



Delft University of Technology

Collective action lessons for the energy transition learning from social movements of the past

Pearce, B.J.; Djinlev, Vanja

DOI

[10.1007/s11625-023-01455-5](https://doi.org/10.1007/s11625-023-01455-5)

Publication date

2024

Document Version

Final published version

Published in

Sustainability Science

Citation (APA)

Pearce, B. J., & Djinlev, V. (2024). Collective action lessons for the energy transition: learning from social movements of the past. *Sustainability Science*, 19(3), 847-863. <https://doi.org/10.1007/s11625-023-01455-5>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.



Collective action lessons for the energy transition: learning from social movements of the past

Vanja Djinlev¹  · BinBin J. Pearce²

Received: 30 March 2023 / Accepted: 14 December 2023
© The Author(s) 2024

Abstract

To accelerate the energy transition and achieve the needed large-scale transformation to address climate change, different barriers including lock-ins and path dependencies, incumbent power structures and changing individual and collective norms, values, and behaviors around energy need to be addressed. In the face of these challenges, citizens are beginning to play a bigger role in the transformation of the energy system. For example, they are becoming prosumers (energy consumers who also produce energy) and are increasingly engaging in collective energy actions, including taking part in energy communities. In the latter instance, collective investment and consumption decisions are made together, and norms, understanding and behavior towards energy are shaped collectively. To better understand the roles that individuals and groups can play in confronting the challenges of the energy transition, we make use of and adapt Ostrom's socio-ecological systems (SES) framework to analyze past examples of collective actions and to delve deeper into the causes and catalysts of collective actions. We show how this framework can be used to analyze collective actions across time and contexts, focusing on connecting individual and group behavior with changing societal norms and the corresponding barriers to change. By applying the adapted SES framework as a lens to analyze historical examples of collective actions that have resulted in a widespread transformation in social norms and structures, we identify similarities and differences between these case studies and the current energy transition. Confronting incumbents and the challenge of changing social norms and behaviors are among the similarities, but the specific tactics used to limit incumbents' powers and the actions taken to influence the norms and behaviors differ. Lastly, we determine the key actors that influenced social and behavioral change, as one of the main outcomes of the analysis.

Keywords Energy transition · Collective actions · Barriers · Large-scale behavioral change · Societal transformation · Social–ecological systems

Introduction

The energy transition is driven by the growing global threat of climate change. Reacting to the current climate change-related events, governments are taking proactive steps to

safe-proof societies from future threats and make their countries more resilient. Accelerating the energy transition is seen as a means for decreasing future climate change-related risks (Thomas et al. 2022; Gielen et al. 2019; Creutzig et al. 2014). However, the energy transition will entail large-scale transformations across different societal systems that will go beyond the adoption of renewable energy technologies and will force governments to confront the implementation gap between top-down policies and bottom-up actions. To successfully grasp the complexities and provide insight in the on-going energy transition, there is a need for a diversity of disciplinary approaches (Cherp et al. 2018). This diversity will also help in determining the variety of barriers for the energy transition, including lock-ins and path dependencies (Nordensvärd and Urban 2015) and incumbent sources of power (Matschoss and Heiskanen 2018), to name a few.

Handled by Thomas Bauwens, Rotterdam School of Management, Netherlands.

✉ Vanja Djinlev
vanja.djinlev@usys.ethz.ch

BinBin J. Pearce
B.J.Pearce-1@tudelft.nl

¹ Transdisciplinarity Lab (TdLab), ETH Zurich, Universitätstrasse 16, 8092 Zurich, Switzerland

² Policy Analysis, TPM, TU Delft, Delft, The Netherlands

Due to technological innovations, new decentralized forms of energy production and governance started to appear. These new forms are backed by legislation that fosters citizen engagement in the electricity system. In Europe, the renewable energy directive (REDII) and the electricity market directive (EMD) are the legal frameworks that support citizen energy communities (CECs) and renewable energy communities (RECs) (Bielig et al. 2022). The new decentralized forms ultimately empower new, local actors, who directly oppose the established *modus operandi* and those who benefit most from the status quo (Blanchet 2015). In line with this empowerment, the concepts of energy democracy and energy citizenship take center-stage. Both concepts are closely linked to the energy transition research. Energy citizenship for example, focuses on ensuring different manifestations of active forms of participation within energy systems (Dunphy and Lennon 2022).

Increasingly, individual consumers are expected to play a greater part in the energy system, taking an active role in producing and consuming energy instead of keeping the passive role they have in the current system (Wahlund and Palm 2022). The role of an active prosumer (individuals being able to produce and consume energy) is increasingly visible, but their number and influence on reorganizing and restructuring the energy system to support the energy transition is still limited. In addition to adhering to this prosumerism, individuals may take on yet more active roles, by forming energy communities as well as other forms of collective actions within the energy system (Shortall et al. 2022). As promising models to implement the energy transition, these collective energy actions are becoming more popular, gaining both public and policy support (Bauwens et al. 2022). They are regarded as grassroots innovations that increase the uptake of new technologies such as renewable energy technologies (Korjonen-Kuusipuro et al. 2017) and serve as a “more inclusive form of strategic green niche development beyond the conventional scope of formal policies and markets” (Sengers et al. 2019).

Considering the new forms of citizen-led activities in the energy transition, understanding the role and impact that individuals and collectives may play for realizing the energy transition is imperative. For this reason, the main goal of this paper is to provide a better understanding of the role of collective actions in creating a social tipping point towards changing individual and collective norms, values, beliefs, and behaviors along with a potential to influence and change political systems, economic structures, institutions, and power relations by turning to historical cases of collective actions. As the energy transition is currently underway, past examples of systemic change may offer rich material and insights. Thus, we ask how learnings from past examples of collective actions might lead to better understanding of the current challenges of the energy transition. To reach

the goal, this paper will attempt to answer the following question: how can we pinpoint key factors of past collective actions that have led to large-scale transformation, requiring changes in individual and collective norms, behavior, institutional and policy change? Based on these insights, we will discuss the implications of these past collective actions to support the current energy transition.

The outline of this paper is as follows. In the literature review part, in “Complexities of and barriers to the energy transition”, we start by positioning this research in relation to existing literature about the social dimension of the energy transition. In “Energy democracy, citizenship, and (collective) citizen participation in the energy transition”, we provide an overview of the energy democracy and citizenship concepts, along with a bottom-up perspective of citizen participation in the energy transition. In “Social tipping points and diffusers of change”, we connect the effects of bottom-up activities and top-down legislation changes through the concept of social tipping points and the associated mechanisms of change. To understand the role of individuals and collective actions in initiating and bringing about large-scale transformation by analyzing past examples, in “Analytical framework: the SES framework”, we adapt the well-known interdisciplinary social–ecological systems (SES) framework. We explain the methodology in “Methodology” and present the results in “Results”. In “Discussion and implications”, we make connections between the findings from the past collective action cases and the barriers of the current energy transition. We outline the limitations of this research in “Limitations”, and we conclude in “Conclusion”.

Literature review

Complexities of and barriers to the energy transition

To understand the complexities of large-scale transformations, we consider transition research as a field of study that focuses on the process of change of complex societal systems from one state to another. One of the most prominent theories relating to the socio-technical perspective in understanding these changes is the multi-level perspective (MLP) (Geels 2002). MLP details the interplay between regime structures, niches as protected spaces for innovation and the landscape exerting pressure on the regime structures and niches over time. Another perspective that positions technological innovations as drivers for transitions is the technological innovations systems (TIS) framework, proposed by Bergek et al. (2008). Both MLP and TIS focus strongly on the technological aspects of transitions with the issues of power and agency in the background. To complement this approach, Loorbach et al. (2017) have defined the

socio-institutional transition approach as a way to “identify the institutionalized cultures, structures, and practices as regimes in which transitional change takes place”. This approach places a greater emphasis on issues of power, politics and the public’s acceptance of the related issues at hand (Fraune and Knodt 2018) and thus enables the exploration of the role of agency, governance, and power associated with incumbents.

When discussing the energy transition as a large-scale societal change, we refer to the “radical, structural change of a societal (sub)system that is the result of a coevolution of economic, cultural, technological, ecological, and institutional developments at different scale levels” as defined by Rotmans and Loorbach (2009, p. 185). In line with the complexities of large-scale transformations, we adopt the definition by Grubler et al. (2016) when referring to the energy transition, and we consider the transition to include the change of the state of the energy system, rather than a change in fuel sources or technologies. In essence, the energy transition entails multiple interrelated change processes across many regions, with varying paces and synchronicities (Markard 2018). Studying large-scale changes within and across (sub)systems reveals the involvement and interaction of different actors, and the resulting changes in institutions, technologies and values (Holtz et al. 2015). Thus, the current energy transition has elements of both socio-technical and socio-institutional perspectives, as it represents a large-scale, complex and multifaceted transformation that requires coordinated efforts at local, national, and international levels.

According to Simoens et al. (2022) there are two main barriers for the energy transition. First, the concept of ‘lock-in’ has been extensively used to describe the continuous reliance of industrial economies on fossil fuels systems, as they are essentially locked to carbon-intensive energy systems and technologies (Unruh 2000). Such incumbent systems are not necessarily better than new entrants, but they are more powerful as they are more diffused and do not face entry costs. Therefore, “lock-in mechanisms are conceptualized as mechanisms, which reinforce a certain pathway of economic, technological, industrial and institutional development and can lead to path-dependency” (Klitkou et al. 2015). To successfully counteract the consequences of these concepts, simultaneous alterations of all system levels are needed, meaning that “one must alter technologies, political and legal regulations, economies of scale and price signals, and social attitudes and values together” (Sovacool 2016).

The dominating power of incumbents in retaining the current system and avoiding sunk costs and stranded assets is seen as one of the greatest barriers of the energy transition (Geels 2014; Haukkala 2015; Lockwood et al. 2020; Firdaus and Mori 2023). Such incumbent actors dominate the discourse around the transition and frame it around financial

and technical risk (Moss et al. 2015), influence its pace and direction and promote the ‘greening’ of the current fossil-based system instead of radically departing away from it (Bosman et al. 2014). Turnheim and Geels (2012) show that political, social and cultural factors play crucial roles in pressuring incumbents, while the technical and economic pressures have a lesser effect when dealing with this barrier. For example, market reforms and regime transformations as political pressures are far more effective than supply and demand reduction, market contractions and cheap alternatives as economic pressures.

Another barrier of the energy transition is the need for changing the norms, behaviors and understandings around the supply and use of energy. As new decentralized forms of governance and energy production increase their presence in the system, people’s access to intermittent renewable energy sources and associated technologies increases. This in turn relates to a need for changing individual behaviors to ensure the technical stability and security of the energy system in terms of supply and demand. More specifically, the presence of intermittent sources entails changes in the way we interact with the system. Steg et al. (2015) argue for the need to shift energy use in time to balance the demand and supply in the new system, while at the same time investing in energy efficient buildings and appliances. Moreover, to succeed in the energy transition, people’s perceptions and norms around energy need to change (Komendantova 2021), as well as their choices, preferences and behaviors (Steg et al. 2018). An example of a moral norm would be ‘to support the use of renewable energy sources as a climate change mitigation option’ (Komendantova 2021).

The transition literature, and the focus on issues within the energy transition as a particular subset of this literature, takes often a top-down perspective of how large-scale change might unfold. However, to understand the role of individuals and groups in fostering such changes, a bottom-up perspective needs to be provided. Related with the current energy transition, particular focus on the role of the individuals and collectives in speeding up the energy transition needs to be provided, which is where the concepts of energy democracy and energy citizenship come into play, as explained in the next subsection.

Energy democracy, citizenship, and (collective) citizen participation in the energy transition

As the role of individuals and collectives in the energy transition becomes recognized and even supported from a policy perspective such as through EU’s renewable energy directive (REDII) and the electricity market directive (EMD), the relationship between the individual and the system needs to be strongly considered and understood. The increased access to and interactions with new technologies leads to greater

citizens' participation and representation in the energy transition, aspects that are embedded in the concepts of energy democracy and energy citizenship. While the latter concept relates to the concept of environmental citizenship and broadly sees energy citizens as active rather than passive players in the energy system (van Veelen and van der Horst 2018), the main focus of energy democracy is “the participatory dimensions of democratic governance, with many arguing for a need to reform how decisions around energy are made” (ibid.). Both concepts promote the rights of individuals and groups to be included in the energy transition in a more active way, going beyond decision-making and including the share of benefits and obligations. However, Lennon et al. (2020) argue that the energy citizenship as a concept is largely open to interpretation, and discussions around it are centered on neoliberal discourses while ignoring issues of exclusion and inequality. Moreover, the energy citizenship concept includes tensions from individualizing the energy consumption problem, as it fails to grasp the range of social positions that the citizen consumer has and the ends for which the energy is consumed (Lennon et al. 2020). Contrary to the individualistic perspective of energy citizenship, the energy democracy literature focuses more on the collectivistic view of energy, its control and ownership (van Veelen and van der Horst 2018). Such collectivization of control and ownership of energy entails people coming and working together, but what would drive individuals towards such coordinated actions?

To understand individual motives for coordinated actions, we turn to collective action theories within the social psychology stream of literature. Two theories that link personal perception and belief to take part in collective actions are the self-efficacy and the collective efficacy theory. Self-efficacy is an individual's belief about their capability to do a certain task or to execute a course of action to achieve some result (Wang and Lin 2007). Collective efficacy is an individual's perception of a group's capability to perform a certain task (Watson et al. 2001). Furthermore, the collective (social) identity theory links individuals' identity with groups or communities, where collective identity is defined ‘as an individual's cognitive, moral, and emotional connection with a broader community, category, practice, or institution’ (Davis et al. 2019). While the efficacy theories link people's belief in the capability of the individual or the group as a reason behind the collective action, the social identity theory deals with individual's connection and belonging to a certain group or community as the reason for the collective action.

Turning to examples of collective actions within the energy transition, energy communities are one such form that is organized around energy, where the community owns and/or manages the energy technologies and/or collaborates across different energy production and consumption practices. Other forms include grassroots associations,

community energy initiatives, collective renewable energy prosumers, or citizen energy communities (Lupi et al. 2021). Additionally, protests and movements geared towards promoting or opposing energy projects can also be regarded as collective energy initiatives.

In essence, energy communities promote “cleaner and more sustainable electricity, energy autonomy and self-sufficiency, economizing own energy production and consumption, participating in the electricity market as a group, and revitalizing local economy” (Gui and MacGill 2018). Moreover, energy communities as collective citizen actions geared towards supporting the energy transition are formally recognized as strategic assets by European institutions, introduced under the Clean Energy Package (Boulanger et al. 2021).

On one hand, top-down policy changes have been considered crucial for the energy transition. On the other hand, bottom-up activities organized around a common goal have been recognized as indispensable assets that will speed up the ongoing energy transition. The combined effects of these two approaches yield the concept of social tipping points, as discussed in the next subsection.

Social tipping points and diffusers of change

Participation in energy communities entails a shift in the way people interact with the energy system as well as with each other. This leads to individual and collective changes around energy. Since the need for changing individual and collective norms and behaviors around energy is regarded as a barrier to the energy transition, we aim to explore the mechanisms behind such changes. For that reason, we consider the concept of social tipping points, which we broadly define as the results of the collective agency that citizens have when undertaking coordinated activities. We consider tipping points to be “points in dynamic systems, where a small change in the underlying elements or actors' behavior triggers an abrupt irreversible change in the social system of which outcome may be both negative and positive” (Juhola et al. 2022). Winkelmann et al. (2022) argue that “a social tipping element is a social system in which small changes in the system or its environment can lead to macroscopic changes”. Compared to climate/ecosystem tipping points which have been long discussed in the literature (Lenton 2011; Dakos et al. 2019), social tipping points differ in terms of the agency present, the mechanisms of change, the temporal and spatial scales in which it occurs, and the complexity of interaction between the natural and the social systems (Winkelmann et al. 2022). The work by Otto et al. (2020) showed that in certain regions, a combination of different actors (including civic organizations and NGOs) is key in influencing the social situation and bringing it towards the tipping status, while Nyborg et al. (2016) argue for the need

of diffusers (connected people in a social network) to spread a norm change to reach the tipping point.

Building on the role of initiators and diffusers to reach the tipping point, concepts from the management and organization sciences might provide insight into how behavior and norm changing activities within social networks can be initiated and steered. In particular, the quality and type of leadership has been identified as being imperative for overcoming initial barriers of change, along with addressing the resistances on the way of reaching the goals. One of the forms of leadership is called collective leadership, which can be defined as “a dynamic leadership process in which a defined leader, or set of leaders, selectively utilize skills and expertise within a network, effectively distributing elements of the leadership role as the situation or problem at hand requires” (Friedrich et al. 2009). Contrary to this leadership form is positional leadership, in which the leadership power is related with the power vested in the position (Grint 2005). This is most often seen in the political power that elected officials have as part of some governmental or public institution.

In this paper, we understand social tipping points to go beyond changing individual and collective norms, values and behaviors to include institutionalization of these changes for a tipping point to be reached in full. For that reason, when referring to social tipping points, we follow Juhola et al. (2022) definition of a social tipping point to be “a social process that involves drastic changes in both individual and collective behaviors, as well as in institutional settings. The latter can include changes in governance, legal and economic arrangements, as well as long-term effects on social norms and values”.

Analytical framework: the SES framework

To understand the role of individuals and collective actions in initiating and bringing about large-scale transformation, we use a framework that recognizes individuals and groups norms and behaviors, the role of leadership and governmental and non-governmental organizations as stakeholders in addressing the challenges, while situating the issue within a context described by political, social and economic factors. The chosen framework should also make use of theories from diverse fields of thought in order to collect a holistic selection of variables influencing individual and group behavior to better understand ‘how’ and ‘why’ different collective actions unfold in a given context.

We use Ostrom’s socio-ecological systems (SES) framework (Ostrom 2009) as a starting point. The SES framework builds on the Institutional Analysis and Development (IAD) framework (Ostrom 1990) as a means of understanding and comparing different instances in which actions or changes in

action by actors lead to certain outcomes. Originally focusing on the governance and management of common pool resources across the world, Kiser and Ostrom (1982) mapped the structure and dynamics of existing institutions formed around such resources. The IAD framework considers an institution as “a widely understood rule, norm, or strategy that creates incentives for behavior in repetitive situations” (Crawford and Ostrom 1995) and has been extensively applied for studying the collaboration and organization of people in managing common pool resources (Imperial and Yandle 2005; Andersson 2006; Brodrechtova et al. 2018; MacKenzie and Gibbons 2019). The IAD framework analyzes the social spaces where individuals interact (‘action situations’) and links it to the outcome of this behavior based on a set of evaluation criteria specific to each context (Ostrom 2011). This framework has been widely adopted by many social scientists to understand the effects of alternative institutional arrangements and rules on the outcomes of the collective management of natural resources (Cole et al. 2019).

The SES framework elaborates the set of the contextual variables from the IAD framework and allows a macro situational perspective to the analysis of action situations. This offers a means of linking more elaborated contextual variables with how actors interact with each other and to policy processes at various scales (McGinnis and Ostrom 2014). The SES framework has not only been used only for understanding the linkages between human and natural systems, but also for analyzing the human–technical systems relations (McGinnis and Ostrom 2014; Ostrom 2011), specifically also in the context of community energy systems (Acosta et al. 2018).

An application of the SES framework for analyzing national energy transitions has been completed by Cherp et al. (2018). While the authors use the SES framework and other frameworks to build a new theoretical framework, our approach differs, as we apply the SES framework as a standalone lens that we link to the energy transition stream of literature, to provide a complementary approach in understanding the role of individuals and groups in bringing changes within a specific context and address the barriers of the transition.

Within the original SES framework, there are four interconnected subsystems that make the core part of the framework. The ‘resource systems (RS)’ part contains variables such as the size, location, and productivity of the system, along with the sector to which the system belongs (e.g., a protected natural area). The ‘governance systems (GS)’ includes the government and non-government organizations, along with the network structure and the monitoring and sanctioning processes. The ‘resource units (RU)’ subsystem includes the number of units, the growth or replacement rate, as well as the economic value (e.g., number of trees,

plants, wildlife, amount of water in the protected natural area). Finally, the ‘users (U)’ subsystem includes, among other variables, the number of users, their socioeconomic attributes and the established norms and social capital. These four subsystems interact leading to outcomes and are also connected with the contextual or the macro environmental ‘political, social, and economic settings (S)’. Lastly, the entire system in which the collective action takes place is linked with other systems, defined in the original SES framework as ‘related ecosystems (ECO)’.

The original SES framework, despite being extensive in terms of the variables found across the subsystems that enable for the complexities of evolving systems to be grasped, lacks a category of outcomes that refer to policy and individual/group norms and behaviors change as part of the social tipping point. In addition, the original framework includes variables that go beyond the scope of this paper and do not offer any insight into the role of individuals and groups in addressing the specific barriers faced in the transition, including lock-ins, path dependencies, incumbent power structures, and established norms and behaviors. Therefore, an adapted version of the SES framework is needed for the complexities of the energy transition to be grasped. This adapted version will serve as an analytical lens that will be applied to historical cases of collective actions to extract insight for the ongoing transition, as we believe that past examples may offer rich insights and provide better understanding of the current challenges of the energy transition. The development of this framework is explained in the next section.

Methodology

The approach taken to analyze and learn from past collective actions using an adapted SES framework is twofold. The first step includes the adaptation of the original SES framework. This is done by analyzing different historical cases of collective action to extract relevant information that will be used to adapt the framework. The second step includes the testing of the adapted SES framework on cases that were not considered in the first step, to learn and relate the lessons from the historical collective action instances to the current energy transition. The two steps of the methodology are explained in greater detail below.

The first step includes a selection of subsystems and variables from the original framework that are present in different historical examples of collective actions. An in-depth analysis of these examples that resulted in changing individual and collective behaviors as well as social and individual norms was performed. In addition to the contextual factors (political, economic, social, technological and environmental) in which the collective actions took place,

we also considered the method of organization, the actions and tactics used, the outcome and impacts of the collective actions, as well as the leadership position found across the case studies. The adaptation was based on detailed analysis of past collective actions out of which relevant information for adapting the SES framework was extracted. On one hand, the adaptation included the selection of variables from the original SES framework that were present across the case studies. On the other hand, important variables that were not present in the original SES framework were identified and added to the adapted version of the SES framework.

The analysis focused on 22 collective actions and social movements in the US, all part of the ‘Collective Action for Social Change’ book by Schutz and Sandy (2011). The book was chosen as it serves as a repository of historical case studies of collective actions centered across different goals. From actions geared towards justice and equality elements such as the American Civil Rights movement, women’s suffrage and gay rights movements as well as different forms of labor actions to anti-war collective actions, this book offers a simplified overview of the ‘moments of social action that seem to best exemplify the range of social action strategies visible in the twentieth century’ (Schutz and Sandy 2011, p. 47). Using historical examples to extract lessons for the energy transition is justified as most, if not all, of the analyzed case studies offer insight in dealing with vested interests, power imbalances and changing individual and group norms and behaviors. Moreover, the variety of case studies offer different mobilization tactics and approaches when it comes to individual and collective actions that may be directly applicable in the current energy transition.

The 22 case studies found within the book relate only to the American context and provide a condensed overview of collective actions across one century. The description of the case studies’ complexities is often downplayed as the authors focus their efforts more to “highlight particular tactics and strategies” (Schutz and Sandy 2011, p. 47). Indeed, the American-specific context and the authors’ approach in analyzing the case studies serve as limiting factors when it comes to the adaptation of the SES framework. Extracting insights from a single source that focuses on a single context has a direct influence on the selection of the variables, as it relies on the lens and approach utilized by Schutz and Sandy (2011). However, we believe that the variety of case studies in terms of scale, scope, duration and goals serve as counterweight to the drawbacks of this approach.

While the first step of the research approach includes the selection of the subsystems and variables from the original SES framework that are present in different historical examples of collective actions that resulted in changing individual and collective behaviors as well as social and individual norms, the second step is to test the applicability and implementation of the adapted SES framework by applying it to additional

case studies, meaning that the new case studies are not related with the book by Schutz and Sandy (2011). The additional case studies were selected because they come from different regions, but they share the same outcome—both cases represent historical examples of collective actions that resulted in large-scale social and societal changes, with a specific aim on the role of individuals and groups in driving that change.

Moreover, despite not being concerned with the energy system, these additional case studies were selected as they share features of the current energy transition, since they involve the need for addressing existing power structures and examples of changing individual and group norms and behaviors. In addition, they include the need for changing individual and social norms, behaviors, and understandings, as well as changing current legislation to create widespread societal change.

We set out to find and analyze case studies that succeeded in reaching their initial aims. We aimed at selecting case studies that differ in the time period, the context, and the stakeholders involved in the collective actions. We did the analysis by following the comparative case study approach as a suitable method that “explores similarities revealed in different situations or cases sharing some common element(s) while differing in others” (Knight 2001). The comparative case study approach relied on different studies and press releases as well as published data from both government and non-government organizations.

While the first case study is a well-documented global example, the second case study has limited available peer-reviewed materials. For the well-documented example, a review of existing literature and official documents was undertaken. This method ensured a comprehensive analysis by drawing on established sources and scholarly insights. In contrast, for the case with limited materials, along with utilizing published data and press releases from governmental and non-governmental organizations, the approach also relied on one of the author's firsthand experience and knowledge of the issues in question. Given the scarcity of available materials, the researcher's direct insights became paramount and played a crucial role in providing depth and context to the analysis. By leveraging these diverse approaches, the reporting on each case is tailored to its unique circumstances, contributing to the robustness of the SES framework's application in the absence of abundant source materials.

Results

The adapted SES framework

After analyzing the 22 past collective actions found in the book by Schutz and Sandy (2011), the most relevant

variables of the case studies were matched with the corresponding variables in the SES framework. The adapted version of the original SES framework excludes the subsystems ‘resource system (RS)’ and ‘related ecosystems (ECO)’ as their variables do not match the corresponding variables from the case studies. These two subsystems are strongly grounded in ecology, with variables including sector (e.g., water, forest, pasture), equilibrium properties, or climate and pollution patterns, making them irrelevant to this study. However, the ‘social, economic and political settings (S)’ and the ‘outcomes (O)’ subsystems were modified to better reflect the results of the analysis. While government policies and market incentives were selected as the only variables for the first subsystem, legislative/policy change and norms/behavior were added in the ‘outcomes (O)’ subsystem, as the original SES framework lacked these outcome variables. Across the other subsystems, variables from the original framework were selected, and no new variables were added. For example, from the ‘resource units (RU)’ subsystem that includes, among other variables, the number of units, the growth or replacement rate, as well as the economic value of the units (e.g., number of trees, plants, wildlife, amount of water in the protected natural area), only the economic value was selected. The variables and subsystems of the adapted SES framework are presented in Table 1.

Analyzing collective actions for social and societal transformation

To extract lessons from past collective actions, we implemented the adapted SES framework to two additional historical case studies of collective action that led to transformative change. The first case study details the complex relations between the tobacco industry and the different citizen-led and NGO actions and tactics, taking place over several decades throughout the twentieth century in the United States. The introduction of legislation that limited tobacco industry's power is an outcome of the decades-long societal struggle in which ‘positional leaders’ had a crucial contribution. The second case study focuses on the collective actions of NGOs, communities and individuals in North Macedonia in reaction to the development of hydropower plants. Motivated by the risks that these plants pose for natural habitats and protected areas, citizens and citizen groups took different forms of non-violent actions to block the planned expansion of hydropower plants in the considered areas. Despite the contextual differences, the chosen case studies share similarities in the types of actions undertaken, as well as in the motivation behind the collective actions, as detailed in the following sections according to the adapted SES framework.

Table 1 Adapted SES framework

Subsystems	Variables	Variable found in the original SES framework
Social, economic, and political settings (S)	Government policies	Yes
	Market incentives	Yes
Resource unit (RU)	Economic value	Yes
Governance systems (GS)	Government organizations	Yes
	Non-government organizations	Yes
Users (U)	Leadership	Yes
	Norms/behaviors	Yes
Interactions (I)	Information sharing	Yes
	Lobbying activities	Yes
	Self-organizing activities	Yes
Outcomes (O)	Legislative/policy change	No
	Norms/behavior change	No

Social, economic, and political settings (S)

As the ‘*product that defined America*’ (Hall 2007), tobacco has a long and complex history in the US. Before being introduced in the form of cigarettes in the early nineteenth century, tobacco in the US was used in the different forms including tobacco for pipes and for chewing, as well as cigars. After their introduction to the market, cigarettes quickly gained in popularity and became a major US tobacco product (Slade 1989; Musk and De Klerk 2003), with subsidized production (Riquinho and Hennington 2012) and made available across different selling points with an affordable price, making tobacco consumption an interesting and easily reachable social activity. Smoking rates soared until 1966 when the first legislation related with tobacco control was introduced. Aimed at placing health warnings on cigarette packs, this legislation was introduced after the first Surgeon General’s report on smoking was published, which outlined the dangers of smoking (Antman et al. 2014). This legislative step can be seen as the first congressional action and the first tobacco control milestone.

The story of hydropower plants in North Macedonia revolves around the country’s commitments to increase renewable energy production, the obligations to international banks for renewable energy projects in the form of loans, one of the last remaining habitats of the Balkan lynx, and different non-violent citizen actions aimed at stopping the implementation of the projects. Located in the western part of the country, the Mavrovo National Park is home to a great variety of flora (Papp et al. 2016) and fauna (Huemer et al. 2008) including, rare trout species, wolves and bears. Besides being the active breeding place of the Balkan lynx, a critically endangered species (Melovski et al. 2020), the Mavrovo National Park also has many rivers which were considered as potential hydropower plant sites. Back in

2010, the state-owned utility company ELEM proposed the construction of two large hydropower plants in the national park—‘Boshkov Most’ with annual generation of 126 GWh, and ‘Lukovo Pole’ with annual generation of 160 GWh. The foreseen energy projects that included the construction of dams, tunnels and new roads secured loans from the European Bank of Reconstruction and Development (EBRD) in the amount of US\$65 million, and the World Bank in the amount of US\$70 million (Schmidhuber 2015). However, the planned hydropower plant projects violated not only the national environmental legislation, but also the EBRD’s own policies.

Resource units (RU)

When analyzing the tobacco in the US case study, the resource taken for consideration is public health—a resource to be protected from tobacco-related diseases. One of the ways in which the associated *economic value* (as the only variable considered in this subsystem) of this resource can be characterized by considering the healthcare expenditures for treating smoking-related diseases. The economic cost of smoking in the US includes the direct medical care costs as well as the lost productivity costs due to smoking-related illness and premature death. When both aspects are considered, the economic costs of smoking in the US exceeds \$300 billion per year, with nearly US\$170 billion for direct medical care costs and more than US\$150 billion in lost productivity due to premature death (Hall and Doran 2016).

When discussing the economic value of the system as the main variable in this SES subsystem, there are two important perspectives that need to be considered for the North Macedonia case study. The first one is the value that the national park provides as a habitat for different species (including protected ones) to which no clear monetary

(financial) value can be attributed. The second one considers the potential extraction of monetary (financial) value from the national park by the local communities, such is the case with fisheries (regulated fishing activities), lakes (regulated leisure and sport activities), or pastures (norms and laws related to grazing). Since the system under consideration is a regulated national park with a strict natural protection system in place (Tiepolo 2007), the value of the park as a habitat for different species including the endangered Balkan lynx cannot be monetarily quantified. On the other hand, the extraction of financial value from the national park by the local communities is already regulated with the strict protection system.

Governance systems (GS)

In the US case study, the efforts to limit the power of the tobacco industry came from various *government* as well as *non-government organizations*. The shift towards increasing tobacco control happened after the landmark report by the Surgeon General was published in 1964. More specifically, this was the first such governmental report that linked smoking cigarettes with dangerous health effects, including lung cancer and heart disease (Alberg et al. 2014). Aside of the Surgeon General, governmental organizations such as the US Food and Drug Administration, the US Department of Housing and Urban Development as well as the US Environmental Protection Agency had a significant impact on the societal fight against the tobacco industry. The Congress also played a crucial role in terms of introducing new control measures. In terms of the non-governmental organizations, the American Lung Association, a voluntary organization, made significant contribution in lowering tobacco consumption through different strategies and scales of action (Stachowiak 2010).

In the North Macedonia case study, it was the state-owned utility company ELEM that initiated the activities for building the two hydropower plants. As a governmentally controlled and owned entity, ELEM obtained support from two crucial non-governmental international organizations that provided the funding—the European Bank for Reconstruction and Development (EBRD) and the World Bank. Opposing these energy projects and organizing the pushback against their realization came from a coalition of Macedonian non-governmental and environmental law activists under the ‘Save Mavrovo’ campaign, led by Eko-svest. Through grassroots actions and international legal mechanisms, Eko-svest with the support of the coalition of other NGOs and activists managed to block and revoke the financing and effectively stop the implementation of the hydropower plants.

Users (U)

In the case of tobacco in the US, this subsystem includes the community leaders responsible for initiating different forms of collective action against smoking, the surgeon general, the tobacco industry and citizen groups and organizations, with the American Lung Association being the most prominent non-governmental actor. All these stakeholders had an impact on the norms, behaviors and perceptions related with tobacco use. In the North Macedonia case study, the ‘users’ include the central and the local governments, the international banks, the ‘Save Mavrovo’ coalition led by Eko-svest and the local communities.

The most prominent type of leadership in the tobacco case study is the positional leadership, as the Surgeon General used the governmental position and its powers to influence the large-scale change. Community leadership also had a role to play, but mainly in local, small-scale mobilization actions that influenced the social norms on tobacco use (Karasek et al. 2012). On the other hand, the community leadership type was decisive in the North Macedonia case study in canceling the energy projects. The efforts by Eko-svest and the other members of the coalition were crucial also for informing, educating and influencing the established social norms related with hydropower plants as renewable energy sources that are congruent with the environment.

Interactions (I)

In tobacco’s case study, community-wide information sharing actions and events were focused on spreading the facts on tobacco’s harmful effects within and across communities, taking direct action to safeguard their collective well-being (Cummings 1999). The work of different NGOs and especially the American Lung Association in informing and educating the public and the government on tobacco’s damaging effects had a positive impact on the large-scale changes that followed. Through research, education, advocacy, and lobbying, the American Lung Association was one of the crucial non-governmental players that helped reshape the society. The parallel to the American Lung Association for the North Macedonia case study is Eko-svest, considering their non-violent actions including petitions, educational events for local communities, face-to-face meetings with foreign ambassadors and presence in public debates intended to inform and educate the public (Bujaroska and Colovic Lesoska 2019), undertaken for promoting the importance of the national park as a habitat for endangered species and the destructive potential of the planned hydropower plants.

Going back to the tobacco case study, the lobbying and influence activities conducted by the non-governmental sector and especially by the American Lung Association were influential but to a limited extent, as they could not be

compared with the influence that the tobacco industry had. The tobacco industry's tactics included buying scientific and other expertise to create controversy about established medical and tobacco facts, investing in political parties, influencing policy through lobbyists, managing front groups to oppose tobacco control measures, pressing for weaker laws to be introduced, corrupting public officials, conducting various PR campaigns and other power-increasing activities (Brandt 2012). Moreover, the tobacco industry was involved in a decades-long conspiracy "to resist smoking restrictions, restore smoker confidence and preserve product liability defense" (Saloojee and Dagli 2000).

The lobbying activities in the North Macedonia case study were mainly associated with the efforts of the 'Save Mavrovo' coalition to cancel the funding for the planned hydropower plants, challenging the international banks' funding decisions before the Bern Convention—the convention on the conservation of European wildlife and natural habitats (Breitenmoser and Sovinc 2021).

In terms of the self-organizing activities and tactics used by citizens and organizations, the US society responded to the growing concerns of tobacco's harmful effects by taking small-scale, community-led actions and measures against smoking (community tobacco control actions) (Cummings 1999). Intended to reduce harm, different community actions were organized in the areas of public policy information, providing support for clinical treatment of nicotine dependence and different community-led youth development programs, often organized and lead by local, community leaders. The self-organizing activities of the local communities in the case of North Macedonia included community-led rallies and road blockades to organizing protests, marches and pickets in front of the central government building, directly supported by the 'Save Mavrovo' coalition.

Outcomes (O)

In the case of tobacco in the US, the small community actions had an influence on the social norms, but the main

shift in imposing control measures on the industry happened after the Surgeon General's report was published. A selection of policy introduction after the Surgeon General report was published are provided in Table 2.

The combination of legislation change and small-scale actions aimed at influencing social norms related with smoking had a great impact in bringing social change. In fact, the social tipping point in terms of tobacco use can be grasped through the decline of the smoking rates in the past decades. According to Cummings and Proctor (2014), back in 1965, more than 40% of adults were active smokers, while less than 20% of adults were active smokers in 2011, with adult per capita consumption of tobacco use decreasing by more than 60% since 1963. Legislation changes made impossible for tobacco products to be marketed via television and radio channels. Pollay (1994) argues that back in 1963, average teenagers in the US were exposed to more than 100 tobacco ads per month, with children and teens representing between 24 and 30% of the bought television audiences by the cigarette firms. Changing of the social norms can also be witnessed by the poll results in 1966 and 2001—while 40% of Americans recognized smoking cigarettes as a major cause of cancer in 1966, more than 70% shared that view in 2001 (Cummings and Proctor 2014).

Considering the North Macedonia case study, the different tactics used by the 'Save Mavrovo' coalition as well as the citizens' participation in the different forms of protests resulted in the international banks canceling the loans for constructing the hydropower plants (Breitenmoser and Sovinc 2021). However, banks withdrawal of funding cannot be regarded as a social tipping point, even though the effects of canceling these projects and raising the environmental concerns related with building hydropower plants in protected areas spilled over in other hydropower plant projects throughout the country.

A summary of the differences outlined above between the case studies according to the adapted SES framework's subsystems and variables is provided in Table 3.

Table 2 Tobacco control measures. Source: Adapted from Emmons et al. (1997)

Year	Explanation of legislation
1960	US Food and Drug Administration (FDA) is empowered to regulate hazardous substances, defined as toxic, corrosive, irritant, sensitizing, flammable, or pressure-generating substances. However, FDA does not interpret tobacco as a hazardous substance
1965	First federal statute for cigarette packages labeling requirements, with no warning on cigarette advertisements
1969	Cigarette advertising in broadcast media is prohibited, and health warnings on cigarette packages are strengthened
1984	Previous health warnings on cigarette packages are replaced with a system of four rotating health warnings
1986	A system of three rotating health warnings is introduced on smokeless tobacco packages, and smokeless tobacco advertising is prohibited in broadcast media

Discussion and implications

The analysis of the two case studies yields insights that may be applied to the current barriers of the energy transition. In terms of dealing with incumbents as one of the barriers, lessons can be drawn from both the North Macedonia case study of the influence of bottom-up activities on incumbent interests, and the US tobacco case study and the role of positional leadership in initiating policy/control measures. The North Macedonia case study shows that bottom-up efforts by citizens and citizen organizations in the form of petitions and meetings with government representatives, foreign ambassadors and the projects' creditors can be effective in avoiding the effects of lock-in driven by national and international incumbents. Persistent non-violent bottom-up actions, with a clear pro-environmental message, organized in different cities and regions of North Macedonia across several years, helped in stopping the funding and canceling the energy projects. The US case study shows that the incumbents were confronted by a top-down, policy approach. The findings are in line with the arguments provided by Turnheim and Geels (2012) who state that political pressures play a crucial role when dealing with incumbents.

Learning from these insights to the energy transition, legislative measures can focus on addressing the industry's marketing tactics. For example, the alternative causation arguments (a misinformation tactic used to deflect attention from the scientific evidence, which is a tactic that was heavily used by the tobacco industry) is a tactic that the fossil fuel industry also relies on (Maani et al. 2022). Biased economic analyses to oppose climate policy (Franta 2022) is another tactic used by the fossil fuel industry to negate the need or delay the transition. Mandatory changes to the marketing activities can be imposed through policy interventions in the same way as tobacco's marketing practices were influenced in the past. Moreover, considering the subsidies associated with tobacco production and the associated influence on making tobacco products easily reachable, changes could also be made in the realm of fossil fuel subsidies. Since more than US\$ 5 trillion are spent by governments yearly on both the consumption and the production sides (Skovgaard and Asselt 2019), cutting these subsidies may have a positive effect towards speeding up the transition. Another control measure that governments can impose on the energy transition incumbents is to cease the issuance of permits for new fossil fuel production (Erickson et al. 2018) and to effectively stop the industry's actions on influencing national policies and international climate change agendas (Nasiritousi 2017). All of these efforts constitute top-down pressures to address incumbents, which is in line with the arguments

of Turnheim and Geels (2012) that political will exercised through legislative pressures yield most favorable results when dealing with incumbents.

Actions and changes can also come from local, bottom-up actions focusing on individual change in norms, understandings and behaviors, as argued by Niamir et al. (2020) and Bal et al. (2021). The bottom-up actions and tactics used in the two case studies were aimed at initiating change on a personal, individual level—making smoking less cool, and shaping people's understanding about the consequences of hydropower plants in protected natural areas. The work done by Eko-svest and the coalition can be regarded as the spark and catalyst that led different NGOs, citizens and entire communities to take action to stop future small hydropower plants in North Macedonia, despite the norm being that 'renewable energy sources are a climate change mitigation option' (Komendantova 2021). The support against hydropower plants in protected areas, regions and within communities directly affected by such energy projects gained due to the coalition's efforts shows the effective change in social norms and understandings. This further outlines the role of connected social actors as diffusers of change towards a social tipping point, as outlined by Otto et al. (2020). In terms of the US case study, the bottom-up collective actions did not manage to assemble critical mass to initiate a large-scale cross-country social movement to demand new policy measures for controlling tobacco. Instead, these growing small-scale community actions shifted the narrative and perception of people, from 'smoking being cool' towards 'smoking is bad for your health'. As such, influencing citizens on an individual level to reduce smoking rates through shifting the social norms had a positive influence on decreasing smoking rates (Karasek et al. 2012).

Both cases show similar motivators behind the non-violent actions taken to address the issues, as they are both related with the protection of the communities' well-being through joined, organized action. Such organized group activities are more effective than individual actions in reaching the goal, as explained by the collective efficacy theory (Watson et al. 2001). Moreover, being part of the same community and being subjected to the same risks, citizens in the two case studies took action as they shared the same beliefs, norms and concerns—smoking is bad for the communities' health, and the planned hydropower plants will have a negative influence on the local communities. Being part of a collective action due to shared moral values and beliefs is explained by the collective identity theory (Davis et al. 2019).

Driven by the need to protect the environment and organizing local groups of collective actions, the non-violent tactics used by the 'Save Mavrovo' coalition share similarities with current climate change actions. From rallies, protests, marches and pickets to the ever-growing

Table 3 Comparison of the two case studies

SES framework subsystems and variables	The story of tobacco in the US	Protecting the Balkan lynx in North Macedonia
<i>Social, economic, and political settings (S)</i>		
Government policies	No restrictions on tobacco consumption in place	Policies geared towards promoting renewable energy expansion
Market incentives	Tobacco products available at affordable prices and across different selling points	Expansion of renewable energy capacity to provide cheaper electricity
<i>Resource unit (RU)</i>		
Economic value	Health as a resource to be protected, with economic cost of smoking determined through the direct medical cost and the lost productivity costs due to smoking-related illness and premature death	The value of the national park as habitat for different species is unquantifiable; The value that can be extracted from the national park by the local communities is strictly regulated
<i>Governance systems (GS)</i>		
Government organizations	Surgeon General, Food and Drug Administration, Department of Housing and Urban Development, Environmental Protection Agency	ELEM—state-owned utility company
Non-government organizations	The American Lung Association	Eko-svest, Save Mavrovo Coalition, European Bank for Reconstruction and Development, World Bank
<i>Users (U)</i>		
Leadership	Positional leadership seen through the Surgeon General's actions	Community leadership enacted by Eko-svest and the Save Mavrovo coalition
Norms/behaviors	Smoking is seen as a cool social activity and is allowed everywhere (no smoking bans in place)	Conflict between no citizen opposition to renewable energy projects and the need to protect the Balkan lynx
<i>Interactions (I)</i>		
Information sharing	Information sharing within and across communities to implement different tobacco protection measures	Information sharing within the Save Mavrovo coalition and between the coalition and the local communities
Lobbying activities	The lobbying activities by the tobacco industry outweighed the American Lung Association and other NGOs/CSOs lobbying efforts	Lobbying efforts from the Save Mavrovo coalition directed towards the government and the two international banks (EBRD and World Bank)
Self-organizing activities	Community efforts in establishing no-smoking zones and tobacco-free areas	Local communities and citizens led by Eko-svest and the Save Mavrovo coalition organized rallies, road blockades, protests, marches and pickets
<i>Outcomes (O)</i>		
Legislative/policy change	Change in policy happened after the publication of the Surgeon General's report	No change in policy, but the energy projects were stopped due to the revocation of the financing by the international banks
Norms/behaviors change	Decreased smoking rates, smoking considered as a bad habit with negative health impact	Citizen recognition of the negative environmental impact that renewable energy projects can have; Increased environmental concerns

number of road blockades organized by collective actions such as Just Stop Oil, Extinction Rebellion, Fridays for Future and others, these non-violent actions are aimed at awakening and mobilizing the public to increase the efficacy of the collective efforts.

The findings from this research also have implications to both academic research and practice. The adapted SES framework can be utilized for the analysis of collective actions geared towards different goals, regardless of the context or the time period, as it allows for different theories and a vast array of variables to be considered which are deemed important for explaining the collective action. In short, using the adapted SES framework might provide more insight than other approaches that rely on a single theory or model. Moreover, the findings complement the existing literature, especially when it comes to the issues of power and politics as one of the key elements of the socio-institutional transition theories (Fraune and Knodt 2018) and the effects that different bottom-up collective actions can have on bringing change across different scales. When it comes to the social tipping point and considering the different definitions of the concept, we align our findings mostly with Juhola et al. (2022) view of the concept—a process that entails changes on individual, collective, and institutional level.

In terms of the implications outside of academia, the findings show that individuals and non-governmental organizations can play a substantial role in the energy transition, especially when it comes to mobilizing bottom-up, non-violent activities to address community challenges and risks. Such mobilized citizen activities may also impact different aspects that go beyond influencing individual and social norms and understandings and have a direct policy impact (Table 4).

Limitations

When it comes to the limitations of this study, we identify two categories of limitations that must be considered. The first category of limitations includes the approach taken to adapt the SES framework. Namely, adapting the SES framework using case studies from the American context outlined by a single source result in a limited consideration of variables that might be relevant in other contexts, or that might be deemed relevant by other researchers and other research approaches. In line with this, treating the adapted SES framework as a ‘one-size-fits-all’ solution for analyzing past collective actions might yield limited insights. In addition, contrary to using models for analyzing transformations, frameworks cannot pinpoint whether and to what extent variables or actions taken by different actors shape the results. This means that the SES framework cannot determine the order of the causal effects of the subsystems and variables considered nor their weight and impact on the final outcome. However, frameworks offer the advantage of considering greater array of variables which are not able to be grasped by models nor theories (McGinnis and Ostrom 2014), thus providing greater potential for explaining the complexity of the considered case study.

The second category of limitations is related with the framework itself, and to the selection of case studies that the framework is applied to. Using the SES framework, pinpointing the social tipping points across the case studies might not be possible. We addressed this limitation by adapting the SES framework to include variables that we define to be part of the social tipping point process. In addition, despite the fact that the two case studies offer different insights into ways to address incumbent sources of power, the different leadership roles and the variety of tactics that can be used to achieve the goals, the examples provided and the lessons that can be drawn from the two case studies are

Table 4 Outcomes of the research process

Key themes and findings	Method of addressing the barrier
Dealing with incumbents	Bottom-up efforts effective in avoiding lock-ins driven by national and international incumbents Political pressures through positional leadership and policy changes crucial when dealing with incumbents
Legislative measures	Addressing industry’s marketing tactics through policy interventions Cutting subsidies as a measure to speed up the transition Ceasing the issuance of permits for new fossil fuel production and limiting the industry influence
Local, bottom-up actions	Initiating change through bottom-up actions Importance of connected social actors as diffusers of change
Non-violent tactics for environmental protection	Similarities between the ‘Save Mavrovo’ coalition and the current global climate change actions Increasing efficacy of collective actions through rallies and protests
Implications outside of academia	Individuals and NGOs/CSOs playing a substantial role in the energy transition Organized citizen actions impacting policy outcomes beyond norms, understandings and behaviors

important but limited. We do not claim that the insights are readily applicable to the current energy transition, nor that the actions depicted through them should be followed to achieve the same goals. Rather, we want to offer examples that can be considered when developing strategies to tackle challenges that might be addressed through individual and collective actions. We point to the importance of the context (time and macro elements including the political, economic and social situation) in initiating, driving and obstructing collective actions. Moreover, both case studies reveal different trajectories and paces in which the intended change happened, despite the fact that the extent of the large-scale transformations achieved in the two case studies varies greatly. However, in the analyzed contexts, both changes can be considered as transformative, as they directly impacted social and societal issues, from influencing individual and social norms, beliefs and practices, to changing existing policies and governmental decisions.

Conclusion

We state that historical cases of collective actions that resulted in large scale transformations offer valuable lessons for the current energy transition. The analysis of the case studies showed different strategies to address the barriers currently faced in the energy transition, from dealing with lock-ins and incumbent sources of power, to changing individual and social norms and behaviors. Using the adapted SES framework, we outlined that both top-down measures and bottom-up activities are needed for effective change to happen across different scales. Focusing on the role that collective actions can play, we showed that bottom-up activities are effective means to reach a social tipping point, with individuals and local organizations acting as catalysts.

The wider lessons that can be drawn from the results presented in this paper extend far beyond the energy transition, offering valuable insights applicable to diverse large-scale transitions. These lessons emphasize the need for interdisciplinary, adaptive, and inclusive approaches that recognize the role of both top-down and bottom-up strategies. Understanding the dynamics of cultural and behavioral change while learning from historical precedents enables the successful navigation and facilitation of large-scale transitions across a variety of contexts.

Acknowledgements The authors would like to thank Prof. Dr. Michael Stauffacher for his suggestions to the first and second versions of the manuscript. The authors would also like to thank the three anonymous reviewers who provided valuable comments that improved the quality of this manuscript.

Funding Open access funding provided by Swiss Federal Institute of Technology Zurich.

Data availability The data used in this study are available on request from the corresponding author.

Declarations

Conflict of interest This research is part of the H2020 ENCLUDE—Energy Citizens for Inclusive Decarbonization project. The ENCLUDE project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 101022791. The authors declare no conflicts of interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Acosta C, Ortega M, Bunsen T, Koirala B, Ghorbani A (2018) Facilitating energy transition through energy commons: an application of socio-ecological systems framework for integrated community energy systems. *Sustainability* 10(2):366. <https://doi.org/10.3390/su10020366>
- Alberg AJ, Shopland DR, Cummings KM (2014) The 2014 surgeon general's report: commemorating the 50th anniversary of the 1964 report of the Advisory Committee to the US surgeon general and updating the evidence on the health consequences of cigarette smoking. *Am J Epidemiol* 179(4):403–412. <https://doi.org/10.1093/aje/kwt335>
- Andersson K (2006) Understanding decentralized forest governance: an application of the institutional analysis and development framework. *Sustain: Sci Pract Policy* 2(1):25–35. <https://doi.org/10.1080/15487733.2006.11907975>
- Antman E, Arnett D, Jessup M, Sherwin C (2014) The 50th anniversary of the US Surgeon General's Report on tobacco: what we've accomplished and where we go from here. *J Am Heart Assoc* 3(1):e000740. <https://doi.org/10.1161/JAHA.113.000740>
- Bal M, Stok FM, Van Hemel C, De Wit JBF (2021) Including social housing residents in the energy transition: a mixed-method case study on residents' beliefs, attitudes, and motivation toward sustainable energy use in a zero-energy building renovation in the Netherlands. *Front Sustain Cities*, 3. <https://www.frontiersin.org/articles/10.3389/frsc.2021.656781>
- Bauwens T, Schraven D, Drawing E, Radtke J, Holstenkamp L, Gotchev B, Yildiz Ö (2022) Conceptualizing community in energy systems: a systematic review of 183 definitions. *Renew Sustain Energy Rev* 156:111999. <https://doi.org/10.1016/j.rser.2021.111999>
- Bergek A, Jacobsson S, Carlsson B, Lindmark S, Rickne A (2008) Analyzing the functional dynamics of technological innovation systems: a scheme of analysis. *Res Policy* 37(3):407–429. <https://doi.org/10.1016/j.respol.2007.12.003>
- Bielig M, Kacperski C, Kutzner F, Klingert S (2022) Evidence behind the narrative: critically reviewing the social impact of energy

- communities in Europe. *Energy Res Soc Sci*. <https://doi.org/10.1016/j.erss.2022.102859>
- Blanchet T (2015) Struggle over energy transition in Berlin: how do grassroots initiatives affect local energy policy-making? *Energy Policy* 78:246–254. <https://doi.org/10.1016/j.enpol.2014.11.001>
- Bosman R, Loorbach D, Frantzeskaki N, Pistorius T (2014) Discursive regime dynamics in the Dutch energy transition. *Environ Innov Soc Trans* 13:45–59. <https://doi.org/10.1016/j.eist.2014.07.003>
- Boulanger SOM, Massari M, Longo D, Turillazzi B, Nucci CA (2021) Designing collaborative energy communities: a European overview. *Energies* 14(24):8226. <https://doi.org/10.3390/en14248226>
- Brandt AM (2012) Inventing conflicts of interest: a history of tobacco industry tactics. *Am J Public Health* 102(1):63–71. <https://doi.org/10.2105/AJPH.2011.300292>
- Breitenmoser U, Sovinc A (2021) Independent advisory mission in the framework of the Bern convention open file no. 2013/1: hydropower development within the territory of Mavrovo National Park (North Macedonia). Council of Europe, Strasbourg
- Brodréchtova Y, Navrátil R, Sedmák R, Tuček J (2018) Using the politicized IAD framework to assess integrated forest management decision-making in Slovakia. *Land Use Policy* 79:1001–1013. <https://doi.org/10.1016/j.landusepol.2016.10.015>
- Bujaroska A, ColovicLesoska A (2019) Practice your environmental rights—legal tools and mechanisms. *EuroNatur, Radolfzell am Bodensee*
- Cherp A, Vinichenko V, Jewell J, Brutschin E, Sovacool B (2018) Integrating techno-economic, socio-technical and political perspectives on national energy transitions: a meta-theoretical framework. *Energy Res Soc Sci* 37:175–190. <https://doi.org/10.1016/j.erss.2017.09.015>
- Cole D, Epstein G, McGinnis M (2019) The utility of combining the IAD and SES frameworks. *Int J Commons* 13(1):Article 1. <https://doi.org/10.18352/ijc.864>
- Crawford SES, Ostrom E (1995) A grammar of institutions. *Am Polit Sci Rev* 89(3):582–600. <https://doi.org/10.2307/2082975>
- Creutzig F, Goldschmidt JC, Lehmann P, Schmid E, von Blücher F, Breyer C, Fernandez B, Jakob M, Knopf B, Lohrey S, Susca T, Wiegandt K (2014) Catching two European birds with one renewable stone: mitigating climate change and Eurozone crisis by an energy transition. *Renew Sustain Energy Rev* 38:1015–1028. <https://doi.org/10.1016/j.rser.2014.07.028>
- Cummings KM (1999) Community-wide interventions for tobacco control. *Nicotine Tob Res: off J Soc Res Nicotine Tob* 1(Suppl 1):S113–S116. <https://doi.org/10.1080/14622299050011701>
- Cummings KM, Proctor RN (2014) The changing public image of smoking in the United States: 1964–2014. *Cancer Epidemiol Biomark Prev* 23(1):32–36. <https://doi.org/10.1158/1055-9965.EPI-13-0798>
- Dakos V, Matthews B, Hendry AP, Levine J, Loeuille N, Norberg J, Nosil P, Scheffer M, De Meester L (2019) Ecosystem tipping points in an evolving world. *Nat Ecol Evol* 3(3):Article 3. <https://doi.org/10.1038/s41559-019-0797-2>
- Davis JL, Love TP, Fares P (2019) Collective social identity: synthesizing identity theory and social identity theory using digital data. *Soc Psychol Q* 82(3):254–273. <https://doi.org/10.1177/0190272519851025>
- Dunphy NP, Lennon B (2022) Whose transition? A review of citizen participation in the energy system. In: Araújo K (ed) *Routledge handbook of energy transitions*, 1st edn. Routledge, p 430–444. <https://doi.org/10.4324/9781003183020-30>
- Emmons KM, Kawachi I, Barclay G (1997) Tobacco control: a brief review of its history and prospects for the future. *Hematol Oncol Clin N Am* 11(2):177–195. [https://doi.org/10.1016/S0889-8588\(05\)70425-1](https://doi.org/10.1016/S0889-8588(05)70425-1)
- Erickson P, Lazarus M, Piggot G (2018) Limiting fossil fuel production as the next big step in climate policy. *Nat Clim Change* 8(12):Article 12. <https://doi.org/10.1038/s41558-018-0337-0>
- Firdaus N, Mori A (2023) Stranded assets and sustainable energy transition: a systematic and critical review of incumbents' response. *Energy Sustain Dev* 73:76–86. <https://doi.org/10.1016/j.esd.2023.01.014>
- Franta B (2022) Weaponizing economics: big oil, economic consultants, and climate policy delay. *Environ Polit* 31(4):555–575. <https://doi.org/10.1080/09644016.2021.1947636>
- Fraune C, Knodt M (2018) Sustainable energy transformations in an age of populism, post-truth politics, and local resistance. *Energy Res Soc Sci* 43:1–7. <https://doi.org/10.1016/j.erss.2018.05.029>
- Friedrich TL, Vessey WB, Schuelke MJ, Ruark GA, Mumford MD (2009) A framework for understanding collective leadership: the selective utilization of leader and team expertise within networks. *Leadersh Q* 20(6):933–958. <https://doi.org/10.1016/j.leaqua.2009.09.008>
- Geels FW (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res Policy* 31(8):1257–1274. [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8)
- Geels FW (2014) Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective. *Theory Cult Soc* 31(5):21–40. <https://doi.org/10.1177/0263276414531627>
- Grint K (2005) *Leadership: limits and possibilities*. Macmillan International Higher Education. ISBN 978-1-137-07058-6
- Gielen D, Boshell F, Saygin D, Bazilian MD, Wagner N, Gorini R (2019) The role of renewable energy in the global energy transformation. *Energy Strat Rev* 24:38–50. <https://doi.org/10.1016/j.esr.2019.01.006>
- Grubler A, Wilson C, Nemet G (2016) Apples, oranges, and consistent comparisons of the temporal dynamics of energy transitions. *Energy Res Soc Sci* 22:18–25. <https://doi.org/10.1016/j.erss.2016.08.015>
- Gui EM, MacGill I (2018) Typology of future clean energy communities: an exploratory structure, opportunities, and challenges. *Energy Res Soc Sci* 35:94–107. <https://doi.org/10.1016/j.erss.2017.10.019>
- Hall W (2007) Cigarette century: the rise, fall and deadly persistence of the product that defined America. *Tob Control* 16(5):360–360. <https://doi.org/10.1136/tc.2007.021311>
- Haukkala T (2015) Does the sun shine in the High North? Vested interests as a barrier to solar energy deployment in Finland. *Energy Res Soc Sci* 6:50–58. <https://doi.org/10.1016/j.erss.2014.11.005>
- Hall W, Doran C (2016) How much can the USA reduce health care costs by reducing smoking? *PLoS Med* 13(5):e1002021. <https://doi.org/10.1371/journal.pmed.1002021>
- Holtz G, Alkemade F, de Haan F, Köhler J, Trutnevyte E, Luthe T, Halbe J, Papachristos G, Chappin E, Kwakkel J, Ruutu S (2015) Prospects of modelling societal transitions: position paper of an emerging community. *Environ Innov Soc Trans* 17:41–58. <https://doi.org/10.1016/j.eist.2015.05.006>
- Huemer P, Krpac V, Plössl B, Tarmann G (2008) Contribution to the fauna of Lepidoptera of the Mavrovo National Park (Republic of Macedonia). *Acta Entomol Slov* 19(2):169–186
- Imperial MT, Yandle T (2005) Taking institutions seriously: using the IAD framework to analyze fisheries policy. *Soc Nat Resour* 18(6):493–509. <https://doi.org/10.1080/08941920590947922>
- Juhola S, Filatova T, Hochrainer-Stigler S, Mechler R, Scheffran J, Schweizer P-J (2022) Social tipping points and adaptation limits in the context of systemic risk: concepts, models and governance. *Front Clim* 4. <https://www.frontiersin.org/articles/10.3389/fclim.2022.1009234>

- Karasek D, Ahern J, Galea S (2012) Social norms, collective efficacy, and smoking cessation in urban neighborhoods. *Am J Public Health* 102(2):343–351. <https://doi.org/10.2105/AJPH.2011.300364>
- Kiser LL, Ostrom E (1982) The three words of action: a metatheoretical synthesis of institutional approaches. In: McGinnis MD (ed) *Polycentric games and institutions*. The University of Michigan Press, Ann Arbor
- Klitkou A, Bolwig S, Hansen T, Wessberg N (2015) The role of lock-in mechanisms in transition processes: the case of energy for road transport. *Environ Innov Soc Trans* 16:22–37. <https://doi.org/10.1016/j.eist.2015.07.005>
- Knight CG (2001) Human–environment relationship: comparative case studies. In: Smelser NJ, Baltes PB (eds) *International encyclopedia of the social & behavioral sciences*. Pergamon, Oxford, pp 7039–7045. <https://doi.org/10.1016/B0-08-043076-7/04195-4>
- Komendantova N (2021) Transferring awareness into action: a meta-analysis of the behavioral drivers of energy transitions in Germany, Austria, Finland, Morocco, Jordan and Iran. *Energy Res Soc Sci* 71:101826. <https://doi.org/10.1016/j.erss.2020.101826>
- Korjonen-Kuusipuro K, Hujala M, Pätäri S, Bergman J-P, Olkkonen L (2017) The emergence and diffusion of grassroots energy innovations: building an interdisciplinary approach. *J Clean Prod* 140:1156–1164. <https://doi.org/10.1016/j.jclepro.2016.10.047>
- Lennon B, Dunphy N, Gaffney C, Revez A, Mullally G, O'Connor P (2020) Citizen or consumer? Reconsidering energy citizenship. *J Environ Plan Policy Manag* 22(2):184–197. <https://doi.org/10.1080/1523908X.2019.1680277>
- Lenton TM (2011) Early warning of climate tipping points. *Nat Clim Change* 1(4):Article 4. <https://doi.org/10.1038/nclimate1143>
- Lockwood M, Mitchell C, Hoggett R (2020) Incumbent lobbying as a barrier to forward-looking regulation: the case of demand-side response in the GB capacity market for electricity. *Energy Policy* 140:111426. <https://doi.org/10.1016/j.enpol.2020.111426>
- Loorbach D, Frantzeskaki N, Avelino F (2017) Sustainability transitions research: transforming science and practice for societal change. *Annu Rev Environ Resour* 42(1):599–626. <https://doi.org/10.1146/annurev-environ-102014-021340>
- Lupi V, Candelise C, Calull MA, Delvaux S, Valkering P, Hubert W, Sciullo A, Ivask N, van der Waal E, Iturriza JJ, Paci D, Della Valle N, Koukoulakis G, Dunlop T (2021) A characterization of European collective action initiatives and their role as enablers of citizens' participation in the energy transition. *Energies* 14(24):Article 24. <https://doi.org/10.3390/en14248452>
- Maani N, van Schalkwyk MCI, Filippidis FT, Knai C, Petticrew M (2022) Manufacturing doubt: assessing the effects of independent vs industry-sponsored messaging about the harms of fossil fuels, smoking, alcohol, and sugar sweetened beverages. *SSM Popul Health* 17:101009. <https://doi.org/10.1016/j.ssmph.2021.101009>
- MacKenzie A, Gibbons P (2019) Enhancing biodiversity in urban green space: an exploration of the IAD Framework applied to ecologically mature trees. *Urban Sci* 3(4):Article 4. <https://doi.org/10.3390/urbansci3040103>
- Markard J (2018) The next phase of the energy transition and its implications for research and policy. *Nat Energy* 3(8):Article 8. <https://doi.org/10.1038/s41560-018-0171-7>
- Matschoss K, Heiskanen E (2018) Innovation intermediary challenging the energy incumbent: enactment of local socio-technical transition pathways by destabilisation of regime rules. *Technol Anal Strateg Manag* 30(12):1455–1469. <https://doi.org/10.1080/09537325.2018.1473853>
- McGinnis M, Ostrom E (2014) Social-ecological system framework: initial changes and continuing challenges. *Ecol Soc*. <https://doi.org/10.5751/ES-06387-190230>
- Melovski D, Ivanov G, Stojanov A, Avukotov V, Gonev A, Pavlov A, Breitenmoser U, von Arx M, Filla M, Krofel M, Signer J, Balkenhol N (2020) First insight into the spatial and foraging ecology of the critically endangered Balkan lynx (*Lynx lynx balcanicus*, Buresh 1941). *Hystrix Ital J Mammal* 31(1):26–34. <https://doi.org/10.4404/hystrix-00254-2019>
- Moss T, Becker S, Naumann M (2015) Whose energy transition is it, anyway? Organisation and ownership of the Energiewende in villages, cities and regions. *Local Environ* 20(12):1547–1563. <https://doi.org/10.1080/13549839.2014.915799>
- Musk AW, De Klerk NH (2003) History of tobacco and health. *Respirology* 8(3):286–290. <https://doi.org/10.1046/j.1440-1843.2003.00483.x>
- Nasiritousi N (2017) Fossil fuel emitters and climate change: unpacking the governance activities of large oil and gas companies. *Environ Polit* 26(4):621–647. <https://doi.org/10.1080/09644016.2017.1320832>
- Niamir L, Ivanova O, Filatova T, Voinov A, Bressers H (2020) Demand-side solutions for climate mitigation: bottom-up drivers of household energy behavior change in the Netherlands and Spain. *Energy Res Soc Sci* 62:101356. <https://doi.org/10.1016/j.erss.2019.101356>
- Nordensvärd J, Urban F (2015) The stuttering energy transition in Germany: wind energy policy and feed-in tariff lock-in. *Energy Policy* 82:156–165. <https://doi.org/10.1016/j.enpol.2015.03.009>
- Nyborg K, Anderies JM, Dannenberg A, Lindahl T, Schill C, Schlüter M, Adger WN, Arrow KJ, Barrett S, Carpenter S, Chapin FS, Crépin A-S, Daily G, Ehrlich P, Folke C, Jager W, Kautsky N, Levin SA, Madsen OJ, Polasky S, Scheffer M, Walker B, Weber EU, Wilen J, Xepapadeas A, de Zeeuw A (2016) Social norms as solutions. *Science* 354(6308):42–43. <https://doi.org/10.1126/science.aaf8317>
- Ostrom E (1990) *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press, Cambridge. <https://doi.org/10.1017/CBO9780511807763>
- Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. *Science* 325(5939):419–422. <https://doi.org/10.1126/science.1172133>
- Ostrom E (2011) Background on the institutional analysis and development framework. *Policy Stud J* 39(1):7–27. <https://doi.org/10.1111/j.1541-0072.2010.00394.x>
- Otto IM, Donges JF, Cremades R, Bhowmik A, Hewitt RJ, Lucht W, Rockström J, Allerberger F, McCaffrey M, Doe SSP, Lenferna A, Morán N, van Vuuren DP, Schellnhuber HJ (2020) Social tipping dynamics for stabilizing Earth's climate by 2050. *Proc Natl Acad Sci* 117(5):2354–2365. <https://doi.org/10.1073/pnas.1900577117>
- Papp B, Szurdoki E, Pantović J, Sabovljević M (2016) Contributions to the bryophyte flora of the Mavrovo National Park (Republic of Macedonia). *Stud Bot Hung* 47(2):279–296
- Pollay RW (1994) Exposure of US youth to cigarette television advertising in the 1960s. *Tob Control* 3(2):130–133
- Riquinho DL, Hennington EA (2012) Health, environment and working conditions in tobacco cultivation: a review of the literature. *Ciencia & Saude Coletiva* 17(6):1587–1600. <https://doi.org/10.1590/s1413-81232012000600022>
- Rotmans J, Loorbach D (2009) Complexity and transition management. *J Ind Ecol* 13(2):184–196. <https://doi.org/10.1111/j.1530-9290.2009.00116.x>
- Saloojee Y, Dagli E (2000) Tobacco industry tactics for resisting public policy on health. *Bull World Health Organ* 9:902–910
- Schmidhuber B (2015) Nature destruction under the guise of energy security? Oekobuero, Austria
- Schutz A, Sandy M (2011) *Collective action for social change: an introduction to community organizing*. Springer, Berlin
- Sengers F, Wieczorek AJ, Raven R (2019) Experimenting for sustainability transitions: a systematic literature review. *Technol Forecast Soc Change* 145:153–164. <https://doi.org/10.1016/j.techfore.2016.08.031>

- Shortall R, Mengolini A, Gangale F (2022) Citizen engagement in EU collective action energy projects. *Sustainability* 14(10):Article 10. <https://doi.org/10.3390/su14105949>
- Simoens MC, Fuenfschilling L, Leipold S (2022) Discursive dynamics and lock-ins in socio-technical systems: an overview and a way forward. *Sustain Sci* 17(5):1841–1853. <https://doi.org/10.1007/s11625-022-01110-5>
- Skovgaard J, van Asselt H (2019) The politics of fossil fuel subsidies and their reform: implications for climate change mitigation. *Wires Clim Change* 10(4):e581. <https://doi.org/10.1002/wcc.581>
- Slade J (1989) The tobacco epidemic: lessons from history. *J Psychoact Drugs* 21(3):281–291. <https://doi.org/10.1080/02791072.1989.10472169>
- Sovacool BK (2016) How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Res Soc Sci* 13:202–215. <https://doi.org/10.1016/j.erss.2015.12.020>
- Stachowiak JA (2010) A brief history of CBOs/NGOs in health and public health. In: Gaist PA (ed) *Igniting the power of community: the role of CBOs and NGOs in global public health*. Springer, Berlin, pp 3–12. https://doi.org/10.1007/978-0-387-98157-4_1
- Steg L, Perlaviciute G, van der Werff E (2015) Understanding the human dimensions of a sustainable energy transition. *Front Psychol* 6. <https://www.frontiersin.org/articles/10.3389/fpsyg.2015.00805>
- Steg L, Shwom R, Dietz T (2018) What drives energy consumers?: engaging people in a sustainable energy transition. *IEEE Power Energ Mag* 16(1):20–28. <https://doi.org/10.1109/MPE.2017.2762379>
- Thomas M, DeCillia B, Santos JB, Thorlakson L (2022) Great expectations: public opinion about energy transition. *Energy Policy* 162:112777. <https://doi.org/10.1016/j.enpol.2022.112777>
- Tiepolo M (2007) Spatial and management plan of Mavrovo National Park, Macedonia: an initial assessment. Politecnico di Torino, Turin
- Turnheim B, Geels FW (2012) Regime destabilisation as the flipside of energy transitions: lessons from the history of the British coal industry (1913–1997). *Energy Policy*. <https://doi.org/10.1016/j.enpol.2012.04.060>
- Unruh GC (2000) Understanding carbon lock-in. *Energy Policy* 28(12):817–830. [https://doi.org/10.1016/S0301-4215\(00\)00070-7](https://doi.org/10.1016/S0301-4215(00)00070-7)
- van Veelen B, van der Horst D (2018) What is energy democracy? Connecting social science energy research and political theory. *Energy Res Soc Sci* 46:19–28. <https://doi.org/10.1016/j.erss.2018.06.010>
- Wahlund M, Palm J (2022) The role of energy democracy and energy citizenship for participatory energy transitions: a comprehensive review. *Energy Res Soc Sci* 87:102482. <https://doi.org/10.1016/j.erss.2021.102482>
- Wang S-L, Lin SSJ (2007) The effects of group composition of self-efficacy and collective efficacy on computer-supported collaborative learning. *Comput Hum Behav* 23(5):2256–2268. <https://doi.org/10.1016/j.chb.2006.03.005>
- Watson CB, Chemers MM, Preiser N (2001) Collective efficacy: a multilevel analysis. *Pers Soc Psychol Bull* 27(8):1057–1068. <https://doi.org/10.1177/0146167201278012>
- Winkelmann R, Donges JF, Smith EK, Milkoreit M, Eder C, Heitzig J, Katsanidou A, Wiedermann M, Wunderling N, Lenton TM (2022) Social tipping processes towards climate action: a conceptual framework. *Ecol Econ* 192:107242. <https://doi.org/10.1016/j.ecolecon.2021.107242>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.