This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101069529 and from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee [grant No 10038991].

A review of the **Climate-Energy-Mobility landscape** through **10 Social Sciences and Humanities literature briefs**

April 2023

SSH CENTRE

Social Sciences & Humanities for Climate, Energy aNd Transport Research Excellence

Editorial: The purpose, process, and cross-cutting themes of the literature briefs

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Introducing the Literature Briefs

The EU Horizon Europe SSH CENTRE (Social Sciences and Humanities for Climate, Energy aNd Transport Research Excellence) project aims to generate best practices for incorporating Social Sciences & Humanities (SSH) and transdisciplinary research into the European Union's (EU's) climate, energy and mobility transition policy. The SSH CENTRE project is developing understandings of how to support cross-sectoral collaborations in order to empower citizens and networks, and develop socially innovative solutions.

As part of the SSH CENTRE project, 10 literature briefs have been produced which capture, and align with, current EU policy priorities. These literature briefs each provide an overview of the topic in focus, and are hoped to be of use and interest to researchers and practitioners wanting to introduce themselves to these topics. The literature briefs provide a platform from which readers can develop further understandings drawing upon the references included within the literature brief and other resources.

The literature briefs perform four main functions:

Firstly, the literature briefs provide an overview of current research and debates related to EU policy priorities, and in particular the climate, energy, and mobility aspects of the EU Green Deal. Focusing specifically on the SSH CENTRE project, the literature briefs also contextualise this 3.5 year research project in relation to current debates and show the contemporary interest in these topics to researchers, practitioners and other interested actors. By introducing topics that are of contemporary policy relevance through these literature briefs, we aim to provide a resource to support understandings and inform engagement by different interested actors.

Secondly, the definitions and framings presented within the literature briefs provide a common language and resource that can bring coherence when discussing these topics. The language, definitions and framings used can be drawn upon in activities related to the policy topics, both within SSH CENTRE project activities and in other contexts. The provision of common definitions and framings supports the translation of understandings across disciplines, which is a key component of the SSH CENTRE project.

Thirdly, the literature briefs discuss the role of SSH and interdisciplinary insights in addressing and furthering EU policy priorities. By identifying the role of these insights, the collection supports the identification of future research opportunities. The future opportunities (and priorities) of SSH research in relation to the literature brief topics can be addressed through research activities within the SSH CENTRE project and beyond. The identification of these opportunities through the literature briefs provides a platform upon which future actions can be undertaken.

Finally, the literature briefs outline key takeaways for different actors informed by the synthesis and discussion of key ideas related to EU policy priorities. The recommendations presented are specific and actionable. Recommendations for a range of actors are presented, including the European Commission, businesses, and researchers. The recommendations developed present the literature briefs as a resource accessible to a range of actors. Takeaways for the SSH CENTRE project itself are also highlighted, showing how these literature briefs inform research activities throughout the remainder of the project.

Developing the literature briefs

Each literature brief is informed by a review of existing literature (focusing on contemporary research activities) and two expert interviews.

The literature review was not conducted in an exhaustive way, rather focus was placed on literature that engages with SSH (or interdisciplinary) aspects of the literature brief topic. The non-exhaustive nature of the literature review reflects the purpose of the literature brief to provide an introduction and overview of the topic, with the literature brief being a starting resource. The literature review enabled presentation of an introduction to key ideas and approaches of the literature brief topic, with focus placed on research practices and outputs. The engagement with the research aspects of the literature brief topics facilitated the discussion of current understandings, emerging practices, and future research opportunities.

The expert interviews that further informed the literature briefs gave insight into current understandings, emerging practices and future priorities related to the literature brief topic. They also guided the focus of the literature review conducted. A broad classification of 'expert' was adopted when identifying interviewees, meaning that different forms of knowledge and expertise could be drawn upon. As such, across the 10 literature briefs interviews were conducted with both academics and practitioners. An interview guide was developed to support the development of insights and brought consistency across the 10 literature briefs. Topics outlined within the interview guide include 1) key definitions, research and literature related to the topic, 2) current understandings and practices of the topic, 3) emerging practices and research conducted related to the topic, and 4) future priorities for SSH in relation to the topic. Ethical approval for the interviews was received from Anglia Ruskin University's ethics committee[1].

Rather than fully transcribe the interviews, key insights and contributions from the interview were noted. These notes are anonymised and will be made open access on the SSH CENTRE's Zenodo community page (consent has been sought and received from interview participants).

The 10 literature briefs

Whilst the 10 literature briefs are standalone documents, there are common threads and themes between them. These threads and themes manifest in the three broad categories: future research design; the value of interdisciplinary perspectives; and approaches for achieving carbon neutrality. Within each of these categories, the focus is on the opportunities and priorities for SSH (and interdisciplinary) research in relation to the EU's carbon neutrality transition.

The first category of literature briefs provides insights that can support the development of future research projects. These insights include how to design the research project, how to conduct the research and how to share and disseminate the insights obtained. The *Epistemic Justice* literature brief [1] focuses on equitable knowledge creation, and the need to address the structures and processes that exclude or devalue knowledge. With the *RRI* literature brief [2] focusing on the development of research that leads to socially desirable outcomes that reflect the public interest, with this being supported by the interaction of between different research disciplines. *Open Science and Open Education* [3] can be incorporated into research projects to help increase the uptake, transparency and confidence in scientific research findings, exchange of knowledge and ideas.

1 Ethical approval granted 20th October 2022 (Reference: ETH2223-0756)

The second category of literature briefs unpacks the opportunity (and need) to approach climate, energy and mobility research from a more interdisciplinary perspective. Across these literature briefs, the three interdisciplinary focused literature briefs present an introduction to transdisciplinary research approach, means to facilitate interdisciplinary (and transdisciplinary) research, and an example of where these insights can be incorporated methodologically. The *transdisciplinarity* literature brief [4] focuses on the production of knowledge that transcends disciplinary and academic boundaries and embraces different forms of knowledge by different actors. With the literature brief on *SSH-STEM networks* [5] providing understandings of how this can be achieved in practice through both formal and informal networks. The *SSH and Modelling* literature brief [6] argues that there is the need to better incorporate social perspectives (such as human behaviours) into models that typically have a technical focus in order to improve understandings and support decision-making.

The final category of literature briefs discusses how approaches to support the achievement of the EU's climate ambitions (as supported by policy) benefit from insights obtained through SSH research. The approaches discussed include how processes and practices could be adapted to support the achievement of the EU's policy priorities, including means through which this can be achieved. The *Circular Economy* literature brief [7] focuses on the influence (and governance) of social phenomena on processes of sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible. Both the *Digital Techologies* [8] and *Mobility Communities* [9] literature briefs outline how processes of digitalisation can support the achievement of carbon neutrality ambitions. The *Digital Technologies* literature brief [8] provides an overview of how digitalisation can support sustainability transitions by shifting physical supply chains, altering work and travel patterns, and supporting innovation towards sustainable decision making. Whilst the *Mobility Communities* [9] literature brief focuses on the justice implications of digitalising mobility systems and services. Finally, the *Energy Communities* [10] literature brief reflects on the opportunities and constraints of energy communities, discussing questions of how to empower citizens and support processes of democratisation, but have drawbacks including how they are financed, their governance structures and not everyone being able to participate.

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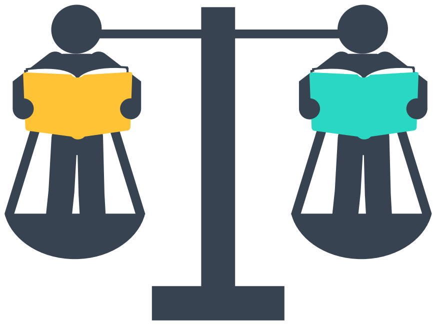
List of Contens

Epistemic justice: How can diverse forms of knowledge improve policy making?



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ABSTRACT

Epistemic justice is a key concept for sustainable transitions. Besides providing opportunities and contributing to equitable knowledge creation, including knowledge on climate, energy and mobility, epistemic justice can lead to more effective policies and minimise their negative impacts. However, there are some procedural and institutional barriers preventing proper integration of the concept into policymaking. SSH research has a poten-tial to deviate from dominant narratives and ideologies and thus, contribute to successful practices and policies.

SUMMARY

- Epistemic injustice refers to the silencing and marginalisation of forms of knowledge and meaning making.
- Bridging the epistemic injustice gap is necessary for just and sustainability transitions in climate, energy, and mobility.
- Consideration of epistemic justice provides opportunities for participation and contributes to equitable knowledge creation, more effective policies, and reduction of unintended impacts of policies, especially on marginalised communities.
- The recognition of the importance of epistemic justice in Social Sciences & Humanities (SSH) research and on policymaking level has been growing.
- There is a lack of discussion of integration of epistemic justice in practice among and across scientists, stakeholders and decisionmakers.
- There is an urgent need to re-evaluate what data are used and whose voices are heard while scrutinising policies; qualitative data and a wide range of epistemologies can contribute to problem understanding from various perspectives and improve implementation of policies.
- There is an opportunity for collaborations between SSH & Science, Technology, Engineering and Math (STEM) to better inform policymakers in questions of climate, energy, and mobility in relation to epistemic justice.

KEY DEFINITIONS

Epistemic justice is concerned with fairness in knowledge production, dissemination, and utilisation while promoting more inclusive knowledge creation and credibility of marginalised voices. Epistemic injustice refers to knowledge shaping by power relations and exclusion of marginalised groups from these processes [1].

Equity refers to fairness and justice while addressing existing disparities and recognising different starting points of individuals and groups of people [12]. *Marginalised communities* are those experiencing exclusion from conventional social, political, economic, and cultural dimensions of life due to (but not limited to) discrimination of race, gender, sexual orientation or identity because of unbalanced power relations among social groups [13] .

Introduction

Epistemic injustice refers to the silencing and marginalisation of forms of knowledge and meaning making. Epistemic injustice can be created through structures and processes that exclude or devalue knowledge, having knowledge co-opted, and misrepresentation or distortion of knowledge [1]. It intersects with issues of gender [2], race [3], sexuality [4], and more. It is also a framework for understanding fragmentation and exclusion of SSH and non-Western-European voices in sustainability research and policy.

In energy, climate and transport (and sustainability more broadly) research, epistemic injustice is further embedded by boundary keeping around what counts as 'knowledge', and dominant framings of quantitative objectivity [5]; connected to perceptions of quantitative measurements having more validity over qualitative science. Pushing to meet policy agendas, that are often based on meeting quantitative goals, has been shown to close down critical contributions of SSH to foster epistemic justice [6]. Epistemic injustices create incomplete and incorrect understandings of problems, their causes and impacts, and equitable interventions.

This literature brief will unpack the ways in which epistemic justice is important for research in energy, climate and transport issues, and will create recommendations on how to achieve it. These will pertain to decolonization [7] and epistemic sensitivity, and will detail methodological [8, 9], institutional [10] and governance actions [11]. The brief is targeted to EU audience but draws upon many non-European examples to demonstrate the range of epistemic injustice examples that are still relevant to European context and the impacts of actions in one place and it's (non)transferability to another. By that, the brief highlights the SSH research potential to bridge the injustice gap and contribute to climate, mobility, and energy effective policymaking.

Current Understandings

Significant Findings to Date

There has been a growing recognition of the importance of epistemic justice in SSH research, including interlinked concepts of decolonisation of knowledge [14], the role of recognition [15], and power relations [16]. However, **the efforts to understand and use epistemic justice in SSH (or STEM) are not mainstreamed in research or policymaking** and the debates among various scholars and actors have not started, yet [LS, MS]. In context of the climate crisis, energy and mobility, the research on SSH, epistemology and justice is siloed in various fields or established concepts such as political geography [e.g. 17], anthropology [e.g. 18], development [e.g. 19], distributive justice [e.g. 20], intergenerational justice [e.g. 21] and participation [e.g. 22], but the focus on epistemic justice is insufficient [MS].

Aiming for epistemic justice in research can help to ensure that issues and related policies around climate, energy and mobility are understood from and formed by various perspectives. That is especially important for the effectivity of policies. **Consideration of a diverse range of social groups and their voices is necessary if policymakers want to achieve their goals in practice** [MS]. Marginalised communities are often the ones that experience the impacts of the climate crisis and issues related to energy and mobility first hand. The understanding of their views of problems, their experiences and needs are a key to successful solutions [MS]. Without inclusion of all epistemic perspectives in meaning making and knowledge production and policymaking, climate change will deepen the inequities and hence, make related policies ineffective. **Diverse knowledges, experiences and practices of local communities and indigenous people are vital for successful policies.** If these epistemologies, needs and values are excluded, policies can end up being ineffective in practise or benefiting only some groups of people [23].

Currently, materials that are used for scrutinising policies on climate change, energy, and mobility, tend to originate from dominant narratives and ideologies in science that largely influence what counts as legitimate knowledge. These are often based on STEM research coming from Western countries and Western university models causing disproportionate power and privilege in knowledge production that is picked up by policymakers [LS]. There is extensive research and numerous documents dealing with climate, energy, and mobility issues, including IPCC [e.g. 24, 25] or UNDP reports [e.g. 26] but the knowledge on different epistemological views is still lacking and the quantitative science dominates [LS].

The problem of not incorporating a sufficient number of qualitative SSH and epistemic justice research into core documents that are used by policymakers is manifold. Some of the barriers include:

- In general, there is a lack of discussion of epistemic justice importance in research and policymaking.
- There is a small number of SSH and epistemic justice studies, and the knowledge on different epistemologies of societal groups is not collected in a systematic manner.
- Quantitative (and STEM) studies dominate the field and are often perceived as superior to other sciences (including SSH).
- Qualitative studies might be more difficult to comprehend and transform to measurable indicators that policymakers often use for measuring success.
- It is difficult to generalise from epistemic justice research as the case studies are specific to a certain context.
- There is lack of mutual understanding and cooperation between STEM and SSH scientists [9].

STEM research is established as undoubtedly critical for identifying and addressing climate, energy, and mobility issues [27]. However, the issues are often rooted in the complexity of socio-economic systems that we live in and that is challenging to translate into quantitative form [28]. **SSH research can offer contextual, social, policy, governance, and epistemic justice lenses to the complex problems and further address the diversity of needs and values of various social groups [LS, 29].** The roles of STEM and SSH are both fundamental in the design of policies that can be translated into specific measures and actions [MS]. The collaborations, mutual acknowledgement, and basic understanding between STEM and SSH are necessary if those policies are to be successful [LS, 30]. Moreover, a creation of space for recognition and respect of diverse knowledge systems, cultural practices, perceptions of reality and manners of being, and challenging the Eurocentric, capitalist and other dominant perspectives can lead to more just, equitable and sustainable world that addresses complex and interconnected problems [31].

Emerging Practices

There are some practices that are emerging in SSH and epistemic justice from the perspectives of climate, energy, and mobility. These are still in early stages and need to be further developed and enhanced for better incorporation into practice, including:

(1) **Amplifying the voices of marginalised communities in research, policy-making and public discussions while supporting capacity building and creating opportunities for communities to participate in knowledge production and dissemination.** For example, UNFCCC established the Local Communities and Indigenous People's platform that is trying to integrate the diverse knowledge systems in international and national climate action and provides opportunities to shape policies from indigenous perspectives [32]. However, there are still material (e.g. funding, lack of translation), procedural (e.g. technical and scientific jargon), and recognition-based (e.g. lack of political will, tokenism) constrains that indigenous people experience while participating which requires deeper institutional transformations [33].

(2) Participatory processes have gained more attention in recent years, especially in drafting and co-developing climate change strategies and in local planning for adaptation, mitigation, or sustainable mobility [34] (e.g. Cascais adaptation strategy [35], Vancouver's Greenest city action plan [36]). **There is an uptake in inclusion of stakeholders and citizens via participatory approaches while designing plans and policies. These processes are often designed by the ones in power or/and coming from dominant epistemological perspectives.** Despite engaging with participation, this design, this may lead to the reproduction of the same understandings and knowledge [MS].

Community-led initiatives are an essential part of equitable planning and can address the challenges of effectively engaging communities in transformational processes. For example, a case study of socio-economic transformation led by the community initiative Common Unity Project Aotearoa demonstrates how involvement of a marginalised community in planning processes of adaptation to climate change contributes to justice, general well-being and success of the plan, and highlights the importance of engagements of local government and community development [37].

In terms of mobility, participatory processes are particularly important. Lack of transportation network can exclude communities from shopping for basic needs and job opportunities, even lead to violence. A good example of an increase in mobility for bridging the injustice gap is a cable car transportation system in Medellín, Colombia [38]. It was designed by the city to connect informal settlements on a steep hill with the city centre while engaging with the local communities and running workshops [39]. The increase in mobility led to a better well-being and drop in violence [40]. The case in Medellín has been very successful and many cities, especially in Latin America, has replicated the model with the expectation of benefits. Not all of them, nevertheless, have been successful. For instance, in Rio de Janeiro, Brazil, the replication of cable car transport model failed as it was designed without the consideration of local context, engagement of local communities, their knowledge, values and needs [40]. **It is important to acknowledge that seemingly similar problems have different contextual settings of injustice and need to be address appropriately.** The intervention, hence, need to be led by people and communities, with the public policy behind, if they are to be successful.

(3) **Decolonisation of knowledge production, acknowledgement of past colonialism shaping current environment and knowledge systems and recognition of marginalised indigenous knowledge systems** [41]. For example, research on water regimes in New Zealand demonstrates how historical sequences of policies based around western hegemonic values of colonial settlers can transform land and waterscapes, leading to increased vulnerability to flood events. The resiliency to flood events can be increased by recognition of indigenous Māori values and knowledge in policies and implementation of actions that break the historical constrains to decision-making [49].

Many colonial dependencies are still being actively negotiated, particularly in Global South. Many African governments sought foreign investments as the aid was declining. A lot of land was acquired by Asian and Gulf states, often for agriculture and carbon credit purposes while imposing their own knowledge systems in a foreign context [42]. Marginalised communities that are directly impacted by the land grabs are often excluded and ignored in decision-making process. This further lead to displacement of communities, loss of access to natural resources, land degradation and deforestation, deepening inequity and worsening climate change and its impacts [42]. **The negative impacts of foreign investments can be minimised if the government ensures the inclusion of marginalised communities, creation of a dialogs with affected communities and amplifying their voices in decision-making processes.**

Similarly, other issues related to climate, energy and mobility can benefit from inclusion of epistemic justice concept in a practice. For instance, **just transitions for energy access and sustainable development need to engage a wide range of stakeholders, including historically marginalised communities to address inequity and energy poverty, ensuring better policy outcomes [11].**

(4) Research on social and human dimensions of climate and energy policies that intersects with a range of social identities such as, for example, gender, race, ethnicity, socio-economic status. **The understanding of disparities in climate change impacts [43] and policies [44], providing access to knowledge and knowledge production are the starting points bridging the epistemic injustice gap in policymaking.**

(5) Transdisciplinary approaches to tackle the wicked nature of climate change, including issues of energy and mobility, based on collaborations of STEM and SSH researchers and integration of the fields [LS, 8, 45]. There are emerging studies combining the two approaches, for example, by using participatory processes combined with mapping or modelling. Delgado-Aguilar et al. [46] combined remote sensing (STEM) with participatory mapping (SSH) to better understand forest degradation and ecosystem services in Ecuadorian tropical rainforest while engaging the local community, governmental and non-governmental organisations.

Future SSH Priorities

Consideration of epistemic (in)justice in research and policy agendas has a high potential to contribute to understanding and mitigating the problems related to climate, energy, and mobility. SSH can help to bridge the gap in research by shifting from the dominant paradigms and opening up space for more diverse and inclusive perspectives in science (including STEM and SSH) [9]. **Interdisciplinary research and bridging the gap between SSH and STEM scientists through respectful and equitable collaborations are a priority if the solutions are to be successful.** There are several barriers to effective collaboration. However, basic mutual understanding of the STEM and SSH fields can help to navigate through potential misunderstandings or undervaluation of methods, perspectives, and types of results, and further develop and improve interdisciplinary methods to tackle wicked challenges [LS].

SSH research has a capacity to bring epistemic justice to the fronts of policy agendas, especially when considering European Green Deal aims for fair transitions and the "no one left behind" principle. The question of what the principle really means and how to achieve it still needs more definition and investigation [MS]. SSH can facilitate that through the engagement with communities and exploration of methods and approaches that let communities organise themselves [MS] (such as done e.g. in BOLSTER[1] project that is trying to understand the impacts of European Green Deal related policies on marginalised communities and the effect of community involvement in decision making processes on the increase in support for transitions [47, 48]). This ensures that marginalised voices are given space and are properly recognised, and that the benefit of contributions of a range of people's perspectives and knowledge in effectivity of practices and policies is demonstrated.

The SSH language (jargon) and theoretical frameworks can seem complicated and inaccessible to anyone who comes from other disciplines [LS, MS]. Further, qualitative results can seem more difficult to present (e.g. for media) and challenging to build policies on as they do not have the quantitative information or (usually) do not come in a graphical format [LS]. The approaches and tools for recognition of qualitative data and their use as a steppingstone for policies need to be better examined and put into practice.

Takeaways

Takeaways for the European Commission

- Epistemic justice is a cross-cutting theme for many EU priorities that needs to be appropriately addressed in policymaking processes. This may include participatory processes that give enough space to marginalised communities, recognising and amplifying voices of marginalised communities, or community-led initiatives, among others.
- Marginalised groups are increasingly being heard and their voices need to be further amplified as they offer new ways of seeing and understanding for those coming from Western and Euro-American ontologies.
- When seeking to narrow the epistemic injustice gap, it is important to acknowledge that marginalised communities often lack resources to participate (e.g. time, financial) and thus, provide sufficient compensation so they are represented in decision-making processes.
- There is a need to reconsider what kind of data are used to scrutinise policies, incorporate qualitative research that enriches the simplified realities and brings a wide range of epistemological narratives.
- When implementing policies, it is important to set up monitoring mechanisms for impacts on affected communities and reflect on possible maladaptation with flexible adjustments also based on perceptions of communities

Takeaways for Stakeholders and Businesses

- When thinking about epistemic justice, it is necessary to recognise the ways in which existing and historical power structures shape knowledge production, dissemination, and hierarchy within an institution, prioritise inclusivity and equity in knowledge generation, actively seek out and value diverse perspectives, and regularly evaluate and adjust policies and practices to ensure they align with epistemic justice.
- To enhance an uptake of epistemic justice practices, institutions can provide and invest in trainings on understanding of how to participate in processes (e.g. institutional, administration, specific jargon), support participation and provide resources, encourage employee-led initiatives and diversify the teams to reflect the communities it is serving.

Takeaways for the SSH CENTRE project

- Collaborations between SSH and STEM scientists contribute to bridge the gap of epistemic injustice. The SSH CENTRE project can facilitate collaborations through established networks as a part of WP2 Epistemic laboratories for the European Green Deal.
- There are opportunities to engage with epistemic justice in many aspects of research, it is important to focus on better understanding of decolonisation of knowledge and engagement of a wide range of identities and exploring the ways of community-led approaches.

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Responsible Research & Innovation: The developing role of interdisciplinarity

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ABSTRACT

Responsible Research and Innovation (RRI) represents an emerging policy framework for supporting science and technology to enhance both their internal processes and their relations with society. Interdisciplinarity within, and between, SSH and STEM could strongly contribute to boosting this process of change and, in turn, is strongly supported by RRI-oriented policies. However, in addition to the numerous factors (social, epistemological, institutional, and professional) that hinder interdisciplinarity, some obstacles specifically concern how RRI is interpreted and managed. Despite this, new forms of interdisciplinary collaboration through RRI programs are emerging and spreading. In this sense, RRI can be viewed as an opportunity to enhance and enlarge the scope of the interdisciplinary work within and between SSH and STEM, through specific strategies and the active involvement of key R&I actors.

SUMMARY

- Responsible Research and Innovation (RRI) has been proposed by the European Commission as a policy framework to make Research and Innovation (R&I) actors more responsible for the social, ethical, and legal implications of science and innovation.
- Interdisciplinarity within, and between, SSH and STEM could greatly contribute to enhancing RRI. It helps scientists identify and anticipate the societal implications of their research and enhances the contribution of science to understanding and solving the societal challenges Europe and the world are facing. In turn, RRI offers motivation and opportunities to promote interdisciplinary work.
- However, several factors, both general in nature and related to the way RRI is interpreted and implemented, are hampering or limiting the role of interdisciplinarity in the construction of responsible research.
- These factors notwithstanding, new RRI-oriented collaborative practices are also emerging, moving towards three main directions: 1) creating new collaborative spaces (like living labs and citizen science platforms), 2) promoting institutional changes in research organisations, and 3) establishing new RRI-based interdisciplinary institutions and programmes.
- Three priorities for SSH are identified: 1) grounding RRI on a genuine interdisciplinary perspective, 2) reinforcing research on RRI in innovation, and 3) creating support services to research organisations to favour RRI mainstreaming across Europe

KEY DEFINITIONS

Responsible Research and Innovation (RRI): Taking care of the future through collective stewardship of science and innovation in the present [1, p. 1517]. Societal actors work together during the whole research and innovation process in order to better align both the process and its outcomes, with the values, needs and expectations of (...) society. [2, p.1]

Interdisciplinarity: Integration of tools, methods, and theories from various disciplines (within the academia) to answer a question, solve a problem or address a topic that is too broad or complex to be dealt with adequately by a single discipline or profession [3, p. 36]

Transdisciplinarity: Opening of academic disciplines to players outside the academic world to include and integrate knowledge produced outside the academic system [3, p. 36]

Introduction

Starting from the EU's Horizon 2020 research and innovation Framework Programme (2014-2020), RRI has been proposed as a policy framework to respond to a series of demands for change in research and innovation governance that emerged from the 1990s onwards [5]. These demands concern changes to be promoted both in research organisations and the research process. The CE's approach to RRI [2] is more focused on institutional change in specific sectors of the life of research organisations (engagement of the public, gender equality, open access to scientific data and products, research ethics and integrity, and scientific education), dealing with the research process only marginally. On the contrary, researchers and experts [1] are more focused on how to embed RRI in the research process to make it more inclusive (open to the contribution of external stakeholders from its early stage), self-reflective (holding "a mirror up to one's activities, commitments and assumptions"[1, p. 1571]), responsive (identifying and managing potential risks related to research and innovation activities), and anticipatory (making research taking into consideration the future of research, innovation, and society) [6].

This literature brief intends to explore interdisciplinarity from an RRI perspective, considering obstacles and limitations and tools and strategies to strengthen it.

Current Understandings

Significant Findings to Date

There is agreement among scholars on how much RRI could benefit from the implementation of interdisciplinary collaborations.

Interdisciplinary work is argued to be essential for RRI based on **two main arguments.** On the one hand, RRI urges scientists to focus on the **"societal challenges"** that Europe and the world are facing [17], the complexity of which is largely due to the continuous intertwining of natural, technological, social, cultural, ethical, psychological, symbolic, and regulatory dynamics. Hence the need for more robust interdisciplinary and transdisciplinary perspectives to address them. On the other hand, RRI calls for better management of **far-reaching downstream implications** of research [6] which cannot be properly managed without solid cooperation between disciplines and the involvement of non-scientific knowledge.

On the reverse side, since RRI urges disciplines and social actors to cooperate during the whole research and innovation process, it can be also seen as a **powerful tool to promote interdisciplinarity and SSH-STEM collaborations** [6]; and, indeed, in many RRI projects implemented in this last decade, numerous innovative collaborative practices have been developed and disseminated.

However, the interdisciplinary and transdisciplinary work explicitly connected to RRI is still unsatisfactory because of many (social, epistemological, institutional, and professional) factors [4], some of which are specifically related to how RRI is interpreted and managed. These factors can be organised into three main groups.

RRI as a weak policy framework. RRI is still a weak policy framework to promote interdisciplinarity. It is a buzzword [18], an umbrella word [19], susceptible to different interpretations, and a concept too ambiguous to be comprehensible for STEM researchers and policymakers and too abstract to be attractive for SSH researchers [7]. Different interpretations of RRI are also given within SSH disciplines (for example, Science and Society Studies researchers are more focused on RRI governance-related mechanisms while other SSH researchers are more interested in the RRI keys) [EF]. Moreover, the research communities based on the different RRI keys (public engagement, gender equality in science, research ethics and integrity, science education, and open access) tend to remain isolated from each other and not recognise themselves as part of the larger RRI community. All this often limits the weight and impact of interdisciplinary work or makes it a simple tokenistic exercise [7].

Narratives on RRI. Some dominant and somehow distorting narratives exist about the collaboration between SSH and STEM in the RRI field, hampering effective cooperation. Policymakers and the same researchers tend to see SSH disciplines as inherently reflexive and STEM disciplines as poorly or not at all reflexive. Thus, interdisciplinarity appears to be a one-way process, in which SSH knowledge and practices contribute to making STEM more reflexive and more focused on the societal aspects of their research [7, EF, DR]. Although this assumption, shared by not a few researchers, is false and biased [EF, DR], its consequences on SSH-STEM collaborations can be remarkable. In particular, It leads SSH researchers to perceive themselves as the sole ones responsible for activating RRI in STEM areas [9], to see themselves as bringing much value and knowledge without receiving much in return [10] and even to feel not being welcomed and taken seriously by STEM researchers as if they are trespassing on land which is not theirs [7]. Consequently, SSH researchers are also inclined to attribute failures in interdisciplinary work to STEM researchers' attitudes and lack of commitment [11]. On the other side, STEM researchers tend not to see SSH researchers as real partners in interdisciplinary work, but as facilitators to assist them in, e.g., recognising the social implications of their own work or as communicators facilitating the relations with stakeholders and the public [12].

Role of practitioners. Another factor to consider is the increasing role played by RRI practitioners, i.e., professionals with specific skills and capacities to design and implement RRI-oriented programmes. On the one side, their presence helps better define the contribution SSH disciplines can give to RRI and counter the perception that SSH researchers are RRI facilitators [EF], even though RRI practitioners' knowhow (related to, e.g., communication, knowledge brokerage, co-creation, or participatory processes) is based on SSH disciplines. On the other hand, the growing role of practitioners makes it more challenging to identify the areas in which collaboration between disciplines is useful or necessary [EF] and their own position and policy role in the RRI context remains poorly defined and ambiguous [20].

Emerging Practices

The above picture describes a contradictory situation. Interdisciplinary work within and across SSH and STEM disciplines is invoked as essential to support responsible research and innovation and is therefore promoted in RRI-inspired initiatives. At the same time, however, RRI seems to be a still weak policy framework to adequately support inter- and trans-disciplinary cooperation and there is not always a convergence on how to interpret RRI. Perhaps the most effective way to overcome this situation is to recognise, strengthen and disseminate the interdisciplinary practices that RRI is nevertheless helping to bring to the fore. Overall, they are moving in three main directions.

- **RRI-oriented spaces for interdisciplinarity and transdisciplinarity.** The first direction is creating RRI-oriented spaces to practice interdisciplinary relationships, often outside or at the boundaries of the academy. This is the case of living and social labs or citizen science platforms involving all stakeholders (industry, policymakers, public administrations) [13, 14] or even light but regular forms of SSH-STEM cooperation within long-term research environmental programmes [DR]. For example, the Universitat Autònoma de Barcelona established a living lab serving as a physical space to practice interdisciplinarity and transdisciplinarity[1]. Similarly, Mistra Urban Futures[2] has created Local Interaction Platforms to facilitate the co-creation, design and development of research and development projects.
- **RRI-oriented institutional change.** The second direction is supporting the institutionalisation of RRI practices in research organisations, thus also favouring interdisciplinary within and between SSH and STEM researchers. Research organisations have increasingly promoted institutional change plans on RRI-related issues (e.g., gender equality plans, open access procedures and infrastructures, and new ethics assessment procedures), favouring closer interactions among researchers with different disciplinary backgrounds. More rarely, new methodologies have been developed to embed interdisciplinary cooperation into the research process. An example is the Midstream modulation approach [21], aimed at including humanists and social researchers in laboratory work to orient decisions and reflection.
- **Interdisciplinary research centres and programmes.** The third direction is creating new interdisciplinary research centres or programmes [16] explicitly incorporating RRI practices and principles or addressing societal challenges where SSH and STEM researchers can share common goals [DR]. One example is the University of Manchester Synthetic Biology Research Centre for Fine and Specialty Chemicals (Synbiochem)[3] which includes an RRI platform for developing major programmes on the ethical and regulatory aspects of research, also including real-time assessment and anticipation of research and innovation trajectories, deliberation and reflection, and collaborative development...

1 https://www.ucitylab.eu/tag/universitat-autonoma-de-barcelona-uab/
2 https://www.mistraurbanfutures.org/en
3 https://synbiochem.co.uk/responsible-research-and-innovation/

Future SSH Priorities

With the start of the Horizon Europe Framework Programme, the policy context with regard to RRI has changed considerably. Indeed, whereas in the Horizon 2020 Framework Programme, the focus was mainly on supporting research organisations to adopt measures to foster RRI, in Horizon Europe the attempt is to implement, although separately, both the mainstreaming of RRI and the integration of SSH in STEM projects. Consequently, an autonomous programme on RRI (e.g. Horizon 2020's SwafS programme) no longer exists.

This is a delicate step, which could lead to a marginalisation of RRI in European research policies. In this context, SSH disciplines could have a vital role to play in maintaining and strengthening the link between interdisciplinarity and RRI. In this respect, some priorities for SSH can be identified.

- **Grounding RRI on a genuine interdisciplinary perspective.** As pointed out above, RRI is often considered the 'stuff' of SSH. This risks distancing STEM disciplines from RRI. Hence the need for SSH researchers to cooperate with their STEM colleagues to build an interdisciplinary view of RRI, starting by recognising that SSH disciplines are not so much inclusive, anticipatory, reflexive, and responsive as often are supposed to be [11]. This can be done by promoting projects that foster the dialogue within and between SSH and STEM on RRI (an example is given by the INTREPID COST Project[4]) and urging natural scientists and SSH scholars to co-research RRI in an experimental mode by developing common projects [17].
- **Reinforcing research on RRI in innovation.** Although RRI in origin was much about emerging technologies, it is now more focused on research than innovation. This represents a serious limitation to the expansion of RRI. SSH should have a key role in enhancing RRI-related research in the field of innovation processes [EF, DR] and in building trust and legitimacy conditions necessary for RRI to be taken seriously by market players [DR]. Different projects have been promoted by the European Commission (like PRISMA[5], RRI-START[6], COMPASS[7], and RESPONSIBLE-INDUSTRY[8]) to explore how to facilitate this process. This effort should continue also under the Horizon Europe Framework Programme.
- **Creating support services for research organisations across Europe.** In order to make RRI mainstreaming policies concrete, interdisciplinary infrastructures for RRI should be created at European and national levels (such as self-organised hubs and learning platforms, communities of practice, reference centres, training centres or RRI-oriented programmes promoted by scientific societies) with the support of SSH, so that individual research organisations are not left alone [DR]. A good example of how this can be promoted is the Global Interdisciplinary Research Hubs promoted by UKRI and the GCRF in developing countries[9].

4 http://intrepid-cost.ics.ulisboa.pt/
5 https://www.rri-prisma.eu/
6 https://rristart.eu/
7 https://innovation-compass.eu/
8 http://www.responsible-industry.eu/
9 https://www.ukri.org/wp-content/uploads/2021/08/UKRI-190821-GlobalChallengesResearchFundHubBooklet-June2019.pdf

Takeaways

Takeaways for the European Commission

- Actions should be taken to foster interdisciplinary collaboration to increase the quality of RRI actions in predominantly STEM projects. RRI-interdisciplinary nexus should be better defined in the work programmes and individual calls. The private sector and innovation actors should be more involved in RRI and interdisciplinary projects.
- To support RRI mainstreaming, European RRI infrastructures should be established to provide training, resources, and consultancy services and favour knowledge transfer across disciplines.
- EC evaluation panels should include both interdisciplinary and RRI expertise to ensure these aspects are duly considered in the evaluation process. EC science policy officers should also be trained to become more familiar with RRI and interdisciplinarity, especially in STEM-prevalent research areas.
- RRI measures in interdisciplinary projects deserve to be made visible and treated as research topics. Interdisciplinary practices should be disseminated through reports and publications.

Takeaways for Stakeholders and Businesses

- Both RRI and interdisciplinarity still need to be institutionalised in universities and research centres. Various tools can be used, e.g., introducing interdisciplinary training courses on RRI at multiple levels (master students, PhD students, postdoc researchers, PIs), establishing RRI-inspired interdisciplinary research departments, promoting the application of RRI practices and evaluation criteria and supporting the integration of SSH researchers in STEM research areas.
- General and sectoral business organisations should foster corporate involvement in CSR by taking up, strengthening and expanding approaches to Corporate Social Responsibility.
- SSH disciplines should be more involved in innovation programmes, especially where the private sector, academia, and governmental authorities meet (science parks, environmental programmes, etc.). This could be essential to sustain both interdisciplinary practices and RRI mainstreaming.
- RRI-oriented SSH-STEM collaborations should be promoted in the research environment. Scientific societies should be engaged in overcoming disciplinary barriers, scientific publishers should enlarge the spaces devoted to RRI-oriented interdisciplinary articles, and research funding organisations should include criteria related to RRI and interdisciplinarity in evaluating research proposals, and results.

Takeaways for the SSH CENTRE project

- The project should include the RRI perspective in the novel SSH-STEM collaborations and interdisciplinary and transdisciplinary activities it will promote. RRI concepts and practices should be referred to in training activities (e.g., WP3, WP5), collaborative work initiatives (e.g., WP2) and project products (e.g., the Research and Innovation Agenda for the EC or the plan of the SSH Centre in WP5).
- The activities conducted under the project could be used, through specific research protocols, to generate new knowledge on practical, cultural, and institutional barriers to interdisciplinary and transdisciplinary activities from the angle of the creation of an RRI ecosystem. Reference can be made to, e.g., the SSH brokerage initiatives (WP3), the epistemic experiments (WP5), and the four series of virtual focus groups on Horizon Europe Missions engagement activities (WP4)

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Open Science and Open Education: Bringing social and technical disciplines into dialogue

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ABSTRACT

The concept of Open Science has gained more attention in recent years, including the European Commission's (EC) inclusion of the concept in its Horizon programme. Open Science provides a foundation for communicating science, connecting stakeholders, and supporting collaborations, as well as the uptake and re-use of the findings. For the successful uptake of Open Science and Open Education practices within research projects, a good technical, organisational and legal infrastructure needs to be established both by the EC and the educational/research institution themselves. These infrastructure include resources for skills development, providing researchers with an understanding of data ownership, and science/knowledge accessibility. Horizon projects, including the SSH CENTRE, should try to raise awareness of the benefits of Open Science and Open Education practices, and strive to make their findings easily accessible, open, and free to everyone, as well as offering the possibility for the open educational resources to be reused, retained, revised, remixed and redistributed (i.e. the 5Rs of OER).

SUMMARY

- Horizon Europe highlights the importance of Open Science and Open Education practices and integrates a more complete approach of the open science concept, including distinguishing between mandatory and recommended open science practices.
- Open science is a broad concept, describing practices and tools, such as open access, open journals, open data, open research, open science policies and open education, all linked by the principle of open access and availability to all.
- The main benefits related to Open Science and Open Education in SSH and STEM are the increased uptake, transparency and confidence in scientific research findings, exchange of knowledge and ideas, and increased accessibility and relevance of education in different fields of science.
- The European Commission should make Open Science skills an integral part of the work programmes with dedicated actions and funding to support and promote Open Science in Open Education both in SSH- and STEM-focussed projects, and especially in projects, aiming to bridge SSH and STEM.
- Educational institutions in SSH and STEM should support and encourage the development of skills, technical infrastructure, and organisational and legal frameworks for the development of Open Science and Open Education practices. This would benefit both SSH and STEM researchers.

KEY DEFINITIONS

Open science: Open science consists of principles and behaviours that promote transparent, credible, reproducible, and accessible science [1].

Open research: an openly collaborative approach, which includes developing relationships with, and working alongside, other researchers, often from other disciplines [2]..

Open Education: a way of carrying out education, often using digital technologies. Its aim is to widen access and participation to everyone by removing barriers and making learning accessible, abundant, and customisable for all [3].

Introduction

Open Science and all its principles can play a crucial role in communicating and sharing findings, as well as building upon existing research. Connecting various forms of openness (open science, open education, OER, open access, open data, open research, open policy etc.) can provide considerable added value, **enabling innovation, improvement of quality, and expansion of knowledge domains, not only for science but also for other stakeholders, such as business**. Specifically, the synergy between Open Science and Open Education has the potential to make scientific information available and shareable via OER (Open Educational Resources) and offer the application of these resources as open educational practices, open courses, open teaching etc. [6]. The importance of Open Science and Open Education principles is also highlighted by the European Commission (EC), who has integrated mandatory and recommended open science practices into the Horizon Europe programme [7].

This literature brief focuses on the coherence between Open Science and Open Education, and their synergistic overlaps. It focuses on how these overlaps can benefit both the SSH and STEM community to **overcome fragmentation on Energy, Climate and Mobility issues** by drawing upon a number of examples from research, projects, reports and toolkits, which help raise awareness on the energy-climate-mobility nexus and introduce system thinking about the interrelationships among these three fields and also their relation to other areas (socio-demographic trends, industry, forestry, agriculture, development of new technologies).

Current Understandings

Significant Findings to Date

Many types of 'openness' exist, for example open science, open education, open access, open-source software, and open innovation. They are all part of the open movement and are based on the same basic principles – to make scientific information available to interested stakeholders (including peer researchers from other fields, the business community, the educational ecosystem, the citizens). The connection of various 'open' areas can provide considerable added value, enabling innovation, improvement of quality, expansion of knowledge domains and development of new insights [8].

Open Science is supported by a number of tools, including open access, open journals, open data, open research and open science policies. By opening all steps of the research process and all research data, as well as open innovation, there are benefits for different stakeholders, including efficiency from reusing data, data quality due to wider evaluation and validation of data, opportunities for innovation and collaborative, and social benefits, particularly global collaboration and knowledge transfer. Stakeholders that benefit from Open Science include students undertaking research activities, institutions and companies developing new solutions, and governments drawing upon insights for policymaking [8]. Researchers, who make their research open access can develop and adapt their research in response to feedback, as well as gather inputs and information. An example of open research used to collect information is the 'Solar Energy' Massive Open Online Course (MOOC) by Delft University, who have, by developing a course, also gained a large research database for further research [9].

Initially, open education focused on the provision of open educational resources (OER) (such as open courseware) but the focus has shifted to the **application of OER** (including open educational practices, open courses, open learning pathways, certification and accreditation) [10]. The shift of focus provides new opportunities for synergies between SSH and STEM research findings, as open courses and learning pathways guide the learners through multiple research findings and research fields, rather than simply focusing on one particular educational resource. These diverse insights and cross-cutting understandings can be considered to strengthen the collaborative processes. They also offer opportunities to integrate open data and research practices, which can benefit the development of new research. Open Data provides the opportunity to discover and re-use other researchers' data in ways that validate outcomes and advance the research undertaken. This also supports future collaborations and can improve the speed at which important research can be conducted and disseminated [11].

While the previously mentioned examples mostly focus on the benefits of Open Science for researchers, the general public can also benefit from open practices, particularly OER and their application.

There is the need to better communicate the components of Open Science and its associated opportunities [12]. Understandings, and practices of Open Science, can be supported through the better provision of training opportunities for open access and open data. A survey of 1,277 researchers across Europe found that **75% of researchers surveyed had not participated in any open access or open data courses** but would like to [12]. These findings show, that to strengthen Open Education and Open Science practices, researchers and academics in all fields should be made aware of the concepts and their benefits. Additionally, platforms and other tools for open science should be readily available to researchers, to support and encourage them to embrace the principles.

Open Science and Open Education supports the **increased uptake, transparency, and confidence in scientific research findings, and increased accessibility and relevance of education** in both SSH, STEM and multidisciplinary (SSH-STEM combined) fields [GX].

KEY DEFINITIONS (CONTINUED)

Open education resources (OER): learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright but have been released under an open license, that permits no-cost access, re-use, re-purpose, adaptation and redistribution by others [4].

FAIR Data Principles: Guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets [5].

Emerging Practices

The key challenge in relation to Open Science and Open Education between SSH and STEM is **how to support open approaches and how to find ways of agreement between all actors on how to implement 'open',** as found by several European and international projects (including ENCLUDE[1], DIAMOND[2], NDC ASPECTS[3], OE4BW[4]). Open Science and Open Education can be supported through the creation of alternative business models for journals to support Open Science and/or by motivating researchers, teachers, and other stakeholders to exchange knowledge and scientific findings [GX]. Open Science and Open Education can also be supported through the development of knowledge platforms which usually focus on specific topics and provide materials and outputs, related to that topic for its users. The format and structure of these platforms differs from case to case. For example, the SENSES project has developed the SENSES toolkit[5], a module-based open course about climate change scenarios [GX]. The FOSTER portal[6] is another knowledge platform which provides training resources addressed to those who need to know more about Open Science or need to develop strategies and skills for implementing Open Science practices in their daily workflows. The content targets different users - from early-career researchers to data managers, librarians, research administrators, and graduate schools.

One of the key messages of open principles is, that the resources and science should not only be open, but also findable. As humans rely on computational support to deal with data, due to the increase in volume, complexity, and creation speed of data, FAIR data principles and guidelines were developed. Their goal is to improve the **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse of digital assets (FAIR) [5]. Research, investigating the meaning and potential impact of FAIR data principles in practice, includes the following significant findings, relevant to the planning and implementation of Open Science and Open Education activities in SSH- and STEM-related projects:

There are low levels of understanding around data ownership in the research community.

There is a diversity of data types across disciplines and variation in corresponding tools and systems to support data management, as well as in attitude to sharing and perceived individual benefits of sharing.

It is common across disciplines that the FAIR data principles are seen as 'going beyond' open access and are considered a helpful concept in bringing together various aspects of data management best practices [13].

Open Science and Open Education practices can improve the **intersectoral and multidisciplinary approach to different topics and areas**, especially those, where both SSH and STEM research is needed. This leads to a more comprehensive and integrated understanding of the topics, providing better leverage for decision-making, policy formation, and further research [9]. The open exchange of knowledge, research, and sources, as well as their integration in open processes (courses, databases), makes bridging the SSH and STEM barriers easier, more accessible, and more collaborative. Increased access to research and publications and open educational practices allows for an increase in national, European and global collaboration. This speeds up the transfer of knowledge between SSH and STEM, and assists in addressing issues that require a wider range of attention and multidisciplinary collaboration - such as energy supply, global warming and clean mobility.

From the viewpoint of key challenges, related to the engagement of researchers and other stakeholders in Open Science and Open Education practices, several emerging practices are observed by the experts [TU, GX] in relation to bridging SSH and STEM. The use of new open platforms and tools is one of the key developments of recent years. New knowledge platforms are developed for specific topics, including new open tools, such as courses and open research. These projects specifically concentrate on linking SSH and STEM research and provide an integrative overview of the selected topic to a variety of stakeholders.

The overall vision of ENCLUDE[7] (ENergy Citizens for inCLusive DEcarbonization) is to help the EU to fulfil its promise of a just and inclusive decarbonisation pathway through sharing and co-creating new knowledge and practices that maximize the number and diversity of citizens who are willing and able to contribute to the energy transition.

The research aims to operationalise the energy citizenship concept at multiple scales of policy and decision-making. Through the creation of the **ENCLUDE Academy for Energy Citizen Leadership**, new knowledge about energy citizenship, opportunities for the energy transition, along with strategies for collaborative decision-making and joint problem framing (based on both SSH and STEM insights) will be **shared with citizens and NGOs across the EU**. The aim is to help mobilize actions for decarbonization, including communities that normally do not or are not able to participate in these civic processes.

The goal of the Academy is to support citizens in becoming energy citizenship leaders in their respective communities by providing them with educational resources and design-thinking methodologies to help them develop and accomplish different citizen-led energy projects. As such, the main audience of educational resources are citizens. Note that the Academy has an almost equal number of participants from Africa and Europe and thus most educational materials were developed to be relevant for citizens within and outside Europe. (GX)

The ENCLUDE project provides a great example of **linking different types of research and providing different stakeholders with a comprehensive overview of insights**, rather than fragments of different research.

The DIAMOND[8] (Delivering the next generation of open Integrated Assessment MOdels for Net-zero, sustainable Development) project aims to **establish vibrant communities of practice to transparently 'open' model enhancements and to develop capacities by producing learning materials and easy-to-use applications, thereby lowering the entrance barriers to the established IAM community** [GX]. Not only will the project bridge SSH and STEM, but it will also take a step further and offer different stakeholders the opportunity

1 https://encludeproject.eu/
2 https://diamond-project.eu/
3 https://www.ndc-aspects.eu/
4 https://oe4bw.org/
5 https://climatescenarios.org/toolkit/
6 https://www.fosteropenscience.eu/
7 https://encludeproject.eu/
8 https://diamond-project.eu/

to apply and adapt these findings based on their needs and situations. Similar practices could be applied to all projects, exploring a different kind of (social) innovation.

Other emerging practices include new open repositories, such as Zenodo and OpenAIRE, which provide great opportunities for OER sharing to a larger, already established set of stakeholders. Open repositories also ensure scientific articles and research aren't hidden behind a paywall, benefiting the readers and other researchers, when searching for data and information. This makes the research – both SSH and STEM – more accessible to everyone. [14]

New learning programmes have also been developed, such as the Open Education for a Better World (OE4BW)[9]. The programme enrols mentees from all over the world to, under the guidance of internationally recognized Open Education experts (as mentors), to develop and implement OERs based on the UN Sustainable Development Goals. The process is person focused, led by the mentee, and supported by the mentor through dialogue. The role of the mentor is to help the mentee find their own solutions. Several Open Education projects have been developed related to SSH and STEM and specific issues related to energy, climate change and mobility. This programme supports the development of open practices around the world, which are then developed further after the project. This includes open libraries, knowledge platforms, open courses and other practices. They can be found in the OE4BW e-Library.

Open Education and Open Science practices are also included in educational programmes. The University of Nova Gorica in Slovenija has developed a Master's degree in Leadership in Open Education[10], which encompasses the design, management and performance of activities related to accessibility, flexibility, quality and sustainability of learning processes. The syllabus has a distinct interdisciplinary character, connecting SSH and STEM, such as information technologies, business studies, and educational sciences.

Learning programmes like this are useful for developing skills and knowledge needed, to further explore Open Education and Open Science practices. The basics of Open Education and Open Science could be included in all educational programmes, to ensure the growth of these practices.

Open Science and Education practices are needed in both SSH and STEM, not only for sharing findings and improving their uptake and application, but also to improve research practices. Open principles can be useful for researchers as they provide open databases and findings from other research, support the development of research principles and help identify research participants [9], as well as offering opportunities for new collaborations. Additionally, through open practices, researchers can increase the chance of the insights being implemented, whether by citizens, other researchers, the industry or policymakers.

Future SSH priorities

There has been a rise in the popularity of Open Science and other open principles, which we are expecting will rise even more in the future. Reasons why this might happen, especially in the EU environment, are the ever more prominent Open Science policies, developed and pushed by the European Commission[11]. The European Commission defines Open Science as one of its policy priorities and requires of the beneficiaries of research and innovation funding to make their publications available in open access and make their data as open as possible [15] Among the recommended practices, those recommendations related to involving all relevant knowledge actors including citizens, civil society and end users in the co-creation of Research and Innovation (R&I) agendas and contents (such as citizen science) are explicitly mentioned [7].

Due to this fact, we can expect further development of open practices in different Horizon projects and other funding programmes. The practices, expected by the projects, can then be further integrated into the researcher's work outside of the EU-funded projects. In SSH, this includes practices, such as:

- Development of open knowledge platforms, providing not only open access to existing materials but also OER, developed for disseminating and education about certain topics – e. g. open courses, webinars, infographics etc.
- Sharing open data, research practices and methods, protocols, research notes, engagement practices and other information, which could help develop further research.
- Sharing project materials and data on Open Repositories to provide maximum findability
- Using FAIR principles, to provide maximum findability.
- Opening research for maximum visibility, and credibility and improving the chances of implementation of the insights.

To support this, Open Science skills will have to be developed and open principles will have to be integrated into the education systems. Some actions might be required to get the maximum positive effects of Open Science principles, such as standardisation of data and research protocols as well as quality control. Additional incentives and rewards might be needed to support open science development [16].

9 https://oe4bw.org/
10 https://www.ung.si/en/schools/school-of-engineering-and-management/programmes/2NVOI/

11 https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en

Takeaways

Takeaways for the European Commission

In order to mainstream skills for Open Science and Open Education, the European Commission should encourage Open Science Policy on the EU level, including:

- Training in Open Science and Open Education skills (technical data management skills, Open Education literacy, legal skills, research integrity skills, business competences, etc.) should be an integral part of the European Commission's work programmes with dedicated actions and funding to support and promote them.
- There is the need for better support coordination across stakeholders providing Open Science and Open Education skills, with this combatting SSH and STEM fragmentation and possible duplication. The European Commission can play a role in the standardisation of a set of recognised skills, competencies and supports, which can then be coordinated across the current landscape utilising the expertise and networks of stakeholders.
- An integrated Open Science and Open Education roadmap should be developed, available to all SSH and STEM students, researchers and staff, with guidelines for integrating open principles into research and educational activities and as part of this roadmap, encourage FAIR institutional and/or funding guidelines to be implemented.

Takeaways for the educational institutions

- Future activities should focus on improving the quality and relevance of skills for Open Science and Open Education. The institutions should offer and promote both traditional and online career-level appropriate Open Science and Open Education training courses for researchers, with an appropriate level of accreditation and modularisation.
- Training courses are not enough to help researchers do Open Science and Open Education. There is the need to ensure adequate support is provided alongside Open Science and Open Education training, including technical infrastructure, data management practices, and appropriate legal frameworks.

Takeaways for the SSH CENTRE project

Planning and implementation of WP5 Evaluation and Synthesis, including the organisation of a *webinar* on the basics of Open Science and Open Education, creation of an *open online course* for ECRs and other stakeholders, and creation of a *digital guidebook* for Horizon Europe Cluster 5 projects on 'How to go Open, and the development of the *SSH Open Knowledge Platform* as part of WP6 should take into consideration the following:

- The benefits oof Open Science practices, particularly Open Access, Open Data, Open Education, Open Peer Review and Citizen Science; these benefits should be explained on both theoretical and practical grounds, integrating their added value on the levels of personal (researchers'), institutional and social benefits.
- The SSH CENTRE's key Open Science and Open Education deliverables, e.g. webinar, online course, digital guidebook and Open Knowledge Platform, should offer as many actual practical exercises as possible to motivate researchers to 'learn by doing' in the areas of knowledge exchange, collaboration and networking, research publishing and dissemination, teaching and supervision, and popularising science for the general public.

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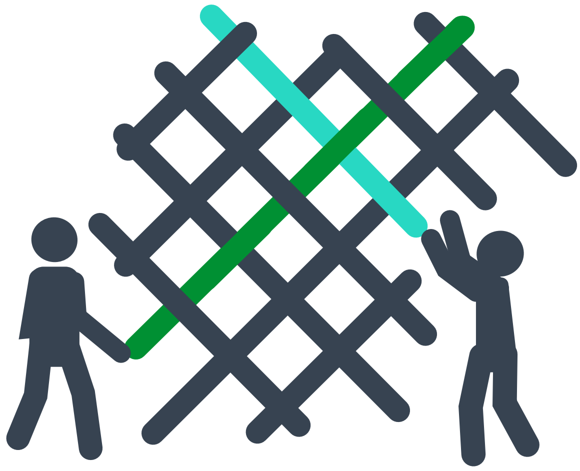
Transdisciplinarity: Breaking down disciplinary and academic barriers



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ABSTRACT

Transdisciplinarity emphasises the involvement of non-academics (e.g. policymakers, practitioners, citizens) in knowledge production. It is a type of knowledge production grounded in real-world perspectives and problem framing, and thus, is considered especially important when dealing with complex societal problems, such as climate change. Social Sciences and Humanities (SSH) contribute a conceptual and empirical understanding of transdisciplinarity, giving important insight into future transdisciplinary research design and implementation. This literature brief presents some of the main contributions of SSH research to energy, climate and mobility, concluding with some takeaways for EU policymakers, stakeholders and businesses, and the SSH CENTRE.

SUMMARY

- Transdisciplinarity is a form of knowledge production that transcends disciplinary and academic boundaries.
- Transdisciplinary research contributes to solving complex societal problems like climate change and finding just solutions for sustainability transitions.
- SSH can facilitate transdisciplinary work through a broad knowledge of methods tailored to a variety of agendas, actors, and cultural/political contexts.
- SSH perspectives can serve to foster mutual understanding between societal actors and scientists/technical expertise.
- SSH scholars can be well suited to identify and consequently adapt power imbalances and exclusion of actors and views in transdisciplinary processes.
- SSH's contribution to transdisciplinary work in the areas of energy, climate and mobility needs to be better recognised in all EU research funding calls that seek to address sustainability challenges facing society.

KEY DEFINITIONS

Transdisciplinarity:

"a mode of research that integrates both academic researchers from unrelated disciplines – including natural sciences and SSH - and non-academic participants to achieve a common goal, involving the creation of new knowledge and theory" [1, p.9]

"a distinctive form of interdisciplinarity, with an active role for non-academic stakeholders and/or wider publics as co-designers and perhaps co-producers" [2, p.79]

"a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" [3, p.26-7].

Introduction

Transdisciplinarity calls for a new type of knowledge production that transcends disciplinary and institutional boundaries. It is recognised as a form of knowledge production that breaks down hierarchies between academic and non-academic knowledges and calls for various actors – from academia, industry, public sector and civil society – to work together. Such a breakdown of barriers is crucial to solving **complex social problems and 'grand societal challenges'** such as climate change [2, 4].

Transdisciplinarity is thus an **important strategy for meeting sustainability transition goals** within energy, climate and mobility. Although transdisciplinarity is often not explicitly referenced, EU policy has increasingly institutionalised public participation in knowledge production and innovation [5]. For example, the EU's move towards mission-oriented research and innovation (R&I), such as the Climate-Neutral and Smart Cities, signals a push towards transdisciplinarity to reach ambitious policy interventions. This often results in cooperation between universities, industry, government/administration, and citizens.

SSH research contributes to the theoretical and practical understanding of transdisciplinarity [6]. Conceptually, scholars shed light on the difference with other forms of knowledge production, such as traditional disciplines and multi- and interdisciplinary knowledge. From empirical studies of practices, SSH also points to many opportunities and challenges connected to the organisation and effectiveness of transdisciplinarity. Insights from this research can help **facilitate transdisciplinary work, manage expectations of the benefits of transdisciplinarity, and avoid common pitfalls**.

This literature brief outlines some of the main features of transdisciplinarity and the different ways it is implemented today. Special attention is put on how transdisciplinarity can benefit sustainable transitions in various sectors. The insights presented are informed by existing academic literature and interviews with two expert academics[1].

Current Understandings

Significant Findings to Date

As can be seen above, transdisciplinarity can be defined in several different ways. Although there is no unified definition of the term, it is important not to confuse transdisciplinarity with the associated terms such as multi- and interdisciplinarity. SSH scholars clarify the most important differences between different forms of knowledge production. Klein's [7] taxonomy offers a helpful distinction:

1. multidisciplinary research refers to knowledge production where different disciplines work together but keep their identities,
2. interdisciplinarity research tries to integrate different disciplines and approaches to answering questions while
3. transdisciplinary research tries to overcome disciplinary boundaries altogether by integrating disciplines.

Multi- and interdisciplinary research is centred on collaboration between different disciplinary fields, while transdisciplinary research tries to overcome disciplinary boundaries altogether, including that between academics and non-academic knowledge.

SSH scholarship has a long-standing interest in how transdisciplinarity works in practice. The main discussions revolve around scholarly engagement in transdisciplinary research, design and implementation of transdisciplinary research, and the effects of transdisciplinarity.

One central debate focuses on the **risks connected to participating in transdisciplinary research**. When working transdisciplinarily, the goal of knowledge production is usually to solve particular problems (e.g. foster system change) and less on scientific publications. Newig et al. [8] found that academic performance is lower in projects with non-academic actor involvement. This creates challenges for academics who need to stay on a career path, especially for early career researchers [9]. Publishing is problematic for various reasons – participants work on different timeframes (e.g. policy cycle vs review processes), or have very other interests (e.g. artists and industry as opposed to academics). 'True' transdisciplinary outputs are thus difficult to attain, whilst publishing channels are still dominated by disciplinary perspectives, making alternative approaches more challenging [10].

A second ongoing discussion is on the **impact of transdisciplinarity**. Scholars argue that it is challenging to assess clear causal effects from transdisciplinary research [3, 11, 12]. Part of the challenge is that societal transformations take a long time [13]. One of the significant impacts of transdisciplinarity is the shift in perspective among participants, which can be hard to trace in their future work casually. Still, SSH literature offers suggestions for how the effectiveness of transdisciplinarity can be strengthened, e.g. through careful project design, which reduces trade-offs between academic and societal outcomes [8] or reflexive approach which accounts for the variety of dynamics among actors [14]. Overall, however, scholars agree that the impact depends on the implementation.

A third debate concerns **the best way to organise transdisciplinary work**. SSH scholars identify many problems with transdisciplinary work. One prevalent theme in the literature is power imbalances between disciplines or academic/business/government actors versus citizens. In energy-related projects, for instance, the engineering and technical expertise is allocated much more resources than SSH [15], while social scientific evidence is less valued [16] and has been shown to be excluded in reports and other project outputs [6]. Certain SSH disciplines, especially Economics, are also traditionally more practically oriented and thus more easily included in projects aimed at, for instance, sustainable mobility as opposed to more critical SSH disciplines [7]. This can create an imbalance in the type of SSH disciplines invited into transdisciplinary collaborations. It is also well documented that academics can control the process of engaging non-academics in a way that may be exclusionary for specific groups or limit meaningful input on the definition of problem and processes as a whole [18, 19]. The most significant contributions of SSH focus on methods for doing transdisciplinarity, which can overcome some of these problems and foster

1 Interviews were conducted in November-December 2022.

meaningful collaboration. We look closer at these methods in the following section.

Emerging Practices

Collaboration across and beyond disciplines is at the core of transdisciplinarity. This means that actors with very different backgrounds, interests, and forms of reasoning work together. Such collaborations can take many different shapes.

Increasingly, Research & Innovation (R&I) calls for transdisciplinary collaborations. Such collaborations are often organised through research and/or development projects which include representatives from academia, industry and government, or increasingly, also through more institutionalised research centres. For instance, Centres for Environment-friendly Energy Research (FME) in Norway or the Energy Research Centre in the UK aim to bring together state representatives, industry and interdisciplinary research groups. However, transdisciplinary work is often only a segment of more extensive research and development initiatives and is thus conducted in particular situations and time periods.

Notwithstanding the form of organisation, a valuable framework for transdisciplinary practices is divided into **three key phases** [3, adapted from various authors, p.28]:

1. collaborative problem framing and team building,
2. co-creation of solution-oriented and transferrable knowledge through collaborative research,
3. (re-)integrating and applying the co-created knowledge.

SSH scholarship offers many methods for operationalising these ideal transdisciplinary phases into concrete practices. These insights build on long-standing learning, which has shown how collaboration often falls short of its ambition, remaining a one-directional or only superficial character and not giving different groups sufficient influence on the outcome [19, 20).

One of the most common **methodologies to facilitate transdisciplinarity is co-creation** [5]. Although co-creation is an umbrella term for a wide spectre of methods, its main benefit for transdisciplinarity is that it is well suited to gather a wide diversity of actors [19] and give them equal opportunity to influence the outcomes of the research/activity [20].

Often, co-creation is practised through workshops as brainstorming activities. This can be done through traditional methods such as table discussions, mind-maps, forums etc. However, the ability for workshops to overcome power imbalances in groups, allow for equal influence on framing problems, and create collective solutions often remains unknown.

Some recent literature, however, highlights the **effectiveness of more creative methods**. One example is storytelling. Storytelling is a method to generate collective understanding and overcome linear knowledge sharing. Mourik et al. [21] used storytelling in workshops across 17 countries and argue that it helped the participants understand problems from other points of view and build new relations and collective future visions for energy policy. Cinderby et al. [22] is another recent example where creative methods as a form of co-design were used to study sustainable mobility solutions in East African cities. They conducted various real world experiments such as street events, creative play, urban dialogues, street art, and pop-up displays with mobility users, transport operators, businesses, artists and academics, which allowed for the voice of marginalised groups to be heard, leading to a more equitable definition of problems and decision making procedure of new and alternative mobility solutions. There are also entire projects which are designed around arts-based and creative social science methods. One good example is the EU Horizon 2020 funded The CreaTures project (Creative Practices for Transformational Futures), where they implemented many different creative practices as means for transformational eco-social change. They also developed a transdisciplinary framework designed for researchers, policy makers, creative practitioners, and funders. Creative and artistic approaches are thus highlighted as avenues for **overcoming traditional forms of communication** necessary for transdisciplinarity and as means to carve new pathways towards sustainability.

SSH scholars still identify **many hindrances and challenges that have been identified to facilitate good transdisciplinary processes**. For example, the fears, histories, and traditions of the participants can make collaboration difficult [21]. Conflict and deadlocks can also emerge, potentially slowing down energy transitions [23]. Participants can also have limited awareness of and unequal interest in the problems discussed and little opportunity to participate in projects over time [3]. These are only a few examples of why careful consideration and well-trained facilitators are necessary for designing and facilitating transdisciplinarity [21]. **Avoiding such challenges, however, can create unjust and unsustainable solutions** [24].

SSH's ability to develop understandings of group dynamics, cultures, and knowledge production processes makes it well suited to both lead transdisciplinary processes, and, of course, contribute directly with its insights. However, it is also important to be aware that **the insights developed by SSH scholars can be misused to facilitate the acceptance of particular solutions,** e.g. smart meters, wind turbines or autonomous vehicles [25]. For example, projects may draw upon and favour particular SSH perspectives, such as mainstream Economics to support technologically driven projects. Likewise, SSH scholars may be expected to convince lay participants of the benefits of proposed solutions, rather than providing an opportunity for lay participants to develop solutions. Thus, the role of SSH needs to be strengthened as both a broad disciplinary field and as a facilitator of transdisciplinarity.

Future SSH Priorities

SSH has an important role in future transdisciplinary research. First, SSH **needs to play a more central role in energy, climate and mobility research** which is currently dominated by STEM perspectives. Moreover, it is necessary to recognise the broad contribution of SSH beyond the disciplines of Economics and Psychology. For example, in mobility research, Humanities perspectives are significantly underrepresented [17].

Second, SSH should be used to **understand best practices** in transdisciplinary processes further. SSH scholars are uniquely qualified to study ground-level experiences and consequences of doing transdisciplinarity, and what this means for R&I professionals (and their working cultures) and the solutions and policy evidence created. For instance, SSH can contribute to a better understanding of the (longitudinal) social learning in transdisciplinary practices and its effects on sustainability transitions [26].

Third, SSH scholars are also well-suited as **facilitators of the transdisciplinary process**. This requires training and a specialised understanding of transdisciplinary dynamics, which SSH scholars are well versed in.

Lastly, SSH disciplines also need to value transdisciplinary research more in their appraisal of scholars and careers. Academic careers are still dominated by evaluation procedures favouring narrow disciplinary publications and achievements. For SSH to have a prominent role in future **transdisciplinary energy, climate and mobility research, it must also be acknowledged as a valued contribution to the sciences** and its development.

Takeaways

Takeaways for the European Commission

- In seeking collaboration between disciplines and with public and private actors in energy, climate and mobility research call, the European Commission (EC) should seek the representation of a variety of SSH disciplines (beyond Economics and Psychology).
- When the EC is devising calls and budgets, the division of resources should be based on equality in partnership to strive for a common purpose.
- When developing policy, the EC should be aware of the strength and weaknesses of different forms of knowledge production – from disciplinary, interdisciplinary, and transdisciplinary – to strategically design projects which can have the most impact.
- Research calls should be designed in a way that can provide actors in academia with the opportunity to further their academic career (scholarly contributions) as well as coproducing solutions across traditional academic/disciplinary boundaries.

Takeaways for Stakeholders and Businesses

- Transdisciplinary research requires stakeholders and businesses to be prepared to work towards common objectives together with academia and laypersons.
- Stakeholders and businesses need to start the transdisciplinary process early to include others in the framing of problems and solutions.
- Stakeholders and businesses need to recognise the contribution of a broad set of SSH disciplines in developing sustainability solutions and not merely convincing publics of their value.

Takeaways for the SSH CENTRE project

- When designing transdisciplinary teams and activities (WP2, WP3, T3.3, WP4) organisers need keep in mind the representation of participants with different profiles and give ample room for them to influence the framing of the agenda in the task.
- When conducting transdisciplinary processes (WP2, WP3, WP4), organisers need to be reflexive of the methods used for implementation and give room for collaborative outcomes that are not purely steered by project objectives.
- In evaluating the project (WP5), the strengths, weaknesses and other lessons from the transdisciplinary process should be included in the reporting.

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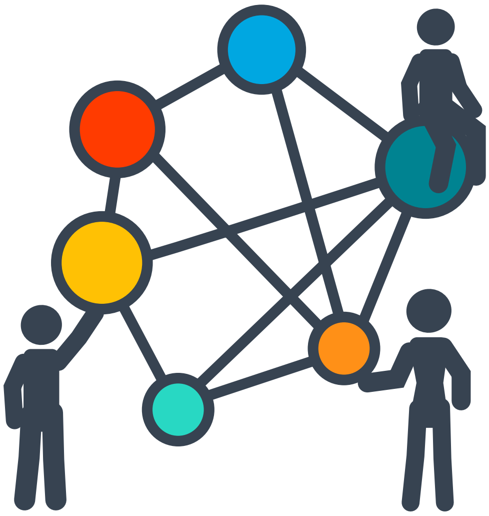
SSH-STEM networks: Bridging divides between social and technical



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ABSTRACT

In research, STEM and SSH fields are often seen as separate areas of study. However, in the real world, we encounter a mix of sensibilities. SSH-STEM networks can help situate knowledge among researchers and connect different actors within and beyond academia to better understand societal challenges. Bridging the SSH-STEM divide and tapping into the unique value of diverse perspectives through networks can open up new partnerships, possibilities, and innovative ways to tackle complex challenges such as the climate crisis.

SUMMARY

- Inter- and trans-disciplinary insights are required to tackle complex societal challenges, with SSH-STEM networks and team science supporting the development of these insights.
- SSH-STEM networks are a means for professional learning, development and knowledge exchange
- SSH-STEM networks can contribute to policy by producing evidence and science for policy, to business through innovation and financial support, and to communities through collective scholarship, practice and encouraging social movements
- SSH-STEM networks support cognitive diversity and encourage different forms of social learning by working with different cultural groups
- SSH-STEM networks are an important channel for science communication and bring visibility to underrepresented SSH disciplines and the work of women

KEY DEFINITIONS

Interdisciplinarity: An approach that urges unrelated disciplines to cross boundaries and create new knowledge [1].

Transdisciplinarity: An approach transcending academic boundaries and producing knowledge through collaboration with multiple actors and the broader community [2].

Communities of Practice (CoPs): A group of professionals (e.g. professional associations) collaborating around a particular area of practice [3].

Professional Learning Networks (PLNs): Networks organised around professional niches to foster learning [4] focusing on career development through exchanging knowledge, resources, and best practices.

Team Science: A collaborative approach making use of the multiple skills of researchers with various backgrounds [JL] [5][1].

1 https://guides.lib.vt.edu/teamscience

Introduction

To understand complex societal challenges such as the climate crisis, SSH-STEM networks can bring together knowledge from different fields to come up with innovative solutions, which otherwise would be unimaginable if each field operated in its disciplinary silo. SSH-STEM networks can also be used as a means to make connections and build relationships across people, uniting actors across different geographies and knowledge domains [SS].

In terms of scope, consolidating knowledge from both SSH and STEM can help tackle broader social-political and ethical concerns while also scrutinising the technical feasibility of real-world problems. **Interdisciplinarity** can encourage cross-fertilisation across disciplines while **transdisciplinarity** can encourage collaboration beyond academia with the broader community.

Networks, in general, are extremely powerful in demonstrating that one can learn so much more by collaborating with others as opposed to in isolation, especially when the emphasis is given to working within a team. From established networks, one can build new networks [JL] (e.g. research spin-offs or **Communities of Practice** (CoP)) increasing collaboration, and improving connections while sharing know-how and resources. However, developing new collaborations between individuals not speaking the same (academic) language comes with time and resources costs [JL].

SSH-STEM networks can be considered **Professional Learning Networks (PLNs)** operating in the world of science, policy and practice that brings together knowledge to promote **inter-** and **trans-disciplinarity.** Networks of SSH-STEM specifically, can help consolidate both theoretical and practice-oriented understandings to tackle current-day challenges [SS].

Within the policy domain, SSH-STEM networks are important for the European Commission (EC) to tap into evidence and science for policy [6] from different disciplines. (e.g. The SET Plan (Strategic Energy Technology Plan) [7] or the EU's climate neutrality goal [8]) which can eventually be adopted across countries located far from one another, both geographically and in terms of ambition.

From a business perspective, SSH-STEM Networks can serve as a hub for talent development, support financing or provide access to funding from new emerging partnerships. Also, the potential of STEM-SSH collaborations can lead to social, technological, or product innovation, thus opening space for new products, services, or processes.

In terms of community, SSH-STEM Networks can promote cross-fertilisation across members and support social movements and protests steered by collectivism. In this sense, scholarship and practice originating from SSH-STEM can stimulate a push for social or cultural change, that would not otherwise see the light of day, resulting in popular mobilisations [SS]. In this regard, SSH-STEM networks can help initiate some of that momentum and dynamism required for transformations for tackling pressing societal challenges.

This literature brief looks into the potential of bridging the SSH-STEM divide by bringing together scientific and practical knowledge to promote inter- and trans-disciplinarily via collaborative networks. The insights presented are informed by academic and grey literature, and interviews conducted with two expert academics[1].

Current Understandings

Significant Findings to Date

In the popular imaginary, STEM has links with the "real world" associated with universal and objective science, while SSH research is more oriented to policy, trying to understand subjectivity and plural interpretations of how things work [JL]. However, such an overly rigid demarcation of SSH versus STEM can result in an artificial divide. In the real world, problems are not so clear cut as in research and academia, rather, we encounter a **mix of these sensibilities** [SS].

Knowledge generated through SSH disciplines is *differently* useful to STEM disciplines [9]: SSH research creates social value [10] and within SSH-STEM networks these relationships can prosper in terms of their **different but equally valid contributions** to science and our understanding of the world.

Despite the ancient origins of SSH, especially the Humanities (e.g. philosophy), concerned with the art of asking questions, dialogue [JL] and the genuine quest for knowledge, until recently, in energy research specifically, there was an **underrepresentation** of SSH disciplines and methods and a lack of interdisciplinarity and women authorship in the field [11]. Moreover, the contribution of humanities research within SSH is also not on par with the social sciences nor appreciated to its fullest potential [JL]. Yet, increasingly within EC projects calling for interdisciplinary and socially-relevant research and innovation, SSH is becoming a key component (See for example [12]) as well as commitments to promoting gender equality [13]. SSH-STEM networks can indeed be a mechanism to bring the advantages and complementarity of SSH research into view and mainstream the role and contribution of women in this respect.

There are, however, different features across SSH and STEM that can emerge such as challenges related to funding, expected outputs and different timescales in producing outputs.

At present, in terms of funding and support, inter and transdisciplinary collaborations, forming the essence of SSH-STEM Networks are **limited by funding of project cycles** (typically 3-5 years) which leads to temporal and disciplinary fragmentation [SS]. There are differences across SSH and STEM disciplines in terms of achieving research outputs, as well as creating visibility across SSH and STEM research that may not particularly be achieved in short temporal scales but are rather experienced over broad social-cultural processes [14]. Moreover, building robust and working relationships across actors takes time and resources, especially if these relationships and new networks are classified as creative, novel and transdisciplinary [JL].

Another point is that in **SSH-STEM knowledge generation**, SSH is generally underfunded. For example, Overland and

1 Interview contributions to the literature brief are indicated through bracketed initials

Sovacool [15] show that **only 0.12% of all research funding**[2] **and 5.21% of all funding for climate change, was spent on the social science of climate mitigation.** This being a foremost priority, can be channelled through SSH-STEM networks for making a scientific impact and highlighting the need for additional funding.

Online networking has shown its central role in creating connections and providing information in many relevant ways [SS]. With the digital revolution, SSH-STEM networks have emerged as online PLNs, along with less formally structured, online social networks and social media as a means for social learning. However, online social networks may also create eco chambers, promote populism, and polarisation, therefore need to be moderated and managed well in line with ethical commitments.

Emerging Practices

In this section, emerging and best practices from science, policy and praxis are explored highlighting several core values in knowledge generation as well as success stories from examples on the ground.

Collaborative networks are a crucial means to bridge STEM and SSH, uniting experts from different fields, and from theory and practice, to work on common goals. **Transparency**, the **democratisation of science** and **open access to knowledge** in SSH-STEM networks are important values [SS], encouraging fairness, accountability and responsibility in societies in terms of Open Science and Responsible Research and Innovation [16]. Within SSH-STEM networks, transparency and the ways in which knowledge is created [17] need to be promoted, which, in turn, feed back into more meaningful collaborations.

Calls for "**reflexive science**"[3] within meaningful SSH-STEM collaboration and networks are emerging as a means for cultivating a shared interest in theoretical and practical-political challenges [18]. For example, **success stories** in SSH-STEM collaboration and numerous Horizon Projects have been documented by the transnational network Net4SocietyHE (N4SHE) for Culture, Creativity and Inclusive Society" (Cluster 2)[4]. These success stories emphasised the added value of integrating SSH in their project's design and implementation as well as visibilsing the evident contribution from SSH partners specifically. Similar efforts can be undertaken for Climate, Energy and Mobility (Cluster 5) in the Horizon Europe Programme.

Another event from Ireland[5], for example, focusing on SSH and interdisciplinarity, concluded the need for diversifying international contacts in a post-Brexit seeing via networks, highlighting the challenge of being included in a network for the first time while also underlining the need for building trust, overcoming language barriers, as well as including early career researchers in the process.

Within the EC there has already been a great learning process of embedding interdisciplinarity within project calls. However, especially within the Horizon Programme, transdisciplinarity must be further encouraged [JL], especially in SSH-STEM networks engaging with actors beyond academia. In transdisciplinary research and application, it is possible to learn from best practices that are already happening on the ground such as **citizen assemblies6**, **low-traffic neighbourhoods7,** or **transition town8 movements** [SS]. These can be listed as exemplary practices that can be elevated into SSH-STEM networks in terms of learning, organisation, motivation and mobilisation.

SSH-STEM networks moreover are gateways for **science communication** and **visibility**. SSH-STEM networks, harbouring multiple actors from science, policy, practice, business and the wider public can support, promote and disseminate energy, transport and climate-related science and knowledge for transformative change.

Future SSH Priorities

In terms of organisational structure, within SSH-STEM networks, there must be an evaluation of group dynamics and balances assuring representation of all actor groups for **inclusion, diversity, equity** and **access** (IDEA). The inclusion of researchers at different career stages should be ensured, especially calling for the **inclusion of Early Career Researchers** (ECRs), as they have different understandings, and are not locked into a particular vision, methodology, or framework [JL][9].

The presence of **women in leadership positions** within SSH-STEM Networks, project work and activities is also vital. While this is emerging, it is not yet mainstream [JL]. For example, the number of applicants for research funding in R&D in the EU shows gender inequalities: the ratio of men to women in the social sciences is 1.1:1; in Humanities is 1.2:1; in Natural Sciences 2:1 and in Engineering and Technology is 3.1:1[10] [13]. Gender equality currently in R&D in the EU, although encouraged, is far from being achieved. Therefore SSH-STEM Networks can be a key **leverage mechanism** in supporting women in this process while also making their contribution to the scientific world more visible.

Within SSH-STEM networks, it is also important to boost work with different cultural groups promoting the IDEA principles to address structural inequities. There are many different cultures inside Europe which manifest in many different ways of learning and working together [JL] – an important dimension of social learning in SSH-STEM networks while

2 Overland and Sovacool 2020 analyse research grants from 1950 to 2021 covering 4.3 million awards with a cumulative budget of USD 1.3 trillion with funding awarded by 333 organizations from 37 countries

3 Linked to WP5 of SSH CENTRE Project

4 https://horizoneuropencpportal.eu/store/success-stories-ssh-stem-collaboration

5 Event co-hosted by Enterprise Ireland (EI), the Irish Marie Skłodowska-Curie Office (IMSCO), and the Irish Universities Association (IUA) titled: "SSH and Interdisciplinarity in Horizon Europe" on May 25th, 2022 See: https://www.iua.ie/wp-content/uploads/2022/07/SSH-and-Interdisciplinary-in-Horizon-Europe_Opportunities-barriers-and-useful-support-Workshop-Report_July-2022.pdf

6 https://europeanclimate.org/stories/the-growing-traction-of-climate-citizens-assemblies/

7 https://www.lowtrafficneighbourhoods.org/

8 https://transitionnetwork.org/

9 Linked with Knwoledge Brokerage with WP3 of SSH CENTRE Project

10 These ratios have been obtained from reference [13] She uses figures from Gender in research and innovation: statistics and indicators in Annex 7.18 and 7.19 for EU-28 Applicants

embracing cognitive diversity. For this purpose, collaboration and education can be harnessed to support **the four R's—Respect, Relevance, Reciprocity, and Responsibility** [19] which can reform the way higher education institutions work, promoting further inclusion and diversity. These features ultimately increase problem-solving capabilities, creativity, and greater innovation: core values also promoted by STEM-SSH networks.

Takeaways

Takeaways for Research and Academia

- SSH-STEM networks provide a space for **collaborative learning** as professional learning networks and can provide opportunities for team science and work in terms of **policy, business** and **community**
- Embrace **reflexivity and transparency** and the **democratisation of science** within SSH-STEM networks as an important value to achieve Open Science and Responsible Research and Innovation
- Promote principles of **inclusion, diversity, equity** and **access** (IDEA) within SSH-STEM organisational structures to include Early Career Researchers, and different cultural groups and engage with actors beyond academia
- SSH-STEM networks can help initiate **momentum for community support** steered by knowledge, collectivism, mobilisation and sociocultural change
- Learn from **best practices** that are already happening on the ground (e.g. citizen assemblies or transition towns movements) and **elevate lessons learned** into SSH-STEM networks and organisation

Takeaways for the European Commission

- Recognise the **time, resources**, and **effort** required for building **SSH-STEM networks** and inter and transdisciplinarity which should be reflected in terms of project funding, length, and expected scientific output
- Acknowledge SSH-STEM networks as important means for generating **evidence** and **science for policy**. Such networks can **raise ambition** in terms of climate/energy/mobility targets and **draw actors closer together**
- Direct efforts to shine the spotlight on the **contribution of SSH partners** while making the added value of **SSH** in project design and implementation **more visible**
- Take advantage of SSH-STEM networks as **hubs for talent** and business **development** for social, technological or product innovation. Encourage SSH-STEM networks for businesses to boost innovation
- Encourage **inclusion, diversity, equity** and **access** (IDEA) in funding opportunities as well as promote **transparency**, the **democratisation of science** and **open access to knowledge**
- Tap into SSH-STEM networks for encouraging **women leaders** for **gender equality** and supporting collaborations between different **cultural groups** for **inclusivity** and **cognitive diversity.**

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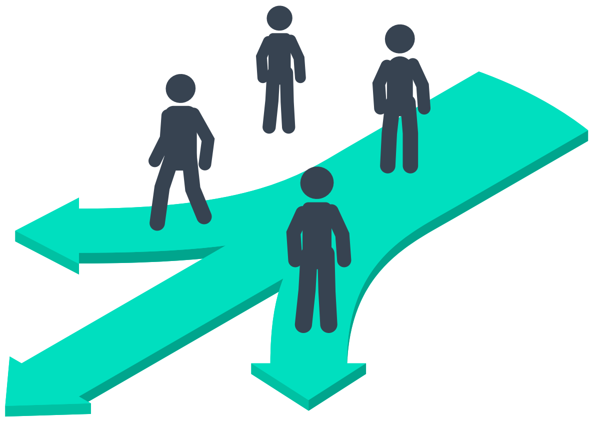
Modelling and Social Sciences & Humanities: Integration of social insights into technical models



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ABSTRACT

Models of climate, energy and mobility systems can support understanding and policy development in these areas, but current models either focus on the physical or social systems, with little integration between the two. An integration of SSH and STEM dynamics via modelling is necessary to advance understanding in these complex systems and develop integrated policy solutions. This can be achieved by promoting interdisciplinary collaborations and by using participatory methods to engage with the actors currently excluded from the policy process.

SUMMARY

- Modelling in climate, energy and mobility systems can support better understanding of interconnected challenges and the development of integrated policy solutions.
- Current models don't integrate technical (STEM) and social (SSH) dynamics well – STEM and SSH modelling communities are (somewhat) divided. An integration of SSH and STEM dynamics via modelling is needed.
- Not accounting for SSH dynamics in models can result in imprecise predictions and ill-thought transition policies.
- Participatory (SSH) methods such as citizen assemblies can facilitate interdisciplinary STEM and SSH collaborations, which in turn can support the development of integrated models.
- Interdisciplinary STEM and SSH collaborations to develop models can bring challenges but give life to more comprehensive models and policies.

KEY DEFINITIONS

Model – "a simplification – smaller, less detailed, less complex, or all of these together – of some other structure or system" [1, p.2]

Complex system – A series of entities or parts, all interconnected with one another. This interconnectedness generates 'emergent' dynamics that would not be capture if each component was examined in isolation

Computer simulation (or modelling) – uses the computing power of pcs to create models of real-life dynamics, to study their behaviour in a virtual environment [2]

Introduction

The development of computer and simulation models has long been part of European strategies to achieve long-term sustainability in in a number of sectors, including the energy sector (e.g. [3,4]). This is reflected in the number of projects funded to develop new models or integrating existing ones (e.g. MEDEAS H2020[1]; SMARTEES[2]) and is supported

1 https://medeas.eu/
2 https://local-social-innovation.eu/

by 'smart' systems (e.g. smart energy meters) and 'big data', which generate a wealth of data critical for simulations [5,6].

One of the key purposes of modelling or Computer Simulation (CS)3 in climate, energy and mobility is to support understanding, decision- and policy-making. Models provide insights on the different systems involved (e.g. amount of critical minerals required by the energy transition) and by simulating how they are connected and how specific dynamics evolve through time, models provide forecasts of the future state of a system (e.g. IPCC reports). These alternative future scenarios can be used to develop integrated policies to support the sustainability transition in these sectors. However, current models tend to focus either on the physical and technical (i.e. STEM) or the human and behavioural components (i.e. SSH), with insufficient integration between the two, therefore leading to partial solutions [WJ].

This literature brief reviews current practices, emerging understandings and future directions for SSH and modelling, highlighting the continued existence of a divide between SSH and STEM modelling communities and a necessary integration between SSH and STEM via CS to support the sustainability transition. This research-based brief argues[4] that the gap can be bridged by supporting interdisciplinary teams that span these communities. In doing so this would support innovative projects that push the boundaries of different disciplines, bringing them closer and therefore giving life to more comprehensive, integrated models of climate, energy and mobility systems.

Current understandings

Significant findings

The **aim of modelling is to develop simplified representations of complex systems** to [1]:

- Help understand the interconnectedness of systems;
- Identify the source of specific challenges;
- Make predictions of the future state of the system;
- Support policy design by understanding potential cascading effects of policies implemented.

In the context of climate, energy and mobility systems, modelling can help answer questions such as 'what is the potential sea-level rise in a +1.5° world?' or 'what is the most efficient carbon policy to reduce carbon emission in the energy system?' or 'what incentives could lead a market to switch to a fully electric car fleet?'. The answers to these questions clearly involve interactions between physical and human systems.

Disentangling the complexity of these systems requires methods and techniques that can capture the interaction between social, technical and ecological dynamics, the decision making of diverse social actors and the non-linearity embedded in some of these interactions [7]. Modelling can support this integrated approach and develop understanding of the interconnections between different systems, but can also be a virtual laboratory to test potential first, second and nth order effects of a policy. **Modelling can therefore support the development of integrated policies that consider both the social dynamics and physical limitations of the systems involved**.

Despite modelling becoming increasingly popular with both STEM and SSH communities, these **modelling communities continue being divided, producing models that focus either on the physical (STEM) or social (SSH) dynamics** [WJ; PMSS]. This is especially problematic when investigating complex topics such as climate, energy and mobility, which are all (interconnected) complex systems where both social and physical dynamics play a large role [8]. Not accounting for either physical or social dynamics can lead to partial understandings and misguided solutions. For instance, climate models that do not include people's choices and behaviours both positively (e.g. fast shift in energy demand) or negatively (e.g. complexity and cost) could lead to wrong future scenarios. Similarly, models that focus on influencing people's transport choices would not see full application unless the technical system was built into the model to show what is technically possible (e.g. how quickly can electric cars be produced). SSH dynamics (i.e. here intended as human behaviours, culture, etc.) influence every step and actor involved in the sustainability transition, particularly on the demand side and around the acceptance of new solutions and how decisions are made. It is widely acknowledged that climate-related challenges are rooted in social behaviour [9].

Integrating SSH and STEM dynamics via modelling is therefore necessary to advance our understanding in these complex systems and develop integrated policy solutions. However, integrated models currently available only include a stylised version of the 'other' system (i.e. STEM stylises behaviours, SSH stylises physical dynamics), which is still a limited approach. This is due to a series of **challenges that hinder a full integration** [WJ; PMSS]: 1) the **balance between simplicity and complexity of integrated models** - embedding SSH understandings (e.g. human behaviours) in technical and physical models increases the complexity of simulations, which may result in a model that is too complex to understand. Significant simplifications need to be made, with the risk of oversimplifying human behaviours [10]. Any model thus comes with serious caveats, which are often not acknowledged (by researchers) and therefore not understood (by decision-makers); 2) how to **translate and implement qualitative SSH data into models** - models tend to require/prefer large amounts of quantitative data and key social dynamics need to be reduced to parameters (e.g. the speed of social change, change of lifestyles, etc), which may result in a misrepresentation of those behaviours and, ultimately, in inaccurate findings; 3) **difficulty in characterising *change*** - to provide future scenarios, models need to specify how behaviours will change to simulate the evolution from today to the future (e.g. 2050), but in SSH research it is challenging to study these hypothetical changes to inform models.

Emerging practices

Interdisciplinary collaborations between and SSH and STEM communities working with models are key to develop models that can better simulate social factors, which are necessary to simulate transition behaviours [7; PMSS]. **These can**

3 Hereafter called 'modelling', as here modelling and CS are used as synonyms.

4 This work is based on a literature review of the fields involved and interviews with two experts.

be facilitated using qualitative, participatory methods such as stories, narratives and storytelling (e.g. see [11]). These are increasingly being used to capture data on social behaviours that can be used to inform climate, energy and mobility models [WJ; PMSS]. **Participatory modelling** [12] is another method that can support the integration between STEM and SSH dynamics via modelling. This involves an iterative process where the model is developed with the actors involved in the system that is being simulated. This process ensures active participation by the actors involved to capture key dynamics and behaviours to include in the model and ultimately their ownership and buy-in in the model and its results.

Some of these methods are implemented in past and current projects that champion best practice in the field. **SMARTEES**[5], for instance, is a modelling project that used participatory methods to engage with a large number of stakeholders to inform model and policy development. The project aimed at improving policy design to support the energy transition by fostering inclusive participation of citizens and local communities in the development of models and found that using participatory methods to involve these actors in model and policy development can lead to acceptance of solutions proposed [WJ]. The team developed a model to evaluate the effects of policy interventions and social innovation related to energy and mobility and implemented a range of participatory methods: co-production to develop scenarios that were used as input in the model, interviews and surveys to capture key behaviours to be represented in the model and engagement activities such as citizen assemblies and neighbourhood open events to ensure members of the public were represented in models' aims and thinking.

Finally, the **BEHAVIOUR**[6] project champions interdisciplinary STEM and SSH collaborations bringing together psychology, social science, technology, economics and energy system analysis to develop Agent-Based Models. The models developed simulate the energy behaviours of private households by introducing human behaviours in the models with the aim of understanding whether individuals can be influenced to support the low carbon transition in Norway [PMSS].

Future SSH priorities

Despite initial efforts to integrate SSH and STEM insights into models, **further work is needed to develop comprehensive, integrated models that capture the nuance of actors in the interconnected climate, energy and mobility systems**. This is going to result in increased understanding of cascading effects in socio-technical-environmental systems, more accurate simulations and, ultimately, in the design of policies that can provide the right incentives to steer behaviours towards sustainability [8]. Future integrated models will be able to test these policies to identify unexpected consequences and prepare for second and nth order (unexpected) effects. However, this is also going to result in a higher complexity of the models and therefore the need for better and more careful communication of the results and their validity [PMSS].

The modelling techniques and methods to integrate SSH and STEM are engaged in a maturation process of their own [WJ], with models being able to simulate increased complexity thanks to increased computing power and the development of participatory approaches that can support wider engagement, which could lead to a longer list of methods to support the integration. The list of actors invited to participate in modelling, policy and future scenarios is also going to expand to include harder-to-reach members of society, businesses, community groups and other organisations and ensure a plurality of opinions, aims and interests is represented. **The increased implementation of participatory methods such as participatory modelling, applied to a larger audience to introduce SSH topics in models around climate, energy and mobility is going to result in higher levels of engagement from all actors involved and a renewed push towards the transition**.

The maturation of modelling, the computing technological advancements and Big Data [13] will allow to run more complex simulations allowing for modelling of more nuanced behaviours. One interesting development in the field is 'plug-and-play' models, i.e. the development of 'modules' (e.g. betting behaviour, energy market, climate change dynamics) that can be reused to enhance existing models or build new ones to avoid duplication of efforts [WJ], which will support the diffusion of more sophisticated behavioural models.

These **developments in modelling and participatory approaches can also lead to new research questions** where models can help understand the role of human behaviours in the solution to key challenges (e.g. 'how can energy use and demand change over time in energy systems?'), or the interconnection between different systems (e.g. 'what are the opportunities in the employment sector driven by the sustainability transition?'), or identify win-win solutions (e.g. 'what are the key components of a policy to promote a just transition and minimise resistance?') [PMSS]. The focus on participation in models could raise new questions on, for instance, understanding the role of local neighbourhoods and generally local democracy in the sustainability transition [WJ]. **Humans have the responsibility to understand how we can limit our impact on the environment, and integrated models can help** [WJ].

Takeaways

Takeaways for the European Commission

- More EC funding should be dedicated to interdisciplinary groups that undertake projects that have a strong and wide participatory component and who involve in the model and policy development actors that are currently left out to lead to more inclusive and (likely) accepted policies;
- EC funding should be directed to developing new shared 'languages' such as modelling which will support interdisciplinary collaborations;
- Funding should prioritise the development of new and extend existing models of socio-technical and ecological systems to bring together SSH and STEM modelling communities;

5 SMARTEES •• LOCAL SOCIAL INNOVATION (local-social-innovation.eu)

6 https://ife.no/en/project/role-of-energy-behaviour-in-the-low-carbon-transition-behaviour/

- Integrated SSH and STEM models on climate, mobility and energy can be used by EC to design proactive future-looking policies that consider potential responses from the actors they are trying to target, to ensure that the measures to promote the transition are likely to be accepted and this should be promoted across all sectors managed by the EC;
- The integration of SSH and STEM via modelling should be included in the EC priorities as it supports just transitions [PMSS];
- Transition is characterised by turbulence and the predictive capacity of models decreases. EC should promote better communication of modelling-based project results explaining validity and limitations [PMSS].

Takeaways for Stakeholder and Businesses

- Businesses should approach interdisciplinary collaborations between SSH, STEM and modelling communities as an investment as it takes time to learn to speak the same language, but climate, energy and mobility models resulting from these collaborations are more comprehensive;
- Not taking SSH dynamics into account in modelling the sustainability transition will lead to underestimating the role of people's behaviours, both positively (e.g. fast shift in energy demand) or negatively (e.g. increased complexity) in the transition and therefore give wrong insights [PMSS];
- It is important to engage with a wide range of actors from different parts of the system (e.g. national energy agencies and governmental institutes) and involve citizens in making change happen by including them in the modelling via participatory methods [WJ].

Takeaways for SSH CENTRE

- The SSH and STEM integration via modelling takes time and requires a long-term vision. People engaging in one should seen it as personal development. SSH CENTRE could support this by making the SSH-STEM collaborations in WP2 longer-term and modelling could be one of the methods used.
- A new type of interdisciplinary education needs to be promoted (e.g. knowledge brokers). This should be included in the principles part of the Open Education and Knowledge Platform being developed as part of WP6.
- The integration between SSH, STEM via modelling has mutual benefits for all fields involved [WJ]. SSH CENTRE can support this with its final recommendations to EC and research more in general.

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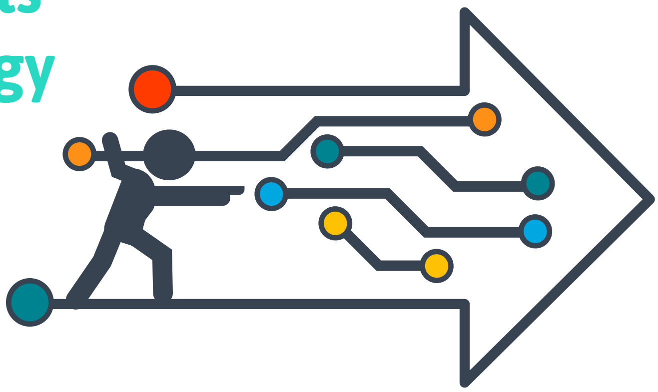
SSH CENTRE

Digital Transitions: Supporting societal shifts related to climate, energy and mobility



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ABSTRACT

Digitalisation sits alongside carbon neutrality as a political priority of the EU. They are framed as twin transitions in the hope that digitalisation creates sustainability outcomes. However, such gains are not automatic; they depend on how digital technologies are implemented, and what practices they support. There are outstanding challenges around ensuring access to digital technology, and in creating proactive governance and regulation of digitalisation. Future research needs to centre on critical themes of power and ethics to address accessibility and social marginalisation.

SUMMARY

- Unsustainability is perpetuated when digitalisation locks in high energy behaviours, infrastructures, and business models.
- Proactive regulation should ensure that digital technologies are built around sustainability and equity outcomes.
- The greatest sustainability outcomes are achieved when digital technologies support social innovation (new ways of organising production and consumption), rather than supports more efficient business-as-usual models (e.g. the same supply chains and production processes).
- Future research must focus on questions of power and equity, and how to equitably and democratically govern digitalisation and digital technologies.
- Research and practice would benefit from co-creative approaches that allow the development of social and technical understandings of digitalisation.

Introduction

A ‘Europe fit for the digital age’ is one of six commission priorities for 2019-2024. The Digital Strategy is based on three pillars: 1) technology that works for the people; 2) a fair and competitive digital economy; and 3) an open, democratic and sustainable society [1]. Under this third pillar, the strategy commits to use technology to assist in the transition to climate neutrality by 2025, while also

KEY DEFINITIONS

Digitalisation: the shift from the physical world to the digital world (e.g. remote working, online meetings/conferences, and apps that aid decision-making). Digitalisation can shift physical supply chains, alter work and travel patterns, and support innovation towards sustainable decision making. Digitalisation includes shifts to online conferences and meetings or transition to virtual communities to connect people.

Digital technologies: the tools and applications to support this process, for example Zoom, crowdfunding platforms, apps for remote sensing in precision agriculture to avoid transport emissions, etc.

Social innovation: new ways of organising supply chains, consumption processes and ways of working that provide alternatives to business and usual. Examples include community energy and car sharing.

The twin transition: refers to the idea that transitions to a digital world and to a carbon neutral society reinforce each other.

reducing the carbon emissions from the digital sector. In this way, digitalisation sits alongside sustainability as the twin transitions whereby digitalisation and digital technology accelerate sustainability objectives [2].

There are significant challenges to achieving these twin transitions as digitalisation does not automatically lead to improved sustainability [2]. Corporate and industrial digitalisation strategies tend towards business as usual, but done more efficiently [3,4]. While this leads to reduced waste and emissions, it can also lead to greater production and consumption that cancel out these savings, thus not actually delivering overall sustainability benefits. Digitalisation itself can also be a driver of unsustainability, particularly around the energy demand of server farms and data centres [5,6].

While digitalisation tends to suggest a clear role for STEM research (e.g. in creating software, sensor, data management), there are significant contributions needed from SSH. There is need to consider the ethics of artificial intelligence and automation, the policy and governance of industry regulation, and the philosophical and political considerations around the roles industry, state and civil society could and should be playing in digitalisation. Further, opportunities and barriers to access of digital technologies play an important role in shaping the extent to which the twin transformations are achieved.

This literature brief summarises existing understandings about digitalisation and digital technologies, and their role in the green transition, with a focus on the future opportunities for SSH research. The insights presented are informed by existing academic literature, policy literature, and interviews conducted with two experts: one from industry, and one from research-practice[1]. Interview insights were used to provide illustrative examples in this brief, and to guide towards topics in the literature.

Current understandings

Significant findings to date

SSH research on twin transitions, or digitalisation as a pathway to sustainability, is an emerging field. It remains largely dominated by STEM. Topics here include the developments of technology, data harmonisation and big data, digital twins, and quantifications of the impact to carbon emissions from digitalisation processes [see e.g. 5,7]. However, **there is an increasing amount of SSH literature available, often exploring the roles and processes of digitalisation to support sustainability transitions within specific sectors or research topics** (e.g. agriculture, energy). Agriculture is a particularly rich topic, and highly relevant to climate, energy and mobility. Here, digitalisation, for example through supporting precision agriculture, is proposed as a way to improve soil quality (including carbon sequestration), reduce energy use, and minimise transport requirements [8]. An exploratory review of the SSH literature on the topic of digitalisation in agriculture [9] revealed 5 thematic clusters of the roles SSH plays in understanding and shaping processes of digitalisation: 1) adoption, uses and adaptation of digital technologies on farms; 2) effects of digitalisation on farmer identity, skills and work; 3) power, ownership, privacy and ethics of digitalisation in production and value chains; 4) digitalisation and agricultural knowledge and innovation systems; and 5) economics and management of digitalised production and value chains [9].

The need for, and forms of, regulation of digitalisation is widely recognised. **Historical analysis shows that technology transition (e.g. to digitalisation) tends to happen faster than energy transition, and there is therefore a need to develop regulations that ensure digitalisation does not undermine future energy transitions by locking-in high-energy behaviours** [10]. Infrastructure, processes and logics of digitalisation become locked in, meaning that regulation occurring in response to digital development is resisted and causes problems to digital service providers [PD]. Proactive regulation ensures that digitalisation stays as a "good servant" to achieving sustainability, rather than a "bad master" [PD]. It requires foresight and understandings of the ethical, political and practical implications of digital technologies and their application. The Digitalization for Sustainability (D4S) project[2], funded by the Robert Bosch Stiftung, has outlined a 'Blueprint for the European Union' on how to reconceptualise digitalisation for sustainability. The document, called 'The Digital Reset', outlines the more fundamental systems changes that need to be created so that digitalisation remains a good servant to sustainability [11].

The need for regulation is linked closely to questions of which actors take what roles in providing and maintaining public services and their capacities and legitimacy to do so. **These are fundamental questions of the ethics and politics of how power, roles and responsibilities are distributed in public service provision, raising tensions around the role of the state and the private sector.** The political priorities to digitalise rely on there being infrastructure, such as mobile, high-speed internet. This infrastructure is arguably a public good that is currently being provided by the private sector [PD]. Thus, there is a tension between the scope to invest private sector money, and the expectation to deliver services (e.g. fast, reliable internet) that meet the needs created in the European Green Deal, as expected by citizens [PD]. For example, the high level of competition between mobile network operators in Europe drives competition and spreads finances thinly, constraining opportunities for investment [PD]. There may also be tensions between the interests of internet providers and the provision of public infrastructure such as shared wi-fi networks in public spaces [12].

There are also concerns raised around the unequal access to digital services and how this affects the European Green Deal objectives to leave no one behind. For example, inequality in internet speeds, particularly between rural and urban areas can create a digital divide where people have different opportunities to access the information society [13]. Digitalisation has been proposed as a mechanism for overcoming some societal inequalities, for example by changing gendered working patterns [14]. However, the use of digital technology has the potential to further embed gender inequality and exclude women from decision-making and transition activities [14]. If women are traditionally excluded from e.g. investment decisions, the creation of crowdfunding platforms

1 Interview contributions to the literature brief are indicated through bracketed initials

2 https://digitalization-for-sustainability.com/digital-reset/

alone will not address this. Rather, for women to be included in decision-making and innovation for an energy transition, crowdfunding platforms must be accompanied by awareness raising and engagement with under-represented groups [SC]. In short, digitalisation alone is insufficient; it must fit within broader social changes.

Emerging practices

Centring social innovation is a way to ensure that digitalisation is a tool to support transitions to sustainability [15] and to achieve the above-outlined social change. For example in the Horizon2020-funded SocialRES project[3], crowdfunding platforms are being used as a form of digital cooperative, bringing multiple small energy operators together with citizen investors [SC]. Aggregators are similarly important in community energy generation and energy cooperatives by bundling distributed energy resources and negotiating higher market prices [SC]. European regulatory frameworks place significant emphasis on the role of aggregators in the energy transition [16,17]. Digitalisation that seeks to just improve efficiency within business-as-usual models is of limited impact to sustainability [3]. **The most effective digitalisation processes seek to rethink these models, for example moving from centralised power generation and big-grid distribution to decentralised and community energy networks, and to work with digitalisation to underpin these processes [18,19].**

A centring of social innovation, and the need to challenge existing social relations creates an emerging emphasis on co-creation and transdisciplinary research approaches. SSH and STEM researchers working in partnership should allow exploration of technology development alongside social needs, use and explorations of ethics and access [20]. For example, in the Horizon2020-funded MUV project[4], citizens were active participants in creating, and testing, apps and games for changing mobility behaviours in a range of urban areas. Bringing these different perspectives together and matching them to societal and practical needs pushes towards transdisciplinarity [9,21]. **Transdisciplinary and co-production processes create space for public debate and the elicitation of public values to consider whose values count, how they play out in digital technologies and their implementation, and how trade-offs should be managed** [22]. This includes considering how technologies interact with social drivers of exclusion, and the behaviours that they embed or promote. It includes questioning who benefits from a digital technology, and who is potentially harmed. Indeed, research that explores the political dimensions of digital technologies must engage with such questions of power [23] and question the governance structures of digitalisation for sustainability [24].

Such co-creative, transdisciplinary approaches are often embedded within practice cases, or real world examples of developing and using a technology, that create new constellations of actors around innovation. For example, the SocialRES project has worked with 9 case studies of social innovation in renewable energy projects in the UK, Spain, Portugal, Germany, Croatia, and Romania. Digitalisation and digital technologies have supported a number of these innovations through e.g crowdfunding of peer2peer lending, and virtual energy transactions. This case approach allows learning from the process of working with digital technologies, while matching them to the needs of the case, and seeing the different ways in which communities work with them [SC]. This can include bring investors, technology developers and end users together, for example in developing an app for precision agriculture [PD]. It can also take the form of exploring, with a community, the use of digital technologies to support e.g. a community energy project [SC].

Future SSH priorities

There are extensive opportunities for SSH researchers to input to questions of design, implementation and uptake of digitalisation. These kinds of research questions are well covered in reviews pertaining to specific sectors where digitalisation is already playing a role in relation to climate, energy and mobility. For example, in their review Klerkx et al. [9] outline a broad range of specific questions relevant to digitalisation in agriculture, around ethics, identity, accessibility and regulation. Trahan and Hess [18] outline a range of questions from the area of energy transitions around the roles taken by actors in digital technology development and the risks they assume; and the impact to organisation structure and workforce characteristics. They point to the research opportunities to explore how local energy organisations are extending beyond priorities of affordability and into community benefit; or how such organisations are shaping relationships with vendors and energy distributors. Kunkel and Tyfield [25] outline a strategic research agenda for digitalisation and sustainable industrialisation in the Global South. From these sector-focussed reviews, it is clear that there is significant scope for SSH research that looks at the application and steering of digitalisation, drawing on disciplines from business studies, law, policy, behavioural science, sociology and ethics.

More critically, and looking across sectors, a common thread through these research agendas is **a call to investigate questions of power, and how they play out across different actor groups in the process of digitalisation and the design (and thus impacts) of digital technology.** Power shapes access, and shapes the way in which digital technologies tackle or perpetuate inequalities. In engaging with technologies, there is a need to consider “who governs, whose systems framings count, and whose sustainability gets prioritized” [23]. Indeed, such questions relate to the issues outlined above around the roles played by actors, and the ethics and politics therein. Examples for SSH research could include exploring the barriers and opportunities to participation in digitalisation processes for marginalised communities, and indeed how social innovations and digitalisation fit to a range of cultural and socio-economic contexts. Policy research could further identify the discourses of digitalisation, and explore how these reflect the lived realities of the communities they should impact.

Beyond the specific research questions to be pursued, there is also a priority with regards to the skills and understandings that SSH researchers need to develop. **A particular SSH priority is to improve digital understanding or literacy amongst SSH communities. SSH researchers tend to be largely digitally illiterate and theories of digitalisation are thus analogue and fail to capture the nuance and oppor-**

3 https://socialres.eu/
4 https://www.muv2020.eu/about/

tunities of digitalisation [26]. There are calls for increasing recognition of the role and scope of digitalisation in our own research practices [27], and how this shapes what we are able to research, how, and how we understand the world [e.g. 28]. Roth [26] calls for a digitalisation of social theory, rather than just a social theory of digitalisation. Indeed, improved digital understanding by researchers themselves would allow recognition of the huge potential of digital platforms in shaping social innovation [SC]. This would require SSH researchers to be more focused on what might be, and what could be, rather than focusing on what has already happened [PD]. Co-productive, practice case approaches help to connect SSH researchers with a greater understanding of the potentials and pitfalls of digitalisation.

Key Takeaways

Takeaways for the European Commission

- Proactive regulation must embed sustainability within digitalisation processes to ensure that digitalisation doesn't lead to higher carbon emissions and serve to undermine the EU's commitment to carbon neutrality by 2025. Digitalisation is not an automatic pathway towards carbon neutrality. Digitalisation can create path dependencies in high energy behaviour which are hard to retrospectively change, can encourage unsustainable behaviours, or reinforce existing inequalities and unsustainable business practices.
- Research funding should focus on creating social innovation supported by digital technologies, rather than focussing on the digital technology as the core outcome. Energy and mobility systems can be transformed by social innovation, for example through decentralised energy supply and distribution (community energy). Digital technologies help to support their set up, implementation and scaling up processes. Funding should therefore be targeted to fostering the social innovation, rather than leading with digitalisation as the primary goal.
- Future research should include critical consideration of the democratic governance of digitalisation. Research that develops social innovation and digital technology should include consideration of the roles, rights, responsibilities and access to digitalisation. Such research must explicitly engage with the political and ethical implications of digitalisation.

Takeaways for Stakeholders and Businesses

- Digital technology developers should seek early engagement with SSH research to co-create digital technologies and digitalisation processes that lead to great social and sustainability benefits. Digitalisation is not a purely STEM process. Questions of what the technology will support, user needs and access, and decision-making processes are all areas of SSH research that must be included within development plans and roll-out strategies. They can be addressed alongside the technical questions for greater uptake and impact.
- To ensure no-one is left behind, the development of digital technology and its implementation must be accompanied by comprehensive infrastructure and capacity building. Digitalisation will not automatically overcome barriers to the participation of marginalised groups, and indeed could create further barriers. Digital tech must be designed in with input from under-represented groups to ensure accessibility.

Takeaways for the SSH Centre project

- Many researchers may need to improve their understandings of the role of digital technology, its potential, the types of technologies available, and how they are used. There are significant opportunities for meaningful and impactful SSH research on digitalisation. However, digital literacy and an active interest and experience of using such technologies will help to fully understand and unpack these research opportunities. Opportunities for such engagement exist through the WP5 and WP6 Open Science and Open Education activities of the SSH Centre.
- SSH Centre can ensure that critical basic research on the topic of digitalisation is included in WP2's collaborative book chapters, and by ensuring representation of more theoretical perspectives in the ECR knowledge brokerage training. Critical basic research is needed to explore normative questions of who has their voice heard and priorities met in digitalisation processes, who loses, and why. These should not be overlooked in favour of those with more tangible, applied perspectives.
- SSH research needs to explore how gender and other barriers shape inclusion and use of digital technologies, and how digital technologies intersect with processes of marginalisation. The SSH CENTRE project could facilitate discussions on this topic through the policy insight events and focus groups.

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Transitioning to a circular economy: Insights from the Social Sciences & Humanities on motivations and opportunities

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ABSTRACT

Circular Economy is a complex concept that requires a careful and multidimensional approach. The complexity of circular economy is shown in vast number of different definitions for circular economy within peer-reviewed articles, policy papers and consultancy reports. circular economy draws its influence from various disciplines [5]. As circular economy not only analyses material flows, rather it also considers how social phenomena influence the transition to circularity, it shows the need to engage with Social Sciences and Humanities (SSH) disciplines.

SUMMARY

- Circular economy is considered as an important priority in EU Green Deal, with the second Circular economy Action plan in force.
- Whilst circular economy is generating new business models, it is most often used in a consolidated manner by market participants.
- When implementing circular economy, it is important to think across territorial scales and acknowledge different socio-cultural societies.
- Shifting a community towards circularity and increasing people's sensitivity towards resource use is essential to achieve circularity.
- Material depletion can draw attention to the shortcomings and accelerate the transition towards circularity.
- STEM-created and visualised data can support decision-making in circular economy-related strategic planning.

KEY DEFINITIONS

Circular Economy: "The economy in which products, materials, and resources last as long as possible and waste is kept at the possible lowest level" [1].

Eco-innovation: "Eco-Innovation refers to all forms of innovation – technological and non-technological – that create business opportunities and benefit the environment by preventing or reducing the environmental impact, or by optimizing the use of resources" [2].

Material Flow Analysis (MFA) - The material flow analysis maps overall waste movements and management procedures [3].

Introduction

A key theme of the environmental movements of the 1960s and 70s was the overuse of the Earth's resources, with circular economy also emerging at this time. Yet, increasing focus and use of the concept has emerged over the past decade in response to sustainability challenges, including population growth and resource depletion [4, 6]. The drive for resource efficiency has been heightened through global geopolitics and crises such as the Covid-19 pandemic, emphasising the value in transitioning towards a circular economy.

Often associated with the R-imperatives of recycle, reuse, recover and repair, circular economy is considered an approach to support more appropriate waste management [6]. Yet, circular economy not only relates to material and/or energy recovery [RS], rather it extends to the entire living and economic model helping "society reach increased sustainability and well-being at low or no material, energy and environmental costs" [9].

Many institutions engage with the concept of circular economy, including, the United Nation Environment Programme (UNEP), the Organisation for Economic Cooperation and Development (OECD) and the Ellen McArthur foundation. These institutions have launched programmes and conducted research which provide insight into the benefits of a circular economy. The European Commission has promoted resource efficiency and the closure of material loops within its policy priorities - in 2015, the EU introduced its first Circular Economy Action Plan and adopted a new one (COM/2020/98) in March 2020, resulting in – among others – the ban on some single-use plastic. The basic goal of the Green Deal presented by the European Commission in 2019 is to "*transform the EU into a modern, **resource-efficient** and competitive economy, ensuring… economic growth decoupled from resource use*"[1], hence, circular economy is one of the central elements of it. The Green Deal – and its associated regulations – has created new goals, and stricter expectations, in material use at every scale.

Reducing waste production by eco-innovating longer-lasting products that can be repaired, recycled, and re-used is an important practice that supports a more circular economy. However, the introduction (or transfer) of eco-innovative solutions cannot occur without understanding the socio-cultural and governance context in which these solutions are to be implemented. The transfer of (best) practices from "place A" to "place B" may lead to suboptimal outcomes due to the different place-specific characteristics, including cultural, institutional, legislative or governance differences [10], with this hampering the achievement of an efficient circular transition[2]. Insights from SSH research can support the understanding of these place-specific characteristics to support the transition to a circular economy transition.

This literature brief provides an introductory overview of the circular economy concept, drawing upon a selection of SSH literature and insights from two expert interviews. Focus is placed on the importance of considering governance and socio-cultural differences when transitioning to a circular economy.

1 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

2 A bad example can be seen in Varjú and colleagues' work who argue that centralised governance arrangement hampers the local (secondary) resource use, resulting in a negative impact on the environment [11].

Current Understandings

Significant Findings to Date

The sustainability movement has received increased attention, in part due to increasing awareness of the damage to the natural environment, the limitation of growth and carrying capacity. Alongside the concepts of green economy and blue economy, circular economy has received a large amount of policy attention in the past decade. **Circular economy attracts great interest from scholars, practitioners, and business as it is seen as a novel opportunity for creating new business models [4]**. The efficient use of natural resources and the process of transition from a linear to a circular economy – as an alternative to the dominant economic development model [9] – became at the forefront after the financial crisis of 2008 [12] resulting in the creation of action plans in the European Commission.

Using product case studies and an economy-wide analysis, an Ellen Macarthur Foundation report outlined the potential benefits of transitioning to a circular economy. The report highlighted how a subset of the EU manufacturing sector could realise net materials cost savings worth up to US$630 billion per annum by 2025—stimulating economic activity in the areas of product development, remanufacturing, and refurbishment [13].

Transitioning to a circular economy would not only bring savings, but also reduce the negative impact on the natural environment, however, the shift is challenging [14]. To transform a business, there is the need to redesign the use of materials and energy and to change the current sales model[3]. There is also the need to adopt system thinking [15].

Many advantages of the transition to a circular economy can be identified through indicators. For example, the decoupling of economic output and the use of resources. However, **the development of indicators that measure and monitor circular economy is challenging, with a range of stakeholders developing indicators to assess progress towards circularity**. The European Academies' Science Advisory Council (EASAC) listed several circular economy related indicators, such as material flow analysis, societal behaviour, and economic performance [16]. Reflecting the indicators established, an aspect of circular economy research focuses on the topic of resource productivity. Resource productivity shows the effectiveness with which an economy, or a production process, is using natural resources and it reflects the output, or added value generated, per unit of used resources [16].

Increasingly circular economy research is focused on micro and meso levels [18], with this revealing the characteristics of material flows in more detail. Undertaking research at these finer-grained levels is important as this **research not only focuses on technological aspects and questions of material scarcity, but also on the governance process showing that management, political aspects and local legislation can have a significant impact on circular transition** [RS]. This highlights where the SSH disciplines have a role to play.

3 A shift from selling volumes of products towards selling services and retrieving products after first life from customers [17]

Emerging Practices

In transitioning to a circular economy, the first step in building new business models is usually the creation and integration of new eco-innovative solutions into company production. This can happen when, for example, a company producing PET bottles creates a bottle made exclusively of one type of plastic. These types of innovations will be followed when the company gradually transforms its entire management system and all its processes into circular ones. However, this takes a long time.

Eco-innovations need to cross the borders between policy sectors and bundles of industry. Based on the theory of transition management, socio-technical transitions – such as the circular transition – need strategic, tactical, operational, and reflexive activities [19].

The results of EU-supported research (e.g., H2020) typically include the latest research results representing the state-of-the-art. In the H2020 EU research call relating to circular economy (H2020-WASTE-2014-2015[4]), it was not only STEM-related innovation projects that were tendered, but the EU also called for SSH related research and innovation action. For example, the H2020 REPAiR project explored and classified the governance barriers for transition experienced by the Amsterdam Metropolitan Area (AMA), with this providing lessons for policy. As the results shows, **what is challenging in the circular economy transition is the need for "all hands-on deck" to close the loop. It means, that to implement a strategical change, there is the need for multiple stakeholders including local government, sectoral institutions (e.g., waste management, water management, energy producers), NGOs, and citizens, to engage with, and participate in, actions**. The analysed AMA case illustrated "the complexity of this regional challenge and the need for an extensive cross-sectoral, cross-scale and cross-boundary partnership to agree on shared strategic, tactical and operational goals and means" [19, p. 26].

Different indicators of circularity can indicate how well the circular economy concept is applied. However, **most of the published indicators do not represent the systemic and multidisciplinary nature of a circular economy** [20]. Indicators are either material-focused (e.g., Domestic Material Consumption) and approached from the side of economics (e.g., Resource Productivity) [16], or they take environmental effects into account (e.g., Life Cycle Assessment). As such, this research typically bypasses the peculiarities of circularity and the multidimensional aspect of sustainability (i.e., environmental, economic and social aspects) [18]. One of the outputs of the H2020 REPAiR project[5] is the elaboration of a complex indicator system to assess the shift of a city or city region towards circularity. This concept (that assesses cities transition towards circular economy) is not focusing – for instance – on the concrete composition of material flows but, on the decision supporting processes going on in the cities. This measurement tool (or indicator system) includes five main indicators (and sub indicators within them) - governance, the tools in use, the awareness, the use of sustainability assessment and the built environment. These five indicators show important elements of an enabling environment for the circular transition.

4 H2020-WASTE-2014-2015
5 https://h2020repair.eu/

The H2020 research FORCE[6] aimed at evaluating tools and instruments for citizen involvement and engagement, providing recommendations of good practices in municipal waste management and circular economy in four European cities. The evaluation framework of the project assessed the process of citizen involvement, focusing on strategic planning, inclusivity, transparency, continuity, and resources dedicated as five key elements of waste management and circular economy. The research showed that not all of the analysed cities applied these five elements to the same extent. The reasons for the variation between cities included a lack of a strategic plan for citizen engagement activities, and the limited personal and financial resources of citizens [21].

Geofluxus[7], a spin-off company of a TU Delft led H2020 project, is a good example of the SSH-STEM interface. Geofluxus is a sustainability-driven tech company, which collects and visualises material flows for city regions and for companies. By monitoring and visualising the resource flows of cities and companies, Geofluxus can identify ways to reduce the demand for resources to the point where consumption and regeneration happens. The company combines knowledge and methods coming from multiple disciplines within a single platform. Data visualisation can support the decision making of businesses and local governments towards a circular economy.

Future SSH Priorities

Circular economy, as a new business model requires balanced and simultaneous consideration of economic, environmental, technological, and social aspects [9, 22]. An SSH-STEM collaboration, the Interreg HUHR CBC RURES[8] project focused on the geographical, technological, economic and social potentials of renewable energy and energy efficiency. The research showed – as also emphasised by [RS] – that attitude, and especially pro-environmental (or pro-circular economy) behaviour, is essential to shift towards a circular society [23]. **It is also important to analyse why the current economy is linear and not willing to use circular strategies [RS] or is not willing to adopt new eco-innovative solutions** [10]. There is the need to consider both the personal and geopolitical level when transitioning to a circular economy, taking into account several dimensions, like distrust, safe or high-quality materials [RS].

Many companies are, by nature, profit-oriented. As such, these companies carry out activities and use materials that are cheap - currently, these cheaper materials are fossil fuels and virgin materials, with recycled materials being more expensive. Therefore, attitude formation in companies will not achieve resounding success. **Regulation from above is necessary in order to prioritise recycled materials, with the role of policy makers, regulation makers, lawyers essential in this process** [24].

The H2020 REPAiR project also had another impact, namely on education. TU Delft has launched several paid courses related to the circular economy. Some teach students how to contribute to a sustainable economic system by implement-

6 FORCE project
7 https://www.geofluxus.com/
8 https://programme2014-20.interreg-central.eu/Content.Node/RURES.html

ing novel business and design approaches[9]. Another course is for those working in spatial development and teaches how to use appropriate tools to develop spatial strategies, plans and actions to support the transition towards circularity of a city or region[10]. In other countries, Bachelor and Master programmes have just started training people not only in circular engineering or in material flow analysis, but in economics and management studies as well. Training for decision makers in government sector is considered essential as well as they do not have enough information about circular economy [KN].

Takeaways

Takeaways for the European Commission

- Circular economy has to be focused not only on material or energy recovery, but it has to improve the entire living and economic model helping society reach increased sustainability and wellbeing at low or no material, energy and environmental costs.
- Emphasising proper tools (financial and personal capacities) for citizen engagement can help circular economy transition. Integration of citizen engagement as a must in all types of EU funding can be an important step.
- Multidisciplinary, SSH-STEM cooperation should be facilitated through funding calls. The insights from this research can support decision-making processes.
- Transition towards circularity, resource efficiency can also stimulate economic activity in the areas of eco-innovative product development, remanufacturing, and refurbishment.

Emerging Practices Takeaways for Stakeholders and Businesses

- There is a need for visualisation of the current material flows in order to support decision-making and to find the best ways shifting a society towards circularity.
- Complex indicator system should be used (by decision makers) to understand better the complexity of circular transition. Transition does not only depend on change of material use but on proper governance processes, but also on the use of proper decision-supporting tools.
- Instead of only focusing on circular products in business sector, there is a need for redesign the use of materials and the energy, the change of sales model, but what is the most important is the system thinking. Converting a business from linear to circular, business can realise net materials cost savings. Small scale research is important, as this can show the processes in more detail.
- Circular economy education for local decision makers is essential to ensure they understand its meaning and incorporate the concept into both policy and practice. Visualisation (based on SSH-STEM cooperation) makes easier the decision making on all scales.

Takeaways for the SSH CENTRE project

- Interdisciplinary understandings of circular economy can be developed through the collaborative projects contributing to the WP2 books. SSH-STEM cooperation can provide new decision-supporting tools.
- For circular economy transition, there is an essential need for understanding local communities, their trust, believes and values [25].
- Research has to focus not only on the technological aspects and material scarcity but on the governance, process showing that management, political aspects or local legislation can have significant impact on circular transition. These ideas can be explored in the knowledge brokerage projects undertaken as part of WP3.

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The Digitalisation of Mobility: Insights from the Social Sciences & Humanities on impacts and innovation

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ABSTRACT

Social Sciences and Humanities (SSH) can play an important role in investigating the impact of digitalisation on the mobility system. While digitalisation has led to the development of new, innovative mobility and logistics services there is an increasing divide between the digital capabilities of many people and the skills that new services require. Emerging methods and approaches developed within SSH can help to bridge this gap by fostering user involvement in development of services and developing tools to assess user needs, assess inclusiveness, and provide recommendations.

SUMMARY/HEADLINES

- This literature brief focuses on the role of Social Sciences and Humanities (SSH) in investigating how the digitalisation of mobility impacts people.
- Digitalisation has led to the development of new, innovative mobility and logistics services and the accelerated transformation of existing services.
- There is an increasing divide between the digital capabilities of large population groups and the requirements that new applications, services, and interfaces impose on them.
- Social Sciences and Humanities (SSH) can help to bridge the digital divide and accelerate the adoption of new mobility technologies.
- Recent EU-funded projects have established a set of tools and methods that can help to overcome the digital gap in mobility.
- Co-creation and co-design are possible approaches to include vulnerable people in the development of new mobility services.
- Research should, in the future, go beyond just identifying the need for digital inclusion, it should focus on additional aspects such as the impact of the digitalisation of mobility on sustainability, how bottom-up innovations can improve the mobility system and the human rights perspective.

KEY DEFINITIONS

Digital mobility services: Transport services that have a digital interface (smartphone app, website, ticket vending machine, information terminal) through which one or more parts of the travel process can be arranged (booking, payment, information, feedback).

Digital divide/digital inequality in transport: "How various levels of engagement with digital technologies in a given context affect access and navigation of transport services" [2, p. 34]

Community of practice: A group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly [4].

Introduction

Mobility communities are groups of individuals utilising particular modes of transport in particular places, and in particular ways. Within the literature brief, focus is placed on the role of digitalisation in mobility and the influence on mobility communities. The ways in which digitalisation provides opportunities for mobility practices, but also reduces the ability for different cross-sections of society to participate in (digital) mobility communities are discussed.

Mobility services are becoming increasingly digital. Some services (e.g., car sharing, shared e-scooters, public transport ticketing) are already exclusively accessible via a smartphone app or a website, with only electronic payment options. According to the Sustainable and Smart Mobility Strategy of the European Commission, digitalisation and automatisation are expected to make transport safer, more secure, more resilient, more comfortable, and more reliable [1]. Yet the strategy also recognises the threat of digital exclusion [1]. **Transport-related digital exclusion** occurs when people cannot access transport services which are exclusively accessible via a digital interface (e.g. app, website) because they lack the motivation, skills (such as being able to use a digital interface) or material access (including having access to a smartphone or computer) [2]not everyone is willing or able to follow the new, more or less formal requirements digitalisation has brought along. Existing reviews on the intersection between Information and Communication Technologies (ICTs. The strategy recognises that digitalisation should not create or reinforce digital exclusion, and mobility should be accessible for all. The European Commission therefore aims to ensure that the digital transition of mobility is socially fair and just using The European Pillar of Social Rights as a "compass" [1].

While the Horizon 2020 and Horizon Europe programmes have invested in research into the technological aspects of digitalisation and automatisation, research into the human and social aspects of these technological developments has been neglected [3]. Many questions can be raised about a potential digital gap in mobility. How does increasing digitalisation in transport affect people with limited digital skills or other vulnerabilities? What measures should be taken to avoid that digitalisation leads to social exclusion? How can stakeholders of the digital mobility ecosystem collaborate to develop inclusive and accessible digital mobility services? Addressing these questions requires research where SSH approaches are involved, or even take a leading role..

This literature brief focuses on recent research on the social aspects of the technological transformation of transport, and especially on accessibility and inclusivity in the context of digitalisation. It outlines the state of the art of how SSH approaches can address the digital mobility divide.

Current understandings

Significant Findings to Date

The current understanding of the implications of the digitalisation of the transport system on social life, justice and equity is still relatively limited. Research about digital literacy will be key in the introduction of new technologies such as autonomous vehicles and especially cooperative intelligent transport systems (C-ITS) [AB]. Although significant research has been carried out on the topics of transport equity, digitalisation, accessibility and inclusion [2, 5, 6, 7], **very limited research is available explaining the impact of digital transport services on people who are vulnerable to exclusion**. Over the last few years, researchers have voiced their concern about the lack of knowledge about the barriers people experience while interacting with the digital transport system and how these affect a person's mobility and their access to essential social activities [8, 9, 10, 11]. For example, Durand et al. [2] concluded that existing transport inequality, digital inequality and the increased digitalisation of the transport system come together to negatively impact accessibility and inclusivity of mobility.

Research should go beyond identifying the need for an intervention, such as why we need to address the topic of digital inclusion, to focus on how technology can lead to a better life for people [FdC]. The capabilities approach [12] offers a powerful theoretical framework to examine this aspect. This approach argues that everyone should enjoy a level of 'capabilities' which allow them to fulfil their needs and develop their lives [13]. Martinez and Keseru [14] proposed that the capabilities approach can provide a new way to appraise the inclusiveness of digital transport services by going beyond socio-technical considerations and acknowledging cultural factors. This approach recognises that individual characteristics of people such as gender, age, ethnicity, income, physical or cognitive impairments, education level and residential location are key factors in the adoption of digital mobility services. Nevertheless, it is very often the technology, (e.g., mobile connectivity) that is an overarching barrier to using digital mobility services even in cities [FdC]

Recently, the European Commission has also recognised digital exclusion as a possible side-effect of the digitalisation of the transport sector [15]. **Research has identified the need for a full understanding of the process that leads to digital transport services, i.e., the design, planning, implementation and operation of digital mobility services**. This process must be viewed from a multi-stakeholder point of view. The stakeholders of the digital transport system include developers, operators, policy makers, users and non-users [16]. An SSH-approach can help to bring the stakeholders into the research and development. On the other hand, there is a challenge that SSH researchers are usually not very experienced with technology [FdC].

Several research and innovation projects have been funded under the umbrella of the Horizon 2020 programme that address this issue. The Inclusive Digital Mobility Solutions (INDIMO)[1], the Digital Transport in and for Society (DIGNITY)[2] and Transport Innovation for Persons with Disabilities Needs Satisfaction (TRIPS)[3] projects improved our understanding of the users' needs and our knowledge about users' requirements towards the digital transport system.

The Dignity project found that people with low education levels, older people, people with disabilities are especially prone to digital exclusion in the transport context [17]. In the INDIMO project, human contact and assistance emerged as key requirements by people in vulnerable situation when using digital mobility services. [18]. The TRIPS project explored the potential of new digital transport technologies in improving accessibility for persons with disabilities. Their findings suggest that a real-time, interactive, accessible journey planner would motivate people with disabilities to travel and make their journey more independent, faster, easier and safer [19].

1 Project website: www.indimoproject.eu
2 Project website: https://www.dignity-project.eu
3 Project website: https://trips-project.eu/

Emerging Practices

Several tools have been developed that aim to assess the needs of vulnerable people, the current level of digital inclusion and propose strategies for the various stakeholders to enhance the design and operation of services.

The **INDIMO Inclusive Digital Mobility Toolbox4** was co-created with the participation of 72 stakeholders through a series of co-creation workshops and 64 communities of practice events related to the five INDIMO pilots in Madrid (Spain), Antwerp (Belgium), Berlin (Germany), Galilee (Israel) and Emilia-Romagna (Italy). This process is a good demonstration of how SSH and STEM researchers, policy makers and citizens can collaborate in developing concrete solutions (such as apps, software and services) as well as guidelines and strategies [20, 21] user involvement is vital for success. Especially critical is the inclusion of groups vulnerable to exclusion, so they can equally benefit from such services. In this respect, the Inclusive Digital Mobility Solutions (INDIMO. The toolbox supports developers and operators when designing accessible and inclusive mobility solutions by incentivising a user-centric thinking and offering a Universal Design perspective. **The online *INDIMO Service Evaluation Tool* supports policy makers to evaluate digital mobility solutions and services before their deployment in terms of compliance with the principles with inclusivity and accessibility principles** [16]. The toolbox that also addresses the STEM community, builds on the assessment of needs of vulnerable people through various SSH methods such as semi-structured interviews, qualitative content analysis and communities of practice workshops [16, 18, 21]but at the same time they have also created uneven impacts across society. It is, therefore, the goal of this paper to introduce the online Service and Policy Evaluation Tool (SPET.

The **DIGNITY Toolkit**[5] developed in the DIGNITY project provides a set of tools that help key public and private stakeholders to improve their understanding of the issues that those vulnerable to social exclusion face. The toolkit provides guidelines for methods such as surveys, focus groups, customer journey mapping and also includes a digital gap self-assessment tool, which assesses how the skills and practices of individuals, the market (i.e., the services offered by mobility service providers and the policies of local, regional and national governments) may cause digital gaps in mobility [22]. In order to bridge any potential gaps, the toolkit offers practice-based tools and methods such as the Inclusive Design Wheel [23].

Co-creation and co-design provide the opportunity to better involve vulnerable people in the design of digital mobility services and applications. According to Vasconcelos et al., [24]**,** however**,** a co-design process may also lead to many frictions between the diverse participants. They propose a set of coping mechanisms based on participant feedback to improve the co-design process, such as listening to the needs of the participants, nurturing local variation, integration of multiple methods into the co-design process, and letting people in vulnerable situation to set the agenda of the co-design process through an identity and vision document. Finding the participants of such process, keeping them motivated and developing a safe space for them is also challenging. Bulanowski et.al. [20] user involvement is vital for success. Especially critical is the inclusion of groups vulnerable to exclusion, so they can equally benefit from such services. In this respect, the Inclusive Digital Mobility Solutions (INDIMO offers some recommendations based on their experience with the co-creation process of the INDIMO toolkit, including strategies for recruitment, user engagement, and face-to-face interviews. Within these recommendations they stress the importance of a customised approach depending on the target group (e.g., which vulnerabilities) and the local cultural, social and demographic context (e.g., ensuring balanced distribution of participants by age and gender). Hueting et. al. [25] introduced a user-centric approach to design accessible user interfaces and icons for mobile applications that includes user evaluation, co-creation workshops and a user survey.

To ensure that the local context and stakeholders are involved in the co-creation process, so-called Communities of Practice (CoP) can be established including developers, operators, policy makers, researchers and users (vulnerable to exclusion) [21]. Communities of Practice are a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly [4]. These CoP's can provide a testing environment where new, inclusive features could be introduced to digital mobility services and tested. Secondly, and perhaps even more importantly, CoPs can provide a safe space for users to voice their concerns and for the other stakeholders to collect knowledge about user groups, interacting with them and co-creating features/recommendations that have a positive effect on the inclusivity and accessibility of a digital transport service [21].

Future SSH priorities

The need for an inclusive digital transport system cannot be understated, as its effect on the mobility of people vulnerable to exclusion may severely impact their potential to participate in social activities. Although initial research has been conducted, with promising results, there are still several questions that are unanswered.

While previous and ongoing research has explored the needs of vulnerable people towards digital mobility services, **it is still unclear how policies and regulatory frameworks could ensure that existing and new digital mobility services are more inclusive and accessible**.

Co-creation and co-design have been found promising approaches to include vulnerable people in the design process of digital mobility services. **It is, however, still unclear how co-creation and co-design can embrace the local specific context,** i.e., the diverse needs of different groups in vulnerable situation, differences in cultural expectations and in policy frameworks.

Since the digital mobility ecosystem includes multiple stakeholders (including developers, operators, policy makers, and citizens), more inclusive and accessible services can only be developed through better collaboration. Therefore, **new ways of stakeholder engagement are needed, that focus on developing a way to match user needs, business priorities and policy objectives**.

There is the need to consider digital inclusion in transport in the context of frugal innovation, i.e. innovations that use

4 Available at https://www.indimoproject.eu/indimo-digital-mobility-toolbox/

5 Available at https://dignity-toolkit.eu/

limited financial, technological, material or other resources but the outcome serves the basic needs of the target groups [26] [FdC].

Gender is an emerging topic in research about digital mobility. Transport is traditionally male-oriented both for the development of the infrastructure (roads), vehicles (car engineers) and software (IT engineers). Nevertheless, gender should not be considered in isolation, but as part of the overall concept of inclusiveness [AB].

Digital inclusion is also related to overall sustainability as digital services use a lot of energy. Devices such as smartphones contribute to pollution due to their rapid obsolescence and their production is often linked to exploitation of people in developing countries. Therefore, the human rights perspective is also important to investigate [FdC].

Overall, it is expected that additional SSH research in the inclusivity and accessibility of digital transport services will have a positive effect on people's access to social activities, it will support the shift to multimodal travel, and it will have a positive impact on carbon emissions, air quality and liveability in general.

Takeaways

Takeaways for the European Commission

- Funding needs to be made available for research that focuses on the intersection between digitalisation and mobility, and not only in the context of high-impact technologies (such as autonomous vehicles) but also related to route planners, ticketing, shared mobility and e-commerce delivery services. Funding is also needed to conduct research focusing on the role of gender in digital exclusion in transport.
- Research on digital inclusion/exclusion should be extended to emerging economies, to account for the impacts of digitalisation on human rights, sustainability and bottom-up innovation.

Takeaways for Stakeholders and Businesses

- There is the need to foster a bottom-up, co-creation approach when planning and designing new mobility services, with this being supported through the provision of guidelines and training. Developers and operators of digital mobility services need easy-to-use guidelines with best practice examples to mainstream inclusivity and accessibility in software and service development.
- The communities of practice method should be embraced through trainings and demonstration of best practices to engage all stakeholders in the development of digital mobility solutions.
- There is the opportunity to provide testing grounds for new inclusive approaches by developing, and undertaking, pilots.

Takeaways for the SSH CENTRE project

- The digitalisation of mobility provides a good topic for the investigation of how SSH research can provide new insights into people's needs, requirements towards new technology and how collaborative research and innovation (e.g. through co-creation) can contribute to better outcomes. This can be incorporated into through the collaborative projects undertaken as part of "*WP2 Epistemic laboratories for the EU Green Deal*".

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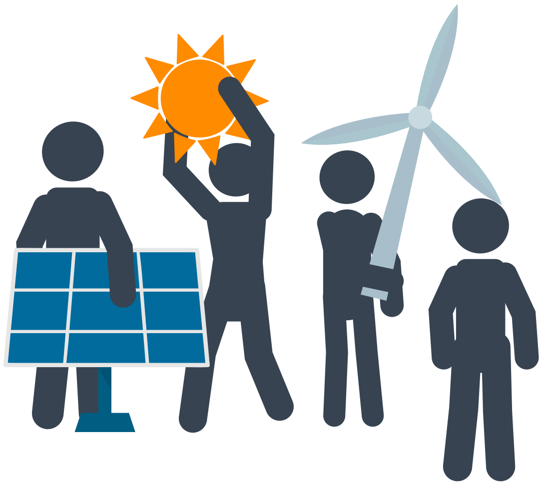
Energy Communities: Insights from the Social Sciences & Humanities on advantages and challenges



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ABSTRACT

Energy communities have the potential to play an important role in low-carbon transitions. There are multiple benefits associated with, and motivations for, participating and encouraging energy communities. However, there are also challenges associated with energy communities including how they are financed, their governance and who is able to participate. SSH research can provide insights to address these barriers and facilitate the development of energy communities.

SUMMARY

- Energy communities can support the achievement of the EU's climate ambitions.
- There are multiple benefits associated with energy communities, including developing contextualised energy systems and supporting the establishment of participatory energy systems.
- There are several challenges which need to be addressed, both at the individual and systemic level, to support the success of energy communities.
- Both Social Sciences & Humanities (SSH) and Science, Technology, Engineering & Mathematics (STEM) research is beneficial for energy communities, as there is the need to understand how technologies work as well as how individuals engage with technologies.
- Further research can provide insights to support the development of more inclusive approaches and support mechanisms for energy communities. Insights can help establish more flexible institutions and legislation, as well as understandings of how to translate knowledge between energy communities.

KEY DEFINITIONS

Energy communities: Collective groups of citizens who undertake actions to support the achievement of clean energy transitions [1].

Prosumers: Active participants in the energy system, either through self-generation (and consumption) of renewable energy, or through the provision of energy system services such as energy storage [2].

Introduction

Energy communities have been defined in the EU's 'Clean Energy for all Europeans' package [3], as well as in the Renewable Energy Directive and the Internal Electricity Market Directive [4,5]. Other EU initiatives acknowledge the potential for energy communities to achieve climate goals including the REPowerEU plan [6] and the Solar Energy Strategy [7].

Currently in the EU, there are over 7,700 energy communities which contribute up to 7% of nationally installed renewable capacity [8]. Energy communities tend to focus on generating environmental, economic, or social benefits rather than financial gains [9]. There are several opportunities associated with energy communities including energy efficiency improvements, reduced household bills and creation of local employment [1, 10]. One way in which individuals can participate in energy communities is through becoming a prosumer, whereby a group of individuals collectively comes together to generate (and consume) energy [11]. Although it is important to note that not all prosumers are part of an energy community.

The establishment of energy communities (including those involving prosumers) provides opportunities to empower citizens and supports the democratisation of energy [12]. However, there are also constraints regarding energy communities including how they are financed, their governance and who can participate [13].

Social Science and Humanities (SSH) research has considered the extent to which energy community opportunities are realised, the motivations for participation, the governance structures established, and the barriers experienced. Through SSH research, insights are developed which help identify actions to support the success of energy communities.

This literature brief summarises existing understandings of energy communities and highlights future opportunities for SSH research on the topic. The insights presented are informed by existing academic literature, recent research projects, and interviews conducted with two expert academics[1].

Current Understandings

Significant Findings to Date

A range of research has been conducted on the topic of energy communities (including prosumers), including identifying their advantages, motivations, and challenges. Existing research is situated at different scales and considers both systemic and individual opportunities and constraints related to energy communities.

Energy communities can support the achievement of low-carbon futures [14,15]. An advantage of energy communities is their localised and contextualised nature. **The practices and technologies of an energy community reflect the particular opportunities (and addresses the specific challenges) of the context in which they are situated** [16]. Context (including affluence and social norms) influences the establishment of energy communities, as shown through the geographically varied spread of energy communities globally [17]. Energy communities can also **support the establishment of more participatory energy systems** through the diffusion of power and responsibility [14,16]. These shifting power relations can facilitate social cohesion and collective action [18], as individuals are able to develop connections through the establishment of energy communities (JB). The sense of connection between individuals, and creation of a collective ambition, can make individuals feel as if they are actively contributing to the energy transition, with this motivating participation [18].

Research has considered individuals' motivations for establishing and engaging with energy communities, identifying economic, environmental and social motivations [19]. Individuals who participate in energy communities as a prosumer can benefit economically by selling excess generation back to the grid [2]. Environmental motivations include addressing climate change by establishing more sustainable societies and low-carbon energy systems [16], whilst social motivations include wanting to feel part of the local community [10], sense of ownership and energy independence [20].

However, there are barriers which affect the establishment of and participation in energy communities [21, 15]. These barriers materialise at both the scale of individuals and more systemically.

Participation in energy communities, particularly as a prosumer, requires individuals to have certain resources including access to finance, knowledge, skills, time, and a willingness to take certain risks [22, 10]. Consequently, it is typically more affluent communities and landowners that participate in energy communities [10]. **The varied ability for individuals to participate in energy communities can exacerbate existing socio-economic divides.** For instance, research shows that households unable to afford the installation of domestic Solar PV panels are facing increased energy bills as they are covering the grid maintenance costs of prosumers (that are less dependent on the grid) [23]. There is a need to ensure that energy communities do not impose burdens on those who do not participate in them [15], and that additional support is available to support participation of individuals that currently lack the means to [24].

The EU Horizon 2020 PROSEU[2] project considered the characteristics of prosumers, and incentive structures required to support the mainstreaming of prosumer practices [25]. The project worked across seven European countries to understand the motivations behind establishing energy communities. The project presented recommendations for establishing energy communities, including supporting the practices of individuals and addressing more systemic challenges. **Enabling balanced involvement of all actors, increasing local acceptance, digitalising the energy system, creating space for innovations, and simplifying system integration of prosumers are recommended to support the establishment of energy communities.**

Considering more systemic challenges, **current infrastructures, institutions, and regulatory frameworks can act as obstacles to the development of energy communities.** These systemic challenges can emerge through different 'lock-ins', whereby decisions are made which commit society to certain configurations of technologies and practices. For example, techno-economic lock-in (whereby technologies are introduced into and supported by particular market practices), social and cognitive lock-in (capturing how individuals know how to use and have certain expectations of technologies as well as established social norms and practices), and institutional and political lock-in (rules and regulations have been developed which reflect the current technologies and

1 Interview contributions to the literature brief are indicated through bracketed initials

2 https://proseu.eu/

social practices) affect the development of energy communities [26, 27].

The lock-in of infrastructures, institutions, regulations, and social norms can reinforce existing power dynamics as they align with the interests of currently powerful incumbents [28]. Centralised grid systems, such as the UK's national grid, are an example of lock-in which affects the development of energy communities. Infrastructures, institutions, and regulatory frameworks have co-evolved alongside the centralised energy system that is composed of a smaller number of large power plants. As such, the current infrastructural and institutional configuration does not align with or reflect the needs of a more decentralised system that includes a larger amount of smaller generating technologies such as renewables and energy community practices [29]. Policy-making decisions also influence the actions undertaken and can lock-in certain practices. As an example, UK policy has shifted focus from community energy to local energy with this contributing to the support of institutional partnerships and company-led investments rather than grassroots, citizen-led action [30].

Emerging Practices

Research is being undertaken to help identify 'best practices' to support the establishment and operation of energy communities, integrating different perspectives from both SSH and STEM disciplines.

Despite a common conception that SSH and STEM research is conducted in silos [25], there are examples of energy communities research being conducted which brings together different disciplines and their understandings (IC). For example, the ScotCLUE[3] project combines modelling techniques and stakeholder engagement activities to support the design, coordination, and implementation of smart local energy communities [31]. **Energy community research benefits from interdisciplinary collaborations as the technical optimisation of energy systems requires consideration of how people interact with these systems, and the governance of energy communities requires understanding of technology installations** (IC). There is a need to support further integration between the disciplines to truly support energy communities and prosumer practices (IC, JB).

There are multiple barriers to the development of, and participation in, energy communities, including a lack of access to resources, finance and knowledge [32]. These barriers are more pronounced for some cross-sections of society, often due to broader societal structural inequalities. Research has acknowledged the impact of these (systemic) issues, with efforts undertaken to accommodate varied experiences to support participation.

Research is identifying ways to support the participation of different socio-cultural groups in energy communities, providing practical resources and alternative approaches. For example, the EU H2020 W4RES project[4] focuses on gender and localised energy generation [33]. Drawing upon eight case studies in eight European countries, the project has identified actions to support the participation of women in localised energy. Recommended actions include business advice and training, gender-based hiring quotas, dedicated promotional events and encouraging women to pursue an education in STEM disciplines [33].

Methodologically, pilots and living labs have been used within SSH research to understand the experiences of energy communities. **By analysing energy community models and practices within the context of a living lab it provides insight into what works and what does not work from a practical perspective (IC).** The EU H2020 funded NEWCOMERS[5] project focuses on ten energy community case studies in six European countries, identifying practical recommendations on how they can be supported. When developing these recommendations, consideration was given to regulatory, institutional, and social conditions [34]. Based upon this research, it highlights the need to consider technological components, social aspects, and governance mechanisms to support local energy initiatives.

The Energy Communities Repository is a European Commission initiative which supports the development of energy communities by sharing resources related to 1) data collection and analysis, 2) technical assistance, and 3) best practices [35]. **The intention of the Energy Communities Repository is to assist local actors with setting up and advancing clean energy projects driven by energy communities [35].**

Future SSH Priorities

Considering the potential role of energy communities and prosumers to support low-carbon transitions, and building on current understandings of the topic and emerging practices, this section outlines further areas of inquiry.

Future research needs to better understand how barriers and systemic challenges manifest and affect the development of energy communities in order to overcome them. SSH research supports knowledge sharing and facilitates different experiences to be considered when developing energy communities. **Insights developed through SSH research can support the development of approaches and support systems that acknowledge, and overcome, the barriers and challenges identified.**

Furthermore, there is the opportunity to learn from experiences of implementing policies, particularly with reference to how policies are experienced by target audiences (IC). These understandings can be drawn upon to support the development of energy communities. Future work on energy communities and prosumers could consider how a space for reflection could be incorporated into implementation processes. **By incorporating reflection during the implementation processes, particularly if different characteristics are considered, it may support the development of more inclusive and flexible environments for energy communities that support participation.**

When developing energy communities, future research needs to consider how actions undertaken at the local scale are influenced by other actors and institutions situated at other scales. As such, **there is the need to (1) understand how to encourage engagement, (2) establish the resources required to facilitate progress, and (3) identify stakeholders that can support processes related to the establishment of energy communities and prosumer practices**. The identification of support and resources needs to extend beyond the individual to consider systemic obstacles to engagement

3 https://ore.catapult.org.uk/stories/clue/
4 https://w4res.eu/
5 https://www.newcomersh2020.eu/

and participation. As such, there is the need to move beyond planning for energy communities and promoting them to providing the support and resources required to implement them.

Takeaways

Takeaways for the European Commission

- In seeking to promote energy communities, support measures need to be available, not only from a financial perspective but also capacity building and the development of enabling environments with supportive actors (such as municipalities).
- Further research on energy communities and prosumer practices can provide applied insights on how to support and encourage participation in these localised energy configurations. For example, funding calls could be developed which cover topics such as gender in energy communities, or political systems and energy communities.
- There is the opportunity to incorporate reflection on the implementation processes when developing new policy and regulations. By bringing in reflections, policy can adapt to different conditions, which in turn creates a more flexible environment that may increase participation.

Takeaways for Stakeholders and Businesses

- The establishment and operation of energy communities requires individuals to have equal opportunities to participate. There is the opportunity for those with appropriate resource and capacity to provide support, such as alternative finance and training.
- Information about how individuals can participate in energy communities, including details on how to engage with technologies and administrative processes, needs to be accessible. A national contact point where expertise is bundled could be established.

Takeaways for the SSH CENTRE project

- Collaboration between SSH and STEM researchers is beneficial for developing understanding of energy communities. SSH CENTRE can support this collaboration through "*WP2 Epistemic laboratories for the EU Green Deal*".
- Engaging with different stakeholders provides opportunities to understand how they can support the development of energy communities. For example, the engagement with EU policy stakeholders in "*WP4 Citizen engagement strategies for Horizon Europe policy communities*" could provide useful insights.
- The presentation of results and outcomes can increase engagement with and support for energy communities. Presenting results from the SSH CENTRE project in such a way could improve stakeholder engagement with the project's outputs ("*WP6 Dissemination, Communication and Exploitation*").

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