P/REFERENCES OF DESIGN

CO-DESIGNING A DECARBONISATION ROADMAP FOR THE HUNGARIAN CONSTRUCTION SECTOR. A DESIGN-LED MISSION APPROACH TO STAKEHOLDER ENGAGEMENT: A CASE STUDY.

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ABSTRACT | In line with global climate goals, the decarbonization of the building sector is an urgent matter. The sector is one of the largest CO2 emitters globally, therefore its potential for emission reduction is unparalleled (IPF, 2022). The World Green Building Council (WGBC) is catalysing this process by funding the creation of sectoral-level decarbonization roadmaps. Such country-specific roadmaps set out a long-term vision for reaching net zero by mid-century for the entire industry. The Hungary Green Building Council, a member of the WGBC is currently in the process of co-designing such a roadmap together with the industry. Hungary is bound by law to reach net zero by 2050. Even though the technology for net zero buildings is widely available (Ürge-Vorsatz et al., 2020), currently there is a very low market and policy awareness on this topic (Szalay et al., 2022). The transition requires a systemic approach regarding the complex character of the construction industry made up of coevolving social and technical components (Singh, 2001). The creation of a macro-level roadmap requires the concerted cooperation of many actors, based on clear and consistent principles. Due to the complexity and interdependence of the value chain, coordinated action is challenging. The process is observed methodologically in the framework of practice based action-research. The research builds on the results of the net zero readiness market research done in 2023, where strategic design methods were employed. This paper summarizes the results of the first Cycle of research. It investigates how design-based methods can function in the Hungarian context to build the case for the engagement strategy for the roadmap where the method of mission-oriented innovation is planned to be employed. The secondary research method is qualitative case study analysis to reflect on transitional barriers and how the chosen method can help overcome them (Robson, 2002). The research contributes to developing a broader body of empirical contextual knowledge of transition barriers for an emerging field of inquiry and can inform diagnosis of problem areas in comparable transition contexts.

1. Introduction

In order to meet global environmental targets, the built environment sector also needs to deliver the required emission reductions. The sector is one of the largest CO2 emitters globally, therefore its potential for emission reduction and neutralization is unparalleled (Ürge-Vorsatz et al., 2020; IPF, 2022). Net zero carbon buildings (NZCBs) are recognized as viable solutions in this context (Ohene et al., 2022a, 2022b, 2023; Pan-Pan, 2020; Þórólfsdóttir, 2023).

Regulations and policies play a key role in promoting NZCBs, with governments globally committing to achieving zero carbon emissions between 2030 and 2060. There is also an increase in market demand for sustainable properties, which is a key catalyst behind the growing interest in NZCBs (IPF, 2022; WGBC, 2022). However, the industry's consciousness of the scale of the problem and responsibilities varies across geographies (IPF).

While there is global advocacy for NZCBs, a consensus on precise parameters and requirements remains elusive (Ohene et al., 2022a; Ohene et al., 2022b; Ohene et al., 2023; Pan-Pan, 2020; Þórólfsdóttir, 2023). Even though the technology for reaching NZCBs is considered widely available (Ürge-Vorsatz et al., 2020), the transition requires a systemic approach taking into account the complex character of the construction industry made up of coevolving social and technical components, such as technologies, policies, infrastructures, markets, institutions, and behaviors, construction industry business and organizational models, demand patterns (Singh, 2021). The complexity and interdependence of the value chain make coordinated action for delivering net-zero (NZ) solutions challenging, requiring concerted cooperation among stakeholders based on clear and consistent principles and criteria (Ohene et al., 2022a; Þórólfsdóttir, 2023). To facilitate this process, design-based methods are increasingly applied in the net-zero transition contexts (Bailie et al. 2023; Wachsmuth et al., 2023; Corr et al., 2023).

In line with the above developments, the Hungarian construction sector also needs to prepare for the transformation and achieve the necessary emission reductions. Even though Hungary is among the few countries obliged by law to reach NZ by mid-century (Act XLIV of 2020), there is a very low market and policy-maker awareness of NZCBs (Szalay et al., 2022).

The Hungary Green Building Council (HuGBC), acting as a business intermediary organization, holds a significant role in uniting stakeholders to raise awareness of NZCBs. It currently represents 156 individual and company members across various segments of the construction sector (see Figure 1 in Appendix). HuGBC leverages its membership in the World Green Building Council (WGBC), a globally operating NGO and a thought leader in the area, to access international best practices and recent developments in the field. The organization currently participates in two WGBC programs aiming to build industry capacity for the NZ transition through the creation of decarburization roadmaps - the *Advancing Net Zero* (ANZ) project at the company level and the *BuildingLife* project at the sectoral level (WGBC, n.d.a, n.d.b).

The ANZ project aims for global buildings to achieve net-zero carbon from 2030 to 2050. It develops tools and programs, including the *Net Zero Carbon Buildings Commitment* (the Commitment), challenging industries to decarbonize building operations by 2030. Signatories of the Commitment accelerate market transformation by acting ahead of mainstream players. Hungary joined the ANZ program in 2022 to advocate for its goals locally (WGBC, n.d.a).

In addition to engaging individual actors, many Green Building Councils (GBCs) commit to developing sectoral strategies for decarbonizing the built environment (Þórólfsdóttir, 2023). These roadmaps outline a vision for achieving NZ by mid-century, incorporating stakeholder action plans. So far, thirty-one countries, including ten in Europe, have published such roadmaps. The *BuildingLife* project harmonizes this process in Europe, and HuGBC is currently involved in the roadmap co-creation with its members and wider industry stakeholders.

In order to explore how to engage its members towards the targets of the ANZ project, HuGBC ran a Net Zero Readiness Stakeholder Research. It aimed to explore barriers and enablers towards the transition to NZCBs. The research also employed design-based methods to develop the engagement strategy and to test a potential tool for engagement. The process was observed in the frame of an action research cycle. The results form the basis of the engagement strategy for the sectoral decarbonization roadmap. This paper summarizes the results of the first cycle and gives an insight into a work in progress with regards to the second.

2. Theoretical Background and Literature Review

The paper frames the decarbonization of the built environment as a transition within a socio-technical regime, encompassing established systems of technologies, building practices, regulations, and actors shaping the design, construction, and maintenance of buildings and infrastructure (Singh, 2001). Transitions are primarily place-based phenomenon, embedded into specific political, institutional, regulatory, and economic settings (Ehnert et al., 2018). It can be conceptually analyzed through the lens of sustainability transition studies and system innovations (Elzen et al., 2004; Markard et al., 2012; Markard et al., 2020).

This view of transition stresses the importance of a multi-level and multi-stakeholder perspective and entails the involvement of actors not traditionally tackled in innovation management and policy (Geels, 2011). It places great emphasis on the collaboration among diverse entities, including state policymakers, regulatory agencies, local authorities, NGOs, citizen groups, private companies, industry organizations, special interest groups, or independent individuals (Kemp et al., 1998 as cited in Elzen et al., 2004). While emphasizing the state's crucial role in driving systemic change, innovation in this context is positioned as a collaborative effort, giving significant importance to bottom-up approaches (Foulds et al., 2023). They act as intermediaries with the capacity of mobilizing communities, facilitating knowledge creation and transfer, fostering civic innovation and allowing room for experimentation (Jütting et al., 2020, Foulds et al., 2023). As such they have the capacity to generate impact on the policy level (Elzen et al., 2004, p. 80.). However, the role of the agency of various actor groups during transition processes, including the strategies of firms has been relatively overlooked in the existing literature on socio-technical transitions (Farla et al., 2012; Markard and Truffer, 2008a as cited in Markard et al., 2012).

Design approaches (e.g. service design, strategic design) are considered as adequate methods in the context of sustainability transitions and systemic change (Jütting, 2020; Whichler, 2018). They can facilitate collaboration, integrate knowledge from various disciplines, help frame challenges and develop clear visions and roadmaps for breaking down missions into actionable steps (Le Masson et al., 2017; Magistretti et al., 2021 as cited in Rabello, 2023). Within the context of sustainability transitions, transition design is becoming a separate and emerging field of inquiry (Gaziulusoy and Ryan, 2017; Gaziulusoy and Öztekin, 2019; Gaziulusoy, 2019).

Research on the relationship between innovation and design ecosystems at the country or regional level is limited (Whicher, 2018). While several studies explore design methodologies in the context of sustainability transitions (e.g. energy, circular economy, transportation) (Glowacki, 2020; Whicher, 2018; Mullaly et al., 2022; Cohen et al., 2023; Baile et al., 2023; Wachsmuth et al., 2023; Gaziulusoy and Öztekin, 2019; Silver, 2022; Auvinen, 2023; Corr et al.), research on the role of design-based methods in building decarbonization is limited and primarily concentrates on technological aspects (Moren-Rangel et al., 2022) or other geographical contexts (Glowacki, 2020).

Most studies in the context of building decarbonization concentrate on various types of technological and socio-political barriers related to the performance and market uptake of NZCBs (Ohene et al., 2022a, 2022b, 2023; Pan-Pan, 2020; Þórólfsdóttir, 2023). Little empirical research exists concerning emerging markets (Ohene et al., 2023). In the Hungarian case of NZCBs, studies have focused on technical characteristics (Ürge-

Vorsatz et al., 2020; Szalay et al., 2018), but the wider range of NZCBs barriers, including policy, political, and cooperative ones, remains underexplored. Some recent studies have examined sustainability transition with a focus on the urban level (Siko-Tomay et al.; 2023; Óvári et al.; 2023; Ehnert et al., 2023) but with limited focus on design-led stakeholder engagement processes (Varjó et al., 2023) and/or the role of NGOs (Neulinger et al., 2023), especially in the context of the building sector. No research was found specifically focusing on stakeholder connectivity in the design of building sector decarbonization within Hungary.

3. Methodology and Research Questions

Considering the above research gaps, the present research aims to apply a multi-stakeholder perspective in order to develop a qualitative case study, informed by action and stakeholder research to answer the following questions:

1. What are the barriers that constrain the transition to NZCBs in Hungary?
2. How can HuGBC engage its members towards the ANZ Commitment and to develop company-level decarbonization roadmaps?
3. How do design-based methods work in this particular geographic context of building decarbonization in helping stakeholder engagement and collaboration?
4. Are design-based methods suitable for the sectoral level roadmap co-creation and what lessons learned from the stakeholder research (Cycle 1) can be utilized in that process?

The research used mixed methods, both quantitative and qualitative.

The primary method used in the study is collaborative inquiry in the tradition of action research (AR) (Reason and Bradbury, 2001). AR falls is a form for engaged scholarship and suits well for studying sustainability transitions. According to the theorist who originated the method, change is facilitated more by identifying and removing barriers than by reinforcing enablers (Coghlan and Miller, 2001). The best way of understanding the system is to change it, and accordingly, AR is increasingly used in system change and sustainability transition contexts (Bartels et al., 2020).

The first cycle of the research was the Net Zero Readiness Stakeholder Research aiming to engage companies to produce company-level decarbonization roadmaps. The aim was to assess their level of awareness and practices on building decarbonization, and their readiness to join the ANZ Commitment. It also aimed to inform the development of an engagement strategy and to explore the role HuGBC can play in accelerating change. The research also aimed to inform the actual state of the sector from the NZ transition perspective.

The lessons from the first cycle served as the basis for the second, the engagement plan for the sectoral level roadmap and the roadmap itself.

Data is derived from the quantitative and qualitative phases of the stakeholder research as detailed below and is supplemented by observational data obtained through participant observation by the authors practitioners throughout the process. This is extended by notes and observations from the design team based on the conviction that participant observation produces significant insights when combined with other primary and secondary data (Lofland et al., 2006; Brannan and Oultram, 2012 as cited in Rabello et al., 2023).

The secondary research method was a qualitative case study analysis of the transitional barriers based on in-depth information from a small number of individuals (Robson, 2002).

The research adopted the organizational level as the unit of stakeholder analysis (Avelino et al., 2016 as cited in Argyriou, 2023). A heterogeneous group of stakeholders from the policy, market, industry, and third sector were approached.

3.1. Cycle 1: Net Zero Readiness Stakeholder Research

The first cycle was composed of 2 phases. The first part was a stakeholder research conducted by HuGBC by two researchers (program manager, and sustainability consultant). This then informed the design research phase run in cooperation with a service design agency (second phase) where two service designers joined the team.

Research among HuGBC Members

In the first phase stakeholder research among HuGBC members was conducted.

It started with a literature review that culminated in the publication of a position paper entitled *Zero Carbon Guideline* (Beleznay et al., 2023). This paper aimed to provide a baseline understanding of NZCBs synthesizing international knowledge (certification schemes, regulations and standards and developed an NZ definition suitable for the Hungarian context).

Then a non-representative online questionnaire was circulated among members of the organization to assess their attitudes and practices vis á vis the papers' findings. Among 136 members 60 responses were collected (Figure 2 in the Appendix).

The results of the questionnaire set the scene for the semi-structured interviews (N = 14) (Figure 6 in Appendix). The aim was to select frontrunners in NZCBs with decision-maker capacity, representing a wide range of actors across the industry including non-members (from policy and related industry fields). Interview participants were asked to describe enablers and barriers and potential solutions and potential first steps to reach the NZCBs sector by 2050.

Phase 2. Inclusion of Design-Based Methods in the Stakeholder Research

The results of the first phase informed the commissioning of a service design agency with the aim to inform the development of the engagement strategy. Two service designers were assigned to the project. They were also tasked to be external eyes, "critical friends" in AR terms in the research.

This phase also aimed to lay the groundwork for meaningful interactions, align stakeholders and gauge their engagement levels to foster a conducive atmosphere for co-creation.

The second phase was composed of 3 steps:

Step 1. Define: two workshops were organized to define the objectives for the process and mapping stakeholders in a Power Interest Matrix. The agency also looked at the interviews and mapped the results into a COM-B model (see below).

Step 2. Co-creation workshops: to test a potential engagement tool, named as a "roadmap template". It was conceived as a strategic gap analysis framework that took the steps and objectives set in the ANZ Commitment as a benchmark and looked at companies' current status, gaps and potential next steps towards it. Stakeholders were grouped as property owners and tenants and could provide feedback on this prototype tool during the workshops (see Figure 7 in the Appendix).

Step 3. Stakeholder workshops: running parallel to Step 2. This third step aimed to look at collaboration opportunities between stakeholders and test a future-oriented design game called Sustainable Future Game (participants in Figure 8 in the Appendix).

Justification for the Design-Based Tools Selected for Phase 2

The COM-B Behavior Change Framework

The COM-B behavior change model (Michie et al., 2011) was used as a key analytical tool in the second phase. It comprises Capability, Opportunity, and Motivation, providing a comprehensive framework to understand and analyze behavior. This model was applied to systematically assess stakeholder's attitudes towards the ANZ objectives. By doing so, valuable insights into the dynamics of behavioral patterns were gained, informing strategies for positive changes aligned with ANZ objectives. Interview transcriptions were meticulously coded to align with COM-B themes, forming the foundation for guiding creative activities in subsequent workshops. This coding system ensured systematic examination and analysis of all data through the COM-B model, offering a cohesive understanding of stakeholder dynamics towards the ANZ initiative.

Integrating Future Scenarios and Gaming for Stakeholder Engagement

Games, traditionally used in urban planning for deliberation and scenario testing (Alexander, 1979), took on a novel role within the context of the research. Their integration with future thinking, crucial for shaping sustainable futures, presented a unique opportunity for engagement. Designed for purposes beyond play, games can become powerful tools for exploring speculative futures, encouraging participants to break from routine thinking and generate desirable alternatives (Rupprecht et al., 2020). The game was adapted to the built environment context based on two game models (Sustainability Futures Game (Hellon, n.d.) and the Nordic Urban Mobility 2050 Futures Game (Nordic Innovation, n.d.)). The resulting game focused on crafting built environment scenarios for 2050, fostering discussions on future states and serving as a basis for prototypical projects. The game sessions aimed to facilitate collaborative exploration, dissolve information silos, and build trust through engagement based on agreed principles (Ampatzidou et al., 2022).

4. Analysis of the Results of Cycle 1

4.1 Drivers and Barriers of Building Decarbonization and the Role of HuGBC

There are 175 signatories of the ANZ commitment on a global level (WGBCb, 2023). Besides companies, public authorities, cities, and regions can also join. Two of the corporate signatories have an outlet in Hungary: a technology company and a building manufacturer, both members of HuGBC. The initial hypothesis of the research was that members of HuGBC wouldn't be ready to sign the *Commitment* due to a lack of capabilities and motivation as it represents a very advanced trajectory within the market of voluntary schemes in building decarbonization. This assumption was based on the literature review and the initial interviews with regional GBCs (Poland, Croatia) and was confirmed by the stakeholder research.

The research has shown that 80% of respondents to the online questionnaire have already taken steps to decarbonize their buildings (for respondents' composition see Figure 2 in Appendix). Reducing energy demand is the most common decarbonization objective, followed by mechanical systems and building automation, strategy development, improvement of the building envelope improvement and the use of on-site renewable energy (Figure 3). Circular resource use and reducing the embodied carbon impact of built-in materials are among the most important and most challenging topics (see Figure 4).

According to respondents' commitment to climate change mitigation and associated branding/PR objectives are the primary drivers (Figure 5), while barriers include high costs, lack of customer expectations and lack of an expert base and decision support strategy. From interviews, it turned out, however, that efforts to reduce operational carbon emissions are driven by the energy crisis.
Global companies with Hungarian subsidiaries lead the way in building decarbonization. But even those companies face challenges regarding the delivery of NZCBs. Even if companies in the construction sector do have a sustainability strategy this does not include determining a pathway on how to reach NZCBs and portfolio by 2030/2050. The high costs and skills requirements to design and deliver NZCBs and the low

demand from clients and investors make the situation more difficult. This is also hampered by a data challenge (lack of available country-specific databases, and lack of transparency of data sources).

Most actors expect an increase in climate ambitions from regulatory change. In this regard the EU Taxonomy (EU, 2020), the Corporate Social Responsibility Directive (EU, 2022) and the current review of the EPBD (EC, 2022) represent opportunities, however, “there is a lot of fumbling in the dark about the concrete effect of these regulations”, as one interviewee put it.

Three key thematic areas emerged from the research where HuGBC should concentrate its efforts.

The first is the lack of appropriate data and measurement systems. Only 30% of respondents to the questionnaire use energy and CO2 emissions records. Moreover, the interviews showed that even frontrunners struggle with this challenge, which also relates to the organizational challenge of developing the right data strategy and new internal processes. This currently hinders commitment as if companies want to set realistic targets, first, they need to know where they currently stand. This could be accelerated with a country-specific scope and target.

The second is education and awareness-raising where HuGBC could step in more actively. 60% of respondents mentioned the need for education on NZCBs. Lack of knowledge on whole-life carbon assessment and methods for embodied carbon measurements are the most sought-after knowledge. This simultaneously means an internal organizational challenge (training need for employees) and the educative role companies might have within their supply chain. Respondents expect "concrete guidelines, case studies, life-cycle analyses based on local and regional data, and best practices to reduce embodied carbon." According to the research, educational activity should focus on the data challenge, internal training revealing climate risks, and the links between ESG compliance and building decarbonization.

The third challenge is the need for new kinds of collaborations based on the culture of openness and transparency that allows for the sharing of best practices. All stakeholders agreed that to achieve the desired carbon-free vision, partnerships and cooperation must be strengthened. The research showed that companies are in the competing phase but to achieve systemic change there is a need to move towards a non-competitive cooperation (Beleznay et al., 2023).

Based on the COM-B analysis, a lack of customer expectations and financial resources can be considered as a lack of opportunity and motivation, however, they are also capability issues, which HuGBC can tackle with an appropriate training portfolio and as a platform of good practices. Apart from the professional service provider stakeholder group, there is no difference between the stakeholders in this regard.

However, to promote corporate engagement, new ways of segmentation are also needed; In the case of front runners (mostly those following a parent company strategy), it is not fear or motivation that needs to be addressed. They make committed and conscious decisions. Their challenge is the international transformation process and a lack of knowledge and data measurement procedures. On the other hand, companies at the beginning of the decarbonization journey have fewer resources but more freedom to adapt their processes. Therefore, HuGBC can have a greater role and impact in facilitating corporate engagement (Figure 9 in Appendix).

The research identified three key players and their challenges HuGBC should focus its activities on:

1. Users as drivers – Users currently lack the knowledge and often the need to create a low-carbon environment. Even with a strong will to change behavior is not clear.
2. Real estate developers as innovators – The transformation processes in large companies are slow and influenced by many factors simultaneously (strategy creation, changing of internal processes, education).
3. State as regulator – The right incentive system, and measurement-based ratings are essential drivers for transformation, which requires increased advocacy efforts.

The research identified three other target groups:

1. New generation – To meet the needs of building users and related students. The office environment and energy use context is a good opportunity for community engagement and partnership building to support responsible use patterns.
2. Utility companies and financial institutions – are less integrated parts of the construction ecosystem, but as both their interest and impact is high, their inclusion is pivotal in the roadmap creation process.
3. Start-ups – integrating start-ups and small businesses experimenting with technological innovation, and new business models into the ecosystem.

These lessons are also consistent with the directions of the ongoing global reassessment of the ANZ project, which is currently being run in consultation with WGBC members and key local industry players.

4.2 The Potential for Design-Based Methods in Sparking Stakeholder Engagement Towards Decarbonization Objectives

In assessing the evaluation of design methods within cycle one, it is essential to establish clear criteria considering aspects such as effectiveness, usability, inclusivity, and adaptability. These criteria serve as guiding parameters to systematically evaluate the success and potential challenges associated with the implementation of design methodologies.

Effectiveness: The tools introduced strategic decision-making methodologies, extending beyond the ANZ project. For instance, they provided insights into which stakeholders would be strategic partners worth strengthening ties with. Interviews and the availability of data unequivocally revealed future ANZ ambassadors. Furthermore, during the future games session, previously less visible players in the ANZ context, such as small manufacturers, were effectively engaged.

Challenges arose from the intention to align with the global ANZ Commitment framework. Interviews highlighted limitations in the roadmap template, affecting its ability to address distinct organizational issues. This led to adjustments in the design of co-creation workshops. While awareness increased, workshops underscored the ongoing need for refinement. This is consistent with the finding that context-specific conditions should be taken into account when replicating and transferring solutions (Foulds et al., 2023). On the other hand, new opportunities have been identified through workshops.

Usability: the games and co-creation sessions successfully reinforced participants' belief in the necessity of closer collaboration. These methods achieved their goal as far as they motivated and engaged participants expressing commitment to initiating changes in collaboration frameworks and promoting more active knowledge-sharing. However, within the ANZ context, which typically emphasizes data-driven methodologies and organizational inertia, some participants found tools like games challenging. This aligns with usability concerns raised in various studies, questioning the tangible results of games. Despite their reported benefits – in providing a comprehensive understanding of complex systems, fostering idea

generation, and a 'fun way' of learning –, challenges in adoption persist. The limited application of serious games and gamified activities in urban planning can be traced back to apprehensions about their immediate, tangible impact (Vervoort, 2022).

Inclusivity: HuGBC engaged with 102 stakeholders, extending the reach of ANZ initiatives beyond the construction sector. While utility companies and financial institutions were included, the implementation of inclusivity remained partial. Inherent limitations, common to NGOs, led to engagement within existing motivated members. However, even among this group, critical voices emerged, emphasizing the need for ongoing collaborative discussions. Critical stakeholders like regulatory bodies and building occupants (e.g. representatives of multinational companies within the service sector) were absent from the engagement. However, the tools highlighted the importance of their future involvement. These initial steps mark the beginning; a fuller systemic inclusion is yet to unfold in the framework of the sectoral roadmap creation.

Adaptability: Cooperation between the research and design team faced obstacles because of several reasons. The abstract and experimental nature of design methods was challenging, particularly for someone with an engineering background lacking prior exposure to these methods, and accustomed to different mindsets and work environments. On the other hand, designers primarily focused on digital products and services found it difficult to navigate the terminology within the sustainability domain, and the lack of specific NZ knowledge made the adaptation of design methods challenging. These difficulties highlight the need for new skills for transition designers (Gaziulusoy, 2018).

Additionally, adaptability plays a crucial role in navigating stakeholder engagement's complex landscape. In a strategic move to enhance effectiveness and scalability, we have introduced advocacy roles within the ecosystem. The identification of advocates by using these methods sets the foundation for transformative advancements, ensuring continuous evolution and widespread impact. The sectoral roadmap stands as a pivotal opportunity in leveraging the identified advocates, paving the way for smoother scalability and extended influence.

4.3 Participant Engagement and Satisfaction Perspective

Stakeholder engagement, as an integral aspect of co-creation, has been meticulously addressed throughout our process, aligning with the principles outlined by Morello and Mahmoud (2018a). Recognizing the importance of a comprehensive understanding of involved stakeholders, we implemented inclusive and tailored approaches at various stages, employing a range of tools to enhance engagement. One noteworthy outcome, drawn from NGO perspectives, identified a pivotal leverage point from COM-B analysis - the deficiency in capability overshadowing motivation. This insight is instrumental for evaluating engagement and satisfaction since it precisely highlights the interventions required. The research elucidated that strengthening collaborations along the knowledge-sharing and value chain is a primary aspiration among stakeholders. The design methods also yielded promising results in drawing in easily accessible yet influential participants. Additionally, participants spontaneously extended assistance to one another during workshops, surpassing prescribed tasks, and revealing a self-driven commitment to collective progress.

Sessions encouraged participants to contemplate their individual sense of responsibility, envision alternative futures, and connect these to their real-world context played a crucial role in enhancing a sense of agency among participants. During the game sessions, participant feedback revealed unexpected opportunities for organizational-level use, emphasizing the transformative impact of the methods and their potential to foster widespread inclusion within organizations. Our experience confirmed that games could indeed play a role in reshaping decision-making models and fostering transformative change at both institutional and community levels with their “all learning together” approach (Bradley et al., 2022, based on Emerson and Nabatchi, 2015). While the unexpected organizational impact is encouraging, challenges faced by participants, such as difficulties detaching from negative scenarios and a tendency towards pessimism, show the need for further refinement.

5. Plans for Cycle 2: Sectoral Decarbonization Roadmap

5.1 Building the Case for Mission-Oriented Innovation

The co-design process of the sectoral decarbonization roadmap has the potential to engage stakeholders beyond HuGBC membership and to make it a truly co-creative endeavor, where the process itself plays as important a role as the end product. We envision the creation of a living document, constantly updated, in which all participants take ownership of the actions and collectively drive the agenda sparking further collaborations.

The results of Cycle 1 inform the planning of the engagement process. The results overall justified the use of design-based methods in our context.

All decarbonization roadmaps produced in the *BuildingLife* projects so far relied on stakeholder engagement but to varying degrees and in different methods. A traditional approach is to set up a steering group composed of key industry actors and sub-working groups segmented by types of actors (e.g. developers, construction companies, policy actors, NGOs) or building types (e.g. new built, retrofit, infrastructure, commercial, public buildings).

In our case we plan to extend this method with the inclusion of the mission-oriented innovation (MOI) approach, which has emerged as a robust method for systemic innovation, aligning stakeholders towards sustainability goals (Jütting, 2020; Bellinson 2021). It fits into our context as it has the potential of breaking down grand challenges (like climate change) into missions (e.g. zero emissions building stock by 2050) and further down into actionable projects in a multi-sectoral way. The method is also being employed in the built environment decarbonisation context at the city level (Bellinson). It will be the first time an NGO would employ the method both in the context of the *BuildingLife* project and in Hungary. This intention is justified by recent academic research where some argue that the growing interest in MOI policy, could result in NGOs taking up this method, and stresses the necessity to enhance their capacities in this regard (Jütting).

The underlying method of MOI is strategic design, which is detailed in a practical guidebook that serves as our starting point (Hill, 2022). The engagement process starts in March, the below table details the plan for stakeholder engagement.

Table 1. Stakeholder engagement plan for the sectoral decarbonization roadmap.

Activity	Justification	Output	Deadline
Literature review (12 roadmaps and academic literature)	To inform the roadmap development and the workshops	Drivers, barriers, stakeholder action plans from the 12 European roadmaps	February
Steering Group (SG) composed of 10 HuGBC members	Results of Cycle 1 mapping will inform the selection, inclusion of identified change agents	Engaged and active SG overseeing the project	February
4 SG meetings	SG work together to oversee the roadmap development and the engagement	Roadmap text	May
8 working groups (WG) per segment	To produce the action plans by segments. Segmented by 8 segments (Figure 10 in Appendix) informed by motivated actors	8 working groups per segment	February
min. 8 Working Group meetings	To produce the action plans by segments		
3 Actors Workshop	to produce a system map which can be considered as a real-time snapshot of the system (i.e. system in the room, Hill, 2022)	System maps that serves the basis of the action/mission planning, candidate mission themes	March - April
SG Design Workshop I.	to synthesize results and reframe them based on angles, levers, layers, levels (Hill, 2022)	candidate mission themes	April
3 Design Workshops	allowing for selected WGs to work in diverse setups, content is informed by the reframing process and Cycle 1 inclusion of scenario planning, visual, narrative techniques	Candidate mission themes, prototype projects, potential demonstrators	May
SG Design Workshop II.	Bringing it all together, roadmap drafting session	Refined mission themes, prototype projects, demonstrators	May

There are several challenges that can be anticipated in the process that should be addressed.

Both Cycle 1 results and the MOI method calls for greater inclusion of policy actors, in order to generate systemic impact, therefore advocacy efforts will have to be increased in this regard. This is also the direction of the current revision of the global ANZ project.

Operationalization of theoretical frameworks into practical actions may present challenges. To resonate with diverse local actors and their unique perspectives, concepts related to decarbonization must be made tangible in practice. Achieving this requires a multilateral dialogue process to break down these concepts, fostering ownership and understanding among participants.

Carbon modelling that will be produced as part of the roadmap introduces another layer of complexity, as finding equilibrium between the “desirable” and “feasible” might involve ongoing negotiation (Wachsmuth, 2023). Tensions may arise between modelled pathways and real-world situations. Balancing aspirations with practical implementation is essential in this context.

The proposed trajectory raises the potential risk of "workshop fatigue" among participants. Successful implementation hinges on strong leadership and commitment from the Steering Group and ultimately from other participants. The advocates identified in Cycle I. are expected to become catalysts by acting as ambassadors and driving the initiative forward.

Additionally, establishing a robust monitoring and evaluation process for the roadmap to become a living document, addressing a current challenge faced by other GBCs, is imperative for tracking progress and ensuring accountability.

6. Future Research and Extension of the Paper

The present paper could be extended with the results and insights gained during the Cycle 2, which is still ongoing. This would enable us to reflect on the design-based and MOI methods based on a larger sample in terms of actors engaged, workshop conducted.

Framing the results as a qualitative case study analysis guided by stakeholder theory and cooperative environmental governance perspectives, as a future research extension, could explore the wider political-economic context of the expected NZ transition, and look at the barriers (both the technical and non-technical) that might constrain the transition process in a more derailed and potentially comparative way. There is limited understanding of these barriers, but addressing them can help to catalyze the system-level change that is required for NZ vision. Such an analysis could inform the practice of professionals within the building industry by providing a context for understanding the obstacles to transition and their impact on systemic change. It is expected that if transition plans are to be successful and inclusive, it is assumed that barriers must be overcome beyond the NZ and construction sector focus.

Such an analysis of the Hungarian context contributes to developing a broader body of empirical knowledge of transition barriers for an emerging field of inquiry, namely net zero transitions and MOI. Further research can also inform the diagnosis of problem areas in comparable transition contexts.

7. Conclusion

The research revealed key, context-specific barriers hindering the transition to NZCBs in Hungary. These barriers include limited awareness, financial constraints, and regulatory uncertainties among HuGBC members. These insights underline the need for tailored engagement strategies that address these specific challenges for which the sectoral roadmap gives an opportunity. A common understanding of the NZCBs objectives for achieving greater alignment, will be helped through the roadmap creation process.

Efforts to engage HuGBC members towards the ANZ Commitment and the development of company- and sectoral-level decarbonization roadmaps are still underway. Transparency and openness, as revealed in expert interviews, are pivotal for overcoming conventional ways of thinking and acting. It requires all participants to critically reflect on their current roles and associated behavioral patterns. Businesses in this regard need to take on increased responsibility, extending beyond their individual companies to encompass their roles in supply chains and society at large. HuGBC has limited capacity and capability in changing a firm's motivation, however with carefully crafted engagement processes, could step into this arena in three key areas. By facilitating sharing of best practices, developing educational activities and promoting increased coherence in addressing the data challenge. For this the carbon-modelling for the sectoral roadmap gives an opportunity. Advocacy efforts for clearer regulatory frameworks should also be

increased. Special emphasis should be placed on actively recruiting and retaining particular groups, such as policymakers and businesses outside the existing HuGBC membership.

Design-based methods have proven effective in this context. Co-creation workshops and game experiments highlighted the adaptability of these methods, showcasing their effectiveness in fostering stakeholder engagement, creative problem-solving, and a sense of ownership.

The study finds that design-based methods are indeed suitable for the collaborative development of sectoral-level roadmaps. Lessons learned from the stakeholder research, can be effectively utilized in this process. The multifaceted approach, incorporating design-based methods, emerges as a valuable strategy for the roadmap. For this the method of mission-oriented innovation is chosen and justified, which incorporates design-methods while providing an effective framework in addressing grand systemic challenges, such as building decarbonization. Breaking away from conventional ways of thinking and doing takes a lot of effort and time. The engagement process itself requires significant motivation from participants who - partly with the help of these methods - should recognize the personal, normative, or moral advantages linked to their engagement.

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8. Appendix

Table 1. Membership composition of Hungary Green Building Council, 15.02.2024.

HuGBC membership composition	**Nr.**	**Percentage**
company members	**88**	**56**
building product manufacturers and distributors	28	18
developers, construction companies & contractors	18	12
professional services	28	18
real estate agents, property management & facility management	11	7
other	**3**	**2**
associated members	21	13
environmental NGOs, associations, and professional societies	21	
individual members	**47**	**30**
	156	

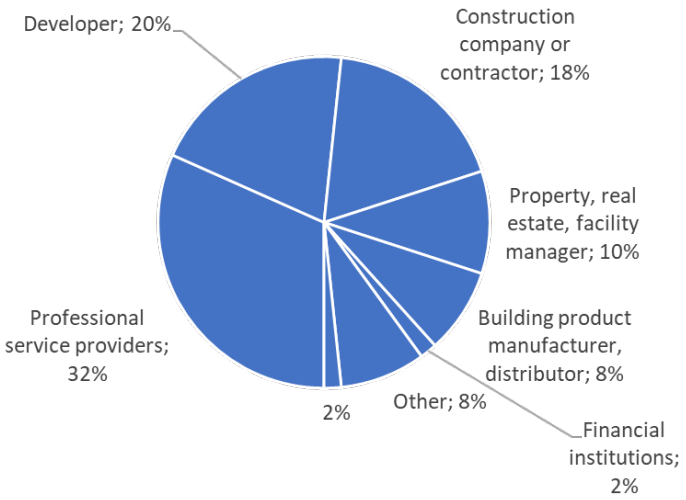

Figure 1. Respondents for the online questionnaire. By the deadline (17.04.2023) among the 134 members, 44% have completed the questionnaire, n = 60.

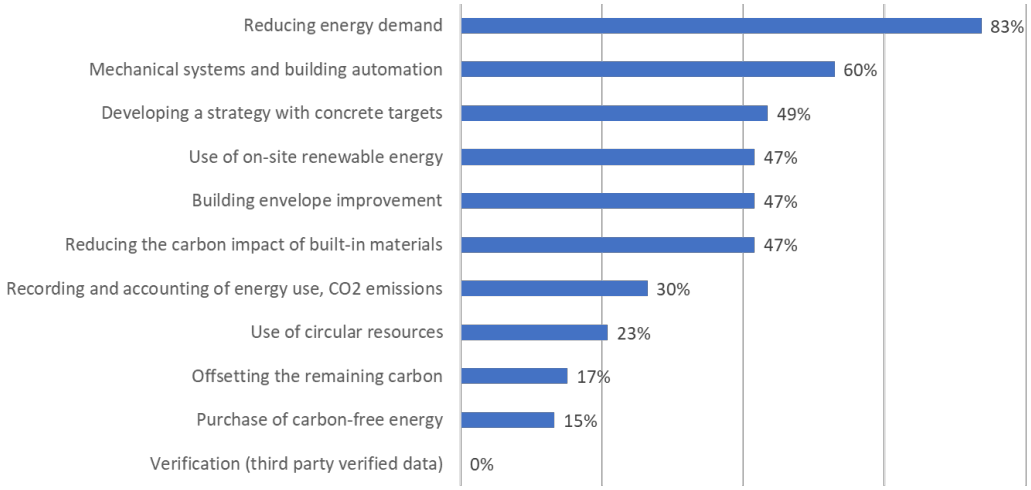

Figure 2. Decarbonisation measures employed be member companies. Question 5. Which measures are used in the realization of targets related to NZCBs? Base, who already have taken steps (N=47).

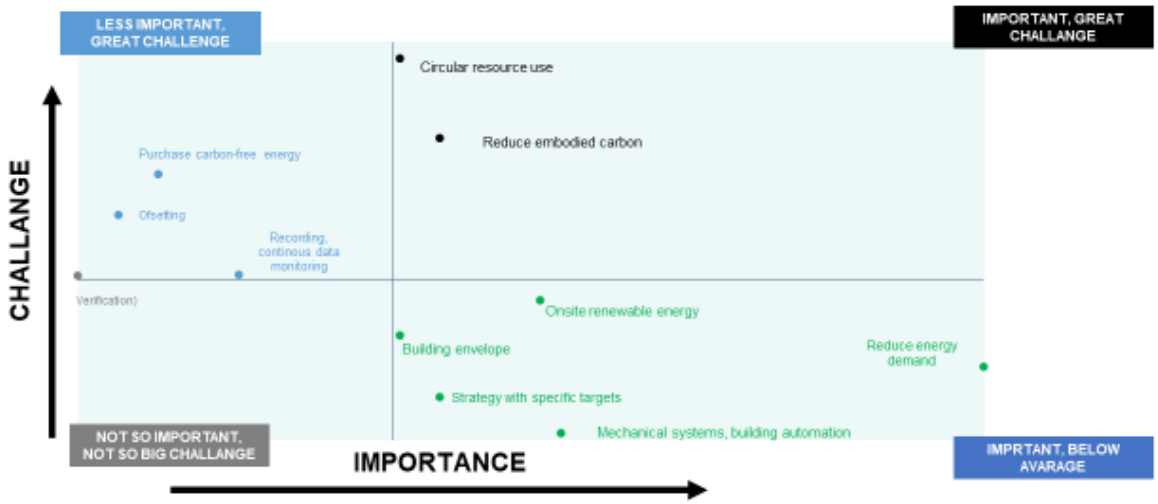

Figure 3. Decarbonization measures rated based the challenge and importance.
IMPORTANCE: Q4. Which of the following do you think are the most important in achieving the objectives related to Net Zero Carbon buildings? (N=60).
CHALLENGE: How challenging is the implementation of these for your organization? Base who rated the challenge (N=37-57).

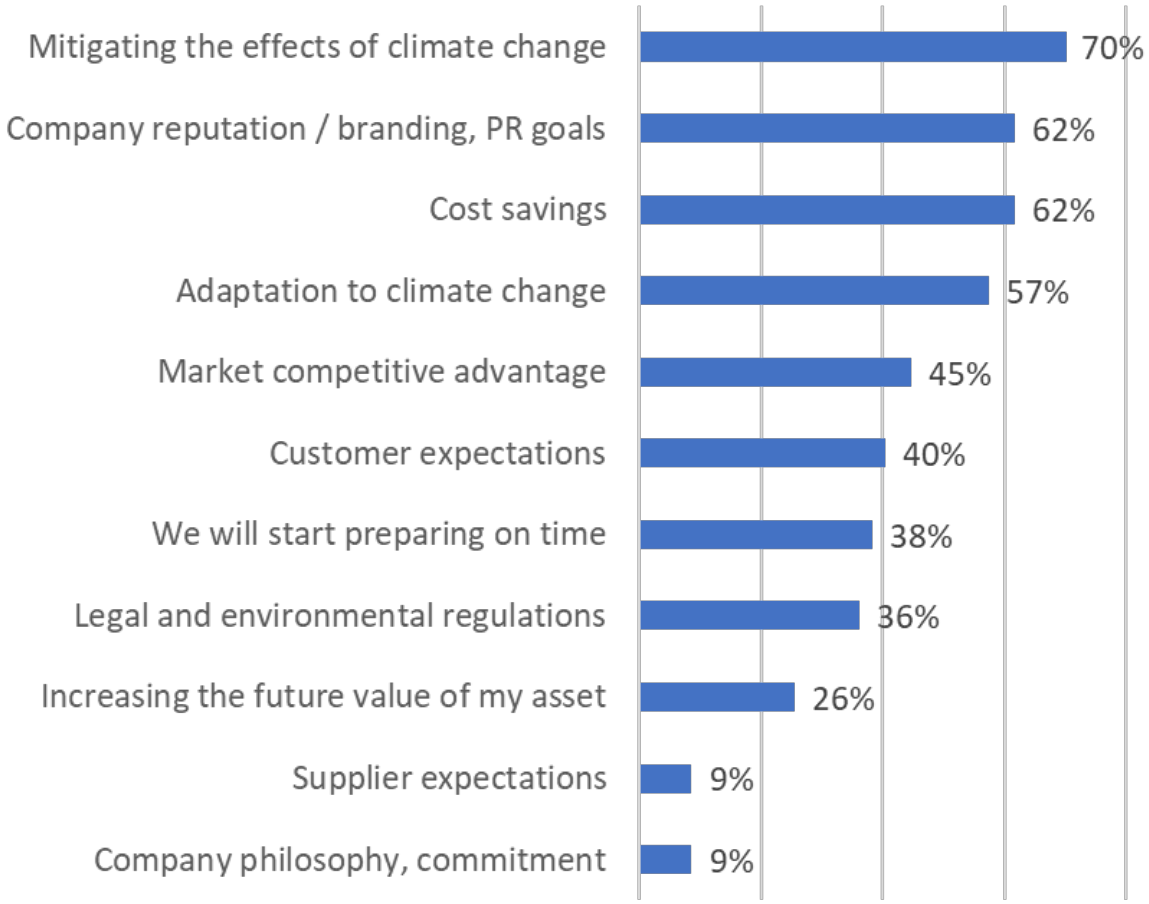

Figure 4. Drivers.
Q5. Which ones are used in the implementation of the objectives related to Net Zero Carbon buildings? Base, who have already taken steps (N=47).

Table 2. List of interviews.

Sector	Organization	Position	Rationale	Date
Utility companies, energy suppliers	Energy supplier	Deputy CEO	Bring the energy sector's perspective	17.08.2023
Building owners, property developers	Sustainability Manager	Property Developer	Net zero readiness assessment	11.07.2023
Building owners, property developers	Multinational Property Developer Company	Project Manager	Net zero readiness assessment	29.06.2023.
Building material manufacturers, distributors, suppliers	Multinational technology conglomerate	Head of Building Products	ANZ	
Contractors	Hungarian contractor company	Sustainability Manager	ANZ	05.07.2023
Contractors	Hungarian contractor company	Head of Real Estate Development	ANZ	05.07.2023
Building owners, property developers	Hungarian contractor company	CEO	market leader	26.06.2023
Building owners, property developers	Hungarian contractor company	Head of Design	market leader	26.06.2023
Building owners, property developers	Hungarian contractor company	Sustainability Manager	market leader	26.06.2023
Professional services	Consultant firm	CEO	Experienced with certificates, market overview	10.07.2023
Professional services	Consultant firm	CEO	Experienced with certificates, market overview	10.07.2023
Professional services	Architecture firm	CEO	role model	24.07.2023
Building operators, tenants, building users	American commercial real estate services and investment firm	Sustainability Manager	ANZ	27.06.2023
Building operators, tenants, building users	investment management company	Head of ESG Strategic Advisory	ANZ	24.07.2023
Professional organizations	a CEO-led organization of international companies	CEO	industry overview	27.06.2023
Professional organizations	Think tank	Head of Climate Policy	policy aspect	24.07.2023
Professional organizations	Multinational strategy and management consulting firm	Partner	industry overview	24.07.2024
Financial institution	Hungarian National Bank	Head of Department	Green finance expert	24.07.2024

Table 3. Participants of the co-design workshops / sector.

Sector	Co-design workshop 1 Focus: owners, developers	Co-design workshop 2 Focus: tenants
Building owners, property developers	5	0
Professional service providers (i.e. consultants)	1	1
Building operators, tenants, building users	0	4
TOTAL	6	5

Table 4. Participants of the stakeholder workshops / sector.

Sector	Stakeholder workshop 1	Stakeholder workshop 2
Developers, construction companies & contractors	2	2
Professional service providers (i.e. consultants)	3	2
Real estate agents, property management, facility management	2	1
Building product manufacturers and distributors	3	1
Other	1	0
TOTAL	11	6

Figure 5. Pictures from the game sessions.

Table 5. Segments in the sectoral decarbonization roadmap.

	Segment
1	National, regional and local government
2	Property and project developers
3	Financial institutions
4	Architects and engineers, consultants
5	Contractors
6	Manufacturers, distributors, suppliers
7	Building owners and users
8	Civil/professional society

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