The ethics and justice dimensions of low-carbon transitions

Keynote Address to the "Online Conference on Power and Justice in Energy Transitions," University of Ljubljana, Slovenia, June 30, 2021

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Disparity: Characteristics of early adopters and potential mainstream consumers for mobility innovations

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	Electric vehicles	*Car-share (and bike-share)*	*Ride-hailing (single and pooled)*	*Automated vehicles*
Demographics				
Income	(+) higher	(+) lower (-) higher	(+) higher	(+) higher
Age	(+) middle age	(+) younger (+) middle age	(+) younger	(+) middle age (+) younger
Gender	(+) male	(+) male (+) female		(+) male
Education	(+) higher			
Other details		(+) has young child		
Travel patterns (context)	(+) longer commutes (-) lack of home charging	(+) walkable residence [c] (+) cyclist (bike-share share only)	(+) walkable residence (pooled only)	(+) people unable to drive
Motivations				
Identity, personality	(+) agreeableness (-) conscientious (+) pro-enviro. identity	(+) opennness (-) risk-loving (+) pro-enviro. (+) innovators	(+) extraversion (+) agreeableness (pooled only)	(-) technophobes (-) low trust in tech.
Priorities, beliefs	(+) enviro. impacts (+) low costs	(+) cost savings (+) environmental impacts (+) convenient (+) higher social trust (peer-to-peer only (-) lack of safety (bike-share only)	(+) predictable costs (+) enviro. impacts	

Source: Jonn Axsen, Benjamin K. Sovacool, The roles of users in electric, shared and automated mobility transitions, *Transportation Research Part D*, Volume 71, 2019, Pages 1-21

"Energy justice" involves:

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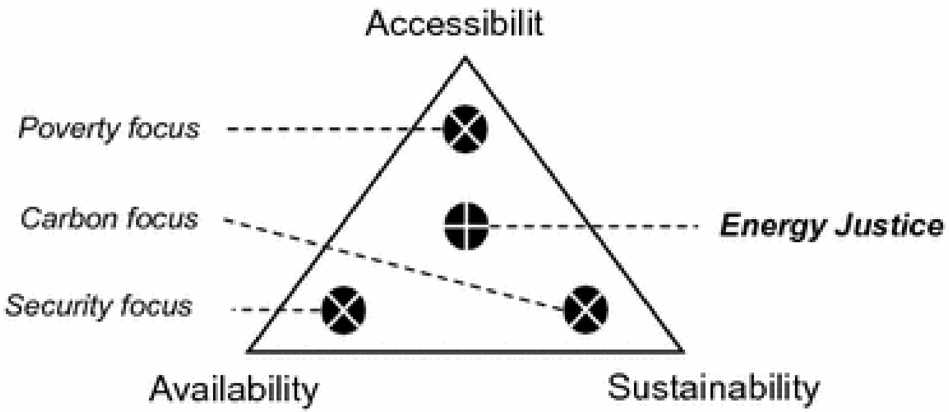
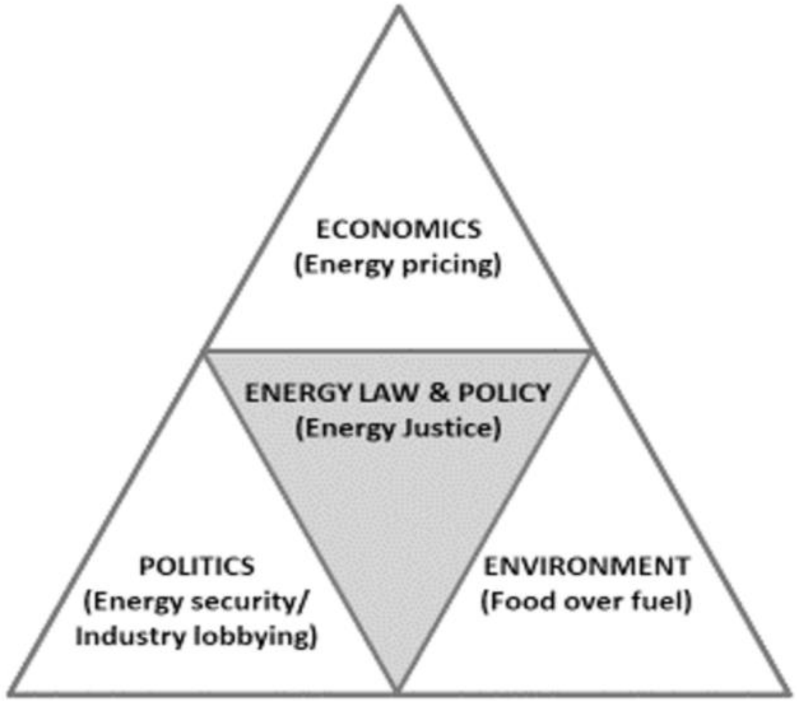
- *Costs*, or how the hazards and externalities of the energy system are disseminated throughout society;
- *Benefits*, or how the ownership of and access to modern energy systems and services are distributed throughout society;
- *Procedures*, or ensuring that energy decision-making respects due process and representation;
- *Recognition*, or assessing the impact of energy systems on the poor, vulnerable, or marginalized.

Source: Sovacool, BK, RJ Heffron, D McCauley, and A Goldthau. "Energy decisions reframed as justice and ethical concerns," *Nature Energy* 16024 (May, 2016), pp. 1-6.

“Energy justice” involves:





Source: Darren McCauley, *Global Energy Justice: Tackling Systems of Inequality in Energy Production and Consumption*, Springer, 2017

“Energy justice” and “just transformations” involve:

J	T R A N S I T I O N	Justice	Justice takes the form of 3 forms of justice Distributional Procedural Restorative
U		Universal	Universal takes the form of two universal forms of justice Recognition Cosmopolitanism
S		Space	Space brings in location, where are ‘events’ happening ? (in principle, at local, national and international levels)
T		Time	Time brings into transition timelines such 2030, 2050, 2080 etc. and also ‘speed’ of the energy transition (i.e. is it happening fast enough?).

Heffron, R. J., & McCauley, D. (2018). What is the ‘Just Transition’? *Geoforum*. https://doi.org/10.1016/j.geoforum.2017.11.016

Applications within the field:

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Dimension	Definition	Application to electric mobility
Distributive justice	Equitable or utilitarian distribution of social and economic benefits and burdens within and across different generations	Benefits and burdens of vehicle use, equity of access
Procedural justice	Adherence to due process and fair treatment of individuals under the law	Planning, due process, and policy issues surrounding incentives and regulations
Cosmopolitan justice	Universal respect for individual human rights regardless of one's identity	Globally produced or distributed externalities including embodied emissions, pollution, and lifestyle impacts
Justice as recognition	Appreciation for the vulnerable, marginalized, poor, or otherwise under-represented or misrepresented populations and demographic groups	Impacts on vulnerable groups, especially women, children, minorities, or indigenous people

Source: Sovacool, BK, Noel, LD, G Zarazua de Rubens, and J Kester. "Energy injustice and Nordic electric mobility: Inequality, elitism, and externalities in the electrification of vehicle-to-grid (V2G) transport," *Ecological Economics* 157 (March, 2019), pp. 205-217

Applications within the field:

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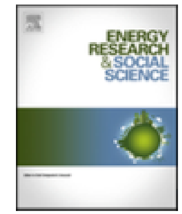

Review

Energy justice: A conceptual review

CrossMark

Kirsten Jenkins[a,*], Darren McCauley[a], Raphael Heffron[b], Hannes Stephan[c], Robert Rehner[a]

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[c] University of Stirling, United Kingdom

Tenet	Evaluative	Normative
Distributional	Where are the injustices?	How should we solve them?
Recognition	Who is ignored? Who is responsible?	How should we recognise? How do we achieve responsibility?
Procedural	Is there fair process?	Which new processes?
Cosmopolitanism	Is everyone afforded equal moral rights?	How do we engage in global decision-making?

Applications within the field (principles):

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Principle	Explanation
Availability	People deserve sufficient energy resources of high quality.
Affordability	All people, including the poor, should pay no more than 10 percent of their income for energy services.
Due Process	Countries should respect due process and human rights in their production and use of energy.
Transparency and accountability	All people should have access to high-quality information about energy and the environment and fair, transparent, and accountable forms of energy decision-making.
Sustainability	Energy resources should not be depleted too quickly.
Intragenerational equity	All people have a right to fairly access energy services.
Intergenerational equity	Future generations have a right to enjoy a good life undisturbed by the damage our energy systems inflict on the world today.
Responsibility	All nations have a responsibility to protect the natural environment and minimize energy-related environmental threats.
Resistance	Energy injustices must be actively, deliberately opposed.
Respect	Intersectional differences in knowledge and epistemic upbringing, culture and experience, and race and gender have to be respected in energy decision-making.

Source: Sovacool, BK, M Burke, L Baker, CK Kotikalapudi, and H Wlokas. "New frontiers and conceptual frameworks for energy justice," *Energy Policy* 105 (June, 2017), pp. 677-691.

Applications within the field (selected principles)

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Case study	**Technological complexity**	**Change in user practices**	**Positive justice dimensions**	**Negative justice dimensions**
Energy services	Incremental	Substantial	Cost savings, more reliable service, more predictable cost, increased productivity of subsidies	Some may be excluded from the market (e.g. because they lack the internet, sensors or a smart phone)
Electric vehicles	Radical	Substantial	Reduced carbon emissions and air pollution, fuel savings	Less accessible to those without off-street parking, and/or those who cannot afford a new car
Solar photovoltaic panels	Radical (especially with storage and time-of-use tariffs)	Modest	Reduced electricity bills, improved resilience and potential revenue from feed in tariffs	Limited to those who own their own roof but subsidized by everyone and too difficult for some to understand
Low carbon heat	Incremental	Modest	Upgrading heating systems and insulating homes can raise property values and improve the quality of indoor environments	Some lack the capital to invest in upgrades or the ability to make the decision because they rent their home

	Energy service contracting	**Battery electric vehicles**	**Solar PV panels**	**Low carbon heat**
Affordability	+++	−	+	+/−
Sustainability	++	+/−	++	+++
Equity	−−−	−−−	−−−	−
Respect	−−	−	−	−

Source: Sovacool, BK, M Lipson, and R Chard. “Temporality, vulnerability, and energy justice in household low carbon innovations,” *Energy Policy* 128 (May, 2019), pp. 495-504.

Healy et al. and “sacrifice zones” – but what about pro-climate interventions?

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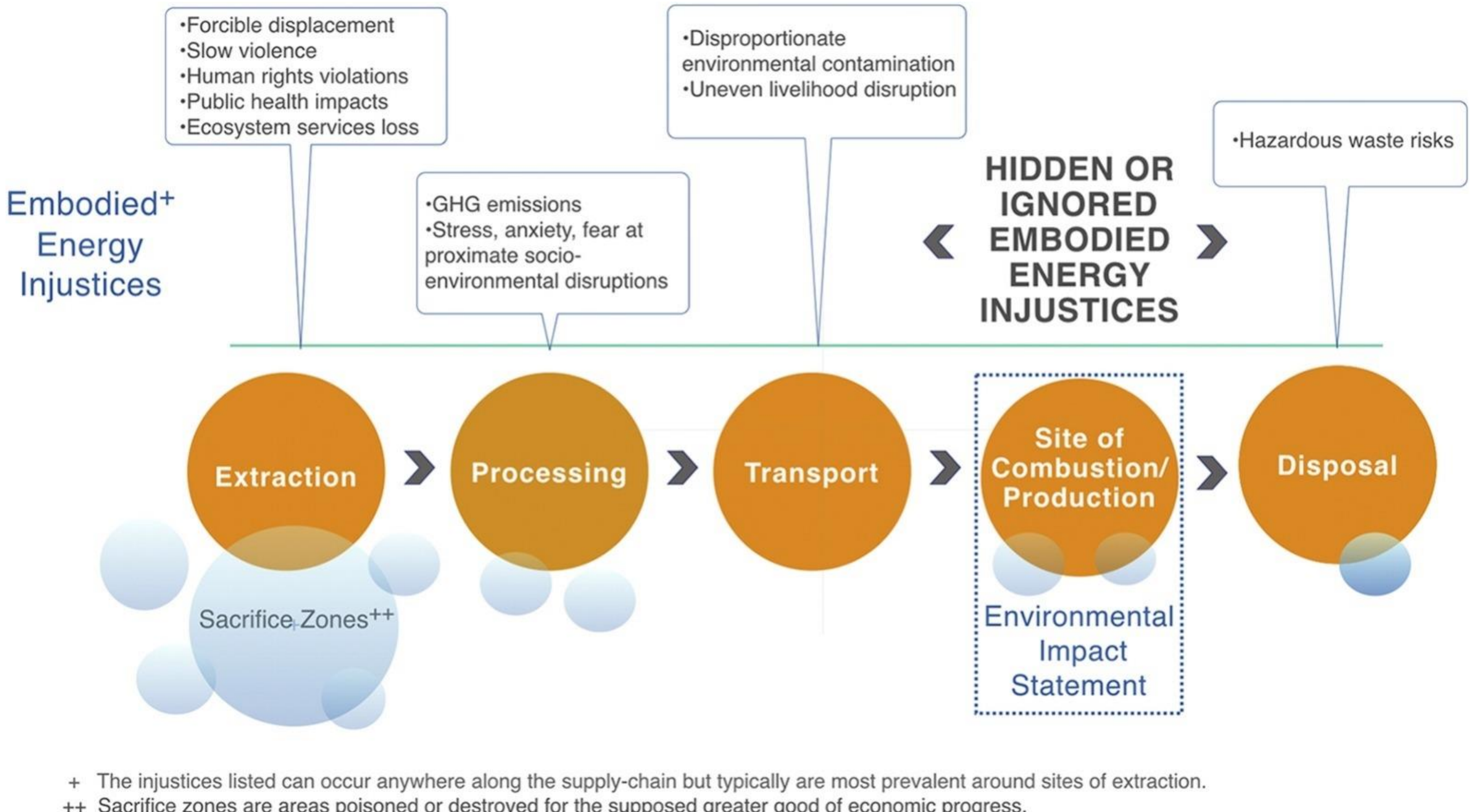

Source: Healy, N., Stephens, J. C., & Malin, S. A. (2019). Embodied energy injustices: Unveiling and politicizing the transboundary harms of fossil fuel extractivism and fossil fuel supply chains. *Energy Research & Social Science*, 48(June 2018), 219–234.

Case study selection: France (1970/80s), Germany (1990s), Norway (2000s), UK (2010s)

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Research design (mixed methods)

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Sixty-four semi-structured expert research interviews

Country	Date	Illustrative Institutions
France	July 2018	CEA (Atomic Energy Commission of France), Electricité de France, ESSEC Business School, Greenpeace, International Energy Agency, Organization of Economic, Cooperation and Development, WISE-PARIS
Germany	July 2018	BMWi (Federal Ministry for Economic Affairs and Energy), Ecologic Institute, Fraunhofer Institute for Solar Energy Systems ISE, German Solar Association (BSW-Solar), the German Energy Agency, the German Solar Energy Society (DGS), Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)
Norway	June - September 2018	Energi Norge, Ministry of Transport and Communications, Norwegian Public Roads Administration, NTNU (Norwegian University of Science and Technology), Statnett, the Norwegian Electric Vehicle Association (NEVA), TOI (The Institute of Transport Economics)
Great Britain	August 2018	Department for Business Energy & Industrial Strategy, Citizens Advice, Energy Saving Trust, Good Energy, Oxford University, Smart Energy GB, University College London

Research design (mixed methods)

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Five focus groups: Lewes (Great Britain), Colmar (France), Freiburg (Germany, two of them), and Stavanger (Norway)

Research design (mixed methods)

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Twelve internet forums (three per country, more than 2m total members) with 58 further responses

Country	Forum	Description	Members	Responses
Norway	Elbilforum.no	Norwegian EV forum	20,487	7
Norway	Tesla motors club Norway	Online forum for Tesla owners in Norway	N/A	4
Norway	SpeakEV	Online electric car forum for all EV owners and enthusiasts	16,152	0
Germany	Photovoltaik forum.com	A solar forum in German	100,823	2
Germany	Solarstrom-forum.de	Photovoltaic forum in German	2,329	0
Germany	Building Technology Forum - Solar Energy	Online forum for all building technologies including solar	N/A	0
GB	Money Saving Expert	Consumer forum	1,778,314	1
GB	Navitron	Private company forum on a range of energy issues	7139	0
GB	OVO Energy	Private company forum on a range of energy issues		0
GB	The IET	The Institution of Engineering and Technology	N/A	38
France	Que Choisir	Consumer forum	130536	1
France	Forum photovoltaique	Energy forum	42596	5
France	Droit Finances	Consumer finances forum	N/A	0

Findings: More detailed results in the study … how many co-benefits in total?

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No.	Type	Benefit	Supported by[a]	Frequency[b]
1	Economic	Cheap electricity for France	RI	10
2	Environmental	Low carbon energy source	RI, IF	10
3	Economic	Created well-paid and stable jobs in nuclear industry	RI	9
4	Political	Secured energy independence and energy security, reduced fossil fuel imports	RI, IF	7
5	Social	Supported egalitarian energy access	RI	7
6	Social	Galvanized pride in national project	RI	6
7	Economic	Supported industrial growth	RI, FG	6

Findings: summary of co-benefits

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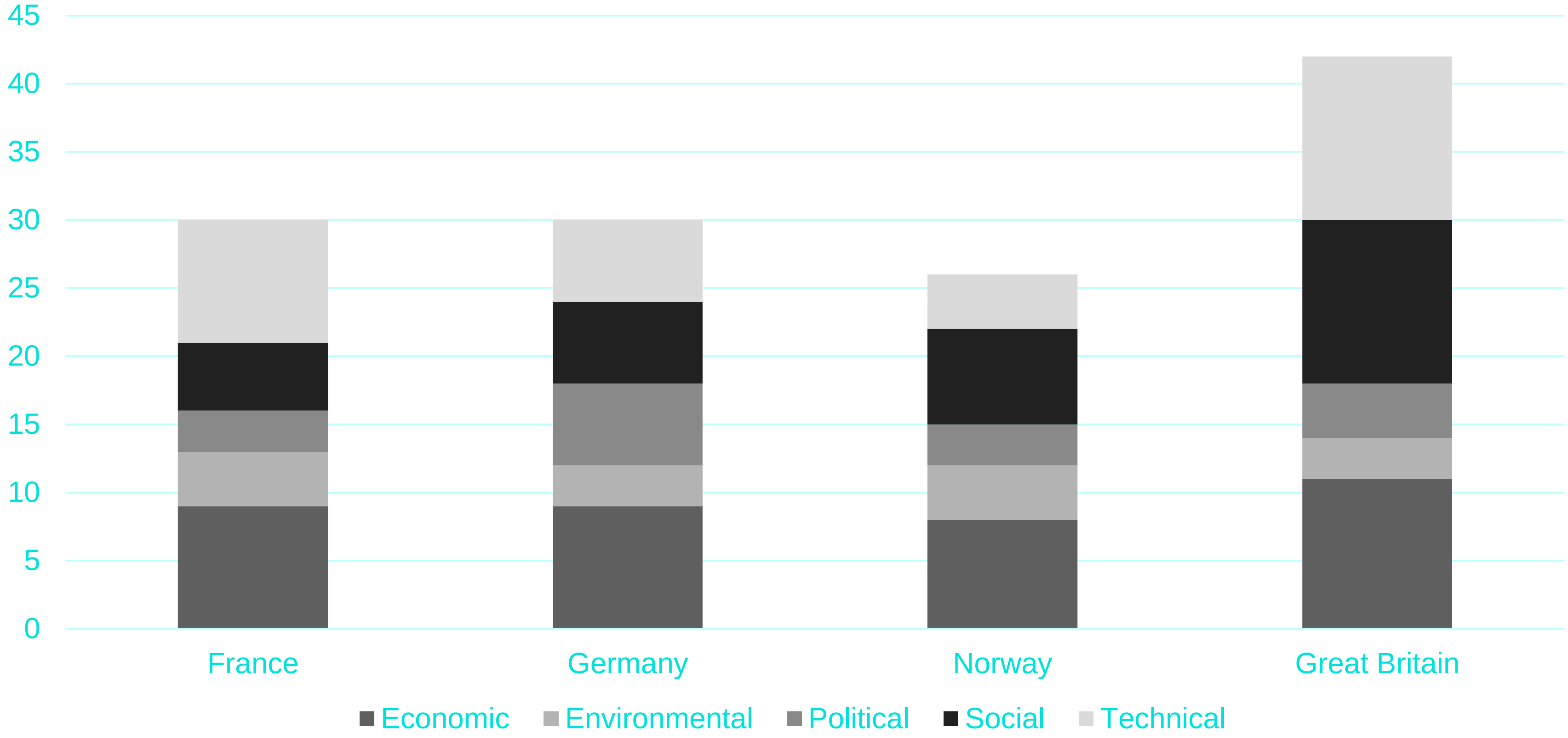
- Our evidence accumulates into 128 (inductively or analytically) distinct co-benefits.
- A significant number of these were **economic** (37), such as fuel savings, jobs, exports, and profits.
- Others were **environmental** (14), such as displaced air pollution, mitigated climate change, reduced land use impacts, and other avoided externalities
- Our remaining 77 co-benefits do not fall into these broad categories of "cost" and "carbon." We captured 30 **social** benefits, as diverse as the way in which nuclear power galvanized national pride in France to the way in which electric vehicles elicited positive feelings of prestige and environmental consciousness in Norway.
- We captured 31 **technical** benefits, from the ways in which smart meters are facilitating distributed generation in Great Britain to the ways in which PV stimulated innovations in solar PV technology in Germany.
- We captured 16 **political** benefits, from policy learning across all four cases, as well as improvements to energy security and reduced energy dependence in all four cases

Source: Benjamin K. Sovacool, Mari Martiskainen, Andrew Hook, Lucy Baker," Beyond cost and carbon: The multidimensional co-benefits of low carbon transitions in Europe," *Ecological Economics*, Volume 169, 2020, 106529

Co-benefits are almost equally distributed across the transitions or technologies

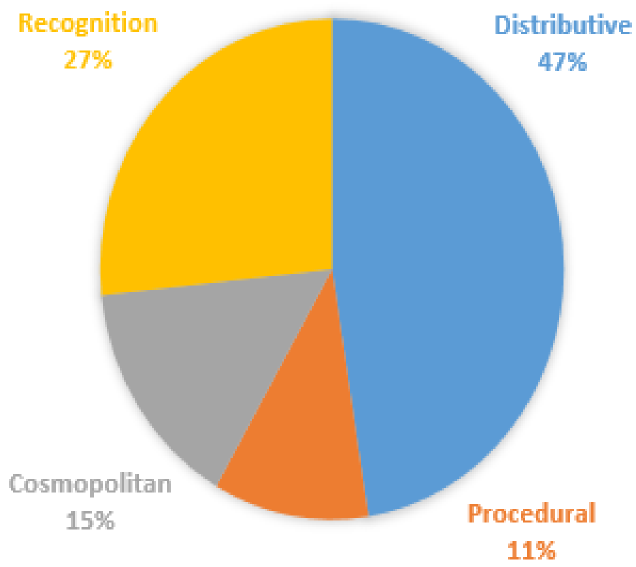


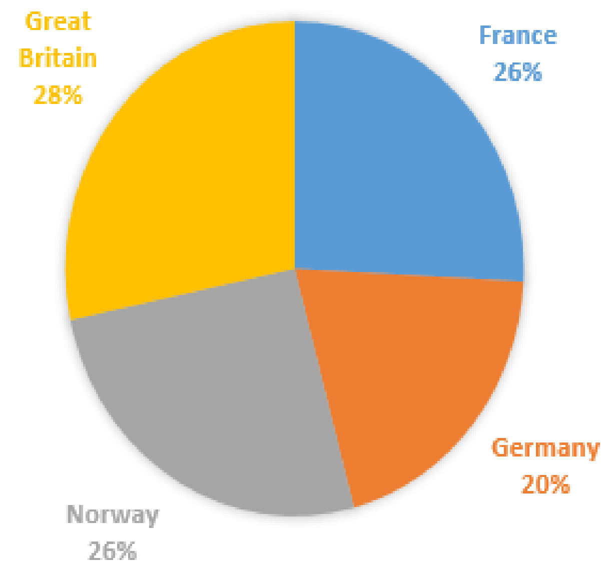
What about injustices?

	No.	Injustice	Description	Supported by[a]	Frequency[b]
France	1	High long-term costs to tax payers	Future tax payers bearing burden of decommissioning and waste management	RI, FG, IF	11
	2	Risk of accidents	Economic and environmental impacts of a serious incident or accident	RI, FG, IF	10
	3	Crowds out other renewable investment, forestalling energy transitions (in France and beyond)	Future citizens will be locked into nuclear investments and denied benefits of clean energy	RI, FG	8
	4	Nuclear waste burdens	Future generations will face statistically higher risk of pollution due to growing amount of waste	RI, FG, IF	8
	5	Rising electricity costs due to rising nuclear costs	Future energy consumers will have to pay higher costs due to rising costs of nuclear (plus the costs of subsidizing renewables, which lag behind because of nuclear lock-in), complacency around electricity consumption	RI	6

Findings: summary of injustices (exhaustive "simple" list)

- Our evidence accumulates into 120 (inductively or analytically) distinct energy injustices
- Distributive injustices dominated (57), followed by recognition (32), cosmopolitan (18) and procedural (13)
- Injustices were more evenly distributed with smart meters (34 injustices) entailing the most, followed by nuclear power (31 injustices), electric vehicles (31), and solar PV (24 Injustices).





Sovacool, BK, A Hook, M Martiskainen, and LH Baker, "Decarbonisation and its discontents: A critical energy justice perspective on four low-carbon transitions," *Climatic Change* 155(4) (August, 2019), pp. 581–619.

E.g. of whole systems approaches

Spatial

Macro scale (global)	• Mineral extraction processes • Transportation of materials • Labor conditions • Global supply chains	• Rising energy demand • Impact on other countries' policies	• Rising global waste • Geopolitical issues
Meso scale (national)	• Increase in subsidies leading to raised taxes • Carbon footprint of installations • Diversion of funds from other sectors	• Inequality of benefits • Increased vulnerability and inequality	• Waste • Costs of disposal • Recycling of old materials
Micro scale (local)	• Disruption of ecosystems • Diversion of funds from other sectors • Loss of local jobs in old systems • Health risks to workers in factories	• Local pollution • Exposure to local risks • Urban-rural divide	• Legacy of local pollution
	Production/ distribution stage	**Consumption stage**	**Disposal/ recycling stage**

Temporal

Source: Sovacool, BK, A Hook, M Martiskainen, and LH Baker. "The whole systems energy injustice of four European low-carbon transitions," *Global Environmental Change* 58 (September, 2019), 101958, pp. 1-15.

Micro injustices

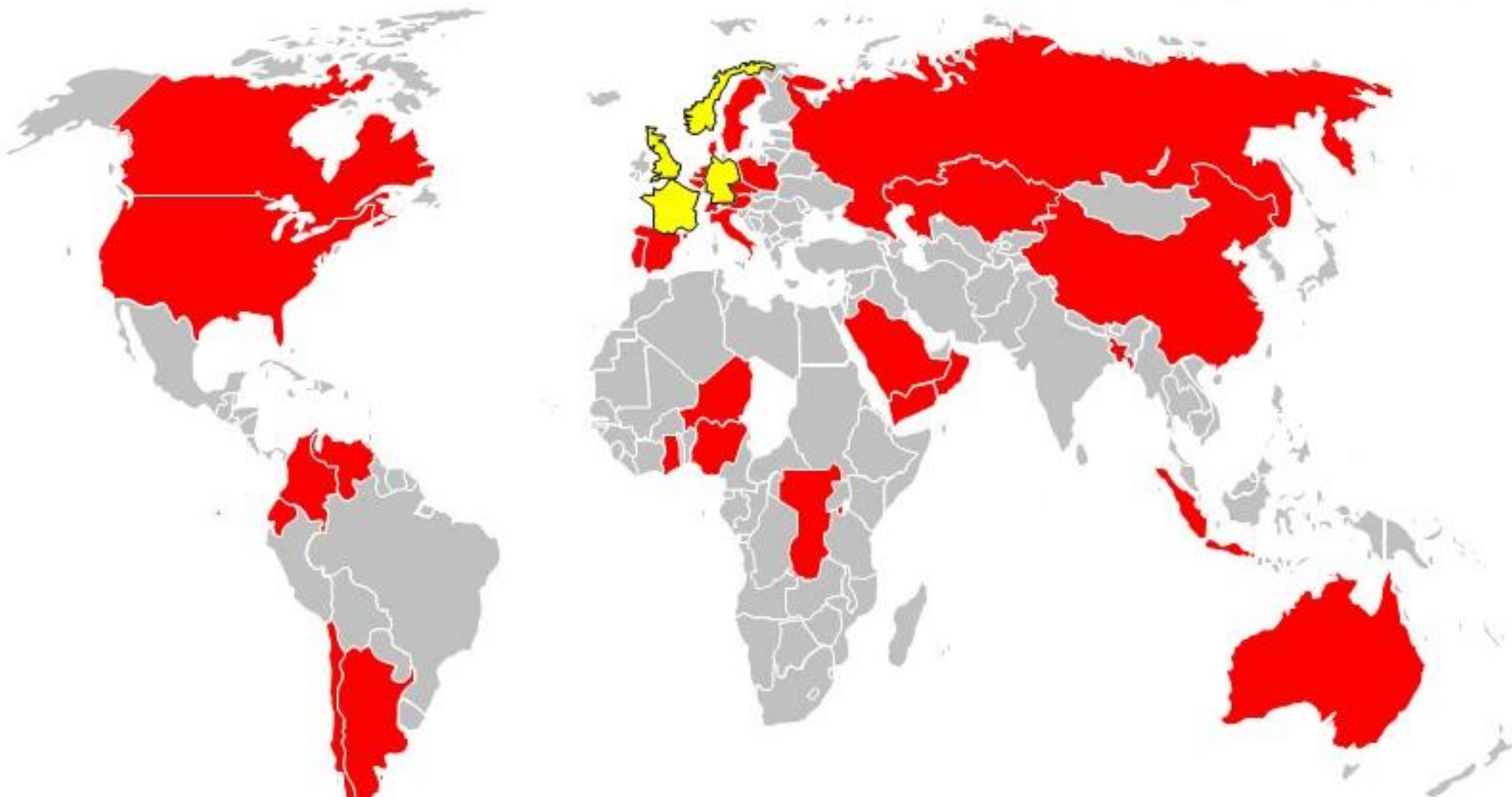
Local pollution and waste
Community health
Property prices
Unequal household benefits
Traffic congestion
Parking
Closure of local coal mines

Meso injustices

Nuclear accidents
Disruption of other national transitions
Higher national energy prices
Loss of national employment
Expansion of roads
Undermining utility business models
Bankruptcy of national firms

Macro injustices

Uranium mining and waste
Unsafe nuclear exports
Metal and mineral inputs
Flows of electronic waste
Exporting of dirty cars
Poor overseas labour conditions
Disruption of fossil fuel industry
Disruption of other transitions



Source: Sovacool, BK, A Hook, M Martiskainen, and LH Baker. "The whole systems energy injustice of four European low-carbon transitions," *Global Environmental Change* 58 (September, 2019), 101958, pp. 1-15.

Energy impacts often befall the *most* vulnerable groups

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- **E-waste workers connected to smart meters and EVs:** Sovacool, BK. "Toxic transitions in the lifecycle externalities of a digital society: The complex afterlives of electronic waste in Ghana," *Resources Policy* 64 (December, 2019), 101459, pp-1-21.
- **Mineral supply chains:** Sovacool, BK, SH Ali, M Bazilian, B Radley, B Nemery, J Okatz, and D Mulvaney. "Sustainable minerals and metals for a low-carbon future," *Science* 367 (6473) (January 3, 2020), pp. 30-33.
- **French wineries (and others):** Sovacool, BK, B Turnheim, A Hook, A Brock, and M Martiskainen. "Dispossessed by decarbonisation: Reducing vulnerability, injustice, and inequality in the lived experience of low-carbon pathways," *World Development* 131 (January, 2021), 105116, pp. 1-14.
- **Modern slaves:** Sovacool, BK. "When subterranean slavery supports sustainability? Power, patriarchy, and child labor in artisanal Congolese cobalt mining," *Extractive Industries & Society* 8(1) (March, 2021), pp. 271-293.
- **Women and children:** Sovacool, BK. "The precarious political economy of cobalt: Balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo," *Extractive Industries & Society* 6(3) (July, 2019), pp. 915-939.
- **Unions and workers:** Brock, A, BK Sovacool, and A Hook. "Volatile Photovoltaics: Green industrialization, sacrifice zones, and the political ecology of solar energy manufacturing in Germany," *Annals of the American Association of Geographers* (in press, 2021)

Energy impacts often befall the *most* vulnerable groups

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Review

Who are the victims of low-carbon transitions? Towards a political ecology of climate change mitigation

Benjamin K. Sovacool [a,b,*]

Abstract

This study critically examines 20 years of geography and political ecology literature on the energy justice implications of climate change mitigation. Grounded in an expert guided literature review of 198 studies and their corresponding 332 case studies, it assesses the linkages between low carbon transitions—including renewable electricity, biofuel, nuclear power, smart grids, electric vehicles, and land use management—with degradation, dispossession and destruction. It draws on a framework that envisions the political ecology of low-carbon transitions as consisting of four distinct processes: enclosure (capture of land or resources), exclusion (unfair planning), encroachment (destruction of the environment), or entrenchment (worsening of inequality or vulnerability). The study vigorously interrogates how these elements play out by country and across countries, by type of mitigation option, by type of victim or affected group, by process, and by severity, e.g. from modern slavery to organized crime, from violence, murder and torture to the exacerbation of child prostitution or the destruction of pristine ecosystems. It also closely examines the locations, disciplinary affiliations, methods and spatial units of analysis employed by this corpus of research, with clear and compelling insights for future work in the space of geography, climate change, and energy transitions. It suggest five critical avenues for future research: greater inclusivity and diversity, rigor and comparative analysis, focus on mundane technologies and non-Western case studies, multi-scalar analysis, and focus on policy and recommendations. At times, low-carbon transitions and climate action can promote squalor over sustainability and leave angry communities, disgruntled workers, scorned business partners, and degraded landscapes in their wake. Nevertheless, ample opportunities exist to make a future low-carbon world more pluralistic, democratic, and just.

Table 3
Vulnerable groups mentioned in academic research on political ecology and climate mitigation (n = 198 studies).

Vulnerable group	No. of articles	% of articles
Non-human species	153	77.3%
Local communities, host communities, adopters or households	152	76.8%
Farmers, agriculturalists, or pastoralists	74	37.4%
Rural poor	73	36.9%
Occupational workers, wage laborers, or their unions	72	36.4%
Indigenous/aboriginal groups, ethnic/racial minorities, or members of a lower caste	71	35.9%
Future generations (e.g., nuclear waste)	71	35.9%
Fishers and water resource users	51	25.8%
Environmental groups, civil society, wildlife reservists, land managers or nature conservationists	38	19.2%
Urban poor	36	18.2%
Women (including gender roles)	27	13.6%
Recreationists, campers, hikers, forest users	27	13.6%
Banks, financiers, investors (including fossil fuel incumbents)	27	13.6%
Elderly	13	6.6%
Students	13	6.6%
Disabled individuals	12	6.1%
Forced labor or modern slaves	10	5.1%
Coastal homeowners (e.g. offshore wind energy)	10	5.1%
Prostitutes	10	5.1%
Children or youth (including health impacts)	5	2.5%
Local businesses (including tourism)	5	2.5%
Refugees (including displaced persons and forced migrants)	3	1.5%
Alcoholics	3	1.5%
Affluent suburban homeowners	1	0.5%

Source: Author.

Table 4
Indigenous peoples and ethnic communities marginalized or displaced by climate mitigation efforts.

Reference(s)	Technology/ies	Particular group(s) negatively effected
Avila [98], Lawrence [124]	Wind energy	Sami herding community in Sweden
Avila [98]	Wind energy	Zapoteco and Huave coastal and agricultural communities in Mexico
Avila [98]	Wind energy	Traditional fisheries and pastoralists in India
Avila [98]	Wind energy	Adivasis forestland users in India
Avila [98], Rignall [125]	Wind energy, solar energy	Saharaui contested territories and other indigenous groups in Morocco
Avila [98]	Wind energy	Lenca communities in Honduras
Avila [98], Calzadilla and Mauger [92]	Wind energy	Turkana, Randile and Borana communities in Kenya, especially ranchers and cattle stewards
Avila [98]	Wind energy	Traditional fisheries in Brazil
Avila [98]	Wind energy	Quilombola communities in Brazil
Avila [98],Carruthers and Rodriguez [86], Gerber [88], Kelly [126], Sánchez De Jaegher [127]	Wind energy, hydropower, forestry, tree plantations	Mapuche communities and Mapuche-Williche indigenous leaders in Chile
Avila [98]	Wind energy	Wayuu communities in Colombia
Avila [98]	Wind energy	Koyna Sanctuary traditional pastoralists in India
Avila-Calero [128], Calzadilla and Mauger [92],Dunlap [129], Dunlap [130], Dunlap [131], Howe and Boyer [132], Siamanta and Dunlap [133], Sovacool et al. [17], Zárate-Toledo et al. [134]	Wind energy	Indigenous peoples of the Isthmus of Tehuantepec in Mexico
Barandiarán [135], Revette [136]	Electric vehicles, smart grids, renewable energy storage (lithium for batteries)	Indigenous communities living near lithium mines and salt flats in Bolivia's Uyuni
Barandiarán [135]	Electric vehicles, smart grids, renewable energy storage (lithium for batteries)	Indigenous communities living near lithium mines and salt flats in Chile's Atacama
Bednar et al. [137], Reames [138], Reames et al. [139]	Energy efficiency, heating, lighting	African Americans in urban Michigan
Bednar et al. [137], Reames [138]	Energy efficiency, heating	Hisdpanics in urban Michigan
Bonds and Downey [105], Sovacool and Bulan [84]	Biofuel (palm oil), hydropower	Erosion of land tenure of the Penan, Kayan, Kenyah, Kajang, and Ukit groups in Malaysia
Bonds and Downey [105],	Biofuel (palm oil)	5 million indigenous people displaced by palm oil development in Indonesia
Borras and Franco [83]	Climate smart agriculture	Indigenous peoples and ethnic minorities in Myanmar
Borras and Franco [83], Poffenberger [140]	Climate smart agriculture, forestry, land use	Indigenous peoples and forest dependent minorities in Cambodia
Borras et al. [141], Fortin and Richardson [142], Leach et al. [143], Lohmann [91]	Biofuel (ethanol), land use (biochar)	Dispossessed indigenous peoples in the Amazon
Brady and Monani [121], Mulvaney [144], Powell [145]	Wind energy, solar energy	American Indian tribal lands and Native American tribes
Brannstrom et al. [146]	Wind energy	Territories of indigenous peoples and traditional communities in Brazil
Cram [147],Cram [148]	Nuclear power (waste)	Yakama Nation, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation in the United States

Table 4 (*continued*)

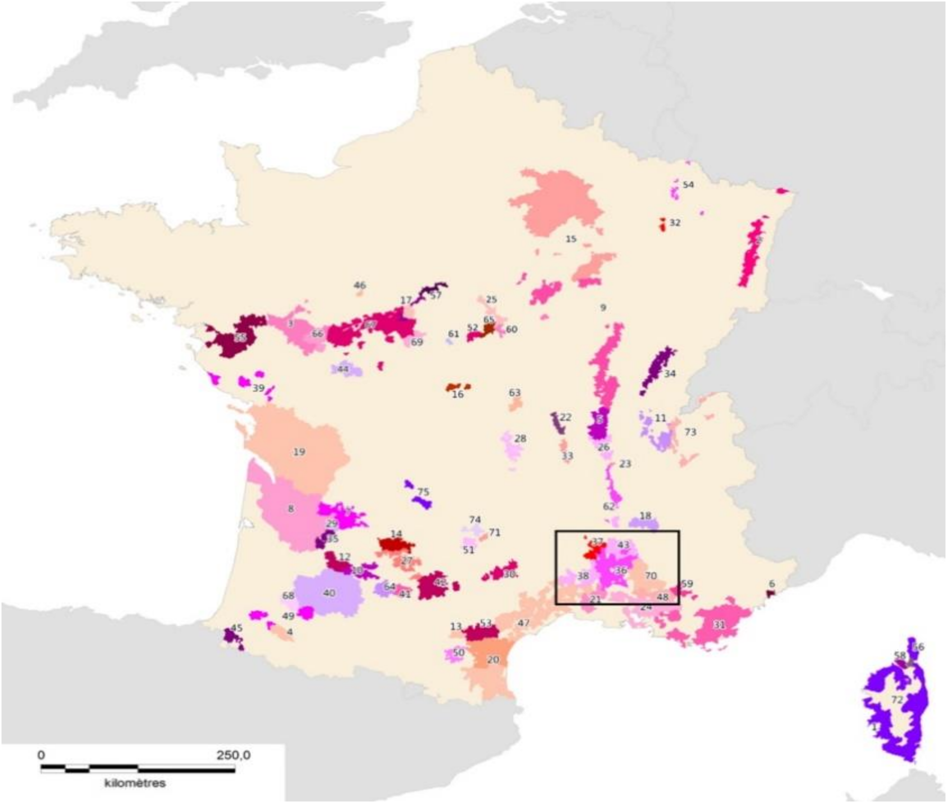
Reference(s)	Technology/ies	Particular group(s) negatively effected
Curley [149]	Wind energy, solar energy	Navajo Nation in the United States
Desbiens [150]	Hydropower	Crees Nation in Canada
Dolter and Boucher [151]	Solar energy	First Nations and Indigenous Peoples in Saskatchewan Canada
Dunlap [85], Dunlap [107], Dunlap [152], Pasqualetti [153], Sovacool et al. [30], Sovacool et al. [17]	Wind energy	Indigenous peoples of Juchitán de Zaragoza in Oaxaca Mexico
Dunlap [154], Dunlap [155]	Wind energy	Zapotec Indigenous community in Mexico
Fairhead et al. [80], German et al. [78], Leach et al. [143], Lohmann [91],Mirumachi et al. [26], Newell and Bumpus [156], Sikor and Lund [157], Stock and Birkenholtz [158]	Biofuel, climate smart agriculture, forestry, land use (biochar), carbon funds, solar energy (solar parks)	Global indigenous communities and ethnic groups affected by land grabbing or appropriation of resources
Finley-Brook and Thomas [159]	Hydropower	Naso and Ngobe indigenous territories in western Panama
Furnaro [160]	Renewable energy (broadly)	Indigenous communities in Chile
Gerber [88]	Bioenergy (tree plantations)	Dayak communities in Borneo
Gerber [88]	Bioenergy (tree plantations)	Tupinikim, Guarani and Pataxó communities in Brazil
Gerber [88]	Bioenergy (tree plantations)	Maisin communities in Papua New Guinea
Graetz [161], Marsh and Green [162]	Nuclear power (uranium mining, nuclear waste)	Aboriginal Australians and Torres Strait Islander "First Peoples" in Australia
Hommes et al. [163]	Hydropower	Ethnic minorities and indigenous peoples in Turkey
Islar et al. [164]	Solar energy, wind energy, hydropower	Dalits (often viewed as the lowest social caste) and indigenous people in Nepal
Martínez and Castillo [165]	Hydropower	Peasant, indigenous, and Afro-Colombian rural communities
Newell and Mulvaney [166]	Solar energy, wind energy, smart grids, electric vehicles	Trade unions and indigenous peoples movements
Richards and Lyons [167]	Bioenergy, land use, forestry (plantation forests)	Indigenous and subsistence farmers in Uganda
Scott and Smith [168]	Wind energy, solar energy	Six Nations communities in Canada
Siciliano et al. [108], Sovacool and Bulan [84]	Hydropower	Orang Ulu peoples and indigenous peoples from the upper Balui River, including some semi-nomads in Sarawak, Malaysia
Sovacool et al. [30]	Biofuel	Indigenous communities such as the Dene, Cree, and Metis in Canada

Table 4 (*continued*)

Reference(s)	Technology/ies	Particular group(s) negatively effected
Sovacool et al. [31]	Smart meters	Exclusion of rural and Scottish communities
Sovacool et al. [94]	Electric vehicles, solar energy, wind energy (waste streams)	Discrimination against ethnic groups and minorities in Ghana
Sovacool et al. [94]	Electric vehicles, smart grids, renewable energy storage (cobalt for batteries)	Discrimination against ethnic minorities in Democratic Republic of the Congo
Stock and Birkenholtz [158], Yenneti and Day [169], Yenneti and Day [170], Yenneti et al. [171]	Solar energy (solar parks)	Indigenous minorities or those of a lower caste in Gujarat India
Sunter et al. [172]	Solar energy (rooftop PV)	African Americans neighborhoods in the United States
Sunter et al. [172]	Solar energy (rooftop PV)	Hispanic neighborhoods in the United States
Temper [173]	Tree plantations (pine and eucalyptus), biofuel (sugarcane plantations)	Farmers and indigenous groups in Uganda
Temper [173]	Biofuel (Jatropha)	Indigenous groups and pastoralists in Ghana
Temper [173]	Biofuel (ethanol)	Indigenous groups and traditional communities in Senegal
Temper [173]	Biofuel, forestry, land use	Mukaya Diaspora in Juba in South Sudan
Temper [173]	Biofuel (ethanol)	Indigenous groups, traditional communities, and landless peasants in Mozambique
Temper [173]	Biofuel (palm oil)	Indigenous groups in southwest Cameroon
Temper [173]	Forestry, land use	Indigenous groups in Rio Negro Argentina
Temper [173]	Forestry, land use	Indigenous groups and communities in San Martin Peru
Velasco [174]	Hydropower	Emberá Katıo indigenous community
Walker et al. [175]	Hydropower	Munduruku people in the Tapajo's River Valley

French winegrowers and vineyards

- *"wine growers … whose vineyards were in the vicinity of plants were affected. In other areas … there is radioactive material in the water supply."*
- One winemaker: "*we made the mistake of believing that this cohabitation with nuclear energy would be profitable.*"
- 40% loss of sales after incidents in AOC Côteaux du Tricastin



Sovacool, BK, B Turnheim, A Hook, A Brock, and M Martiskainen. "Dispossessed by decarbonisation: Reducing vulnerability, injustice, and inequality in the lived experience of low-carbon pathways," *World Development* 131 (January, 2021), 105116, pp. 1-14.

Eastern German solar workers

Centre on Innovation and Energy Demand

- *“The real vulnerable group from the solar transition is not often talked about, namely 100,000 people who lost their jobs in the German solar sector over the past years. You have trade unions and government going, oh my goodness, we cannot shut down coal because of all the work and these regions. Yet Solar World and other big producers have shut down in the past years and they didn’t make a peep about those workers. Workers in the German renewable energy sector are a vulnerable population.*”
- One local mayor said, “*Berlin got the electricity, we got the ashes*”

Sovacool, BK, B Turnheim, A Hook, A Brock, and M Martiskainen. “Dispossessed by decarbonisation: Reducing vulnerability, injustice, and inequality in the lived experience of low-carbon pathways,” *World Development* 131 (January, 2021), 105116, pp. 1-14.

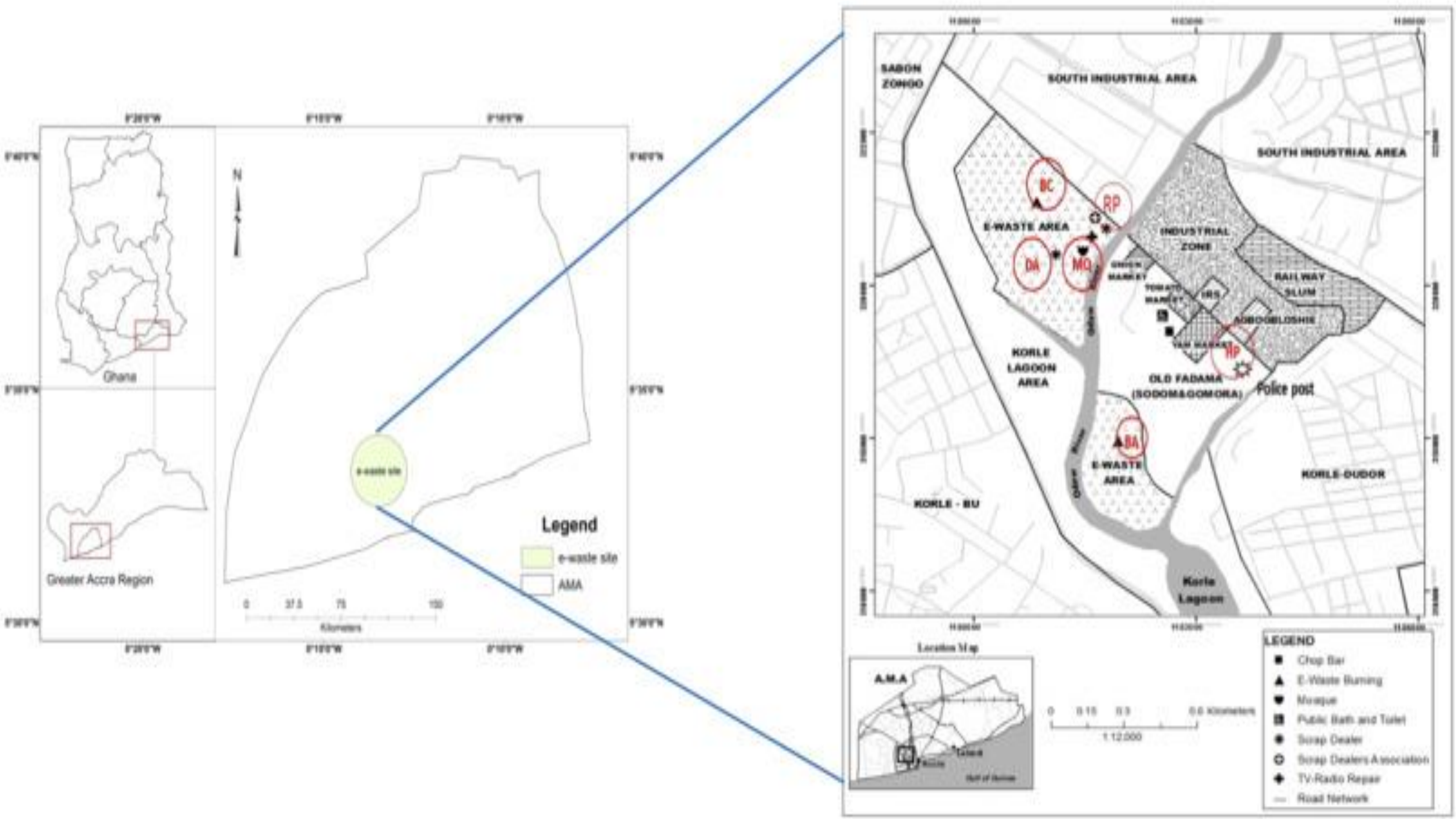

SOLIBRO


SAAL ANHALTINER
DÖNER


SUN PARK

E-waste scrapyard workers in Ghana

Centre on Innovation and Energy Demand



Source: Sovacool, BK. "Toxic transitions in the lifecycle externalities of a digital society: The complex afterlives of electronic waste in Ghana," *Resources Policy* 64 (December, 2019), 101459, pp-1-21.

E-waste scrapyard workers in Ghana

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"More than 100,000 people live here in abject poverty, home to the biggest dump for scrap metal and e-waste in the world. Young boys and girls, children as young as six, seven, and eight years old are engaged in this business. They miss school or end up dropping out of school, they go to the slum for a career, or they look for scrap to finance their own education. Even though they go to look for scrap metal, they end up doing it for the rest of their life. I know a story of a young boy, who was not wearing any protective clothing, who got so damaged by the hazardous material he died at the age of 12. Others see their life shortened by decades. They cough, get infected, and fall sick. They dedicate their youth to renting a wooden structure to sleep at night, 5-6 children in a shack, close to the metal business so they can work longer hours"

Source: Sovacool, BK. "Toxic transitions in the lifecycle externalities of a digital society: The complex afterlives of electronic waste in Ghana," *Resources Poli*cy 64 (December, 2019), 101459, pp-1-21.

Congolese cobalt miners

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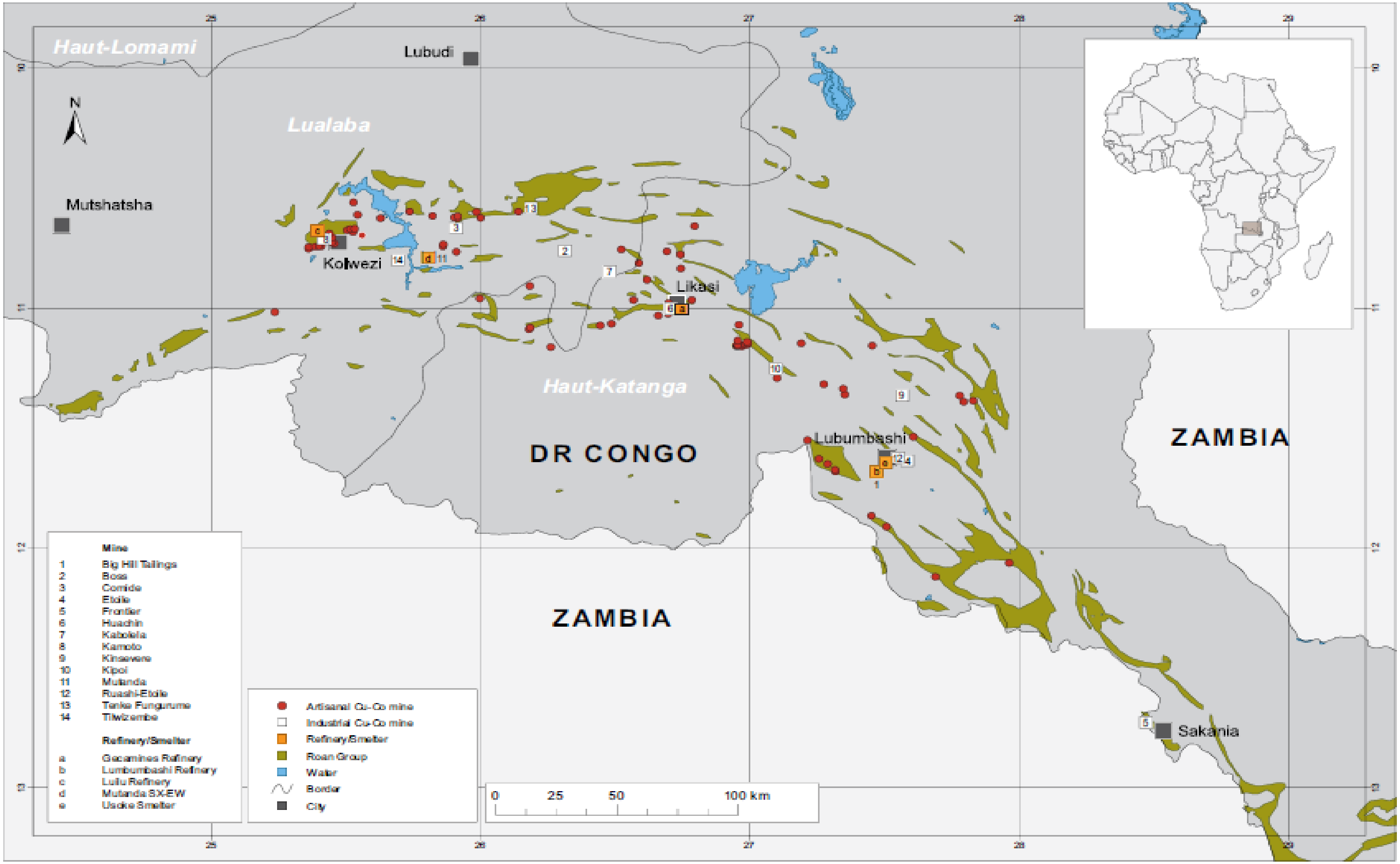

Source: Sovacool, BK. "The precarious political economy of cobalt: Balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo," *Extractive Industries & Society* 6(3) (July, 2019), pp. 915-939.

Congolese cobalt miners

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"ASM cobalt mining is not living, it's dying. The moment you step inside the mine, the clock starts ticking. You are exposed to dust which can lead to silicosis, or be poisoned by mercury. You can drown, or become trapped in a mine collapse. You can get crushed by rocks, or even contract diseases by people shitting or urinating into the mine. You can suffer diseases from sitting in water all day, such as cholera or malaria, or get bitten by animals, as many miners will bring them into the mine. This is especially the case when they remain underground in deep shafts for 5 or even 7 days at a time—it's an underground circus at that point, full of animal and human excrement, I've even heard of people contracting the plague in such conditions … Even if such things cannot kill you, they can still dismember or injure or disable you. I know of people who lose arms or legs in a collapse, they have to painfully break their bones to pull free. Many then bleed to death in the jungle.

Source: Sovacool, BK. "The precarious political economy of cobalt: Balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo," *Extractive Industries & Society* 6(3) (July, 2019), pp. 915-939.

Concluding thoughts and insights

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- The energy studies and energy economics communities may need more sophisticated research designs that are capable of understanding and capturing the non-environmental and non-economic aspects of low carbon innovation
- The complementarity or coupling of innovations (e.g., smart meters with solar PV, EVs with energy storage) suggests the need to move beyond analyzing individual technologies to entire systems
- Analysts and policymakers should look beyond carbon pricing, and exclusively economic or environmental benefits, instruments, and institutions

Concluding thoughts and insights

- Low-carbon transitions in Europe are not net beneficial for all, can result in toxic, exploitative, patriarchal, discriminatory, environmentally destructive and patently unjust implications for some
- Injustices were *not* just dominated by centralized supply (nuclear); we also see it with decentralized supply (solar) as well as end-use devices (smart meters, EVs, displays, batteries), some of which will ironically be used to help eradicate fuel poverty (!)
- Procedural injustices remind us that issues of fairness, transparency, and decision-making can stand apart from a technology or program

Concluding thoughts and insights

Centre on Innovation and Energy Demand

- Cosmopolitan concerns remind us that justice impacts are *multi-scalar* and do not occur only in Europe
  - Nuclear reactor designs being exported, cheap electricity trade, uranium mining, and nuclear waste
  - Low-wage manufacturing in China, factory waste streams for solar
  - Copper and cobalt (DRC), e-waste (Ghana) for smart meters
  - Extractive industries (cobalt, lithium) for EVs, e-waste, cheaper/dirtier cars flooding other markets
- Clean energy may be a human right, but securing it currently forces tradeoffs with other human rights, leading to *green on green* and *poor on poor conflict*
- We must avoid conceptual approaches or research designs that obscure or mask this emerging *decarbonisation divide*

Source: Sovacool, BK, A Hook, M Martiskainen, A Brock, and B Turnheim, “The decarbonisation divide: Contextualizing landscapes of low-carbon exploitation and toxicity in Africa,” *Global Environmental Change* 60 (January, 2020), 102028, pp. 1-19.

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