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Renewable energy:
A Social Sciences and Humanities annotated bibliography

Energy-SHIFTS
ENERGY SOCIAL SCIENCES & HUMANITIES INNOVATION FORUM TARGETING THE SET-PLAN

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Executive summary

Background

This annotated bibliography evolved as one outcome of the European Commission (EC) funded project *Energy Social Science and Humanities Innovation Forum Targeting the SET-Plan* (Energy-SHIFTS), which contributes to the European Energy Union by further developing Europe's leadership in applying energy-related research and knowledge from the Social Sciences and Humanities (Energy-SSH). The bibliography provides context to the findings from the extensive Horizon Scan exercise, which resulted in the '100 priority SSH research questions on Renewable Energy' reported earlier[1].

The aim

This report provides annotations to 26 key publications from SSH research on renewable energy deployment to provide a backdrop to the 100 priority SSH research questions in the Horizon Scanning report. With this annotated bibliography, we aim at informing policymakers and other non-experts on the breadth of energy-SSH knowledge that characterises the richness of the research field today.

The approach

We present a selection of peer-reviewed scientific publications that contextualises the research priority questions identified in the Horizon Scan. Expert recommendations on the key literatures and further sampling of relevant scientific publications led to a literature sample from which the final collection was then selected. The set of presented literatures follows the idea to feature the diversity of research themes and the plurality of perspectives in the energy-SSH field.

The findings

SSH research on renewable energy has seen different key themes such as social acceptance or the governance of energy transitions over the last decades. It has more recently engaged with new research strands such as energy (in)justice and power or renewable energy citizenship from diverse disciplinary perspectives. Overall, research on renewable energy emerged with a focus on techno-economic feasibility studies. The scientific literature illustrates a shift to coupled, socio-technical and socio-ecological perspectives with more academic responses evolving to questions of energy justice and power dynamics, of novel policy mixes, of cross-sector governance and to novel institutional alternatives for renewables. SSH research contributions to the study of energy system change have diversified and enriched the field, offering important theoretical and empirical work and providing the cross-disciplinary knowledge needed for transitions to renewables-based energy systems.

1 Available at: https://energy-shifts.eu/wp-content/uploads/2020/12/D2.3_WG1_renewables.pdf

Contents

1. Introduction

1.1. Background: Energy-SSH and the Energy-SHIFTS project

This annotated bibliography was compiled as one outcome of the *Energy Social Science and Humanities Innovation Forum Targeting the SET-Plan* (Energy-SHIFTS)[2]. Energy-SHIFTS has worked to support the EU Energy Union by developing Europe's leadership in energy-related Social Sciences and Humanities (energy-SSH) research. The growing field of Energy-SSH has remained marginal in terms of funding and policy impact, giving way to energy research interests dominated by the natural and technical sciences (Øverland and Sovacool, 2020; Robison and Foulds, 2019; Foulds and Christensen, 2016). However, the European Commission (EC) has expressed a commitment to mainstream SSH research and innovation activities, including supporting standalone energy-SSH projects. The Energy-SHIFTS project aims to strengthen energy-SSH for European research and innovation, as well as to strengthen its relevance to EU's energy policy.

Energy-SHIFTS has contributed cutting-edge research priorities from energy-SSH research communities, which can guide and anchor EU research and innovation funding for SSH research and bridge the current science-policy gap. Through the Horizon Scanning exercise, four Europe-wide working groups identified each a set of 100 priority SSH research questions on key topics within the EU Energy Union and EC research and innovation funding priorities: (1) Renewable energy (von Wirth et al., 2020), (2) Smart consumption (Robinson et al., 2020), (3) Energy efficiency (Foulds et al., 2020), and (4) Transport and mobility (Ryghaug et al., 2020). Four annotated bibliographies serve as companion pieces to these four Horizon Scan reports.

2 For more information, please visit the official project website: https://energy-shifts.eu/

1.2. Aims of the Annotated Bibliographies

This annotated bibliography aims to provide a contextual backdrop and a sense of the evolution and state of the academic research on SSH research on renewable energy. It is supposed to be read alongside the 100 priority SSH research questions presented in the Horizon Scanning report on renewable energy. An annotated bibliography is a compilation of references to scientific articles and book chapters followed by short descriptions of their content and key arguments. This report provides annotations to 26 key publications in SSH research on renewable energy. Similar to the four Horizon scan reports, this is one of four bibliographies, alongside smart consumption, energy efficiency, as well as transport and mobility. These are intended to give policymakers and other non-experts insight into the breadth of energy-SSH knowledge and approaches, which characterise the field today. They portray the main advances in energy-SSH fields and, as such, offer context for the forward-looking priority SSH research questions.

The annotated bibliographies offer a taste of the main SSH debates, milestones, and advances in the field through a summary of key scholarly contributions, without claiming to provide full coverage of the field. The ambition is to demonstrate the range and variation of energy-SSH research, incorporating different and sometimes contradictory disciplinary perspectives, research themes and approaches. The bibliographies can give policymakers and other non-experts insights to help navigate the SSH field of renewable energy.

1.3. The topic of this bibliography: Renewable Energy

This annotated bibliography focuses on SSH research on Renewable Energy. Decarbonizing energy systems is a key priority in EC research and innovation funding

and critical to achieving the EU's aim of carbon-neutrality by 2050. The Energy-SHIFTS Working Group on Renewables has framed the SSH research purpose as "*contributing to a better understanding of just transitions to renewables-based energy systems, by recognising the social conditions and consequences of using and further implementing renewable energy technologies*" (von Wirth et al., 2020, p.7). While research on renewable energy has been conducted in Europe for several decades, the contribution of SSH disciplines remained marginal for long. Yet, diverse research has indicated that in order to realise a future energy system that is low carbon, just, and reliable will require a more intense and meaningful collaboration between the physical sciences and the SSH (Sovacool et al., 2015).

The Horizon scan exercise to identify priority research questions for renewable energy SSH research resulted in eleven themes: (1) Transformative governance, (2) Culture, imaginaries, narratives, (3) Social acceptance, (4) Energy democracy, (5) Energy Justice, (6) Financial and organisational structures, (7) Socio-ecological effects, (8) Renewables Policies, (9) Renewables System Design and integration across sectors, (10) Geography of renewables, and (11) Power dynamics and conflicts. While the identified research questions in these themes highlight pressing topics and perspectives, we highlight that the field is much broader, encompassing topics that resist immediate categorisation. In this annotated bibliography, we therefore aim to present a broader view of what constitutes SSH scholarship on renewable energy, which does not always relate to "*energy system transitions*". Nevertheless, the presented key pieces are relevant stepping stones and serve hopefully as sources of inspiration for stimulating new research topics, interests, perspectives, and debates.

1.4. Procedure for selecting key pieces of literature

Twenty-six publications were selected based on their relevance to address the research priority questions in the Horizon Scan. This selection includes peer-reviewed scientific publications, review articles, and monographs. The selection process was guided by the principles of diversity (of research themes) and plurality (of disciplinary perspectives) in order to highlight the breadth and richness of the energy-SSH field.

Publications were collected by conducting ten expert interviews with an interdisciplinary cross-section of leading experts and frontrunners in the research field (all working group members). The interviews were conducted between January and March 2020, during the initial stages of the Horizon Scanning process. Each interviewee was asked to recommend at least five publications they considered seminal for the development and the current state of the field. From this sample, a selection of publications were included into the annotated bibliography based on criteria such as: number of citations, perceived impact within the field, and contribution to new research avenues, thematic shifts and emerging key discourses within the field. Decisions were made by members of the Steering Committee of the working group on Renewable Energy. Some publications suggested by interviewees were excluded due to their lack of focus on SSH research, or due to being situated out of scope with respect to our definition of renewable energy. The authors then identified additional gaps based on the interviewees' descriptions of the field and key research themes that emerged during the Horizon Scan. Hence, additional publications were sourced from the Horizon Scanning survey responses[3].

1.5. How to use the Annotated Bibliographies

The annotations are short summaries of the original source material and provide a taste of each scientific contribution. We hope readers become inspired to seek out the full publications on their topics of interest. This collection does not claim to be comprehensive. In addition, we acknowledge that there cannot be a single, all-encompassing set of key literatures that all SSH communities would agree upon. Given the limited selection of publications, readers may also use the list as a tool to seek out additional or more specific literature on the research field. The bibliography may, for instance, be read prior to viewing the 100 priority SSH research questions in the Horizon Scan report, or as an independent source of information.

Readers may also be interested in studying the annotated bibliographies from the *Social Sciences and Humanities for Advancing Policy in European Energy* (SHAPE-Energy) project which was the predecessor to Energy-SHIFTS and offers more systematic reviews of the given fields[4].

3 For more information on the expert interviews and annotated bibliographies, please read the methodological guidelines (Foulds et al., 2019).

4 Can be downloaded here: https://shapeenergy.eu/index.php/publications/annotated-bibliographies/

2. Key literature in the field of SSH research on renewable energy

In the following sections we present summaries for the identified key literatures illustrating relevant SSH research on renewable energy. We have structured the literature into seven themes, which reflect the evolution and current state of the SSH research field on renewables. The field has shifted from a focus on economic feasibility studies and early work on social acceptance of infrastructures to a more comprehensive and diverse understanding of energy system transitions, including aspects of energy justice and power, energy system imaginaries and visions, community energy and energy citizenship as well as aspects of policy mixes for renewables' deployment and energy citizenship.

Given the still marginalised role of SSH research on renewable energy compared to the natural and engineering sciences, complementing energy system modeling with SSH perspectives receives increasing attention and is addressed as a separate theme here as well.

2.1. Overviews of SSH energy research

There has been an increase in SSH contributions to studying renewable energy over the last years. While the starting point was a reflection on the rationale using the perspectives and analytical methods offered by SSH, the further development of energy-SSH research led to identifying the dynamics of energy transitions as a non-linear, long-term and complex socio-technical process with its inherent challenges. The energy-SSH community has started a reflection about capacities and provided already first attempts of overviewing the field and proposing future research agendas, which is reflected in the below listed review studies of energy transitions in general and renewable energy deployment in particular.

Sovacool, B.K., 2014. What Are We Doing Here? Analyzing Fifteen Years of Energy Scholarship and Proposing a Social Science Research Agenda. *Energy Research & Social Science*, 1, pp.1–29.

This is a relevant review article that offers a retrospective analysis of Social science research in energy studies in general. The author provides both quantitative and qualitative analyses of 15 years of energy scholarship including a content analysis of several thousand research articles that were published in the three leading energy journals between 1999 and 2013. The authors demonstrate that only 19.6 percent of authors reported training in a social science discipline, and less than 0.3 percent of authors had disciplinary affiliations in areas such as History, Psychology, Anthropology, or Communication studies. Hence, this article provides thorough evidence that SSH scholarship is still underrepresented and marginal in energy research over the studied period. The author concludes with presenting methodological and topical areas for future research, in order to deepen and broaden social science energy research.

Gross, M. and Mautz, R., 2015. Renewable Energies (Key Ideas). Milton Park, Routledge.

This concise book was designed to provide a better framing of contemporary theories of energy transformation, including challenges of transitioning from centralised to decentralised systems, the relationships between renewable energy technologies and the patterns of using them, as well as addressing risks and conflicts and the strategies of coping with them. It uses a sociological lens to explain different configurations of actors, technologies and cultural contexts. The authors discuss the notion of energetic foundations of sociology and then reflect on how renewables are being integrated into existing electricity systems. In conclusion, the authors underline the uniqueness of ongoing energy transition processes, which in contrast to other sectors are not just adding the new energy

sources to existing systems, but instead, have to focus more than ever on exuviating existing forms of energy production and consumption in order to amplify the transformation.

Markard, J., 2018. The next phase of the energy transition and its implications for research and policy. *Nature Energy*, 3(8), pp.628-633.

This article is relevant in providing a concise analysis of the emerging dynamics in energy transitions. In many places, the electricity sector is continuing to accelerate a transition towards larger shares of renewable energy technologies. During early phases of such transitions, a key concern for researchers and policymaker was the establishment of renewables as technically and economically feasible and reliable alternatives. The author then highlights the changing situation today: renewables are adopted rapidly in electricity grids, generating significant changes for established technologies, organisations and infrastructures in current energy systems. In this new phase of the energy transition, qualitatively new phenomena can be observed and need to be addressed by research and policy. According to the author, these are: the complex interactions of different energy technologies, the decline of established business models and technologies, intensified economic and political struggles among the key actors (e.g. utility companies, industry associations), and further challenges for the overall performance of the electricity sector (e.g. the integration capacities for renewables).

Hirsh, R. F., & Jones, C. F. (2014). History's contributions to energy research and policy. *Energy Research & Social Science*, 1, 106-111.

The authors argue for the relevance of historical research for assisting research and policy in analysing contemporary energy systems or designing energy policies. It is suggested that the value of history for energy research stems from offering insight into often-overlooked considerations among practitioners who propose and adopt energy policies. Such considerations may include social and political impediments that designers of new energy technologies often cannot imagine or may manifest in long-standing, yet difficult-to-articulate resistances among established stakeholders who oppose implementation of novel energy plans. The authors ask for caution as history does not directly repeat itself or allows for future prediction. With presenting several case studies, this article highlights historians' efforts to identify the essential role of social and cultural considerations in co-shaping the successes and failures of dominating practices in energy systems. In essence, energy researchers and policy makers can learn much from history about the links between energy, culture, and society as well as the need to reevaluate the traditional notion of energy transitions.

Jacobsson, S. and Bergek, A., 2004. Transforming the energy sector: the evolution of technological systems in renewable energy technology. *Industrial and corporate change*, 13(5), pp.815-849.

With this paper, the authors present an analysis of the development and diffusion of technologies that utilize renewable energy sources in Germany, Sweden and the Netherlands. This analysis enlarges the life cycle model of industry evolution towards a model, where the focus is on the formation and evolution of new technological systems. The particular focus in this work is on explaining success and failures in shifting from a formative phase into one characterised by positive feedbacks. A set of challenges is identified for policy makers (e.g. the challenge to implement powerful, predictable and persistent pricing policies to generate favourable conditions for investing in renewables as well as the challenge to design these pricing policies in a technology specific way), attempting to influence the process of transforming the energy sector further into renewables-based systems.

2.2. The social acceptance of renewable energy deployment

The public perception of renewable energy infrastructures and their social acceptance remains a controversial challenge for research, industry and policy (de Geus et al., 2020). Over more than 30 years, SSH studies have provided better insight into the phenomena of acceptance and acceptability of deploying diverse energy technologies in society. In consequence, a significant shift in the understanding of social acceptance of renewables can be observed: evolving from an instrumental approach considering the (lack of) social acceptance in terms of an investment risk and as a barrier to participatory approaches, towards deliberative energy governance guiding the inclusion of diverse stakeholders and communities as a key ingredient for energy transitions to move forward. The discourse around Social acceptance of renewable energy has seen a reevaluation of the 'Not-In-My-Backyard (NIMBY) phenomenon' to overcome simplistic assumptions discrediting local stakeholder positions as

being in resistance or opposition against installations of renewable energy innovations. Instead, SSH research contributed to better recognising the factors shaping local and national responses to energy infrastructures and has offered a more nuanced understanding of contextualised processes laying behind (the lack of) social acceptance of renewable energy deployment.

Wüstenhagen, R., Wolsink, M. and Bürer, M.J., 2007. Social acceptance of renewable energy innovation: An introduction to the concept. *Energy policy*, 35(5), pp.2683-2691.

This paper provides a conceptual introduction to social acceptance of renewable energy innovation. It is one of the first and seminal overview articles unpacking the dimensions and characteristics of social acceptance of renewable energy. With ambitious government targets to increase the share of renewable energy in many countries, it is increasingly recognised that social acceptance may be a constraining factor in achieving this target. This is particularly apparent in the case of wind energy, which has become a subject of contested debates in several countries largely due to its visual impact on landscapes. The paper introduces three dimensions of social acceptance, namely socio-political, community and market acceptance. The article outlined opportunities for further research on social acceptance of renewable energy.

Devine-Wright, P., 2005. Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. *Wind Energy: An International Journal for Progress and Applications in Wind Power Conversion Technology*, 8(2), pp.125-139.

This paper is devoted to public perception of wind technology. This work makes a relevant contribution to the field by critically reflecting on the 'Not in my backyard' (NIMBY) phenomenon, which refers to peoples' resistance to development if it happens proximate to people's (residential) location. Devine-Wright in this work highlights the shortcomings and limitations of the concept, and instead offers a multidimensional framework that integrates previous research findings on social acceptance with theory from social and environmental psychology. Based on existing empirical research, the author discusses several factors shaping the public acceptance for wind technologies' implementation, which entails physical, contextual, political, socio-economic, social, local and personal aspects. With this integrated perspective, the article broadens the previous narrow NIMBY understanding of social acceptance. This allows for critical reflection of the complex and multidimensional dynamics shaping public perception of renewable energy implementations.

Batel, S., 2020. Research on the social acceptance of renewable energy technologies: Past, present and future. *Energy Research & Social Science*, 68,101544.

With this article, the purpose of social acceptance research on renewable energy is presented as a relevant way forward to anticipate and create more just, democratic and sustainable energy systems and societies. The paper offers an overview on the research conducted on the social acceptance of renewable energy technologies over the last 30 years. It describes how the conceptual ideas and the research have emerged and changed over time. For example, the author presents three waves of research on the social acceptance of renewable energy technologies (RET): the social side of RET with normative approaches during the 1990's; the social acceptance of RET with criticism approaches from 200 onward; and the people's responses to RET with critical approaches from 2010 onward. The author comments and differentiates the current state of research and identifies directions for future research.

Cuppen, E., 2018. The value of social conflicts. Critiquing invited participation in energy projects. *Energy Research & Social Science*, 38, pp. 28-32.

Invited participation is a popular approach in recent work on energy governance that aims to achieve more fairness in participatory planning processes and claims to help build public acceptance. This paper proposes a critical consideration of this approach taking into account the possible constructive role that social conflicts can play in energy policy and planning. It defines social conflicts as self-organised participation and rises attention to its value. The author discusses two basic characteristics of conflict and shows limitations of the invited participation approach. Among these limitations is the fact that social conflict emerges to challenge existing rules and practices in the energy system, while at the same time invited participation is often initiated by governments, companies and other actors that are entangled with incumbent institutions being challenged. Secondly, social conflict is a dynamic phenomenon which often faces the emergence of diverse values and novel actor groups over time. Tools for invited participation reveal limitations as they tend to neglect these notions of emergent values and groups. In essence, this article offers a novel perspective on conceptualising conflict and participation in the debate about social acceptance of renewable energy technologies.

2.3. Frameworks and models of energy system transformations

When addressing energy system transformations, scholars but also diverse other stakeholders from the energy sector (e.g. energy utilities, grid operators, energy cooperatives) construct and use mental tools and assumptions (i.e. models and frameworks about how energy systems function) as a prerequisite of their actions. These models and frameworks also co-determine policymaking in the energy sector and hence, are most consequential for the transformation of the sector. SSH research proves that including social, ecological and systemic elements in these models and frameworks is indispensable for successful transformations. The scientific literature included in this section provides guidance and examples of successful implementations of more comprehensive models and frameworks, especially on meso (policy) and macro (country) level.

Trutnevyte E., Hirt F.L., Bauer N., Cherp A., Hawkes A., Edelenbosch O.Y., Pedde S. and van Vuuren D. P., 2019. Societal transformations in models for energy and climate policy: The ambitious next step. *One Earth*, 1(4), pp. 423-433.

This article provides a key contribution for involving societal aspects into energy and climate policy modeling. Questions on how long-term energy and climate targets can be reached depend on diverse interlinked factors: technology, economy, environment, policy, and society at large. The article argues that integrated assessment models of climate change or energy-system models have so far limited representations of societal transformations, such as behavior of various actors, transformation dynamics in time, and heterogeneity across and within societies. After reviewing the state of the art, the authors propose a research agenda which guides experiments to integrate more insights from social sciences into models. The proposed agenda allows for interdisciplinary learning between modelers and social scientists, improved models with a more complete representation of a multifaceted reality, and identification of new and more effective solutions to energy and climate challenges.

Hodbod, J. and Adger, W.N., 2014. Integrating social-ecological dynamics and resilience into energy systems research. *Energy Research & Social Science*, 1, pp.226-231.

With this study, the authors address the often-relegated role of the ecological impacts of energy production and consumption. Social–ecological dynamics are presented as critical aspects with respect to the access to modern energy services which tend to be inadequate for significant sections of the world's population. The ecological impacts of energy use are often analysed as a set of environmental externalities, many of which are uncertain or unquantifiable (e.g. species extinction or the loss of visual landscape amenity), particularly if they stem from earth system change such as anthropogenic climate change. The authors hence suggest to analyse energy systems as social–ecological systems. The paper builds on an extensive literature review from ecology and resilience theories. It compares the analytical domains, major findings and emphasis of social–ecological systems with socio-technical transition research. The authors demonstrate that social–ecological systems research combines the analysis of interactions with ecological systems and power relations between actors in energy systems.

Geels, F.W., Kern, F., Fuchs, G., et al., and Wassermann, S., 2016. The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990-2014). *Research Policy*, 45, pp.896-913.

This paper makes a relevant contribution to the field by presenting a typology of transition pathways which is illustrated by an analysis of the German and UK low-carbon electricity transitions. The authors argue that (energy) transitions may shift between pathways, depending on struggles over technology deployment and institutions. The analysis shows that Germany is on a substitution pathway, enacted by new market participants deploying small-scale renewable electricity technologies (RETs), while the UK is on a transformation pathway, enacted by the currently dominating actors deploying large-scale RETs. Further analysis shows that the German transition has recently shifted from a 'stretch-and-transform' substitution pathway to a 'fit-and-conform' pathway, because of a fightback from utilities and altered institutions. It also shows that the UK transition moved from moderate to substantial reorientation towards the established actors, as government policies became stronger. Recent policy changes, however, substantially downscaled UK renewables support, which is likely to shift the transition back to a less disruptive path.

2.4. Energy (in)justice and aspects of power

As all socio-technical systems, energy systems are subject to questions of (in)justice and power. While justice, equity and societal inclusion in deploying energy infrastructures and shaping energy systems were rarely covered until recently, more systematic frameworks and approaches to study energy justice and questions of power were developed in the last decade. Some of these literatures provide the conceptual foundations to study just energy systems from interdisciplinary SSH perspectives while others address the facets of fair transition processes to renewables-based energy systems more explicitly. Aspects such as dealing with energy poverty, socio-economic inequality, and implications of energy transitions on employment are further evolving themes. SSH research offers both a critical analysis of justice issues, as well as more normative questions about how a 'just transition' can be attained.

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, pp.677-691.

This article makes a relevant contribution to the field because it analyses how different concepts from justice research and ethics can help informing decision making in the energy sector. The authors emphasise the moral and equity dimensions of energy production and use and contributes a novel definition of "energy justice", when referring to "a global energy system that fairly distributes both the benefits and burdens of energy services, and one that contributes to more representative and inclusive energy decision-making" (p.677). The authors focus on a list of new research frontiers for the future of energy justice. It starts with a call for the inclusion of non-Western justice theory and argues to expand justice frameworks beyond human agency, hinting to neglected aspects for example of the rights of nature. Another avenue for future research is identified in cross-scalar issues of justice such as embodied emissions as well as is the generation of novel business models and the associated benefits expected to emerge when considering a justice perspective. Still overlooked are also research questions addressing the tradeoffs within energy justice principles and the uncovering of unjust discourses. The research agenda presented in this article is exemplified with 30 research questions and is underpinned with a conceptual framework in order to guide decision-making.

McGee, J. A. and Greiner, P.T., 2019. Renewable energy injustice: The socio-environmental implications of renewable energy consumption. *Energy Research & Social Science*, 56, pp.2-11.

This article makes an important contribution to understanding the role of income inequalities may influence the relationship between renewable energy consumption and the reduction of CO2 emissions. The authors test the hypothesis that renewable energy consumption reduces emissions more effectively when it occurs in a context of increasing inequality, while it would reduce emissions to a lesser degree when occurring in a context of decreasing inequality. This study builds upon data from a large sample of 175 nations for the period from 1990 to 2014. The authors demonstrate that when income inequality increases, renewable energy consumption is found to be associated with a much larger decrease in CO2 emissions. The authors refer to previous research conducted by energy poverty scholars; the authors conclude that national income inequality affects the way renewables are deployed. It is recommended to policy makers that efforts aimed at increasing renewable energy consumption should be combined with policies that aim for the effective displacement of fossil fuels and the reduction of inequality.

Jasanoff, S., 2018. Just transitions: A humble approach to global energy futures. *Energy Research & Social Science*, 35, pp.11-14.

This is a key article that presents persistent mismatches between current problems, policy framings, and proposed solutions in the context of energy transitions. These mismatches are pointing to unsettled ethical considerations such as that the energy system is being imagined at the centers of global power. The author argues that development is still too often considered as the means to achieve sustainable futures, even though decades of research point to complex and uncertain relationships between prosperity and sustainability. The author also addresses the neglected aspect of disparities within societies that demand differentiated socio-technical solutions rather than considering a focus on technological change as essential for energy transitions. The perspective paper then turns to principles about how to navigate and guide energy transitions with paying particular attention to social justice. Among these are: being more attentive to systematically neglected issues as for example the role of communal practices and norms in relation to energy use. Integrating more prominently the influence of history and culture, especially when these affect experiences of vulnerability and resilience. Moreover, the author strongly invites to restore

normative concerns to energy policy deliberations for example with a focus on distribution, fairness, and justice. Finally, the paper argues for the design of new participatory strategies to offer larger publics greater access to scientific resources and official political institutions at diverse levels of policy making.

Jenkins, K., McCauley, D., Heffron, R., Stephan, H. and Rehner, R., 2016. Energy justice: a conceptual review. *Energy Research & Social Science*, 11, pp.174-182.

This is a relevant article that offers a broad conceptual review of the literature to date and provides empirical examples of its applications in the contexts of energy policy, energy production and systems, energy consumption, energy activism, energy security and climate change. The authors pay particular attention to distributional, recognition and procedural justice aspects. These three aspects are key because if (energy) injustice is to be tackled, actors need to identify the concern – 'distribution', identify who it affects – 'recognition', and only then identify strategies for remediation – 'procedure'. The authors present a novel research agenda related to the notion of 'energy systems justice' and emphasise energy justice as being of a pluralist nature; that is not restricted to a particular technology, application, location or point in time. Future research should aim to further detect where injustices occur, identifying new processes for mitigating and recognising new further affected parts of society. More concretely, the authors highlight the lack of research on the energy justice movement which is seen as seemingly mute in comparison to activist origins of environmental and climate justice.

2.5. Energy system imaginaries and visions

Studying possible and plausible future states of energy systems has been on the agenda of SSH research for a while. However, the potential of future imaginaries and visions of renewables-based energy systems for policymaking seems to be still untapped. In addition, many visions for energy transitions are still focused on techno-economic factors and often overlook social conditions and social consequences. Unlike market strategies and technical forecasts, imaginaries incorporate future visions, dreams and expectations of citizens or other social actors. In recent years, policy making has started acknowledging the plurality and contestations in visions of future energy systems. Implications of this multiplicity have been addressed and communicated by SSH scholars.

Longhurst, N. and Chilvers, J. 2019. Mapping diverse visions of energy transitions: co-producing socio-technical imaginaries. *Sustainability Science*, 14(4), pp.973-990.

This is a relevant paper as it expands beyond the dominant visions of energy transitions and brings counter- hegemonic, alternative imaginaries onto the agenda. It describes how there has been growing criticism of the dominant technocentric transition visions for energy systems. The paper reveals that what is often presented as a primarily 'technical' transition is always normative in bringing forward particular forms of social and political order. It presents new insight into the diversity of visions for energy transitions within the societal context of the UK by studying twelve visions produced across different institutional settings such as the state, business, science and technology, and civil society. The authors introduce a new analytical framework grounded in relational co-productionist perspectives in science and technology studies (STS). This opens up debates for alternative models of progress, social change, and the roles of publics in imagining energy futures. The authors claim that mapping these visions will contribute to reflexive, and responsible practices of future-making of the energy system.

Delina, L. and Janetos, A., 2018. Cosmopolitan, dynamic, and contested energy futures: Navigating the pluralities and polarities in the energy systems of tomorrow. *Energy research & Social science*, 35, pp.1-10.

This paper considers energy futures as cosmopolitan, multidimensional, contradictory as well as being politically, geographically and culturally contextualised. It underlines plurality and reflexivity in understanding the multiple ways of imagining energy futures. The authors reflect on the consequence of how people imagine, navigate, and contest such futures. This article highlights that energy futures are not free of cultural, political, and economic influence, and hence can be best approached with cosmopolitan and plural lenses. Plurality is as well evidenced in terms of the disparate geographic locations, disciplinary foundations, conceptual frameworks, and methodological choices in particular for SSH research on energy system transformation. This breadth points to the many roads of imagining energy system futures and of making these expectations real and durable.

2.6. The politics and policies of renewable energy systems

At the heart of transitions from fossil fuel to renewables-based energy systems is a societal change which implies new configurations of actors, material objects, interactions, and meanings. SSH research provides in-depth insights into the complexities of these configurations paying attention to politics and policies as drivers of the anticipated changes as well as the instruments for coping with their unintended consequences. An energy transition is inherently political and requires public debate and political interventions. Regarding political interventions, the unique value offered by SSH research lies with discussing multiple scenarios and pathways which can make public debate more flexible, open and adaptive. Offering the systematic monitoring of interventions which recognise multiple societal interest, positions, and practices, SSH scholars provide the evidence that supports policymaking, while stimulating further discourse on the values and possible horizons of designed actions, which hopefully makes the transition processes more reflexive.

Munro, F. R.,and Cairney, P., 2020. A systematic review of energy systems: The role of policymaking in sustainable transitions. *Renewable and Sustainable Energy Reviews*, 119, 109598.

This article unpacks the role of policy and policy making in the context of studying the transition of energy systems. The authors indicate the interconnectedness of key actors, outcomes from a large number of interactions, and the proposed transformation towards sustainable energy systems. According to the authors, applying systems analysis and 'systems thinking' are promising lenses to capture the dynamics in energy system change, yet, remains often too vague to guide energy transitions well. The authors show how these concepts arise frequently in UK energy policy research and what their impact can be on policymaking. Clear conceptual underpinnings for policy and policymaking are identified as key in amplifying energy transition research, but a key challenge remains to identify the appropriate policy mixes as well as their likely effects. In this context, the study argues that non-governmental action is crucial, yet, the relationship and collaborations between governmental and other actors is often not clear. The authors conclude with the call to develop rules within and beyond government action to generate mechanisms to ensure high cooperation among diverse actors and to instigate societal ownership of the means to achieve energy transitions.

Meckling, J., Sterner, T. and Wagner, G., 2017. Policy sequencing toward decarbonization. *Nature Energy*, 2, pp.918-922.

With this relevant article the authors challenge the proposition held by many economists that carbon pricing—either through a carbon tax or cap-and-trade—is one of the most cost-effective ways to achieve decarbonized energy systems, preceded with subsidies for basic research and development. So far, green innovation and targeted industrial policies aiming to foster low-carbon energy technologies have proliferated. According to the authors, such initial government support for low-carbon energy technologies faces two enduring challenges: avoiding the lock-in of sub-optimal low-carbon technologies and maintaining support for government investment in low-carbon technologies. With the prominent exceptions of a few Scandinavian carbon taxes and some EU fuel taxes, most early carbon pricing systems had a limited effect in reducing emissions or inducing innovation The authors unpack the distinct sequence of policies introduced by low-carbon frontrunners such as the government of California and the European Union (EU). Their policy sequences helped to overcome some of the political challenges facing low-carbon policy by building economic interest groups in support of decarbonization and reducing the cost of technologies required for emissions reductions. The authors illustrate the three-stage policy sequence of California and the EU, which has primarily played out in the electricity sector. When aiming for deeper emissions cuts in the future, further cuts in the electricity sector and efforts to broaden policies to the transport and building sectors are crucial.

Jacobsson, S. and Lauber, V., 2006. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy*, 34, pp.256-276.

This article presents a detailed historical analysis of the political and policy measures related to the rapid spread of wind turbines and solar cells in Germany. The authors explore the diffusion of the two renewable energy technologies with a particular focus on the employed policy instruments and to the political process which led to the adoption of these instruments. The instruments as part of the wider regulatory framework formed in an institutional battle , during which the German parliament, which was informed and supported by an advocacy coalition, backed support policies for renewable energy sourced electricity against often

reluctant governments and the opposition from interests of nuclear and coal industry. This study traces the details of a political process in Germany over decades and provides further insight into the societal costs that the political and environmental achievement brings about.

Stirling, A., 2014. Transforming power: Social science and the politics of energy choices. *Energy Research & Social Science*, 1, pp.83-95.

This paper addresses energy choices, both for the social sciences and for society at large. The author argues for opening up active political spaces for critical contention over alternative energy transition pathways. A key principle identified in this paper is that the roles of social science in interdisciplinary energy research are not just about the social complexities encountered in pursuing goals driven largely by natural sciences or engineering. Instead, social research can also assist in framing priorities, questions and options for these disciplines such as engineering. Yet, social science perspectives require acknowledging plurality. According to the author, it should not only refrain from, but rather actively critique, policy recommendations presented in singular prescriptive forms. This article suggests instead that it should convey to policy making and wider political debates an explicit and symmetrical plurality of social interpretations of energy alternatives, each valid under different reasonable perspectives with each, its associated constituting conditions. The ideas and hopes about possible pathways for energy system change can be deeply constituted by interests of established energy system actors. In conclusion, the authors emphasise that the social choice of energy transition pathways is inherently a matter for explicitly political rather than solely analytical resolution.

2.7. Community renewable energy and energy citizenship

Energy communities are manifestations of community-led approaches to energy transitions. In contrast, energy citizenship emphasises the energy consciousness and literacy as well as sustainable energy practices by citizens engaging as social and political actors. Both notions have been used frequently in scientific and media discourses. Their multidimensional character and evolution still offers further potential to SSH research regarding questions about ownership, agency and relations in energy systems. Literature on energy community and energy citizenship have addressed issues of rights, responsibilities, identities and civic relations connected to energy issues. The papers chosen for this section provide systematic overview and insights into the diverse understandings of energy communities and citizenship and discuss important implications for policymaking.

Walker, G. and Devine-Wright, P., 2008. Community renewable energy: What should it mean? *Energy policy*, 36(2), pp.497-500.

This paper is based on a UK case study and proposes two key dimensions that underlie the views on what community means to policy makers, administrators, activists, project participants and local residents. The authors then construct the analytical matrix to place the utility of wind farms in relation to the different understandings of community energy. They argue that community is an easily used word that is readily attached to projects, initiatives and policies as part of the discursive politics of modern governance. In this work, the authors consider the way in which community has become attached to renewable energy projects both in grassroot action and in mainstream energy policy. The study presents community understandings and interpretations that revolve around questions of both process and outcome. The importance of the process design for realising meaningful local participation are highlighted.

Ryghaug, M, Skjølsvold, T.M. and Heidenreich, S., 2018. Creating energy citizenship through material participation. *Social studies of science*, 48(2), pp.283-303.

This relevant paper draws on STS theories and is focused on the topic of creating energy citizenship emphasising the active role of social actors in decarbonizing energy systems. The authors use the theory of material participation and illustrate how novel energy practices emerge. Referring to artefacts such as electric vehicles, smart meter and photovoltaic panels, the study reflects on how the material participations shape energy citizenship. As connectors or bundlers of interests and practices, such artefacts show potential to co-produce energy citizenship and new modes of engagement with environmental issues. The authors argue that material objects can anchor energy and climate change-related discourses and practices in everyday life, through processes of material localisation, integration and diversification. Hence, in order to evolve from passive users or mere customers to active energy system participants, different forms of user and community with new low-carbon energy technologies should be co-created. The paper concludes with

a discussion about the role of policies for low-carbon energy transitions on the making of energy citizenship, as well as limits of introducing a materially based energy citizenship.

Kunze, C. and Becker, S., 2015. Collective ownership in renewable energy and opportunities for sustainable degrowth. *Sustainability Science*, 10(3), pp.425-437.

This paper is a relevant work because it provides empirical insides to test the hypothesis that small-scale energy technology and decentralised ownership can be regarded as precursors of a sustainable degrowth society. Based on the results of a survey conducted in European Union member states during 2013, the authors discuss small-scale ownership structures in renewable energy as an alternative to community energy approach. The survey data is paired with four case studies relating to the debates on degrowth to small-scale renewable energy schemes. The concept of collective and politically motivated renewable projects (CPE) is introduced as a heuristic notion to broaden the debate on small-scale renewable energy. CPE's combine collective forms of ownership and decision-making with explicit political aspirations, with a degrowth orientation being one of the possible aspirations. These projects can be seen as degrowth initiatives as they seek to reduce the per capita energy consumption and integrate ecological principles into their business practice.

Bauwens, T., 2016. Explaining the diversity of motivations behind community renewable energy. *Energy Policy*, 93, pp.278-290.

This is a relevant article that addresses the plurality of motivations behind engaging with community renewable energy (CRE) initiatives. The author empirically investigated the heterogeneity among members of CRE projects in terms of their motivation and levels of engagement. CRE initiatives are becoming more important actors in the transition toward decarbonizing energy systems. However, in order to further stimulate investments in CRE projects, a better understanding of investors' motives and attitudes is required. Based on quantitative data from a survey study conducted with two renewable energy cooperatives in Flanders, Belgium, the paper presents a more fine-grained analysis of how institutional factors and, in particular, social norms may interplay with spatial patterns and attitudes towards innovation diffusion that shape renewable energy investments at the community level. Activating social norms is illustrated as a promising mechanism for triggering investment decisions into CRE, although the implications of its interplay with economic incentives are still to be further explored.

3. Conclusions

This annotated bibliography has surveyed the breadth of scholarship characterising SSH research on renewable energy. The field has shifted from a focus on economic feasibility studies and early work on social acceptance of infrastructures to a more comprehensive and diverse understanding of renewables, including aspects of energy justice and power, cross-sector integration, governance of energy system transitions, policy mixes for renewables' deployment, or energy citizenship.

Our selection of scientific work also pays tribute to the agenda-setting done by the European Commission, directing the course of changes in European energy systems towards just transition pathways to renewables-based energy systems, by recognising the social conditions and consequences of using and further implementing renewable energy technologies.

In order to identify the possible and desirable pathways towards just, renewables-based energy systems, unintended consequences and appropriate incentives to overcome the inertia and path dependencies of the existing energy system structures will likely become more prominently in the scientific debate ahead. Moreover, the expected cross-sector effects of energy transitions (e.g. with the mobility, housing, agricultural sectors) and aspects of subsequent system-integrations have not been adequately covered in the literature to date.

The highlighted contributions have policy relevance and/or have influenced new research trajectories. Nevertheless, several important debates, themes, and studies could not be included here. Topics related to emerging SSH research on renewables system design and cross-sector integration, novel financial and organisational structures, or on particular social geographies of renewable energy are some examples of work that was not integrated at this stage.

We critically acknowledge a selection focus of studies primarily produced in and focusing on North-Western Europe. Although scholars from these geographical regions have dominated the field, this focus constitutes a limitation to our literature overview. Yet, we are convinced, this bibliography characterises some of the different avenues of scholarship and debates within the field, and we hope readers are inspired to seek out in-depth knowledge and further literatures on renewable energy beyond the publications presented here.

4. Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 826025. We are grateful to the ten working group members who devoted their time and expertise during intensive interviews on the development of SSH research on renewable energy, as well as many energy-SSH colleagues submitting thorough justifications for their Horizon Scanning research questions which offered an additional source of literature for this bibliography.

5. References

Foulds, C. and Christensen, T.H., 2016. Funding Pathways to a Low-carbon Transition. *Nature Energy*, 1(7), pp.1–4.

de Geus, T., Bode, N., Robison, R., Rohse, M., Foulds, C., Wagner, A., Krupnik, S., Świątkiewicz-Mośny, M., Rudek, T., Kuittinen, H. Lisi, V., Søraa, R., Lunevich, I., Wittmayer, J. 2020. *Shifting perspectives: insights from the Energy Policy Fellowships.* Cambridge: Energy- SHIFTS

Foulds, C., Royston, S., Berker, T., Nakopoulou, E., Abram, S., Ančić, B., Arapostathis, E., Badescu, G., Bull, R., Cohen, J., Dunlop, T., Dunphy, N., Dupont, C., Fischer, C., Gram-Hanssen, K., Grandclément, C., Heiskanen, E., Labanca, N., Jeliazkova, M., Jörgens, H., Keller, M., Kern, F., Lombardi, P., Mourik, R., Ornetzeder, M., Pearson, P., Rohracher, H., Sahakian, M., Sari, R., Standal, K. and Živčič, L., 2020. 100 *Social Sciences and Humanities priority research questions for energy efficiency in Horizon Europe*. Cambridge: Energy-SHIFTS.

Foulds, C., Bharucha, Z.P., Krupnik, S., de Geus, T., Suboticki, I., Royston, S. and Ryghaug, M., 2019a. *An approach to identifying future Social Sciences & Humanities energy research priorities for Horizon Europe: Working Group guidelines for systematic Horizon Scanning*. Cambridge: Energy-SHIFTS.

Øverland, I. and Sovacool, B.K., 2020. The misallocation of climate research funding. *Energy Research & Social Science*, 62, p.101349.

Robison, R. and Foulds, C., 2019. 7 *principles for energy-SSH in Horizon Europe: SHAPE ENERGY Research & Innovation Agenda* 2020-2030. Cambridge: SHAPE ENERGY.

Robison, R., Skjølsvold, T.M., Lehne, J., Judson, E., Pechancová, V., Foulds, C., Bilous, L., Büscher, C., Carrus, G., Darby, S., Demirbağ-Kaplan, M., Douzou, S., Drevenšek, M., Frantál, B., Guimarães Pereira, A., Hargreaves, T., Karvonen, A., Katzeff, C., Kola-Bezka, M., Laakso, S., Lettmayer, G., March, H., Parag, Y., Renstroem, S., Sáfián, F., Swora, M., Tjørring, L., van der Werff, E., van Vliet, B., Wallenborn, G., Wolsink, M. and Wyckmans, A. 2020. 100 *Social Sciences and Humanities priority research questions for smart consumption in Horizon Europe*. Cambridge: Energy-SHIFTS.

Ryghaug, M., Suboticki, I., de Geus, T., Loorbach, D., Foulds, C. and Bharucha, Z.P., 2019. *Terms of Reference: Energy-SHIFTS Working Group 4 – Transport and Mobility.* Cambridge: Energy-SHIFTS.

Ryghaug, M., Suboticki, I., von Wirth, T., Smeds, E., Scherrer, A., Foulds, C., Bertolini, L., Beyazit, E., Brand, R., Cohen-Blankshtain, G. Dijk, M., Freudendal-Pedersen, M., Gössling, S., Guzik, R., Kivimaa, P., Klöckner, C., Nikolova, C.L., Lis, A., Marquet, O., Milakis, D., Mladenović, M.N., Mom, G., Mullen, C., Ortar, N., Paola, P., Oliveira, C.S., Schwanen, T., Seidenglanz, D., Tuvikene, T. and Wentland, A., 2020. 100 *Social Sciences and Humanities priority research questions for transport and mobility in Horizon Europe*. Cambridge: Energy- SHIFTS.

Sovacool, B. K., Ryan, S. E., Stern, P. C., Janda, K., Rochlin, G., Spreng, D., ... and Lutzenhiser, L.. 2015. Integrating social science in energy research. *Energy Research & Social Science*, 6, 95-99.

von Wirth, T., Loorbach, D., Wagner, A., Koretskaya, O., Wade, R., Krupnik, S., Rudek, T., Foulds, C., Adem, C., Akerboom, S., Batel, S., Caspar Rabitz, F., Certoma C., Cherp, A., Chodkowska-Miszczuk, J., Denac, M., Dokupilová, D., Dotterud Leiren, M., Frolova Ignatieva, M., Gabaldón-Estevan, D., Horta, A., Karnøe, P., Lilliestam, J., Markard, J., Mišik, M., Mühlemeier, S., Nemoz, S., Nilsson, M., Osička, J., Papamikrouli, L., Pellizioni, L., Sareen, S., Sarrica, M., Seyfang, G., Smith Stegen, K., Sovacool, B., Telesiene, A., and Zapletalova, V., 2020. 100 *Social Sciences and Humanities priority research questions for renewable energy in Horizon* Europe. Cambridge: Energy-SHIFTS.

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Energy Social sciences & Humanities Innovation Forum Targeting the Set-Plan

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drift for transition

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E3G

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Smart consumption:
A Social Sciences and Humanities annotated bibliography

Energy-SHIFTS

ENERGY SOCIAL SCIENCES & HUMANITIES INNOVATION FORUM TARGETING THE SET-PLAN

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Executive summary

Background

- This annotated bibliography is one of four produced as part of the European Commission (EC) funded project *Energy Social sciences & Humanities Innovation Forum Targeting the SET-Plan* (Energy-SHIFTS).
- Energy-SHIFTS has worked over 2019-2021 to contribute to the European Energy Union by further developing Europe's leadership in using and applying energy-related Social Sciences and Humanities (energy-SSH).
- This bibliography offers accompanying context to a set of 100 priority SSH research questions on smart consumption (Robison et al., 2020)[1]; these questions were developed through a Horizon Scan process which ran during 2020 alongside three other energy-related topic areas: renewables, energy efficiency and transport and mobility.

Aim

- The bibliography is intended to inform those working in policy and other non-SSH experts on the breadth and diversity of energy-SSH knowledge that characterises the field.
- An annotated bibliography is a list of references to books and articles followed by short descriptions of their content and arguments.
- This bibliography contains 200-300 word annotations to 25 key publications from SSH research on smart consumption, providing a backdrop to the 100 priority SSH research questions described in the separate Horizon Scanning report (Robison et al., 2020).

Approach

- The annotated bibliography presents a selection of social scientific and humanities based publications including journal papers, books and book chapters.
- Publications were selected to reflect the substantive and disciplinary diversity of the energy-SSH field relating to smart consumption, and include works from across e.g. Geography, Psychology, Political Science, Science and Technology Studies, Sociology, Anthropology, as well as interdisciplinary collaborations.
- Ideas for publications to include were drawn from interviews with 10 energy-SSH experts and responses to the Horizon Scan survey from 74 energy-SSH scholars from across Europe; four Working Group steering committee members then produced the annotations.

Findings

- Building on early contributions that situated energy consumption as part of broader socio-technical processes shaped by cultural and historical contexts, there has emerged a significant SSH literature on smart consumption.
- In its early incarnations, much of this literature was concerned with assessing how or if smart technologies, new price signals, or new types of information could stimulate behaviour change amongst energy consumers.
- The focus has expanded to probe ways that smart technologies and instruments can become parts of social practice, as well as to highlight the many ways that people can interact with smart technologies, one of them being as energy citizens.
- SSH has become increasingly concerned with how smart consumption is an element of broader institutional configurations, as well as critically discussing how smart consumption is organised and produced through technical and social arrangements.
- An important element of SSH debates about smart consumption relates to justice. Thus articles explore whether smart consumption is a good solution for all, and whose needs might be being overlooked in the pursuit of smart. Here the broader social and economic consequences of an energy transition underpinned by smarter energy consumption are made more visible.
- Policy assumptions about what smart consumption may achieve have been substantially critiqued from SSH, e.g. through accounts that see smart consumption as part of a broader governance strategy that obscures political aspects of energy transitions and new technologies.

1 Available at: https://energy-shifts.eu/wp-content/uploads/2020/12/D2.3_WG2_smart-consumption.pdf

Contents

1. Introduction

1.1. Background: energy-SSH and Energy-SHIFTS

This annotated bibliography was developed as part of the *Energy Social sciences & Humanities Innovation Forum Targeting the SET-Plan* (Energy-SHIFTS) project[2]. Energy-SHIFTS has worked to support the EU Energy Union by developing Europe's leadership in energy-related Social Sciences and Humanities (energy-SSH) research. The growing field of energy-SSH has remained marginal in terms of funding and policy impact, giving way to energy research interests dominated by the natural and technical sciences (Foulds and Christensen, 2016; Overland and Sovacool, 2020). However, the EC has expressed a commitment to mainstream SSH research and innovation activities, including supporting standalone energy-SSH projects. As part of this commitment, the Energy-SHIFTS project has therefore worked over 2019 – 2021 to strengthen energy-SSH for European research and innovation, as well as highlight its relevance to EU energy policy. Amongst other activities, Energy-SHIFTS has contributed cutting-edge research priorities from energy-SSH research communities, to help guide and anchor EU research and innovation funding for SSH research and bridge current research-policy gaps. To achieve this, a major part of the Energy-SHIFTS project has been a Horizon Scanning initiative, involving four Europe-wide Working Groups each culminating in the presentation of 100 priority SSH research questions on key topics within the EU Energy Union and EC research and innovation funding priorities, these topics being: (1) renewables (von Wirth et al., 2020), (2) smart consumption (Robison et al., 2020), (3) energy efficiency (Foulds et al., 2020), and (4) transport and mobility (Ryghaug et al., 2020). The four annotated bibliographies, of which this is one, are companion pieces to these four sets of Horizon Scan results.

2 For more information about the project, visit the official website: https://energy-shifts.eu/

1.2. Aims of the Annotated Bibliographies

The four annotated bibliographies aim to provide a contextual backdrop and sense of the evolution of energy-SSH academic research over time, that can be read alongside the Horizon Scanning reports. An annotated bibliography is a list of references to books and articles followed by short descriptions of their content and arguments. This report provides annotations to 25 key publications in SSH research on smart consumption. The annotated bibliographies are intended to give policyworkers and other non-experts insight into the breadth of energy-SSH knowledge and approaches which characterise the field today. They portray key advances in energy-SSH fields and, as such, offer context for the forward-looking priority SSH research questions.

The annotated bibliographies offer a taste of the main SSH debates, milestones, and advances in the field through a summary of key scholarly contributions, but do not provide full coverage of the field. The ambition is to demonstrate the range and variation of energy-SSH research, incorporating different and sometimes contradictory disciplinary perspectives, research themes and approaches. The bibliographies can give policy workers and other non-experts or new researchers insights to help navigate the SSH field of smart consumption.

1.3. The topic of this bibliography: smart consumption

This annotated bibliography focuses on smart consumption. The Energy-SHIFTS Smart Consumption Working Group has taken 'smart' to refer to technologies which are digitally enabled and networked for (usually real-time) monitoring and/or control. The term 'consumption' shows an emphasis on these technologies in homes, workplaces, and communities, rather

than at industrial scale (Robison et al., 2019). Through a comprehensive, future-looking Horizon Scanning exercise (with methods detailed extensively in Foulds et al., 2019), the Working Group produced a list of 100 priority SSH research questions in the field. In doing this, the Smart Consumption Working Group aimed "*To demonstrate how Social Sciences and Humanities (SSH) must play a leading role in smart energy transitions, in dialogue with technologists and policy makers, to accelerate a shift towards a sustainable energy future. To communicate that the social and technical aspects of smart cannot be separated, and the value of SSH in addressing challenging questions including those around values, justice, institutional change, democracy and participation. To reframe the smart consumption conversation, by highlighting how consumption is anchored in existing institutions and systems, which means that transitions challenge power structures and vested interests*" (Robison et al., 2020, p.7).

The 100 SSH priority research questions for smart consumption were grouped into seven themes: (1) Power relations and smart energy transitions, (2) Engagement and trust in relation to smart technology roll-out, (3) Exclusion and unevenness in smart futures, (4) Building communities for smart consumption and presumption, (5) How smart can become part of or disrupt everyday life, (6) Beyond smart: evaluating assumptions and alternatives, and (7) Citizen, worker, parent: different roles involved in smart. While the questions highlight pressing topics and perspectives in SSH research on smart consumption, the field is broader, including topics that resist easy categorisation within these seven themes. In this annotated bibliography, we therefore aim to represent some of this broader view of SSH scholarship on smart consumption. Some of the publications presented here therefore do not explicitly deal with smart consumption or energy transitions, but are still important stepping stones and inspiration for stimulating new research topics, interests, perspectives, and debates.

1.4. Methodology for selecting key pieces of literature

As noted, this bibliography accompanies a Horizon Scanning exercise. As part of that work, we conducted 10 interviews with leading SSH scholars who were tasked with outlining the historical development of the field, including a focus on key publications. This produced around 40 references, which were reviewed for this report alongside the final themes and questions resulting from the Horizon Scan. We wanted a list of publications that illustrated disciplinary diversity and representations, while also providing insights on the historical developments of the field. Most interviewees suggested at least one of the references included here. Following this initial selection, we probed material submitted by 74 scholars from around Europe as part of the Horizon Scan, which contained references to academic work, to fill out gaps. This method allowed for a combination of bottom-up identification of literature and top-down narrowing of scope. In sum, this should provide a useful entry into many key debates in and around SSH on smart consumption. Our selection, however, is by no means intended to be exhaustive, and readers who want a fuller picture should expect to need further reading. Nevertheless, reading this bibliography should give a rapid initial grounding in the breadth of key debates.

1.5. How to use the Annotated Bibliographies

These annotations are short summaries of the original source material and provide a taste of each contribution. We hope readers are inspired to seek out the full publications on their topics of interest. Given the limited selection of publications, readers may also use the list as a tool to discover broader and/or more specific literature in the field. The bibliography may, for instance, be read prior to viewing the 100 priority SSH research questions in the Horizon Scan report, or as an independent source of information.

Readers who wish to go further may choose to explore the four annotated bibliographies from the *Social sciences and Humanities for Advancing Policy in European Energy* (SHAPE ENERGY) project which was a predecessor to Energy-SHIFTS, and offer more extensive reviews of the given fields[3]. In particular Sumpf et al. 2017 provides 85 SSH references across the areas of '*Energy system optimisation and smart technologies*'. We have deliberately avoided too much overlap, with only 3 publications appearing in both bibliographies (Goulden et al., 2014; Strengers, 2014; Wolsink, 2012).

3 The SHAPE ENERGY bibliographies are available open access via: https://shapeenergy.eu/index.php/publications/annotated-bibliographies/

2. Key SSH literature on smart consumption

2.1. Introduction

As the transition to a more carbon neutral energy system unfolds, there are strong incentives to change not only how energy is produced, but also how it is consumed. First, many scholars are now pointing to the opportunities for strongly reducing greenhouse gas emissions through changes at the demand-side of energy systems, i.e. through new modes of consumption (Grubler et al., 2018). Second, transitions in energy production mean that we will rely more on energy sources such as wind and solar power. The production of electricity from these technologies varies with weather, season, and time of day. This means that supply and demand require different management to match up, as compared to coal or nuclear power. Changing energy consumption patterns is a way of addressing this challenge. Third, a strong element of European decarbonization strategies is electrification e.g. of transport and heat (e.g. Rogge et al., 2020). This might increase the strain on existing, often old, electricity grids. With this as a backdrop, smarter consumption can be a way to avoid large scale investments in electricity grid capacity expansion. All of this has resulted in strong appraisals amongst policy makers, innovators and scholars for ideals such as 'active consumption', 'flexible consumption' and 'smart consumption'.

Discussions about how to make consumption smarter are often highly technical, e.g. rooted in questions about how to combine technologies such as energy feedback monitors, home automation systems, batteries and solar PV. There is often a strong focus on the potential for sensors, software and other enabling ICT technologies to help energy systems calibrate the relationship between production and consumption in new, and smart ways.

In this annotated bibliography, our assumption is that smart consumption cannot, and should not, be reduced to a technical issue alone. Decades of SSH research, as highlighted in this bibliography, support this claim as self-evident. Energy consumption is an activity undertaken (and overseen) by people who occupy spaces such as households, neighborhoods, and cities, within different historical, cultural and political contexts. Changing how, why, what and when we consume energy therefore entails changing how we live, what we do across scales, and how we relate to other people, broader systems, and institutions. Consumption is a fundamentally social and societally embedded activity, which both shapes and is shaped by our societies. The contributions from SSH presented here cover such issues from diverse perspectives, including critical ones, which ask us to consider alternative ways of framing both questions and solutions to contemporary challenges.

2.2. Setting the stage for an SSH-agenda on smart consumption: some historical roots

While the study of smart consumption as discussed in this annotated bibliography is a relatively new endeavour, it builds on past work within SSH which situates consumption as a broad societal phenomenon. The two references discussed in this subsection are of this type, and help us to situate what we today discuss as smart consumption within broader historical and cultural analyses and discussions.

Hughes, T.P., 1983. *Networks of power: electrification in Western society, 1880-1930*. Baltimore, MD: Johns Hopkins University Press.

Published in the early 1980s, this pioneering book on the history of technology contains a series of case studies which detail the invention, development, and

expansion of electricity systems within Western societies. Its relevance for this annotated bibliography lies in its systems-oriented ffocus; highlighting how the social and technical elements of such systems go hand-in-hand, to such an extent that they cannot meaningfully be separated. Thus, the book illustrates that consumption is not only an act performed by individuals, but rather as one element, or one process within a broader system. Translated into work for advancing smart consumption, this book asks us to zoom out from individual consumers to look at their roles in broader systems, and to understand how specific cultural and historical conditions shape such systems. This illustrates that a concept such as 'smart consumption' needs to be considered as embedded in broader systems (existing or new ones) and that such systems needs to be fitted with pre-existing social and technological conditions in the places where they are expected to work.

Lutzenhiser, L., 1992. A cultural model of household energy consumption. *Energy*, 17(1), pp.47-60.

This article was part of an emerging SSH critique in the late 1980s and 1990s which pointed out the problems of assessing energy consumption and energy choices through narrow models of techno-economic rationality. To counter this, this article put forward a cultural model which emphasised the collective character of consumption and choice, noting how groups, not individuals, are the entities we need to understand if we seek to deploy new technologies, new practices and new meanings. This insight is highly valuable when thinking about smart consumption. A key for Lutzenhiser was to stress that different cultural forms, and ways of living across groups, might hold different potentials and constraints in terms of enabling consumption changes. As a hypothetical example, he illustrated the difference between "*Retired working class couples - spending most of their time inside modest, well-kept homes in older neighborhoods, [with] limited food habits, [and] short trips in neighborhood*" and "*Young urban families – with a new baby, new car, smaller unit, newer appliances, fast food, frozen food, travel for commuting, shopping and visiting*" (p.56). In terms of promoting smart consumption this suggests avoiding catch-all solutions, while thinking about change in broader terms than individual.

2.3. SSH to support, verify or reject proposed smart technologies and instruments to trigger behaviour change

Many early SSH contributions on smart consumption sought to gather evidence about the relationship between the provision of various forms of feedback on energy use, e.g. via 'smart' energy monitors, and whether this changed users' patterns of energy consumption. Another related strand of research sought to probe social barriers to adoption of such technologies. Hence, while the historical roots of SSH on smart consumption were relatively broad, early application of SSH insights to understand smart consumption were quite limited in scope and mainly served to verify or reject technological or economic solutions to energy system challenges proposed by non-SSH disciplines. In this annotated bibliography we have included two widely cited contributions that synthesised and reviewed insights from such studies.

Darby, S., 2006. *The effectiveness of feedback on energy consumption. A Review for DEFRA of the Literature on Metering, Billing and direct Displays.* Oxford: Environmental Change Institute.

Building on literature that dates from the 1970s onwards, this widely cited report discusses whether feedback technologies, which show users how much energy they use, are able to influence energy consumption. The report builds on the assumption that energy use is invisible to energy users, and that users therefore do not know what difference they could make by changing their behaviour. The report illustrates that feedback can be a useful tool in changing behaviours. A key point of the report, however, is that feedback works in many ways and that to be effective may require combining different forms of feedback, as well as combining feedback with other measures. While feedback is noted as a useful learning tool, its effects must therefore be interpreted in context. The report also notes that the effects of feedback are not uniform: it affects different social groups in different ways. The report is highly policy relevant. It notes that immediate and direct feedback provided over time can have important impacts on consumption behaviours, especially if combined with other measures such as informative billing and annual energy reports. However, it also cautions against

uniform embrace of feedback as a set of technologies assumed to affect behaviour in similar ways across contexts.

Balta-Ozkan, N., Davidson, R., Bicket, M. and Whitmarsh, L., 2013. Social barriers to the adoption of smart homes. *Energy Policy*, 63, pp.363-374.

The starting point for this article is the observation that smart home technologies might provide valuable assistance in realising energy demand management goals, e.g. associated with demand response programs, as well as a range of other cited benefits. The article proceeds to ask why smart home technologies are not more widely adopted and how one could develop new markets for such technologies. Building on past literature, the article identifies a range of social barriers to adoption: poor fit with existing and changing lifestyles, lack of interoperability (i.e. easy recognition and use of new components), perceived lack of reliability, privacy and security, as well as consumer perceptions and attitudes. These identified barriers are then discussed in interviews with technology developers and experts, as well as in workshops with members of the public. An outcome of these interviews and workshops is the addition of costs and trust to the list of potential barriers. Public lack of trust in industry, and authorities' abilities to regulate industry, are noted as important. The authors highlight that there must be a better match between technology development and public interests, e.g. through adopting user-centric design principles.

2.4. The social practice turn, and related approaches: beyond behaviour change

As a critique of the focus on individual responses and social barriers to change, work rooted in theories of social practice have become important in enabling new discussions about stability and change of energy consumption. These approaches note that energy use is never a goal in itself, but a derived demand of multiple interlocked practices, such as driving to work or cooking a meal, and associated with goals like keeping clean or being comfortable. This perspective does not focus on individual behaviour change but see individuals as carriers of practices that consists of ways of acting, forms of knowing, and material things. In this section we also include articles with a focus on technology use that goes beyond the idea of adoption, highlighting the active and generative potential of technology users in processes of change, e.g. through what is sometimes called domestication.

Wilhite, H. and Lutzenhiser, L., 1999. Social loading and sustainable consumption. ACR ***North American Advances*****, 26, pp.281-287.**

This was one of the first articles that discussed the social foundations of energy demand, and as such it is an important building block in a long-standing SSH debate about how energy consumption can be understood. The article uses the engineering terms of base and peak electricity load as a starting point to develop the concept of social loading. Social base load is an idea which highlights demand for energy that is produced by ordinary, routine, regular activities (e.g. cooking, cleaning, washing, commuting), while social peak loading refers to increases in consumption that arise around specific social events and activities. The authors argue that a focus on social loading helps us re-think energy loads as social accomplishments, noting that physical infrastructure must always be equipped to deal with social peak loads. By mobilising examples from different countries and cultures, the concepts of social base and peak load are used to discuss what constitutes what a society understands as necessary energy consumption (social base load), how this changes over time, as well as the social determinants of social loads. Four determinants are discussed: the role of status and display, the role of sociality and conventionality, the role of security and convenience, and the embeddedness in systems and structures. In terms of policy, the article urges us to think of consumption as a social and political phenomenon, which should be actively discussed and deliberated on. It notes that many of the things we take for granted are the results of framing (e.g. is a small car inferior or is it 'sporty'), and that there is political scope to debate what we as individuals and societies deem necessary.

Hargreaves, T., Nye, M. and Burgess, J., 2010. Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy*, 38, pp.6111–6119.

This article represents one of the first qualitative field studies carried out with households using real-time displays to monitor their domestic energy consumption. Based on interviews with 15 UK householders trialling smart energy monitors of differing levels of sophistication, the authors focuses on householder motivations for acquiring the monitors, how the monitors have been used, how feedback has changed consumption behaviour, and the limitations to further behavioural change the householders experienced. Smart energy monitors,

it would appear, are only as good as the household, i.e. the social and political contexts in which they are used. Ensuring that these contexts are supportive of changes in domestic energy consumption patterns seems vital if smart energy monitors are to realise their potential. Several direct policy implications are apparent from the field study. Monitors need to look good to fit in with the wider household, the information they provide needs to be clear, transparent and flexible (i.e. presentable in a variety of formats and perhaps customisable) so that it can easily be related to everyday practices and contextualised. Further, monitors should address whole households rather than individual consumers. Finally, and keeping with other contributions in this bibliography, the wider policy and business context should be configured to support changes based on monitor information.

Goulden, M., Bedwell, B., Rennick-Egglestone, S., Rodden, T. and Spence, A., 2014. Smart grids, smart users? The role of the user in demand side management. *Energy Research and Social Sciences*, 2, pp.21–29.

This article focuses on the role of users in smart grids. It discusses how two different conceptions of the energy systems demand side ('energy consumers' and 'energy citizens') tend to stimulate and generate different forms of engagement. The notion of energy consumers tends to signal a passive consumer who hands limited control of some devices over to other actors to manage. Energy citizens signals an active citizen who 'manages' process of consumption and sometimes generation. The authors propose that smart grid design must transgress the technology itself and recognise that a smart user, who is actively engaged with energy, is critical to many demand side management proposals. More than just a technological project, however, a smart grid has the potential to fundamentally change the social dynamics of the energy system. Ultimately, the authors argue, the most effective smart grid will be one in which intelligence is sourced from users as well as devices.

Smale, R., Spaargaren G. and van Vliet, B., 2019. Householders co-managing energy systems: space for collaboration? *Building Research and Information*, 47(5), pp.585–597.

This is one of several SSH articles that expands on the role of households in smart energy systems through a social practice perspective. In doing so, it focuses on the role of households as co-managers in energy systems, emphasising that smart energy systems tend to imply new responsibilities for households in terms of managing supply and demand in the energy system. The article uses a social practice approach to home energy management and distinguishes between consumption practices and home energy management practices. Home energy management practices are portrayed as those which involve oversight of energy use in the home (and thus may involve tasks to do with buying or monitoring electricity). They therefore sit between energy consuming practices (e.g. cooking) and production and distribution practices within the broader energy system. Analysing the use of a series of technologies, this article highlights the importance of information – not only as a way of communicating price, but as a way of elevating energy as an asset to be managed. Further, the article highlights that homes consist of domestic spaces and utility spaces. Home energy management systems are often confined to utility spaces (garages, attics, storages), but the authors argue the importance of using domestic space (kitchens, living rooms) actively in energy management.

Ryghaug, M., Skjølsvold, T. M. and Heidenreich, S., 2018. Creating energy citizenship through material participation. *Social studies of science*, 48(2), pp.283–303.

This article studies citizen participation in energy transitions, specifically how material devices can enable participation. On the one hand this entails an expansion of how to think about participation in transitions, and on the other hand it entails moving beyond a traditional understanding of social acceptance of new technology. The article probes participation through photovoltaic solar cells, electric vehicles and smart meters. The authors observe how the use of such technologies is not only influenced by attitudes held by users but how the use of these technologies becomes part of re-constituting the ways that citizens engage with energy and climate issues more broadly. The technologies in question become part of processes of producing new forms of awareness, new forms of knowledge and new actions and practices. This sometimes translates into broader forms of political and practical engagement also within other domains. In terms of smart consumption, the article provides a repertoire of opportunities for policy makers and designers, in thinking about how to design and deploy technologies that mobilise wider understandings of why humans act, other than those concerned with price.

2.5. Institutional and organisational dynamics of smart consumption

Publications in this section are concerned with smart consumption as an element embedded in and shaped by broader institutions and organisations. This means that analyses in this section go beyond treating consumption as individual acts conducted by consumers, instead focusing on how such acts are produced in relationships between actors and things. The publications explore themes including governance, innovation, and trust in infrastructures.

Luque-Ayala, A. and Marvin, S., 2016. The maintenance of urban circulation: An operational logic of infrastructural control. *Environment and Planning D: Society and Space*, 34(2), pp.191-208.

This article elaborates on new forms of governmental structures associated with smart technologies by using digital urbanism and urban resilience as a point of departure. This uncovers novel ways of seeing and engaging with the city. A detailed case study of Rio de Janeiro's Centro de Operações Rio (COR) is discussed. COR is a metropolitan control room aimed at integrating public and private organisations in charge of managing urban infrastructure. COR represents coupling between networked infrastructures and information technologies and is designed to function both as a daily operation centre and an emergency response centre. COR seeks to integrate two sectors: logistics (aviation, transportation, freight, distribution) and nodal points of commercial spaces (sporting facilities, shopping centres, office complexes). However, the priority is given not only to the material flow of resources (waste, traffic, water, power), but also to the configuration of information as a key urban resource. Constant information flow is the new nature of the city. The authors show how the citizens become operational components of the infrastructure through this control room. With this, the article describes how a new form of governance is established, where the city is managed as a logistical enterprise developing control mechanisms through information technologies.

Wolsink, M., 2012. The research agenda on social acceptance of distributed generation in smart grids: Renewable as common pool resources. *Renewable and Sustainable Energy Reviews*, 16(1), pp.822-835.

This article explores what the author calls the social foundations of smart grids. The article argues that current smart grid developments with substantially distributed energy generation suffer from an overtly technical focus. Most technical studies apply largely unfounded assumptions about the participation of actors. However, ongoing problems with deployment of renewable energy have shown that implementation is largely determined by a broad range of social acceptance issues, such as policy makers' rejection of new institutional configurations, or citizens unwillingness to change consumption patterns. The basic assumption of the article is that smart grids are socio-technical systems founded on organisational principles. They consist of decentralised networks that underpin the electricity consumption of groups of end-users who are increasingly becoming autonomous. These socio-technical networks form communities that exhibit high levels of interaction and integration between the actors. The author concludes that the governance of emerging smart grids may become a textbook example of a new kind of environmental governance. On the one hand, there are high expectations of smart grids, and on the other a complete lack of understanding of the need for institutional change required to establish them in real life. Research as well as policy agendas should therefore focus on how such new systems become institutionally embedded, and how they are socially constructed.

Pallesen, T. and Jenle, R.P., 2018. Organizing consumers for a decarbonized electricity system: calculative agencies and user scripts in a Danish demonstration project. *Energy Research & Social Science*, 38, pp.102-109.

Drawing on an empirical study from Denmark, and building on the sociology of markets, this article critiques much of existing social scientific literature which tends to claim that humans do not act as rational economic agents. Instead, the authors note that humans indeed sometimes do act as *homo economicus*, but are quick to note that this should not be considered an integral part of human nature. Instead, the authors urge us to consider economically rational behaviour – or what they call 'calculative agency' – as an outcome of work which e.g. includes the making of new markets, the training of users and the installation of technical equipment to assist in decision-making. The authors note that smart energy systems tend to be designed based on principles of control, which

means that embracing the messiness of everyday lives as a design principle is not straightforward. In light of this, the authors call for new types of interdisciplinarity, which would require both engineers and social scientists to work harder to understand the logics behind their respective work. This suggests that policy makers should stimulate research which re-thinks the relationship between social and technical research. By transgressing stereotypes anchored either in the social sciences or economics, such work could assist in creating new kinds of smart consumption.

Bulkeley, H., McGuirk, P. M. and Dowling, R., 2016. Making a smart city for the smart grid? The urban material politics of actualising smart electricity networks. *Environment and Planning A: Economy and Space*, 48(9), pp.1709-1726.

This article deals with the city as a site for governance of smart energy digitalisation and management of energy-related big data. The authors note that smart energy systems in cities lead to new forms of governmental interventions operating at the conjunction of the grid and the city. The article focuses on one case study of practical smart city governance, a major Australian, Federal government initiative called the Smart Grid Smart City initiative. The project was enacted in the Sydney and Newcastle Metropolitan region, Australia between 2010 and 2013, and at the time it was considered one of the widest-ranging technology assessments of smart grid products in the world, with the potential and goal of enabling no less than a new electricity economy. Based on this example, the authors argue that the urban context is not a mere background to the transition in electricity provision and use, but central to its politics, while electricity is also critical to the ways in which we should understand the politics of urbanism. It is argued that through seeing smart cities as both urban projects and grid projects, broader insights into the politics of governing energy in Australia's cities might be generated.

Grandclément, C. and Nadaï, A., 2018. Transitioning through markets. In: Labussiere, O. and Nadaï, A. (eds.), *Energy transitions: A socio-technical inquiry*. Cham: Palgrave Macmillan. pp.101-142.

This book chapter examines various aspects of the contribution of markets to the energy transition. Its relation to smart consumption lies in its examination of markets as instruments to incentivise private actors to engage in energy transition processes. It explores the practical consequences of the close association between energy transitions and markets by using analytical tools from economic sociology. Through four case studies on energy transition processes in France, the authors critically examine the transition of energy markets. The case studies reveal a series of market-like devices, rather than substantive market forces. Building on the sociology of markets, the article highlights that markets do not exist in and of themselves, but that they are products of the work and processes conducted by a series of actors and organisations; complex processes define and shape who can participate in energy systems such as buyers, sellers, commodities and marketplaces, as well as what they can each do. To policy makers this signals that smart consumption is the outcome of complex processes of work, definition and role attribution through devices and actions – emphasising that such processes can also be affected through policy making.

Ritzer, G. and Jurgenson, N., 2010. Production, consumption, prosumption: The nature of capitalism in the age of the digital 'prosumer'. *Journal of consumer culture*, 10(1), pp.13-36.

This article provides a sociological exploration of prosumption in the context of contemporary capitalism; 'prosumers' are those who both generate and use energy, such as homeowners who install solar panels. It is part of an agenda to explore prosumption as a generic phenomenon and does not explicitly deal with energy. Its relevance here is that it explores how combining processes of production and consumption might affect social and economic relationships, which in the context of energy transitions have been made pertinent with the proliferation of solar panels and smart grids. The authors argue that in prosumer capitalism, control and exploitation take on a different form than in other types of capitalism. Four characteristics of prosumer capitalism are elaborated in the article: (1) capitalists have more difficulty controlling prosumers than producers or consumers and there is a greater likelihood of resistance by prosumers; (2) the exploitation of prosumers is less clear-cut; (3) a distinct economic system may be emerging where services are free and prosumers are not paid for their work (or in our case, energy); and (4) there is abundance rather than scarcity, a focus on effectiveness rather than efficiency in prosumer capitalism. The authors note that prosumption has always been important, but that in late capitalism, there is a tendency towards attempting to capitalise on the free labour sometimes provided by prosumers. In the context of this report, the article provides a critical reading of contemporary calls from energy policy makers for more prosumers and a more active demand side, suggesting that we should be wary of the potential exploitative relationships that we might be establishing and building future energy systems upon.

Sumpf, P., 2019. *System Trust: Researching the Architecture of Trust in Systems*. Berlin: Springer.

This book explores the importance of trust in systems – from legal systems and training systems to political systems – for the functioning of modern society. The author applies this thinking to the energy system, and in particular the decentralisation of energy and transition from fossil fuels to renewable sources in Germany. He poses the question: if trust is essential to the success of future (smart) energy systems, how will this be secured? The book contains sixteen hypotheses, including that systems need to build stable identities to become objects of trust, and that an 'architecture of trust' is built in order to make abstract systems like energy real for participants (or 'trustors'). Amongst the book's conclusions are a prediction that trust will come to play a greater role than currently in energy systems, as we move towards smart grids. The author observes that, unlike in the twentieth century, the increase in prosumer involvement in the energy grid means there may be systemic consequences if trust is lost.

Woodruff, A., Augustin, S. and Foucault, B., 2007. Sabbath Day Home Automation: "It's Like Mixing Technology and Religion". In *Proceedings, SIGCHI conference on human factors in computing systems*, pp.527-536.

This article presents a qualitative study of 20 American Orthodox Jewish families' use of home automation technologies for religious purposes, primarily observing their role in Jewish religious rules on the Sabbath. It highlights American Orthodox Jews as a leading group in home automation practice, but a group which has been overlooked in home automation research. By focusing on the use of home automation to augment spiritual life the article highlights assumptions and biases often present in smart technology research, which has a tendency to over-emphasise values such as efficiency or mastery. In doing so, the article illuminates significant heterogeneity amongst households' lifestyles, goals and value systems. The article translates learning from the study into three principles for consideration in future design of home automation systems: 'surrender of control as a design resource'; 'support for varied lifestyles and long-term goals'; and 'respite as a mandate and as a community experience'. This article is useful for highlighting an alternative perspective on smart consumption, encouraging more heterogeneity in smart consumption research, and demonstrating the value of the above in relation to building a more holistic picture of how smart consumption interacts with different elements of social, family and spiritual life.

2.6. Unevenness and justice aspects of smart consumption

Promoting smart consumption might seem like a neutral endeavor. However, SSH scholars increasingly show how that is not the case. Different groups have different means and opportunities of participating in the activities that provide the benefits of smart consumption, which means that the benefits and burdens of smart energy systems will often be distributed unevenly across territories, between generations, and across social groups. The articles referenced in this section look at the background for and consequences of such inequalities, while asking how they can be avoided, thus providing key insights for policy makers on issues that are often overlooked.

Barnicoat, G. and Danson, M., 2015. The ageing population and smart metering: A field study of householders' attitudes and behaviours towards energy use in Scotland. *Energy Research & Social Science*, 9, pp.107-115.

This article builds from the principle that smart technologies must be inclusive of diverse populations if they are to be adopted and used efficiently, and if they are going to bring the intended benefits. The article specifically focuses on older tenants in rural Scotland, examining their attitudes and behaviours towards energy use in the home after the installation of smart meters and in-home displays. Results from four research elements are given, encompassing: current and past engagement with energy use, strategies for managing energy use and alleviating fuel poverty, perceptions of using smart technologies, and external control of home energy. This article presents several implications for policy makers, outlining areas where the experience of research participants differed from assumptions in energy planning and practices. For example, habitual fuel-rationing practices were identified during non-peak times of the day, despite energy (gas) rates being cheaper. Low knowledge of energy pricing, energy efficiency and smart technologies were also identified as potential barriers to technology adoption and positive user experiences. The above points challenge assumptions that uptake of residential demand-response will automatically follow the introduction of variable pricing. More generally, this study serves as a reminder that assumptions built into energy planning and policy practices should be tested

on diverse user groups in order to check whether the approach is likely to yield intended results, and/or whether one size fits all approaches are appropriate.

Powells, G. and Fell, M.J., 2019. Flexibility capital and flexibility justice in smart energy systems. *Energy Research & Social Science*, 54, pp.56-59.

Written from a sociological perspective, this article engages with the notion of flexibility in energy consumption and the potential justice implications of instigating flexible consumption. The article discusses conceptually how one can think about a situation where flexibility is desired from an energy systems perspective and incentivised accordingly. This would entail penalising peak load energy consumption, while economically rewarding load shifting. The article discusses the possibility for citizens to contribute to such an endeavour in terms of flexibility capital. Flexibility capital illustrates how different households have different capacities in terms of economic capital, technology ownership, home ownership, size of home etc., and that these differences in capacity influence the possibility of reaping the economic rewards from selling flexibility. For example, people who own a house, have an electric vehicle and many other loads (e.g. induction oven, large water boiler, floor heating) to play around with have more flexibility to sell than those who rent a small apartment and who mainly use a few essential loads. This means that people with high shares of flexibility capital can actually afford to opt out of providing flexibility, while those who have few means to provide flexibility may be forced to do so, or incur economic penalty. The policy implications of these dynamics are that policies meant to stimulate flexibility should also develop and implement tools that seek to avoid injustices inflicted by flexibility schemes.

Strengers, Y., 2014. Smart energy in everyday life: are you designing for resource man? *Interactions*, 21(4), pp.24-31.

This article describes the archetype of a rational, individual, masculine energy consumer – 'Resource Man' – around which many smart technologies are built. The article then challenges this dominant image, arguing that very few households or individuals actually reflect the archetype in practice. It points to several risks of 'designing for Resource Man', including: consumer apathy or disengagement, ignorance of the daily activities and social practices that actually implicate energy consumption, and a tendency to encourage new forms of consumerism in the consumption of smart energy devices and services. The article closes with five recommendations for designing future smart technologies such as: embracing messiness, designing for others (different social groups, family structures, dwelling types etc.), and questioning common assumptions in design processes. The article provides a practical challenge to current dominant design paradigms and highlights how they may fail to deliver desired results if deployed unquestioningly at scale. New principles for smart technology design may help to overcome these hurdles ensuring that technology serves a broader diversity of people, practices, lifestyles and living situations. This can ultimately contribute to greater reductions in overall energy demand, demand peaks and greenhouse gas emissions whilst serving a wider range of social needs.

2.7. Beyond smart: questioning assumptions and evaluating alternatives

The critique of current ways of promoting smart consumption has also prompted calls for radically different thinking about smart technology and how it might change our societies. Studies that do this often end up calling for alternative ways of mobilising ICT technologies to instigate change, or more creative ways of understanding human rationality.

Boucher, A., Gaver, W., Kerridge, T., Michael, M., Ovalle, L., Plummer-Fernandez, M. and Wilkie, A., 2018. *Energy Babble*. London: Mattering Press.

This book presents the outputs from a collaborative study between Design and Science and Technology Studies researchers. During the project, researchers created computational devices called 'Energy Babbles', described as 'automated talk radios for energy' consisting of synthesised voices reading out energy-related content from a variety of sources (e.g. policy announcements, social media, National Grid etc.). The devices were given to eight participating community groups in the UK who focused on community energy demand-reduction, and reactions they provoked were observed. The book presents research findings in textual and visual formats. A key aim of this book is to present differing views alongside each other in the same space, rather than attempting to synthesise this 'babble' into a single narrative. This research is useful for policy makers as it explores the complexities of public engagement with and understanding of energy-related issues. Importantly, it highlights the heterogeneity of views and reactions within even fairly small, engaged communities. It also highlights the

agency and expertise held within energy communities, inviting researchers to reconsider how participants are characterised, and engaged with, for future research studies.

Sadowski, J. and Levenda, A.M., 2020. The anti-politics of smart energy regimes. *Political Geography*, 81, 102202.

The main argument of this article is that energy systems, including smart energy systems, are political. This is explained using the concept of technopolitics, which outlines how technological systems and infrastructures embed and enact politics - even where they are superficially presented as a-political. The USA and Australia are presented as two national case studies providing empirical evidence of politics within smart energy system development. The article demonstrates how smart energy systems are not only the subject of de-politicisation on a technocratic basis, but also through neoliberal processes of deregulation and marketisation. Anti-politics, conceptualised as a way of doing politics by destroying the political, is highlighted as a particular form of technopolitics that is emergent in the smart energy space. In particular, anti-politics is characterised by the extension of real-time energy markets and the shaping of 'good' market subjects through automation, removing human messiness and inefficiency from market function. This article is useful in highlighting the political implications of decisions and philosophies that may otherwise be assumed not to hold political consequence. This can provide a valuable prompt for policy makers to re-assess where and what political assumptions are built into their work, whether these are intentional, and whether they will support policy outcomes to align with desired goals.

Morozov, E., 2013. *To Save Everything Click Here: Technology, solutionism and the urge to fix problems that don't exist*. London: Penguin.

This book has popularised and brought to a large readership the types of critical analyses that scholars from SSH have often provided on what Morozov calls 'technological solutionism'. The book does not specifically concern smart energy consumption, but rather engages broadly with how contemporary culture tends to uncritically praise new technologies based on the collection and exploitation of data, e.g. by making algorithms that assist in consumption choices, systems that gamify choices, or markets that sell new types of products that are based on the collection and analysis of data in near real time. The book is concerned with the dark side of such developments, noting that while rhetorically promoting free individual choice, such technologies tends to concentrate economic power and other elements of control in a few hands, while catering for capitalism based on surveillance and triggering behaviour change through cynical manipulation. The policy relevance here is clear, as the book calls for developing new institutions that regulate the action of big technology companies to benefit the public good, governance procedures that work to anticipate and mitigate dark side consequences, as well as acknowledging the political aspects of new technologies.

Kitchin, R., 2015. Making sense of smart cities: addressing present shortcomings. *Cambridge journal of regions, economy and society*, 8(1), pp.131-136.

This article describes and critiques research on smart cities. The article points to the seemingly common sense and non-ideological character of the smart agenda rhetoric, which has obscured the political assumptions, ideologies, processes and consequences built into smart cities. The article then outlines the development of a smaller body of critical smart city research aiming to fill this gap. However, the author also points to shortcomings in this literature. The article argues for the need to expand on the historical understanding of smart cities, by analysing the term's differential origins and interpretations, developmental paths, influential actors, and inbuilt economic/political assumptions. Further, the article critiques the tendency to use overly general ('one size fits all') analytical approaches when seeking to understand smart cities. The article also criticises the use of canonical examples, i.e. a small number of smart, typically newly built cities (e.g. Masdar in the United Arab Emirates) – and a lack of comparative research. Finally, the article highlights weak collaboration with technically-oriented stakeholders as a gap in critical smart city research. The article is a useful tool for highlighting gaps in knowledge that policy makers should be aware of when developing smart city policies, which are arguably also key contexts for the promotion of smart consumption. It may also be useful for funding bodies looking to advance research that targets these gaps.

Bina, O., Inch, A. and Pereira, L., 2020. Beyond techno-utopia and its discontents: on the role of utopianism and speculative fiction in shaping alternatives to the smart city imaginary, *Futures*, 115, 102475.

This article builds on a body of work regarding 'smart city imaginaries' (SCIs); visions of technologically-enhanced urban futures used actively in policy and planning. It takes a critical stance on many mainstream SCIs as presenting a 'techno-utopian' vision of the future that risks glossing over potential negative side

effects for citizens and the environment, for example erosion of political agency or reduction of access to green space. However, the article does not take an anti-utopian view. Rather, it argues that engaging with different forms of utopianism can become a useful analytical tool. To do this, the article analyses 57 'culturally significant' speculative fictional representations of technologically-driven futures. The authors argue that engaging with this kind of literature can be valuable for two main reasons. Firstly, utopian depictions can help to explain, bring to life, and expand existing social scientific critiques of SCIs. Secondly, they can help people to creatively engage with the construction of new and different SCIs. This article provides a useful reminder of the importance of engaging with artistic and literary disciplines, alongside other forms of social and scientific study, in creating visions for the future. It is also valuable in highlighting how practising this form of interdisciplinarity can broaden the collective imagination of what it is possible to build in the future, potentially promoting more inclusive and environmentally friendly approaches.

3. Concluding remarks

This annotated bibliography has surveyed the breadth of scholarship characterising SSH research on smart consumption. It has illustrated how the field emerged in broader SSH debates focussing on the cultural and historical contexts of consumption. As smart consumption became a more distinct theme, much early literature was concerned with assessing how or if smart technologies, new price signals or new types of information could stimulate behaviour change amongst energy consumers. The focus has later expanded to probe ways that smart technologies and instruments can become parts of social practice, as well as to highlight the many ways that people can interact with smart technologies, one of them being as energy citizens. Further, SSH has become concerned with how smart consumption is an element of broader institutional configurations, as well as critically discussing how smart consumption is organised and produced through technical and social arrangements. Finally, an important element of SSH debates about smart consumption relates to justice. For whom is smart consumption a good solution, and for whom is it not? What are the social and economic consequences of an energy transition underpinned by smarter energy consumption?

Thus SSH research offers both critical and productive perspectives for how policy and (smart) technology development can better be facilitated, to achieve more sustainable futures. We believe these debates and insights need to be much better reflected in policy, which today over- emphasises targets related to technically and economically 'optimal' solutions whilst turning a blind eye to the discussions raised in this report.

We by no means intend the list of articles in this report to be exhaustive. Yet, we think this bibliography characterises some of different avenues of scholarship and debates within the field and we hope readers are inspired to seek out in-depth knowledge on smart consumption.

4. Acknowledgements

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5. References

Foulds, C. and Christensen, T. H., 2016. Funding pathways to a low-carbon transition. *Nature Energy*, 1(7), pp.1-4.

Foulds, C., Royston, S., Berker, T., Nakopoulou, E., Abram, S., Ančić, B., Arapostathis, E., Badescu, G., Bull, R., Cohen, J., Dunlop, T., Dunphy, N., Dupont, C., Fischer, C., Gram-Hanssen, K., Grandclément, C., Heiskanen, E., Labanca, N., Jeliazkova, M., Jörgens, H., Keller, M., Kern, F., Lombardi, P., Mourik, R., Ornetzeder, M., Pearson, P., Rohracher, H., Sahakian, M., Sari, R., Standal, K. and Živčič, L., 2020. *100 Social Sciences and Humanities priority research questions for energy efficiency in Horizon Europe*. Cambridge: Energy-SHIFTS.

Grubler, A., Wilson, C., Bento, N., Boza-Kiss, B., Krey, V., McCollum, D.L., Rao, N.D., Riahi, K., Rogelj, J., De Stercke, S., Cullen, J., Frank, S., Fricko, O., Guo, F., Gidden, M., Havlík, P., Huppmann, D., Kiesewetter, G., Rafaj, P., Schoepp, W. and Valin, H., 2018. A low energy demand scenario for meeting the 1.5 C target and sustainable development goals without negative emission technologies. *Nature energy*, 3(6), pp.515-527.

Robison, R., Skjølsvold, T.M., Lehne, J., Judson, E., Pechancová, V., Foulds, C., Bilous, L., Büscher, C., Carrus, G., Darby, S., DemirbağKaplan, M., Douzou, S., Drevenšek, M., Frantál, B., Guimarães Pereira, A., Hargreaves, T., Karvonen, A., Katzeff, C., Kola-Bezka, M., Laakso, S., Lettmayer, G., March, H., Parag, Y., Renstroem, S., Sáfián, F., Swora, M., Tjørring, L., van der Werff, E., van Vliet, B., Wallenborn, G., Wolsink, M. and Wyckmans, A., 2020. *100 Social Sciences and Humanities priority research questions for smart consumption in Horizon Europe*. Cambridge: Energy-SHIFTS.

Robison, R., Skjølsvold, T. M., Foulds, C. and Bharucha, Z.P., 2019. *Terms of Reference: Energy-SHIFTS Working Group 2–Smart Consumption*. Cambridge: Energy-SHIFTS.

Rogge, K.S., Pfluger, B., and Geels, F.W., 2020. Transformative policy mixes in socio-technical scenarios: The case of the low-carbon transition of the German electricity system (2010–2050). *Technological Forecasting and Social Change*, 151, 119259.

Ryghaug, M., Subotički, I., von Wirth, T., Smeds, E., Scherrer, A., Foulds, C., Bertolini, L., Beyazit, E., Brand, R., Cohen-Blankshtain, G. Dijk, M., Freudendal-Pedersen, M., Gössling, S., Guzik, R., Kivimaa, P., Klöckner, C., Nikolova, C.L., Lis, A., Marquet, O., Milakis, D., Mladenović, M.N., Mom, G., Mullen, C., Ortar, N., Paola, P., Oliveira, C.S., Schwanen, T., Seidenglanz, D., Tuvikene, T. and Wentland, A., 2020. *100 Social Sciences and Humanities priority research questions for transport and mobility in Horizon Europe*. Cambridge: Energy-SHIFTS.

Sumpf, P., Klemm, M., Throndsen, W., Büscher, C., Robison, R., Schippl, J., Foulds, C., Buchmann, K., Nikolaev, A. and Kern-Gillard, T., 2017. *Energy system optimisation and smart technologies – a social sciences and humanities annotated bibliography*. Cambridge: SHAPE ENERGY

von Wirth, T., Loorbach, D., Wagner, A., Koretskaya, O., Wade, R., Krupnik, S., Rudek, T., Foulds, C., Adem, C., Akerboom, S., Batel, S., Caspar Rabitz, F., Certoma C., Cherp, A., Chodkowska-Miszczuk, J., Denac, M., Dokupilová, D., Dotterud Leiren, M., Frolova Ignatieva, M., Gabaldón-Estevan, D., Horta, A., Karnøe, P., Lilliestam, J., Markard, J., Mišik, M., Mühlemeier, S., Nemoz, S., Nilsson, M., Osička, J., Papamikrouli, L., Pellizioni, L., Sareen, S., Sarrica, M., Seyfang, G., Smith Stegen, K., Sovacool, B., Telesiene, A., and Zapletalova, V., 2020. *100 Social Sciences and Humanities priority research questions for renewable energy in Horizon Europe*. Cambridge: Energy-SHIFTS.

Overland, I. and Sovacool, B. K., 2020. The misallocation of climate research funding. *Energy Research & Social Science*, 62, 101349.

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Energy -SHIFTS

Energy Social sciences & Humanities Innovation Forum Targeting the Set-Plan

a.r.u. Global Sustainability Institute

drift for transition

EERA European Energy Research Alliance

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E3G

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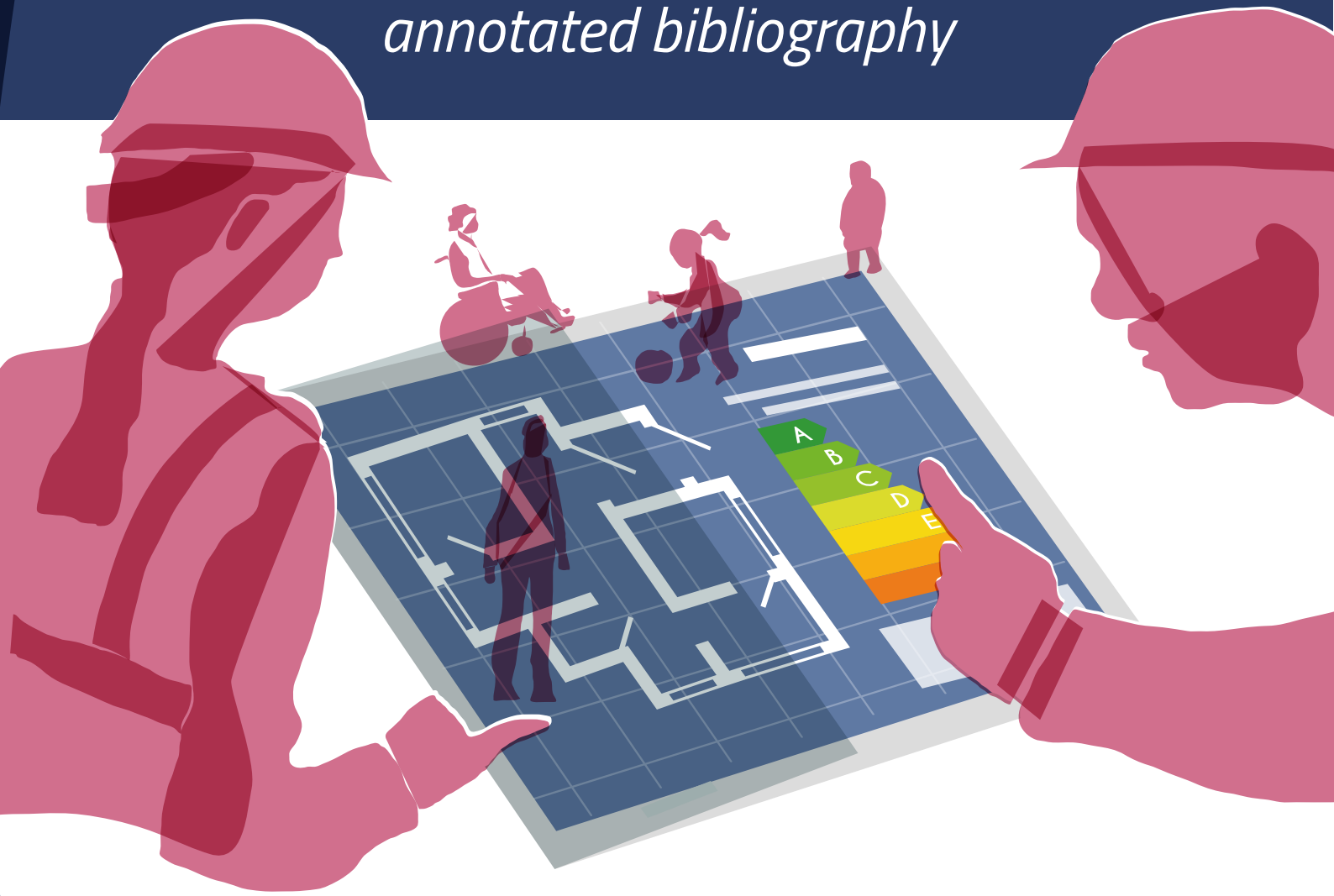
Energy efficiency:
A Social Sciences and Humanities annotated bibliography



Energy-SHIFTS
ENERGY SOCIAL SCIENCES & HUMANITIES INNOVATION FORUM TARGETING THE SET-PLAN

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June 2021

Energy efficiency:

A Social Sciences and Humanities annotated bibliography

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Executive summary

Background

- This bibliography was developed as part of the European Commission (EC) funded project Energy Social Science Humanities Innovation Forum Targeting the SET-Plan (Energy-SHIFTS), which contributes to the European Energy Union by further developing Europe's leadership in using and applying energy-related Social Sciences and Humanities (energy-SSH).
- The annotated bibliography offers context to the Horizon Scan results developed through the project.

The aim

- This report provides annotations to 24 key publications in SSH research on energy efficiency and should serve as a companion piece to the 100 priority SSH research questions in the Horizon Scanning report.
- This report is intended to inform policymakers and other non-experts on the breadth of energy-SSH knowledge that characterises the field today.

The approach

- The annotated bibliography presents a selection of peer-reviewed scientific publications that contextualise the research priority questions identified in the Horizon Scan.
- Publications were selected to reflect the substantive and disciplinary diversity of the energy-SSH field.

The findings

- We structured past SSH contributions to the energy efficiency literature around six themes: SSH overviews and syntheses of energy efficiency (subsection 2.1); innovations in and of energy efficiency (2.2); policies and politics of energy efficiency (2.3); challenging behavioural assumptions of energy efficiency roll-out (2.4); lived experiences of energy efficiency (2.5); and, moving to issues of energy demand (2.6).
- It is clear that SSH has much to offer the normative pursuit of widespread energy efficiency. SSH can therefore offer more in-depth understanding of and new pathways for such pursuits, than a traditional reliance on, for example, the rational choice assumptions of mainstream Economics approaches to energy efficiency. Examples include policy mixes, transition pathways, modelling assumptions, innovation processes, experimentation, lived experiences, expectation management, and the consideration of various (e.g. professional) actors beyond that of the usual 'end-user'.
- This said, it is also clear that much of the SSH literature remains firmly ambivalent with energy efficiency as an end-goal. Indeed, there are many papers dedicated to its critique (e.g. assumptions within its underlying paradigm) and many relatively new papers that argue for research/policy communities to fundamentally shift their attentions to instead focus on bigger questions of energy demand (i.e. energy conservation and sufficiency, over efficiency).

Contents

1. Introduction

1.1. Background: energy-SSH and Energy-SHIFTS

This annotated bibliography was developed as part of the Energy Social Sciences and Humanities Innovation Forum Targeting the SET-Plan (Energy-SHIFTS) project. Energy-SHIFTS supports the EU Energy Union to develop Europe's leadership in energy-related Social Sciences and Humanities (energy-SSH) research. The field of energy-SSH has remained marginal, giving way to energy research interests dominated by the natural and technical sciences (Foulds and Christensen, 2016; Overland and Sovacool, 2020; Robison and Foulds, 2019; Royston and Foulds, 2021). However, the EC has expressed a commitment to mainstream SSH research and innovation activities, including supporting standalone energy-SSH projects.

The Energy-SHIFTS project aims to strengthen energy-SSH for European research and innovation, as well as strengthen its relevance to EU energy policy. Energy-SHIFTS contributes cutting-edge research priorities from energy-SSH research communities, which can guide and anchor EU research and innovation funding for SSH research and thereby bridge the current policy gap. Through its Horizon Scanning initiative, four Europe-wide working groups presented 100 priority SSH research questions on key topics within the EU Energy Union and EC research and innovation funding priorities: (1) renewables (von Wirth et al., 2020); (2) smart consumption (Robison et al., 2020); (3) energy efficiency (Foulds et al., 2020); and (4) transport and mobility (Ryghaug et al., 2020). The annotated bibliographies are companion resources to these Horizon Scan outputs.

1.2. Aims of the Annotated Bibliographies

The annotated bibliographies aim to provide a contextual backdrop and sense of the evolution of academic research, which is intended to be read alongside the 100 priority SSH research questions in the Horizon Scanning reports. An annotated bibliography is a list of references to academic books and articles, accompanied by short descriptions of their content and arguments. Specifically, this report provides annotations to 24 key publications in SSH research on energy efficiency. It is one of four annotated bibliographies, alongside renewables, smart consumption, and transport and mobility. These annotated bibliographies are intended to give policyworkers and other non-experts insight into the breadth of energy-SSH knowledge and approaches that currently characterise the field. They portray the main relevant advances in energy-SSH and, as such, offer context for the forward-looking priority SSH research questions.

The annotated bibliographies therefore offer a taste of the main SSH debates, milestones, and advances in the field through a summary of key scholarly contributions, without providing full coverage of the field. The ambition is to demonstrate the range and variation of energy-SSH research, incorporating different and sometimes contradictory disciplinary perspectives, research themes and approaches. The bibliographies can give policyworkers and other non-experts (or new researchers) insights to help navigate the SSH research relating to energy efficiency.

1.3. The topic of this Bibliography: Energy efficiency

This annotated bibliography focuses on energy efficiency, as a clear priority of EU energy, climate, and now Green Deal policies. The Energy-SHIFTS Working Group on energy efficiency took the EU's 2012 Energy Efficiency Directive as a starting point for defining the group's scope, which refers to "*the ratio of output of performance, service, goods or energy, to input of energy*" (European Parliament and Council, 2012: article 2, point 4; p.10). Critically, the Working Group did not regard energy efficiency as being equivalent to energy-saving behaviours, but was open to critical perspectives that more deeply considered energy efficiency in light of wider energy demand (and energy sufficient) considerations (Foulds et al., 2019; Foulds et al., 2020).

Through a comprehensive, future-looking Horizon Scanning exercise (Foulds et al., 2019a), the Working Group produced a list of 100 priority SSH research questions, primarily relating to EU funded research and innovation on energy efficiency. These 100 questions together aimed to "*promote SSH research that better situates energy efficiency in relation to social systems of energy demand and supply; and to constructively challenge notions of energy efficiency by opening up questions of its meanings, applications and implications across diverse contexts, actors and scales*" (Foulds et al., 2020, p.7).

The 100 SSH priority research questions for energy efficiency were clustered across seven themes: (1) Citizenship, engagement and knowledge exchange in relation to energy efficiency; (2) Energy efficiency in relation to equity, justice, poverty and vulnerability; (3) Energy efficiency in relation to everyday life and practices of energy consumption and production; (4) Framing, defining and measuring energy efficiency; (5) Governance, policy and political issues around energy efficiency; (6) Roles of economic systems, supply chains and financial mechanisms in improving energy efficiency; and (7) The interactions, unintended consequences and rebound effects of energy efficiency interventions. While these questions highlight pressing topics and perspectives in SSH research on energy efficiency, the field is broader, encompassing topics that resist easy categorisation within these seven themes. In this annotated bibliography, we, therefore, aim to present a broader view of what constitutes SSH scholarship on energy efficiency, which does not always relate to the normative pursuit of ever greater (energy) efficiency. Nevertheless, these key pieces are important stepping stones and inspiration for stimulating new research topics, interests, perspectives, and debates.

1.4. Methodology for selecting key pieces of literature

Our 24 publications were selected based on their relevance to the research priority questions in the Horizon Scan and policyworkers. This selection includes peer-reviewed scientific publications, review articles, monographs and anthologies.

The selection criteria were diversity and disciplinary representation to highlight the breadth of the energy-SSH field. Publications were selected following 10 expert interviews with SSH leaders with significant experience working in the broad areas of energy efficiency research. These 10 interview participants were also part of the energy efficiency Working Group, and thus did also formally contribute to the Horizon Scanning exercise. The interviews were conducted between January and February 2020, in the initial stages of the Horizon Scanning. Interview participants included energy-SSH experts working on a range of topics and within different disciplinary traditions, and geographical and gender diversity (Foulds et al., 2019a, p.17-18, p.25). Each participant submitted approximately five publications they considered seminal for the development of the field. From these, a selection of publications was included in the annotated bibliography based on number of citations, perceived impact within the field, and contribution to new research avenues and themes within the field. Some publications suggested in the interviews were excluded because they lacked a focus on SSH, were less relevant to the Working Group theme, or were marginal in terms of their impact and relevance to the topic and our definition of energy efficiency. The authors then identified gaps based on the participants' descriptions of the development of their fields and key research themes that emerged during the Horizon Scanning exercise. Additional complementary publications were sourced from the Horizon Scanning survey responses (evidence and rationale for proposed research questions) and the authors' expertise within the field.

1.5. How to use the Annotated Bibliographies

These annotations are short summaries of the original source material and provide a taste of each contribution. We hope readers are inspired to seek out the full publications on their topics of interest. Given the limited selection of publications, readers may also use the list as a tool to seek out broader and/or more specific literature in the field. The bibliography may, for instance, be read prior to viewing the 100 priority SSH research questions in the Horizon Scan report, or as an independent source of information.

Readers may also be interested in reading annotated bibliographies from the Social Sciences and Humanities for Advancing Policy in European Energy (SHAPE ENERGY) project[1], which was the predecessor to Energy-SHIFTS and offers more systematic reviews of the given fields.

1 https://shapeenergy.eu/index.php/publications/annotated-bibliographies/

2. Key pieces of Social Sciences and Humanities (SSH) literature on energy efficiency

Research on energy consumption, conservation and security began in earnest in the 1970s, partly in response to the oil crisis at the time; this increasingly involved calls for greater energy efficiency at both micro- and macro-levels. In the decades that followed, more and more SSH research (although mainly Economics-led) was undertaken in the pursuit of improving energy efficiency levels, albeit against the backdrop of energy supply issues usually being prioritised over energy demand issues. But it was not, however, until the 1990s that this SSH research went beyond these techno-economic positions; the likes of Lutzenhiser, Shove, Wilhite and others were central to this evolution of the literature. Since then, there was a ballooning of SSH research on energy efficiency, especially during 2000-2015 approximately, mirroring policy interest in energy efficiency as a route to addressing energy poverty and carbon reduction goals. In more recent years, we would argue that many SSH researchers who had published widely on energy efficiency began to evolve their work to e.g. critique and explore the implications of the next generation of energy-related techno-fixes (including smart technologies), and/or moved beyond energy efficiency in exploring wider systemic issues of how energy demand is socially and culturally organised (including calling for energy sufficiency).

In the following six sub-sections, we present six themes representing clusterings of similar SSH literature. These themes primarily relate to current debates within the critical-SSH literatures, and we do thereby push back against the traditionally-dominant (instrumental) utilisation of SSH as a dissemination tool for technology transfer of energy efficiency. We therefore intentionally exclude much of the SSH literature that still enable the continuation of such arguments - and policy positionings - as including these would directly contradict a core ambition of this bibliography: to demonstrate the diversity, richness and overlooked potential of much of the energy-SSH literature.

2.1. Social Sciences and Humanities (SSH) overviews and syntheses of energy efficiency

Given the array of studies around energy efficiency over recent decades, there have been a small number of review articles that set themselves the task to offer overviews of past works and critically distill cross-cutting lessons. These review papers have reiterated the point that energy efficiency research has been dominated by technical research interests, and hence Engineering research dominates the evidence base. But within the relatively small subset of SSH-focused papers on energy efficiency, these overviews and synthesis papers also emphasise that the research that is meant to be more societal in its remit is still really rather techno-economic in its positioning. As such, the illustrative papers that we cover below step back in identifying the research gaps and policy dangers of this mainstream, technical energy efficiency agenda. Within this, questions are also raised of the normative assumptions of energy efficiency, i.e. that energy efficiency is good for societies and that it should be a priority in energy and climate change strategies. All the papers complicate such interpretations and suggest avenues through which SSH can contribute to a more nuanced view on energy efficency.

Patterson, M.G., 1996. What is energy efficiency? Concepts, indicators and methodological issues. *Energy Policy*, 24(5), pp.377–390.

Written at a time when energy efficiency was only starting to take hold in mainstream energy policy agendas, this paper unpicks what energy efficiency indicators are and usefully problematises the concepts and methodologies that underpin their development

and implementation. Whilst much of this paper is Engineering in nature, the interdisciplinary stance leads to a number of SSH-related findings. Firstly, Patterson argues that the assumption that thermodynamic measurements are fundamentally objective is wrong; value judgements exist and thus the way that energy efficiency performance is calculated is not "free of human values and perceptions" (p.383). Secondly, energy efficiency can be assessed at multiple scales and, as such, systems-level considerations only add to the complexity of any methodology being applied. Thirdly, assessing energy efficiency requires one to draw boundaries (e.g. regarding energy input definitions), which are often not transparently presented, properly justified, nor thoroughly thought out. The paper argues that these issues need due consideration, if energy efficiency policies are to be appropriately monitored.

McAndrew, R., Mulcahy, R., Gordon, R. and Russell-Bennett, R., 2021. Household energy efficiency interventions: A systematic literature review. *Energy Policy*, 150, pp.112136.

In focusing on household-level energy efficiency interventions, McAndrew et al. undertook a systematic review of 160 publications (over 1990 to November 2019) and 153 relevant interventions. They specifically explored how effective energy efficiency interventions were in advanced economies, in the context of of households. Their reviewed energy efficiency interventions were shown to improve: health and well-being; thermal comfort; air quality; productivity; energy security; and social capital. These benefits were said to justify the place of energy efficiency within dominant energy policy agendas, although they cautioned that the evidence was mixed and that there were actually significant inconsistencies and gaps in e.g. intervention types, approaches, population groups, etc. More work was therefore needed to inform evidence-based policymaking, including more comparisons for instance. They finish by recommending that energy policy move beyond a "one-size-fits-all approach" (p.9) by grounding its interventions in specific theories, clear purposes, local contexts, and targets on co-benefits.

Dunlop, T., 2019. Mind the gap: A social sciences review of energy efficiency. *Energy Research & Social Science*, 56, pp.101216.

This review demonstrates that a mere 2.6% of energy efficiency research literature over 1909-2018 (totaling 155,156 publications) is from the Social Sciences, and thus Dunlop argues that this underrepresentation needs to be urgently addressed - not least because of energy efficiency's prominent positioning in energy policies globally. In propelling the Social Science literature on energy efficiency, she cautions that deeper discussion is needed on what exactly 'energy efficiency' means from a Social Scientific perspective, in both conceptual terms and in how interventions are designed. Such frank debate is essential given the value judgements that are embedded within different approaches to energy efficiency. In particular, the review argues that more attention is needed on: the historical aspects of energy efficiency relating to its origins and evolutions, including its connections to societal notions of efficiency more broadly away from energy; how our socially-shaped value judgements are shaping how we measure energy efficiency; a deeper interrogation of the (contested) benefits of energy efficiency and the default assumption that its roll-out will always represent a social good; and, finally, a greater utilisation of Sociological approaches in unpicking the consequences of energy efficiency solutions (e.g. in relation to energy justice issues).

Lutzenhiser, L., 2014. Through the energy efficiency looking glass. *Energy Research & Social Science*, 1, pp.141–151.

The focus of this paper is on what is said to be an overused 'model' that dominated both research and policy discourse on energy efficiency. The paper argues that even if this model is not explicitly discussed, it is implicitly present in the fundamental arguments put forward for (and about) energy efficiency. The model in question assumes a rational, linear, predictable, and ordered roll-out of energy efficiency technologies, which is only made possible because of the assumed predictability and stability of society. A key message from this paper is that this model inherently conflicts with the problem definitions posed by Social Scientists, and thus the mainstream rationales and approaches that sit behind energy efficiency are argued as being at odds with what the Social Sciences bring to the energy efficiency (policy) discussion. In this vein, the paper strongly argues for greater research and policy consideration of the political and institutional contexts that produce and maintain societal visions and approaches to energy efficiency.

2.2. Innovations in and of energy efficiency

Energy efficiency policy and research has largely focused on innovations as means for transitions. SSH mainly contribute to this theme by studying innovation processes historically and empirically. The papers included in this theme reject the idea that innovations are driven by technology or markets alone. They explore how other factors – such as policy and politics, societal structures, technology framings, and collectively held norms and values, together with technology and markets – spur innovations. Innovation, here, is conceived as the outcome of negotiations between a broad variety of directly or indirectly involved actors and actor groups. This implies that innovations rarely are progressing in a linear way and that there is no single factor or actor that is able to move a new technology from its inception to widespread adoption. Instead, what this literature captures are tensions, abrupt changes and composite motivations that characterise innovation trajectories

Geels, F.W., Schwanen, T., Sorrell, S., Jenkins, K. and Sovacool, B.K., 2018. Reducing energy demand through low carbon innovation: A sociotechnical transitions perspective and thirteen research debates. *Energy Research & Social Science*, 40, pp.23-35.

This paper gives an overview of issues related to the emergence, diffusion and impacts of radical innovations aiming at reduced energy demand. Arguing against the simplifications of Neo-classical Economics and Social Psychology, the authors first introduce a socio-technical transition perspective and then discuss 13 related key research debates. Topics touched upon include: the power struggles between challengers and incumbent actors; the question of scalability; the role of space and place; how economics and financing should be organised; the nature of diffusion and how it can be accelerated; how user practices affect and are implicated in innovations; the existence, strength and causes of rebound effects; the availability and appropriateness of quantitative impact modelling tools; the co-construction of impacts; and, the role of policy and politics. The paper concludes with a summary of the central characteristics of a low-carbon transition; involving systemic, cultural and political change, and characterised by pervasive uncertainty. The paper can serve as a starting point for those who are looking for useful entries to a specific aspect of low-carbon demand-side innovation, and also for those who are interested in looking at a comprehensive picture of a broad set of issues that are at stake when demand-side energy reduction is conceived as an important part of climate change mitigation.

Lovell, H., 2008. Discourse and innovation journeys: the case of low energy housing in the UK. *Technology Analysis & Strategic Management*, 20, pp.613-632.

Lovell tells the story of the innovation journey of low energy housing in the UK, from its beginnings in the 1970s to the (paper's) present. Based on interviews and documentary analysis, she analyses the discourses that have framed, promoted and impeded the development and diffusion of sustainable housing and the coalitions of actors sharing these discourses. While in the 1970s, a broader movement for radical social change experimented with buildings that conserve energy and was mainly motivated by a desire for autonomy, the 1990s saw a reframing of language and problems. Here, the lack of innovation in construction, poor construction quality, fuel poverty, and traffic congestion were added to concerns about energy and climate change. Leading to the present (i.e. 2008), Lovell describes how a low-carbon discourse coalition had become dominant in UK policy. According to Lovell, central in this process were early pilots, above all the BedZED and Hockerton housing developments, which provided the public, professionals and policymakers with physical evidence of the feasibility of low-carbon construction. This evidence, however, was not without problems, as it favoured a particular framing, which neglected negative consequences of a one-sided reliance on technological solutions. Two lessons drawn from this brief history are particularly relevant beyond the UK. First, based on the presented observations, Lovell warns against the tendency of projecting current discourses into the past, which produces stories of innovation journeys that in reality were much less friction-free and linear leading. Second, the UK story resonates with developments in many other countries, where the same shift occurred from sustainable housing being part of a broader vision for social change to becoming framed as a technological fix, which is embedded in the promise that climate change mitigation, comfort and cost-efficiency can be achieved at the same time.

Morrissey, J.E., Dunphy, N.P. and MacSweeney, R.D., 2014. Energy Efficiency in Commercial Buildings: Capturing Added-Value of Retrofit. *Journal of Property Investment and Finance*, 32, pp.396–414.

Energy retrofitting of commercial buildings is a prime example of the so-called energy efficiency paradox,

based on the observation that cost-efficient energy saving measures are only hesitantly implemented. This paper provides an analysis of the whole value-creating process involved in energy efficiency retrofits. After a thorough discussion of tangible (i.e. monetary) and intangible value created by retrofit activities, the authors set out to empirically study the different stakeholders' viewpoints and relations. To make sure that the whole life cycle of energy efficiency retrofits is covered, they identify six life cycle stages (which they call activity hubs) on which value is created: upstream; initiation and viability; design and planning; construction/implementation; operation and maintenance; and, end of life. Based on 57 interviews with professionals involved in these stages across Europe, they then propose a model of informational, monetary, and value flows in office construction and retrofit projects. They found that perceptions of value vary considerably between and within the involved stakeholder groups, which in turn influences the focus of value creation activities. Moreover, temporal perspectives – which matter greatly in questions of *when* a value is expected to materialise – were found to be different among stakeholders. Because of this complexity, a key message of the paper is that only a careful analysis of the various perceptions of value (both tangible and intangible) is able to yield the knowledge required to increase market uptake of energy efficiency innovations.

2.3. Policies and politics of energy efficiency

This theme of SSH work addresses a series of interrelated and complementary sets of issues surrounding energy efficiency policy and politics, by posing different sets of questions. The historically informed empirical analyses, which draw from Science and Technology Studies (STS) and Innovation Studies, trace some of the most important shortcomings of energy efficiency policy and the corresponding goals, while offering fruitful insights on some of the possible ways towards overcoming them. While some work focuses on how the authority of (EU) energy efficiency policymaking is contested, attained and managed, other work offers insights on how to mobilise key actors and address key issues (e.g. energy poverty) that can expand the policy links and have a positive impact on policy goals. The papers pay attention to the need for consistent and coherent policies and calls for a shift on how energy efficiency policy is defined, understood and implemented.

Bergman, N. and Foxon, T.J., 2020. Reframing policy for the energy efficiency challenge: Insights from housing retrofits in the United Kingdom. *Energy Research & Social Science*, 63, pp.1-12.

Directly aimed at policymakers and industry stakeholders, the paper provides policy recommendations for overcoming the shortcomings of stimulating (large-scale) investments for residential energy efficiency. Even though the study is UK-focused, Bergman and Foxon provide insights that transcend the country-specific case study. The authors argue that the dominant policy framing for addressing market failures is insufficient in resolving the lack of investments, especially for overcoming concerns by investors. By shifting the focus away from market failures, which limit the scope of the problem and the avenues for taking action, the authors show how a different pathway can – at least, partly – resolve some of the shortcomings of achieving the policy goals. Namely, Bergman and Foxon argue that the lack of coherent and long-term policies can halt the mobilisation of various actors, which could otherwise be involved and play an incremental role towards the achievement of the policy targets. Drawing from interviews with key stakeholders and an extensive literature review, they suggest three aspects of a more systematic policy framing, namely: energy efficiency as infrastructure; new business and financing models for energy efficiency provision; and decentralised financing institutions for energy efficiency investment (p.3). Each of these framings can provide (new) policy links that can enable further investments and engage the correspondingly relevant actors in the process.

Kern, F., Kivimaa, P. and Martiskainen, M., 2017. Policy packaging or policy patching? The development of complex energy efficiency policy mixes. *Energy Research & Social Science*, 23, pp.11-25.

Investigating policy mixes involves the combined study of policy instruments and policy goals, and how they change or evolve overtime. Through a comparison between the UK and Finland, the authors trace differences and similarities in the energy efficiency policy mixes for buildings, from 2000 to 2014. They specifically examine how changes in such policy mixes can affect policy outcomes over time, in the hope that their ex-ante evaluation can offer guidance on how best to achieve energy efficiency policy goals. They discuss how their policy mixes included four processes – layering; drift; conversion; and, replacement – which influence the coherency of policy goals, and thus ultimately the effectiveness of the policy. Kern et al. also adopt concepts of policy packaging (i.e. where previous policies are discarded) and policy patching (i.e. where

additions and/or substitutions are made to existing policies), in discussing two different policy design processes, which can help to provide coherence and consistency between policy goals and instruments. Based on the differences found between the two case studies, the authors provide good suggestions for how the conceptual framework can be applied, while providing insights on how policy coherence can be achieved regardless of the policy mixes that have been adopted.

Dupont, C., 2020. Defusing contested authority: EU energy efficiency policymaking. *Journal of European Integration*, 42, pp.95-110.

Covering a period of nearly fifty years (1970s-2020), Dupont traces changes in the dominant types of contestations surrounding the EU's energy efficiency policymaking. With contestations on policymaking being a constant, the author suggests strategies for how to manage them. Such strategies mainly build on a discussion of previous EU efforts for establishing authority. Essentially, the author poses the following questions: "How has the EU attained the authority(-ies) of doing energy efficiency policy?" and within the context of attaining this authority "What have been the dominant types of contestations that the EU responded to, and how were they resolved?". By shifting the attention to the links between contestations and authority, the author provides useful insight on understanding the policymaking process(es). This enables her to suggest different strategies for managing policymaking contestations.

Urge-Vorsatz D. and Herrero S.H., 2012. Building synergies between climate change mitigation and energy poverty alleviation. *Energy Policy*, 49, pp.83-90.

Urge-Vorsatz and Herrero aim to provide policy links between energy poverty alleviation and climate change mitigation. As they argue, the two have, insofar, remained relatively distinct and disassociated policy spheres, despite their mutual interactions and common policy merits. The authors provide a bridge between energy poverty and climate change by placing the two at the heart of energy efficiency policy for buildings. Through an overview of the limited corresponding literature addressing energy efficiency in building, the authors offer a critique of the narrow definitions, which restrict further connections with energy efficiency policy goals. They argue that these definitions are narrow because they primarily focus on a single aspect of energy poverty (e.g. household heating) while completely ignoring other key-areas of energy poverty (e.g. cooling, lighting etc.). In order to remedy this conceptual gap, they provide a broader definition of energy poverty as: "encompassing the various sorts of affordability-related challenges of the provision of adequate energy services to the domestic space" (p.84). By doing so, they pave the way for further links between energy poverty and climate change, specifically targeted at energy efficiency policy for buildings.

2.4. Challenging behavioural assumptions of energy efficiency roll-out

The papers included in this theme collectively challenge the expectations attached to the roll-out of energy efficiency improvements. Fundamentally, they emphasise how inserting new energy efficiency technologies into people's lives is not a clear-cut, simple, or linear process. For instance, on one side, embedding energy efficiency technologies is dependent on people being prepared to make them part of their everyday lives, and on the other side, that integration may also affect people's lives. The papers argue that energy efficiency roll-outs cannot be understood as technological innovations that will one-directionally shape people's lives and lead to energy efficiency, but that there is a mutual shaping and a dynamic relationship between energy efficiency and people's practices and behaviors. Deeper reflection on assumptions regarding energy efficiency roll-out can therefore help improve management of societal expectations of energy efficiency improvements, and then possibly also their roll-out effect.

Gram-Hanssen, K., 2013. Efficient technologies or user behaviour, which is the more important when reducing households' energy consumption? *Energy Efficiency*, 6, pp.447-457.

This paper questions whether it is the introduction of energy efficient appliances and houses or user behaviour, which is more important in shaping efficient energy consumption. Using a range of qualitative and quantitative datasets (mainly from Denmark), Gram-Hanssen argues that user behaviour is consistently at least as important as new energy efficiency technologies. Moreover, in the case of heating-related domestic consumption, the study showed that 40-50% of its variation can be explained by building characteristics (e.g. house size, year of construction), with householder characteristics only marginally influencing consumption. Nevertheless, the paper also showed that completely identical houses varied (by a factor of 2-3) with regard to heating consumption, mainly due to

user behaviour. All in all, this paper essentially argues that it is not helpful look at energy efficiency technologies/houses and behaviour as a binary. Rather, they both matter and are interrelated. Policymaking should therefore target both when designing policies towards energy consumption reductions.

Shove, E., 1998. Gaps, barriers and conceptual chasms: theories of technology transfer and energy in buildings. *Energy Policy*, 26, pp.1105-1112.

Shove argues that mainstream policy agendas assume that the reason for why energy savings are not achieved is due to 'non-technical barriers'; that is, people's behavior and its associated determinants. Moreover, the mainstream assumes that these non-technical barriers are identifiable and linear in terms of their cause-effects relationships with energy efficiency uptake, and, critically, that new technologies represent the solution and thus must be pursued. The main (perceived) challenge, then, is to convince users to buy new energy efficiency solutions and/or use them correctly. By using insights from the STS, Shove argues against this techno-economic position. Similar to the previous paper, she argues that social and technical dimensions are being inappropriately separated (often implicitly) by those working in building energy management. In response to this, she discusses how technical innovations are socially structured, and thereby argues for a fundamental critique of interventions that seek a simple solution through technology transfer.

Lutzenhiser, L., Cesafsky, L., Chappells, H., Gossard, M., Moezzi, M., Moran, D., Peters, J., Spahic, M., Stern, P., Simmons, E. and Wilhite, H., 2009. *Behavioral assumptions underlying California residential sector energy efficiency programs*. White Paper prepared for California Institute for Energy and Environment (CIEE) Behavior and Energy Program, Oakland: CIEE.

This white paper examines California's utility-managed energy efficiency programmes, and their behavioural assumptions of residential consumers embedded within those programmes. Specifically, it examines the assumptions present in the physical-technical-economic model (PTEM), which has shaped California's energy efficiency programmes since the mid-1970s. The PTEM was shown to be wrong, given that its underlying assumptions did not represent anything close to real-world dynamics and its associated energy-consuming behaviours. Uncertainties that the PTEM poorly dealt with included: interactions between consumption determinants (e.g. values, behaviours, building characteristics); actual programme experiences as opposed to policy expectations (e.g. in terms of actual energy savings and market uptake); and viabilities of alternative approaches (e.g. driving energy efficiency improvements). The paper also discusses various Social Scientific reviews of energy efficiency programmes and paradigms, on route to generating recommendations for both research and policy. For policymakers and programme managers, the paper recommended that: policy conversations need to be reframed to better reflect Social Scientific evidence; they need to embed experimental and pilot-focused approaches to innovation; and, that craft knowledge needs to be better accounted for.

Sorrell, S., 2009. Jevons' Paradox revisited: The evidence for backfire from improved energy efficiency. *Energy Policy*, 34(4), pp.1456-1469.

Jevons' Paradox - as per William Stanley Jevons' original argument in 1865 - asserts that economically-justified energy efficiency interventions will increase energy consumption. If true, then the implications for low-carbon energy transitions and associated policy programmes will be significant, given that the default expectation is that energy efficiency will reduce energy consumption. Sorrell argues that most of the literature that has engaged with Jevons' Paradox has been overly theoretical and ultimately inconclusive. In this paper, he therefore attempts to test out the Paradox by connecting it to the literature on 'rebound effects'. This paper argues that whilst it is very unlikely that all energy efficiency improvement will lead to increases in energy consumption (or as the rebound effect literature would refer to it as, 'backfire'), it is possible. Hence there is much to still be learned from the factors that make said backfire in energy consumption more or less likely to happen. Evidence also suggested that Jevons' Paradox was more likely to hold for different types of improvements, e.g. electric motors in the early 1900s as opposed to modern thermal insulation improvements. From this, the policy message was that rebound effects (i.e. economic-led reductions in the potential energy savings achievable through energy efficiency upgrades) matter, are inevitable, and warrant further consideration by research and policy communities alike.

2.5. Lived experiences of energy efficiency

In this theme, the papers put more emphasis on the direct experiences individuals and collectives have with energy efficiency measures, how these are adopted in their everyday lives, and whether they lead to the

intended outcomes. SSH research addresses experiences predominantly as activities that are performed together with others and that interact with material settings and technologies. The papers below open several new ways in which lived experiences are discussed: as a concern about whether users' well-being is reduced by energy efficiency measures; as difficulties experienced in the practical implementation of energy efficiency; and, as embodied experience connected to practices that imply energy consumption. Together, they all refocus energy efficiency debates back onto the users and call attention to the complexity of their experiences and the multiple dynamics of their everyday lives.

Ornetzeder, M., Wicher, M. and Suschek-Berger, J., 2016. User satisfaction and well-being in energy efficient office buildings: Evidence from cutting-edge projects in Austria. *Energy and Buildings*, 118, pp.18-26.

This paper looks more closely at the various connections between the lived experience and well-being of occupants and the energy efficiency in office buildings. Ornetzeder et al. use mixed methods to study two highly energy efficient buildings and a larger sample of office buildings. Using a socio-material perspective, the authors assume that energy use and well-being are influenced by both the building and non-technical factors, such as work satisfaction and relations between occupants. The main finding of the study is that there is no systematic correlation between well-being and energy use. They identify three main factors that explain this finding: occupants compared experiences with the building with previous experiences in other buildings; building management and operation had an important influence on occupant well-being; and, the available area per occupant, for example in the form of break-out rooms, was in one case positively correlated with occupant well-being. Of these three factors, only the last one is more directly related to energy efficiency, but its effect can be neutralised by the other factors.

Gram-Hanssen, K., Christensen, T.H. and Petersen, P. E., 2012. Air-to-air heat pumps in real-life use: Are potential savings achieved or are they transformed into increased comfort?. *Energy and Buildings*, 53(10), pp.64-73.

In techno-economic analyses, the term 'rebound effect' describes situations in which energy saving directly or indirectly causes increases in energy consumption, for instance through reduced energy demand, which in turn lowers energy prices. In this paper, the relevance of this term is tested for a specific form of rebound which is connected to changes in what users do and experience after they have acquired and installed energy saving devices. The case studied was air-to-air heat pumps installed in Danish buildings. Based on a survey, which was analysed using a regression analysis, qualitative interviews, and technical inspections, the authors found solid evidence for actual energy savings falling behind the technical potential. For Danish summer houses, this effect was calculated to be 100% (i.e. no energy saving); for regular homes, this effect was less pronounced, 26%, but still significant. The main factor responsible for this rebound effect was identified as the changes in heating practices to achieve higher norms for comfort. Gram-Hanssen et al. conclude the paper with a call for the acknowledgement of such socio-economic phenomena in policymaking, for example through adding progressive energy tariffs to the promotion of energy efficient technologies.

Hansen, A.R. 2018. 'Sticky' Energy Practices: The Impact of Childhood and Early Adulthood Experience on Later Energy Consumption Practices. *Energy Research & Social Science*, 46, pp.125–39.

Norms about what level of energy consumption is 'normal' differ greatly between individuals, households, and cultures. In this paper, the role of early childhood and early adulthood experiences is analysed for their influence on adult energy consumption. Hansen compared energy use, sociodemographic factors, and attributes of the inhabited building and its installations in three cohorts of individuals at different points in time: during their childhood, in early adulthood, and as adults. Household characteristics from childhood and early adulthood contributed significantly to variations in energy consumption, including when the study controlled factors such as income and characteristics of the current building. This finding corroborates the hypothesis that individual energy consumption levels are related to embodied experiences, which are acquired in the formative years of childhood and early adulthood, and which at least partly persist during the rest of the life. The paper demonstrates that just as taste and cultural preferences are a part of a 'habitus' (as shown in the classic study by Bourdieu), preferences for heating and hot water consumption are deeply rooted in personal history and are an integral part of the user's individuality. The most important practical implications of this research is that material and social surroundings do form expectations about what is seen as 'normal' energy consumption, but they do so in the most pronounced way only early in an individual's life. This both sheds light on what can be expected from future energy consumers, whose formative experiences

are made now, and it should moderate exaggerated expectations regarding the effectiveness of technical, economic, or informational interventions around energy efficiency.

Murto, P., Jalas, M., Juntunen, J. and Hyysalo, S., 2019. The difficult process of adopting a comprehensive energy retrofit in housing companies: Barriers posed by nascent markets and complicated calculability. *Energy Policy*, 132, pp.955-964.

In this paper, a user perspective on energy retrofit markets is presented, which sheds light on reasons for the slow adaptation of comprehensive energy retrofits. The study is based on field notes of researchers who conduct a potential comprehensive energy retrofit and interviews with housing company representatives that had undergone such a retrofit. Particularly one assumption that is taken for granted when talking about markets turned out to be wrong: the object purchased on the market – comprehensive energy retrofit – is far from clearly defined as it depends on a large number of input variables that are needed to identify suitable solutions for a particular site and building. The process of acquiring this information was additionally made more difficult by market actors providing contradictory information, and by varying availability of data about the building. This led to high degrees of uncertainty and complexity despite considerable efforts to succeed. The interviews with housing company representatives confirmed these findings. Despite having more technical expertise than regular end-users, they often had hired help from energy consultants. These intermediaries, however, were hard to find and were recruited through pre-existing networks and happenstance. The article concludes with recommending more widespread public support for energy counseling services and other intermediaries that close the gap between solutions that are available on the market and the potential users of these solutions.

2.6. Moving to issues of energy demand

An influential body of recent literature aims to move beyond techno-economic framings of energy efficiency, towards more holistic understandings of energy demand and how it can be reduced. This work draws largely on Sociology and on Science and Technology Studies (STS), and is informed by historical and philosophical perspectives, as well as responding directly to the limitations of energy efficiency approaches (such as rebound effects) that have been identified within more technical literatures. These critiques have crystallised particularly clearly in the last five years, but build on decades of energy-SSH research, as well as on the concept of 'sufficiency', which originated in sustainability and justice literatures, drawing on philosophical debates about needs. Work within this field pays attention to 'what energy is for' (the services that energy provides), opening up questions about how these services could be provided differently. For example, how shifted timings or altered standards and expectations can reduce energy demand. The papers in this section therefore call for systemic approaches to energy, within both research and policy, that recognise the diverse ways that policies shape and steer energy demand.

Alexander, J.K., 2008. *The Mantra of Efficiency: From Waterwheel to Social Control*. Baltimore: The Johns Hopkins University Press.

In this book, Alexander explores how the concept of efficiency has evolved in modern history, from a simple measure of the thermal economy of a machine, to much wider applications across different spheres of technology, economy and society. She uses six historical case studies (from Britain, France, Germany, and the United States) to illustrate the concept's development, including the 'efficiency craze' of the twentieth century, which was said involve a societal-wide pursuit of efficiency across sectors. Alexander suggests that efficiency fundamentally entails the pursuit of mastery through techniques of surveillance, discipline, and control. In particular, she argues that since the mid-nineteenth century, efficiency has been seen as a way of overcoming natural limits to facilitate progress and growth; this goal, and recent ecological challenges to it, directly inform current debates on sufficiency. While the book is not directly on energy efficiency, it therefore provides valuable context to issues currently high on energy policy and research agendas.

Shove, E., 2017. What is wrong with energy efficiency? *Building Research & Information*, 46(7), pp.1-11.

This influential recent paper distills criticisms of energy efficiency that have developed over several decades within sociological energy research. Shove argues that established criticisms of energy efficiency, including those which focus on rebound problems, rarely challenge the basic idea of 'efficiency'. This paper offers a more fundamental critique, arguing that, far from being a solution, the current notion of efficiency can undermine reductions in actual energy use. This is because policies that promote energy efficiency often reinforce

energy-intensive ways of life, and lock in expectations about the levels of service that energy provides; for example, expectations about services of comfort, lighting and mobility. While not presenting concrete policy prescriptions, the paper raises the possibility of crafting buildings and equipment that do not meet present needs, and that do not deliver equivalent levels of service, but that do enable and sustain much lower-carbon ways of living. Shove suggests fostering forms of design, manufacture and planning that actively unpick carbon dependency, giving the example of providing householders and office workers with opportunities to adapt to their thermal conditions (e.g. through building design), and so enabling different interpretations of comfort. The paper is also significant in having sparked debate, including a response from authors defending energy efficiency (Fawcett and Rosenow's 2017 Commentary[2]), with a further response by Shove in 2018[3].

Labanca, L. and Bertoldi, P., 2018. Beyond energy efficiency and individual behaviours: policy insights from social practice theories. *Energy Policy*, 115, pp.494-502.

This paper presents a critical analysis of the idea of energy efficiency, building on SSH concepts similar to those of Shove (2017) above, but offering a more explicit focus on current policy and the provision of recommendations. The paper argues that policies based on energy efficiency have limited impacts because they are based on quantitative estimates of reductions in energy inputs and neglect how qualitative changes in the energy outputs can offset these reductions. For example, more energy efficient engines can enable the production of larger cars, which consume more energy overall. It suggests that radically alternative policies should target qualitative changes and re-organisations in energy outputs, aiming at 'doing better' with less energy, rather than 'doing more'. To achieve this, the authors call for 'governance on the inside', which refers to (among other things): greater democratic participation of citizens in energy transitions; use of qualitative approaches that recognise diverse types of expertise, perspectives and interests; and support for upscaling grassroots innovations.

Rinkinen, J., Shove, E. and Marsden, G., 2020. *Conceptualising Demand: Distinctive approaches to consumption and practice*. London: Routledge.

This recent book brings together many of the arguments about efficiency and demand that have been mentioned so far in this theme, with a particular focus on identifying and challenging assumptions about energy 'needs' that are embedded across policies, investments, energy models and other aspects of governance. The foundational idea of the book is that resources such as energy are consumed in accomplishing social practices: activities in everyday life such as heating, cooling, commuting and laundering. Energy demand is an outcome of these practices, and the social, institutional and material arrangements that structure them; not simply an outcome of individual choices and technical efficiency. Furthermore, the amount of energy (and the timing of energy provision) that these practices require is not fixed, but changes over time. Building on this, the authors argue that energy demand is *made* and not simply met; and that it is influenced, deliberately or not, by many forms of policy and governance. They also highlight differences in how demand is understood in different fields, which the energy field could learn from. For example, in the transport sector, demand is often seen as derived from what people do (for more on this, see the Annotated Bibliography by Suboticki et al., 2021) – a useful interpretation of demand that has rarely been applied to energy use in buildings. They also suggest that energy policy could benefit from considering the concept of an obesogenic environment (an environment that favours habits that contribute to obesity) which has informed more holistic approaches to interventions within public health. Such innovative thinking could inform approaches that recognise and work with the multiple ways that policies can shape practices and their energy demands.

Darby, S. and Fawcett, T., 2018. *Energy sufficiency: an introduction*. Concept Paper. European Council for an Energy Efficient Economy: Stockholm.

From 2017 to 2020, the European Council for an Energy Efficient Economy (eceee) ran the Energy Sufficiency Project, aiming to explore and operationalise this emerging concept within energy research. Among a number of events and publications, the project produced this Concept Paper that offers a helpful introduction to the idea of energy sufficiency, building on the authors' own work dating back to 2007, as well as on notions of sufficiency and needs within wider literatures on sustainability and ethics. The paper reviews research literature on sufficiency, incorporating ideas from recent work on 'doughnut economics' (which is

2 https://bricommunity.net/2017/11/02/what-is-right-with-energy-efficiency/

3 https://bricommunity.net/2018/01/04/commentary-writing-the-wrongs-of-energy-efficiency/

based on the idea that there is a safe and just space for humanity that lies between a minimum foundation of meeting basic human needs, and the upper ceiling set by planetary limits). The paper defines energy sufficiency as "*a state in which people's basic needs for energy services are met equitably and ecological limits are respected*". In highlighting policy implications, the authors note that energy sufficiency requires consideration of equity; for example, an energy sufficiency approach might prioritise investing in the building stock so that *all* housing would be of sufficient quality to allow those on low incomes to experience adequate thermal comfort. Developing 'sufficient energy services' could also include prioritising the use of ambient, untraded energy services (e.g. passive house design, natural cooling and ventilation); valuing and enabling adaptive and non-expert ways of achieving comfort in buildings; and developing people's skills and practical know-how to facilitate this.

3. Concluding remarks

This annotated bibliography set out to capture the breadth and diversity of SSH scholarship on energy efficiency. As mentioned, this is not an extensive review, but aims to give a taste of what energy efficiency SSH has to offer to broaden research agendas and strengthen policy-responses aimed at energy efficiency improvements. Whilst there has been a traditional deployment of SSH to focus on 'users' of new technologies and systems, the literature presented here shows a wide back-catalogue of examples that clearly demonstrate the broader application of SSH ideas on furthering and critiquing the energy efficiency agenda.

SSH ultimately problematises the notion that energy efficiency in a number of ways. It unpacks and consequently challenges the normative assumptions and framings which guide energy efficiency policies and programs. Most notably, it challenges expectations which posit energy efficiency efforts as neutral and simple. The annotations give insight into how energy efficiency can be distributed and affect people differently, how different people and users may experience and adapt to them in diverse ways, and consequently, how its roll-out is intimately linked to the everyday lives of its users. With a broader understanding of both what energy efficiency entails and how it may transform energy use and users, the literature collectively points to the need to diversify understandings of energy efficiency transition pathways. Some scholars also question if it is indeed the most appropriate, default path for (demand-focused) energy policy initiatives. It is clear that many SSH researchers feel inherently uncomfortable in pursuing the normative agenda of energy efficiency; although many SSH researchers would seem to nevertheless agree that energy efficiency improvements should happen, but with more realistic expectations (relating to e.g. unintended consequences) and as part of a wider set of intervention priorities that also considers changes to everyday life (in line with e.g. energy sufficiency arguments).

All in all, this literature is an important contribution to both review previous energy efficiency outcomes and programmes, and to critically engage with the future energy efficiency agenda.

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5. References

European Parliament and Council, 2012. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. Available: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32012L0027 [Accessed 10 February 2021].

Foulds, C. and Christensen, T.H., 2016. Funding Pathways to a Low-carbon Transition. *Nature Energy*, 1(7), pp.1–4.

Foulds, C., Bharucha, Z.P., Krupnik, S., de Geus, T., Suboticki, I., Royston, S. and Ryghaug, M., 2019a. *An approach to identifying future Social Sciences & Humanities energy research priorities for Horizon Europe: Working Group guidelines for systematic Horizon Scanning*. Cambridge: Energy-SHIFTS.

Foulds, C., Genard, Q., Berker, T. and Bharucha, Z.P., 2019b. *Terms of Reference: Energy-SHIFTS Working Group 3 – Energy Efficiency*. Cambridge: Energy-SHIFTS.

Foulds, C., Royston, S., Berker, T., Nakopoulou, E., Abram, S., Ančić, B., Arapostathis, E., Badescu, G., Bull, R., Cohen, J., Dunlop, T., Dunphy, N., Dupont, C., Fischer, C., Gram-Hanssen, K., Grandclément, C., Heiskanen, E., Labanca, N., Jeliazkova, M., Jörgens, H., Keller, M., Kern, F., Lombardi, P., Mourik, R., Ornetzeder, M., Pearson, P., Rohracher, H., Sahakian, M., Sari, R., Standal, K. and Živčič, L., 2020. *100 Social Sciences and Humanities priority research questions for energy efficiency in Horizon Europe*. Cambridge: Energy-SHIFTS.

Overland, I. and Sovacool, B.K., 2020. The misallocation of climate research funding. *Energy Research & Social Science*, 62, pp.101349.

Robison, R. and Foulds, C., 2019. *7 principles for energy-SSH in Horizon Europe: SHAPE ENERGY Research & Innovation Agenda 2020-2030*. Cambridge: SHAPE ENERGY.

Robison, R., Skjølsvold, T.M., Lehne, J., Judson, E., Pechancová, V., Foulds, C., Bilous, L., Büscher, C., Carrus, G., Darby, S., Demirbağ-Kaplan, M., Douzou, S., Drevenšek, M., Frantál, B., Guimarães Pereira, A., Hargreaves, T., Karvonen, A., Katzeff, C., Kola-Bezka, M., Laakso, S., Lettmayer, G., March, H., Parag, Y., Renstroem, S., Sáfián, F., Swora, M., Tjørring, L., van der Werff, E., van Vliet, B., Wallenborn, G., Wolsink, M. and Wyckmans, A. 2020. *100 Social Sciences and Humanities priority research questions for smart consumption in Horizon Europe*. Cambridge: Energy-SHIFTS.

Royston, S. and Foulds, C., 2021. The making of energy evidence: How exclusions of Social Sciences and Humanities are reproduced (and what researchers can do about it), *Energy Research & Social Science*, 77, pp.102084.

Ryghaug, M., Suboticki, I., de Geus, T., Loorbach, D., Foulds, C. and Bharucha, Z.P., 2019. *Terms of Reference: Energy-SHIFTS Working Group 4 – Transport and Mobility*. Cambridge: Energy-SHIFTS.

Ryghaug, M., Suboticki, I., von Wirth, T., Smeds, E., Scherrer, A., Foulds, C., Bertolini, L., Beyazit, E., Brand, R., Cohen-Blankshtain, G. Dijk, M., Freudendal-Pedersen, M., Gössling, S., Guzik, R., Kivimaa, P., Klöckner, C., Nikolova, C.L., Lis, A., Marquet, O., Milakis, D., Mladenović, M.N., Mom, G., Mullen, C., Ortar, N., Paola, P., Oliveira, C.S., Schwanen, T., Seidenglanz, D., Tuvikene, T. and Wentland, A., 2020. *100 Social Sciences and Humanities priority research questions for transport and mobility in Horizon Europe*. Cambridge: Energy- SHIFTS.

Suboticki, I., Ryghaug, M., Smeds, E., Valler, T.M., Scherrer, A., Haugeland, B.T., von Wirth, T., 2021. *Transport and Mobility – a Social Sciences and Humanities annotated bibliography*. Cambridge: Energy-SHIFTS.

von Wirth, T., Loorbach, D., Wagner, A., Koretskaya, O., Wade, R., Krupnik, S., Rudek, T., Foulds, C., Adem, C., Akerboom, S., Batel, S., Caspar Rabitz, F., Certoma C., Cherp, A., Chodkowska-Miszczuk, J., Denac, M., Dokupilová, D., Dotterud Leiren, M., Frolova Ignatieva, M., Gabaldón-Estevan, D., Horta, A., Karnøe, P., Lilliestam, J., Markard, J., Mišik, M., Mühlemeier, S., Nemoz, S., Nilsson, M., Osička, J., Papamikrouli, L., Pellizioni, L., Sareen, S., Sarrica, M., Seyfang, G., Smith Stegen, K., Sovacool, B., Telesiene, A., and Zapletalova, V., 2020. *100 Social Sciences and Humanities priority research questions for renewable energy in Horizon* Europe. Cambridge: Energy-SHIFTS.

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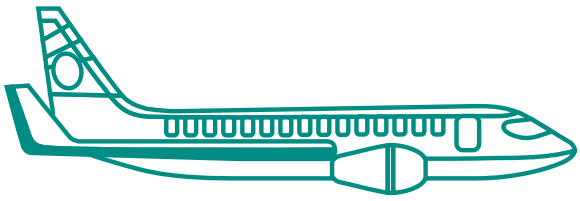

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Transport and Mobility:
A Social Sciences and Humanities annotated bibliography

Energy-SHIFTS
ENERGY SOCIAL SCIENCES & HUMANITIES INNOVATION FORUM TARGETING THE SET-PLAN

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Executive summary

Background

- This annotated bibliography developed as part of the European Commission (EC) funded project *Energy Social Science Humanities Innovation Forum Targeting the SET-Plan* (Energy-SHIFTS), which contributes to the European Union (EU) Energy Union by further developing Europe's leadership in applying energy-related research and knowledge from the Social Sciences and Humanities (Energy-SSH).
- The bibliography provides context to the findings from the extensive Horizon Scan exercise, which resulted in the '100 priority SSH research questions on transport and mobility' reported earlier.

The aim

- This report provides annotations to 26 key publications from SSH research on transport and mobility to provide a backdrop to the 100 priority SSH research questions in the Horizon Scanning report.
- With this annotated bibliography, we aim at informing policymakers and other non-experts on the breadth of energy-SSH knowledge that characterises the richness of the research field today.

The approach

- Expert recommendations on the key literatures and further sampling of relevant literatures to address gaps led to a collection from which the final set of publications was selected.
- Publications were selected to reflect the substantive and disciplinary diversity of the energy-SSH field.

The findings

- Transport and mobility research has engaged with new research strands and disciplines over the last decades (e.g. Anthropology, Sociology, Political Sciences, Science and Technology Studies), new approaches to study transport and mobility (from techno-economic to mobility perspectives), new themes of research (autonomous vehicles, car-sharing), and new political agendas (from instrumental to critical).
- SSH contributions to transport and mobility have diversified and enriched the field, offering important theoretical and empirical work and providing the cross-disciplinary knowledge needed for transitions to more sustainable mobility systems.

Contents

1. Introduction

1.1. Background: energy-SSH and Energy-SHIFTS

This annotated bibliography was developed as part of the Energy Social Science and Humanities Innovation Forum Targeting the SET-Plan (Energy-SHIFTS).[1] Energy-SHIFTS supports the EU Energy Union to develop Europe's leadership in energy-related Social Sciences and Humanities (energy-SSH) research. The field of energy-SSH has remained marginal within (and beyond) the EC's research, giving way to energy research interests dominated by the natural and technical sciences (Foulds and Christensen, 2016; Overland and Sovacool, 2020; Robison and Foulds, 2019). However, the EC has expressed a commitment to mainstream SSH research and innovation activities, including supporting standalone energy-SSH projects. The Energy-SHIFTS project aims to strengthen energy-SSH for European research and innovation, as well as to strengthen its relevance to EU energy policy. Energy-SHIFTS contributes cutting-edge research priorities from energy-SSH research communities, which can guide and anchor EU research and innovation funding for SSH research and bridge the current science-policy gap. Through the Horizon Scanning initiative, four Europe-wide Working Groups each presented a set of 100 priority SSH research questions on key topics within the EU Energy Union and EC research and innovation funding priorities: (1) Renewable energy (von Wirth et al., 2020), (2) Smart consumption (Robison et al., 2020), (3) Energy efficiency (Foulds et al., 2020), and (4) Transport and mobility (Ryghaug et al., 2020). The annotated bibliographies are companion pieces to these Horizon Scan results.

1.2. Aims of the Annotated Bibliographies

The annotated bibliographies aim to provide a contextual backdrop and sense of the evolution of academic research over time that can be read alongside the 100 priority SSH research questions presented in the four Horizon Scanning reports. An annotated bibliography is a list of references to scientific articles and book chapters followed by short descriptions of their content and key arguments. This report provides annotations to 26 key publications in SSH research on transport and mobility. Similar to the four Horizon scan reports, this is one of four bibliographies, alongside renewable energy, smart consumption, and energy efficiency. These are intended to give policymakers and other non-experts insight into the breadth of energy-SSH knowledge and approaches which characterise the field today. They portray the main advances in energy-SSH fields and, as such, offer context for the forward-looking priority SSH research questions.

The annotated bibliographies offer a taste of the main SSH debates, milestones, and advances in the field through a summary of key scholarly contributions, without claiming to provide full coverage of the field. The ambition is to demonstrate the range and variation of energy-SSH research, incorporating different and sometimes contradictory disciplinary perspectives, research themes and approaches. The bibliographies can give policymakers and other non-experts insights to help navigate the SSH field of transport and mobility.

1.3. The topic of this bibliography: Transport and mobility

This annotated bibliography focuses on transport and mobility. Decarbonizing transport and mobility is a key priority in EC research and innovation funding and critical to achieving the EU's aim of carbon-neutrality by 2050. The Energy-SHIFTS Working Group on

1 For more information about the project, visit the official website: https://energy-shifts.eu/

transport and mobility has approached transport transitions "*as the development and appropriation of new transport technologies, governance and management of transport, as well as efforts to change mobility practices*" (Ryghaug et al., 2019, p.5). Through the comprehensive and prospective Horizon Scanning exercise (Foulds et al., 2019), the Working Group produced a list of 100 priority SSH research questions in the field. These questions aim to "*promote SSH research in the transition towards a carbon-neutral and socially just European transport system by 2050, which caters for human well-being, while acknowledging planetary boundaries and the need for climate change mitigation*" (Ryghaug et al., 2020, p.6).

The 100 SSH priority research questions for transport and mobility are divided into eight themes: (1) Co-producing knowledge and professional practices, (2) Scenarios, futures, visions and transition pathways, (3) Dominant mobility regimes and car dependency, (4) Governance, policy and incentives, (5) Participation and citizen engagement, (6) Mobility practice and mobility needs, (7) Risks, disruptions and negative or unanticipated consequences, and, (8) Social justice and inclusion. While these questions highlight pressing topics and perspectives in SSH research on transport and mobility, the field is much broader, encompassing topics that resist easy categorisation within these eight themes. In this annotated bibliography, we therefore, aim to present a broader view of what constitutes SSH scholarship on transport and mobility, which does not always relate to 'the transport transition'. Nevertheless, the presented key pieces are important steppingstones and inspiration for stimulating new research topics, interests, perspectives, and debates.

1.4. Methodology for selecting key pieces of literature

Twenty-six publications were selected based on their relevance in providing context and insight regarding the research priority questions in the Horizon Scan. This selection includes peer-reviewed scientific publications, review articles, monographs and anthologies. The main selection criteria were diversity and disciplinary representation to highlight the breadth of the energy-SSH field. Publications were selected following ten expert interviews with leaders in the SSH transport and mobility field, as well as members of the Working Group. The interviews were conducted between January and February 2020, in the initial stages of the Horizon Scanning process. Interviewees included energy-SSH experts from diverse disciplinary backgrounds (Foulds et al., 2019, p.17, p.25). Each interviewee was asked to recommend five publications they considered seminal for the development of the field. From these, a selection of publications was included in the annotated bibliography based on number of citations, perceived impact within the field, and contribution to new research avenues and themes within the field. Some publications suggested in the interviews were excluded because they lacked a focus on SSH, were less relevant to the Working Group theme, or were marginal in terms of their impact and relevance to the field. The authors then identified gaps based on the interviewees' descriptions of the development of their field and key research themes that emerged during the Horizon Scan. Additional publications were sourced from the Horizon Scanning survey responses (evidence and rationale for proposed research questions) and the authors' expertise within the field.[2]

1.5. How to use the Annotated Bibliographies

The annotations are short summaries of the original source material and provide a taste of each contribution. We hope readers become inspired to seek out the full publications on their topics of interest. Given the limited selection of publications, readers may also use the list as a tool to seek out broader and/or more specific literature in the field. The bibliography may, for instance, be read prior to viewing the 100 priority SSH research questions in the Horizon Scan report, or as an independent source of information.

Readers may also be interested in studying the annotated bibliographies from the Social Sciences and Humanities for Advancing Policy in European Energy (SHAPE Energy) project which was the predecessor to Energy-SHIFTS and offers more systematic reviews of the given fields. [3]

2 For more information on the expert interviews and annotated bibliographies, see the methodological guidelines (Foulds et al., 2019).

3 These can be downloaded here: https://shapeenergy.eu/index.php/publications/annotated-bibliographies/

2. Key literatures in the field of SSH transport and mobility research

Transport studies originated in engineering and physical sciences. The 1960s and 70s were formative years, paralleling rapid growth in car ownership and expansion of transport networks and systems in many countries. Research on transport was, at the time, mainly concerned with so-called 'predict and provide' questions, that is, how to best predict mobility patterns and provide transport solutions (e.g. expand road networks). Consequently, early inquiries were rooted in techno-economic concerns related to speed, efficiency and reliability of transportation modes. This tradition in mainstream transport studies is still prevalent, but human geographers, sociologists, psychologists, environmental scientists, anthropologists and political scientists – to name just a few SSH disciplines – have started to engage with transport issues, and questions surrounding mobility as a distinct and broader concept. This expansion has challenged dominant assumptions about travel behaviour, broadened the understanding of travel as part of socio-technical networks and practices, and diversified inquiries into different normative and experiential aspects of travel, mobility and transport systems and technologies.

In what follows, we highlight key contributions from SSH research on transport and mobility and how they have changed the field. Contributions are arranged into sub-themes that reflect important trajectories within the field and highlight shifts and changes in the SSH transport and mobility field. Author contributions, however, are not limited to the theme named in the title.

2.1. Complicating travel: activity-based perspectives and the emergence of accessibility research

A key shift in transport studies in recent decades is from thinking about travel in terms of minimizing costs to thinking about travel as a 'derived demand'. Travel is not an activity that people undertake for its own sake, but to reach activities available at different destinations. Travel demand is generated by the distribution of activities in time and space, which is determined in different parts of the economy. Rooted in Hägerstrand's (1970) time geography and activity-based perspectives on travel behaviour, this was an important shift because it challenged the core assumptions of transport studies, which viewed travel as only a means to an end and travellers as generic figures. The publications below paved the way for activity-based perspectives on travel behaviour that emphasize understanding travel as part of everyday life and daily activities and understanding the experiences of travel. Simultaneously, this also contributed to the emergence of accessibility research which highlights how time, location, activities and groups, among others, influence travel behaviours. These perspectives are relevant to current transport transitions, where influencing individual travel behaviour is a central policy goal.

Kwan, M.P., 1999. Gender and individual access to urban opportunities: a study using space–time measures. *The Professional Geographer*, 51(2), pp.210-227.

This article approaches quantitative accessibility research from a gender perspective, drawing on Hägerstrand's (1970) time geography and activity-based perspectives of travel behaviour. Previous examinations of quantitative accessibility conceptualised the

proximity of opportunities as originating from a single location (typically, the home), but this ignored two crucial aspects of women's everyday mobility: (1) multi-stop journeys, e.g. 'trip-chaining' of different activities, and (2) the fact that women have a more constrained time 'budget' because they typically shoulder more household responsibilities (e.g. picking up children from school), and travel is often 'fixed' to specific locations and times of the day (e.g. school hours). These findings, based on travel diary data from residents of Ohio in the United States, provided insights into how women experience higher levels of space-time fixity. This research highlighted the presence of choice limitations with respect to travel in the context of complex everyday life, and how this choice is further differentiated by gender. The work has three policy implications: (1) policies seeking to influence attitudes do not necessarily enlarge the choices available to people in real life, and understanding people's constraints is crucial; (2) notions of the 'universal citizen' that underpin new quantitative planning and analysis must be broadened to encompass social difference; (3) not all solutions to transport problems lie within the realm of transport policy – in this case, more appropriate policies might include more flexible school hours or social policies to advance gender equality by influencing the division of domestic labour within the household.

Mokhtarian, P.L. and Salomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. *Transportation research part A: Policy and practice*, 35(8), pp.695-719.

This article was one of the first to challenge core assumptions in neo-classical economic perspectives of travel. Personal travel was often understood as a derived demand, i.e., travel is undertaken because the traveller wants to engage in an activity at another location. Thus, generally, the traveller seeks to minimize the time and cost spent traveling, regardless of the mode of transport. This article claims the opposite: many people express an affinity for travelling, and may engage in both undirected travel (i.e., travel for travel's sake) and excess travel e.g. choosing a longer route than necessary to reach a destination. Rather than positing a model of travel behaviour where rational humans seek to minimize the time spent travelling, the authors develop a model where travel is sometimes enjoyed and undertaken for its own sake. This model represented a break with the instrumental view of transport, meaning that a person's response to policy measures might differ depending on their general affinity for travel.

Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice*, 39(2-3), pp.147-162.

In this seminal article, Steg draws on social psychology to understand how non-instrumental factors can explain car use. Previous research on transport usage focused on speed, flexibility, and convenience. This article builds on the results of two separate surveys located in two different cities in the Netherlands. The first study is explorative and identifies categories that can explain car use, including instrumental, symbolic, and affective motivations. Symbolic motives are generated by identity, social position, norms and expectations of travel habits. Affective motives derive from emotions that driving a car may evoke, such as excitement and relaxation. The second study determined the relative importance of motives in explaining car use for commuter traffic. The results were striking, revealing that symbolic and affective motives best explained car use, while convenience was relatively unimportant. Moreover, the article found differences among population groups. For example, younger, male and lower-income groups were overrepresented in highlighting symbolic aspects. These results challenge a highly functional view of commuter travel. Policies aimed at reducing car-use must consider how policy solutions can compensate for the symbolic and affective motivations in driving.

Silva, C., Bertolini, L., te Brömmelstroet, M., Milakis, D. and Papa, E., 2017. Accessibility instruments in planning practice: Bridging the implementation gap. *Transport Policy*, 53, pp.135-145.

This article examines why there is an 'implementation gap' with respect to accessibility planning. While the science of defining and measuring accessibility has continued to develop, and many instruments for supporting policy decisions have been developed, these are not widely used in urban/transport planning practice. Silva and colleagues explore this issue by collecting data on 20 'accessibility instruments' (decision-support tools for analysis or modelling), ranging from national to regional and municipal scales of planning. Survey research and workshops in 12 European cities were conducted with organisations developing instruments and planning practitioners, to understand their user-friendliness and usefulness for practical planning tasks. Practitioners were generally found to be positive about instrument usefulness. The article concludes that the primary barrier to the uptake of accessibility planning is not the user-friendliness of decision-support tools, but other issues such as weak

policy commitment, mainstreaming and formal requirements for this type of planning. Most policymaking still focuses on enabling travel as the primary goal, rather than providing access to activities and services. This paper also illustrates a case of the commonly discussed gap between science and policymaking. A lack of quality tools is not necessarily the problem, rather, slow policy changes may result from issues related to institutions, governance and politics.

2.2. Broadening the field: the new mobilities paradigm

Next to the broader and more complex view on 'derived demand', one of the most important shifts in transport studies was 'the mobility turn'. The new mobility paradigm was a conceptual reframing of transport from a purely technical challenge (i.e., how to move most effectively from point A to B), to an understanding emphasizing how physical and social aspects of mobility are deeply embedded in society. This shift was relevant for transport studies and challenged SSH scholars on the lack of attention to mobility as an essential part of daily life. Transport was reframed as a technology and activity embedded in wider social relations and ways of life, illuminating the co-production of inequalities through such relations. Research subsequently turned to studying the norms and values connected to mobility, meanings attached to and sensemaking of different mobility practices, and how movement shapes and is shaped by everyday life.

Kaufmann, V., Bergman, M.M. and Joye, D., 2004. Motility: mobility as capital. *International journal of urban and regional research*, 28(4), pp.745-756.

This article developed the concept of 'motility', which refers to the ease of moving within spatial and social structures. Motility may be seen as a form of capital and thus exchangeable (e.g. for social, human or economic capital). With this, the article bridges two incommensurable (or at least isolated) theoretical frameworks in mobility research, namely structuralism and post-modernism. In particular, the authors sought to bypass two long-running debates within social theory: (1) whether recent developments in logistics and communications have fundamentally reshaped society by compressing time-space, and (2) whether social structures (e.g. poverty, class) exist in the real world or merely as an analyst's construct. This move helped explain how societal positions might fluctuate with spatial locations; and how motility is depending location. This expands the theoretical and empirical understanding of how mobility connects to questions of accessibility and inequality.

Sheller, M. and Urry, J., 2006. The new mobilities paradigm. *Environment and planning* A, 38(2), pp.207-226.

Building on their previous research, this article presents a cohesive argument for the new mobility paradigm, aiming to rectify the social sciences' lack of attention to mobility. Here, mobility is understood in the most general sense, i.e., real or imagined, physical or digital, local or global movement of people, animals, objects, technologies, images, and ideas. Rather than choosing places and meanings as a starting point, the new mobilities paradigm uncovers the processes through which mobility is facilitated or obstructed, including the material structures implicated in these processes. This view turned attention to how various mobilities influence and constitute social life. The article was central in spelling out the tenets of the then-nascent new mobilities paradigm, including the presentation of a diverse set of theoretical and methodological resources for conducting mobilities research.

Cresswell, T., 2010. Towards a politics of mobility. *Environment and planning D: society and space*, 28(1), pp.17-31.

As part of the emerging mobilities paradigm, this article theorised mobility – as distinct from transport – further. Mobility is more than movement from A to B, it encompasses the representation of different mobilities in terms of the cultural ideas and meanings produced in law, media, literature; and embodied experiences. For example, with cycling, mobility includes cycling trips and how different cyclists are represented in the media or policy discourse in relation to socio-economic class; or how cycling might feel to individuals with different bodies, e.g. to women and disabled people. This article provides a framework for thinking about the politics of mobility, referring to the ways which mobilities are related to social relations, including those between classes, genders, ethnicities, and religious groups. The key point is that 'mobility is a resource that is differentially accessed' – in other words, people have different opportunities for and experiences of mobility. Cresswell proposes a set of questions relevant for thinking about social equity and justice issues in transport policymaking: (1) *the politics of movement*: who moves furthest? Who moves fastest? Who moves most often?, (2) *the politics of representation*: how are mobilities represented (e.g. visually)? How is mobility discursively constituted, and what narratives have been constructed about mobility?, (3) *The politics of mobile*

practice: How is mobility embodied (related to bodily capabilities and experiences)? How comfortable is it? Is it forced or free?

2.3. Taking materiality seriously: the sense-making and construction of transport technologies and infrastructures

Another key contribution of SSH scholars to transport studies highlights how different transport-technologies and infrastructures gain meaning in peoples' lives, as well as how they are shaped by peoples' practices. While some literature focuses on how travel needs to be understood as a sense-making experience, other contributions call attention to how transport technologies and infrastructures are shaped by people and through material-social relations. These theoretical contributions from anthropology, and science and technology studies, brought a new disciplinary perspective to the interconnectedness between materiality and people, and thus also how transport-technologies and infrastructures may be imbued by politics. Such interconnectedness also highlights how similar technologies and infrastructures may be experienced and mean different things across different sites, which precludes one-size-fits-all policy solutions.

Callon, M., 1986. The sociology of an actor-network: The case of the electric vehicle. In Callon, M., Rip, A. and Law, J. eds., 1986. *Mapping the dynamics of science and technology: Sociology of science in the real world.* Springer. Palgrave Macmillan, London, pp.19-34.

In this book chapter, Callon provides an Actor-Network Theory (ANT) perspective on the attempted introduction of electrical vehicles in the 1970s in France. This approach provided an alternative to the more traditional sociological analysis. ANT posits that the world can be regarded as a set of networks through which ideas travel and power is exerted. A distinctive characteristic of ANT is that it does not see nature and society as separate entities and regards material components, such as batteries, as having agency. In this specific network, Electricité de France (EDF), an electric utility company, was central in the attempt to electrify public transport and private vehicles. EDF engaged several actors in this network, such as municipalities, manufacturers, and research institutions. They needed to convince other actors of the value of electrification for reducing pollution, in additional to the need for further research. The chapter provides insights into the failures of the project and presents a case for the examination of the role of science in society. As networks are strengthened by sets of connections, if one part fails the rest may follow. In this case, for example, car manufacturers dragged their feet and challenged EDF, in addition to fuel cells breaking down.

Ryghaug, M. and Toftaker, M., 2014. A transformative practice? Meaning, competence, and material aspects of driving electric cars in Norway. *Nature and Culture*, 9(2), pp.146-163.

This article brings perspectives from Science and Technology Studies (STS) to transport studies, showing how technologies and technology users mutually shape each other in everyday life. User-technology relationships can be understood as domestication – a perspective recognizing that technologies are not stable and immutable, but must align with pre-existing routines, practice, identities, and values. Ryghaug and Toftaker focus on the introduction of electric vehicles in Norway and analyse the practical, cognitive, and symbolic dimensions of electric car use with a domestication approach. The analysis unpacks the implications of user-designated meaning in driving practices, the competencies considered necessary when driving electric cars, and the material aspects of electric car driving. Material aspects related to electric car driving may, for example, alter driving habits and raise technological and environmental awareness. Thus, the paper highlights the importance of materiality in transport-technologies to transformation in practices and sustainable transitions.

Dalakoglou, D. and Harvey, P., 2012. Roads and anthropology: Ethnographic perspectives on space, time and (im)mobility. *Mobilities*, 7(4), pp.459-465.

In this article (later developed into a book by the same title), the authors approach the study of the road from an anthropological perspective. They argue that roads and highways have been a marginalised area of investigation, arguing that infrastructure should interest the social scientist for several reasons. Roads may seem mundane in comparison to newer forms of technology, but nonetheless are a key part of the globalized world. Roads are also controversial spaces produced by competing interests – sometimes across national borders. This article also functions as an introduction to a special issue and provides a taste of various anthropological studies of the road. For example, roadbuilding in Mozambique involves a tense engagement between Chinese corporate capital and local road

workers, and hawkers in Ghana make a living by the road with entrepreneurship. Although roads may look similar globally, their cultural and social significance differs greatly. Roads are political also in their potential to reinforce power differences. For example, roads facilitate the extraction of resources from disadvantaged regions and enhance connections between some people more than others – shaping both mobility and immobility.

2.4. Turning to transitions: climate change concerns and sustainability questions

Climate change and the importance of sustainability transitions for the political and environmental agenda has prompted a wide range of SSH scholarship with a specific focus on transport transitions. Much of the scholarship has been theoretical, developing new models of understanding how transitions occur and how new solutions can be upscaled. Others have explored questions related to why current (unsustainable) mobility practices and technologies, especially the car regime, remain incumbent and resistant to change. This literature frames transitions as multi-dimensional issues; across policies, practices, values, transport technologies and infrastructures.

Bertolini, L. and Le Clercq, F., 2003. Urban development without more mobility by car? Lessons from Amsterdam, a multimodal urban region. *Environment and planning* A, 35(4), pp.575-589.

This article presents the 'accessibility-sustainability dilemma' whereby sustainable cities require reduced car use while policy measures are often politically difficult to implement. Few transport modes can match the convenience of cars. To solve this dilemma, the most politically promising solutions will address sustainability and aspects such as economy and accessibility. Importantly, the article argues that a successful strategy needs to include land-use policy and good alternatives to the car. Modes of transport should thus be utilized and seen as complementary rather than competing. In this article, the Amsterdam urban region is used as an example of good practice. This region consists of a network of urban nodes connected by train and highway. These urban centres, or nodes, are in turn dominated by different modes of transport. Urban areas with high levels of biking and walking are possible in multifunctional neighbourhoods that reduce commuting distances, and with deliberate measures such as dedicated bike lanes. In areas with high levels of public transport, service facilities and office buildings have been concentrated around nodes. Parking has also been restricted. Other urban centres are more car-based. Overall, this study of the Amsterdam region shows how they have kept the growth rate of car trips lower than that of the population and number of jobs.

Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of transport geography*, 24, pp.471-482.

Geels articulates a socio-technical approach and a systems perspective to transport studies, moving beyond changes in technology and behaviour. Geels applies the multi-level perspective (MLP), a prominent theory of transitions which analyses change as the interplay between three analytical levels (niches, sociotechnical regimes and a sociotechnical landscape), to empirical examples from the auto-mobility-system, illustrating potential barriers, drivers and pathways for a low-carbon transition of the transport sector. Examples include the niches of inter-modal travel, sharing schemes, green propulsion technologies, and intelligent transport systems (ITS). Geels also explores destabilizing landscape pressures such as climate change or Peak Oil and stabilizing landscape pressures like the cultural preference for timesaving or values associated with cars. The author concludes that stronger innovation policies are needed, especially to put pressure on the existing regime. The article acknowledges, however, that this is difficult because policymakers are a part of the system that they aim to change. An ongoing analysis of multi-actor processes in transitions between industry, policymakers, consumers, and civil society, therefore, remains crucial.

Hoogma, R., Kemp, R., Schot, J., and Truffer, B., 2002. *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management.* London and New York: Spon Press.

This landmark book on socio-technical transitions contributed to the development of Strategic Niche Management (SNM). SNM focuses on how niche innovations, in competition with dominant regimes (in this case, the car and automobility), may build momentum through mechanisms of niche protection. Socio-technical transitions researchers also developed real-life strategies for managing niches, which involved supporting innovations to become market-competitive, and eventually breaking through and causing a regime shift (e.g. transition from Internal Combustion Engines to electric vehicles). Hoogma and colleagues

studied innovations such as car-sharing, electric vehicles and bike-sharing through 13 experiments in different European countries. The book documents the successes and challenges of different mobility technologies at the turn of the 21st century. However, Hoogma and colleagues concluded that they overestimated the potential of SNM as a tool for fostering transitions. Instead, they found that their experiments remained relatively 'isolated projects', and that most did not scale up significantly or cause the actors involved to invest further in the innovations. This finding has been of enduring relevance, as many subsequent academic studies have confirmed the limits of experimentation on its own as a mechanism for fostering transitions. The crucial policy implication is that research and development funders and policymakers must carefully consider the diverse transformative impact of technological innovations, rather than pursue innovative pilot projects with blind enthusiasm.

Sperling, D., 2018. *Three revolutions: Steering automated, shared, and electric vehicles to a better future.* Island Press, Washington.

Building on decades of research on sustainable transportation, this recent book presents an innovation-based perspective on the future of transportation. Three vehicle innovations exemplify the three revolutions that the author sketches: electrification, pooling, and automation. The individual chapters explore the current status of automated, shared and electric vehicles and what a future based on these innovations could look like. The main takeaway is that innovation alone cannot guarantee a desirable future. On the contrary, the absence of conscious policymaking can lead to detrimental consequences. Steering innovations in the right direction, however, could result in a future with abundant and affordable choices, reduced climate impacts, liveable cities and a healthy population. The analyses and policy recommendations in this book provide a thought-provoking basis for shaping the transportation system of the future.

Temenos, C., Nikolaeva, A., Schwanen, T., Cresswell, T., Sengers, F., Watson, M. and Sheller, M., 2017. Theorizing mobility transitions: an interdisciplinary conversation. *Transfers*, 7(1), pp.113-129.

In this chapter, the authors present different perspectives on mobility transitions. While this chapter is a theoretical discussion, it touches on core issues of what sustains and might change a (un)sustainable mobility system. The contributors agree that deep-rooted changes are required to steer our mobility systems in a more sustainable direction, requiring technological, social and political change. Yet, they have different foci and understandings of technology and social action. First, the Multi-level Perspective outlines how large-scale, long-term changes can be generated when technological niches gain widespread use. Second, geographers emphasize the local-level dimensions of transitions. In effect, this may slow down research which is controversial given the pressing need to address climate change. Third, the mobilities approach highlights that sustainable shifts might not always require technological innovation. For example, grass-root organizations can play a central role in lobbying for green policy. Fourth, perspectives from systems of practice and transition illustrate that people consume, bear, and enact social practices associated with technologies they did not produce. Practices such as car driving are sustained by a number of other practices (productions, transport planning etc.), highlighting the interdependence of actions. And lastly, the new mobilities paradigm draws on a similar understanding of action, arguing that incremental change is insufficient. Existing energy systems require radical change. In sum, this article reviews how multidisciplinary interest in low carbon mobilities opens a range of emerging issues in mobility transitions.

2.5. Putting justice on the agenda: questioning transport inequalities

Social justice issues have engaged transport and mobility scholars. This literature often challenges transport study perspectives that overlook inequalities in the way people move, what systems they have access to, and how such transport inequalities can reinforce disadvantage. Scholars have raised questions about exclusion, and equal access to transport and mobility. Moreover, they have highlighted features that may exclude certain groups, including age, gender, ability, socio-economic status, and location. In recent years, scholars have also sought to explore the (un) intended consequences of injustices connected to new low-carbon mobility solutions.

Law, R., 1999. Beyond 'women and transport': towards new geographies of gender and daily mobility. *Progress in human geography*, 23(4), pp.567-588.

This article offers a feminist perspective on gender and mobility by moving beyond the typical dualistic focus on men versus women to shape a new course for the study of gender and transport. Law characterizes the

more traditional focus of 'women and transport' as too narrow. This traditional focus uncovered important differences in gendered travel patterns, primarily due to work-related reasons and fear of sexual violence, but needs to be broadened. Law suggests two avenues. First, reframing the field from 'transport geography' to 'social and cultural geographies of mobility', and second, to stake out a theoretical position that accounts for both symbolism and gendered travel patterns. The article points to five areas for further research: (1) *Gender division of labour and activities*, i.e. the role of paid and unpaid work, changing needs for travel with the development of Information and communications technology (ICT), online shopping, and how these changes are gendered, (2) *Gendered access to resources*, or how gender shapes access to resources, notably time, money, skills, and technology, and how gender and technology mutually shape each other, (3) *Gendered subject identities*, i.e. how do biological processes interact with social roles and translate into mobility constraints, (4) *Gender as a symbolic code*, i.e. how can access to spaces and transport modes be shaped by gendered roles, and (5) *Gendered built environment*, i.e. how is infrastructure shaped by and how does it shape gender roles? This contribution opened a new agenda for feminist geography.

Lucas, K., 2012. Transport and social exclusion: Where are we now? *Transport policy*, 20, pp.105-113.

In this article, Lucas summarises the theoretical, empirical and policy progress made in the field of transport and social exclusion. The concept of 'transport disadvantage' is becoming increasingly relevant as societies are based on hypermobility. Low transport capability will create major obstacles in reaching employment opportunities, educational facilities, and social networks. The article argues that low mobility can be connected to issues of information, physical barriers, driving skills, travel times, safety, and exclusion from spaces. Perhaps unsurprisingly, the empirical evidence shows that the poorest parts of the population travel less and over shorter distances, have lower rates of car ownership, and experience more social exclusion due to low mobility. In many countries, Black and minority ethnic people and senior citizens also experience lower mobility. Similar patterns are found in developing and developed countries. Lucas finds that many programmes that initially showed promise had been cut due to austerity measures. She also examined Victoria in Australia, where funding for public transport was increased, focusing on fringe urban and rural areas, in addition to reducing fares for disadvantaged groups. Lucas concludes that transport disadvantage reflects overall societal structures, and researchers should contribute with innovative methods and theories to move from 'trickle-down' models to 'just cities' for all.

Martens, K., 2012. Justice in transport as justice in accessibility: applying Walzer's 'Spheres of Justice' to the transport sector. *Transportation*, 39(6), pp. 1035-1053.

Martens provided new insights into how transport projects are evaluated based on equality issues, including the measurements used and how transportation systems can offer equal opportunities. The article puts transport poverty, social justice and inclusion high on the research agenda. Martens challenged the (often implicit) utilitarian principles underpinning traditional transport planning. She argues that certain goods carry social meaning which should be distributed in society as for instance education, healthcare, and transport. As transport is composite in nature (encompassing artefacts, infrastructures, services, regulations, etc.) and significantly influences social life (including processes of social exclusion), market mechanisms cannot ensure the just distribution of accessibility. Hence, the article stresses that a distributive sphere of transport is needed, whereby average accessibility should be maximized while minimizing the gap between the best and worst level of accessibility. This has profound implications for transport planning practices. An area devoid of public transport should be prioritized over, for example, expanding the passenger capacity of a railway line, even if this benefits fewer people.

Pereira, R.H.M., Schwanen, T. and Banister, D., 2017. Distributive justice and equity in transportation. *Transport Reviews*, 37(2), pp.170–191.

The authors review key theories of justice and discuss what justice means and should mean in the context of transport policies. They start by exploring how transportation scholars have framed transport disadvantages. First, they find that transport inequalities are mainly framed as inequalities of transport-related resources, observed daily travel behaviour, and transport accessibility levels. Second, they find that moral principles for changing the distribution of transport-related benefits or burdens are weak or not addressed. Third, the literature on redistribution of transport-related benefits and burdens has mainly been framed as an issue of scaling the level of access different groups have to transport good or services, or questions of why certain groups lack access. Pereira and co-authors conclude that transport researchers and policymakers need to engage with an ethical perspective more explicitly. Drawing on prominent theories of justice in political philosophy,

they argue for an approach that takes into account: (1) how socio-economic opportunities shape access to transport, (2) how a focus on accessibility connects morally to basic needs and equality of opportunity, and lastly, (3) that redistribution of accessibility should not threaten basic rights and liberties, should aim to reduced inequality of opportunity, prioritize vulnerable groups, and set minimum standards of accessibility.

2.6. Exploring emerging transport technologies: potentials and pitfalls of new (transport) concepts

New transport technologies (such as electric, hybrid and automated vehicles, smart transport systems, sharing services, and micro mobility such as electric scooters) are a recent avenue in SSH transport studies. Much of this literature looks at barriers to and opportunities for mainstreaming new transport technologies, with some overlap with transition scholarship. Researchers have explored the historical roots or new emergent transport, as well as possible controversies regarding their appropriation in current infrastructures. Moreover, this research highlights the unpredictable effects and risks of such systems. Some of the selected contributions connect technology development, mobility practices, and policies in exploring emergent technologies and novel ways of organizing mobility.

Mom, G., 2013. *The electric vehicle: Technology and expectations in the automobile age*. Baltimore: JHU Press.

Mom takes a historical look at the electric car in this book. Similar to Dijk and Yarime (2010) (see below) he shows that the electric car has a long history, dating back to the gasoline powered automobile, showing how thousands of electric vehicles were in use before World War II. The book challenges the assumption that the combustion engine 'won' and became dominant because it was superior, rather, it shows how electric vehicles had many advantages. In a careful retracing of Electric Vehicles (EVs) in Europe and America, the book demonstrates how a multitude of factors produced the dominance of the combustion engine. For instance, expenses for charging stations, the floatation of EV companies, cultural ideas of gasoline-powered vehicles as more adventurous, and price of vehicles. With this, the book illustrates how technological properties alone do not drive technology-adoption and development. This has implications for sustainability transitions because it shows that policymakers must consider a wider range of factors for sustainable transport technologies to become dominant modes of transport.

Dijk, M. and Yarime, M., 2010. The emergence of hybrid-electric cars: Innovation path creation through co-evolution of supply and demand. *Technological Forecasting and Social Change*, 77(8), pp.1371-1390.

This article demonstrates how an effect called the 'sailing ship effect' also unfolded in recent car mobility innovation. It shows that sailing ships did not disappear with the invention of the steam engine, which had advantages, but for many were not attractive, and sailing ships remained the main method for shipping goods for about 40 or 50 years. A similar pattern is evident in the case of EVs. The EV was unveiled at an American automotive show in 1990, and regulators were convinced this was supposed to be the future, at least in California. Despite friendly regulation, automotive manufacturers did not shift investments to electric mobility, but invested more in diesel and gasoline engines, which outcompeted EVs for at least 25 years. While the introduction of the pure electric vehicle was seen as a failure at first, developments since 2000 have created more potential for electric mobility.

Pangbourne, K., Mladenović, M.N., Stead, D. and Milakis, D., 2020. Questioning mobility as a service: Unanticipated implications for society and governance. *Transportation research part A: policy and practice*, 131, pp.35-49.

In this article, the authors examine the emerging concept of Mobility as a Service (MaaS) which has garnered significant attention. MaaS combines information and communication technologies with a business model which offers subscribers integrated access to a variety of transport modes. According to the rhetoric of MaaS proponents, MaaS will provide increased freedom of movement for subscribers, a more efficient transport system for transport authorities, and a new market for the private sector. However, the authors in this article show that the realization of MaaS could have negative ramifications for the environment, public health, and social inclusion, suggesting that public intervention might be warranted. By contrasting the promises made by MaaS proponents with potential negative outcomes, the authors make the case for properly assessing emerging transport innovations. What possible negative side effects exist, how would these affect the realization of wider urban objectives, and how might this be avoided through governance intervention?

Milakis, D., Van Arem, B. and Van Wee, B., 2017. Policy and society related implications of automated driving: A review of literature and directions for future research. *Journal of Intelligent Transportation Systems*, 21(4), pp.324-348.

Milakis and co-authors review existing literature on automated driving, and map research gaps. Automated driving may substantially impact the organization of society depending on unknown aspects such as the degree of automation, connectedness of vehicles, sharing, electrification, and how widely they are used. The study notes that owning an automated vehicle will probably be expensive, which might not outweigh savings from fuel consumption. Various simulations show that less congestion can reduce travel times by 30-40% even in scenarios where only a part of the vehicles is automated. Over the longer term, however, a potential increase in number of vehicles may neutralize such effects. Vehicle ownership rates are difficult to predict and will depend on aspects like vehicle sharing, consumer willingness, and public transport services. Research is lacking on the effects of land-use, but automation might increase urban sprawl as travel becomes easier. The article stresses that implications for energy consumption, air pollution, safety, social equity, the economy, and public health, can arise from the direct and indirect effects of automation. While available research indicates that automation can reduce fuel use and enhance traffic safety in the short term, the authors argue that the long-term impacts are more uncertain and difficult to predict.

2.7. Stepping into the realities of policymaking: new perspectives on the governance of transport

Transport governance has become a broad topic of debate, including cross-cutting issues related to land use, urban development, and sustainability. SSH scholars have contributed political critiques and policy recommendations for how transport governance can be improved. Some studies in this field challenge the dominant paradigms that govern transport planning by placing the broader societal and environmental implications of transport policies on the agenda. The scholarship also questions of power and the distribution of responsibilities between the state, private sector and civil society. The study of transport governance is characterised by cross-fertilization between transport studies and fields like political science, public policy, and organizational and management studies.

Banister, D., 2008. The sustainable mobility paradigm. *Transport policy*, 15(2), pp.73-80.

In this landmark article, Banister offers a very useful overview of some of the key issues in sustainable mobility particularly for a policy audience. Banister questions a key premise of conventional transport planning: that travel time should be minimized, on the basis that slower forms of travel can reduce emissions, be safer, and provide relaxation and exploration. The tools necessary to provide sustainable mobility already exist: reducing travel demand, policy measures (road pricing, parking control, relocation of space, better access to public transport etc.), reducing commuting distances through urban planning, technological innovation, and alternative fuels. Creating public acceptance for existing tools that can drive political action is the critical question. Banister points out that alternative travel modes and policies often enjoy higher acceptability than policymakers assume. Yet, to increase acceptance, people need to experience the effectiveness and fairness of measures, as mere information provision is not enough. However, compromises are often made when legislating in a democratic-electoral system that may reduce the effectiveness of a measure. To overcome such issues, participatory processes including broad expert coalitions, practitioners, and policymakers are needed. Such processes should also include debate on the wider societal benefits of a sustainable transport system, such as public health.

Aldred, R., 2012. Governing transport from welfare state to hollow state: The case of cycling in the UK. *Transport Policy*, 23(C), pp.95–102.

Aldred adopts a historical governmentality perspective on transport policy. The paper begins by discussing shifts in policy governance that have affected transport policy and two distinct periods within UK cycling policy: (1) from 1945–1990, when cycling was marginalized in policy debate (via a slight return in the 1980s when cycling was seen as a risky and marginal pursuit) and, (2) the 1990s and onwards. Aldred explains why cycling never became a 'strategic' priority for the national government by introducing concepts of the 'hollow state' and the 'responsible individual' to transport policy analysis, where they have been seldom used. Dominant policy approaches have led to cycling being, (a) located outside the national state, and (b) attached to discourses around healthy and environmental lifestyle choices. This in turn has shaped the evolution and boundaries of policy solutions.

Marsden, G. and Reardon, L., 2017. Questions of Governance: Rethinking the Study of Transportation Policy. *Transportation Research Part A: Policy and Practice*, 101, pp.238-251.

Marsden and Reardon review 100 articles from two leading policy-oriented journals in the transport research field. While the number of articles on transport policy is growing, the authors question the extent to which researchers study policy processes as such. Most articles were concerned with optimizing a given policy rather than looking into the mechanisms driving decision-making processes and assessing which policies should be implemented. Further, studies employing abstract simulations are overrepresented in the field, compared to studies engaging with real-world policymakers and processes. The article argues that real life policymaking is not a clean-cut process well captured by abstract models, but characterized by compromises, speedy decisions, ideologies, and coalitions. A more thorough focus on these processes is therefore needed, often requiring qualitative research and conceptual frameworks that can be generated by SSH.

3. Concluding remarks

This annotated bibliography has surveyed the breadth of scholarship characterising SSH research on transport and mobility. The field has shifted from a techno-economic focus to a more comprehensive and diverse understanding of transport and mobility, including the sensory experiences of travellers, interrelatedness between transport, technologies and practices, transport cultures, and the politics of transport and mobility. The selection of scientific work also pays tribute to the agenda-setting done by the European Commission, directing the course of transition from the dominant mobility practices towards more just and socially inclusive transport in the future.

While the digitalization of mobility services has already been taken up in recent debates and is also featured already in our selection of literature, we expect this theme to further accelerate over the next decade. In order to identify the possible and desirable pathways towards sustainable and just mobility systems, unintended consequences and appropriate responses to rebound effects will likely become more prominently in the scientific debate ahead. Moreover, the presented co-benefits of mobility transitions for other sectors (e.g. energy, housing) and aspects of subsequent system-integrations have not been covered in the literature to date.

The highlighted articles are seminal papers that have policy relevance and have influenced new research trajectories. Nevertheless, several important debates, themes, and studies could not be included here. Topics related to walking, air travel, freight, mobility practices related to tourism and migration, the growing connection between art and transport, and social movements connected to transport and mobility questions are just some examples of work that was not involved. We critically acknowledge a selection focus of studies primarily produced in and focussing on North-Western Europe. Although scholars from these geographical regions have dominated the field, this focus constitutes a limitation to our literature overview. Yet, we think this bibliography characterises some of different avenues of scholarship and debates within the field and we hope readers are inspired to seek out in-depth knowledge and further literatures on transport and mobility that were not included here.

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5. References

Foulds, C., Bharucha, Z.P., Krupnik, S., de Geus, T., Suboticki, I., Royston, S. and Ryghaug, M., 2019. *An approach to identifying future Social Sciences & Humanities energy research priorities for Horizon Europe: Working Group guidelines for systematic Horizon Scanning*. Cambridge: Energy-SHIFTS.

Foulds, C. and Christensen, T.H., 2016. Funding Pathways to a Low-carbon Transition. *Nature Energy*, 1(7), pp.1–4.

Foulds, C., Royston, S., Berker, T., Nakopoulou, E., Abram, S., Ančić, B., Arapostathis, E., Badescu, G., Bull, R., Cohen, J., Dunlop, T., Dunphy, N., Dupont, C., Fischer, C., Gram-Hanssen, K., Grandclément, C., Heiskanen, E., Labanca, N., Jeliazkova, M., Jörgens, H., Keller, M., Kern, F., Lombardi, P., Mourik, R., Ornetzeder, M., Pearson, P., Rohracher, H., Sahakian, M., Sari, R., Standal, K. and Živčič, L., 2020. *100 Social Sciences and Humanities priority research questions for energy efficiency in Horizon Europe*. Cambridge: Energy-SHIFTS.

Overland, I. and Sovacool, B.K., 2020. The misallocation of climate research funding. *Energy Research & Social Science*, 62, p.101349.

Robison, R. and Foulds, C., 2019. *7 principles for energy-SSH in Horizon Europe: SHAPE ENERGY Research & Innovation Agenda 2020-2030*. Cambridge: SHAPE ENERGY.

Robison, R., Skjølsvold, T.M., Lehne, J., Judson, E., Pechancová, V., Foulds, C., Bilous, L., Büscher, C., Carrus, G., Darby, S., Demirbağ-Kaplan, M., Douzou, S., Drevenšek, M., Frantál, B., Guimarães Pereira, A., Hargreaves, T., Karvonen, A., Katzeff, C., Kola-Bezka, M., Laakso, S., Lettmayer, G., March, H., Parag, Y., Renstroem, S., Sáfián, F., Swora, M., Tjørring, L., van der Werff, E., van Vliet, B., Wallenborn, G., Wolsink, M. and Wyckmans, A. 2020. *100 Social Sciences and Humanities priority research questions for smart consumption in Horizon Europe*. Cambridge: Energy-SHIFTS.

Ryghaug, M., Suboticki, I., de Geus, T., Loorbach, D., Foulds, C. and Bharucha, Z.P., 2019. *Terms of Reference: Energy-SHIFTS Working Group 4 – Transport and Mobility*. Cambridge: Energy-SHIFTS.

Ryghaug, M., Suboticki, I., von Wirth, T., Smeds, E., Scherrer, A., Foulds, C., Bertolini, L., Beyazit, E., Brand, R., Cohen-Blankshtain, G. Dijk, M., Freudendal-Pedersen, M., Gössling, S., Guzik, R., Kivimaa, P., Klöckner, C., Nikolova, C.L., Lis, A., Marquet, O., Milakis, D., Mladenović, M.N., Mom, G., Mullen, C., Ortar, N., Paola, P., Oliveira, C.S., Schwanen, T., Seidenglanz, D., Tuvikene, T. and Wentland, A., 2020. *100 Social Sciences and Humanities priority research questions for transport and mobility in Horizon Europe*. Cambridge: Energy-SHIFTS.

von Wirth, T., Loorbach, D., Wagner, A., Koretskaya, O., Wade, R., Krupnik, S., Rudek, T., Foulds, C., Adem, C., Akerboom, S., Batel, S., Caspar Rabitz, F., Certoma C., Cherp, A., Chodkowska-Miszczuk, J., Denac, M., Dokupilová, D., Dotterud Leiren, M., Frolova Ignatieva, M., Gabaldón-Estevan, D., Horta, A., Karnøe, P., Lilliestam, J., Markard, J., Mišik, M., Mühlemeier, S., Nemoz, S., Nilsson, M., Osička, J., Papamikrouli, L., Pellizioni, L., Sareen, S., Sarrica, M., Seyfang, G., Smith Stegen, K., Sovacool, B., Telesiene, A., and Zapletalova, V., 2020. *100 Social Sciences and Humanities priority research questions for renewable energy in Horizon* Europe. Cambridge: Energy-SHIFTS.

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