



Beyond technology: A research agenda for social sciences and humanities research on renewable energy in Europe

S. Krupnik^{a,*}, A. Wagner^a, O. Koretskaya^b, T. Rudek^a, R. Wade^c, M. Mišik^d, S. Akerboom^e, C. Foulds^f, K. Smith Stegen^g, C. Adem^h, S. Batelⁱ, F. Rabitz^{aa}, C. Certoma^j, J. Chodkowska-Miszczuk^k, M. Denac^l, D. Dokupilová^m, M. Dotterud Leiren^t, M. Frolova Ignatievaⁿ, D. Gabaldón-Estevan^o, A. Horta^p, P. Karnøe^q, J. Lilliestam^r, D. Loorbach^s, S. Mühlemeier^u, S. Nemoz^v, M. Nilsson^w, J. Osička^x, L. Papamikrouli^y, L. Pellizzioni^z, S. Sareen^{ab}, M. Sarrica^{ac}, G. Seyfang^{ad}, B. Sovacool^{ae}, A. Telesiene^{aa}, V. Zapletalova^x, T. von Wirth^{af, ag}

^a Jagiellonian University, Poland

^b Erasmus University Rotterdam, the Netherlands

^c Queen's University Belfast, Northern Ireland, UK

^d Comenius University Bratislava, Slovakia

^e Utrecht University, the Netherlands

^f Anglia Ruskin University, UK

^g Jacobs University Bremen, Germany

^h Public Administration Institute for Turkey and the Middle East, Turkey

ⁱ Instituto Universitário de Lisboa (ISCTE-IUL), Cis-IUL, Lisboa, Portugal

^j University of Turin, Italy

^k Nicolaus Copernicus University in Torun, Poland

^l University of Maribor, Slovenia

^m CSPPS, Slovak Academy of Sciences, Slovakia

ⁿ University of Granada, Spain

^o University of Valencia, Spain

^p University of Lisbon, Institute of Social Sciences, Portugal

^q Aalborg University, Denmark

^r Institute for Advanced Sustainability Studies Potsdam, Germany

^s Erasmus University Rotterdam, Dutch Research Institute for Transitions (DRIFT), the Netherlands

^t CICERO - Center for International Climate Research, Norway

^u Verband Schweizerischer Elektrizitätsunternehmen, Switzerland

^v University of Bourgogne Franche-Comté, France

^w Stockholm Environment Institute, Sweden

^x Masaryk University, Czech Republic

^y General Secretariat for Research and Technology, Greece

^z Università di Pisa, Italy

^{aa} Kaunas University of Technology, Lithuania

^{ab} University of Stavanger, Norway

^{ac} Sapienza University of Rome, Italy

^{ad} University of East Anglia, UK

^{ae} University of Sussex, UK and University of Aarhus, Denmark

^{af} Dutch Research Institute for Transitions (DRIFT), Erasmus University Rotterdam, Rotterdam, the Netherlands

* Corresponding author at: Jagiellonian University, Institute of Sociology, Golebia st. 24, 31-007 Kraków, Poland.

E-mail addresses: seweryn.krupnik@uj.edu.pl (S. Krupnik), aleksandra.wagner@uj.edu.pl (A. Wagner), tadeusz.rudek@uj.edu.pl (T. Rudek), R.Wade@qub.ac.uk (R. Wade), matus.misik@uniba.sk (M. Mišik), s.akerboom@uu.nl (S. Akerboom), chris.foulds@aru.ac.uk (C. Foulds), K.SmithStegen@jacobs-university.de (K.S. Stegen), Susana.Batel@iscte-iul.pt (S. Batel), florian.rabitz@ktu.lt (F. Rabitz), Chiara.Certoma@ugent.be (C. Certoma), jchodkow@umk.pl (J. Chodkowska-Miszczuk), matjaz.denac@um.si (M. Denac), merethe.leiren@cicero.oslo.no (M.D. Leiren), mfrolova@ugr.es (M.F. Ignatieva), Daniel.Gabaldon@uv.es (D. Gabaldón-Estevan), ana.horta@ics.ulisboa.pt (A. Horta), karnoe@plan.aau.dk (P. Karnøe), Johan.Lilliestam@iass-potsdam.de (J. Lilliestam), loorbach@drift.eur.nl (D. Loorbach), sophie.nemoz@univ-fcomte.fr (S. Nemoz), mans.nilsson@sei.org (M. Nilsson), osicka@mail.muni.cz (J. Osička), luigi.pellizzioni@unipi.it (L. Pellizzioni), Siddharth.Sareen@uis.no (S. Sareen), mauro.sarrica@uniroma1.it (M. Sarrica), G.Seyfang@uea.ac.uk (G. Seyfang), B.Sovacool@sussex.ac.uk (B. Sovacool), audrone.telesiene@ktu.lt (A. Telesiene), zapletalova@mail.muni.cz (V. Zapletalova), vonwirth@drift.eur.nl (T. von Wirth).

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ABSTRACT

This article enriches the existing literature on the importance and role of the social sciences and humanities (SSH) in renewable energy sources research by providing a novel approach to instigating the future research agenda in this field. Employing a series of in-depth interviews, deliberative focus group workshops and a systematic horizon scanning process, which utilised the expert knowledge of 85 researchers from the field with diverse disciplinary backgrounds and expertise, the paper develops a set of 100 priority questions for future research within SSH scholarship on renewable energy sources. These questions were aggregated into four main directions: (i) deep transformations and connections to the broader economic system (i.e. radical ways of (re)arranging socio-technical, political and economic relations), (ii) cultural and geographical diversity (i.e. contextual cultural, historical, political and socio-economic factors influencing citizen support for energy transitions), (iii) complexifying energy governance (i.e. understanding energy systems from a systems dynamics perspective) and (iv) shifting from instrumental acceptance to value-based objectives (i.e. public support for energy transitions as a normative notion linked to trust-building and citizen engagement). While this agenda is not intended to be—and cannot be—exhaustive or exclusive, we argue that it advances the understanding of SSH research on renewable energy sources and may have instrumental value in the prioritisation of SSH themes needed to enrich dialogues between policymakers, funding institutions and researchers. SSH scholarship should not be treated as instrumental to other research on renewable energy but as intrinsic and of the same hierarchical importance.

1. Introduction

A broad consensus exists about the urgency of decarbonising today's energy systems. Within the European Union (EU), its member states provisionally agreed in 2021 to fulfil at least 32% of their total energy needs with renewable energy by 2030.¹ The continued installation of capacities for renewable electricity generation is considered a key strategy for climate change mitigation.

Providing evidence of the technical and economic feasibility of energy transitions is fundamental [1–4], yet it is insufficient to solely inform societies about decarbonising energy systems [5,6]. Energy system transitions are evolving at differing paces and in diverse ways across countries and regions. Here, we define *transitions* as the processes of long-term, fundamental shifts in societal (sub-) systems, such as the energy sector or the mobility system. Transitions are complex, unstructured, non-linear and unplanned processes unfolding over decades from one dynamic system equilibrium to another, whereas 'sustainability' transitions refer to large-scale disruptive changes in societal systems that are deemed necessary to address grand societal challenges, such as climate change [7,8]. Transitions of energy systems emerge from different socio-technical configurations [9]. The energy sector can be conceptualized as a coupled, socio-technical system consisting of technologies, actors and institutional structures undergoing a fundamental shift of becoming decarbonised from a carbon-intensive to a carbon-neutral system state [10]. While the substitution and phase-out of fossil energy carriers is necessary for decarbonisation, a substantial increase in energy generated from renewable sources is required. With renewable energy sources, we here refer to the 'energy sources (that) replenish themselves naturally without being depleted in the earth; they include bioenergy, hydropower, geothermal energy, solar energy, wind energy and ocean (tide and wave) energy' [11]. In this study, we have built upon the definition of renewable energy provided by the International Renewable Energy Agency (IRENA) in 2013, which states that 'renewable energy includes all forms of energy produced from renewable sources in a sustainable manner [...] [12]. However, transforming energy systems is not just an 'intractable technical undertaking; it is also a

monumental cultural and political challenge' [13]; decarbonising energy systems are inescapably coupled, socio-technical phenomena that are being imagined, politicised, contested, progressed or slowed down, engineered and obtained by human agency.

While there has 'long been recognition for the role of social science research in energy studies' [13] and its importance is well documented [14], it has remained underrepresented in energy scholarship [15]. Techno-economic conceptualisations of energy and society have been shown to be overly rational, linear and simplistic [16]. Although social sciences and humanities research on energy, and on renewable energy in particular, has found scientific forums of discourse with the establishment of, for example, the *Energy Research & Social Science* journal, the Energy and Society biannual conference, and the Energy Research and Social Science conference, evidence indicates that the energy-related SSH disciplines have much unfulfilled potential, both in terms of policy and governance impact, as well as in research investment [17].

One way to raise the profile of SSH disciplines has been via research agendas (i.e. recommended avenues for future research) that aim to advance social perspectives on energy systems [15,18–20]. The main goal of this paper is to contribute to this discussion by developing a research agenda for future research in the SSH on renewables' contribution to decarbonisation. Our aim is to add 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' [21]. To accomplish this, we invited 85 European researchers to take part in a horizon scanning process and asked them which research questions should be answered in future research when it comes to renewable sources of energy. The result is a set of research questions that form the backbone of a future research agenda in the SSH on renewables. This work thus advances the understanding of SSH research on renewable energy by signalling the intent of leading renewable energy SSH scholars. Moreover, through the relative number of questions assigned to each theme, it offers an implicit prioritisation of policy-relevant (even if not policy-supportive) SSH themes, something that is undeniably needed in dialogues between policymakers, funding institutions, researchers and civil society. The research agenda was originally created to guide the European Union Framework Programme 9 (which started in 2021 under the name Horizon Europe), in the context of achieving the SET-Plan actions.² However, it can also be

¹ Amended proposal for a Regulation of the European Parliament and of the Council on establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law), Brussels, 17.9.2020, COM (2020) 563 final 2020/0036 (COD) <<https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020PC0563&from=EN>> (accessed 27 July 2021).

² Energy SSH Innovation Forum Targeting the SET-Plan: <<https://energy-shifts.eu>> (accessed 27 July 2021).

of use for a much broader audience. We also go beyond the formal presentation of the 100 research questions. Using the various strands of data collected during this process, we offer some critical reflections on how the field of renewables in the SSH was (re)constructed by the researchers and the priority research questions they suggested and ultimately chose.

This paper continues as follows. In the next section, we present our methodology for data collection and analysis of the Europe-wide horizon scanning process. We then present a reconstructed overview of the field of SSH research on renewable energy systems, indicating the key development strands of the field. This particularly involves popular but overlooked research, tensions between SSH disciplines, normativity, geographical differences and the relation of the field to policymaking. This is followed by a presentation of the key findings from our horizon scanning procedure involving a European panel of SSH energy research scholars. Four directions and 11 key themes for our future research agenda are presented. We conclude by discussing the implications for future research, policy and funding.

2. Methodology

2.1. Conceptual framework

The presented agenda is based on propositions submitted by a wider group of 85 researchers and on the final choices deliberately made by the members of a working group composed of 30 researchers with diverse disciplinary backgrounds and expertise, working in the field of renewable energy and beyond. While we took particular care to be inclusive and comprehensive in the selection process, some facets and research areas may still be underrepresented.

To get a better insight into the rationale behind ongoing SSH energy research, we reconstructed the field of SSH research on renewable energy as it was perceived individually and collectively by the scholars. These perceptions were gathered, first, by leading scholars during a series of interviews; second, by a wider group of European researchers in their justifications given for the proposed research questions; and finally, by the working group members, determined by a voting procedure and negotiated during deliberative workshops.

This constructivist perspective builds upon a conceptual framework inspired by situational analysis (SA) [22]. Our approach draws upon Anselm Strauss' interactionist grounded theory and Foucault's discursive approach. It focuses on how social situations are defined and what the relations are between those different definitions. It underlines the role of individuals and collective actors who 'are committed to act and produce discourses about the arena concerns' [23]. We then use the concept of the field as a symbolic arena of production, circulation, appropriation and exchange of goods, services, knowledge or status [24]. However, contrary to Pierre Bourdieu's field analysis, we do not focus as much on struggle and domination in the field. Instead, we investigate the situational elements of discourses that define the directions of the field's development. SA, in its postmodern form, accepts the partialities, instabilities, situatedness or heterogeneities of grounded theorising [25].

Thus, the definition of a situation, shared by some and questioned by others, can be legitimised differently in relation to external elements (economy, geographical location, personal experience, politics) or internally (through the inner logic of scientific development). It includes tacit knowledge and engages the symbolic capital of members of the field. Moreover, in accordance with the relational character of the field, its members do not necessarily have direct interactions, but they can still be connected relationally [25]. In SA, a situation is understood as a comprehensive methodological notion that allows us to overcome the duality of the object of investigation (i.e., the field of SSH research on renewables) and its contexts. Instead, the situation, being at the same time an object and an ongoing process, helps to integrate different lev-

els of analysis, researchers' interpretations and the observed data. This approach framed our analyses of the interviews with leading scholars to reconstruct their definitions of the situation in the field. It also guided our interpretation of the research question justifications submitted by the wider group of researchers to identify the elements of tacit knowledge underlying perceptions of the field.

2.2. Data collection

The data collection process is presented in Fig. 1. We began our research process by conducting 10 in-depth interviews with frontrunners in the field of SSH research on renewable energy. The characteristics of the interviewees are provided in the supplementary materials to the article. The respondents are actors with a wide overview of scientific activity in the field and experience working in various research communities that have had a visible impact on developments in the field. They are editors of impactful scientific journals, members of the boards of international scientific associations, leaders of well-known research centres, authors of influential, highly cited publications or pioneers of renewable energy research in their regions. Their observations were guided by the interview questions and then coded abductively by the research team. The interview guide and codebook are included in the supplementary materials.

At the next stage, the 10 respondents³ were included in the working group of renewable energy scholars and collaborated with 20 other researchers recruited according to the criteria of scientific achievements in the field of renewable energy SSH and diversity in disciplines, gender and geography (see the supplementary materials). Two representatives of early-stage researchers were also invited to the group. With the help of our working group members, the call for the submission of key research questions was disseminated among European researchers active in the field of the SSH. They were asked to suggest priority research questions together with brief justifications via a horizon scanning survey [21]. From across Europe, 85 researchers submitted research questions and provided justifications for them. The 280 submitted research questions were edited to address issues such as irrelevance to renewable energy, non-SSH focus, need for disaggregation, cross-question similarities or English language fidelity. The questions were then evaluated by the working group members in two stages (for procedural details, see [21]).

At the final stage, 100 priority research questions were selected from the edited list of 278 questions [21]. First, the questions were submitted to a voting procedure, where each question was scored on a scale from 1 ('definitely exclude') to 5 ('definitely include'). Two deliberative workshops then facilitated the collective consideration of the top-ranked questions, and eventual gaps were addressed; this procedure is described in the supplementary materials to the article.

2.3. Data analysis

The final 100 research questions were the key results of the horizon scanning procedure [21]. From the perspective of this paper, they were the product of the second step of the analysis (Table 1). The set of research questions, read in the light of the two other steps (i.e. analyses of interviews with frontrunners and the justification of proposed research questions), stimulates critical reflection on knowledge production within the field. Moreover, it provokes speculation about further

³ The interviewees were included in the working group and at the later stages of research; they had the possibility of submitting and discussing the proposed research questions like any other working group member. They were also offered the opportunity to reflect on the final version of the paper and invited to contribute to writing the last section of this paper, 'Concluding Discussion'. Therefore, they are co-authors of the paper. However, it needs to be underlined that for methodological reasons, they were not included in the process of data analysis. They also did not write any analytical parts of the texts.

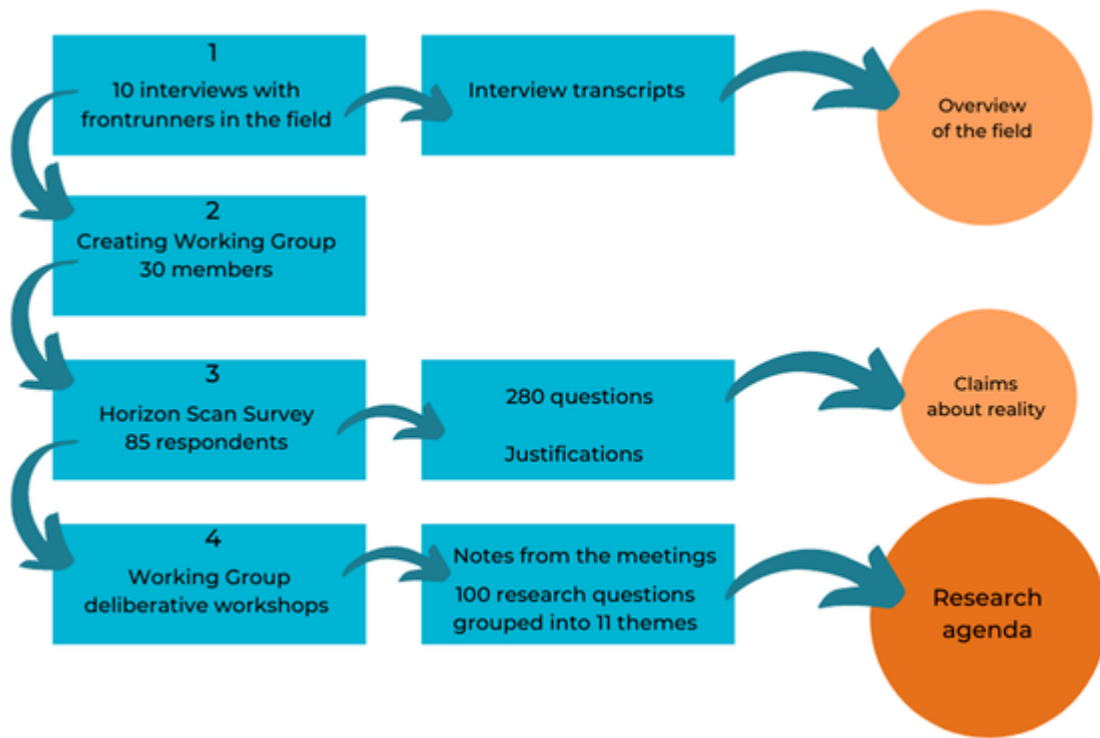


Fig. 1. Procedure and methods applied to generate a systematic SSH research agenda for renewable energy in Europe
Source: Authors.

Table 1
Details of the three-step analysis.

General research question: How do renewables SSH researchers construct the field, and what are the implications for future research directions?						
Steps of the analysis	Research questions	Data source	Method of collecting data	Time of data collection	Method of analysing the data	Product
Step 1	What are the most important developments within SSH research on renewables from the perspective of researchers?	10 frontrunners in the field of SSH related to renewables	Interviews	January to February 2020	Abductive coding inspired by situational analysis	Conditional matrix presenting overview of the field (six major developments in the context of actors, institutions and events) i.e. Fig. 2
Step 2	What are the most important research questions that reflect key priorities for SSH research on renewables?	85 SSH researchers, including 30 members of the working group	Horizon scanning	March to October 2020	Quantitative (statistical analysis of votes on questions) and qualitative (deliberative process leading to selection of final 100 questions)	Final 100 questions on 11 themes and four directions, i.e. Table 2, supplementary materials
Step 3	What are the justifications provided by the researchers proposing questions?	85 SSH researchers	Online questionnaire	March 2020	Qualitative	Evidence including claims about the reality and persuasive elements

Source: Authors.

changes in the logic of the field and its consequences, going beyond the scientific field.

The first step of the data analysis was related to the interviews. This part of the analysis includes the reconstruction of the scholars' reflection on the normativity of energy SSH and the possible trajectories of future development. In this way, *situations* were co-constructed by respondents (the individual perception of each respondent and similarities, overlaps and differences across the interviews) and researchers who interpreted them and integrated the noted categories into the reconstructed 'logic of the field'. 'The logic of the field' is understood as the configurations of actors, institutions, events and developments.

The second step was the analysis of the proposed research questions. The third step was the analysis of the 280 justifications of proposed research questions submitted by the 85 researchers, with the aim of recognising how the perceptions of actual and desired situations, reflected in these brief justifications—only a few sentences each—are related to the situations co-constructed in the first step of the analysis. To

do so, we used a twofold procedure: following the structure of the argument composed of 1) a claim about reality (a claim about the truth), and 2) persuasive elements. Both of these can be driven by the internal logic of the field (e.g. the rules of science development, institutionalisation of the discipline or promoting one's own research) or external discursive elements (referring to the economy, politics, moral values, social problems, history or geography). The scholars were defined as normative and engaged agents of change, which in this case was the transition from fossil fuels to fully renewable-based energy systems. Following the constructivist approach, we analysed their individual and collective perspectives on what is needed for the next stages of the energy transition.

We systematically coded the justifications, identifying the tacit knowledge about reality implied by the provided reasoning and persuasion. The persuasive practice is a form of symbolic capital engaged to influence the structure of the field, here through the proposed research agenda. As a result, we identified a set of assumptions about the politi-

cal, economic, scientific and cultural realities that (possibly motivated by empirically unobservable interests, values or desires) led participants to identify gaps and define the priorities of research development. The aim of this step was not to construct the shared vision of the field, but instead to better understand how the situations constructed by the interviewed leaders resonated in the wider group of diverse researchers and how the themes of the research agenda reflect their assumptions.

3. Overview of the renewable energy field

Based on interviews with frontrunners in the field, an overview of SSH research on renewable energy was constructed. The interviewees' statements about the state of the field were coded into six major development strands. As such, the overview presents the dynamic context for the agenda described in the next section. However, very often, there is no single general direction for the evolution of SSH research on renewable energy. Instead, a plurality of approaches and tensions among them emerges.

Actors, institutions and events condition the developments (Fig. 2). Among the key actors, researchers and academic institutions are those described as central to SSH research on renewable energy, as the ones responsible for conducting research. Various European, national and local public administration bodies also feature as key actors, influencing the field through various policies, and more specifically through funding. Other important actors are industry, activists—including social movements—and the media. Industry influences the field mostly via market forces, technological development, and promoting alternative—typically protective of their own interests—perspectives. The relation between researchers and activists is complex; together with politics, it influences the normative perspective of research (as discussed in subsection 3.6). Some interviewees also mentioned the media as instrumental in enabling and amplifying communication among actors.

As regards to events, the introduction of specific policies, regulations and other broader events related to politics appears as the most important external force influencing developments in the field of SSH

research on renewables. For example, the EU's enlargement in 2004 had a crucial impact on research in Central and Eastern Europe.

The following subsections describe six major development strands in the field.

3.1. Disciplines and interdisciplinarity

Many interviewees agreed that there is a lack of multidisciplinary collaborations, which results in a lack of articles and studies with a holistic, systemic view on energy transitions. There is a perception that most of the research is conducted from a so-called 'classical' or monodisciplinary perspective, such as pure economics studies or pure engineering work. When scholars stay within their silos, they may lack information from other disciplines and therefore have a limited view on 'feasible' solutions for sustainability issues. Social scientists, for example, may take for granted basic economic factors in their explanatory frameworks, such as the profit imperative, whereas technology researchers/engineers may tend to downplay the social aspects of energy problems.

Another constraining factor for collaborations is an implicit hierarchy between disciplines. When most people think about renewables, they think about physics, engineering and economics. These sciences are 'the designers of the energy regime', as they develop the financial tools or technologies to facilitate energy transitions. Only when the 'proactive disciplines' develop solutions that people do not accept, or the diffusion is not progressing as planned, are the social sciences employed to reactively analyse these developments and critique them—and find solutions, ensuring that new technologies and adaptations are implemented. Political scientists and sociologists do not shape the discussion and do not produce visions and potential futures at a scale that is comparable with the influence of the economic and engineering sciences. Many interviewees believed that the social sciences and humanities can play a greater role in the design stage of transitions and can open up new ways of understanding this field. For instance, philosophy, ethics, moral studies, critical human geography, political ecology, neoMarxism and feminist studies open up challenging normative questions about power and dispossession, as well as questions about deaths, slavery, patriarchy, race, fairness and spatial conflicts that other disciplines tend to avoid. It is largely agreed that multidisciplinary dialogues should be strengthened and that a common vocabulary and quality criteria should be developed to facilitate research that deals holistically with complex societal problems.

[...] political scientists [...] and sociology, I see it as a reactive community for now. They don't really shape the discussion, they don't really produce visions and potential futures right now, at least what I'm seeing. So the main, I don't know, differences are in the way how (...) these communities approach their research object. They have either an active and design thinking-like approach or a more reactive and reflection and critique style to approach. And I think that's one of the major clashes you have [Interview, 1].

3.2. Popular topics and gaps in research

Popular topics and gaps in research were identified as SSH studies on emerging renewable energy technologies and standards as well as their interaction with social norms, lifestyles, expectations and behavioural changes. Also of concern was the respective influence of values and attitudes, as well as legal, technical, infrastructural and social contexts.

However, most SSH research is conducted on water, sun and wind (WSW) energy. Other technologies, such as bio-fuels, biomass, biogas, biogas and geothermal energy, are predominantly studied by 'hard' sciences (e.g. engineering). Another weakness of SSH research is that it is too often focused on one technology, one case or one configuration. These types of analyses are not able to capture the true complex-



Fig. 2. Frontrunners' view of the field
Source: Authors.

ity of the technology, especially if we consider that each technology has its own unique associated political economy; for instance, the political economy of hydro power is very different from that of solar and wind power. It was the opinion of some interviewees that even if a study is focused on one technology, it should take into account a comparative perspective to better understand the topic of the research and facilitate the generalisation of results.

The decline of existing technologies is an emerging theme in SSH energy research as well. As renewables are diffusing more widely, broader system changes are becoming increasingly relevant. Debates about the discontinuation of specific technologies depend on the context, but they are often about phasing out coal or nuclear energy. Research in this area focuses on issues around decline, regional restructuring and difficulties in organisations that must adapt, as well as regions coping with changing technologies, changing environments and the loss of jobs.

When it comes to social aspects, grassroots movements and new ways of organising around renewables get more attention. Interviewees recognised that looking at innovations in the community field is very different from looking at technical innovations in the market. Renewable energy at the local level is not so much about energy as it is about politics, power asymmetries, socio-spatial conflicts and ownership. Other important themes are democratising the energy sector, energy justice and gender justice. Interviewees posit that class, wealth and inequality are often hidden or implicit themes.

There are still many gaps in SSH research on renewable energy. Some interviewees suggested conducting more studies on psychology, emotions and transition, exploring, for instance, how people manage their feelings when they are afraid of losing their jobs and how that relates to voting behaviour. Other interviewees considered it important to look beyond typical behavioural changes and explore broader systemic shifts, opening up the debate on what kinds of systems we want in the future, what constitutes a good life and happiness, what people's needs are and how these needs are determined.

3.3. Popular and underused theories and methods

Along with the broader dynamics between disciplines and their relative contributions, there are also the tools used by researchers operating within and across these disciplines. Some disciplines are more inclined to use certain theories and methods than others, so there is a close congruence between researchers' disciplines and the tools employed, as well as the philosophical underpinnings of their research (e.g. psychology tends to be positivist, while much European sociology has an emphasis on constructivist/interpretivist research designs). Indeed, one interviewee made a distinction between tools/approaches based on their ontological assumptions about the relevant entities of analysis, commonly referred to as methodological individualism versus holism. She argued that methodological individualist approaches have generally had the greatest impact from a policy perspective.

When asked about the future direction of theoretical innovation in the field of energy SSH, one interviewee stated that she sensed that theoretical development in the field had not yet plateaued and that there was room for more innovation. Interdisciplinary theories were seen as important for the future. Others flagged meso-level theories as a gap in the existing literature (e.g. organisational level) and some form of micro-macro integration. By contrast, one interviewee expressed caution at the consistent need for theoretical innovation and noted that many classical theories are well suited to addressing the problems we face. This constant push for novelty is possibly linked to existing institutional and promotion structures within academia.

In terms of specific methods, one interviewee recounted that the early days of energy SSH (the 1950s) were dominated by modelling and energy statistics. Social science perspectives then started to filter in, and another respondent recalled that this began with small sample sizes or looking at individual case countries. This was followed by more

cross-national perspectives and comparisons in the 2000s. One interviewee felt that quantitative methods, such as surveys, are dominant relative to qualitative methods. Suggestions for future methodological directions included action research, more comparative studies and a combination of objective and subjective indicators and dimensions.

3.4. Geographical differences

As the goals of this study are related to the EU, interviewees described geographical differences related to either comparisons of the EU with other countries or between specific European countries and regions. The most important differences can be described in terms of two dimensions. First, the amount of knowledge related to certain regions and countries is closely related to the inclusion of researchers from these regions in international networks and debates. Second, regarding the topics of research, spatial differences stem from diverse physical, cultural, political, technological and economic conditions. The important mediating factors between the aforementioned conditions and the actual research are different energy mixes and the dynamics of renewables deployment.

Interviewees highlighted the limits of generalising conclusions based only on analyses in Western European countries. Therefore, research becoming more global is a welcome trend. Still, more research is needed on non-Western regions, as well as more cooperation with researchers based there. From a European perspective, there is a special interest in countries in Southern and Eastern Europe and the Arctic. As the development of renewables in Northern and Western European countries has been more dynamic, these regions and relevant researchers prevail in the field. There is relatively less research on Central and Eastern European countries. At the same time, researchers from these countries are perceived as not sufficiently linked with the academic networks and debates taking place at the European level. There are also important differences between the spatial scales of analysis. While many studies have addressed the national level, other spatial scales and contexts have often been overlooked. For example, there is not enough research on rural areas and peripheries, including inner-country peripheries and islands.

3.5. Normativity

Various respondents held different, often conflicting perspectives on what energy SSH research is, has been and should be. Overall, none of the respondents adopted what might be considered by science, technology and society studies (STS) and sociology of science scholars as a naive understanding of science as being entirely distinct from normativity and politics, but rather held different understandings of how they should manage these connections.

I think that we have to kind of fight against this notion too, that to be scholarly means to be dispassionate, dispassionate and I guess, above these types of conflicts, when the humanities are all about revealing that we're never above them. We're always entangled in them and we might as well do something about it [Interview, 3].

For example, one interviewee distinguished between the normative positions of pragmatic, applied, and empiricist research, which 'gives you simple answers: choose efficiency and solar instead of nuclear, for instance', versus more (de)constructivist research, which 'talks more about contingencies and complexities and theories and concepts, and all these other things'. Most energy SSH research falls into one of these camps, he said; however, neither takes explicitly normative positions. This was contrasted with the humanities, which were perceived to be neglected while providing important normative questions and, potentially, answers. Another interviewee categorised these camps differently, arguing that much abstract, (de)constructivist research is 'very normative' and that she would like to see this body of work communi-

cate more with pragmatic, empirical, policy-focused research, and vice versa.

By contrast, some interviewees expressed caution about or dissatisfaction with the level of normativity in energy SSH research. For example, one researcher argued that transition scholars tend to assume that all change or transformation is desirable, whereas classical sociology would be more sceptical of change. Furthermore, some SSH researchers harboured assumptions about the inherent desirability of including the local community or grassroots level and the contextualisation of energy studies, whereas engineers were perceived as tending to think in terms of top-down solutions.

Another interviewee also expressed wariness about the close relationship between activism and energy SSH, although sociologists and anthropologists are considered a source of this normativity, as they often take sides with social movement activists. He reasoned that this bias towards certain socio-technical configurations may restrict our openness to future possibilities and may be particularly problematic as green-on-green conflicts become increasingly common; that is, conflicts emerging from competing claims and weightings of different environmental values, such as renewable energy versus local biodiversity [26]. Interestingly, this interviewee expressed that his position had changed over time in favour of decoupling research from activism to avoid tacit bias in the results.

3.6. Relation to politics and policy

The above discussion on normativity referred to the relations between science and politics in the broad sense of power and contested values and interests in society. It is also possible to consider the science-politics relation in a narrow sense of 'politics' as referring to tangible parliaments, elections and policy-making, which constitute governments.

One recurring element in the interviews was the impression that energy SSH research is reactive to politics and policies. For instance, in Lithuania, the academic discourse was perceived to respond to the international political discourse on energy and climate change, which cascaded down to the national level and national academic institutions—for example, the EU's mandating of renewable energy production targets spawned a wave of renewables research in the SSH. One interviewee argued that, in the UK, even when academics set agendas, they rely on policymakers and funding to do the research and are thus reactive in a slightly different sense.

Well, we have set as many agendas as we like, but nothing was gonna happen without funding. So we kinda have to wait perhaps until policy catches up, and then we can do the work we've always wanted to do [Interview, 4].

One interviewee hypothesised that this reactive nature and the lack of influence of some energy SSH on politics may be partially due to the holistic approaches adopted by some research studies (although, as previously noted, numerous interviewees felt that such research was lacking in prevalence and impact). Such approaches require complex, holistic solutions that may not be politically desirable compared to quick fixes, such as taxes, which might be proposed by methodologically individualist approaches—for example, in economics. However, others emphasised that some energy SSH research does provide pragmatic, simple answers. In addition, many journals require policy recommendations, but these are often made without thinking about the pre-existing policy regime or how they would be implemented.

Some interviewees did feel that energy SSH is becoming more proactive and influential in policy circles, to some extent catching up with the impact of natural science. In Lithuania, this closer connection was perceived to be largely driven by the academic community, with civil servants varying in their responsiveness, often based on their age (younger civil servants might be more open). There were also some cau-

tionary comments on how this increasing closeness between science and policymaking may undermine the integrity of research.

Furthermore, in the era of post-truth and rising populism, there is a concern that scientists may not feel as free in what they can say. Alternatively, there is also the fear that science itself is seen as less important by populist leaders.

4. The four directions of social sciences and humanities research on renewables

To provide a more complex picture of the possible contribution of SSH research to future energy research, we categorised 100 priority research questions identified during the horizon scanning (see supplementary materials and [21]) into 11 themes, presented in Table 2 (second column). The themes were constructed through a deliberative process in which the content of the questions and the expert knowledge of the working group members were taken into consideration. The boundaries between the themes are not sharp, with some overlapping. For example, financial and organisational structures depend on the geographical context and lead to diverse intended and unintended effects, which may be related to both environmental and social issues.

Moreover, we aggregated these themes further and created four directions for social sciences and humanities research on renewable energy (first column in Table 2). This aggregation is based on the justifications proposed by scholars involved in the research: asked to propose research questions to construct the agenda, scholars reflected on the current situation and the priorities for the future. We used the themes identified in the first step as reference points to discuss the reconstructed scholars' perceptions of the current reality and priorities for the future, even if those perceptions cut across the themes and questions and escape unambiguous assignment.

4.1. Deep transformations and connections to broader economic system

In the context of the transition to decentralised renewable energy technologies, radical ways of (re)arranging socio-technical, political and economic relations are being considered by academics and social practitioners. This is captured under the theme of *transformative governance*, which includes questions on (de)growth and renewables, as well as questions about the potential for democratic, localised models of energy production and distribution. The theme of *financial and organisational structures* similarly touches on this latter element. At the same time, there is a perception that perhaps more fundamental changes are not sufficiently explored or supported through research:

But as much technological change is pushed and people investigate which policies and regulations would need to be changed in which way, there is not much work about how policies would need to be changed to allow for societal paradigm shifts and new organisational forms (e.g. standard discussion: does every energy cooperative or municipal energy company need a banking licence to manage a local energy trade platform?) [Justification, Case 60].

Related to these initiatives is the contested concept of *energy democracy*, which can be 'conceptualized as an analytical and decision-making tool, defined along three dimensions: popular sovereignty, participatory governance and civic ownership' [27]. While energy democracy remains a contested concept with various interpretations by different actors [28], it has nonetheless underpinned movements for decentralised control of energy systems. While these movements have had a long and, at times, successful history in places like Denmark and Germany, it appears now to be a common trend that these movements are coming under pressure and are 'at a crossroads' as the commercial renewable industry matures and consolidates its position [29,30]. The economic reality of the neoliberal environment is seen by some as shaping the implementation of renewable technologies. These structural

Table 2
Research agenda for SSH research on renewable energy.

Direction	Theme (# of questions)	Description
Deep Transformations and Connections to Broader Economic System	Transformative governance (14)	The aspects of guiding and navigating the fundamental changes from the existing fossil-dominated energy regime to a renewables-based energy system; the emergence of renewable alternatives and innovative knowledge from different actors in the energy system; procedural aspects of moving towards a new system
	Financial and organisational structure (5)	Financial mechanisms supporting renewables as well as organisational conditions and dynamics; distributed investment and novel organisational models as well as centralised, national and international financing models
	Energy democracy (9)	Aspects of democratising the energy system, including the potential for energy initiatives and structural conditions to foster transparency and participation; citizen engagement with innovation processes, ownership structures and decision-making mechanisms concerning renewables
Cultural and geographical diversity	Culture, imaginaries, narratives (14)	The role of socio-technical imaginaries, learning and media discourses addressed according to their geographical differences, interconnections with the dominant energy regimes, and their impacts on transition dynamics; how discourses are constructed and evolve, and how they affect people's identities and perceptions
	Geography of renewables (2)	Geographical similarities between and differences among emerging renewable energy transitions, specifically between different EU member states; localities and scales of renewable energy systems in different contexts
Complexifying Energy Governance	Renewable energy policies (9)	Evidence to guide multi-level policy processes and decision-making on renewable energy related to public policy design, implementation and evaluation; legislation
	Renewable energy system design and integration across sectors (13)	Specific features of renewables system design and integration of socio-technical configurations; the ways renewables may be deployed and integrated within and across sectors (e.g. transport, agriculture); design and integration ensuring lasting deployment
	Power dynamics and conflicts (11)	The role of power dynamics and conflicts within energy transitions towards renewables, and the power relations in play between different types of actors; the relations between social actors; political dimensions
From Instrumental Acceptance to Value-Based Objectives	Socio-ecological effects (7)	The impacts of socio-technical change on a renewables-based energy system, on ecosystems, biodiversity and landscapes; unintended consequences of undertaken actions
	Social acceptance (6)	Social acceptance as a crucial symbolic resource or framed as a disposition related to trust and local involvement; factors shaping social acceptance for different technologies and aspects of trust-building and citizen empowerment
	Energy justice (10)	Justice, equity and societal inclusion, addressing the facets of fair transition processes to renewables-based energy systems; energy poverty, socio-economic inequality, energy access and implications of energy transitions on employment, the critical analysis of justice issues, as well as more normative questions

Source: Authors, based on [21].

conditions that disadvantage the strategies of certain actors, such as community energy activists, must surely be understood and analysed in the broader context of 'green capitalism' [31,32]. Indeed, some voices in this research process have suggested the potential of the SSH for (re) thinking about renewable energy's connection to capitalism(s):

It is my understanding that many SSH scholars in their approach to 'the economics of renewables' are victims of the distinctions made by economists [...] that there are 'subsidy-dependent' renewables and 'market-efficient' fossil fuels. [...] Seen from the perspectives of political economy, valuation studies and Michel Callons' 'markets as agencements', it becomes clear that the specifics of making the economic market arrangements that turn fossils and renewables into economic assets entail strong entanglements of politics and economic science. Most SSH scholars—and other scholars—still think that there is 'one capitalism' or 'one market economy' and overlook the political-economic-cultural roots of the varieties of capitalism. [...] We need much more SSH research into this important theme [Justification, Case 114].

Understanding these connections may enable SSH researchers to step into more proactive positions as opposed to being reactive to other disciplinary fields, as discussed in previous sections. Nonetheless, it is surprising to note that only two questions from the list of 278 proposed edited questions explicitly mentioned capitalism, and neither of these were ultimately selected for the final list of 100 questions in the course of the voting and negotiation workshops. This shows that there is perhaps some way to go before the field of energy SSH internalises these recent interventions and connects our understanding of the energy transition to broader capitalist dynamics.

As an example, the following questions belong to this direction: *What role have civil society and social movements played so far in the diffusion of renewables, and what potential do they have for the future? What are new economic principles, incentives and institutions needed to support a transformation towards a just energy system? How do different varieties of capitalism influence the deployment of renewable energy in different regions, and can we identify common, 'core' capitalist tendencies across these? How can renewables technology design be aligned with transformative visions of democratic and localised energy systems?*

4.2. Cultural & geographical diversity

Citizen participation is widely regarded as crucial for the energy transition.⁴ It is related to both government decision-making and bottom-up initiatives within the energy transition. Researchers claim that citizen participation depends on contextual cultural, historical, political and socio-economic factors. The EU is perceived as diverse, and the differences among member countries make generalising about citizen participation challenging. Moreover, the diversity of the EU is reflected in various perspectives on the energy transition:

While there are ambitious objectives to boost renewable energy (RE) transition in the European Union (EU), it is more and more evident that it is going differently in different European countries, as the nature of restructuring trends in the energy sector is contingent upon regional and national circumstances. Thus, the desired end state of energy transition is understood differently in the EU countries [Justification, Case 92].

Recognising the differences in normatively evaluated visions of the future state of society among different countries has led to the increasing significance of a cultural approach. This approach creates a space for developing social imaginaries and narrative research. Many scholars believe that different cultural and geographical contexts demand different transition paths. Cultural differences and their perceived signifi-

⁴ Citizen participation broadly refers to inclusive participation open to citizens, residents who are not citizens, local communities and other stakeholders.

cance are reflected mainly by the *culture, imaginaries and narratives* theme. The role of public and group discourses in shaping transitions is highlighted here. The most important assumption underlying this set of questions is the constructivist belief that social reality is not just a given but is actively constructed through imaginaries and discourses that are culturally diverse. Imaginaries, narratives and discourses have the power to reconfigure the relations between symbolic and material elements of reality and, as such, can reproduce the status quo and activate the resistance of old regimes. However, they also have the capacity to redefine old rules, legitimise new connections and create new rules and patterns. These dimensions therefore interact with the dynamics discussed in the previous section on (alternative) political and economic configurations as well as the following section on energy governance.

This direction includes questions such as the following: *What are the challenges that transitions to renewable energy pose to multi-, inter- and trans-disciplinary university education? What are the most geographically suitable and feasible scenarios for reaching 100% renewable energy in different EU member states? How do broad socio-cultural frames in different countries or regions interact with socio-technical imaginaries?*

4.3. Complexifying energy governance

Overall, SSH scholars do not question the general direction of policymaking, such as the decentralisation of the energy system or the need for the acceleration of energy transitions, which just a few years ago were perceived as controversial [33]. However, the sheer complexity of policymaking for renewable energy transitions is becoming increasingly clear. Despite many renewable energy technologies reaching a certain point of economic and technical maturity, the political choices that need to be made are far from simple. This is because renewable technologies do not exist as discrete objects but need to be tied up within broader complex systems where changes in one domain create feedback effects on others. Therefore, energy systems need to be understood from a systems dynamics perspective, with stakeholders being mobilised from different parts of each system. To add to this complexity, all these actors have positional interests that they are incentivised to defend, many of which are in conflict with one another. Finding policy coalitions to overcome incumbency becomes a key strategy since, as was underlined by the researchers, the development of renewables is linked to the limitation of market domination by the fossil fuel industries. That is why the influence of actors such as states and international organisations is crucial in pushing the transitions forward against the competing interests of different stakeholders. The political choice for transformation towards decentralisation and decarbonisation is linked to cross-sector conflicts and tensions. The strong assumption that the energy transition is inseparable from competing interests, powers and conflicts makes it important to understand how powerful actors and regimes are interconnected in policymaking processes.

Some future research questions might include the following: *Which renewable energy policies need to be designed to decarbonise all parts of energy systems to reach the EU 2050 carbon-neutrality goal? What role do carbon-heavy industries (e.g. aviation, shipping, cement, chemicals) play in the transition towards renewable energy? What effect is the strategic realignment of large incumbent actors from fossil fuels to renewables (e.g. offshore wind) having on the dynamics of the energy transition?*

4.4. From instrumental acceptance to value-based objectives

Public support is often described as a condition for a successful transition. However, social acceptance itself is not fully understood and operationally difficult to achieve. As a normative notion, it is linked to trust-building and citizen engagement. On the level of practice, it is perceived as a complex, context-dependent and often problematic issue. According to some scholars, the lack of acceptance of renewable technologies is caused by people's expectations (embedded in socio-

technical imaginaries) that energy should be cheap, reliable and safe. At this point, renewable technologies are not framed in this way in some regions:

In some European countries [...] there is a strong public service notion related to energy supply, which means that energy should be affordable, secure and available for all in every corner of the country [Justification, Case 119].

Another important framing is the dominant tendency in the public sphere to present renewables as clean, green and healthy. This is questioned by some scholars, who say we need to recognise the uncertainties and unintended consequences of renewables, which cannot be disregarded. Renewables, like any energy source, have impacts, both for the environment and landscape as well as society, which have not yet been fully recognised by policymakers or even by the wider research community [34]. Implementing renewables opens new areas of uncertainty, and the unintended consequences in the form of *socio-ecological effects* contribute to challenges with regard to social acceptance. The dominant framing of clean, green and healthy has been an important symbolic driver supporting the growth in the support of renewables. However, when taken too far, this framing can crowd out important concerns and impacts. Indeed, recent critical approaches in *social acceptance* research even 'question if opposition to renewable energy technologies should be reduced or overcome' [34]. This is in response to the 'managerialist' tendencies that stem from the normative goals of social acceptance and the related framing of renewables as clean, green and healthy [35]. This can lead to the treatment of opposition as deviant and inherently undesirable when, in fact, opposition is a legitimate and healthy part of democracy. Therefore, priorities for effective policy include better recognition and pursuit of social acceptance via 'agonistic' and provisional planning and policies [36], which recognise the multifarious uncertainties and competing values inherent in the deployment of renewable energy. The concept of *energy justice* provides a useful way of conceptualising and evaluating substantive impacts at different scales without resorting to the binary of acceptance (good) and opposition (bad). Future research could tie these three themes together in a way that simultaneously pursues the substantive goals of rapid renewables deployment and a just transition. These directions also tie in with discussions above on SSH research taking a more proactive role in technology choice instead of reacting to social 'problems' emerging from renewables deployments, as well as discussions around SSH adopting more normative perspectives.

Questions in this direction might include the following: *What are the climate, environmental and social injustices associated with renewable energy? How do socio-technical imaginaries frame and evaluate different socio-ecological impacts of renewables, and how does this influence social acceptance? How can justice outcomes at different scales be compared and operationalised (e.g. climate justice vs. local project impacts)?*

5. Concluding discussion

The importance and role of SSH research in renewable energy is well documented. This article enriches this literature by showcasing the possible contributions of the SSH to future energy research based on the perspectives of researchers in the field. The developments of SSH research on renewables are presented and a research agenda for SSH research on renewable energy in Europe is proposed based on the horizon scanning process. The researchers engaged in this process used their expert knowledge of the field to propose and select questions. This contrasts with bibliometric analysis as a potential alternative approach, which builds a research agenda based on an extrapolation from historical data, thus potentially reproducing blind spots and biases. The horizon scanning process therefore offers advantages in this respect because it allows for more critical and forward-looking avenues to emerge. The downside of this approach is that the initially selected interviewees and

working group participants may already reflect and reproduce the existent normativity and power structures of SSH research in Europe. This leads to some interesting reflections, as will be discussed below. This agenda has been proposed by European researchers for the European Commission. It may be a useful reference point for similar exercises focused on different geographic scopes, such as North or South America. The comparison of agendas related to different scopes will enrich SSH research on renewable energy.

This paper complements existing studies [15,18–20]. As such, it confirms that the SSH should not be treated as instrumental to other research on renewable energy but as intrinsic and of the same hierarchical importance. Historically, SSH research has analysed why the solutions proposed by the ‘proactive disciplines’ have faltered or failed. Our study may hopefully instigate a shift in perspectives. It pinpoints the topics of concern that experts see on the horizon and by which SSH scholars can proactively shape the directions of research on renewable energy. The proposed research agenda stands out from previous studies, as it explicitly asks about new economic principles (including post-growth) and new organisational forms of energy production, exchange and consumption needed to achieve a full transition to renewable energy. The agenda highlights the necessity of a systems dynamics perspective to investigate how renewable energy can be reconciled with other important trends and objectives, e.g. regarding a circular economy, development goals, and new evidence about the impossibility of decoupling economic growth from energy use in a timely way. The issue of time and urgency of transitioning is another aspect that distinguishes this research agenda: it proposes to critically assess political statements of climate emergency, EU 2050 goals of carbon-neutrality and how the required speed of transformation can be reconciled with energy justice and democracy. Last but not least, the agenda bluntly asks about the role of populist politics, resistance of energy oligopolies and potential co-optation of the transition by elites and incumbents.

In many ways, the agenda confirms the importance of policy processes for SSH research on renewables. While aligned with policy-making processes, the ambition of SSH is not only to influence the implementation or evaluation of policies; the signalled topics should also impact the earlier stages of policy processes, that is, diagnosis and agenda setting. Since these stages involve many diverse actors, including NGOs and social movements, the proposed agenda may also be useful to them. The active role of the SSH is especially clear in themes such as *transformative governance* and *culture, imaginaries, narratives*. In addition, by highlighting and unpacking normative goals, such as democracy and inclusion, the agenda and the resulting research may help in providing insights and recommendations for all actors involved in the decarbonisation of energy systems. Through this, future SSH research on renewable energy can play an active role in contributing action-oriented knowledge for sustainability [37] to guide decision-making and policy interventions towards fully renewables-based energy systems in Europe.

The study was conducted in the early stages of the global COVID-19 pandemic, and some questions originally proposed by the researchers referred to the impact of the pandemic on renewable energy deployment. However, in the process of selecting questions, this topic was evaluated as less significant for renewable energy research. Eventually, only one question related to external disruptive events made it into the final set of priority research questions. This decision does not downplay the expected role of the pandemic, which has been investigated in other studies [38–40]. Instead, it likely reflects our attempt to generate a research agenda that provides longer-term guidance for the field.

The agenda may be criticised for not highlighting or downplaying some topics. One version of this criticism was advanced by an anonymous reviewer of the paper, who proposed a list of additional topics worth mentioning. As an example, even if more disruptive and transformational pathways for renewable energy transitions, such as degrowth [30] and other alternative sustainabilities [41], are indicated in the pa-

per, they were perceived by the reviewer as insufficiently discussed. Another example involves race, racialisation and racism. Even if the broad topic of energy justice is very much present in the agenda, race was not mentioned in any of the proposed questions. However, the list of 100 research questions is a compromise; some of the topics suggested in the list of 278 questions did not make it to the final list after voting and deliberations. The research agenda was not intended to be, and could not be, comprehensive. Nonetheless, it is interesting to reflect upon these gaps, such as race and the pandemic, which were not deemed to be important by the field of energy SSH researchers. Does this, for example, reflect a simple lack of relevance of race issues to energy transitions, or does the field of energy SSH suffer from a lack of sensitivity to such issues for underlying structural reasons? Similarly, for the pandemic, do researchers underestimate the long-term implications of seismic external events or shocks to systems?

Similarly, the list of 100 research questions may seem overwhelming and in need of prioritisation. The scholars engaged in creating the agenda did not rank the final list of questions by importance or priority because it was not the objective of the research. However, the relative number of questions that made it into each theme can be considered a form of implicit prioritisation of themes. Furthermore, interested readers may find the 50 questions with the highest votes in the supplementary materials. The 100 questions were chosen from a longer list of 278 research questions and therefore represent the most popular questions. The supplementary materials also show how the priorities differed among groups of researchers defined by STEM (science, technology, engineering, mathematics) experience, gender or the region of Europe in which they are based. Therefore, the process of further prioritisation could involve a transparent articulation of the normative foundations of these decisions and choosing a more specific scope, e.g. geographical, substantive or related to specific groups of stakeholders.

Making use of this research agenda bears a risk of only symbolic usage [42]. When deploying the agenda, researchers and policymakers should ensure to go beyond only invoking the terms themselves without proper reflection, attribution and integration into a project, policy or practice's inception, design and delivery. SSH experts are best positioned to spot when SSH language is being used without due consideration of its implications for problem definition, methodology and research-policy interactions. Therefore, if funding organisations are serious about ‘mainstreaming’ SSH approaches across all of their work, they need to do more to incentivise the participation of SSH researchers in funding decisions [42,43].

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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