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Transformative Changes Towards Carbon Neutral Society: Barriers and Drivers

Dalia Streimikiene 

ABSTRACT

The barriers of climate change mitigation and mechanisms to overcome these barriers and achieve transformative changes towards carbon neutral society need to be investigated in order to define the main drivers and barriers of transformative change towards carbon neutrality and how policies and measures can be developed to overcome barriers and to support drivers. The main drivers of transformative change that include various types of institutions including social norms and rules, governance schemes, cultural values, demographic, social, economic, technical and technological elements are analysed and systematized based on literature review. Transformative change towards carbon neutral society necessitates systematic changes as simple scaling-up is not enough. These important roles are the levers or main pathways for achieving transformative change towards a carbon neutral society.

KEY WORDS: transformative changes; carbon neutral society; barriers, drivers, policies and measures.

JEL Classification: H30, P18, Q20, Q30.

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1. Introduction

European Commission (EC) in 2018 developed long-term strategy for achievement of climate-neutral society by 2050 in accordance with the Paris Agreement. In 2019 European Council endorsed this objective and The European Parliament introduced net-zero greenhouse (GHG) emission target in resolutions on climate change and European Green Deal by 2020. The European Union (EU) has developed its long-term low greenhouse gas emission development strategy to the United Nations Framework Convention on Climate Change (UNFCCC) in 2020 by including these objectives as well.

The governance regulation requires EU MS (Member States) to present their national long-term low greenhouse gas emission development strategies to EC by 1 January 2020 and 2029 and

every 10 years thereafter. EC provides support to MS in developing long-term strategies, however deep decarbonisation requires transformative changes in all EU Member States and for the achieving low carbon transition and implementing these longterm climate strategies the disruption of fossil fuel-based economies and shift to carbon free energy sector and climate smart and resilient societies is necessary. Authors (Brand, 2016; Chan et al., 2020; Fazey et al., 2018; Hölscher et al., 2018; Linner & Vilbeck, 2020, 2021; Patterson et al. 2017; Winkler et al., 2022) agree that societal transformation to carbon neutrality entails essential, universal and systematic, non-linear transformations in various spheres of societies.

There is no agreement in the increasing number of studies on transformational changes and transition governance about how societal changes can be realised and promoted.

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This paper aims to overcome this gap and is dedicated to comprehensive analysis of barriers of transformative changes towards carbon neutral society and drivers that can influence successful societal transformations. The policies and measures aiming to cope with barriers of societal transformations and support drivers of these processes are discussed.

The paper is organised in the following way: in second section literature review on societal transformations towards carbon neutrality; in third section methods and data are described; in fourth section the barriers of transformative changes are systematized; in fifth section drivers of societal changes are investigated, in sixth section policies and measures are defined to cope with barriers and support drivers, in seventh section conclusions are provided.

2. Literature Review

The definition leverage points, firstly was introduced by Donella Meadows (2008). This concept aims to define places to interfere in a structure where a minor modification can provide for a huge change in behavior (Meadows, 2008, 2008). So, it is important to analyse various drivers of system change having impact on low carbon energy use in terms of technology, institutions, behavior, and culture.

A system under consideration can be economic sector, business enterprise, region, city, community and so on. Meadows (2008) defined 7 leverage points and ordered them from the lowest degree of impact to the most significant impact for transforming the system.

Authors in analysis of societal transformations towards carbon neutral society highlights the importance of governance for transformations. (Biesta, 2016; Bodin, 2017; Folke et al., 2005; Loorbach, 2010; Loorbach et al., 2010, 2017; Patterson et al., 2017).

In developing or lower income countries the handling with ongoing societal deep decarbonization transformations were built on continuing governance of economic and social transformation. (Linnér & Wibeck 2020, 2021).

The governance of economic and social

transformations is the control of powers dedicated to seizure handlers making societies more robust in handling ongoing long-term change and following problems of dynamical complexity.

The authors (Brondizio et al., 2019; Chan et al., 2022; Constantino et al., 2022; 2020; Diaz et al., 2019; Kuenkel 2019; Linnér & Wibeck 2021; Lu et al., 2020;) mentioned a wide range of drivers including technological innovations, financial incentives, education and changes in attitudes having impact on societal transformations towards carbon neutrality. Leadership, new values, environmental awareness, public participation, and communication, institutional change, technological innovations and deployment were defined as significant factors for delivering important transformations to the set objectives of deep decarbonization. Education and capacity building for lifestyle changes are aimed at empowering population to initiate structural changes in systems and archetypes. Lifestyle changes usually are being considered as second-order enabler of systematic changes instead of primary driver. This is because lifestyle changes were enabled by specific interventions as well. The main policies and measures to change life style are awareness-raising and regulations. Shifts in perspective is also being treated as second-order enabler as it is result of transformative learning or creation of new narratives.

Transformative changes in societies necessitate macro-level changes in societal structures entailing agencies, laws, norms, technological and other innovations, market instruments etc. (Chan et al., 2017, 2019, 2022; Kolmuss & Agyeman, 2002; Larson et al., 2015; Lorenzoni et al., 2007).

According to (Baker et al., 2019) transformative change captures transformations of individuals including their behavior and also their choices, values, motivations, and perceptions underlying their behaviors. Individual behavior changes may have impact on the way societal systems are formed, and societal systems postulate policy-making backgrounds for individuals and society (Seto et al., 2016; Sovacool & Griffiths, 2020)

Thus, for realising transformative societal change it is necessary to employ consolidative method that intensely involves individual-level and structural-

level elements as societal transformations can be obtained due to interface between these elements (O'Brien 2015, 2018).

There are several possible actions that individuals can pursue to encourage low carbon transitions. Some of these actions are in line with individual purposes or targets, whereas other actions are initiated by wider collective interests. Whereas these specific actions are called as pro-environmental actions, they are linked to diverse instruments and processes of encouraging social changes. Based on the assumptions of Stern's theory (Stern, 2000; Stern et al., 2011) and study by Larson et al. (2015), the individual actions linked to transformative change can be grouped in sets: private, social-signaling, and system-changing actions of environmentally significant behavior. These action groups represent the distinctive contributions of individuals which can be solely individual or a group contribution by entering into a broader action targeting important societal outcomes. For implementation of transformative societal change it is necessary to consider each group of actions instantaneously.

The first group of action, namely private actions, are behaviors that individuals perform solely in order to decrease their private negative environmental impacts (Kuenkel, 2019). These type of individual actions include recycling, energy and water conservation, environmentally conscious purchasing, and so on. They also contribute to a decrease of demand for energy or water, but they do not automatically create purposeful waves spreading through social media among great number of population. Therefore, most of private actions are restricted to individual decision making and do have impact on solving structural problems.

The second group of actions or social-signaling are individuals behaviors aiming to share them with other people and signal their pro-environmental values and attitudes, for others. They include sharing of their attitudes and behavior patterns on social platforms and networks, wearing special badges or/and T-shirts with environmental slogans, joining mass pro-environmental events like Earth Day etc. Such types of actions are contributing to spreading new social norms of responsibility for nature and linked values and inspire other pro-

environmental actions (Klain et al. 2017).

The last group of actions, namely, system-changing actions are the most important group of behaviors then people perform collectively with the aim to change institutions, regulations, laws, policies, corporate actions, etc (Constantino et al., 2022; Geels & Schot, 2010;). These actions involve collective meetings, petition signing, specific voting, civil non-compliance actions, contributions to NGOs and various environmental organizations. These actions encourage systematic changes and has impact on many people behavior through policies and measures, laws and institutions etc.

The three group of actions are driven by four important factors (Linner & Wibeck, 2021). Therefore, the four drivers of societal transformations towards carbon neutrality are the following: technology innovations, political economy redistribution, new narratives, and transformative learning were highlighted in various studies (Linner & Wibeck, 2020, 2021). These drivers can be considered as interventions in the societal systems (levers) at specific places (leverage points) (Chan et al., 2017, 2019, 2020). They have important consequences in various contexts for various actors having divergent or opposite priorities and contradictory visions (Naito et al., 2022).

3. Approach and Methods

The main approach followed in this paper is the review of barriers and drivers of societal transformations towards carbon neutrality in order to systematize policies and measures targeting these barriers and strengthening drivers.

The main methods applied are: analysis and synthesis and qualitative assessment of barriers and drivers for societal transformations towards carbon neutrality based on the results of recent scientific research conducted in this field. Therefore, the qualitative research method was applied for analysis of the main leverage points and levers of societal transformations towards carbon neutrality.

4. Barriers of Transformational Changes Towards Carbon Neutrality

The main barriers of transformational changes

in society towards carbon neutrality are summarized in the main following areas: cultural barriers, economic barriers, governance and organizational barriers, technological and technical barriers, social

and behavioral barriers (Lorenzoni et al., 2007; Lu et al., 2020; Seto et al., 2016;).

Detailed explanation of barriers is provided in Table 1.

Table 1

Barriers of Societal Transition Towards Carbon Neutrality

Types of barriers	The main barriers
Cultural barriers	Aggressive driving like tailgating, speeding, horn honking, obscene gestures, red-light running, blocking the passing lane etc.; Autonomous/connected vehicles or self-driving cars; Shared (car pooling and /ride sharing) mobility; Solar energy systems installed in households; Improved cookstoves, or cleaner cooking devices; Energy efficient heating systems in households High operational costs;
Economic barriers	Additional capital costs for demonstration plants and industrial deployment; Limited access to funding and financing; Limited financial support institutions; Unknown and rapidly changing market conditions
Governance and organizational barriers	Limited availability of qualified staff; Intellectual property management etc.; Various limitations linked to emissions-related legislation; limitations associated with social acceptability and environmental protection; uncertainty related to carbon contracts etc.
Technological and technical barriers	Limited infrastructure for renewables etc. Limited accessibility for raw materials Limited availability of renewable energy Limited technical expertise and capacities Risk of unsuccessful development.
Social and behavioral	No habits to save energy, water of other natural resources; Resistance to change; Rebound effect; Social comparison with neighbours Social norms and networks having impact on specific behavioural norms Perceived inequality by raising the question why should I change my behaviour if others won't change? A lack of information about energy saving options and benefits Lack of information and knowledge about own's energy consumption Justification of current system or energy consumption architecture.

Source: created by authors based on (Chan et al., 2020; Folke et al., 2005; Gifford, 2011; Lu et al., 2020; Raza et al., 2018, Rejuda et al., 2018; Seetharam et al., 2019; Seto et al., 2016; Sovacool & Griffiths, 2020)

As one can notice from Table 1, cultural barriers are defined as (Sovacool & Griffiths, 2020):

- aggressive driving;
- autonomous mobility;
- shared mobility.

The cultural barriers linked to modern cooking and energy efficiency improvement in households include:

- solar panels and other renewable energy microgeneration technologies in households;
- Improved and clean cookstoves;
- Efficient electricity, heating and hot water supply systems in households.

The five specific economic barriers of low carbon transition are the following (Seetharam et al., 2019; Lu et al., 2020; Chan et al., 2020):

- High operational costs of new renewable technologies;
- Additional capital costs for demonstration plants and industrial positioning;
- Restricted access to funding and financing sources and institutions;
- Unknown and rapidly changing market conditions

Governance regimes can create important barriers for low-carbon transitions as market players can contest, delay or overturn low-carbon transitions. Moreover, there are difficulties linked to lock-in, tensions, cracks, and destabilization in terms of governance.

The governance and organisational barriers consist of the following hurdles (Folke et al., 2005; Lu et al., 2020; Seto et al., 2016):

- limited availability of qualified staff;
- intellectual property management etc.;
- various limitations linked to environmental and GHG reduction legislation;
- restrictions connected with social appropriateness and environmental security.
- uncertainty related to carbon contracts etc.

Within the technical and technological barrier category, the following barriers have been identified (Lu et al., 2020; Seetharam et al., 2019):

- Limited infrastructure for renewables etc.
- Limited accessibility for raw materials and other natural resources;
- Limited availability and intermittency of renewable energy;

- Restricted technical expertise and capacities
- Risk of unsuccessful development.

Due to intermittency and limited availability of renewable energy it is necessary to develop new infrastructure and implement large-scale storage systems and new instruments for demand-response flexibility increase. This also requires to build capacities and technical skills to implement these technical and technological hurdles.

The risks linked to unsuccessful development show the problems in reaching technical objectives or achieving them in sustainable way as sustainability issues are addressed at a later stage technologies development stage linked to industrial deployment. Therefore, the risks of unsuccessful technologies development need to be addressed in all stages of technologies development including R&D activities.

There are important behavioral barriers of low carbon transition (Gifford, 2011; Raza et al., 2018, Rejuda et al., 2018) like unavailability of habits to conserve energy, water of other natural resources; Resistance to change; Rebound effect in energy saving; Social comparison with neighbours; Social norms and networks having impact on specific behavioural norms and perceived inequality by raising the question why should I change my behaviour if others won't change? A lack of information about energy saving options and benefits and knowledge about own's energy consumption including justification of current system or energy consumption architecture are also important behavioral barriers of systemic transformations to carbon neutral society.

5. Drivers of low carbon transformations

There are four drivers (technological innovations, political economy redistribution, new narratives and transformative learning that can interfere at diverse points of the systems and encourage changes based on the Meadows concept (2008). The drivers of transformative societal change towards carbon neutrality are described in Table 2.

As one can see from Table 4 all defined drivers are important for transformative changes towards carbon neutrality in societal systems. For example, technological innovations can have impact on the size of barriers and the capacity to change the struc-

Table 2*Drivers of Transformative Change Towards Carbon Neutrality*

Drivers	Explanations
Technological innovations	Technological innovations have impact on the size of barriers for societal transformations and provide a lot of power for shifting structure of the complex systems. Technology innovation can quickly change the conditions and flows in societal structures and consequently effect the initialization of changes, the path and ate of societal system changes.
Political economy redistribution	The allocation of wealth and financial influence are the critical drivers of all transformations. The political economy is responsible for how material or non-material resources are utilised and allocated within and among society members. It shows the links and interactions among the state and agencies responsible for economic changes.
New narratives	New narratives is important driver as it can donate to directing mind-shifts necessary for transformative societal change. New narratives can incentive changes in perceptions, employ the private sphere in a collective and can influence systems of meaning and influence new actions.
Transformative learning	Transformative learning is a significant driver of transformations of societal structures which are dynamic and multifaceted. Transformative learning provides the shifts in the long run, perspective and empower attentiveness to shifts in paradigms and mind-sets and finally inspire individuals to go beyond the paradigms.

Source: created by authors based on (Chan et al., 2020; Frazey et al., 2018;; Linner, Wibeck, 2020; 2021; Winkler et al., 2022;)

ture of the societal system. Technology innovations as a driver of system transformations also has impact on the rate or speed of system changes as technological revolutions can change dramatically all conditions and flows in system. Nevertheless, the innovation breakthroughs and be uncertain and prolonged and if rapid system changes are anticipated it requires policies and measures to support technological innovations. It is necessary to stress that technological innovation and fast penetration of renewable and energy efficient technologies are critical not just for energy sector, but also for the transformations of entire societies all around the world.

Political economy redistribution between the state and the institutions regulating economic change and how resources—whether monetary, material or non-material—are used and distributed within and between societies (Caporaso & Levine, 1992; Gilpin, 2016). The main points for reasoning on political economy changes as important drivers are the following:

1. Boosting the adaptive capability to handle structural changes in societal systems;
2. Safeguarding the legitimacy and success of transformative interventions in societal structures;
3. Acceptance of political economy power arrangements.

Third important driver – new narratives have four important functions to enable a transformational societal change towards carbon neutrality:

- Incentivise perceptions of desirable societies;
- Employ the private domain in a collective story;
- Encourage systems of meaning having an impact on changes in main concerns;
- Direct new forms of activities.

In addition, new narratives, together with political economy redistributions, may provide to the mind-shifts necessary to ensure transformative societal changes.

Transformative learning is an exceptionally critical driver of transformations of dynamical and multifaceted systems, like societies. As transfor-

transformative learning can provide the shifts in long term perspectives and can empower not only the shift of paradigms and mindsets, but can finally enable individuals to surpass the paradigms.

Hence, the transformative learning can deliver instruments to handle with risks and doubts linked to the long-term planning of multifaceted systems. It enables the capacity to cope with risks and increase resilience and agility by enabling people to become environmental guardians performing important jobs to achieve carbon neutral society.

Therefore, technological innovations, political economy, new narratives and transformative learning can be considered as the main drivers of societal transformations towards carbon neutrality, however these drivers need be supported and enforced by well-shaped policies and measures.

5.1. Policies Promoting Transformative Societal Changes

The low-carbon transitions will stay inhibited without thoughtful and well-established policies and measures, research programmes etc. that can successfully cope with the barriers created by culture, behavioral barriers, economic circumstances, governance and organizational hurdles, technological and technical barriers.

So, achieving societal transformations towards carbon neutrality, requires many instruments to support drivers of transformations. For example, economic policies and measures like subsidies and incentive programmes—coupled with other instruments like information dissemination and environmental awareness rising, capacity building to develop and spread environmentally friendly and sustainable consumption and stewardship exercises whereas promoting new social norms and creating new values (Nilsson et al., 2016).

Incentive programmes are efficient policy measures including positive incentives like subsidies for renewables and clean technologies as well negative incentives like taxes, pollution trading systems and other regulations aiming at charging carbon content of the energy carriers or consumption of fossil fuels with high carbon content (Bako et al., 2022; Constatntino et al., 2022; Frazey et al., 2018; Kuenkel, 2019; Loorbach et al., 2017).

In achieving low carbon transition coordination among sectors of economy is crucial. In addition, integrating management across administrative silos and regions is necessary for providing co-benefits and avoiding trade-offs between competing low carbon transition goals among different sectors. Therefore, for implementing multiple objectives policy coherence is necessary (Nilsson et al., 2016; Peterson et al., 2017) guaranteeing the mainstreaming of low carbon transition goals across various institutions within and among authorities and developing harmonized policies and measures across sectors.

Various low carbon transition ways can be selected having different risks therefore, for the addressing emerging risks the precautionary principle should be applied, which allow to test the impact of policies before system-specific proof of impact has achieved. This requires to understand the scale of changes in advance, however in the absence of necessary knowledge of causal relationships it is very difficult to achieve as social and ecological systems often include unpredictable phase shifts (Chan et al., 2020) or reverse (Folke et al., 2005). In this case it is difficult to determine and appropriately support the main drivers in advance (Chan et al., 2020).

Policies and measures including various programmes and initiatives that pursue optimal results by predicting linear system dynamics can provide for undesirable outcomes as societal systems usually operate in nonlinear way (Seto et al., 2016).

Policies and measures can be more successful in the long term if they are designed by taking the following principles into account (Winkler et al., 2022; Zhang & Ding, 2022):

- Robustness towards uncertainty;
- Learning and adapting and cultivating system resiliency and agility via diversity and redundancy

Constant enforcement of laws or strong rule of law is necessary to low carbon transition (O'Brien, 2015). This is because rule of law is key for protecting the public interests of current and future generations from intrusion by private interests. It is important to stress that strict international and local laws and improved enforcement of existing laws are vital to ensure low carbon transition and transformations towards carbon neutral society (Seetharam et al., 2019; Winkler et al., 2022).

The well-developed harmonized a across sectors policies and measures targeting the coping with the main barriers and supporting the main drivers of societal transformations towards carbon neutrality enable faster societal transformations.

6. Conclusions

Transformative societal changes towards carbon neutrality requires analysis of barriers and drivers to shape policies and measures to cope with these barriers and support drivers. It is important to stress that transformative changes towards carbon neutral society can be achieved by interrelating transformations across societal system structures involving various social, cultural, and political contexts, while these transformations encounter conflicts among goals and inevitable trade-offs.

The main barriers of societal transformations are cultural, economic, governance and technological.

The main drivers of transformative societal changes towards carbon neutrality are technological innovations; political economy redistribution, new narratives and transformative learning.

The main policies and measures to support transformative societal changes towards carbon neutrality include: a various incentive schemes and programmes—coupled with information dissemination, education and capacity building—to ensure sustainable consumption practices whereas cultivating new social norms and values. Coordination across all sectors and jurisdictions is vital for attaining multiple objectives and demands policy coherence. The precautionary principle should be applied.

Policies need to be robust to uncertainty, able to learn and adapt and to cultivate system resilience to maintain critical functions in the face of disturbance and change. Consistent enforcement of laws is also necessary.

Policy makers should discuss with community leaders about their energy consumption and mobility needs. Policy makers can learn from the previous other policies, projects, and campaigns. Policy makers need to pay more attention on strengthening the institutional capacity of local communities by notifying and teaching them about the new technologies.

Instead of regularly trusting on imported tech-

nologies, programs can initiate and promote local design, manufacture of new technologies provided by local contractors understanding well the cultural values of their end-users. Therefore, cultural trends need to considered as a main competence necessary within the organizations engaged in implementation of low-carbon transitions.

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