrogen economy. This may also be true for water injustices related to water scarcity, privatization and pricing schemes, or degradation of marine ecosystems due to desalination plants (Sadhwani et al 2005, Munia et al 2016). Placing hydrogen justice at the nexus of energy justice and water justice focuses on potential injustices arising in both fields. In addition, a global climate justice perspective highlights global injustices and power asymmetries associated with climate mitigation that surface in the global hydrogen economy and its modes of governance. Practising climate justice thus entails taking responsibility for the root causes and impacts of climate change, as well as solidarity with and centering on marginalized voices in addressing the global crisis.

We propose a multifold understanding of hydrogen justice that builds on the theoretical foundations of the debates on environmental, energy, water and climate justice in terms of procedural, distributive, recognitional and restorative justice. To integrate post- and decolonial contributions, we include dimensions of epistemic justice (Bhambara 2021, p 10, DeBoom 2021) and relational justice that focuses on human–nature relations (Linton and Budds 2014, Todd 2014). Our concept combines six justice dimensions:

(a) Procedural justice: Which multi-stakeholder hydrogen governance constellations are evolving? How inclusive are these global decision-making structures?
(b) Relational justice: How does resource-intensive hydrogen production interfere with human–water relations or human–land relations?
(c) Recognitional justice: Whose interests, needs and vulnerabilities are considered in the development of hydrogen strategies, governance and projects? How are existing vulnerabilities deepened and which new vulnerabilities can be associated with hydrogen production?
(d) Distributive justice: How are costs and benefits distributed along the hydrogen value chain? How do hydrogen economies restructure access to energy and water?
(e) Restorative justice: To what extent may hydrogen economies deepen historical injustices and dependencies linked to colonialism, such as land conflicts, project-induced displacements, exploitative labour conditions or exclusion from resource use?
(f) Epistemic justice: How do knowledge transfers take place in the hydrogen economy? Whose knowledge over land use or energy production counts?

3. Methodology

To assess the potential and shortcomings of future hydrogen economies, much research focuses on quantifying the economic costs of hydrogen supply (Hank et al 2018, Khzouz et al 2020), while few studies focus on environmental impacts along the supply chain (Bhandari et al 2014, Baykara 2018, Fortier et al 2019). Less is known about socio-ecological impacts with respect to justice-related concerns, such
as energy and water access, labour regimes or impact on vulnerable livelihoods, particularly in the Global South.

To shed light on the ways in which hydrogen production may interfere with water, energy and climate justice, we outline implications for hydrogen (in)justices along the six dimensions introduced above. We illustrate the concept’s analytical value through a qualitative case study of the two exemplary cases, Morocco and Namibia, that are in the spotlight of German hydrogen diplomacy (Yin 2017). As case studies, we collected contextual data on political, socio-economic and socio-ecological conditions in the two countries, conducted stakeholder mappings as well as document and media analyses about planned hydrogen projects, and investigated the German hydrogen partnerships with Morocco and Namibia (FMST 2021)

4. Applying hydrogen justice: case studies from Morocco and Namibia

Hydrogen justice reveals how the planned expansion of hydrogen production may interfere with people’s livelihoods. Moreover, hydrogen injustices are interwoven with previously existing structural injustices, such as an unequal global political economy, violations of labour laws, or gender inequalities. Due to their high wind and solar potentials as well as low projected production costs, Morocco and Namibia are featured in Germany’s hydrogen strategy. In Namibia, Hyphen Hydrogen Energy, a joint venture between the German energy company Enertrag and the investment company Nicholas Holdings, is planning a large-scale project that will produce 300 000 tonnes per year of green hydrogen for export and whose construction costs approximate Namibia’s annual GDP. Likewise, the German–Moroccan Hydrogen Alliance promotes hydrogen production and the establishment of a Power-to-X research platform, although the unresolved Western Sahara conflict complicates hydrogen diplomacy. We illustrate the applicability of the hydrogen justice concept by analyzing both cases along the six justice dimensions.

(a) Procedural justice: Morocco has developed one of the most ambitious RE strategies in the world and launched its own hydrogen roadmap that focuses on integrating domestic industries to reduce import dependency. Morocco’s comprehensive RE policy framework and integrated hydrogen strategy involve a variety of actors. However, despite commitments to transfer ownership of the energy transition process to its citizens, Morocco’s energy transition has been a largely centralized process driven by the government, ministries, private energy companies and European development banks and institutions (Müller et al 2021, Okpanachi et al 2022). This indicates that the energy transition is rather guided by market forces than by public interest. Inadequate community consultations regarding large-scale solar projects (Hamouchene 2016), as well as low freedom of dissent and restricted spaces for human rights activists (Aziki 2020), raise concerns that civil participation is excluded, if not suppressed, in Morocco’s emerging hydrogen economy. In another instance, Namibia envisions building an entire hydrogen economy from scratch, requiring large investments in infrastructure and education. Whether these developments are guided by the interests of investors or if decisions are taken in an open, democratic and inclusive process will be the litmus test for procedural justice. Systematic and just participation at every stage in energy decision-making is crucial in order to achieve a just hydrogen transition.

(b) Relational justice: RE projects in Morocco have led to land conflicts with local communities. For example, the Noor Ouarzazate solar project took place on 3000 ha of land that was communally owned by a Berber clan and used for pastoralism. The administration of the solar project restricted the herders’ access to the land and replaced local institutions that governed the land as commons with state and market institutions that commodified the land and resources (Ryser 2018). Local communities and civil society groups voiced their opposition to the land grab and unsuccessfully demanded a fair share of the project’s benefits (Cantoni and Rignall 2019). Future hydrogen projects will lead to additional land acquisitions that may displace local communities and damage local institutions. Likewise, in Namibia, the construction of large-scale desalination plants, solar parks and infrastructure for the hydrogen economy is planned. It remains to be seen to what extent large-scale infrastructures will restrict the habitat of pastoralists and nomads, interfere with their ecosystems and thus change traditional socio-cultural relationalities or replace them with commodified human–nature relations. To consider these aspects, established modes of environmental impact assessments are not sufficient, as socio-cultural dimensions need to be covered.

(c) Recognitional justice: Morocco partially sources its RE from the occupied territories of Western Sahara, whilst Sahrawis are denied access...
to energy and water. The dependence on disputed territories for green hydrogen supply may not only perpetuate these injustices, but further weaken Sahrawi claims for recognition and self-determination (Allan et al. 2021). In Namibia, the rights of Indigenous Peoples might be affected as well. The envisaged Namibian hydrogen ecosystem covers large parts of the country, including the Kunene region in the North, which is home to Indigenous communities. As marginalized and discriminated population groups are particularly affected by water and energy poverty, recognitional justice holds that their perspectives should be integrated into hydrogen policies, labour laws and contracts.

(d) Distributive justice: While RE produced in Western Sahara is being exported to neighbouring regions, Saharawi people face recurring power cuts and prohibitive costs for electricity bills. Meanwhile, jobs in the Moroccan-occupied Western Sahara energy industry have almost exclusively been allocated to Moroccan settlers, raising the question whether the distribution of the costs and benefits from hydrogen production will follow the status quo of ‘discrimination along ethnic lines’ (Allan et al. 2022, p 59). In Namibia, the project’s export orientation carries the risk of creating an enclave economy, in case integration into the energy production chain that would stimulate local economies is not put into practice. If this is the case, benefits primarily accumulate in the Global North, which imports green hydrogen and sells hydrogen technology, while few spillover effects are generated for the local economy. In a similar sense, in a country with an electrification rate of 56.3% (World Bank n.d.), who gets access to the 5 GW RE that Hyphen plans to generate will be an issue of distributive justice.

(e) Restorative justice: Global hydrogen governance is prone to reproduce historical injustices through hydrogen diplomacy. The soft governance approach towards Morocco may be a case in point, as long as the claims of the Polisario liberation movement for self-determination of the Saharawi people are downplayed in return for hydrogen supply and energy security. Several European governments have withdrawn their support for the UN resolution for a referendum on independence in Western Sahara, while aiming to improve energy relations with Morocco and build hydrogen partnerships (Gilmartin 2022). As a former colony of the German Empire, Namibia repeatedly demanded restorative justice through financial reparations from the German government for the colonial atrocities of the 1904 Herero and Nama genocide. After many years of denial, in 2021 the German government admitted to the genocide and offered a recompense of €1.1 billion over 30 years (Cotterill 2022). In addition, German and South African colonial rule has led to highly unequal land distribution, with the white population owning 70% of land in Namibia (Namibia Statistics Agency 2018, p 38). To pay respect to this delicate historical heritage and the current reconciliation attempts, hydrogen partnerships must take a stance and remedy colonial injustices by transferring ownership, technology and financial and material benefits to the producing countries.

(f) Epistemic justice: While the German–Namibian hydrogen governance framework claims that the emerging hydrogen economy must adhere to good governance and mutually beneficial standards, this has not yet been well implemented. The tender for the project was allocated in an opaque process, driven by technomanagerial and cost-effectiveness criteria (Links 2022). Hydrogen policies and strategies may lead to epistemic injustices if they pay insufficient attention to local knowledge systems and reproduce a colonial or Eurocentric knowledge order. For example, colonial narratives of development and modernization that accompany hydrogen plans may misconstrue the social and political realities of marginalized communities. While the Moroccan state links the production of green hydrogen to decarbonization, energy independence and new market opportunities, the development of RE for hydrogen production in Western Sahara territories denotes exploitation, occupation and oppression for Sahrawis. These developmental narratives obfuscate the experiences of Sahrawis, of the exploitative practices of state powers and private corporations, as well as the violent practices that aim at silencing dissenting voices.

5. Discussion and conclusion

The cases of Morocco and Namibia indicate that the envisaged hydrogen partnerships risk enforcing inequities rather than leading to a just transition, as long as the justice dimensions are not covered systematically. We find that hydrogen (in)justices result from interdependent processes at the global and local level: Hydrogen (in)justices are a function of the interplay of the rules of the global hydrogen economy, hydrogen partnerships and the design of hydrogen projects together with the specific social, environmental, economic and political conditions in producing countries. This means that a neoliberal global hydrogen market, import-focused hydrogen strategies in consuming countries and export-oriented hydrogen projects in producing countries increase the risk of hydrogen injustices as do high drought risks, high energy poverty, lack of RE in the energy mix, lack of participation opportunities, and weak labour, social
and environmental standards in producing countries. Researching the often overlooked socio-ecological, political and economic risks of the global hydrogen transition from a justice perspective responds to the call for more critical social science research on the hydrogen transition than Hanusch and Schad (2021) and Kalt and Tunn (2022) have made. Furthermore, this paper contributes to transition studies that have started to take the issue of equity and justice more seriously (Carley and Konisky 2020). Creating a conceptual framework for hydrogen (in)justice allows to centre justice principles on transition research, to identify injustices in the global hydrogen transition and to set conditions for a just hydrogen transition. Whether the hydrogen economy bears the potential to mitigate environmental impacts, support affected communities, and create sustainable energy futures and decent jobs ultimately depends on incorporating principles of justice at all scales: from the global rules of the hydrogen economy and the decision-making arenas of global hydrogen governance down to the local contextual conditions that matter for the siting, design and implementation of hydrogen projects.

**Data availability statement**

All data that support the findings of this study are included within the article (and any supplementary files).

**Funding**

This article was supported by the Federal Ministry of Science and Technology’s funding line INSIGHT (Grant Number: 16INS102A).

**References**

Allan J, Lakhal H and Lemaadel M 2021 An unjust transition: energy, colonialism and extractivism in occupied Western Sahara (available at: https://longreads.tmi.org/an-unjust-transition)

Allan J, Lemaadel M and Lakhal H 2022 Oppressive energopolitics in Africa’s last colony: energy, subjectivities, and resistance Antipode 54 44–63

Allan T 2006 IWRM: the new sanctioned discourse? *Integrated Water Resources Management* ed P Molлина, A Džit and K Athatokula (New Delhi: Sage) pp 38–63

Aziki O 2020 ATTAC CADTM Morocco: 20 years of struggle for another possible Morocco—one of social and environmental justice, of dignity and freedom Committee for the Abolition of Illegitimate Debt (available at: www.cadtm.org/ATTAC-CADTM-Morocco-20-years-of-struggle-for-another-possible-Morocco-one-of)

Barthel B 2019 Erneuerbare und dezentrale Energien aus postkolonialer Perspektive (Baden-Baden: Nomos)

Baykara S Z 2018 Hydrogen: a brief overview on its sources, production and environmental impact *Int. J. Hydrog. Energy* 43 10605–14

Bhambra G K 2021 Decolonizing critical theory?: Epistemological justice, progress, reparations *Crit. Times* 473–89

Bhandari R, Trudewind C A and Zapp P 2014 Life cycle assessment of hydrogen production via electrolysis—a review *J. Clean. Prod.* 85 151–63

Boelens R, Perreault T and Vos J 2018 Water Justice (Cambridge: Cambridge University Press) (https://doi.org/10.1017/97811316831847)

Braço V C, Baptista I, Kirchner J, Smith S and Alves S N 2018 Energy justice and sustainability transitions in Mozambique *Appl. Energy* 228 643–55

Bullard R D 2005 The Quest for Environmental Justice: Human Rights and the Politics of Pollution (San Francisco, CA: Sierra Club Books)

Cantoni R and Rignall K 2019 Kingdom of the Sun: a critical, multiscalar analysis of Morocco’s solar energy strategy *Energy Res. Soc. Sci.* 51 20–31

Carley S and Konisky D M 2020 The justice and equity implications of the clean energy transition *Nat. Energy* 5 569–77

CBD—Convention on Biological Diversity n.d. Namibia: Biodiversity Facts (available at: www.cbd.int/countries/profile?country=na&facts)

Cotterill J 2022 Battle for Namibia reparations: German deal ‘was never about us’ Financial Times (available at: www.ft.com/content/ab289014-0414-4514-a77e-a3f030505e0f)

Delboom M J 2021 Climate necropolitics: ecological civilization and the distributive geographies of extractive violence in the Anthropocene *Ann. Am. Assoc. Am. Geogr.* 111 900–12

Dillmann K J and Heinonen J 2022 A ‘just’ hydrogen economy: a normative energy justice assessment of the hydrogen economy *Renew. Sust. Energ. Res.* 167 112648

Dunlap A 2021 More wind energy colonialism(s) in Oaxaca? Reasonable findings, unacceptable development *Energy Res. Soc. Sci.* 82 2214–6296

ETC 2021 Making the hydrogen economy possible: accelerating clean hydrogen in an electrified economy *Energy Transition Commissions* (available at: www.energy-transitions.org/publications/making-clean-hydrogen-possible)

Federal Ministry for Science and Technology 2021 Wie der Potenzialatlas Wasserstoff eine deutsch-afrikanische Energie-Partnerschaft vorbereitet (available at: www.wasserstoff-leitprojekte.de/partner_projekte/potenzialatlas)

Federal Ministry for Trade and Energy 2020 Die Nationale Wasserstoffstrategie (Berlin: Bund)

Fortier M-O, Teronb L, Reamesc T G, Mundardy D T and Sullivan B M 2019 Introduction to evaluating energy justice across the life cycle: a social lifecycle assessment approach *Appl. Energy* 236 211–9

Fraser N 1999 Social justice in the age of identity politics *Geographical Thought: A Praxis Perspective* ed G Henderson (London: Taylor and Francis) pp 65–89

Galvin R 2020 “Let justice roll down like waters”: reconnecting energy justice to its roots in the civil rights movement *Energy Res. Soc. Sci.* 62 101385

Gilmartin E 2022 Europe is replacing energy dependence on Russia with reliance on North African dictatorships (available at: https://jacobin.com/2022/03/eu-germany-energy-green-hydrogen-repowerwestern-sahara)

(ACCESSSED 27 March 2022)

Grafton R Q, Fanaian S, Sacco G and Liberman L 2022 Bending carbon dioxide—power-to-methanol production based on renewable hydrogen and recycled carbon dioxide—power-to-methanol *Sustain. Energy Fuels* 2 1244–61

Hank C, Gelpke S, Schnabl A, White R, Full J, Wiebe N, Smolinka T, Schaadt A, Hebling C and Henning H 2020 Energy efficiency and

---

**Boelens R, Perreault T and Vos J 2018 Water Justice (Cambridge: Cambridge University Press) (https://doi.org/10.1017/97811316831847)**

**Braço V C, Baptista I, Kirchner J, Smith S and Alves S N 2018 Energy justice and sustainability transitions in Mozambique *Appl. Energy* 228 643–55**

**Bullard R D 2005 The Quest for Environmental Justice: Human Rights and the Politics of Pollution (San Francisco, CA: Sierra Club Books)**

**Cantoni R and Rignall K 2019 Kingdom of the Sun: a critical, multiscalar analysis of Morocco’s solar energy strategy *Energy Res. Soc. Sci.* 51 20–31**

**Carley S and Konisky D M 2020 The justice and equity implications of the clean energy transition *Nat. Energy* 5 569–77**

**CBD—Convention on Biological Diversity n.d. Namibia: Biodiversity Facts (available at: www.cbd.int/countries/profile?country=na&facts)**

**Cotterill J 2022 Battle for Namibia reparations: German deal ‘was never about us’ Financial Times (available at: www.ft.com/content/ab289014-0414-4514-a77e-a3f030505e0f)**

**Delboom M J 2021 Climate necropolitics: ecological civilization and the distributive geographies of extractive violence in the Anthropocene *Ann. Am. Assoc. Am. Geogr.* 111 900–12**

**Dillmann K J and Heinonen J 2022 A ‘just’ hydrogen economy: a normative energy justice assessment of the hydrogen economy *Renew. Sust. Energ. Res.* 167 112648**

**Dunlap A 2021 More wind energy colonialism(s) in Oaxaca? Reasonable findings, unacceptable development *Energy Res. Soc. Sci.* 82 2214–6296**

**ETC 2021 Making the hydrogen economy possible: accelerating clean hydrogen in an electrified economy *Energy Transition Commissions* (available at: www.energy-transitions.org/publications/making-clean-hydrogen-possible)**

**Federal Ministry for Science and Technology 2021 Wie der Potenzialatlas Wasserstoff eine deutsch-afrikanische Energie-Partnerschaft vorbereitet (available at: www.wasserstoff-leitprojekte.de/partner_projekte/potenzialatlas)**

**Federal Ministry for Trade and Energy 2020 Die Nationale Wasserstoffstrategie (Berlin: Bund)**

**Fortier M-O, Teronb L, Reamesc T G, Mundardy D T and Sullivan B M 2019 Introduction to evaluating energy justice across the life cycle: a social lifecycle assessment approach *Appl. Energy* 236 211–9**

**Fraser N 1999 Social justice in the age of identity politics *Geographical Thought: A Praxis Perspective* ed G Henderson (London: Taylor and Francis) pp 65–89**

**Galvin R 2020 “Let justice roll down like waters”: reconnecting energy justice to its roots in the civil rights movement *Energy Res. Soc. Sci.* 62 101385**

**Gilmartin E 2022 Europe is replacing energy dependence on Russia with reliance on North African dictatorships (available at: https://jacobin.com/2022/03/eu-germany-energy-green-hydrogen-repowerwestern-sahara) (ACCESSSED 27 March 2022)**

**Grafton R Q, Fanaian S, Sacco G and Liberman L 2022 Bending towards water justice: pathways for truth, reconciliation, inclusion and transformative actions *Int. J. Water Resour. Dev.* 38 1–10**

**H2POLITICS 2022 Mapping hydrogen risks in the Global South University of Hamburg Working Paper**

**Hamouchene H 2016 The Ouarzazate Solar Plant in Morocco: Triumphant “Green” Capitalism and the Privatization of Nature *Jadaliyya* (available at: www.jadaliyya.com/Details/33115)**

**Hank C, Gelpke S, Schnabl A, White R, Full J, Wiebe N, Smolinka T, Schaadt A, Hebling C and Henning H 2020 Energy efficiency and**
economic assessment of imported energy carriers based on renewable electricity. *Sustain. Energy Fuels* 4 2236–73.

Hanusch F and Schad M 2021 Hydrogen research: technology first, society second? *GAIA* 30 82–86.

Harris I M, Rodina L and Morinville C 2015 Revisiting the human right to water from an environmental justice lens. *Polit. Groups Identities* 3 660–5.

Heffron R J and McCauley D 2017 The concept of energy justice across the disciplines. *Energy Policy* 105 658–67.

Hickel J, Dorninger C, Wieland H and Suwandi I 2022 Imperialist appropriation in the world economy: drain from the global South through unequal exchange, 1990–2015. *Glob. Environ. Change* 73 102467.

IRENA 2022 Geopolitics of the energy transformation: the hydrogen factor (available at: www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Feb/IRENA_Geopolitics_Hydrogen_2022.pdf).}

Jenkins K, McCauley D, Heffron R, Stephan H and Rehner R 2016 Energy justice: a conceptual review. *Energy Res. Soc. Sci.* 11 174–82.

Joy K J, Kulkarni S, Roth D and Zwartveld M 2014 Re-politicising water governance: exploring water re-allocations in terms of justice. *Local Environ.* 19 954–73.

Kalt T and Tün J 2022 Shipping the sunshine? A critical research agenda on the global hydrogen transition. *GAIA* 31 72–76.

Khzouz M, Gkanas E, Shao J, Sher F, Beherskyi D, El-Kharouf A and Al Qubeissi M 2020 Life cycle cost analysis: tools and applications for determining hydrogen production cost for fuel cell vehicle technology. *Energies* 13 3783.

Koj C, Wulf C and Zapp P 2019 Environmental impacts of power-to-X systems: a review of technological and methodological choices in Life Cycle Assessments. *Renew. Sust. Energy Rev.* 122 965–79.

Lehman R 2019 *Der Konflikt um Wüdenergie in Mexiko. Partizipation, Diskurse und die ungleiche Gestaltung der Naturverhältnisse im Isthmus von Tehuantepec* (Wiesbaden: Springer) (https://doi.org/10.1007/978-3-658-25675-3).

Links F 2022 Transparency concerns dog ‘largest tender in nation’s history’ *Procurement Tracker Namibia* (available at: https://ipptr.org/na/publication/the-largest-tender-in-namibias-history).

Linton J and Budds J 2014 The hydrosocial cycle: defining and mobilizing a relational-dialectical approach to water. *Geoforum* 57 170–80.

Mirosa O and Harris I M 2012 Human right to water: contemporary challenges and contours of a global debate. *Antipode* 44 932–49.

Müller F, Neumann M, Elsner C and Claar S 2021 Assessing African energy transitions: renewable energy policies, energy justice, and SDG. *7 Politics Gov.* 9 1–18.

Munia H, Guillaume J H A, Mirumachi N, Porkka M, Wada Y and Kummu M 2016 Water stress in global transboundary river basins: significance of upstream water use on downstream stress. *Environ. Res. Lett.* 11 014002.

Namibia Statistics Agency 2018 *Namibia Land Statistics* (available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NA).

Neal M J, Lukasiewicz A and Syne G J 2014 Why justice matters in water governance: some ideas for a ‘water justice framework’. *Water Policy* 16 1–18.

Okpanachi E, Ambe-Uva T and Fasih A 2022 Energy regime reconfiguration and just transitions in the Global South: lessons for West Africa from Morocco’s comparative experience. *Futures* 139 102934.

Pulido L and de Lara J 2018 Reimagining ‘justice’ in environmental justice: radical ecologies, decolonial thought, and the Black Radical Tradition. *Environ. Plan. E* 1 76–98.

Ravs J 1991 [1971] *A Theory of Justice* (Cambridge: Cambridge University Press).

Robinson J, Cosens B A, Jackson S, Leonard K and McCool D 2017 Indigenous water justice. *Lewis Clark Law Rev.* 22 841–921.

Ronzoni M 2009 The global order: a case of background injustice? A practice-dependent account. *Philos. Publ. Aff.* 37 229–56.

Rule T 2014 *Solar, Wind and Land: Conflicts in Renewable Energy Development* (London: Routledge).

Ryser S 2018 *The anti-politics machine of green energy development: the Moroccan solar project in Ouazarzate and its impact on gendered local communities* (Cambridge: Cambridge University Press).

Sadhwani J, Veza J M and Santana C 2005 Case studies on environmental impact of seawater desalination. *Desalination* 185 1–8.

Schlosberg D 2004 Reconciling environmental justice: global movements and political theories. *Env Polit.* 13 517–40.

Sen A 2009 *The Idea of Justice* (Cambridge, MA: Allen Lane and Harvard University Press).

Sovacool B K, Burke M, Baker L, Kotikalapudi C K and Wlokas H 2017 New frontiers and conceptual frameworks for energy justice. *Energy Policy* 105 677–91.

Sovacool B K and Dworkin M H 2015 Energy justice: conceptual insights and practical applications. *Appl. Energy* 142 435–44.

Sultana F 2018 Water justice: why it matters and how to achieve it. *Water Int.* 43 483–93.

Sultana F 2022 Critical climate justice. *Geog. J.* 188 118–24.

Svarstad H and Benjaminsen T A 2020 Reading radical environmental justice through a political ecology lens. *Futures* 118 1–11.

Todd Z 2014 Fish pluralities: human-animal relations and sites of engagement in Paulatuuq, Arctic Canada. *Etnud. Inuit Stud.* 38 217–38.

Waligore T 2018 Redress for colonial injustice: structural injustice and the relevance of history. *Glob. Justice Theory Pract. Rhetoric.* 11 15–28.

World Bank 2022 Access to electricity in Namibia (available at: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NA).

Yin R K 2017 *Case Study Research and Applications. Design and Methods* (Newcastle: Sage).

Zografos C and Robbins P 2020 *Green sacrifice zones, or why a green new deal cannot ignore the cost shifts of just re-allocations in terms of justice* (Wiesbaden: Springer).

Zwartveld M and Boelens R 2014 *Defining, researching and struggling for water justice: some conceptual building blocks for research and action* *Water Int.* 39 143–58.