Technology Analysis & Strategic Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ctas20

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To cite this article: Mari Martiskainen , Benjamin K. Sovacool & Andrew Hook (2020): Temporality, consumption, and conflict: exploring user-based injustices in European low-carbon transitions, Technology Analysis & Strategic Management, DOI: 10.1080/09537325.2020.1841895

To link to this article: https://doi.org/10.1080/09537325.2020.1841895

Published online: 12 Nov 2020.

TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
https://doi.org/10.1080/09537325.2020.1841895

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Temporality, consumption, and conflict: exploring user-based injustices in European low-carbon transitions

Mari Martiskainen [a], Benjamin K. Sovacool[a,b] and Andrew Hook[c]

[a]Science Policy Research Unit (SPRU), School of Business, Management, and Economics, University of Sussex, Brighton, UK; [b]Center for Energy Technologies, Department of Business Development and Technology, Aarhus University, Aarhus, Denmark; [c]Department of Geography, School of Global Studies, University of Sussex, Brighton, UK

ABSTRACT
The urgency of climate change means that low-carbon transitions are needed in large socio-technical systems such as energy and transportation. These transitions must be rapid, but also fair. An emerging body of evidence suggests that users have important roles in transitions, yet much previous research has examined user involvement while assuming it to be largely a positive force. This goes against a growing amount of evidence within sociotechnical studies that highlight the potentially obstructive or negative role that users may play in transitions and innovation. In this study, we pose a critical question: In what ways may users perpetuate injustices within a transition? To answer this question, we provide conceptual background on energy justice and user adoption of low-carbon energy and mobility technologies. We then analyse users and energy injustices in three low-carbon transitions – solar energy in Germany, electric vehicles in Norway, and smart meters in Great Britain – based on empirical data from interviews, focus groups, and internet forums. Our main contribution is to show how users in low-carbon transitions are not always positively engaged, or even neutral, but can introduce and contribute to inequality and exclusion.

ARTICLE HISTORY
Received 12 November 2019
Revised 19 October 2020
Accepted 20 October 2020

KEYWORDS
Users; low-carbon innovation; sustainability transitions; energy justice

1. Introduction

The urgency of climate change requires changes in how socio-technical systems such as electricity supply and transportation are designed and utilized. Polluting fossil fuel-based systems are no longer environmentally or socially admirable, requiring low-carbon transitions that shift one socio-technical system to another, often over a considerable period of time (Geels et al. 2018). Low-carbon options used in such transitions increasingly include renewable energy such as solar photovoltaics (PVs) (IEA 2018a), and transport such as electric vehicles (EVs) (IEA 2018b).

There have been calls for research to consider two particular aspects of low-carbon transitions: (1) justice dimensions, so that benefits and costs are shared equally (Jenkins, Sovacool, and McCauley 2018; Williams and Doyon 2019); and (2) how users shape transitions (Schot, Kanger, and Verbong 2016). Previous studies analysing users in low-carbon transitions have largely highlighted the positive contributions users can have on innovation processes (Fursov, Thurner, and Nefedova 2017; Heiskanen and Matschoss 2016; Hyysalo, Juntunen, and Martiskainen 2018).

CONTACT Mari Martiskainen m.martiskainen@sussex.ac.uk Science Policy Research Unit (SPRU), School of Business, Management, and Economics, University of Sussex, Jubilee Building, Room 323, Falmer, East Sussex, BN1 9SL UK

However, there is growing evidence concerning the potentially obstructive impact that users may have in low-carbon transitions. This study utilizes an energy justice approach to the exploration of user involvement in low-carbon transitions, asking: In what ways may users perpetuate *injustices* within a low-carbon transition? We provide a conceptual background on energy justice and user involvement in low-carbon transitions, and then analyse users and energy injustice in three European low-carbon transitions based on empirical data. Our main contribution is to show how user involvement in low-carbon transitions may not always be positive, or even neutral, but can introduce injustices.

2. Conceptual framework: users and energy justice in low-carbon transitions

This research adds to literature examining the justice implications of low-carbon transitions. Such transitions entail changes in technologies, infrastructure, markets, business models, institutions and cultural discourses (Geels, Berkhout, and van Vuuren 2016), and at times user practices (Schot, Kanger, and Verbong 2016).

To date, limited attention has been paid to ethical aspects of low-carbon transitions (Köhler et al. 2019), with calls made for increased awareness of energy justice, which can help recognize who has a say, and who benefits or loses, and how, in low-carbon transitions (Jenkins, Sovacool, and McCauley 2018). This means developing low-carbon transitions through a due process (procedural justice); with no disproportionate impact on vulnerable groups, or causing new vulnerabilities (recognition justice); having equally shared costs and benefits (distributive justice); and being protected by moral principles (cosmopolitan justice) (McCauley et al. 2019). A 'just transition' (Newell and Mulvaney 2013) thus means addressing climate change *and* social inequalities.

Energy justice literature recognises that certain people will be, or may become, vulnerable in policy decisions (Sovacool and Dworkin 2015; Sovacool et al. 2017), though less attention has been paid to users perpetuating, or alleviating, injustices in low-carbon transitions. Focus has been more on the state or private sector, especially in the fossil fuel and nuclear sectors, generating injustices (Jenkins et al. 2016a) and community movements in alleviating them (Lacey-Barnacle and Bird 2018; Thombs 2019), but less at the individual user scale (Sovacool, Lipson, and Chard 2019c).

Users are nevertheless a core theme in the research on new innovations (Schot, Kanger, and Verbong 2016) – innovating, adopting and adapting new technologies, and playing a key role as user experience can determine the success or failure of new innovations (Rogers 1995). Users are now understood to be active players in socio-technical change, not just passive consumers (Köhler et al. 2019).

Previous transitions literature has largely explored user involvement as positive in innovation processes. Several user types have been identified (Bogers et al. 2010; Schot, Kanger, and Verbong 2016), building on von Hippel's (1986) lead users and early adopters, who are competent, solution-oriented, have access to vital resources in the innovation process (Hoogma and Schot 2001; Schweisfurth 2017) and realize their need for, and benefits of, new innovations before others (von Hippel 1986). Lead users are opinion leaders, relaying user experience to development processes, and to later adopters (Morrison, Roberts, and Midgley 2004). Similarly, 'user-legitimators' create expectations and narratives for new innovations (Schot, Kanger, and Verbong 2016), while 'user intermediaries' promote diffusion beyond early adopters and enthusiasts (Hyysalo, Juntunen, and Martiskainen 2018; Kivimaa et al. 2019). Studies have examined users for example aiding the diffusion of small-scale renewable energy technologies such as heat pumps, pellet systems, solar thermal (Heiskanen et al. 2014; Nygrén et al. 2015; Ornetzeder 2001) and community energy (Seyfang et al. 2014; de Vries, Boon, and Peine 2016).

Lead users, user-legitimators and user intermediaries are thus important innovation ambassadors, influencing other users, creating supportive narratives, and spreading the message to other actors (governments, firms and NGOs) (Schot, Kanger, and Verbong 2016). Users for instance played a key part in the US automobile transition (Kanger and Schot 2016),and have helped the EV transition (Kurani et al. 2018; Peters and Dütschke 2014), e-bikes and e-scooters (Seebauer 2015), and smart charging systems elsewhere (Schmalfuß et al. 2015).

We address a research gap and build on previous work examining the justice implications of low-carbon transitions, which has highlighted negative externalities and temporal aspects, and the need to examine users more carefully (Sovacool et al. 2019a). We aim to widen studies examining user involvement in low-carbon transitions, many of which have reflected a common normative stance that low-carbon technologies will inevitably generate fewer social 'bads' than fossil fuel-based energy systems. We thus make a contribution to a small, but emerging literature on low-carbon transitions showing that users *can* use innovations in ways that have social and environmental implications.

Users have, for example, been shown to use technology 'incorrectly' (Heiskanen et al. 2014) or resist it (Kline 2003). Previous research has analysed users' energy consuming behaviours and how they may act in contrary ways (such as saving money versus carbon) (Abrahamse et al. 2005; Gölz 2017; Wemyss et al. 2019). Users have chosen cooking devices that need poisonous heat sources such as solid fuels (Malakar, Greig, and van de Fliert 2018), used energy-efficient buildings inaccurately (Day and O'Brien 2017), and installed hybrid heating systems combining renewable energy technology with air-pollution linked fireplaces (Hyysalo, Juntunen, and Martiskainen 2018).

In our study, users refer to adopters, consumers, investors, and actors utilizing, deploying, or supporting a low-carbon technology. This includes for example EV drivers but also passengers and users of the electric mobility system, including automotive dealers and maintenance technicians. It also includes homeowners installing solar PV or smart meters, but also solar investors, planners, and repair firms, energy suppliers and network operators. This broad definition of users lines with recent research (Axsen and Sovacool 2019). Having highlighted the need to examine users in low-carbon transitions, we use the energy justice lens to question the notion that users of low-carbon technologies always have positive impacts.

3. Research design and limitations

Our research is based on an analysis of three European low-carbon transitions. Our case selection, data collection and data analysis are explained below.

3.1 Case selection

To examine specific low-carbon transitions, we selected three case studies: smart meters in Great Britain, EVs in Norway and solar PV in Germany. The cases were selected based on them being prominent examples of low-carbon transitions in terms of scale and diversity (detailed in Sovacool et al. 2019a, 2019b).

3.2 Data collection

We used mixed methods data collection to maximize validity and triangulation across interviews, focus groups, and internet forums (see Table 1), which are detailed below:

Table 1. Summary of data sources.

Country	Germany	Great Britain	Norway	Total N by type
Expert interviews (N)	16 (8 face-to-face, 8 phone); Interviewee reference = G00X	16 (9 face-to-face, 7 phone); Interviewee reference = GB00X	16 (12 face-to-face, 4 phone); Interviewee reference = N00X	48
Focus groups (N)	4*	2	6	12
Internet forums (N)	2	39	11	52
Total N by country	22	57	33	

Source: Authors.
*Two groups.

(1) *Expert interviews*. We conducted 48 qualitative, semi-structured expert interviews (see Table 1). Interviewees were emailed to arrange the interview, which was conducted either in person or over the phone/Skype. Interviewees received an Information Sheet and a Consent Form to sign, guaranteeing full anonymity and data protection. We cannot name interviewees to protect anonymity, but we interviewed representatives from academia, government, industry, and NGOs in all cases. Interviews lasted 30–90 min, were digitally recorded, and transcribed. Interview questions asked about the social/environmental benefits/advantages of the specific low-carbon transition in each case country; who benefits and how; what are social/environmental disadvantages; who loses and how; who are vulnerable in the transition, and to what extent; what/who may lose beyond Europe; what has the policymaking process been like and who has been involved; have there been examples where users may have caused in justices or made them worse; and what actions can be done to mitigate those injustices. We did not predefine 'users' or 'injustice' to avoid bias and give respondents full flexibility in their responses. Interviewees were given a unique identifier to protect anonymity (referred to in the text as GB00X in Great Britain, N00X in Norway and G00X in Germany).
(2) *Focus groups*. We conducted four public focus groups in Lewes (Great Britain), Freiburg (Germany), and Stavanger (Norway). The researchers advertised the focus group in Lewes and Stavanger a day before via a poster at the venue. This was not possible in Freiburg due to logistics, so the researchers approached passersby on the street. Participants were offered a light lunch in a café. The focus groups had a total of 12 participants including a mix of gender, ages and occupations. The discussions centred on the same questions as the interviews. Each lasted 90–120 min, were digitally recorded and transcribed.
(3) *Internet forums*. We also posted the following question on nine online internet forums (three in each country): 'What are the biggest positive or negative issues with electric vehicles in Norway/PVs in Germany/smart meters in GB, and how can these be addressed?'. Answers were collected three weeks after posting. This resulted in 52 responses, saved as data text files.

3.3 Data analysis

Data analysis was inductive and thematic, enabling the identification and analysis of data patterns (Braun and Clarke 2006; Thomas 2006; Schiavone, Tutore, and Cucari 2020). This meant having no predefined, or biased, proposition as to what energy injustices could be in the cases. Yet it allowed reflection on our theoretical energy justice framing. We developed a coding protocol guided by our interview questions, including questions on the energy justice implications of users in low-carbon transitions. Two researchers used NVivo software to code all transcripts. Our coding process was inductive and iterative, allowing the addition of new nodes as coding progressed (Thomas 2006). At first, we identified all answers that included injustices related to users. This resulted in 9 expert respondents in Germany, 14 in Norway and 12 in Great Britain highlighting injustices linked to users. We then cross-checked other transcripts, and all nodes, grouping them according to patterns of injustices. This resulted in three inductive core themes: (1) temporality of adoption benefits; (2) rebounds and increasing consumption; and (3) conflict between different user groups. We present and discuss these in Section 4.

3.4 Limitations

The study aim was to examine potential perceived injustices in the three cases. We did not aim to make a statistically representative or generalizable study, but instead set out to take first qualitative steps towards examining this topic. Our data collection process focused more on documenting perceived injustices, rather than determining causal links, or connections between the cases. Our interpretation of injustices draws across expert interviews, focus groups and internet forums. Finally, we treated respondents' perceptions of injustices as equally valid, even if they differed in their severity or scope. This was critical to meet the energy justice principle of 'recognition' and not exclude any particular viewpoints (Jenkins, Heffron, and McCauley 2016b; Sovacool et al. 2019a; 2019b).

4. Results and discussion: users and energy injustices of European low-carbon transitions

Our results showed three themes of users and energy injustices in the three low-carbon case studies: the temporality of adoption benefits; rebounds and increasing consumption; and conflict between different user groups. These are summarized in Table 2 and presented next.

4.1 The temporality of adoption benefits

The first dimension of injustice relates to temporality of benefits. Here, benefits are not distributed evenly across time, having tensions with principles such as equity and respect. Early adopters were mentioned as benefiting the most from the low-carbon innovations, especially when uptake was supported by financial benefits.

In Germany, the benefits for early adopters accrued to users who had the financial and physical capability to install solar PV early and benefit the most from the feed-in-tariff (FIT). Focus group respondents discussed how many early adopters were more motivated by generous financial incentives, rather than by environmental motives, contrary to the more idealized conceptions of low-carbon innovators as having 'green' aims (Caird, Roy, and Herring 2008). FIT guaranteed early adopters a high income for 20 years, paid for by everyone in society. G005 explained: 'What others perceive as unjust is with the early FITs which have been very very high and they are received for 20 years'. Some user groups have benefited in particular, including large landowners, as exampled by G005 of their strategies: 'For example in Southern parts of Germany farmers use rooftops on their fields a lot for solar PV, huge areas to get early access to a lot of support'. Similar findings by Bouzarovski and Simcock (2017) have highlighted the temporal energy justice aspects of energy transitions, with people in different locations benefitting unequally. G012 too highlighted the injustice of early adopters reaping high benefits, especially groups of investors (rather than single households). G015 added that even though solar PV costs had reduced considerably, not

Table 2. Qualitative summary of users and energy injustices.

Theme	Germany	GB	Norway	Energy justice principle
The temporality of adoption benefits	Users with financial capacity accessing early high FIT rates; users with land and capital installing large solar farms; everyone pays high electricity prices	Everyone subsidizes the rollout, even non-users who do not adopt a smart meter	Users with financial capacity to buy an EV access multiple early benefits; users who are able to buy multiple EVs and then sell them on due to long waiting lists	Recognition justice; Distributive justice
Rebounds and increasing consumption	Germany's overall emissions are not going down despite increase in solar PV	Users consume more energy as a result of having a smart meter; rebound effects; increased use of smart technologies	Users buying more cars in Norway; EV users possibly driving more; environmental impact from EV construction	Distributive justice; Cosmopolitan justice
Conflict between different user groups	Conflict between those who have the means to install solar PV and access high FIT payments and those who do not have the same opportunity	Conflict between household members; users monitoring each other; domestic decision making	Conflict between those who drive EVs and access all benefits and those who do not (public transport users, pedestrians, fossil fuel car users); people living in flats	Recognition justice; Cosmopolitan justice

Source: Authors

all could afford them, showing how non-users were paying for the benefits of early adopters but not being able to take part in the low-carbon transition themselves.

In Great Britain, the case for early adopters benefiting the most from smart meters is more complex. Approximately 17.14 million smart meters had been installed in Britain in March 2019 – but the government was committed to completing the roll out by 2020 so that each home and small business have a smart meter (BEIS 2019). Interviewees indicated that most engaged users may benefit the most, as outlined by GB003:

> Those who are engaged – who may be more educated – may disproportionately benefit from smart meters, leaving those unable/unwilling to engage with the interface with higher bills. Disadvantaged/ignorant customers will always subsidize more informed and engaged customers.

Projections of the smart meter program suggested that early users would benefit from more accurate billing, the avoidance of billing problems or needing meter readings, and the avoidance of debt accumulation through accurate information. The government initially estimated the total costs of the smart meter program to be £8-£11 billion, but with benefits estimated at £17.1 billion when monetizing savings to consumers and suppliers, and improved air quality (DECC 2014). GB006 pointed out, however, that users less engaged with the energy market could end up paying for those more engaged:

> because the costs of this program … are ultimately being divided out in a regressive way, which we know punishes people who do not engage with the energy market, who we know are some of the most vulnerable consumers … and citizens in society.

Interviewees also said that many users have resisted smart meters due to concerns about data privacy (GB003), installation process (GB011) or if 'things go wrong during installation' (GB014).

In Norway, users who adopted EVs early when incentives were first introduced in 1990s have benefited most from financial benefits, lower taxation, free charging, free parking, free toll roads, free ferries and the ability to drive on bus lanes – paid for by all tax payers. N015 said many thought that subsidizing expensive EV owners was unnecessary or unfair, adding: 'Because they are very heavily subsidized. There is no country in the world with so many Teslas as Norway. There is discussion … why this much public money or these subsidies are going towards fancy EVs'.

Some users have also sought to exploit the long EV waiting times. N001 explained: 'Some people have speculated ordering several EVs, just owning them for a short period and selling them, trying to make a profit on them. It is short of a speculation, it's hard to tell if this is an issue'. The benefits that EV early adopters were taking for granted, were nevertheless being discussed in Norwegian political circles, as N002 explained:

> To be just they should pay for the actual disadvantages that they create to the society, that's what taxes are supposed to cover but today they don't. I think everyone understands that this will be changing sometime. That has also been part of the political discussion in Norway that how long should we keep them [incentives] and how will they be cut off.

The Norwegian government is keeping the policy incentives at least until the end of 2,021 (Norsk elbilforening 2018b). Only a small minority of users benefited from the most generous incentives, supporting the use of expensive EV models such as Tesla. While cheaper models have entered the Norwegian EV market, the expected fall in future incentives means that early adopters have received the most benefits, paid for by all tax payers.

The benefits from all three transitions have not been shared equally (Jenkins et al. 2016a on distributive justice). Even though early adopters took on the most risk with new technology, they also often had the pre-existing resources (financial, land, educational) to benefit the most.

4.2 Rebounds and increasing consumption

Our second justice dimension focuses on externalities that users can create (McCauley et al. 2019; Mundaca, Busch, and Schwer 2018). Despite all our cases being leading examples of low-carbon transitions, respondents indicated that users could end up increasing resource and energy consumption.

In Germany, solar PV has been popular with a range of users but in ways that may increase electricity consumption. Of the 1.6 million installed solar PV plants, the majority has been by households and farmers who have become small-scale utilities, benefiting from the FIT (Fraunhofer 2018). However, the increase in solar PV has not necessarily equated to environmentally beneficial behaviour change, or lower overall emissions. Our German focus group participants mentioned examples where users had installed solar PV in order to benefit from the FIT, but were still enacting other high carbon behaviours such as driving large diesel cars. Expert G008 argued that the solar PV transition had had little effect on Germany's total emissions: 'at a macro level, German emissions have barely gone down and in fact in the electricity sector they budged a bit. Because we just keep producing more and more'. Germany's household related greenhouse gas emissions reduced 107 million tons in 2010–91 million tons in 2011 – the most active period for solar installations – but household emissions since 2014 have increased and were 92 million tons in 2017 (Clean Energy Wire 2018). Other studies on PV adopters for example in Switzerland similarly found that PV installation did not necessarily equal the desire to save energy (Bach, Hopkins, and Stephenson 2020).

In Great Britain, smart meters and associated in-home displays are intended to give better information on energy consumption so users can make better usage decisions. Some users may not, however, be motivated to save energy but may only care about convenience, as expert GB003 highlighted: 'some parts of the community couldn't care less about how much things cost because they're fairly comfortable and might not be motivated by the costs of energy' (GB003). GB008 pointed out that the 'rebound effect' (Chitnis et al. 2013), i.e. using money saved through energy efficiency measures in other areas of life which may increase total energy consumption, was an issue and could result in higher energy consumption: 'We saw minimal energy savings, mainly because households, when they did save energy, were then using that leeway to heat their homes'. Other studies providing feedback to users on their energy consumption have found that savings can be less than expected (see Gölz 2017).

GB001 said that smart meters could connect to other home appliances, potentially leading to an increase in high-tech equipment and subsequent energy demand. GB010, too, highlighted the potential unintended consequences from new services enabled by smart meters, such as household security: 'you can start to use appliances while people are away that start to replicate their normal patterns of use, which offers a nice service, but uses more energy'.

Lastly, in Norway, the high benefits given to EV owners have resulted in many users embedding automobility in their lifestyles, with EVs bought as additional cars, and leading in some cases for people driving more. N004 explained:

> That's the main sample, driving more, rather than taking the bus. Because these cars can use bus and taxi lanes, I know that some households have actually bought a second car to be able to use that, when they go to work etc. instead of waiting for the bus or the train, they can skip the queue.

A survey of EV buyers found that 2% of respondents had walked, 4% cycled and 10% used public transport as their main means of daily travel before switching to an EV as the main means of daily travel (Norsk elbilforening 2018a). N011 also mentioned that with EVs, it was difficult to maintain the message that less cars were better for climate:

> Many people buy it as a second car because there have been few models of EV that you could use for all your needs. We have had a really huge consensus around the zero growth in passenger cars so that makes it more difficult to give information on why this is important, when you have kind of solved the climate issue with an EV. The environmental argument for letting your car stand still is weakened. … The overall question about why you should not use your car is more difficult to communicate to people.

Thus, rebounds, increasing consumption, and increasing use underscore that users will not always consume or behave in positive ways regarding the use of low-carbon innovations. Instead, they may become accustomed to higher levels of comfort or convenience through purchasing resource-intense equipment such as EVs or high-tech appliances. Even energy saving measures can lead to rebound effects outweighing some benefits, and leading to negative externalities in low-carbon transitions (Mundaca, Busch, and Schwer 2018).

4.3 Conflict between different user groups

Our third dimension relates to conflict between user groups. These stem from perceptions of injustice related to equity (intergenerational) and due process (representative decision-making) (Jenkins, Heffron, and McCauley 2016b; McCauley et al. 2019).

In Germany, G007 indicated that injustices were emerging related to those users who could afford solar PV and those who could not: ‘If you have a neighbor who is involved and you hear about the benefits and costs and see you don’t have the money to invest you may be jealous!’ G008 pointed out a long-standing narrative of people on low incomes paying for the subsidies of wealthy solar users. This was centred on Freiburg, a town known for high renewable energy capacity. G008 added: ‘Freiburg is a town in South West Germany which is super super super rich and super into renewables, and sort of green conservative. And that’s why it became the dole recipient living in Hamburg versus the Freiburg solar dentist’. The potential conflicts related to users who can invest in solar PV were also mentioned by G005, who highlighted regional differences:

> Private small-scale PV, it’s mostly in the South, in the richer part of Germany, Bavarian and Baden-Württemberg. And in the North, for example going to Lausatia in the coal region, you have a lot of PV there, but then it’s more the large-scale installation, with big investments by companies and not by individuals.

Thus, the German solar transition has arguably accentuated how differently this sector emerged between different geographical regions (Bouzarovski and Simcock 2017), leading to potential conflict.

In Great Britain, GB007 mentioned potential disagreements between different smart meters users within homes: ‘It might have impacts on domestic decision making. … In-home displays have caused disagreements within households’. GB011 agreed that suddenly being aware of what energy everyone is using could generate conflict and monitoring of others’ use. GB0014 suggested that some users could associate smart meters with increased control:

> Being able to monitor the energy use of other people may be a negative as well as a positive. You wouldn’t want people to take too much control over other peoples’ lives! There is a bigger issue around smart appliances and smart living. That does need to be considered, so if somebody else can monitor what you’re doing. I don’t see how it could happen with smart meters, but I think it’s something people could associate with smart meters.

Previous research on smart homes has found that users adopting new, and potentially disruptive, technologies, can unsettle relationships (Hargreaves and Wilson 2017). One internet forum respondent too highlighted what many others touched upon: ‘Some people do not like smart meters because they rightly or wrongly assume that they can be spied upon’.

In Norway, EV users were considered disruptive for other motorists and public transport users. Examples included causing congestion in bus lanes, clogging up parking spaces in cities and potentially causing accidents. This had created resentment, particularly among public transport users and EV owners, which some also saw as a class issue: ‘With the toll road and low emissions policy, it is creating a class difference between people who can and can’t afford an EV for their family’ (focus group attendant). N004 explained road congestion problems:

> these cars can use bus and taxi lanes, some households have actually bought a second car to be able to use that, when they go to work etc. instead of waiting for the bus or the train, they can skip the queue.

N015 observed too that ‘In some areas … there are so many EVs that the buses have been delayed. So, the politicians have taken the EVs out of the bus lane, at least in rush hour’.

N007 explained that EVs have also sparked disagreements over who should pay for the infrastructure:

> If you live in an apartment with, say 50 others, who should pay for the charger, should we pay for it ourselves or shall other people, everyone living in that building pay for it. You can say maybe in ten years most people will

> have a benefit from this charger but you don't see it today. Or there can be some conflicts between people living in the same building, who should pay for it. Or should you use the money on other things.

In sum, each case has seen disagreements between different user groups,. This finding is directly linked to both recognition and distributive aspects of energy justice in terms of which users benefit, and how.

4.4 Synthesis and recommendations for research and policy

We next synthesize findings and make policy recommendations. Our findings across the three key themes and how they relate to the key principles of energy justice are summarized in Table 2 below.

From this summary, we focus on three points: type of early adopters, participatory processes and transition design.

First, users are having an increasingly impactful role in low-carbon transitions (Köhler et al. 2019). Previous research has found user-innovators to be on average younger, male, better educated and more digitally savvy (Fursov, Thurner, and Nefedova 2017). Early adopters meanwhile have been shown to be bold, willing to take risks (Lee et al. 2018), extroverted and keen on sharing information online (Lynn et al. 2017). In our cases, many of the early adopters were better educated (smart meter adopters in Great Britain), wealthier (wealthy German PV adopters, those in Norway who can buy second cars), strategic (German PV adopters) and engaged (smart meter adopters in Great Britain). Justice approaches require us to examine early users' impacts further, involving examining those who are 'carbon literate' (see Figure 1 for illustration), as well as those who are less so. This is especially relevant in low-carbon transitions, which can span over generations.

Second, the different types of user traits raises questions in regards to the development and design of transitions. The energy justice principles of recognition and procedure encourage us to examine who has a say and will be listened to when policies supporting transitions are developed (McCauley et al. 2016).

Third, there is a risk that without a balanced transition design, we will have a 'carbon literate' elite that benefits unequally from transitions, while the rest of society is left to rely on polluting technologies. With many people unable to take part and benefit for example from solar PVs in Germany, distributive energy justice thus requires us to ask who are set to benefit not only through policy design but perhaps also through certain personality traits or socio-demographics.

Based on our synthesis, we thus make the following recommendations for further research and policy:

- We encourage research into the personality traits and socio-demographics of users. This would include examining how for example a person's age, gender, education, ethnicity, income, class, digital literacy, low-carbon literacy and willingness to take risks, influence the adoption, and use, of low-carbon innovations. Such research ought to examine long-term social and environmental impacts, and impacts between different user groups.
- As for policy, we encourage user involvement in low-carbon transition policy design. Initiatives like the UK Climate Assembly[1] are examples of participative processes where a range of

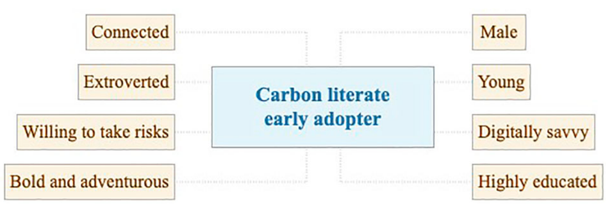

Figure 1. Illustrative – though but not exclusive – traits of the 'carbon literate' early adopter.

different people have a chance to get involved in, and be listened to. This could foresee, and minimize, potential future conflicts between different user groups.
- We recommend that low-carbon transitions policy design takes into account distributive aspects, so that some users do not benefit disproportionally at the expense of others. Here, previous experience from countries who have witnessed transitions, such as EVs in Norway, can help, as can research on the political economy of justice (Jenkins, Heffron, and McCauley 2016b).

Low-carbon transition policy design needs a holistic approach – one also cognizant of power imbalances and the chances for opportunistic cooptation.

5. Conclusion

A 'just' low-carbon transitions aim to ensure that such transitions are designed and delivered in an equitable and transparent way. Our research, examining users and potential energy injustices of low-carbon transitions, shows several perceived injustices linked to users – either intentionally or unintentionally.

Our results show that injustices within low-carbon transitions can emerge in terms of which users benefit and when, raising questions over affordability and intergenerational equity. Wealthy early adopters of EVs and PV benefited the most in Norway and Germany regarding fiscal incentives respectively. A key driver for low-carbon transitions is the move to limit emissions. Smart meters in Great Britain are being rolled out with an objective that more awareness of energy consumption will hopefully reduce that consumption. However, our results show that such technologies have the potential to increase energy demand through rebounds and other linked smart technology.

We thus need a more nuanced stance on early adopters, and other users, in low-carbon transitions, and how potential injustices can be balanced with the need to incentivize early adopters. This could influence public support for future low-carbon transitions, if for example those with sufficient resources to acquire new innovations such as expensive EVs are given financial benefits subsidized by everyone. Our results also show that unequal benefits between different users could cause conflict, especially if one group exploits the benefits of a system. New technologies linked to smart meters, for example, could enable services such as home security systems, potentially increasing conflict between different users over surveillance. This can have added implications on how well users can legitimize new innovations.

Users can perpetuate injustices as they seek to serve their own interests, even though they perhaps mitigate climate change in the process. Furthermore, just because some users have the ability to uptake new low-carbon innovations, they may not necessarily use those innovations to their best intentions. We require an urgent low-carbon transition, but our findings show that we must examine the impact of users further. Here, low-carbon transition policy design could benefit from energy justice principles, recognizing what types of users could have what potential impacts across a low-carbon transition. Energy justice scholars, in turn, should recognize that user empowerment may not always go hand in hand with social justice priorities.

Note

1. The Climate Assembly UK brought together over 100 people from diverse groups over 6 weeks in 2020 to discuss, and make recommendations, on the UK's transition to Net Zero. https://www.climateassembly.uk/

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the European Union's Horizon 2020 Framework Programme research and innovation programme under grant agreement No 730403 'Innovation pathways, strategies and policies for the Low-Carbon Transition in Europe (INNOPATHS)'. The content of this deliverable does not reflect the official opinion of the European Union. Responsibility for the information and views expressed herein lies entirely with the author(s).

Notes on contributors

Dr. Mari Martiskainen is a Senior Research Fellow at the University of Sussex.

Dr. Benjamin K. Sovacool is a Professor of Energy Policy at the University of Sussex.

Dr. Andrew Hook is a Lecturer at the University of Sussex.

ORCID

Mari Martiskainen http://orcid.org/0000-0002-3503-9197

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