University of Utrecht

Master Thesis

Riding the Renovation Wave

Systemic barriers in the construction sector

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A thesis submitted in fulfilment of the requirements
for the degree of Master of Science in

Innovation Science

at the Faculty of Geoscience, Utrecht University

Handed in on

January 9th, 2023

Abstract. The mission-oriented innovation system (MIS) framework is applied to study the sustainability transition in the German building and construction sector. The case study is embedded in the greater context of the European 2030 and 2050 targets and the German ones for 2030 and 2045. Since directionality for missions is exerted through policy, the multilevel governance (MLG) structure is connected to the MIS to provide another analytical lens. Following the steps of problem-solution diagnosis, structural analysis, functional analysis, and system barrier analysis, the following research questions are answered:

1. Given the context of the EU-level mission of doubling the renovation rate until 2030 as a step-stone to achieve climate neutrality in 2050, what systemic barriers hinder Germany to contribute to these goals by reaching its own the respective 2030 and 2045 goals the country has already set?
2. How does the MLG structure influence said MIS in terms of directionality and clarity?

A qualitative approach was chosen with 15 interviews, a complementary document analysis, desk research of relevant policy documents, reports, websites, and experts consulted for specific questions. Based on the analysis, various barriers were identified, e.g., the lack of definitions and data by which to assess progress, governance structures being understaffed and underfinanced and yet, of vital importance for mission progress, the inachievability of the mission of a resource, monetary, or time perspective, internal discourses of framing and lobbying put up by incumbents that cements its power by means of standardisation. Possible alleviations and solution pathways are discussed. The thesis closes with reflections on how to improve the MIS framework. The research has been completed without an internship.

Key words Mission-oriented Innovation System (MIS), multilevel governance (MLG), built environment, construction sector, mission governance, systemic barriers

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1 Introduction

La réalité va s'imposer.

Tabea Menez

Born out of a rigorous research tradition marked by varying degrees of disappointment, the now sixth IPCC report (Masson-Delmotte et al., 2021) underlines the following breakdown of affairs: If the world does not begin to drastically cut emissions, it will no longer be possible to limit anthropogenic global warming to 1.5 °C as committed to in the Paris Agreement (cf. Article 2 1. (a)). Indeed, scientific consensus does exists on that greenhouse gases (GHG) released due to human activities heat up Earth (Oreskes, 2004) and have potentially dramatic effects on human life (Hardy, 2003; McMichael et al., 2006) as well as on flora and fauna (Cahill et al., 2012; Thuiller, 2007).

Modern building construction practices provide many core necessities for human life in modern society. However, the practices of the construction sector contribute to emissions, pollution, and contamination that are harmful from the local up to the global environment (Zhang et al., 2013). Various studies conducting a life cycle analysis identified issues that range from but are not limited to the extraction of raw materials and their industrial processing, land clearing, surface sealing as well as noise, transport, and dust during construction, building use and associated emissions, direct and indirect energy use (Sharma et al., 2011), transformation of the surrounding environment, e.g., newly built roads (Mroueh et al., 2000), as well as end-of-life treatment, i.e., improper deconstruction and waste of resources due to lack of recycling practices as well as lack of adequate information and planning for this case (Butera et al., 2015). To be able to reach the climate target aims, a wide array of current practices must change. Thus, also the construction sector is in dire need of an eco-transformation.

Indeed, the sector has been under close watch of policy makers as improvement of its environmental performance has become more and more crucial: The UN Sustainable Development Goals (SDGs) 8, 9, 11, and 12 mandate the construction sector to be less polluting, more inclusive, more circular, and more sustainable (UN General Assembly, 2015). Furthermore, the European Green Deal, a set of policy measures and initiatives

to make the EU climate neutral in 2050, including targets for i.a. the construction sector (European Comission, 2019, c.f. 2.1.4). Its 'flagship'[1.a] is the housing renovation plan, requiring the annual renovation rate varying from 0.4% – 1.2% in the member states to 'at least [. . .] double' (European Comission, 2019, c.f. 2.1.4) until 2030. These targets' specific adaption into governmental policies is up to the respective member states. Thus, the European Green Deal is translated into different national, regional, and local legislation via lower-level governance institutions.

Such policy goals that set a desirable target for the good of society are termed '(societal) missions'[1.b]. Missions have experienced a renewed interest from policy makers that transform these missions and into suitable and executable policy. Their systemic effects are to provide directionality, i.e. overall direction and alignment of efforts, to the target group that is called the Mission-oriented Innovation System (MIS). It is defined as 'the network of agents and set of institutions that contribute to the development and diffusion of innovative solutions with the aim to define, pursue and complete a societal mission' (Hekkert et al., 2020). As a novum, missions and their transposition remain understudied and there is an academic and societal interest in their understanding and achievement and consequently, the identification, analysis, and removal of barriers to the mission. However, missions as top-down policy from higher governance structure to lower levels can, though well-meaning, in their varying prioritisation of connected issues be perceived as ambiguous, nonsensical, or even contradictory, thus negatively impacting the chances for mission success. As such, the two research questions that will further be specified in section 3.1 for this thesis read as follows:

- What systemic barriers hinder the building and construction sector to achieve its sustainability missions?
- How does the multilevel governance (MLG) structures influence said MIS in terms of mission directionality and clarity?

Specifically, Germany is an interesting case study for two reasons: First of all, as the EU's strongest economy by GDP, Germany inherits an exemplary role and is a 'proof of feasibility'. Secondly and because the federal and decentralised governance structure is so clearly divided, Germany makes for an interesting case study for the second MLG substudy.

[1.a] F. Simon 'Housing renovation plan will be "flagship" of European Green Deal' (Dec 2019). Retrieved from: https://www.euractiv.com/section/energy-environment/news/housing-renovation-plan-will-be-flagship-of-european-green-deal/, accessed on January 26th 2022.

[1.b] For a clarification of the term 'mission' we ask the reader to tame their curiosity until the theory chapter.

Ultimately and intimately connected to the first research question is the problem of avoiding and dealing with construction and demolition waste (CDW) that must necessarily occur when renovating and modernising buildings. Consequently, common practices such as cement production and alternative construction materials such as wood, steel, and glass play into this research question as well as their sustainable business case. The first research question further involves the societal needs addressed, the solutions at hand, and the discourse around competing or complementary solution pathways. The second question is a sub-question of the first and related to overall communication and coordination of these activities within the system sparked by the mission, as well as the problems that top-down mission spark in multilevel governance settings. Herein lies the societal and political contribution of this research.

Additionally, the intent is to contribute to the corpus of empirical mission-oriented innovation system studies of which there have not been undertaken many yet except for, e.g., the work of Wesseling et al. (2020), Hekkert et al. (2020), conferences papers like Elzinga et al. (2021), articles in review, and student theses, however, none of which on the construction sector and both on Dutch national level – Wesseling et al. (2020) focus on the impact of the Dutch Green deal on maritime ports and Hekkert et al. (2020) on circular fashion. The research question presented, however, addresses a European mission 'top-downed' to a federal nation over multiple levels of governance and the conversion and contribution these levels provide. Thus, the scientific contribution or novelty will be to use multilevel governance (MLG) literature to shed light on MIS processes that are to eventually lead to regime change[1.c], specifically, on the governance side. Herein lies the scientific contribution of this research.

[1.c] The notion of 'regime' is also postponed for later.

2 Theoretical Framework and Literature Review

Down to Gehenna, or up to the Throne,
He travels the fastest who travels alone.

Rudyard Kipling in *The Winners*
Envoi to *The Story of the Gadsbys*

In recent years, various authors with backgrounds like innovation systems, transformation policy, or economics have converged on the topic of the Mission-oriented Innovation System (MIS) – see 2.3. To understand the topic of discussion, it is vital to introduce the notion 'innovation system' – see 2.1 – and what the quality (of being) 'mission-oriented' denotes – see 2.2. For this, a brief recap with special focus on the work of Wesseling et al. (2020) and Hekkert et al. (2020) will be given and later, an additional review of multilevel governance (MLG) literature – see 2.4.

2.1 Innovation Systems

Researchers' efforts to find a context or frame within which innovation occurs resulted in, e.g., a nation's or region's boundaries due to cultural somewhat-homogeneity coupled with geographical proximity, the so-called national or regional innovation system, respectively. Born out of the complexity of the modern world, the notion of a 'system' emerged as the network of agents, entities, organisations, institutions that are connected via feedback loops through their various activities contributing to the innovation process.

An innovation system theory that left the approaches of geographical boundaries like sectoral or national is the Technological Innovation System (TIS). Like any innovation system, the TIS also is a (social) network that is constituted by actors and institutions. The TIS considers the actors and institutions relevant to a specific technology. Implicitly, however, as the TIS focuses on merely one technology, it does not acknowledge the importance of social innovations in order to solve wicked and nested societal problems – and that

the solution itself is wicked, referring to highly complex, uncertainty, and being contested (Alford & Head, 2017; Wanzenböck et al., 2020).

Efforts to assess the performance of an innovation system resulted, e.g., in the development of 'system functions'. 'System functions' refers to 'key activities' that are vital to the system's functioning in an engineering perspective, see (Hekkert et al., 2007). System functions will come back later in the thesis, and the TIS displays an array of shortcomings when applied to missions, see (Elzinga et al., 2021, p. 3 et seqq.).

2.2 MISSIONS AND BEING MISSION-ORIENTED

In their historic overview article, Schot and Steinmueller (2018) lay out three frames – i.e. reasonings or causal narratives – for innovation policy. The essential shift from frame one to frame three is that the assumption that, blatantly put, could read 'innovation is a means for creating a better world' is in doubt. Rather, the externalities generated by growth could not be addressed by those frames ex post. Thus, the starting point for frame three is that innovation cannot be equated with social progress. Rather, that innovation needs to be directed to create social value. Instead, different topics and trajectories can be focused on such that the effort is aligned in terms of a 'mission' that is to provide social benefits.

With this understanding, Mission-oriented Policy (MIP) can be understood as a compositum: MIP is policy targeted on formulating and achieving missions that aim to solve a wicked societal problem and thus provide social progress through aligning efforts to achieve a set of desirable solutions, e.g., see (Mazzucato, 2018; Wanzenböck et al., 2020). To give a more explicit understanding to the term 'mission', a mission provides direction to the innovation that is required to overcome societal challenges, and is characterised by a limited time frame, measurable goals, and a domain of societal relevance across a wide variety of geographical, sectoral, and cultural boundaries. With this, mission-oriented thinking recognises the complex interdependences between social, political, technological, economic, and other factors involved in the persistence of wicked societal problems (C. Haddad et al., 2019). Wanzenböck et al. (2020) hereby emphasise that a mission's understanding also benefits from the study of its historic development. Furthermore, Wesseling et al. (2020) stress that for a holistic approach, not only the development and diffusion of 'new' solutions must be considered, but also the active phase-out of harmful practices or 'exnovation' (David, 2017).

2.3 Mission-oriented Innovation System

It has been laid out how a MIP framework – as employed in, e.g., (Janssen et al., 2021; Wanzenböck et al., 2020) – focuses on providing directionality in formulating policy towards a desired goal of societal relevance, the mission. To allow a comprehensive study of the impact of such policies on the targeted innovation system and mission achievement, the MIS has been put forward in (Hekkert et al., 2020), defined as the 'the network of agents and set of institutions that contribute to the development and diffusion of innovative solutions with the aim to define, pursue and complete a societal mission' (idem.). As such, it is semi-independent from geographical or political boundaries and overlaps with priorly named innovation systems as shown in figure 1.

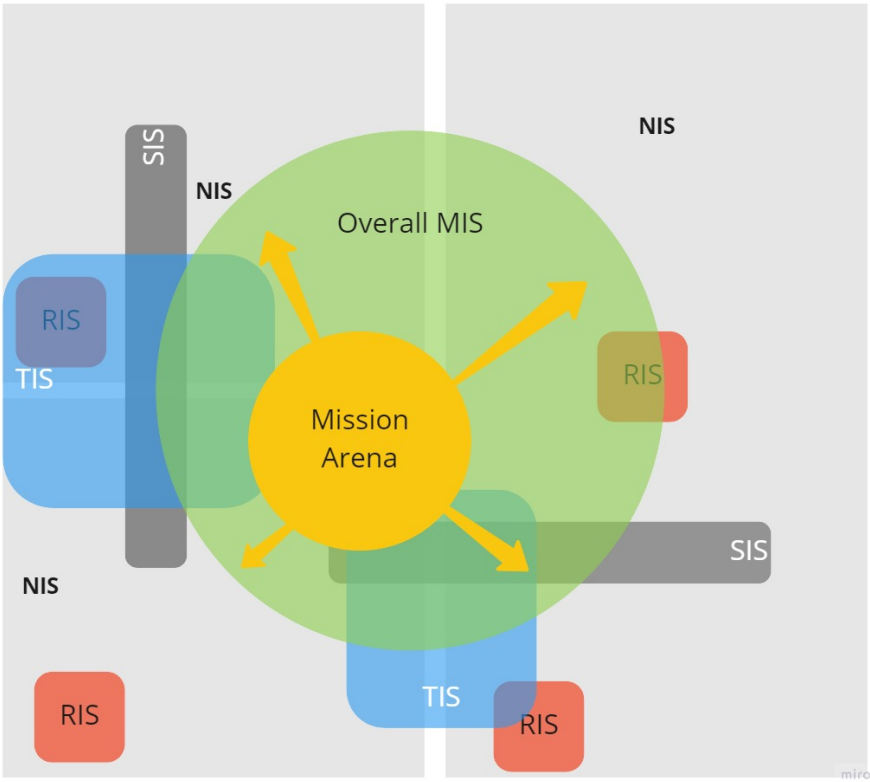

Figure 1: Contextual overview about the respective positioning of different theories of innovation systems. RIS stands for Regional IS, SIS for Sectoral IS, NIS for National IS, TIS for Technological IS. The remaining notion 'mission arena' will become clear over the course of this chapter. This graphic is self-made and inspired from Wesseling et al. (2020, fig. 1).

To distinguish between the priorly mentioned TIS and the MIS, the MIS does not restrict itself to a (set of) specific technological innovation(s) that need to scale up as a central focal point. Instead, also social innovations can be considered such as directed change in behaviour. With this, the MIS acknowledges that not only social technological innovations, but their interplay and synthesis are key to fulfilling societal missions, thereby allowing for policy evaluation and recommendations also for wicked societal problems like climate change. Next to the drawbacks and perks Elzinga et al. (2021) mentions, this is what makes the advantage of and decisive argument for using the MIS for this research question.

The system function employed in this thesis to asses the MIS performance can be found in table 1 and are except for the marked changes taken over from Wesseling's yet unpublished work currently in review. His work adds an innovation and a destabilisation side to every system function and thus acknowledges not only the need for innovation but also active destabilisation for regime[2.a] change. In the spirit of this, phrasings have been added and edited to account for this, i.e. to assert that every system function can not only be fulfilled on a scale from zero to one but also negatively fulfilled – that is, actively hindered – with a scale from negative one to one. A more historic comparison between system functions sets in earlier work Wesseling et al. (2020) and Hekkert et al. (2007) is laid out in the appendix in table 8.

Furthermore, Wesseling et al. (2020) identify a 'mission arena' – inspired by the notion of a 'transition arena', see Loorbach (2010), also referred to as 'mission's governance' – as the set of actors central to formulating and dispersing the mission. As such, the mission arena, similar to an entrepreneurial state (Mazzucato, 2015) (but also subsequent work (Mazzucato, 2016, 2017, 2018)), can activate an innovation system's structural components and direct their galvanising movement that can be naïvely conceptualised as the equivalent of charisma on a structural level, see figure 1. In other words, it provides directionality and can thus mobilise the overall MIS. Furthermore, the notion 'arena' suggests processes that are rarely unanimous but instead, highly political and internally contested which allows for changes in the mission and strategies employed. Thus, the mission arena is also involved in 'mission governance via monitoring, coordination, evaluation and reflexive redirection of the mission' (Wesseling et al., 2020, p. 6). The notion of 'inner MIS' is sometimes used synonymously with the term mission arena and serves to define the 'outer MIS' as its complement. Only mission arena and outer MIS are used here.

[2.a] Regime (change) comes from another but related school of literature, namely the MLP (Geels, 2002a, 2002b, 2006, 2012) and further development, e.g., Fuenfschilling and Truffer (2014) and Kivimaa and Kern (2016). Still, 'regime' is used here since the two perspectives have not yet been joined but study the same phenomenon. The notion merely inherits a meta-position in the MIS framework.

Table 1: The System Functions as applied in the functional analysis of this thesis based on the work of Wesseling et al. (2020) and newer publications currently in review.

System Function	defined as ...
SF 1: Entrepreneurial Activity and Disruptors[2.b]	Innovation side: Experiments with solutions (or clusters of solutions) to enable learning; entering markets for new solutions; engaging in business model innovation to foster the diffusion of solutions. Destabilisation side: experiment with destabilisation of actors, institutions, networks and technology that support harmful practices.
SF 2: Knowledge Development and Unlearning	Innovation side: Learning by searching and by 'doing', resulting in development and better understanding of new technical and social knowledge on innovative solutions, through R&D, social research and behavioural science research. Destabilisation side: Similar but for knowledge on societal problems caused by harmful practices; unlearning harmful practices.
SF 3: Knowledge Diffusion and Breakdown	Innovation side: Stakeholder meetings, conferences, governance structures, public consultations, mission progress reports and other forms of disseminating technical and social knowledge for innovative solutions. Destabilisation side: Similar but for dissemination of destabilisation solutions and societal problem awareness, including breaking down knowledge-sharing networks on harmful practices.
SF4: Providing Directionality	Besides pre-existing directional institutional structures, the mission arena is central to providing transformative direction and mobilising support from the existing innovation system structures that comprise the overall MIS. It is subdivided into...
SF 4a: Problem Directionality	The direction provided to stakeholders' societal problem conceptions and the level of priority they give it.
SF 4b: Solution Directionality	The direction given, both by existing system structures and the mission arena, to the search for new and further development of innovative and destabilising technological and social solutions, as well as the coordination efforts needed to identify, select, and exploit synergetic sets of solutions to the mission.

System Function	defined as ...
SF 4c: Reflexive Governance[2.c]	Reflexive deliberation, monitoring, anticipation, evaluation and impact assessment procedures; these provide the analytical and forward-looking and retrospective – in the sense of lessons learned through deliberate reflection – basis for redirecting the system's problem framing and search for solutions based on lessons learned and changing contexts. Reflexive governance can be seen as second-order directionality, and it can be initiated by the mission arena or by critical outsiders, and is inherently transformative.
SF 5: Market Transformation and Destabilisation	Innovation side: Creating a niche market and up-scaling support for technical and social solutions. Destabilisation side: Phasing out or destabilising markets for practices and technologies harmful to the mission.
SF 6: Resources Re-allocation and Search for Alternatives[2.d]	Innovation side: Mobilisation of human, financial and material resources to enable all other system functions. Destabilisation side: Withdrawal of resources and supportive physical infrastructure from harmful practices
SF 7: Legitimacy Creation and Withdrawal	Innovation side: Creating legitimacy for development and diffusion of innovative solutions. Destabilisation side: Creating legitimacy for prioritising the societal problem over vested interests; withdrawing legitimacy from harmful practices; lobbying against institutions supporting harmful practices and in favour of destabilising institutions; mitigate power and access of established incumbents' lobby.

[2.a] In Joeri Wesseling's work, the discussion of a disruptor is not mentioned explicitly and is an addition of the author.

[2.b] The phrasing has been edited by the author as to include ex post reflection and 'lessons learned' in order to stress a historic learning component. Without this, reflexive governance merely encompasses an ex post evaluation and learning implicitly, making the system function a scale from zero to one instead of negative one to one, i.e. not acknowledging the non-fulfilment of the function.

[2.c] In Joeri Wesseling's work, the search for alternatives is not mentioned explicitly and is an addition of the author.

2.4 MULTILEVEL GOVERNANCE

We will now review Multilevel Governance (MLG) literature with the aim of being able to discern the dynamics within the many levels of the mission arena – the exact connection of how and why this is a theoretical fit is laid out in section 2.5. Assuming most readers to be more familiar with the theory priorly laid out than with MLG literature, this review is less targeted and more overview-focussed. MLG – as governance and not government from multiple levels – has replaced the state as a centralised source of authority with many decentralised sources. Indeed, MLG is defined as the 'dispersion of authority within and beyond national states' (Hooghe et al., 2001) or 'dispersion of authority away from central government — upwards to the supranational level, downwards to subnational jurisdictions, and sideways to public/private networks' (Hooghe, Marks et al., 2001).

The decentralisation of governance stems from two logics (Hooghe et al., 2020)[2.ɦ] that also cause path-dependence in jurisdictional institutions (Hooghe, Marks et al., 2001, sec 5.2). The first is a functionalist logic that sees governance as a tool or instrument in the provision of public goods such as clean air or goods that are not economic for individuals to provide for themselves. Examples of such goods include local parks, healthcare, containing a pandemic that may spread around the globe but also externalities from, e.g., climate change. The premise is that each of these has its individual optimal scale of governance to achieve maximum functionality, i.e., the local park is best governed by a regional government and not by the UN; healthcare on national or local international level and not varying on municipal level; climate change and pandemics on a global level and not by local governments. In other words, to account for or internalise the multilevel – read as differently levelled – externalities of different goods, their governance should be multilevel, too. Then, the appropriate or optimal jurisdictional design of a good across different levels of government is found when the externalities of the good are internalised and benefits from economies of scale are maximised. Assuming no discourse or nested interests, the result would be a governmental structure arranged like a Russian matryoshka doll with the lower levels nested within higher levels and a 'policy gradient' from mission to contextual implementation. To state it explicitly and give more nuance by adding grain of salt, there are examples on how dispersion of power away from the central government, specifically sideways to private sector, led to massive systemic problems, e.g., as became evident internationally in the health care sector during the COVID-19 wave peaks.

[2.ɦ] The following paragraph is based on this source. However, to avoid repetition and increase readability, it is only cited once.

The second logic is driven by identity, i.e. 'governance as an expression of the desire for self-rule by a group that sees itself as a distinct community'. Thus, the simple reason for MLG is that a decentralised jurisdiction can reflect heterogeneity and preferences of its citizens better, see Hooghe, Marks et al. (2001, endnote (5)) and DeHoog et al. (1990) and Lowery et al. (1995). Indeed, this is distinct from the first logic: self-rule may be insisted upon even if this is to the community's economic disadvantage, e.g., as could be observed during the Brexit. The rights of the many autonomous communities in Spain, Quebec in Canada, or Scotland and Wales in the United Kingdom is the result of 'differentiated governance' that in many ways breaks the uniform authority in the higher-level governance structure to the benefit of a lower-level, self-defining community. Thus, MLG also encompasses a negotiated order conceived through a complex political game.

While Hooghe et al. (2020) further summarise the effects and reasons of governance of the second logic, Hooghe, Marks et al. (2001) distinguish two types of MLG that will be discussed shortly. Before that, however, it has to be remarked that these types, despite the unfortunate names 'Type I MLG' and 'Type II MLG', are not binary or opposite to one another, but rather, these ideal-typical arrangements – that have as such been assembled and contrasted in table 3 – co-exist in parallel and on a gradient scale. These types and their differences shall be laid out now.

Table 3: Contrasting juxtaposition of type I and type II MLG, extracted from (Hooghe, Marks et al., 2001; Liesbet & Gary, 2003).

Category	Type I	Type II
Jurisdiction type	General purpose – authority to make decision comes in compact packages but is dispersed across jurisdictions that do not intersect	Multiple independent and task-specific jurisdictions
Membership	Not intersecting at any level and durable, mostly territorial (national, regional, local, communal)	'Dispersed overlapping domains [with] incongruent memberships' (Schmitter, 1996, p. 136)
Levels	Limited to few, clearly distinguished jurisdictional levels	Organised over a large number of levels, see first logic.
Set-up	Durable, system-wide architecture	Intended to respond flexibly and agile to functional requirements or preferences

So far, reasons have been named of what logics drove the development and adoption of MLG, allowing for scale flexibility (Liesbet & Gary, 2003). However, the answers on how MLG should be organised diverge which is distinguished into two types (Hooghe, Marks et al., 2001). Common to both is, naturally, the dispersion of authority as the core principle of MLG. In the first type, however, the dispersion is limited to a number of jurisdictions at a limited amount of levels that – horizontally – do not overlap. Consequently, authority is bundled in large and, on a time axis, stable institutions. Essentially, the origin of this type is federalism though elements of federalism can be found in Type II MLG, too. Thus, the second type is characterised by a 'complex, fluid, patchwork of innumerable, overlapping jurisdictions' (Hooghe, Marks et al., 2001, p. 4) where 'innumerable', of course, refers to a vast and barely surveyable but by no means endless amount. The competences of these jurisdictions may be 'extremely fungible' (Hooghe, Marks et al., 2001, p. 4), i.e. overlap organically like hypha and are often flexible and lean to demands on governance: 'There is generally no reason why the smaller jurisdictions should be neatly contained within the borders of the larger ones. On the contrary, borders will be crossed, and jurisdictions will partly overlap. The "nested", hierarchical structure of the nation-state has no obvious economic rationale and is opposed by economic forces' (Casella & Weingast, 1995, p. 13). Common to both Type I and Type II MLG is the negative cost that lies in the transaction costs of the jurisdictional coordination. Indeed, the so-called 'coordination dilemma' in MLG can be stated as follows: 'To the extent that policies of one jurisdiction have spillovers (i.e. negative or positive externalities) for other jurisdictions, so coordination is necessary to avoid socially perverse outcomes' (Liesbet & Gary, 2003, p. 239); note that there is no direction up or down the hierarchy given in this definition. Analytically speaking, these coordination costs increase exponentially for a linear increase in relevant jurisdictions to consider. Strategies to avoid the dilemma include limiting the number of involved autonomous actors – underpinning Type I MLG – or limiting the interaction between actors – underpinning Type II MLG in the sense that Type II MLG demands no upper boundary for the creation of jurisdictions and, through flexible design, can sprout new ones functional to current needs. In this sense, Type I and Type II MLG can achieve different targets and as complementary governance strategies, their seemlingy contradictory co-existence is resolved.

Yet, they are not simply different means to the same end. Instead, their notion of community, that Liesbet and Gary (2003) label as 'intrinsic' and 'extrinsic community', makes them diverge as follows: As Type I MLG are often based on territory in an effort to capture a community's intrinsic will for self-governance, Type I MLG 'is oriented to voice, rather than to exit' (Liesbet & Gary, 2003, p. 240). In other words, Type I MLG enables a

multitude intrinsically held-together local, ethnic, or religious community to self-govern, resolve conflicts among themselves, and voice their preferences rather than enabling an exit of the overarching governance – though, of course, it can happen to some degree, see the striving for independence of Catalonia from Spain, Scotland from the UK, or Quebec from Canada. Meanwhile, Type II MLG is more pliable and together, its constituencies have a need for collective decision making such as an athlete in a sports club, workers through unions, or a state in an environmental protection alliance. Thus, membership in these communities encompasses only one or a few aspects of the member's identity and is functional, voluntary, and extrinsic (Liesbet & Gary, 2003, p. 240). Due to fluctuations in preferences, Type II MLG allows voting by membership and thus, implicitly solving disagreements by avoiding them. Though this phrasing has to be taken with pinch of salt: In (Ostrom, 1990), multiple common pool resource arrangements are described equipped with democratic or deliberative decision-making solving an assemblage of community problems where jurisdictions have been added on due to path dependence.

2.5 SYNERGY

Lastly, it is vital to briefly lay out how the integration of MIS and MLG can be done and specifically, how MLG enriches the MIS. For this, it is worthy of noting that MLG originates from a politology and governance literature stream. As such, could only inform the governance side of the MIS, that is, the mission arena.

Why indeed is this a theoretical fit then? As per the prior sections, the mission arena is not to be equated with the corpus of governance actors. Instead, it incorporates public and private non-governance actors relevant to the mission and thus not *all* governance actors either: There is a shared overlap but none of the two is subset of the other. Indeed, as stated before, the idea of MLG is the 'dispersion of authority away from central government — upwards to the supranational level, downwards to subnational jurisdictions, and sideways to public/private networks' (Hooghe, Marks et al., 2001) – and authority with respect to the mission rests within the mission arena. Herein lies the reason for the link between MIS, mission arena, and MLG. It is thus valid and sensible to attempt to connect MLG with the MIS via the mission arena.

What is the mission arena then? Earlier this chapter, the mission arena has been described as 'the set of actors central to formulating and dispersing the mission. As such, the mission arena, similar to an entrepreneurial state, can activate structural components and direct their galvanising movement. In other words, it provides directionality and

can thus activate or mobilise the overall MIS.'[2.i] Thus, while prior works identified the mission arena as an un- or semi-structured conglomerate of actors, the mission at hand provides a mission arena equipped with an inherent multi-level structure. Remembering the alternative term 'mission governance' for the mission arena, it is valid to assume the mission arena displays MLG features itself. Contrary to that, previous literature and figure 1 assume the mission arena a monolithic block, a black box that inexplicably 'activates' the outer MIS from time to time. In this incongruity lies the identified literature gap this research does not attempt to close, but at most to gauge and humbly illuminate it. Thus, the added value of viewing the mission arena through the lens of MLG literature lies in acknowledging the mission arena as an MLG structure itself. Through this, the mission arena itself could become more open to disambiguation instead of a 'black box' of mysterious 'government plus X's' workings. An MLG view on the mission arena is not only more realistic, it also gives more nuance to the essential 'activation' of the system towards and onto the desired trajectory.

In terms of problems that can arise in such MLG structures and the categories listed in table 3, the coordination dilemma has been named as well as internal nested interests within, and the logic for assembly, i.e. the aspect of intrinsic or extrinsic community. The mission arena may prove to be a more or less aligned group with various interests, priorities or motivation for joining and pushing for certain solutions. This must necessarily influence the results of the structural analysis, mission clarity and directionality. Insights on (barriers to) internal alignment, coherence, or support can be gained from this, benefiting provision of directionality or mission achievement.

These arguments flow into the formulation of openly-phrased MLG interview questions that are incorporated in and also listed separately below the interview guide. Note however, that a clear separation between MIS and MLG question is not always possible as typical MIS questions are also relevant in a MLG setting or have been fused together.

[2.i] Thus, merely by definition, a trivial ex ante result would be that part of the German federal government are indeed in close proximity to the mission arena governing the sustainability transition.

3 Methodology

At this point, it's about what ends first: the world or your research.

ANTON TER KLOOSTER
during a discussion with the author

3.1 Case Description

The European Green Deal is a set of policy measures and initiatives to make the EU climate neutral in 2050. Its targets for the construction sector include the housing renovation plan, requiring the annual renovation rate varying from 0.4% – 1.2% in the member states to 'at least [...] double' (European Comission, 2019, c.f. 2.1.4) until 2030. As a part of the European Green Deal, the EU Circular Economy Action Plan (CEAP) solidifies these targets, diversifies the means, and stresses the urge to act:

> '[The construction sector accounts] for about 50% of all extracted material [and] is responsible for over 35% of the EU's total waste generation. GHG emissions from material extraction, manufacturing of construction products, construction and renovation of buildings are estimated at 5-12% of total national GHG emissions (range varying between the member states; author's note (AN)). Greater material efficiency could save 80% of [all] those emissions.' (European Comission, 2020, c.f. 3.6)

The strategy laid out in the CEAP addresses i.a. enhanced life cycle assessment, possibly the introduction of a requirement for recycled content and a revision of recovery rate targets as well as lastly, stresses the focus on the 'renovation wave' (European Comission, 2020, c.f. 3.6).

These targets' specific adaption into governmental policies is up to the respective member states. Specifically, it is noteworthy that the goals in question must be achieved over a European average, and not in each member state individually. This fact rounds the research

in the sense that its focus is to investigate the status of, barriers to, and chances in reaching these sustainability goals in the EU's strongest economy[3.a]. Thus, the European Green Deal is translated into different national, regional, and local legislation via lower-level governance institutions, e.g., while the Netherlands made its own Green Deal, Germany i.a. was legally forced to make adjustments to its Climate Protection Law (Klimaschutzgesetz). Said renewed law encompasses an 'Instantaneous Programme' (Sofortprogramm), part of which is, e.g., the devotion of 5 billion Euro to building refurbishment. The goal of these measures is not a renovation wave of 2%, but to achieve a two-third reduction in GHG emissions in the building and construction sector by 2030 relative to 1990 levels, i.e., from 210×10^6 t to 67×10^6 t in 2030. Due to Germany's federal system, further measures apply in the sixteen different federal states that due to their multitude shall not be named here. Said federal system and the clear distinction of levels provides the second reason Germany was chosen as a case, namely, to answer the second research question. The 2030 goals are an intermediate step to the 2050 EU goal to achieve climate neutrality which Germany is legally committed to achieve by 2045 the latest. The German 2030 goals thus seamlessly integrate into the country's overarching 2045 goal to achieve climate neutrality as part of the targeted 2050 EU-level climate neutrality and contribute to the 2% renovation rate aimed for.

To recapitulate, the European mission of increasing the annual renovation rate must be considered in the context of European climate neutrality by 2050. Due to feasibility reasons, this research is narrowed on Germany – which as of now does not mandate renovations yet or has a definition for what counts as 'renovated'[3.b]. While this may seem up and about, switching between EU and member states, one must keep in mind that

- the mission of doubling the renovation rate cannot be inspected in isolation but is, conceptually, a sub-mission to the European mission of climate neutrality.
- the German 2030 goals focus on the reduction of CO_2 primarily but acknowledge the essential role of renovation without, for better or worse, mandating a fixed rate.

In other words, the ultimate goal of the EU Green Deal is to transition the EU towards climate neutrality by 2050. The 2030 goals and thus, the desired doubling of the annual renovation rate, are a necessary intermediate step stone towards this aim and can only be researched, analysed, and understood in this greater context. The research at hand must incorporate issues, solutions, and aspects of the system that are not necessarily only

[3.a] following the mindless ordering by GDP

[3.b] For this thesis, it is sufficient to consider 'renovation' in the sense of a structural retrofitting targeted to increase energy-efficiency of the building at hand. Thus, renovation, modernisation and refurbishment are loosely encompassed by the term.

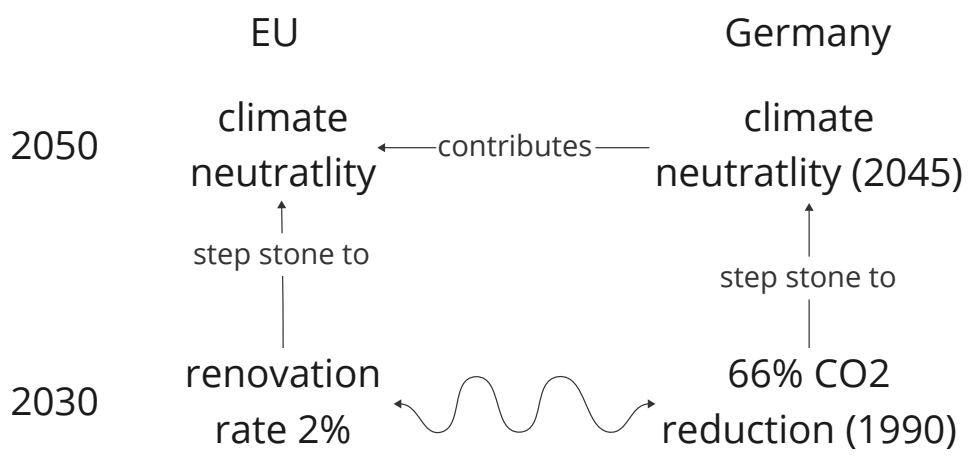

Figure 2: The interrelatedness of the missions from German national and EU level for 2030 and 2050 (2045)

directly connected to the renovation wave but beyond that. Indeed, as the last chapter made clear, missions cannot be understood as an isolated system network patch and must be understood holistically to the best of the researcher's abilities – that is, beyond their formulated borders, at least as far as their embedding context. With this context that is visualised in figure 2 in mind, the first research question can be expanded to the following phrasing that is as clear as it is clunky:

> Given the context of the EU-level mission of doubling the renovation rate until 2030 as a step-stone to achieve climate neutrality in 2050, what systemic barriers hinder Germany to contribute to these goals by reaching its own the respective 2030 and 2045 goals the country has already set?

Thus, the mission is clear in the sense that its goals, scope, and context with its measures are known and documented. With the aforementioned lack of MIS studies, this case study presented is a suitable example for a MIS analysis with its novelty laying in its MLG focus and in the until now unconsidered building and construction focus.

3.2 RESEARCH DESIGN

The research design is that of a qualitative case study, structured through the steps indicated in the previous section. It thus constitutes a 'structural-functional approach'

(Wesseling et al., 2020) that will first be concerned with the structure of the MIS and later with its functioning.

Both Wesseling et al. (2020) and Hekkert et al. (2020) operationalise the MIS analysis qualitatively as a case study with interview data and secondary data. Both employ – different, see table 8 in the appendix, page 89 – system functions to identify systemic barriers to the mission. Meanwhile, quantitative approaches have been undertaken as well, e.g., see Owoyele and Hajikhani (2020) or Dosi et al. (2021). However, the 'common' – the quotes are to indicate the conceptual state of the framework – MIS framework methodology is a four-step approach summarised in figure 3 and that will be laid out now.

First, a problem-solution diagnosis aims to map and understand the scope and complexity of the mission, which societal problems it aims to address, and which solutions – technological, social, other – are at hand. Indeed, missions are linked to societal challenges and a purely technological innovation and solution focus does not do justice to its wickedness. Rather, its 'success depends on complementary change processes [namely, social innovation; AN] which a MIS analysis should thus capture as well.' Elzinga et al. (2021, p. 17). Thus, this first step can be understood as a composite of problem diagnosis and solution diagnosis which Wesseling et al. (2020, p. 6) define as 'the way the different societal problems are included and prioritized in the mission formulation' and 'the factors that determine how stakeholders search for and invest in the solutions they deem promising for fulfilling the mission.', respectively. In other words, the problem-solution diagnosis aims to clarify the mission, its directionality and its scope, as well as to identify the social and technological problems it aims to tackle as well as solutions that are at hand to achieve the mission.

Second, a structural analysis is to reveal structures – that is, actors, networks, and (in-)formal institutions[3.c], and organisations – in the MIS. With the definition of the MIS, Hekkert et al. (2020) give a criterion by which to discern between members and non-members of the MIS. Wesseling et al. (2020) further distinguish between the mission arena and the overall MIS: As stated before, the mission arena, also referred to as mission governance, provides directionality and can thus activate or mobilise the overall MIS, see figure 1. While the mission arena mostly consists of governmental or formal institutions, the overall MIS involves industrial and economic actors that are crucial to the success of the mission itself through legitimisation, development, diffusion, and adoption of solutions to the mission. A purpose of this research is to investigate the concept of a 'multilevel mission arena', i.e., how the governance structure set up influences the achievement of the

[3.c] Classically, 'institutions' are what guides human behaviour. An example for a formal institution would then be laws, for informal institutions mentalities or beliefs.

mission. Thus, the MLG literature review is of particular interest to the structural as well as the following analysis.

Third, the functional analysis refers to the analysis of how well a set of system functions – reminder: 'key innovation activities' (Hekkert et al., 2007) – are fulfilled to enable mission achievement. The system function employed in this thesis are listed in table 1, all containing a innovation and destabilisation side. While having originally been used for TIS research, research have shown the concept to be useful for innovation systems (Wesseling & Van der Vooren, 2017) or transition research (C. R. Haddad & Bergek, 2020). Trivially, the system function analysis will assess the functioning of these innovation system functions. The system functions in yet unpublished work from Joeri Wesseling currently in review – or rather from Wesseling et al. (2020) – are chosen over Hekkert et al. (2020) for the simple reason that the additional ones in Hekkert et al. (2020) are part of Wesseling et al. (2020) and the more parsimonious approach makes analysis and distinction less complicated. MLG literature will also play a role in system function four on directionality and reflexivity, see the interview guide in table A.2 in the appendix. Bear in mind, however, that system functions are not 'holy' but heuristically chosen as generic-enough to 'do justice to the specific nature of the mission-oriented innovation systems' (Elzinga et al., 2021, p. 19) and been in practice and refinement since their introduction by Hekkert et al. (2007).

A system barrier analysis could carried out as an interpretive step, based on which recommendations for system improvement could be derived. Hereby, a system barrier would be a systemic root-cause for hindrances to the fulfilment of the mission which arise from unfulfillment of one or multiple system functions (Wesseling et al., 2020). Here, a tracing back of issues through system functions could reveal a diagram similar to figure 4 that reveals systemic root problems in the system. Indeed, with such a network, analyses can be done to identify systemic barriers, feedback loops, and root problems, but also intervention points. In this reasoning lies one particular strength of the system functions: This 'meta-network' itself is as much of interest as are the contents that lead to its creation. However, this step has been left out in this thesis as four missions were considered and separating them would have been unfeasible due to time constraints.

3.3 DATA COLLECTION AND SAMPLING METHODS

Data collection went via desk research – documents such as publications, road maps, newspaper articles, and furthermore, documentaries, podcasts – and targeted, semi-guided[3.3]

[3.3] guided through an interview guide in appendix A.2 and interrupted by follow-up questions or skipped questions if data saturation for a particular question has been reached.

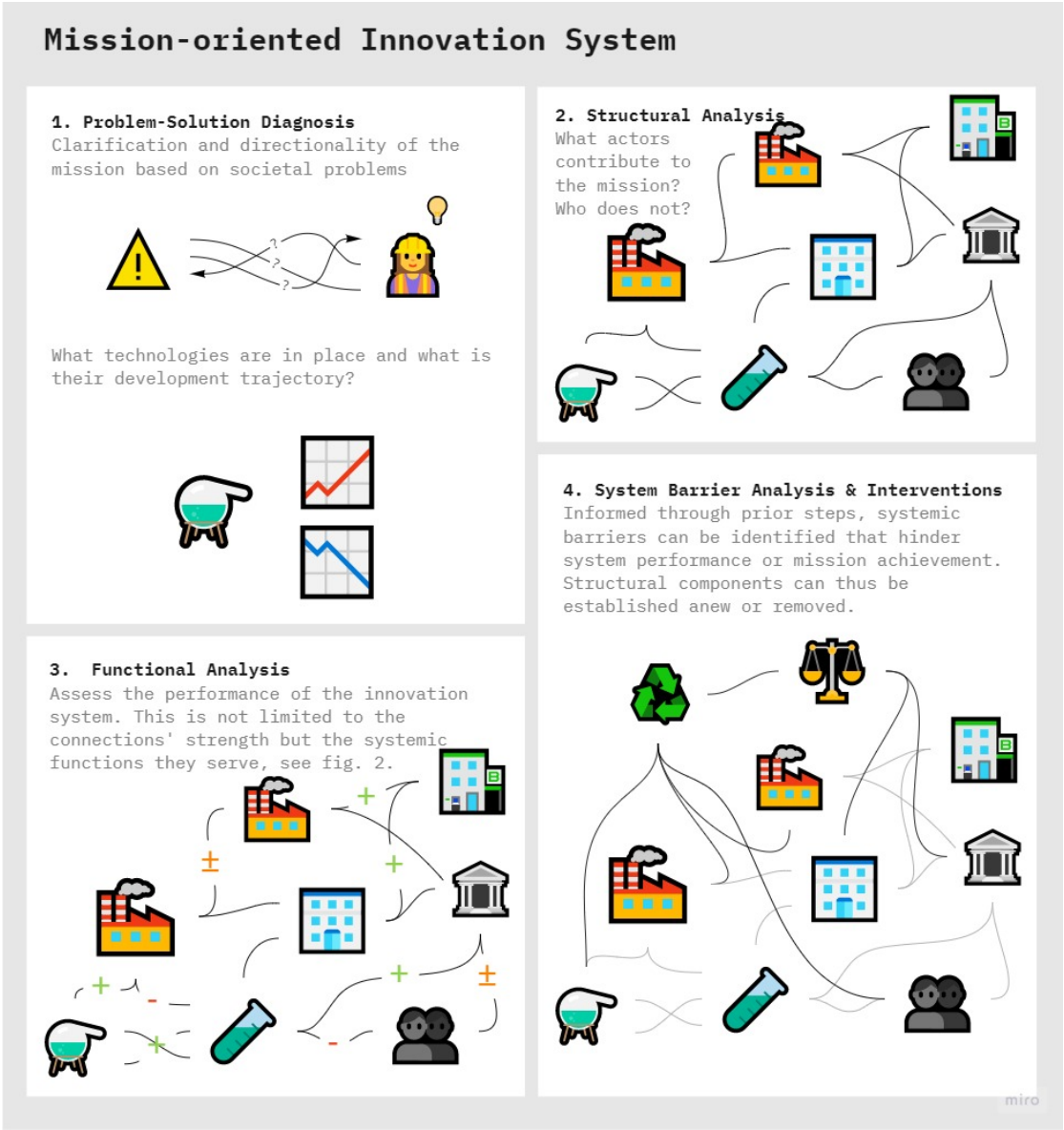

Figure 3: Graphical visualisation of the four-step MIS methodology.

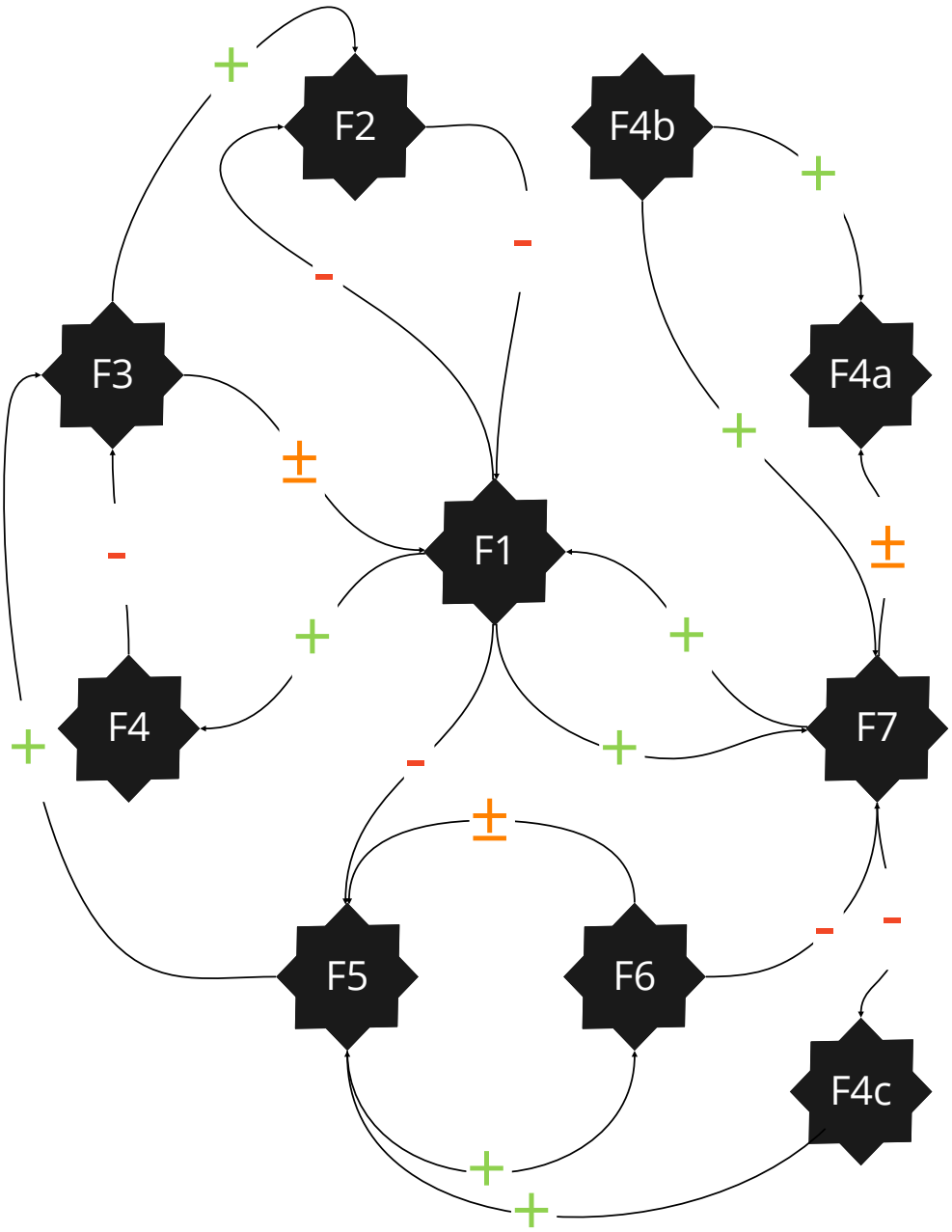

Figure 4: Exemplary interaction of the system functions with positive or negative feedback loops

interviews that were held in German as most interviewees were able to express themselves more nuanced and context-appropriate in German. The data in the case of interviews were collected through recording the interview once the interviewee had been presented and agreed to the standard interviewee consent form the university provides.

The sampling strategy employed was that of purposive sampling which means to 'sample cases/participants in a strategic way, so that those sampled are relevant' (Bryman, 2012, p. 418) to the research question. Thus, interviewees were found through desk research and contacted via phone or email with an exposé of the research. After an interview or a negative response for one, recommendations who to talk to ('snowball sampling' (idem.)) was asked for. This was done for two reasons:

1. It would ensure that the definition of 'relevant' sampling was 'peer-reviewed' in the sense that actors in the system named relevant actors or organisations that may or may not have been considered yet.

2. It would be a heuristic measure of saturation in the sense that if recommended actors or organisations had been contacted or interviewed already, a satisficing overview of the innovation system had been achieved. In retrospect, this did not occur but the author considers it a wise process for a bigger (see table 5) MIS analyses.

Hekkert et al. (2020) divide their interviewees into six groups: policy, institutions, research, support, supply, and demand. To ease this in its operationalisation, the first two are joined together into 'policy and formal institutions' – from local to European level – , as well as the last two into the broader 'value chain'. A definition of the four categories can be found in table 4 together with the achieved sample. A dispersion of the achieved sample over the various MLG levels can be found in table 5. By mere comparison, this allows for another heuristic measure for a balanced representation of the innovation system.

Table 4: Categorisation of interviewees

Actor Group	Achieved	Definition
Policy & Institutions	5	Political and policy actors as well as non-governmental organisations
Research	4	(Applied) Universities or research institutes
Support	4	Organisations that through their network, guidance or financing contribute to innovation diffusion or coordination of innovation system activities
Value Chain	2	Start-Ups and entrepreneurs, existing firms

Table 5: Dispersion of achieved interview sample over the MLG levels – the ½ refers to one actor that is active on both EU and German national level while the others remain on German national level. Regional and local level have been joined together into one category as analytically, these levels are distinct, but their differences were unfeasible to also consider in this thesis.

	Policy & Institutions	Research	Support	Value Chain
EU	1	–	½	–
National	1	4 active on 3 all levels	3 ½	–
Federal	2		–	1
Regional & Local	1		–	1

Thus, a total of 15 interviewees was achieved amounting to 812 minutes (58-minute average[3.c]) of interview audio, the interviews ranging from 30 to 120 minutes, depending on the availability of the interviewee. One interview had technical failures which was compensated by extensive note-keeping and letting the interviewee review and comment on those notes afterwards. Before another interview, the interviewee agreed to the data being recorded and used under the condition of them reviewing and editing the transcript ex post, i.e. taking out or reformulating certain passages as they saw fit. This edited document has then been used for the analysis instead of the original.

As 15 interviews is rather low for a comparable MIS analysis, this has been compensated through a more extensive document analysis with the selected passages totalling to 75 pages. This count does not include the laws and reports sighted for the structural analysis and documents interviewees and experts sent upon questions and requests for further information for the simple reason that these have not been coded. Similar to table 4, a distinction has been made ad hoc to account for a balanced document overview, listed in table 6. Documents have often been selected upon recommendation of interviewees when asked for more sources and information on certain topics. When there was not enough time during an interview, interviewees mentioned keywords for what to look out for. To report on this, documents were chosen to learn more about the 'source principle' and sector emission accounting, about entrepreneurial activities and solution-directionality, about the tension field of efficiency and sustainability and the connection to lobbying, about the principle of building less and more simply, about the power of municipal city design and social solutions, about the strategy of the state to take a galvanising pioneering role, about legislative options for solutions to break through, about alternative materials and

[3.c] Only 14 were recorded, see rest of this paragraph.

the role of art and architects, and about digitisation, entrepreneurial activity, and market transformation. Other data is not publicly available but this sample count is negligible.

Table 6: Categorisation of documents – for transparency, it should be mentioned that this classification has been made up by the author and is solely based on his own whim as he thought was best. While this may seem problematic, a (somewhat) even distribution has been achieved that is deemed fairly representative and meaningful.

Document Group	Sampled	Examples
Internal documents	2	Yet unpublished report on how unachievable the targets are; discussion about new federal strategy lines
Public reports or strategy paper	5	Current coalition treaty; position paper on digitisation; assessment of governmental measures for reaching the sustainability targets
Newsletter or newspaper article	3	Start-up reports; Lobbying against sustainable practices; new legislation passed allowing for more flexibility concerning standards
Newsletter or newspaper interview	3	Interview on the interplay of artistic freedom, legislation, and alternative materials in the sustainability transition; on what municipalities have achieved a sustainability consultant or local caretaker

As anticipated, over the course of the entire thesis process, multiple experts and MIS members have been consulted via video conference or email contact for remaining questions, contrasting opinions, or bouncing thoughts. These calls and talk have not been recorded, the emails have not been coded, neither were the additional documents sent as these merely informed the analysis.

Despite this low number of interviewees, data saturation had often been reached in many areas. Still, it is worth considering who was not reached why: Does this reflect anything about the state of the MIS? Are important actor types missing? And is there a 'positive people bias' due to only optimistic people replying to the interview request? From table 5, a first indication can be derived who did not respond. Essentially, (almost) every cell had been contacted but many actors from various backgrounds did not respond initially and ghost the author. For the research column, it is noteworthy that only few EU-level research actors would have the necessary focus on Germany for the interview not to be too far off, general or abstract. Concerning support actors, mere regional support initiatives are scarce and federal actors were often represented by their national-level

umbrella organisation. Thus, the support structures interviewed had sub-level support structures that due to capacity reasons directed upward for an interview. For value chain actors, the author concludes that this low outcome must be due to capacity reasons as the construction and building sector is at full capacity – see results for further elaboration. Additionally, the lack of a back-up organisation with a network the author could utilise made interview data collection difficult, especially for value chain actors. However, the second research question on the MLG effects are facilitated through the large share of policy & institution actors. Lastly, it is worth addressing the positivity bias. As the results will reveal, the sustainability targets are unanimously considered illusory and unachievable with no interviewee spreading any sort of optimism they could be reached, further expressing fatalism yet being 'obligated to be confident'[3.f]. It stands to dispute whether the achieved interviewees still reflect the optimistic part of the MIS. However, as the document analysis revealed a similar attitude and problem directionality, this bias is discarded and seen as a contributing or validating factor to internal reliability, more on that in section 3.5.

3.4 DATA ANALYSIS

Firstly, it should be mentioned that the MIS has indeed been operationalised similarly and successfully in Wesseling et al. (2020) and Hekkert et al. (2020). Thus, it was valid to assume the data collected as described above would indeed be useful to answering the research question presented and should therefore be analysed.

The data obtained were analysed in a three-way process using condens.io[3.g]: After transcribing, the interviews were coded openly, referring to 'the process of breaking down, examining, comparing, conceptualizing and categorizing data [which] yields concepts [...] later to be grouped and turned into categories' (Bryman, 2012, p. 569). In other words, the first step after transcription was to go through the text data, synthesise or summarise the general theme of a particular phrase that stood out on a content dimension, and label these appropriately. As a second step, the result of the open coding was reviewed, i.e. the interviews and documents were reviewed and re-coded, separating or joining labels, adding or removing certain tags from the quotes. Thirdly, axial coding was be applied, that is 'a set of procedures whereby data are put back together in new ways after open coding, by

[3.f] A policy & institution actor, quote translated by the author. Further quotes are stated in the same manner without footnotes that hamper the flow of the text.

[3.g] Condens is a cloud- or web-based service for qualitative data analysis that is primarily not NVivo which for unknown reasons keeps being used despite major deficits. As expected, condens provides labelling, coding categories, and transcription.

making connections between categories [which] is done by linking codes to contexts, to consequences, to patterns of interaction, and to causes' (Bryman, 2012, p. 569). In this context, the labels were assigned to system functions, structural components, as well as problem and solution diagnosis.

Lastly, the functional analysis was carried out as follows: For each system function, the assigned issues were listed with the number of different sources that mentioned the respective issue being three or higher to assert a certain gravity of the issue. These issues will be elaborated on in the results. Based on this, a qualitative synthesis is drawn to assess the system function with regards to contributing to mission achievement. As the sustainability transition is quite complex with many nuances, the author does not see a necessity to transform this qualitative assessment into a quantitative one for the sake of producing a vacuous spider diagram. Instead, a brief abstract will be provided for each system function.

3.5 RESEARCH QUALITY ASSESSMENT

To ensure the quality of the research undertaken and specifically, the analysis, the three quality criteria reliability, replication, and validity (Bryman, 2012, p. 89 et seqq.) will be addressed in this section. This section is rounded off by a discussion on the limitations of this study.

3.5.1 RELIABILITY, REPLICATION, AND VALIDITY

Firstly, reliability in this sense refers to the coherence and consistence of terms and concepts used, but also results found. For internal reliability, through citation, quotes, and definitions of MIS and MLG terminology, the author considers the theoretical framework to be consistent with prior literature cited. Further, the results are internally aligned. To account for external or intercoder reliability, the method of Krippendorff's Alpha has been employed, see (Krippendorff, 2011), and will further be elaborated on below.

Secondly, as this is a qualitative study with interviewees, replication in the sense of whether the study can be replicated by another researcher depends on interviewees willing to engage in an interview. Thus, replicability this is hard to ensure as is the case with all qualitative studies but can be maximised by detailed step-by-step documentation of the approach taken. For documents, this is done to the best of the author's knowledge and belief. For the literature review, the published papers should remain available and it can thus be replicated.

Thirdly, validity is again split up into internal and external validity, the latter one – whether the results of this study can be generalised beyond the scope and context of this research – being hard to ensure, again, due to the qualitative nature of this case study. While admittedly, there are many links to outside of the scope of this research, this only shows the truly systemic nature of the mission in question. For internal validity, i.e. the question whether there is sufficient reason to believe a conclusion to encompass the element of causality, it is commonly suggested to incorporate a wide array of sources. With the split-up of interviewees and documents into different categories, an attempt has been made to show that this balance has been considered and employed. Keywords, examples or topics have been provided to guide a potential replicating study. Thus, while, as in any thesis or report written alone, the analysis is limited by the understanding of the author, the strong internal alignment of the results is seen as sufficient to account for and thus neglect this concern.

To come back to external reliability as promised: As all interviews conducted and documents collected were in German, three fellow students – denoted as R1, R2, and R3 – with experience in qualitative work and native-level German skills were asked to review the coding. One student had worked with the MIS already, the two others were given an introduction to the research, the MIS, and system functions. These statements have been selected by the researcher with no system in mind but with an intent to balance between the system functions, interviewees and documents. The statements are displayed at the end of this document – see the table in the appendix on page 96 et seqq. – in original form as well as in translation. Translation was done via deepl.com from German to British English, reviewed by the author, and edited in case of translation mistakes through idioms, slang, or simple context.

In total, thirty-four codings of twenty-six quotes were chosen. Indeed, given the systemic nature of the object of interest, the coding done often encompasses several double-codings, i.e. quotes that were assigned multiple labels at once. Some of these labels of the same quote were assigned multiple and distinct system functions. An example of this would be a quote on market mechanisms that govern the use of recycled material, followed by an elaboration on said recycled material and its (marketing-relevant) properties. While these are indeed separate points on a content-dimension, direct and original transcriptions from speech to text makes it difficult to separate these two distinct yet related aspects, especially when this requires a cutoff and subsequent loss of context of the quote. Thus, the quote has been extended to keep its context, coded multiple times, and assigned multiple system functions at the same time. The students asked to review the coding were given the full quote along with all system function classifications that they had to assert or negate

individually. If in doubt or if more elaboration was needed, they could consult the author on why the coding of this quote was done this particular way and with what labels it was coded, i.e. they could request the intermediate steps from quote to system function. They could then assert or negate again.

Given the review data, Krippendorff's Alpha could be calculated. Following Krippendorff (2011), Krippendorff's Alpha is a standard measuring technique to assert for generalisability of the result of an individual coding process beyond mere subjectivity, thus allowing to conclude external reliability. A standard quality criterion for sufficient generalisability is a value of $\alpha \geq 0.8$ with the value increasing in reliability with the amount of raters and amount of codes. The data were read into R and calculated with the package 'irr' (interrater reliability) which yold $\alpha = 0.95 \geq 0.8$. Thus, the coding performed could be accepted as sufficiently generalisable.

Table 7: Summary of measures to assert the research quality

	External	Internal
Reliability	Definitions cited from literature	Krippendorff's $\alpha = 0.95 \geq 0.8$
Replicability	difficult (qualitative study) but	step-by-step documentation
Validity	difficult (qualitative study)	wide array of sources used

3.5.2 LIMITATIONS

Lastly, limitations of this research must be discussed. Indeed, since this content fits more to this section, this is done here instead of – more commonly – in the discussion chapter. Most importantly, however, limitations are discussion here prior to the results to provide the reader with a perspective on these before presenting them.

How horribly wrong could the author be then and why? What are the pitfalls the research might have? The limitation concerning the amount of interviewees and data have been addressed at the end of section 3.3. Similarly, the issues concerning generalisability beyond the case study have been discussed in this very section. Concerning biases specifically in the analysis, the reader is further referred to section 4.1 due to the fact that reporting on the result of the coding is seen as a result and that biases concerning these are best addressed together with them. The word 'addressed' would denote the state of affairs best as these limitations are simply inherent to the research and would have been impossible to avoid: Indeed, even an interview size of forty would still be indicative of the MIS and not allow a full and comprehensive review. The same way, a qualitative study brings its perks as well as drawbacks. And subjective coding may very well inherit biases. These

can be named, accounted or controlled for – as has been done to the best of abilities of the researcher –, but not erased and are thus inherent to the research.

Thus, a true possible pitfall may be that the author did not strictly stick to the 'common' MIS methodology as has been anticipated in section 3.2: The system barrier analysis has been done differently in the sense that a 'causal' diagram of system functions as figure 4 has not been produced. Instead, a heuristic approach has been taken to descriptively link issues to others in the perspective and within the boundaries of these system functions. As described, this is due to time constraints and the fact that four missions were considered which made a de-tanglement uneconomic. Consequently, the system barrier analysis could indeed have been more narrowed down to a list of 'these are the problems'-problems – an absolute statement the author did not consider to be qualified to make. Furthermore, a visualisation in a diagram would allow for an analysis of the network of problems and the interaction of the system functions. On the other hand, the presentation chosen allowed for a more narrative- and understanding-focused writing style that in its quality is deemed equal to such a list. Additionally, the author did during the analysis not believe in the fitness of the system functions to represent the issues adequately – the system functions are reflected upon in section 5.3. Having shed light on the costs and benefits of this decision, this choice has been undertaken from a 'creative wiggle-room' the author perceived. Indeed, the MIS methodology has been termed 'common' at the beginning of this paragraph, the quotes representing the conceptual state of development the MIS framework still is in (Elzinga et al., 2021). Thus, what on the one hand is a procedure more tailored to the case is a heuristic approach deviating from the given framework on the other. The author believes that not strictly sticking to a non-fixed procedure benefited his understanding and that of the reader, but is of the opinion that this should be named as a possible pitfall.

4 | Results

Happy families are all alike; every unhappy family is unhappy in its own way.

LEW TOLSTOY in *Anna Karenina*

As the title suggests, this chapter is dedicated to the presentation of the results found in this qualitative study. Due to the systemic nature of the system at hand, there must necessarily exist considerable overlap between the sections. This overlap has been attempted to reduce and to cross-reference whenever necessary by considering the same issue from various perspectives. Following and showing the spirit of systemic inseparability, the results on the MLG substudy are in between the MIS results and stated separately as a summary after the system functions. Par conséquent, some solutions will only become more clear as to why they are being pursued when the respective issues are elaborated on in the system function discussion. The author thus kindly asks the reader for their patience in his elaborations on why the construction and building 'family' is 'unhappy in its own way'.

The documents collected and interviews conducted were analysed to answer the questions set in the interview guide, see the appendix, table A.2. To remind the reader, these questions are stated again at the start of every section and subsection, followed by the respective answer and broader elaborations gained from the interview.

Lastly, interviewees almost unanimously and proactively mentioned during the interview that they considered the scope of this research very broad and wide. Thus, a last little word of guidance that is not structural is deemed appropriate. Naturally, it is illusory to expect a nine-month thesis to cover the German building and construction sector. However, an overview has been achieved that captures more than the bare essentials and provides ample details to certain points of critical interest with the extent of achieving data saturation in a few cases. Consequently, some other points are merely glanced over or possibly even neglected. As such, the term 'results' must be understood not as the one answer to the research questions set out with, but as the qualitative synthesis of the circumstances encountered during the search conducted in pursuit of an answer. In other words, this

chapter termed ‘Results’ contains the ‘dry facts’ with in-depth real life examples where deemed informative.

4.1 Achieved Sample and Coding

The sample size has already been discussed in chapter 3. To report on the coding, a total of nine-hundred twenty-seven[4.a] highlights has been coded, seven-hundred twenty-six of which in the interviews and the remaining two-hundred and one in the documents. While the documents amounted to seventy-five pages, a total of two-hundred twenty-one pages of interview text data were collected and analysed plus two pages of bullet points from the interview that had technical difficulties. Thus, the code density for the document analysis was lower than for interviews. The interviews were very broad, jumping from one topic or system function to the next. As paper is more ‘patient’, the documents elaborated more narrowed down and in depth on one topic and less repetitive so. The author conjectures this to be the reason for the slight code-density divergence between interviews and documents. However, there is no economic possibility to check the highlight length to confirm this hypothesis. Furthermore, the counterthesis that the documents have been coded less due to a divergence in the approach of the researcher has been discarded as the data have been analysed together and by the author alone.

4.2 Problem-Solution-Diagnosis

Following the nature of this composite word, the problem diagnosis and solution diagnosis are presented separately over the following subsections. Due to the systemic nature of the object of interest, matters are not always as inseparable as it would seem in the theory. Par conséquent, some solutions are named in combination with their problems to keep their connection visible throughout this linear report of systemic research results.

4.2.1 Problem Diagnosis

Answers to the questions ‘What societal or technological wants or problems are related to the mission?’ have been searched for. Here, the notion ‘problem’ reflects one or an area of related issues or focal points and thus vary in precision and elaboration. To provide structure, the problems encountered are subdivided into the categorisations of social,

[4.a] The numbers are written out to avoid typos and to make an extra effort in report the numbers correctly.

technological, and miscellaneous[4.b] problems. This third category is uncommon in MIS analyses but chosen here to not force-fit important points into unfit classifications.

SOCIAL PROBLEMS

The need for and lack of (social) housing particularly in urban areas is one of the most pressing social problems encountered during this research. For now, this is sufficient to know as the housing market will be elaborated on in the structural component analysis, especially the connected mentalities as part of informal institutions. How this issue of lack of housing is further connected to and conflicts specifically with a renovation wave is elaborated on in the problem directionality.

A second problem that will be further elaborated on in the same sections as the priorly mentioned problem is an – essentially – communication problem with primarily the private sector due to its owner and capital structure. The private sector is knowledge- and network-wise unfit and, despite the subsidy system, financially unequipped to carry the financial burden a renovation would bring about. Regardless of this problem's connection to the structural components and problem directionality, it is listed here for two reasons:

1. To introduce the, essentially, communication problem to home owners: How to (know how to) renovate what with whom concerning the buildings in question? As will be elaborated on more later, mostly very specialised handypersons[4.c] are consulted by home owners instead of more holistic planners or architects, leading to non-optimal renovation results.

2. To clarify the immense heterogeneity of building and home owners and users,especially tenants that are at a disadvantage through the lessor-tenant dilemma [4.d].

This communication and knowledge sharing is necessary because of the immense complexity of the matter – logistics, planning, communication, consulting etc. that home-owners need to fix themselves – and of the technology built in, see next subsubsection.

[4.b] defined as neither uniquely or definitely social nor technological

[4.c] The gender-neutral term 'handyperson' is chosen over the more common term 'handyman' to account for and include people that would not identify with the suffix '-man'.

[4.d] Referred to as the 'Mieter-Vermieter Dilemma' in German – the dilemma is that while a lessor would pay for a renovation, the costs must by law not simply be passed on to the tenant who would benefit from higher energetic quality and lower heating costs. The value in a renovation – for a lessor – lies in the monetary equivalent of the upgrade of the housing unit and the market value of said unit on the housing market – which does not match the costs of renovation. Cost allocation is therefore an unresolved problem.

TECHNOLOGICAL PROBLEMS

Unanimously, the biggest technological problem reported was the two-fold problem of electrification of the MIS, namely, the energy transition towards green and sustainable energy and digitisation. Depending on the system of measuring – see 4c for further elaboration – as well as on sector and function of the building, the way a building is heated, illuminated, and operated over its lifetime represents the most energy- and CO_2-intensive component in its environmental footprint[4.e].

Second and related to that is the issue of digitisation that assumes the role of the 'neglected child' in Germany. Indeed, the process of digitisation has not been advanced on the technical level of, e.g., nationwide coverage with internet or broadband expansion, but also not on the social level of processes in formal public institutions or commercial companies like, e.g., civil servants, going to administrative authorities, planners, architects, handypersons, construction companies, or building operators. Digitisation will further be elaborated on in the solutions and the system function on entrepreneurial activity.

To connect to the issue of home-owners that the prior session has been ended with, a trend that has been driven as much as it has been lamented by interviewees is the increase in mechanisation[4.f] of buildings, the complexity of which, when installed, exceeds the knowledge and capabilities of both handyperson or homeowner, showing a gap in the transition from theory (conceptualisers, manufacturers, ...) to practice (installer, user, ...) along the value chain. This has been termed the 'interface problem' and results in frustration, dependencies, long fixing times, and incompatibilities of systems built in.

MISCELLANEOUS PROBLEMS

Lastly, standardisation through the many DIN (Deutsche Industrie Norm, German Industry Standard) standards is named here despite its legislative nature. Standards will elaborated on later in almost every system function, the reason being that the focus of standards lies on fine technicalities and construction products. Next to that, the amount of standards has taken unprecedented proportions: About 2500 standards concern construction, 500 of which being part of an architect's or planner's daily business together with additional codes and regulations. These standards also overlap or even contradict

[4.e] To put more numbers to this claim, the building sector represents 36% of the yearly German energy consumption (dena, 2018) and 13% of CO_2 emissions (dena, 2019). This does sound low, hoever, one must consider that the source principle, see 4c, is how these numbers come about.

[4.f] used here to denote the trend to equip buildings with more and more complex technology that, according to some interviewees, grows to an extent of technophilia and is accompanied by an overall loss of understanding for simple or frugal ways of constructing.

one another which causes a wide amount of legislative problems – despite there being flexibility clauses – and a widespread fear of lawsuits.

Second, existing buildings show a high degree of individuality which results in a two-fold problem: Renovation of an individual building causes more case-specific decisions and planning, an issue that will come back in the structural analysis. Renovation also goes beyond the individual building when one considers mass or large-scale projects. Indeed, city (re)design and pursuit for creating liveable cities are considerations that weigh into renovation or demolish-and-rebuild considerations. An example of the aesthetic dimension would be old Sowjet-era buildings in East Berlin that are still functional but not considered beautiful – the implicit mentality aspect of this will be elaborated on in the structural analysis – and are, in the end, demolished for market reasons. Furthermore, studies were cited during interviews that a public investment in refurbishing and renovating town centres is followed by (private) refurbishment or renovation investments at a scale of one to seven to eight, indicative of the directionality creation potential. Thus, the fact that renovation of a building is an issue that extends beyond the building at hand is listed as a problem as it complicates considerations systemically beyond a private economic or energy-efficiency rationale.

Thirdly, the subsidy system set up in Germany on the various levels has repeatedly been described as a 'subsidy jungle', addressing a lack of (digital) overview, mutual exclusion of multiple subsidies, bureaucracy in the application process, and recently, the messy communication concerning subsidy stoppage. Furthermore, and this is an issue of greater gravity, the dilemma of subsidy and regulation must be addressed, referring to a range of problems encountered:

1. By law, it is mutually exclusive to subsidise what is mandated by regulation. Meanwhile, standards for newly built houses to achieve better passive houses or ultra-low energy buildings are increased, thus demanding investments.

2. An interviewee explained that from a governing perspective, subsidies were preferable because, as money was distributed, rarely anyone complained whereas regulations were often followed by law-suits and hardship cases. According to interviewees, climate policy in Germany has mostly been done via subsidy policy, rarely – but then most effectively – via regulation. Interestingly, most interviewees saw the need for and demanded stricter regulation.

While this section on problems may seem rather short in both amount and detail, it should be mentioned that some problems were not mentioned for the sake of, firstly, avoiding repetition in the coming sections where they would, secondly, fit better. After all,

what other is a problem than a systemic condition that has been assigned a value? In this spirit, these other problems are listed at the more appropriate spots.

4.2.2 SOLUTION DIAGNOSIS

Answers to the questions 'What solutions are pursued to achieve the mission? Which are the most prominent or promising solutions?' have been searched for. Again, to provide structure, the solutions found are subdivided into the categorisations of technical and technological, social and cooperative, and legislative solutions. Again, this third category is uncommon in MIS analyses but chosen here to not force-fit important points into unfit classifications.

TECHNICAL AND TECHNOLOGICAL SOLUTIONS

Assuming structural change in a building is necessary and imminent, the alternative to renovation is to deconstruct the building and build another one that would be of the latest energetic standard. Considering the social housing crisis, another option would be to leave the old building be and build an entirely new one[4.g] somewhere else that would conform to the latest energetic standard as well. These are the solutions available to achieve climate neutrality and solve other societal problems that provide alternatives to renovation. The actual approach taken is not generalisable but more sector-specific: Interviewees reported that while the commercial sector tends to deconstruct and rebuild more, the private sector renovates more or builds on entirely new ground. The public sector declares an intent for renovation where possible and viable[4.h]. This phrasing is a rough over-simplification and should be taken as merely indicative.

A technological solution in any of these cases would be the installation of heat pumps, solar panels and insulation, targeted to improve the building's energy efficiency and greening the energy use – in the implied necessary energy transition lies the connection of the mission to electrification and individual overall mobility. Each of these solutions provides its own challenges:

- Next to the possible problems and costs that the apparatus and construction may bring up, heat pumps operate with a lower wattage than the classic radiators of a

[4.g] Due to the high prices of newly built buildings, this solution would provide only a mild relief to the social housing crisis. Furthermore, these considerations do not involve the drastic lack of resources of all kinds that will be introduced in full scope in system function 6 on resources reallocation and the search for alternatives.

[4.h] More on that notion of 'viable' later in the distinction between the economic rationale and the new rationale of thriftiness in system function 5 on market transformation and destabilisation.

gas- or oil-based heating system. Thus, heat pumps work as a surface heating for which either the floor has to be redone structurally or the ceiling covered, driving the already high costs further.

- Solar panels provide electric energy with low and varying wattage, depending on availability of the sun among many other crucial factors. For electro-technical reasons and the lack of batteries installed, this electric energy can in most cases not be saved and must be used immediately, either fed in the electric system – which also has its restrictions for reasons of grid stability and where the energy must be used on location, too – or used on the spot by the owner, e.g., to charge an electric car or to replace electricity purchased and taken off the grid. This option is more desirable compared to feeding in the energy due to the low feed-in tariffs – while in 2010, feed-in tariffs of almost 40 ct per KWh were guaranteed, they have now gone down below 10 ct per KWh[4.i].
- Lastly, insulation of walls, roof, or basement is a relatively inexpensive way to increase energy efficiency. Proper assessment, planning, and consultation is necessary, however, to avoid moulding or insufficient performance. Insulation often to combined with exchanging windows for the same reason. The discourse on insulation is postponed to system function 7 on legitimacy creation and withdrawal for solutions.

To round off this first paragraph of solutions, the attentive reader will surely have noticed that thus far, resources as well as construction material and waste have been excluded from considerations listed here. Indeed, resources are only mentioned in this subsubsection as a minor point. The reason for this is that the main focus lies indeed on

- increasing the energy-efficiency of the buildings and
- greening the energy supply.

This shall be elaborated on further in system function 4c on reflexive governance where the 'source principle' is discussed. The resulting discourse of energy efficiency vs green energy supply that specifically revolves around insulation is discussed in system function 7 as well. Resource and material discussions are postponed to system function 6.

Given the prior subsections, it is no surprise that driving digitisation, electrification, and the supply with renewable electricity is seen as a technological solution as a self-reference to the corresponding original problem. Considering the aforementioned process – and, essentially, behavioural – side of this issue, a solution lies in using the so called Building

[4.i] See https://www.solaranlage-ratgeber.de/photovoltaik/photovoltaik-planung/eigenverbrauch-von-solarstrom (accessed October 7th, 2022)

Information Modelling (BIM). BIM denotes a process or methodology to plan a building collaboratively similar to a cloud document or GitHub where digital plans are matched automatically and mismatches reported. While reportedly architecture students are taught to use these methods and programmes, incumbent office and civil servant structures struggle with the conversion of digital media and tools into real life practice. Experts reported legal barriers too, e.g., oes an electronically signed document count too, or must it be printed, signed, scanned, and sent? Digitisation of plans and processes provides further value, e.g., when deconstructing the building, only few surprises would remain in what one may find behind the façades: often enough, material is discovered that by renewed legislation is classified as pollutant, poisonous or cancerous and must be disposed of as hazardous waste by specialists in a proper and costly manner. Furthermore, digital planning provides the basis for (future) solutions like a (currently non-existent) database of houses, material pass for material used or technological systems build in like new heating, air exchange systems, windows etc. Interviews reported that the discourse of individual privacy versus a mandatory digital copy has not even begun yet (which indicative of the state of digitisation in Germany). The problem seen is that the strong privacy laws in Germany may conflict with a mandate to store a digital plan of the building in the case of, e.g., private home owners that may not want public administration to know how large their living room is. Interviewees praised the Netherlands for ruling that such a plan belongs to the building and is bought with the building, thus settling the dispute.

The next solution encompasses many ideas that fit under the umbrella term and the idea of questioning formal and non-formal standards. While these solutions presented here are not exclusively of technical or technological nature, they have been put together as to not have the same category ‘question standards’ in each subsection of solution types. Indeed, dealing with standards s consdiered a technical manner as it involves a high degree of abstraction and complexity and a low degree of creativity. The word ‘technical’ does thus not inherit a disparaging connotation but a descriptive one. With this in mind, attention is turned to questioning standards: Firstly, in the introduction is has been established that, blatantly put, most practices of the construction, building, and adjacent sectors add up to environmentally damaging CO_2 emissions. Together with that, the problems through standardisation and the mechanisation have led to the solutions of

1. building less in general,
2. building less complicated, i.e.
    a) with less technology used, that is, a decrease in mechanisation, and

b) more intelligently in the sense of less force-fit or one-size-fit-all solutions but more context-dependent.

Hereby, 'building' is interchangeable with any activity in these sectors like renovating or producing – and could be boiled down to the term 'de-growth' or 'sufficiency'. There are a few experiments with this solution and building less (complicated) is being demanded, especially by NGO's and non-commercial actors. Related to this topic are alternative models regarding flexibility and mobility in the commercial sector – e.g., the flexibility to work form home, thus saving office space – and alternative housing and living concepts for the private sector – be it through sustainable construction and multiple-party housing concepts, see the 'Bauhäusle' or the 'Gröninger Hof' which reuses, redesigns, and offers vacant parking space as housing and communal space. So far for questioning informal standards, the issue or solution of questioning formal standards remains to be discussed. Herefore, two examples:

1. To avoid and prevent law-suits, planners, architects, and constructors cling to construction standards – which are exactly that, standards that guarantee a certain quality, safety, and validate an expectation, but only in a limited number of cases are they laws that must be adhered to. Due to the immense amount of standards to be considered and the resulting inability to know and consider all these, planners etc. overshoot the standards, using – and thus, wasting – a lot more material than necessary, an amount that should not be underestimated and that interviewees estimated between 10% and 50%. Indeed, what may seem like a mere change to a wall has systemic effect on the building through its static.

2. What has been termed the 'interface problem' denotes the gaps between the different actor groups through the hands of which a building passes. It encompasses a certain blindness and naïveté to the situation at hand that is compensated by accepting standards demanded from somewhere else. This is best clarified by an example where one interviewee reported being tasked with a renovation and conversion of barracks into a school building. When the costs had amounted to the double of what was estimated, higher than demolition and reconstruction, reaching out had revealed that the shift of carrying walls to adhere to a school board's area standard of 65 m^2 for class rooms instead of the available 53 m^2. Through negotiation of the interviewee, the school board accepted the smaller classrooms.

Thus, the need to question standards is established exemplary – a special case of this will be discussed in the subsection on legislative solutions. How can this solution that

this paragraph worked to, the questioning of standards, be achieved in the eyes of the interviewees? The answer is two-fold, half of which is given now: these flexibility clauses that would enable deviation from standards do indeed exist to some extent. Furthermore, an interview quoted a statistic according to which 85% of planners reported to preferably continue developing an existing building than plan a new one while only 7% resulted in doing so. Thus, to question the standards implies to be able, allowed, willing, and confident to *make use* of these flexibility clauses: this is the other half which is postponed to the next subsubsection on social and cooperative solutions and a more in-depth example in the legislative solutions.

Attention is now turned to particular insulation-related solution that concerns the modality of renovations: the 'Energiesprong' (Dutch for energy leap) programme, also referred to as 'serial renovation'. The latter name is more self-explanatory than the clunky 'energy leap', referring to the process of industrially pre-manufacturing roof or façade elements that only need to be installed on the roof or wall, thus saving costs through saving on time on site. This method is particularly applicable to terraced houses and apartment buildings, not as much to single-family homes of which there are roughly 18×10^6 in Germany with strongly deviating shapes and designs. Similar considerations apply to modular or container-based construction: Inteviewees acknowledged that these could be suitable solutions depending on need, e.g., for flexibility in setup and breakdown, or circumstances at hand.

The lessor-tenant-dilemma has been mentioned in the social problem diagnosis as well as the need for a renovation to be, financially speaking, economic. A solution that also considers the rising per capita area consumption for living space, see figure 6, and need for (social) housing is to combine renovation together with 'ex post densifying'. The notion 'ex post densifying' refers to an increase in urban density by adding more housing units on top *while* renewing or retrofitting the roof or façade of the building. The rational lies in co-financing the energetic upgrade through the additional rent. Yet, the costs for retrofitting are often still too great to be economic for the reason that renovated buildings must adhere to the same standards as newly-built houses. This will be further elaborated on in the subsection on legislative solutions together with an example and the reader is kindly asked to be patient in this matter.

Lastly, the use of alternative materials is an indirect way to reduce the energy consumption of a building. This can take many forms, be it wooden, petrol-free, or recycled material like recycled steel, concrete, glass or plastic, or reused material, e.g., for interior design. These alternatives are considered, but the dominant focus is indeed on energy, see 4c, hence this brief paragraph. More elaborations on this noteworthy topic, the why (not)

and how can be found in system function 6 on resource re-allocation, and the search for alternatives where wood, steel, and concrete are considered.

SOCIAL AND COOPERATIVE SOLUTIONS

Using the surface potential of especially private houses and apartment buildings for solar panels – as well as, though barely mentioned, green roofs and walls – is a solution that, despite its low effectiveness[4.j], has gained considerable interest according to interviewees. One federal state has taken a pioneering role and issued a mandate for every newly-build building to cover the roof with solar panels, thus overshooting federal mandates. An application of this principle into national standard is considered and discussed, and this example will return a couple of times in the chapter.

Further decentralising heat distribution beyond communal to local level is another way of de-carbonising heating that requires an extent of organisation and cooperation. The classic showcase example is to capture excess heat – from a nearby data centre or supermarket – and deliver it to a close-by apartment complex or family homes in an adjacent street. This requires a 'city architect' or a 'local caretaker' equipped with a formal and informal position – similar to a 'subject position', see Maguire et al. (2004) – in the region that can credibly bring the respective actors together. The author anticipates the fact that the housing market is rather inflexible and rigid – see structural analysis – by saying that the 'local caretaker' could further be a facilitator for house exchanges. The idea of the local caretaker and the possible relation to standardisation will further be elaborated on in 4b as for now, it suffices to understand this role as a facilitator for local-level organisational needs related to housing and buildings, also because the respective interviewees' precises conceptualisations varied.

It has been mentioned that private home owners, being network- and knowledge-wise unfit to handle the tasks of renovation, face immense complexity of renovation alone. To counter this, interviewees reported experiments with so-called 'one-stop shops' that would provide the service of handling the necessary planning, optimising, subsidies, and coordination of handypersons. Naturally, this is entirely compatible with the priorly introduced local caretaker. This common shared target approach is what should strike the reader as important and as essentially the same solution pathway in different designs compatible with various problems.

[4.j] One interviewee mentioned that for the public sector, merely solar panelled roofs would have an effect of 2-3% in the CO_2 footprint. Exchanging heating to heat pumps or using green gas would, in most cases, have an effect of 70-80%. Naturally, the effectiveness of solar panels could be increased, e.g., through charging electric vehicles with excess energy and would be of particular interest for the private housing sector. Still, the effect would not be comparable.

As building usage and individual mobility was named as a problem, a small but noteworthy solution is to increase flexibility and mobility in work settings, i.e. to guarantee a right to working from home and thus reduce the necessary office space, necessary heating energy, necessary material for new office buildings, and necessary area consumed which will be hinted again in the system functions 1 and 6.

Lastly, on the note of behaviour: interviewees often mentioned the need for and lack of individual courage, proactivity, and creativity, e.g., to use flexibility clauses to manoeuvre around cost-driving and material-wasting standards. Related to that, the inability to question certain unnecessary standards or a lack of common sense was lamented. This inability would drive the costs of newly build or renovated buildings, e.g., by demanding a load-bearing wall to be shifted by one metre to adhere to a certain area standard as an earlier example showed. Furthermore, interviewees mentioned how this conglomerate of avoidant tendencies slows down processes especially on the administrative and governance side, relating to but exceeding the coordination dilemma. Thus, the ability to actively make a justifiable decision is a quality solving the struggle of not taking these decisions only analytically. The barrier to this solution lies in the dialectic and hierarchical struggle that planners, architects, and constructors deliver a product to whoever ordered – who is neither necessarily educated in those matters nor the paying party – and which demands the delivering party to speak up and raise these concerns without fearing consequences.

LEGISLATIVE SOLUTIONS

Thirdly, the – for a MIS analysis uncommon – category of legislative solutions. One could argue that these can be counted as organisational, cooperative, or social solutions as they require an intra-organisational discourse of some sorts to come about. However, the term intra-organisational dismisses the strong legislative character that are inherent to the solutions assembled here. One could further argue that, in order to be fully complementary with the miscellaneous problems introduced in the problem diagnosis, this section should be named 'Miscellaneous Solutions'. However, this isomorphic understanding is at risk of – wrongfully! – implying that social problems can only be solved by social solutions, technical or technological problems can only be solved by technical or technological solutions, and that whatever is left can be solved by miscellaneous solutions. In order to prevent such 'linearistic' assumptions, the author has decided for the term 'Legislative Solutions' that can be understood as exactly that: A subset of the solutions to the problems named in the problem diagnosis that inherit a predominantly legislative character and thus address legislative barriers.

Attention will stay with the issue of standards for a little longer, this time from the perspective of decluttering the system of standards as this is a solution all interviewees stressed. The existing flexibility clauses have already been mentioned, as well as the fact that an unmanageable amount of standards exist. However, it is noteworthy that, being merely a standard, only few of them are legally binding. Instead, a standard would, e.g., guarantee certain levels of noise cancellation properties. When standards are not adhered to, this may be perfectly legal. However, the ordering party has a guaranteed 'right to a flaw-free end product' where a legal but to their taste, essentially, insufficient standard may not be what they had in mind. This discrepancy can be preempted by thorough documentation but not entirely prevented and would then be followed by a law suit where the respective planner is financially held responsible. To prevent this, the highest standard becomes the overall default, leading to material waste and even overshooting standards. Now that the problem with standards is more clear, a legislative – and intuitive – solution would be to declutter the standardisation system, especially since – here again, results from system function 1 are anticipated – this system cements a status quo and hinders developments like BIM, experiments, or entry to the market for start-ups. Indeed, interviewees asserted that the decluttering of the standardisation system proves very difficult. Some suggested that it could be lessened through the aforementioned local caretaker that could serve as a neutral consulting instance to investigate and sign off where lower standards would also suffice, relating to the solution of building less in general and less complicated. However, this is no 'how'-solution to the decluttering of standards and would merely be a weakening of the formal institution it presents.

An example has been promised on ex post densifying and how legislative requirements can hinder renovation projects to become economic. Consider an old apartment building that is to be retrofitted by exchanging the façade and adding insulation. At the same time, the roof storey is to be converted and provide space for new residential units to be rented out. Through this, the investment for the renovation measure can be amortised more quickly or better. However, according to the Federal State Building Code (Landesbauordnung), a house that is renovated must also adhere to the latest federal security standards. Thus, the (say) wooden stairwell in the building needs to be replaced with a staircase of steel and concrete in order to adhere to modern fire safety standards. This replacement has logistic consequences and drives the costs immensely. The owner thus reconsiders and leaves both the façade and the stairwell as they were. While fire safety is a legitimate social concern, the reader must admit that there is a certain irony to this situation. The federal state building code is a federal regulation that regulates i.a. fire protection, escape routes, parking, or illumination and that will come back repeatedly as a clarifying example.

Here too, a (team of) local caretaker(s) could provide the necessary legal flexibility in the necessary individual cases which is already necessary for cases like monuments. A solution would be to install smoke detectors and a sprinkler system for the staircase[4.ℓ]. Alternatively, this federal state building code could be rewritten into a federal state building retrofitting code, putter greater emphasis on retrofitting and renovation rather than new buildings. Many interviewees reported on engaging in the discourse around and design of this solution.

An attempt to solve the apparent dilemma of the need to be economic and necessary renovations for sustainability has been decided on by the national government in 2019. For the government's own buildings, the guiding principle of 'economic viability' – the principle that serves as a guidance for taking decisions – has been extended to 'thriftiness': Given a target, the thriftiness approach would mean that the target must be reached with the least amount of resources. This is a change of paradigm as priorly, the target would only be reached when it was indeed economic to reach it. For sustainability targets, this implies that a holistic perspectives can be taken on buildings and thus, e.g., an initially more costly heat pump can compete with a cheaper but oil- or gas-based heating, combatting a 'carbon lock-in' (Unruh, 2000). This solution and its effects will be further discussed in system function 4c and 5.

The idea of a CO_2-tax, considerations of including grey energy (see 4c), a tax for material consumption, and a material pass are both well-known and self-explanatory and are thus only mentioned here for the sake of completeness. Similarly, the lack of a data base has been mentioned that would need to be mandated in order to properly monitor the sustainability transition and counter the void of knowledge. This topic will also return often throughout this chapter.

It has been mentioned already that the sustainability targets for the construction sector were unanimously considered illusory by interviewees – this too will be a reoccurring theme over the system functions, especially in system function 6. Specifically, the (lack of) conversion of these targets into conceivable, manageable, realistic, and achievable policy 'packages' has been criticised – and proposes a clear solution to the problem itself.

Lastly, interviewees reported considerable deficits in legislation in need of being changed and that changing these was vital, a few examples of which are named here: Concerning, e.g., fiscal regulation, interviewees reported that for companies, the demolition of a building could be deducted from tax. To prevent 'demolish and rebuild' solutions and create an

[4.ℓ] Or, as one interviewee remarked, realise that wood only burns when it's thin: A massive block of wood burns merely on the outside, creating a protective layer against further burns of the inside. Thus, also a legislative approach is a viable (part of a) solution.

incentive for building owners to work more with the portfolio, such deductibles should be eliminated, the interviewee elaborated. Another idea reported to incentivise the reuse of material, e.g., for interior design but also construction material, was to lower VAT to 7% instead of the more common 19%. Furthermore, apart from the subsidy 'jungle', interviewees called it 'madness' that new buildings were subsidised while subsidies for renovation were limited to individual measures that possibly excluded each other – here again, it is hindering that 'renovation' is so ill-defined. Lastly, for regulatory law, mostly the increase of standards and a mandate for a share of renewable energy – as is put into legislation, see structural analysis – or renewed material[4.f] is demanded.

4.2.3 REPRISE

Having laid out the problems and solutions in detail, it is due time to consciously stop for a reprise of the two. Indeed, after such a section of many detailed concepts, it is worth summarising what has been named with the utmost clarity, yet possibly at the risk of formulating blatantly, trusting the reader to have gained the necessary nuance from the above.

1. There is great focus on renewable energy and green electrification for building usage (exchange heating for heat pumps, adding solar panels on top – optimising technology) or insulating building (discourse about that elaborated in SF 7). There is exploration of new practices with most notably serial renovation-.

2. There is increasing focus on local possibilities like heat networks and cooperative solutions, facilitated by a local caretaker or energy consultant (market demand & publicly subsidised) at a one-stop shops, on densifying (directionality), and different housing concepts (subsidised).

3. Legislative solutions were discussed that would lay the groundwork of the coming years – material pass, digitisation of plans processes, building of data bases, and thriftiness instead of economics, and changes in subsidy, fiscal, and regulatory law benefitting renovation by incentivising working with the portfolio. This encompasses the acknowledgement of case-specific, holistic individuality through (a somehow?) reduction of formal standards, and informal standards like building less (complicated) and planning more thoroughly.

[4.f] For renewed material mandate, two points that will return later are anticipated: some interviewees opposed this idea as, as they stated, first, there was not enough recyclable material available and second, such a mandate would destroy companies' business cases.

4. In this spirit, attention is turned towards renovation and building less and more parsimonious as an alternative to erecting new buildings with high energetic standards. In the case of new buildings, standards are seen as having to greatly increase.

4.3 Structural Analysis

4.3.1 Mission Arena

Only a brief report will be issued here on the mission arena as the concept will return in the report on the MLG substudy after the functional analysis. Thus, this subsection is to be read as 'Mission Arena I'. This is due to difficulties in separating the mission arena results from the MLG substudy results, stemming from their theoretical proximity.

During the research, problems were encountered identifying an actor as part of the mission arena or the outer MIS. The problems stemmed from a lack or misapplication of definitions but, most importantly, the same actors engaging in various activities on various levels that classify them as actors from both outer MIS and mission arena. An example of a heating manufacturer was given during an interview that deals with handypersons and their training (see end of system function 3 on licensing), delivers products to larger shops or distribution companies, and engages in consulting the federal government in policy matters, e.g., on production and diffusion rates for heat pumps. This sparked a conceptualisation of the distinction between outer MIS and mission arena as not a binary distinction but two ideal-typical settings that co-existed in parallel – indeed, as could be recognised by the phrasing, this was inspired by the two types of MLG. Figure 5 displays a more continuous conceptualisation of the mission arena with the red area representing the area of fictitious activities of the aforementioned heating manufacturer.

Within the governance structure, feedback flows between the governance levels were stressed as a vital tool and instrument, allowing for a more 'flat' discourse that was not entirely dominated by higher governance levels over lower levels. While it may not be surprising that these exist, the strength of these 'upward-flows' must not be underestimated that is taken most serious by the national level.

Lastly, an interesting phenomenon of 'self-exclusion' from the mission arena occurred. A support actor interviewed representing a large group of value chain actors was prompted with various questions about solutions to social problems, market transformation, and disruptors. A reoccurring statement in their answers was that they would 'build what is commissioned. It's not our job to judge that.' Indeed, this was interpreted as a self-distancing from actively directing the MIS as mission arena members would be expected to

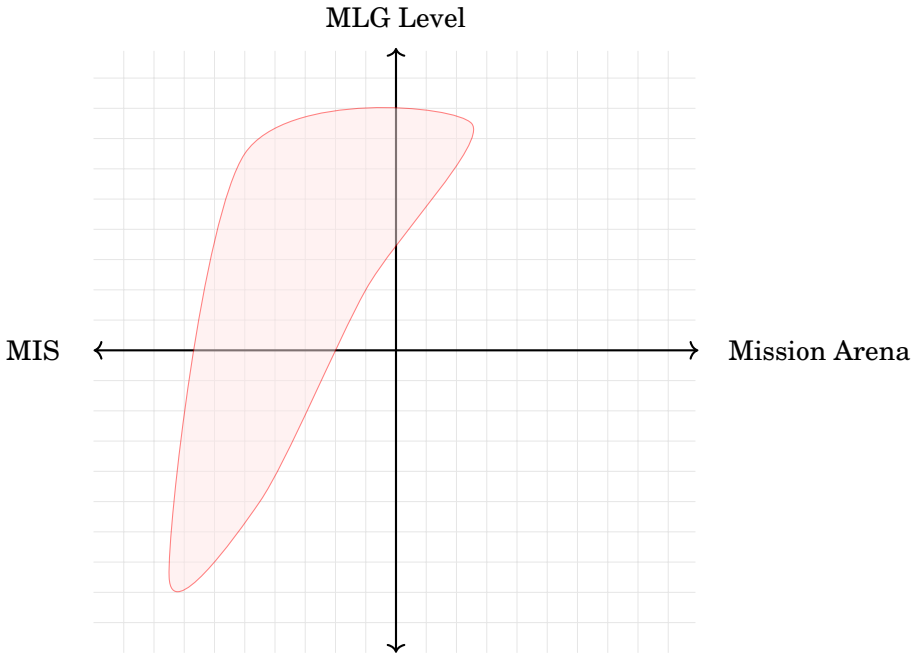

Figure 5: Continuous conceptualisation of the mission arena

do. More elaboration on this phenomenon can be found in system function 7. Elzinga et al. (2021) points out various mission arena or MIS dynamics that have varying effects on the alignment of the MIS. The sample found in this thesis is too small to make more definite guesses but when actors were not included, they 'consequentially showed hesitation or acted reticent' (cf. p. 14, idem.), thus harming mission achievement.

4.3.2 SECTORS AND STRUCTURE

The areas and sectors connected to the mission are the heat and energy sector, the construction industry, the building industry, and the building material industry ranging from raw resources like wood to bricks, windows to technological apparati like heat pumps. Crucial actor groups in the MIS are skilled craftspeople or handypersons, architects, city planners, energy consultants, and home owners. In this subsection, light will be shed upon these sectors – split up in private, commercial, and public sector – and the actor groups within.

For the private sector, about 18 million single family homes exist in Germany, making up the overall majority together with two-family homes, and one fifth apartment buildings. These private home owners represent very heterogeneous conditions in terms of barriers and motives to renovation. Overall, however, their age distribution is skewed, averaging between 60 and 70 years now that as young families in the 1970's bought these houses built

in the 1950's or 60's 'after the war'. These now 70-year old buildings make up a considerable share of and overlaps greatly with the 'worst-performing buildings' (rated per member state) as denoted in the EU energy performance of buildings directive (EPBD, elaborated on later) and are thus a priority target group for renovation. However, these home owners find themselves unable to get a loan or do simply have the financial power to stem an investment such as renovation. Furthermore, if they did, the investment would amortise in around ten to fifteen years – which interviewees described as good conditions – when, on average, these very owners would have passed away. Additionally, a renovation mandate would violate a right to property guaranteed by the Fundamental Rights (Grundgesetz)[4.m]. As a solution, there are mandates for renovation during 'user switches' that are only poorly adhered to according to interviewees. Lastly, drastic housing and material price increases in the past twenty years do not ease tension for (aspiring) home owners.

For the commercial sector, it is most noteworthy that currently, there is a construction boom and that currently, the construction industry is at full capacity. The construction industry encompasses 70.000 to 360.000 companies[4.n] and consists of mostly – interviewees reported 90% – small-sized companies with handypersons usually as single-person companies. Correspondingly, these companies' equity capital is rather low. The same structure applies to planners, engineers, and architectural offices. For the commercial housing sector, most are small companies own between 50 and 400 housing units with only few medium-sized or large companies whose whose unit numbers are in the thousands. As anticipated, the housing market was reported to be rigid and inflexible. Interviewees exemplified this with a single elderly person to be stuck in a too large, multi-room apartment for a low rent and would not be able to afford a smaller apartment if they moved. In this case, an aforementioned 'local caretaker' in a sufficient subject position could bring alleviation, given formal legislative backing.

Lastly, the public sector varies greatly between the MLG levels and also 'sideways' on the same level. Furthermore, the distinction between Liegenschaft (real estate) and Besitz (property) of the different levels is complicated beyond the scope of this thesis. Important national-level ministries are the newly-founded Ministry of Construction, the Ministry of Environmental Affairs, the Ministry of Finance also as a land and property manager, and the Ministry of Economy and Climate Protection. While similar structures exist on the different federal levels, regional or local levels do not have specific ministries but other institutional frameworks dedicated to similar tasks and areas. To give an example and an

[4.m] At the same time, article 14 (2) states that ownership entails an obligation. This dilemma remains unsolved.

[4.n] 70.000 purely construction related companies and 360.000 if conversion companies are considered as well – again, these numbers stem from interviewees.

understanding to the size, one federal state manages 3×10^6 m^2 with a total building value of 3.5×10^9 € divided over 1600 single buildings and 600 real estates (Liegenschaften) which include all real estate of the federal state, schools, universities (which are notably the largest energy consumers), forestry buildings, police stations etc. Equipped with a 'good' budget of 2×10^8 €/year, repairs, renovation, and new buildings must be achieved. The respective interviewees reported that 80% of the total CO_2 emissions are due to heating and electricity production and supply with a share of energy:heating between 50:50 and 60:40, giving clear directions for change and fields of attention. The example will be continued in system function 6 on resources.

4.3.3 FORMAL INSTITUTIONS

Attention is now turned to formal institutions in a by no means exhaustive presentation of the relevant laws and regulations. These are mostly emission-related laws as building-specific legislation is too technical to be translated or laid out here. Indeed, it is noteworthy that the aforementioned sectoral distinctions, e.g., between construction sector – the construction of buildings – and building sector – the usage of buildings – manifests in the design and target of the laws and regulations. Laying this out, however, would blow out of proportions for this thesis, and it suffices to understand these as two different regimes.

The EU Green Ddeal has been mentioned and described already as well the the CEAP – both of which serve more as, for lack of a better term, 'mission papers', not as 'conversion papers'. Thus, they are merely referred to again for the sake of completeness. The Emission Trading System (ETS) and a CO_2-tax have been mentioned already, as well as the standardisation system which overlaps with a European standardisation system. Noteworthy in this context is the Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz) as a German complement to the ETS for all emissions exempted from the ETS that came into force in 2019. Furthermore, legislation on construction material is both extensive and beyond the scope of this thesis. Lastly, the KfW has already been mentioned as a subsidy structure.

The EPBD is an EU directive that some interviewees were working on converting into national legislation. It is currently under revision with one of the propositions being that by 2027, there must not be any public building in the lowest energy efficiency class, by 2030, not in the second-lowest class, and so forth. The same would apply to private homes with a three-year shift. While this novelisation would provide a mandate for renovation and would aid the target of the renovation wave and climate neutrality, one interviewee mentioned that it was heavily disputed with 'only opposing voices' against the proposal.

The Coalition Treaty of the coalition from the social-democratic labour party, the green party, and the (neo-) liberal party sets a target of 400.000 new housing units per year, a quarter of which subsidised, and intends to tackle social housing. It has become evident that this target will be failed as have been similar targets set by prior governments. Most noteworthy, standards for newly built houses will be raised, the path for digitisation will be paved, and a 65% share of renewable energy mandated in every new heating system by 2025.

The climate protection law (Klimaschutzgesetz) in its novel form from 2021 is the 'stepping stone' for Germany's climate neutrality in 2045 and the origin of the German climate target for 2030: reducing emissions by 66% compared to 1990 standards. For the building sector – among energy sector, industry, traffic, and agriculture – the targets have been mentioned in the case description. It is noteworthy that the Federal Constitutional Court (Bundesverfassungsgericht) mandated a novelisation of this law in April 2021 to set more strict targets after ruling the prior version as unfit.

The building energy law (Gebäudenergiegesetz) joins the three laws EnEV (Energieeinsparverordnung, the energy saving mandate for minimal energy use standards), EEWärmeG (Erneuerbare-Energien-Wärmegesetz, the renewable energy heat law) and EnEG (Energieeinsparungsgesetz, the energy saving law) and regulates the energy quality of buildings and energy performance certificates. It contains an innovation clause that allows for exemption from certain fixed regulations if other measures provide the same or more saving of emissions. A novelisation was decided on in July 2022 and in comes into force in January 2023.

The circular economy law (Kreislaufwirtschaftsgesetz) is the central national law concerning waste. It is listed here due to the ubiquitous problem in any topic concerning circular economy: 'waste' is an end product and, by law, not a resource. Waste is usually landfilled or treated thermally, i.e. incinerated, which is particularly worthy of reconsideration for wood-based constructions, see system function 6. Interviewees reported a recycling quota of twelve percent.

Lastly, the State Building Code (Landesbauordnung) has been mentioned already and is thus listed for purely for completeness sake. While a national-level model template exists (Musterbauordnung), each federal state is responsible for their own version, each regulating safety standards and other aspects.

4.3.4 INFORMAL INSTITUTIONS

The overall path dependence of the construction and building sector became apparent over the course of this research, an often reported manifestation being scepticism and even resistance against new sustainable concepts like, e.g., open offices. Slow changes, especially concerning digitisation in small or medium-sized companies but also architectural or planning offices and public administration processes have been reported over the past thirty years with little changes if at all concerning handypersons. Interviewees explained this phenomenon through

- the predominantly small size of companies for which administration by hand was and still is feasible and
- the construction boom of the past decade that set no incentives for change of internal processes.

Representatives of the construction sector stated that they were ready to and would 'deliver whatever is being ordered' or mandated. This shows a general indifference to, acceptance of, or readiness for compliance with digitisation and sustainable construction practices but also a redirecting of responsibility in that matter as elaborated on in the subsection the mission arena.

It has been mentioned already that interviewees lamented the lack of proactivity and individual courage to question certain standards. This extends to essentially making decisions that are well within one's competences, but 'not really anyone's job' to make. An example one interviewee mentioned is the following: A prison that had less need for space was renovated and part of the area became available. At the same time, a businessman approached the interviewee and asked for a free area to cover it with solar panels. The prison administration, the Ministry of Justice, and other relevant stakeholders were content and the formal approval was given for when the construction work was done. After that, the business man needed a building permit which took its due time. When it was time to get the lease contract, the respective stakeholders had switched and the new ones were doubtful, did not want to decide this, and wanted to pass the decision upward to the Ministry of Finance that serves as a property manager. The entire process so far has taken more than ten years. The interviewee finished saysing that currently, another company was buying a nearby forest area to cut it down and place solar panels on the area — while this story only has anecdotal value for the public sector at best, it connects to the bigger theme of overshooting standards to prevent law-suits due to mistakes in the sense of making decisions that were explicitly allowed. The interviewee traced this back to a

problematic culture of mistakes in the public sector administration where, blatantly put, that instead of learning from a mistake, punishment is exerted.

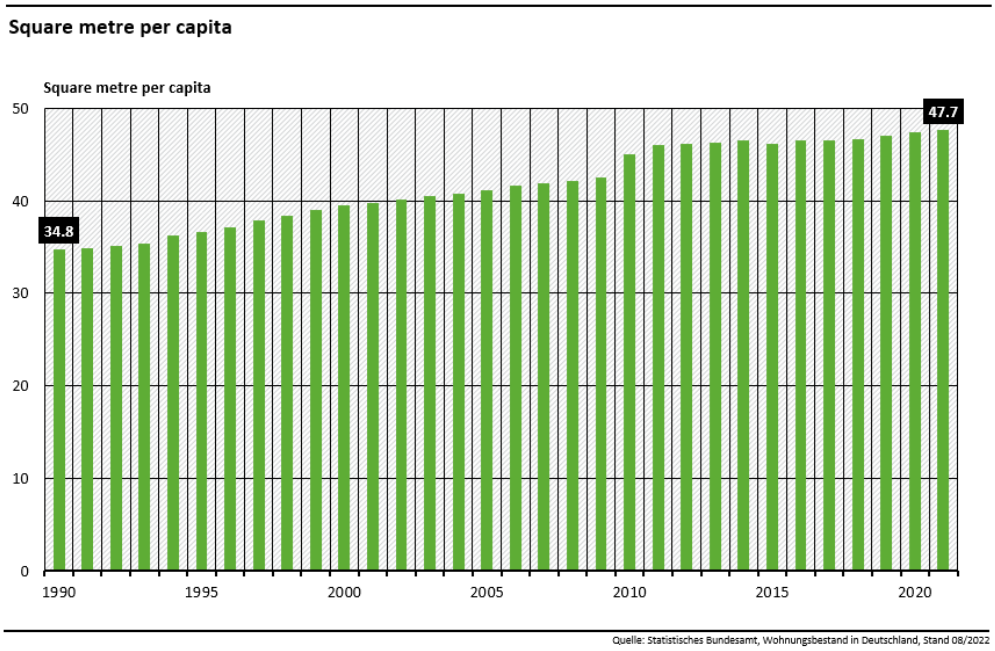

Figure 6: Square metre per capita in housing in Germany from 1990 to 2021. The data displays huge differences for households with respect to the amount of inhabitants per housing unit due to shared facilities like kitchen, bathrooms, and hallways. This confirms that shared housing saves space due to shared facilities. As expected, there is a trend towards more single-inhabitant housing, but the overall increased area consumption should stand out to the reader.

Additionally, as figure 6 shows, the per capita area consumption in square metres in housing has increased by 37% since 1990. This is indicative of a trend that is implicit to the aforementioned increased mechanisation, and that interviewees described as a 'luxury mentality'. While this notion is implicitly clear, planners and architects further reported (private) clients to show an attitude of allowing themselves more luxury in exchange for climate-friendly behaviour that the author termed the 'sustainability reward fallacy'. Indeed, it is a fallacy for as one interviewee remarked: 'One can only save energy by saving energy' and that 'this has nothing to do with innovation.' However, this notion of luxury goes beyond the individual consumer. Interviews reported it is further driven by the standardisation system: Noise cancellation and related material consumption has been named as well as the fire hazard example replacing a stairwell. With this list being by no means extensive, it indicates another dimension, namely that this is predominant on a

societal scale: If indeed materials are as scarce as will be laid out in system function 6, society cannot afford to waste material, money, and energy in such extends. Interviewees said that the cost-leverage was the most effective but only one demanded higher energy and material prices.

Lastly, the principle of thriftiness has already been explained as an extension of the principle of economics. It is indicative of a mentality and an acknowledgement that 'climate change will cost us something', as one interviewee put it, countering this 'diffusion of responsibility' through taking action – see section 4.5 for further elaboration.

4.3.5 INHERENT LANDSCAPE CONDITIONS

At last, one subsection that was not announced in the theory or methodology as its mere existence is a result in itself. What (Bergek et al., 2015) hint as 'contextual barriers' and is similar to the grey boxes in (Wesseling & Van der Vooren, 2017, figure 3), is termed here as 'inherent landscape conditions' where 'landscape' is to be understood in the lingo of the Multilevel Perspective, see Geels (2002a, 2002b, 2006, 2012), and can be equated for now with 'background'. Inherent landscape conditions would be inherent states the system is in or conditions to the system that provide a certain background to every discussion in the particular topic. Indeed, such inherent landscape conditions have been found over the course of this research that indeed qualify as a problem. However, these also go beyond the mere notion of a 'problem' and signify 'a way things simply are now'. These conditions lead to their own problems that are mentioned here to show the 'systemic anchor' these conditions enforce. Nevertheless, these elaborations are merely illustrative and the condition itself should take the readers attention.

The first condition and perhaps the most clear example, is the long investment and life cycle of high financial volume that is inherent to buildings – similar considerations as laid out in this paragraph apply to education and training of professionals. In other words, buildings take a long time to be constructed, stay around for a long time, and cost a lot to erect, maintain, and tear down. This means that buildings are costly to experiment with, and that essentially (less than) one product cycle remains until the 2030 targets. This is contrary to smartphones where the average user replaces their smartphone around every few years, giving much more time for product experiments and paths to, e.g., achieve circularity. Concerning buildings, climate-neutral buildings would only be erected in 3-4 years from now, assuming the planning to begin now and financing to not be an issue. To understand the gravity and implications of this, one interviewee put it as follows: 'We now have [...] perhaps one shot left, if you like to put it in such martial terms. So, the

standards we are setting now for renovations and for existing and new buildings are essentially decisive for what we will find [in our building portfolio, AN] in 2040, 2045 or 2050.' Current regulation does not mandate climate neutrality for new buildings.

Secondly, the aforementioned has strong implications for a renovation wave or achieving climate neutrality in the private (housing) sector. A large heterogeneity in the private sector has already been stated that complicates renovation immensely and provides little target for solutions such as serial renovation. While for the commercial sector, no generalising statement could be made, in the public sector, many schools or administration buildings are in need of modernisation and renovation dilapidated due to years of austerity. Here as well, though not as extensive, a heterogeneous building typology with a lack of documentation complicates matters.

Thirdly, the long chain of 'hands' a building passes through from planning over building and usage to deconstruction must be mentioned that has been termed 'interface problem' as consequently, many interfaces and, frankly, gaps exist that can pose barriers to sustainable practices: As quoted before, 85% of architects and planners would prefer to work with an existing building instead of planning an entirely new building while only 7% succeed when consulting with their client and building owner. A second example is the struggle between handypersons and private customers that is postponed to system function 3 where it fits better and to avoid repetition. As one interviewee put it: 'There is no scrutiny. Those who stipulate the area requirements are not identical with those who then also plan and construct or operate the buildings. There are always institutions that come in between and there is no feedback.' All these relate to what was referred to as 'essentially a communication problem' in the social and cooperative solutions and the questioning of standards. Interestingly, this is a problem that digital planning through methods like BIM aims to ease as figure 7 visualises.

Fourthly, it is no surprise that the Ukraine War, the post Covid recession, the energy crisis, and inflation add to the economic uncertainty about a dawning sustainability transition. Indeed, interviewees reported of a narrative or perception of 'drastic' changes coming up for the MIS. They anticipated a course and directionality set by the government towards towards sustainability, notably mostly through hard standards and requirements. Interestingly, this is somewhat contrary to the policy path taken as, as mentioned before, climate policy has mostly been realised through subsidy policy and not regulation and standards that are often disputed and softened through, e.g., hardship cases or lobbying.

Lastly, it should be reported that during every interview, the precise research topic and question was presented to the interviewee. Upon mentioning the set targets, almost all interviewees, independent of whether they were part of the MIS or the mission arena,

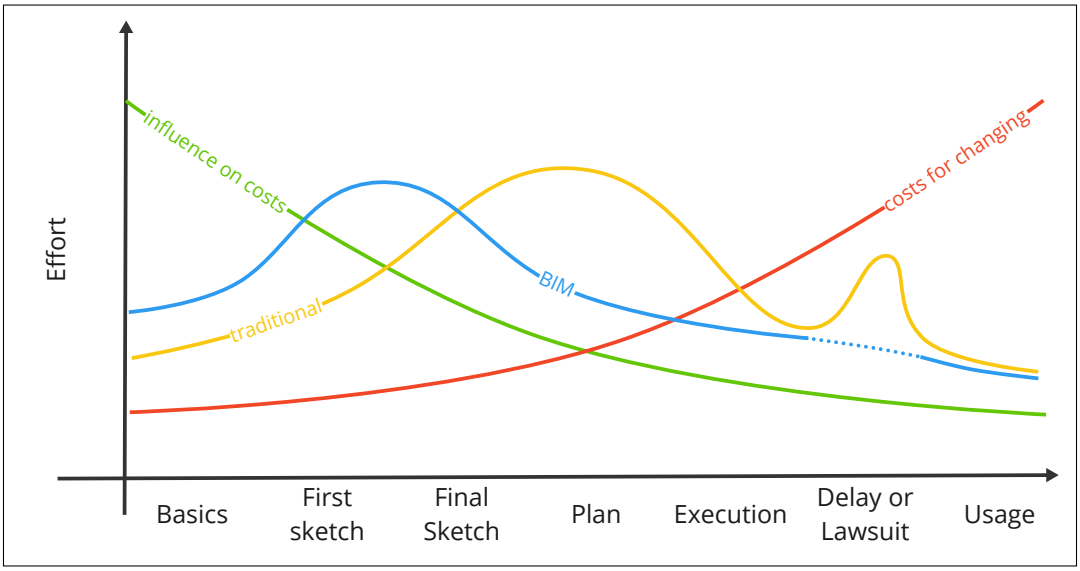

Figure 7: Comparison between traditional planning and planning with BIM in the dimensions of costs for changing, effort for changing, and influence of changes on costs over the early building lifetime. Graphic inspired by an internal report an interviewee submitted for the document analysis and re-done by the author.

expressed immense doubt in their feasibility or rated them as illusory. Beyond that, the question was brought up whether climate change and sustainability were currently the most important priorities. One reasoning for the unachievability of the targets is laid out in system function 6 that focuses on mere resources; leaving out the inter-human component entirely as, e.g., the luxury mentality mentioned in the informal institutions. Despite this negative outlook, one policy and institution actor said that that 'nevertheless, we have an obligation to confidence'.

4.4 FUNCTIONAL ANALYSIS

With this broad overview of problems, solutions, and structure of the MIS, attention now turns to the system functions. Some of the content has already been anticipated. Thus, the purpose of this section is to sort this content into the respective dimensions of system functioning and continue the examples begun.

4.4.1 SF 1: ENTREPRENEURIAL ACTIVITY AND DISRUPTORS

This subsection attempts to answer the question from the interview guide: 'How would you assess the amount, speed, and quality of experimentation with technologies, business models, and destabilising solutions?'. To split this up, alternatives will be addressed first, then sources of and barriers to innovation, and lastly, directions for destabilising start-ups and disruptors.

Alternative living space and housing concepts have already been hinted. Examples for living in communities are the Bauhäusle for self-repairs contrary to the technophile mechanisation and reuse of waste material, or the Gröninger Hof for re-purposing urban space and existing buildings. Indeed, beyond re-purposing vacant office buildings as living spaces, the redesign of office space is also of particular interest to facilitate individual mobility and flexibility in working. In both cases, the area saving hinted in figure 6 applies. Interviewees stated that these non-standard solutions are difficult to pursue: For creating alternative living space, interviewees assessed them as mere 'feasibility studies' that were only economic due to high subsidy volumes and thus not suitable for the masses. This is also due to the high degree of individuality these projects inherit and thus, increased costs due to non-standard planning. For alternative work environments in offices, a resistance and unwillingness has already been mentioned in the subsection on informal institutions and mentalities, the source of which remaining unidentifiable.

As per commercial sector structure mentioned in structural analysis, particularly the construction and housing sector are rigid and path-dependent. Together with the standardisation system and the current construction boom, little room is left and little incentives exist for deviating or experimental practices. It was reported that innovation in this MIS mostly comes from 'outside', that is, from material producers delivering more efficient windows, insulation, or heating systems, and start-ups that focus on digitisation and alternative material. Though loosely connected to digitisation, logistics and optimisation of processes is left relatively unconsidered. As one interviewee put it:

> The guys on the construction site, and they are really just guys, work 30% of the time. For the rest, they are looking for something, have to wait for someone – 30%! Now, if they didn't work 90%, but let's say 80% of the time, then we would already have a doubling [...]. So we have to change the logistics, we have to provide a stringent planning consistency, but all that is so strenuously denied. You can even provide them [(construction companies); AN] with figures

> and they say 'no, it's completely different here, it works there', and still, they cannot manage.

Other notable novelties are the inclusion of building usage into considerations, digitisation, and, most prominently, BIM as a transformation with wide-ranging effects to other system functions. It is listed here as many start-ups follow this digital approach as a necessary condition for their business. Start-ups mostly engage in digital construction-related activities or, alternatively, new materials that, e.g., avoid petrol. There are barriers to such efforts due to, e.g., costly permits or path dependence.

Lastly, on the topic of disruptors. Next to digitisation and the opportunities it enables – planning, material pass, digital building documentation that renovations get added to etc. – for the industry, the disruptor is seen as coming 'from below'. Interviewees identified new disruptive consumers as people in their twenties and thirties about to enter the housing market but also older generations that developed a sustainability prioritisation. These would choose for houses with sustainability certificates like a share of recycled, local, or reused material with low CO_2 impact, thus driving the demand for climate neutral housing in both the private and commercial housing sector. In parallel, sustainability or climate neutrality certificates of other privately owned non-housing buildings could serve as a figurehead for companies. For the public sector, see system function 4c.

4.4.2 SF 2: KNOWLEDGE DEVELOPMENT AND UNLEARNING

This subsection attempts to answer the question from the interview guide: 'To what extend is there research and development of new knowledge relevant to the mission, understanding societal problems or harmful effects of practices, and unlearning harmful practices?'

First of, it is very well known what in the construction and building sector accounts for what impact, what practices and processes are harmful – examples like concrete and steel will be discussed in SF 6 when talking about material as part of resources. Thus, a building's lifetime impacts can be calculated or approximated reasonably well with little room for discourse. In this spirit of the technical, numerical, calculative part being 'no problem at all', the discourse concerning a building's evaluation and assessment is more on how to optimise and balance what in relation to each other. Instead, the uncertainties lie in the unquantifiables and systemic effects. Indeed, interviewees reported that it was the processes and practices that hamper, especially concerning digitisation. Thus, novelties, unlearning moments or stoppage of harmful practices would be that

1. by new regulation, a material priorly commonly used is classified as dangerous, poisonous, cancerous, or environmentally damaging and must thus be sent to a special landfill site for disposal. As this can become rather costly, renovation considerations are often stopped in their tracks by the lack of documentation.

2. a more holistic view on buildings beyond the mere build-up is attempted where predominantly building usage and operation are considered. However, for deconstruction, the building life cycle is too long to be an issue for the owner, especially in the private housing or commercial sector. A design or road map to facilitate building backwards does currently not provide any incentives except for fulfilling a perceived moral obligation.

Secondly, research directions and finance shall be discussed. Overall, the research field was described as 'highly dynamic', broad, and under-funded. As mentioned before, the overall industry's R&D mostly produces material innovations and material research results. Yet, this positive phrasing must be put into perspective: The document analysis indicated that most of the – few large – companies reduced their 'already small' R&D departments due to economic hardships in the 1980's, 1990's, and 2000's. Universities and technical universities were repeatedly mentioned as well as MLG-directed research, often in collaboration. These would mostly be hands-on studies concerning potential especially on local level, possible pathways and trajectories and related necessary policy measures, systemic effects of interventions or renovation investments under uncertainty, sustainable and smart city planning as well as the aforementioned 'one-stop shops'. Interviewees lamented the fact that universities and the public focus have long neglected research areas like design for sustainability or emission-reduced buildings. Furthermore, while research contracts are awarded and financial means allocated by both MLG structures and, for better or worse, by the industry[4.0], results 'take time'. NGO's mostly focused on a limited array of topics such as how to combat the ubiquitous lack of skilled labour, digitisation or the related benefits through optimised logistics.

Lastly, interviewees mentioned an overall cutback on research and education on all MLG levels that led i.a. to the aforementioned lack of and late development of sustainable building knowledge and practices. Furthermore, through the more strict separation of disciplines, interviewees lamented, particularly of design and functionality, holistic considerations that are deemed so necessary are harder to achieve and the 'interface problem'

[4.0] Interviewees stated that through the great dependence of universities to be awarded research contracts, there would be a risk of biased results to the clients wishes for the result.

from the structural analysis aggravated. Is is a shared believe that interdisciplinary studies and teams could bring alleviation.

4.4.3 SF 3: KNOWLEDGE DIFFUSION AND BREAKDOWN

This subsection attempts to answer the questions from the interview guide: 'How lively is the knowledge exchange – about societal problems or the development and use of solutions – through networks or events? To what extend do networks support the breakdown of harmful practices?'

As expected, interviewees reported of conferences, meetings, research and reports being published, and awareness or public information days being held. However, interviewees either whisked that away as unnecessary or mentioned that it worked reasonably well. Regardless, they agreed on the need to battle the 'disciplinary silos' that had formed around the various occupations and only the immediately connected professions. Instead, the interdisciplinary exchange is unanimously seen a critically necessary step-stone. As one interviewee put it:

> I hardly ever go on specialist network events any more, I hardly ever do that, well, maybe it's my job, but that doesn't really bring any stimulation any more, does it?, in other words, it confirms my belief, not meant to be arrogant, but there (inaudible; AN), it doesn't help me any further. The inspiration comes from outside, from the adjacent science or field of study.

Thus, the inter-specialist exchange is deemed vital as a first point, connecting to the 'interface problem' earlier. Beyond this 'formal' side of knowledge exchange, interviewees and documents considered knowledge diffusion to private home owners as similarly important. While being at the 'receiving end' of policy and thus critical to target conversion, individual home owners are on average the actors with the least developed network and renovation specific knowledge. The following example stresses the importance of knowledge exchange to these parties: When renovating, private home owners highly rely on planners, architects, or handypersons – out of which they mostly choose the handyperson, both documents and interviewees unanimously reported. Interviewees agreed in different words with the documents that described handypersons as generally path-dependent specialists in their field and, frankly, only their field. Handypersons were said to have little to no holistic knowledge on the systemness of buildings or renewable energy and be unable to keep up with or handle the complexity of technology of modern control systems such as, e.g., boilers for heating. As a response and to prevent damage to the manufacturing company from a

handyperson's incompetent misjudgements, some manufacturers offer courses to obtain permits for the installation of their products. While these courses are being taken and completed by handypersons, the document analysis suggests that this poses barriers to the scale-up sustainable alternatives: As mentioned before, the majority of companies is small or very small. Thus, for capacity reasons, there is an inherent risk in specialising on the license-based installation of (say) heat pumps in exchange for more commonly used oil or gas-based heating systems. With the words of Unruh (2000), the system is increasingly self-referential deepening its lock-in.

Interviewees mentioned that knowledge of more sustainable practices and alternatives or digitisation of processes was diffused to the MIS through universities to students of, e.g., architecture or engineering, and most employees in the MIS have a basic digital literacy. The 'upward percolation' of that knowledge, its adaption and conversion into specifically formal and official practices is hampered by path dependence, complexity, and remains questionable. As one interviewee put it: 'It's these infamous old men in suits!'

Lastly, the federal state building code (Landesbauordnung) has been referred to already. With this building code, the aforementioned cutback on education becomes problematic as there is regional variation in practices and complicated regulations that (future) employees are trained with. One interviewee gave an example of an applied university that discontinued its engineering department despite it delivering very well-educated and skilled engineers, leaving the education and training of engineers for construction to far less renowned departments of other universities.

> For just over 10 years, no more skilled workers were trained, so to speak, and the probability that someone who comes from [here], goes to another city and studies there with a different state building code, which he gets to know there, then goes back to [this federal state's] market, is of course much lower than someone who might go to [the now closed university in this federal state] and completes their studies here in close contact with the federal state building code, and then ultimately wants to work here on the market somewhere, is of course much greater, but yes, this is politically, in the training sector, in principle a mistake. [quote anonymised by the author through the [. . .] notation]

4.4.4 SF 4: PROVIDING DIRECTIONALITY

SF 4 is subdivided into problem (4a) and solution directionality (4b) as well as reflexive governance (4c) and will be treated accordingly.

SF 4A: PROBLEM DIRECTIONALITY

This subsection attempts to answer the question from the interview guide: 'How much are the mission's societal problems prioritised in relation to other societal problems and wants?'

The need for social and affordable housing is widely acknowledged. As mentioned before, this governs considerations of investors deciding between creating new or renovating existing housing space. Despite the federal governments plans to subsidise 100.000 housing units, its target to annually create a total of 400.000 new housing units is seen with scepticism concerning feasibility and achievability.

The financial burden of renovation is widely acknowledged too. However, the financial burden of most current issues are too. Specifically energy prices were mentioned as a dominating priority as well as other energy-related concerns expressed. A far more growing concern, however, are the rising costs due to inflation that is currently – October 2022 – about 10% according to the press release No. 413 of 29 September 2022 of the Federal Administration for Statistics (Destatis). These two concerns both benefit and hinder the mission to an extend as they both pose a barrier for and can partially be solved by renovation and climate-neutrality. However, interviewees expressed doubt about prioritisation – 'We have to ask ourselves: is climate change the most important thing right now?' – and, despite the acknowledgement that sustainable, green, circular topics are more dominant, whether politics was actually concerned with the most important issues:

> If you listen to her [minister of construction; author's note], she is not yet dealing with current problems. She is still talking about creating housing and social housing. She doesn't talk about the current massive increases in construction prices due to skyrocketing material prices. Or rather, that should be her current topic, because she can forget about her social, affordable housing if it can't be implemented financially.

In this light, the missions' social problems are prioritised – however, this is not due to the missions themselves. Rather, their perspective and framing benefits from the priorisation of these social problems.

Lastly, a problem that has not been entered the discourse yet, but – according to interviewees – will in the next decade: Germany has strong laws protecting the individual privacy that might conflict with a mandate for a digital plan of the house including floor plan and which material was used where. Experts consulted agreed that this would be a tough barrier to overcome with its roots being in another legislative system. Tthis social

problem is prioritised highly – again, not due to the mission – and hampers the mission likely.

SF 4B: SOLUTION DIRECTIONALITY

This subsection attempts to answer the questions from the interview guide: 'To what extend is there a shared understanding of the solutions necessary to achieve the mission, real or in development? What solutions are part of a dominant set of solutions? Is the interrelatedness of solutions acknowledged and understood well enough?'

No interviewee doubted that a mix of systemic solutions was necessary to achieve the mission as much as possible. The main pathway seen to achieve the necessary CO_2 decrease is to reduce energy consumption during usage of new buildings through higher energy standards and of existing buildings through renovation measures, and thus, as per the solution diagnosis, through technological solutions: insulation, heating exchange to heat pumps, renewable energy with mainly solar panels as the building's contribution and partial self-sufficiency[4.p]. As mentioned before, the technical part of calculating costs and impacts is not seen as a problem. Rather, the complexity of the matter – standards, subsidies, regulations, aim of the renovation (economic vs sustainable impact) – make for different (social) optimisation models. Thus, the focus is predominantly on reducing energy consumption of existing buildings through renovation with existing technological solutions.

However, despite this declared focus on renovation, it has not led to a decline in newly built buildings. For these, higher energy efficiency standards are designed and a renewable energy supply share mandated – one federal state was reported to pioneer and overshoot national mandates by mandating solar panels in their federal building state code. Changes in fiscal, subsidy, and regulatory law are proposed by interviewees but beyond intent of going in the general direction, no definite plans could be found to put these suggestions into practice.

The rest of this subsection is dedicated to display the dominant set of solutions targeting to improve the overall 'willingness' to renovate more: Reduce standards and bureaucracy, redesign of targets, reaching homeowners, and digitisation.

Firstly, to reduce standards and bureaucracy. It has been elaborated already in what various ways the standardisation system hampers experiments and renovation attempts by putting up formal and, effectively, economic barriers. As could be expected, these complaints come especially from the outer MIS as well as from the lower-level governance structures in mission area.

[4.p] Note that no statements can be derived from this order.

Practically all the policy and governance actors and overall mission arena actors that lamented the unachievability of targets called for the adaption of targets into

a) more realistic, achievable, reduced versions and similarly,

b) multiple broken-down steps that were more handleable and could more easily be converted to national, federal, regional, and local policy.

These calls often included the consideration and taking into account of 'grey energy', i.e. the consideration of energy that has been put into the building at hand already. This will be elaborated on more in 4c. Particularly, the 2% renovation rate as a fixed renovation mandate was considered 'mindless'. Thus, the stated mission in the EU Green Deal is *not* seen as part of the set of viable solutions for the German targets of decreasing CO_2 emissions or climate neutrality.

Thirdly, particularly the support actors and part of the policy actors considered it vital to diffuse knowledge to and reach home owners through consultation offers, one-stop shops or local caretakers. What was denoted as 'reaching' mostly concerns technical consultation for technological considerations or manoeuvring through the subsidy jungle.

Lastly, digitisation has been reported to have a great focus as a means for planning processes and – also ex post – documentation of buildings, optimised logistics, and creating central public contract-awarding or subsidy platforms. Particularly the potential for directionality was acknowledged.

In summary, the focus is greatly on technological and legislative solutions. Social, organisational and cooperative solutions are considered valuable but not chased, hence why they were mentioned in the solution diagnosis but are not part of the dominant set of solutions. They do not exceed the status of a grassroot singularity.

SF 4C: REFLEXIVE GOVERNANCE

Question asked were 'How and to what extend is mission progress evaluated?' with a distinction between outer MIS and mission arena actors based on a preliminary first assessment. For outer MIS actors: 'To what extent does your organisation participate in mission progress measuring?', and for mission arena actors: 'How easily could the mission itself, its supporting measures, or indexes be redesigned?' Answers to these questions are assembled in this subsubsection.

First consider the evaluation of mission progress. As mentioned before, there is no strict definition of the term 'renovation' – which in this thesis loosely encompasses any form of structural retrofitting targeted to increase energy-efficiency. Next to this general

problem, the lack of a (German) database has been mentioned as well as the related future privacy concerns that might well hinder building up one. Despite this lack of knowledge, interviewees reported that studies to assess a renovation or CO_2-saving rate could be done. This enabled them to report in the interviews that the targets would be missed again and have been missed repeatedly in the past evaluations. Indeed, the new annual climate protection report 2022 recently restated this failure.

The system of measuring has been hinted as a noteworthy discussion point in the subsubsection on technological problems. Commonly used is the 'sourcing principle' (Quellprinzip), referring to the principle of assigning emissions to the sector in which they are physically emitted into the atmosphere. By this principle, increasing energy efficiency is the most important measure of buildings. While this measuring system asserts for no double counting of emissions, critique has been issued that it lacks a holistic perspective. By comparison, the originator principle (Verursacherprinzip) assigns the emission of (say) a building not to the building sector but its (say) energy provider and thus, the energy sector. Under this principle, the material used must be considered as well as emissions from concrete, steel, glue separation, or wood also influence the holistic climate assessment of buildings. While none of the two systems is intrinsically 'better', it should be remarked that the primary measuring tool, the sourcing principle, has its blind spots and different focal points are available and reasonable.

Similarly, the discussion of grey energy remains unsolved. 'Grey' energy – or 'golden' energy as some interviewees put it – refers to the amount of energy that has already been put into the building through material production and building construction. Unlike a sunk costs in economics, one must consider the energy used as material can still be used: it did not 'sink away' but is very much still present. With a mandate for considering the grey energy of a building, an intention set in the coalition treaty, the balance in considerations between renovation or demolish and rebuild would be shifted in favour of renovation. However, experts brought up the issue with connecting grey energy to emission scopes and, consequently, a connection to monetary equivalents. According to them, grey energy would qualify as a 'scope < 2' emissions as scope 2 emissions denote indirect emissions by using a product. This would imply the emissions released through bulldozers, cranes, and cutting tools but not the building to be deconstructed. Doubts have been expressed whether scope 3 is an applicable framework for grey energy as grey energy does not denote the entirety of emissions up and down the value chain but merely indirect emissions put into the building at hand. Thus, grey energy would also qualify 'scope > 3' and thus some form of scope 2.5. This question is indicative of what difficulties are related to grey energy. Regardless, many initiatives like the Climate Round Table Construction (Klimarunde Bau) or the Earth's

Bauhaus (Bauhaus der Erde) are concerned with the matter and raising their voice in support it. Furthermore, assuming a price of 195 €/tCO_2[4.q], experts consulted stated that the resulting costs for grey energy would still be dwarfed by the costs for larger building projects, e.g., public buildings like universities. This dilemma remains unsolved.

Concerning the deliberate reflection on and reflection on the mission's progress that is part of 4c, it should be mentioned that mission arena – or rather, governance – actors mentioned that the core knowledge and ideas aimed to implement now are rather old (around 40 years) and thus, much time has been lost. In that sense, the mentality change to use the principle thriftiness that encompasses an acknowledgement of the costs that come with climate change, is seen as a huge and overdue step. However, an assessment report quantifies the effect of the pioneering role as 0.04 million tonnes CO_2, see (Thamling et al., 2020, table 1). While this is rather minimal, hopes were expressed by interviewees from the mission arena that this would cause spillover effects from the public to the private and commercial sector. No studies could be found that would assess this.

Lastly, the redesign of indices and targets was perceived as difficult. For one, the governmental structure was described as slow and the remaining time as insufficient. Value chain actors and representatives of value chain actors interviewed described political structures and actors as lost and with contradicting decisions and priorities that turned a blind eye to 'reality'. On the other hand, mission arena and governance actors stressed the immense complexity, novelty, and haste of the matter. With the unachievability of the targets being undisputed, however, further design of the targets is to be expected.

4.4.5 SF 5: MARKET FORMATION AND DESTABILISATION

This subsection attempts to answer the questions from the interview guide: 'To what extend is there a market (forming) that enables the mission? To what extent do (in-) formal institutions facilitate this transformation? To what extend are harmful practices abandoned or phased out?'

The overall situation of the market has been described spread of this chapter so far; to repeat: with the current construction boom, the construction industry is operating at full capacity and only little incentive for change is seen. At the same time, the building industry is impacted by the gas and energy crisis. An anticipation of what interviews described as 'drastic changes' is in the overall narrative of the MIS. When asked about the direction these expected changes would go to, interviewees reported they expected mandates that

[4.q] In its press release no. 63/2020 from December 21st, 2020, the Federal Ministry for the Environment calculated 195 €/tCO_2 as an appropriate CO_2-tax in 2020, or 650 €/tCO_2 if future environmental damages are to be accounted and future generations equated with today.

would increase the overall sustainability benchmarks for buildings – with the grains of salt elaborated on in the subsection on solution directionality. Lastly, next to the per capita surface consumption increase displayed in figure 6, figure 8 displays the price increase of selected construction material that an interviewee described as 'skyrocketing'.

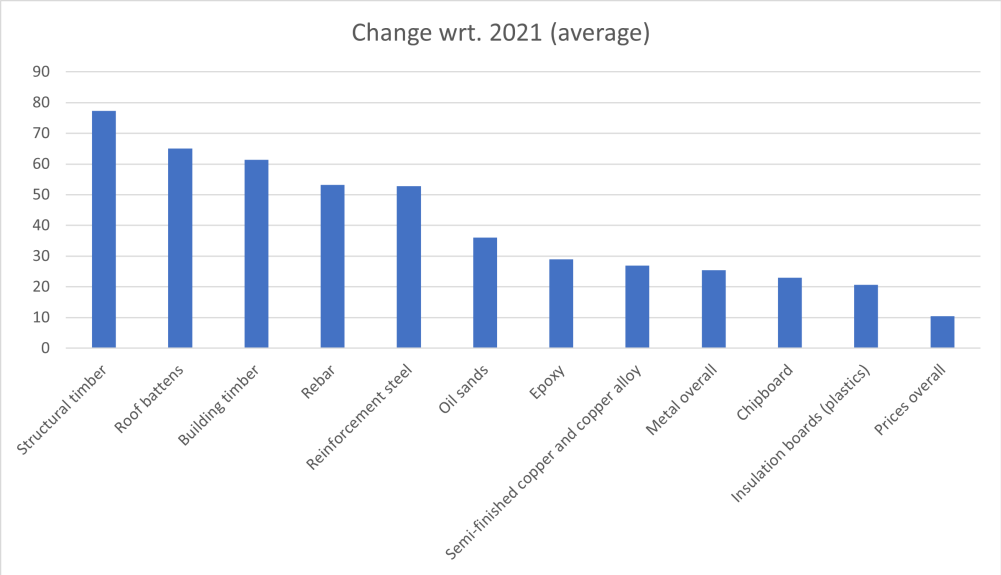

Figure 8: Price changes in 2022 with respect to the 2021 average for selected construction material products, most of them being vital to modern construction practices and processes. The data is taken from the Federal Administration for Statistics (Destatis) from press release N 006 from Februar 10th, 2022. The diagramm is made by the author.

Next to hindering of experiments as described in system function 1, interviewees reported the standardisation system would cement current practices and market dependencies. While this is part of system function 7, the 'lock-in' effect is part of the reason for the lack of market destabilisation and thus put here. Firstly, note that standards are not set by the government but formal institutions such as and for the most part the German Institute for Standardisation. The bureaucratic and formal process of creating such a standard is costly for those that wish to get involved with it. While these committees consist in part of volunteering professionals and specialists, interviewees reported that financially more powerful companies would be able to send full-time representatives to these committees and thus, standards would show a strong 'industry touch'. By mandating high standards for, e.g., acoustic protection and driven by a fear of law-suits, an over-use of heavy material such as energy-intensively produced steel-reinforced concrete or heavy bricks is common.

The same way, standards for recycled or reused material are hindered – see next system function – and more sustainable, alternative material is invalidated:

> Interviewee: Of course, besides the question of the resources of our contractual partners, i.e. the construction industry, these are open questions: the optimisation of building materials. It seems that clay, for example, can be a building material that can actually be returned to the natural material cycle after the building is no longer in use.
> Researcher: It's a pity then that there is no DIN standard for building with clay [anymore; author's note].
> Interviewee: Exactly, exactly, exactly.

Indeed, a DIN standard for clay existed and an older interviewee recalled working with clay. This phenomenon can be seen as the antonym of the 'lock-out' as it displays a 'lock-in deepening'. Lobbying and other practices than enable this are postponed until system function 7 on legitimacy creation and withdrawal.

The fact that alternative and sustainable material more expensive not only process- but also permit- or standardisation-wise is no surprise and has been mentioned already. It is listed here as most interviewees traced the discussion of reusing material back to a mere market question. The argument is rather straight-forward: It is more effort to break down buildings and leave the material unharmed and re-sell it than just produce it anew. An interviewee termed this the 'fundamental flaw of our economic system'. To counter this mechanism, interviewees suggested that actors that re-use material could enjoy tax benefits or reduced VAT on these products. Whether or not 'green capitalism' can work is not discussed here.

In the light of the prior point on affordability of sustainability, it is interesting to mention the federal level's pioneering role in prioritising thriftiness instead of the in its scope more limited economic viability as a sole criterion. The respective interviewees expressed their hopes for spillovers and imitators particularly in the commercial and upper private sector. As an internal report shows, the expected direct effect size rather small though (Thamling et al., 2020). However, an interviewee described it as an acknowledgement of the costs in the sense that 'climate change will cost us something' and deemed it a valuable sign of progress. Regardless, in light of this, market transformation and phase-out of harmful practices remains a mere suggestion on a voluntary basis.

BIM and overall digitisation of planning processes has been mentioned repeatedly. One interviewee working closely with and pioneering BIM lamented that BIM was being standardised despite it being an open methodology that was 'totally dynamic' inherently.

Concerning the expected market effect, interviewees predominantly reported cost savings especially on big projects through planners and architects being able to work together and not having to align their plans manually, see also figure 7. Furthermore, facility management is expected to be made easier for necessary repairs and renovations. Companies and actors without the necessary digital literacy are reportedly already in part excluded from contracts and it is mostly the public sector that is 'obviously hopelessly lagging behind', especially using the directionality potential interviewees saw.

4.4.6 SF 6: RESOURCES REALLOCATION AND SEARCH FOR ALTERNATIVES

This subsection attempts to answer the question from the interview guide: 'To what extent are resources – human capital, financial and material – mobilised, available, or withdrawn to achieve the mission?'

As a preliminary one-quote prologue to this subsection, it should be mentioned that one interviewee reported the sectors in question would already draw resources away from other sectors and that barely any more would be available. In this light, the title of this subsection should be read stressing the *re*allocation and *alternatives*.

Overall area consumption as well as material and price increase has been shown in figure 8 already. Value chain actors reported price increases of 200-300% since the pandemic with there material prices component making up 50-60% of total construction costs. Thus, the overall price increase or lack of resources in the construction sector is well-known. In fact, this lack extends from material over financial means to skilled labour with a particular deficit for human capital. It was well-accepted among interviewees that this deficit in resources of all kinds would not be the only shortfall for reaching the mission. In fact, as interviewees elaborated, even if there were enough resources, the boundaries the issue at question sets – that is, planning and execution cycles – would be close to insurmountable. To illustrate this further, the example begun at the end of the subsection on sectors and structure is continued: recall that the interviewee reported to have 200 million for total budget per year. According to their own calculations and reports, the total costs for the renovation of existing buildings until 2045 amount to 5.7 billion for the existing buildings and 2 billion for the new buildings that would be needed as temporary replacement buildings, totalling to 7.7 billion. The interviewee concluded their elaborations as follows: 'I think our whole federal state's budget with all the salaries is smaller than this, you know? So and that is, those are dimensions, uhm, that are beyond good and evil. [...] So that [calculation; AN] means starting now, right?'

Thus, leaving capital or capacity boundaries unconsidered, the re-use of material and use of alternative materials seems worth considering for a variety of reasons, be it to ease the tensions related to resource scarcity[4.τ] or financial matters, or to prevent emissions from the production of new material. For this, consider the most prominent materials: concrete, steel, and wood.

1. Concrete continues to bring great benefits in modern construction practices in all areas of construction. First, the concrete production steps and usage will be assessed, followed by that of the current practices concerning recycling concrete. Cement is an essential ingredient, as is water, sand, and gravel. It is well known that there are problems with water scarcity to be expected in the future and Earth is running low on the latter two that must thus be sourced – partly – from used material. Generally, demolition materials are all the more recyclable the more purely they were processed. This is generally the case with older buildings from the 1960's that were mostly constructed using mortar and bricks. With the increased use of glue, foam, material compounds, however, separation has become more difficult and cost-intensive. The document analysis described cement as essentially ground limestone that is fired at around 1450 °C. If that primary firing were switched to electricity from green or renewable sources, an estimated 50% of emissions could be saved in this process, the other half stemming from the chemical processes that could, theoretically be captured (partly) via carbon capture technology. Next to that, the document stated the 'often overlooked' property of concrete to also take up CO_2 from the air. While this is an ideal-typical setting and not enough to 'redeem' concrete, it is information that if applied can put concrete into a not solely negative perspective. Interviewees stated that in the short and middle term, continuing without concrete was not possible. Concerning the current practices regarding concrete recycling, it is noteworthy that indeed, concrete is ground and reused. However, this merely extends to ground concrete being used as mass material for road sub-bases which form a base for the actual road, essentially downcycling concrete. Furthermore, for new concrete, the maximal admixture of recycled concrete was reported as 55%. As one interviewee concluded, recycling was 'not the optimal way' as next to this boundary, there was the one set by the use of glue and compound material that are hard if not impossible to recycle. Another interviewee reported that even if there were no such hindrances, cutting (steel-reinforced) concrete was hard to cut, causing a 'gigantic amount of cutting tools consumed'.

[4.τ] Interestingly, interviewees stressed that even if all material used were recycled, it would not be enough to satisfy the material needs of the building and construction sector.

2. For steel, similar considerations apply: A document stated that firing the oven with green electricity or hydrogen is technically possible and would greatly improve the CO_2 assessment of steel. Furthermore, steel is 'without any problems' fully recyclable multiple times.

3. Lastly, wood is used in most modern constructions and deemed as sustainable by many as a re-growing resource that could replace concrete or reinforced concrete constructions. However, interviewees expressed considerable doubt about the sustainability assessment of wood that will be elaborated in three steps: Firstly, the time necessary for growth conflicts with the imminent need for resources and to save carbon. Consider the immense life time span of trees that naturally live more than a hundred years and meanwhile continue to absorb CO_2. While the exact CO_2-absorption rates over the life time of a tree go beyond the scope of this discussion, it is beyond doubt that in the first (say) fifty years, it should be a monotonously increasing function of time. Thus, if a tree is harvested and replaced with a new seedling immediately, the overall CO_2-uptake rate must necessarily go down. While the fact that a cutting down trees is not good for climate is hardly a surprise, the point that it takes multiple decades for the seedling to grow into a replacement is quite clear. There remains uncertainty on whether or not the emissions saved by replacing (say) concrete with tree logs saves emissions in total. However, there is no uncertainty in the analytical argument of the loss of CO_2 uptake due to the disparity between the need for wood now and the replenishment delay. With increased demand for wood, this gap will widen. Secondly, the efficiency of the industrial processes from the forest into the building must be considered. A document sighted described that a 'considerable' amount of branches, leafs, and roots was left in the forest to rot, thus emitting the bound CO_2. The sawmill cuts the log with a yield of up to 70%, the remaining 30% consisting of unusable wood parts or sawdust that is sent to the paper or fertiliser industry or is incinerated. Before processing, the sawn timber is refined by sorting out unusable pieces that are incinerated, resulting in a yield between 40-70%. Documents reported a total yield between 25-30% of the mass of the tree – which coincides with the above calculation – and that 40-50% of the CO_2 stored in the tree are within a very brief time – that does not match CO_2-uptake rates – emitted back into the atmosphere. This damaging effect is cumulative in its impact to what has been explained in the first point. Thirdly, construction wood is not repurposed but almost exclusively incinerated for energy. Due to prior chemical treatment of the wood, the ashes cannot be used for fertilising and must be landfilled.

> These are reasons why there is considerable doubt about the sustainability and circularity of wood as a construction material.

The prioritisation in the conflict of reduce, reuse, or recycle has been explained already: With the current practices, recycling is not necessarily the optimal way to go. Reuse is not always an option as has been exemplified in the case of wood. One interviewee reported a current recycling rate of twelve percent because 'who builds with rubbish anyway?' For the most part, the material journey ends in downcycling or incineration, be it due to waste classification, standards, or the use of glue, synthetic or compound material, and polymers in buildings. While the remaining conclusion to reduce overall material use that is both very much in line with the proposed solution of simply building less overall and a viable strategy to, e.g., reduce tensions concerning material prices, it is remarkable that this conclusion takes the current practices as a set axiom. Apart from how realistic the idea of de-growth or sufficiency may be and apart from how valid the logical chain may be, there is no analytical reason to not stop the downcycling of material for the sake of saving emissions as the sustainability targets demand. This implies the need to use recycled concrete, construction timber, and a corresponding change in practices and legislation where any hindering economic hesitations must be left to the handling of the market or the state. Furthermore, it is interesting that the repeatedly stated argument that there would not be enough material that could be recycled to satisfy material needs is, by some interviewees, seen as an argument to not pursue this path more.

Lastly, one must not forget human capital. Particularly the lack of skilled labour is a well-known and -established fact that is ubiquitous. Indeed, the lack of skilled labour is not limited to the hands-on professions, i.e. handypersons, industry workers or facility managers, but also to administrative personnel, planners, or architects, particularly well-educated ones with the ability and personal standing to make decisions, question standards, or raise concerns regarding sustainability to clients or project leaders. Here too, great delay is inherent to investments and efforts of all kinds attempting to fix this issue.

4.4.7 SF 7: CREATION AND WITHDRAWAL OF LEGITIMACY

This subsection attempts to answer the question from the interview guide: 'To what extend is there vocal support for the mission, its problems, and solutions? By whom and to what extend is lobbying carried out? To what extend are there power shifts away from the regime?'

Before engaging with the topic of this system function, however, a word of intention is deemed necessary. The line between on the one hand, illustratively describing industry

practices and pointing out how these in their junction lead to systemic bumps and on the other hand, seeming to implicitly value or condemn these practices is not only very fine, but also a step stone to unscientific practice. Thus, the author's explicit intention in writing this subsection to not overstep it should be kept in mind by the reader.

With only few exceptions, none of the missions' problems and solutions were explicitly rejected by interviewees. Some like modular construction or serial renovation were considered case-dependent. Only for a mere handful of solutions, doubts have been expressed concerning the size of their effect which was unanimously deemed positive concerning mission achievement, and vice versa for problems, i.e. problems that were seen as valid and as a negative contributor to mission achievement but with varying effect size assessments. These problems and solutions would be the use of – or mandate for – solar panels[4.5] where a heating exchange to heat pumps and building usage considerations were deemed more important with a much higher effect size. Similarly, some interviewees had strong opinions about the Federal State Building Codes (Landesbauordnung), its sixteen variations, and the barriers it sets while others almost disregarded these and saw other problems in the standardisation system. Most interviewees deemed a wide array of changes in subsidy, fiscal, and regulatory law more important.

Similarly, there are solutions and problems that had a more heated discourse to them and that shall be presented now in three cases. First, opinions diverge on whether or not insulation was a preferable strategy or not. One interviewee termed the rise of minimum standards to passive house or ultra low energy standards and the increase in interest for serial renovation as 'insulation mania'. According to them, a house that was using renewable energy could be left insulated as it was because it would not matter and further renovation would only increase the costs and consequently, worsen the business case. On the other hand, another interviewee described an industrially pre-manufactured insulation wall or insulation in general as relatively cost-effective and pointed out that in the above argument, efficiency was left out: 'Apparently it doesn't matter whether I need one wind turbine for an energy-efficient settlement or 65 wind turbines to supply an existing settlement with hydrogen. Efficiency no longer seems to play a role [in these discussions; AN]'. Furthermore, the amount of renewable energy available in Germany is still very much limited with a great North-South imbalance and grid deficiencies. This topic of 'insulation mania' will come back when reporting on lobbying, as will the topic of sustainability of alternative or recycled materials. Secondly, the solution of renovation itself is disputed beyond the idea of a renovation mandate that many interviewees whisked

[4.5] A federal property and real estate administrator stated that solar panel coverage would make a difference of 2-3% in the overall CO_2 balance.

away as non-sense: As elaborated in the problem and solution directionality, the discourse is on whether one should renovate or build a new, more sustainable building, either by tearing down the old building or leaving it as it is and constructing another one. Judging by how much interviewees stressed it, the economic rationale and considerations for renovations would be shifted the most by the incorporation of grey energy in the future. The renovation decision is currently guided by housing considerations; apartment housing as capital investments of any size in times of low interest rates, and social housing by mostly MLG structures. If renovation is chosen, the questions of how and to what extend pop up that have been elaborated and shall not be repeated again. Thirdly and lastly, almost all interviewees reported raising their own or their organisation's voice for greater use of the legislative leverage that were available to bring about change, uttering critique in the direction of the mission arena with the extent of disregarding politicians or overall politics. Furthermore, most interviewees were eager to point out other actors' or sectors' failures or hindering activities, redirecting responsibility to or demanding proactiveness from others. The researcher believes to have stumbled on a blame-game, a situation where almost every party involved blames actors other than themselves for overall failure of the solution discourse so far. Furthermore, it is a comfortable position to criticise 'the others' in an interview, pushing for or vocally supporting a general direction and avoiding tedious detail questions where most disagreements lay.

When prompted with the questions of lobbying and power shifts away from the regime, it was reported that 'the industry' cements its power position 'very skillfully' through the use of standards that inherit a strong 'industry touch' as elaborated in system function 5. As an example for this, one interviewee mentioned that according to elevator-specific standards that have mostly been written by a committee of elevator manufacturer represenatives, elevators must be serviced annually 'and they can only be maintained by the manufacturers, so you have a standing order.' While the interviewee acknowledged that this was hear-say, it shows the possibilities of how a legitimate societal interest – safe and secure elevators, certified and serviced by competent specialists – can be exploited through standards that turn out to be 'clearly guided by interest'. A second strategy reported was contract-awarding to universities mentioned in the footnotes of system function 2. Overall, interviewees and documents agreed on the regime's influence having increased and still increasing. Furthermore, the statement that the industry would 'cement' its power position is not (only) a pun but a fitting description as standards are rarely changed: Indeed, their intuitive purpose would be to provide detail and information to a product to ensure system-wide inter-compatibility as well as quality and safety standards. Changing or even decluttering standards is thus not per se intended as the laws of physics rarely change, and the latter

would allow more interpretive leeway in law-suits. If the word of guidance from the start of this subsection is taken to heart, then to prevent this paragraph to be seen as unscientific critique in the eyes of the reader, the role of the devil's advocate must be taken and a word of neutrality spoken: It is indeed not the intention to point the finger at the 'evil industry that makes evil standards'. Remembering the process of how standards are made, it is rather solely actors of the industry that are able to (co-)finance the lengthy and costly standardisation process and now profit from their position – and, in the spirit of sportsmanship of market competition, it has to be acknowledged that they pulled it off quite elegantly.

Concerning explicit lobbying, it was reported to come from the commercial industries: from the construction or material as well as from building or housing industry. Remembering the difference between the two very different part of the MIS from the structural analysis, these two industry conglomerates must be considered separately. The leverages available to and practices followed by the first group have been elaborated in the prior paragraph with their focus on focus on using alternatives like wood or the prevention of recycled materials. For the building and housing industry, one interviewee reported it would be '3-4 actors in Germany who are trying to block [...] anything that involves tightening requirements for new buildings or existing buildings.' Instead, the interviewee reported, these companies' framing (for a delineation see, e.g., (Smink et al., 2015)) focuses on stressing the importance of user behaviour and hydrogen. To come back to insulation as promised, one interviewee stated that the first report on flammable insulation was placed 'very purposefully' to construct a narrative of 'insulation mania' by the building and housing industry. Indeed, a Google search uncovered a large discourse on the flammability of insulation material and the possibility of mould growth.

4.5 MULTILEVEL GOVERNANCE RESULTS

Lastly, a report on the sub-study undertaken on the influence of the MLG structure is due.

The federal state building code (Landesbauordnung) has appeared repeatedly throughout this research and reappears here as a suitable example for the MLG results. The encountered varying degrees of problematisation shall not be bothered with here but to recapitulate, the sixteen different building codes were reported to hamper the sharing and flow of knowledge and skilled labour. At the same time, the possibilities for pioneering legislation are given, remember a federal state's solar panel mandate that surpasses national mandates. In MLG lingo, doubt is sparked over what the optimal governance level would be. However, considering the various frames that each federal state building code

provides for inspiration and experimentation, the national-level model building code, and the available three levels, it is valid to assume the setup to be near-optimal. It remains the question how to govern – or rather, un-govern – such that the so yearned-for flexibility for existing buildings is made more feasible. Reported ideas were to create a parallel legislation for building conversion and renovation, a federal state building conversion code – an analytically correct solution that, however, must be taken with a grain of salt when considering the new level of bureaucracy that would be attached to standardising cases comparable in individuality to those of the buildings they concern. Others saw local caretakers as a possible committee to manually approve certain standard deviations – however, there is inherent risk that these decisions would be guided by favours or interests.

Secondly, the coordination dilemma was repeatedly reported to occur between ministries: Indeed, the directly responsible ministries were stated to be the newly-founded Ministry of Construction, the Ministry of Environmental Affairs, the Ministry of Finance also as a land and property manager, and the Ministry of Economy and Climate Protection with similar structures applying on lower MLG levels. Interviewees reported the occurring lack of decision-making to create a stalemate situation in which progress rarely seems possible and the issue re-directed to higher levels. Concerning the federal level and the conversion of targets, interviewees report they 'notice[d] that they don't get it done' and had 'the impression that of course they also like to slow each other down.' This was traced back to internal coalition conflicts.

This coordination dilemma resonates with an observed phenomenon that has been termed the 'diffusion of responsibility'. The term sparked as a common denominator of various phenomena reported: the self-exclusion from the mission arena, the calling for making decisions, the redirection of responsibilities and the respective blame game, the narrative of upcoming 'drastic' changes, the misalignment of the MLG structure, and need for questioning formal and informal standards. Indeed, these points symptomatically lead to a situation that goes beyond the classic coordination dilemma in the sense that coordination is not necessary to account for spillovers or externalities of adjacent jurisdictional efforts, but to appropriately begin with these efforts – a 'stalemate dilemma'. This could be due to multiple reasons that may very well be interlinked:

1. Potentially, the mission arena could be too big such that coordination in the form of communication with all relevant actors is too difficult.

2. The mission could be too recent and thus, the mission arena still in assembly. Alternatively, the mission is not a priority. Both assumptions would imply that not

enough directionality is exerted to the outer MIS or within the mission arena from the governance side, leading to the situation at hand.

3. The mission itself too complicated – as interviewees said the targets would need to be broken down more to more realistic, achievable packages – and the complexity of governing the mission is too great.

Interestingly, all three reasons the researcher could come up with see the mission arena and governance side under obligation to action. Whether this could indeed come from a governance side or from a non-governmental self-starter would necessarily not matter as the different types of MIS dynamics Elzinga et al. (2021, p.14 et seqq.) uncovered show.

The MLG structure of the mission arena was conjectured and elaborated on in the structural components as well as the feedback mechanisms stressed by interviewees during the research reported in the functional analysis. Together with the overshooting of minimal standards, this sparked another conceptualisation of the MLG structure other than the intuitive top-down depiction of MLG governance. Indeed, the 'matryoshka doll model' with subsystems stacked into upper ones is a valid conceptualisation that captures the essence of hierarchical governance. Interviewees stressed that, in addition to the aforementioned, the lower levels can go further in the sense that 'upper' legislation sets a bare minimum. This bare minimum can always be overshot by further, stricter, or more refined lower-level policy, e.g., with a mandate for solar panels on new roofs. This dual conceptualisation has been captured in figure 9.

In this light, the aforementioned experimental frame of the federal state building code extends to the entire debate of climate change mitigation and reaching of sustainability targets: every local or regional government can, in theory, specify their own context-dependent ambitions in the sense of adding minor tweaks to their programme. In other words, the governance part of a multilevel governance extends to setting a regulatory framework of bare minimums and common denominators. The proactive, creative, regulation-extending side of such lower-level structures has not been brought into consideration yet and includes the possibility to, e.g., create own subsidy programmes or mandates. While this elaboration cannot be seen as a result in a rigorously scientific way or even politological, it stresses a point that interviewees stressed and lamented: Much more could be done and achieved through the lower governance levels that are closer to citizens that are at the receiving end of policy. That is, if municipal governance structures were able to as financial of personnel struggles were named as barriers but also local discourses – this is in line with prior MIS findings:

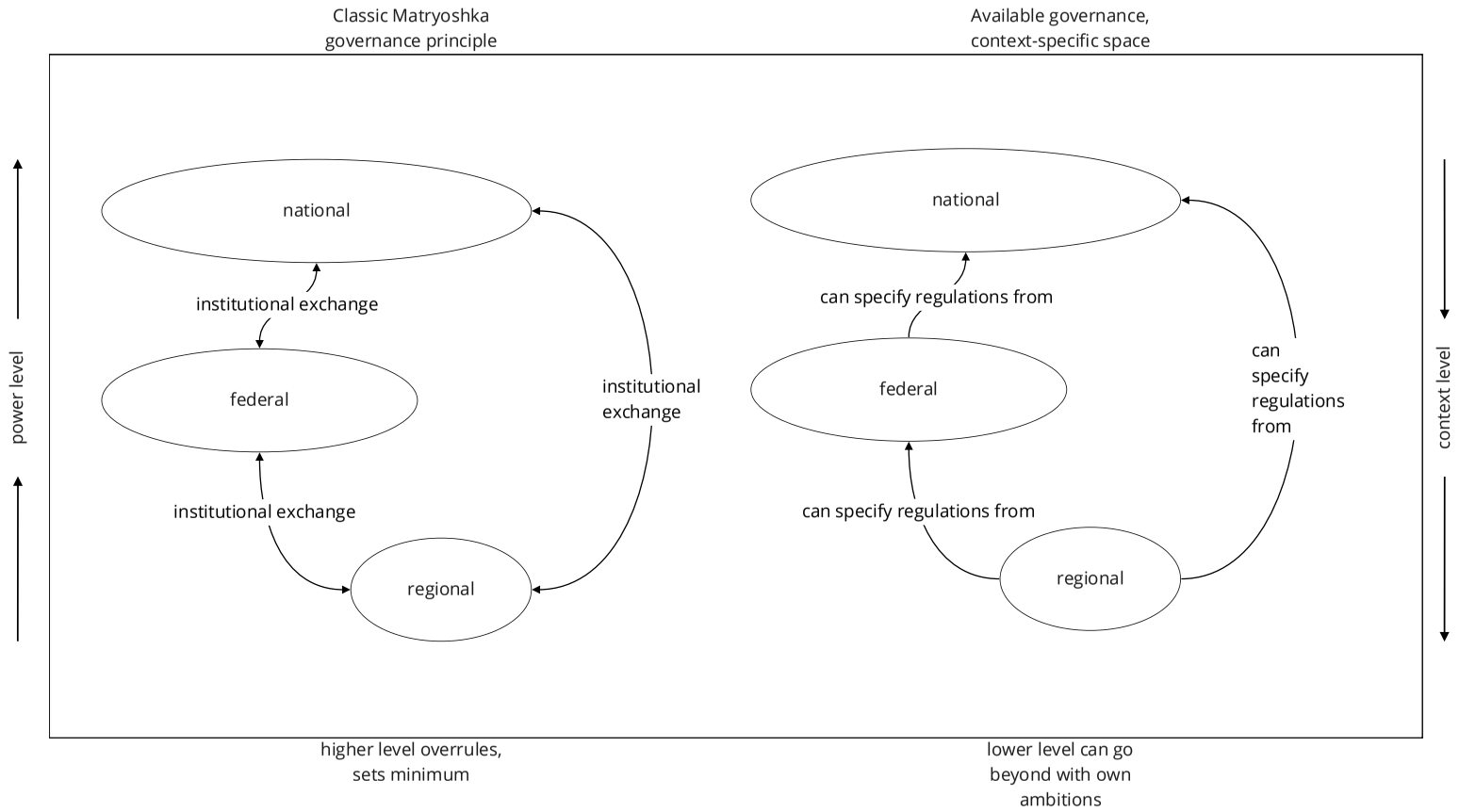

Figure 9: Conceptualisation of the MLG levels with regards to the duality of overruling. While higher governance levels set a minimum requirement for lower ones, lower ones can regulate stricter and further. A corollary of this figure is that in order to context-specifically drive the sustainability transition, the empowerment of regional and local governments is a necessary condition.

‘“The ministry itself performed important coordination tasks as well. While understaffed and underfinanced, civil servants played a key role in starting a myriad of activities that otherwise would not take place.”’ (Elzinga et al., 2021, p.14)

Furthermore, the lower governance levels were reported to have many internal discourses and problems, some of which even related cronyism or favour-guided politics when awarding contracts or converting targets into practice. Most building disputes were the result of civil resistance against plans for new, more dense housing or buildings – contrary to the federal line of densifying living space and reducing surface sealing. At the same time, particularly the lowest governance level was reported to issue and award the most contracts, followed by the federal and the national level. Interviewees acknowledged the immense power for directionality that was further enabled through the principle of Local Self-Government (Kommunale Selbstverwaltung) that includes a liberty in budgeting. A conclusion that some interviews and documents drew was that regional governments must be enabled more financially – an easy but not thoroughly thought through claim as interviewees reported the lack of skilled labour would also extend to local administrative personnel. Meanwhile, other interviewees reported that research on impact potential of increased regional (self) governance was still being done and would not draw conclusions yet, so the aforementioend conclusion is to be enjoyed with reservations.

Concerning the type of MLG structure in the mission arena, it is worth reporting that both type I and II could be identified in parallel. This duality was to be expected as stated in the theory. Overall, a very rough distinction could be made between the type I MLG being represented by the governance actors (intrinsic community) and type II MLG the extrinsic, ‘governance-consulting’ part of the MIS which sparked the conceptualisation of the MIS-mission arena continuum in figure 5. As to why the mission arena would also show type II MLG characteristics, consider the following: Firstly, one would naïvely expect type I MLG as structurally, the German MLG structure is type I MLG and the governance structure has considerable overlap with the mission arena. Secondly, by definition, achieving a systemically-targeted mission that is functional to internalise or avoid externalities from climate change is a problem where type II MLG would be expected. Additionally, many interviewees criticised the lack of action and guidance, the ever-changing rules and multitude of unrealistic targets and, as a response, set up their own initiatives and networks, using their legitimacy as an economic power to steer, thus making the governance more type II. The same rationale would apply to value chain actors that engage in lobbying. Thus, as a hypothesis, one can suggest that the type I part is the respective part of government concerned with the missions, and type II, the more fluid

part of the mission arena, is formed by non-governmental actors. This is a hypothesis and would have to be confirmed, modified, or rejected through further (sub-) studies.

In the MLG literature review, it was stated that 'there are examples on how dispersion of power away from the central government, specifically sideways to private sector, led to massive systemic problems, e.g., as became evident internationally in the health care sector during the COVID-19 wave peaks.' Remembering the elaborations on standardisation, it seems valid to revisit this effect for the case of standards: Indeed, the results of this research suggested that the standardisation system that interviewees described 'unmanageable' and 'beyond oversight' has grown out of proportions together with the already cited 'industry touch' and professional standardisation structures representing the industry. Standards are issued through the German Institute for DIN Standards and are thus not strictly part of the public hand, yet standardisation can be said to have shifted sideways towards the private sector, giving an indication of how to potentially declutter the standardisation system. This phrasing is not as straight-forward as one might hope or expect from a result chapter. Indeed, this is a hypothesis expression after positivistically reflecting about a connection of the observed phenomenon to MLG theory. To state it explicitly: Is 'sideways governance' happening? Presumably, yes. Is it a problem? Standardisation in its current regime is, definitely, and thus its governance. Thus, is it a problem? Presumably, yes. Further (sub-) studies would have to shed more light on this for a more definite answer.

Lastly, the MLG perspective also had implications for other functions that were not directly foreseen by the theory. The avid reader noticed that the interview guide contained the question whether the governance structure set up was effective in influencing and mobilising the MIS: Indeed, respondents acknowledged problems with the federal system as being not agile or fit for quick responses, particularly concerning the transformation from targets into policy. These remarks go beyond the aforementioned problems with bureaucracy which is a critique on the process level but more structural and the reason as to why it is listed in this section. One interviewee elaborated that the system had 'grown historically' into today's setup 'for good reasons'. However, adding a grain of salt to this elaboration is deemed necessary: Despite the term 'mission-oriented' in the description for the selection of sources, these problems were acknowledged and accepted in the sense that they were whisked away with the argument that this is the political system at hand. Thus, the MLG's structural conditions can be conceptualised and left as an inherent background condition for two reasons: First, the effort inherent to undergoing structural political change for the sake of achieving the missions for the sustainability transition in the building and construction sector is not feasible time-wise among other problems. Second,

such changes that would maximise the achievability of the missions for the sustainability transition in the building and construction sector could hinder the achievement of other sectors' impeding and necessary transformations.

5 Discussion

Sometimes, you just cannot make an omelette.

BENJY from ULTI.TV

Firstly, the results stated on the prior pages are re-stated here as an 'essence'. This section is followed by a reflective step on these results and on the theories employed as well as further research directions outlined. To avoid diversion of focus, the research quality and possible pitfalls have already been discussed in section 3.5. The chapter and therewith the thesis is concluded with final remarks.

Indeed, it should be repeated that merely results are stated – in this thesis, a restrain is practised as much as possible from suggesting ideas for improvement or even proposing solutions to the barriers. This is due to three reasons:

1. The term 'solution' assumes an absoluteness the author considers flawed. Given the methodology as an interview-based study, the results, echoing the choir of interviewees in a balanced and contextualised manner, can only inherit a repetitive character. As such, it contains the interviewees' ideas for good fixes which would be, as a best guess, near-optimal to the solutions.

2. Contrary to the mindset expressed in some consultant projects, the matter is considered as too complex to be understood with sufficient depth in the time span available for a thesis. The author considers it unwise and presumptuous to assume otherwise or believe to know better than an entire MIS of working professionals.

3. A research thesis independent from any company or institute should use its chance to be exactly that and not be reduced to a research-based consulting report. Indeed, 'reduced' is the correct term as suggestions for solutions would implicate that the results themselves are not enough when they are what the research set out to find. Thus, it is believed that this is a character the thesis at hand would inherently gain by providing 'solutions' and a fate that has been intended to avoid.

With these words of guidance, attention is turned to the results.

5.1 Synthesis – The Only Page to Read

Like most sustainability targets, these missions are almost beyond a doubt not achievable. Worse, despite the acknowledgement of renovation as a core solution, the target of a 2% annual renovation rate was whisked away as unachievable, mindless, and illusory.

Inner tensions skew these considerations: (social) housing needs together with high and increasing prices meet inherent landscape conditions as a barrier. With the lack of time remaining, this composes an at least four-dimensional wicked system of tensions, the background of which displays large regional differences as well as a large potential for conversion, exertion of power, and provision of directionality. Yet, the MLG structure showed cracks concerning alignment. Responsibility is diffused within the MIS.

Due to lack of documentation, the portfolio's individuality complicates renovation immensely, demanding more planning and causing more work, uncertainty, and costs. Yet, it appears inevitable to work more with the portfolio at hand. For this, there is a large focus on technological solutions on particularly increasing the building's energy efficiency. Problems are social or behavioural to a large part while social solutions do not extend beyond experiments with cooperative housing. Meanwhile, barriers mostly lie in the legislative and formal apparatus, consisting of tedious technical fine-print largely driven by the regime. This triadic constellation's invisible dance creates distance between actors and actions and hinders systemic transformation. These barriers in the legislative and formal apparatus largely lies in the bureaucracy and ubiquitous standards. The tension field here is between the need for safety- and stability-guaranteeing regulation and their unhandlability due to complexity. This sparks fear for lawsuits.

Digitisation is considered as a partial relief and a tool to hasten and improve processes. One-stop shops or local caretakers for citizens or municipalities are seen as sustainability drivers by means of knowledge diffusion. Reaching citizens that are at the receiving end of policy was stressed as important repeatedly, particularly when dealing with harmful mentalities such as the 'sustainability reward fallacy' or 'luxury mentality'. There is agreement that this is due to a knowledge sharing or conversion problem.

Essentially, however, one of the two core problems lies with a market failure to provide a business case for renovation or sustainable practices like material reuse. This is a fundamental flaw of the economic system. A clear direction was given through potential changes in regulatory, fiscal, and subsidy policy. Indeed, there is overall agreement that this would provide alleviation. The second core problem lies with resources: a lack of everything concerning resources was reported and especially concerning skilled labour. It has been exemplified as to why and how exactly this alone makes the missions unachievable.

5.2 'SO WHAT?' BEYOND DRY RESULTS

This section deals with the interpretation of these findings. As at such an advanced state of the research, a continuous text leading from one point to another is not impossible to achieve. Thus, the elaborating paragraphs stand for themselves.

A word on the nature of the barriers Firstly, it seems that the legislative, regulatory, and formal barriers hampering systemic change take the form of small, tedious fine-print. Metaphorically speaking, instead of turning a large steering wheel, many specialised buttons and leverages would have to be 'played' as a complex sonata by many hands. Indeed, the MIS at hand has shown to be unable to 'play', that is, shown to be 'unable to address these externalities' (Schot & Steinmueller, 2018, p. 1561) or rather, take sufficient action to prevent. An appropriate internalisation through policy proves difficult due scientific, political, and economic discourse regarding quantification as well as on the levels of governance: Climate change addresses the global sphere with regional differences, the business case is handled on a national level. Fittingly, the current governance level of climate change mitigation is that of an in-between or, positively phrased, symbiotic state of national and international level. Ideally, agreements are achieved on international level and respective responsibility to conversion remains with the lower governance levels each and individually. This international component does mitigate the collective action problem. The respective responsibility can be addressed via changes on the respective national fiscal, subsidy, and regulatory policy. In the case presented, a dilemma between subsidy and regulation has been uncovered where subsidies are preferred for smooth transitioning and regulation being more effective and actively demanded. While, admittedly, generally supporting and calling for climate action but then uttering critique in detail is a comfortable position to be in, it does show an overall willingness and orientation towards 'steering-wheel' measures to address these externalities. Thus, a new dilemma of expectations and possibilities unravels where influential systemic action is expected but hardly possible through the many, small leverages at hand that are pulled or influenced by actors that on top of that are in discourse.....

A word on resources It has become clear that nudges to alleviation concerning the tension around resources and connected issues must go in the direction of

1. building less CO_2-intensive, that is, with more natural resources, less 'technophile', with less energy used;

2. building more 'future proof', that is, with a design and accessible plan for mono-material deconstruction and reuse and sufficiently high standards. This is particularly important for the long product life cycles; and

3. in combination with building less overall, mending the available portfolio while acknowledging its individual typology.

Regarding the first point on saving energy and the reduction of technology, energy can admittedly be saved through incremental technological improvements. However, to resolve this seeming paradox, consider Jevons' well-established paradox: An increase in technological efficiency involving a resource does not lead to an decrease but an increase in consumption of said resource. Thus, the prior argument must only be granted on special terms. Yet, it must not be disregarded as more efficient technology is implemented much easier than new practices or mentalities. Still, there is no analytical argument as to why the practices of saving gas during this year would not work for the issues laid out in this thesis. Considering the second point, one must ask whether a circular economy as intended by, e.g., the CEAP is possible. Naturally, in any industrial process, there is a loss of material or energy. Thus, the answer must read 'No, but it is possible to an extent.'[5.α] To quantify the exact extent was not the objective of this thesis. However, it has become apparent that *if* wood is indeed to be used increasingly, large scale afforestation is needed in the very near future.

A word on the sense of discourses Lobbying, framing, and discussions have been exemplified by reporting on various discourses, e.g., on the reuse, reduce or recycling of material or on insulation vs energy efficiency. These discourses, it would appear, demand an all-mighty answer, a binary 'yes' to one optional and 'no' to the other. Yet, these discourses originate from the fact that *if* done a certain way in the respective case, certain practices are more efficient and sustainable than others: Importing ground concrete from the other side of the world must necessarily be more environmentally harmful than regional production of fresh concrete. Indeed, these are special cases due to which a binary answer becomes impossible. Yet, this differentiation must be made to account for the complexity of the matter and for the choice to be correct beyond its label as correct: Any practice can be labelled as officially sustainable or green. However, that changes very little for climate change. In fact, physics cares very little about whether or not something has been declared sustainable. This dilemma between complexity and the need to be sufficiently correct provides ever-new ground to these discourses. Meanwhile, stagnation occurs: Instead of

[5.α] Remember the current recovery rate that was reported to be around 12%, yielding room to improve.

reusing, reducing, or recycling concrete, current practices stay in place. Due to what was elaborated on in system function 7, the author considers these and similar discourses as artificial debates (see, e.g., (Smink et al., 2015) for reference), merely showing the influence of the regime .....

What do these results mean? It means that if indeed a climate crisis is to not be averted but at least lessened in impact (Masson-Delmotte et al., 2021), if human rights like the right to life or the right to being unharmed are an indisputable value, then being on the highway towards more than 2 °C global warming means that measures must go beyond those discussed in the solution directionality or proposed and discussed in this or the previous chapter. Indeed, while changes in subsidy policy, in ways of building, renovating, and breaking down, in digitisation or in reuse rate of material are a necessity, they only form a bare minimum. In fact, logically, they can merely present a delay to the unsolvable paradox of constantly positive economic growth and 'finiteness' of available resources.

It means that measures that aim to solve – remembering the absoluteness inherent to the word 'solution' – these issues must go beyond those laid out here toward a fundamental change in the way humankind lives and economises on this planet. Additionally, these changes must occur soon as any climate report never fails to stress. In light of the recent acts of vandalism where climate activists attempt to gain societal and political attention for their agenda by damaging art or gluing themselves onto something, the author wonders whether a 'dogmatic approach' to climate change needed where unsustainable or environmentally damaging practices would simply not be a choice anymore to prevent oneself and others from harm. On that note, the author, a mere observer, expects that within a few decades time, it will not be the activists that would have to answer to critical questions.

It means that with the current socio-economic and socio-political climate, climate change is not a priority and most do not feel like doing something about it or capable to. There is a lack of galvanising directed movement sparked by the mission arena. There is uncertainty about how to achieve this .....

5.3 'SO WHAT?' BEYOND MERE THEORY

This time, consider the MLG first. This thesis is a master thesis written in the discipline of innovation science, not politology. Thus, the only important question is whether the MLG theory did prove to be of value. The MLG concepts did indeed shed light on inner processes of the MIS and provided a ready-made and nuanced frame for the interpretation

of the results. This is particularly true for the concept of governance levels that provided a interface or port to many results. After all, the type I or type II MLG was not of much use in practice. Although, it did help with the conceptualisation of the results encountered, e.g., the hypothesis on mission arena composition or, in particular, the duality of the two ideal-typical types inspired the MIS-mission arena continuum, see figure 5. The latter seems to be a promising way to understand actor fields better and not conceptualise them as an stationary point. Yet, this positivistic view should be challenged in further studies.

Second, the missions considered are, in their conversion into practice towards achievement, a market question about whether or not it is profitable to go for sustainable options or not. Thus, it seems worthy to make a structural comment on system function 5 on market destabilisation and transformation, particularly after the paragraph on externalities in the prior section. Indeed, the MIS assumes an innovation system willing to transition or rather, one that is not unwilling to change, but hesitant with investments. Lobbying, nested interests, framing, and diverting public discourse only happen to be stumbled upon through interviewees that mention the (say) tight industry grip. To me, this appears to be a naïve approach and, thus, more consideration should be given to, e.g., investigative journalists' work. Otherwise, a MIS analysis can act as the industry's mouthpiece: Their framings enter the MIS results and if significant, are repeated through papers or theses, and amplified through their inherent scientific credibility. This is very much in line with the results of Elzinga et al. (2021, section 5.3).

Third, the MIS Theory has to square the circle between macro- and micro-level scope by paying attention to macro-level system conditions while also acknowledging the micro-level mentalities. After this thesis, the author considers the MIS to be prone to average into a blurry meso-level analysis: The MIS attempts to capture everything and thus, most is, theoretically, included. However, through this, the MIS becomes a holistic monster that becomes too big to handle. Regardless, two suggestions for a more refined macro- and micro-level focus are made:

1. With the strong focus on system functions, MIS only happens to show the existing institutional problems, formal and informal, by mere chance. Thus, theory on formal and informal institutional (assessment and) change would be helpful– what was encountered is that, losely said, everyone wants sustainability and it doesn't happen. Analysis of legislative pathways leading to lock-ins may prove helpful.

2. Taking the second point further, the MIS does not capture the fact that these sustainability problems are caused by the system's rules of the game. It aims for changes within the system, not changes of the system itself. It inherits a belief that if enough

knowledge is produced, enough resources are redirected, enough different focal points are set and followed, any mission will be achieved without considering the stage the play takes place on. Things like positive economic growth rates that necessarily conflict with finite resources remain untouched and for sure unquestioned. The construction of alternative 'imaginaries' (Hajer & Pelzer, 2018; Hoffman et al., 2021; Pelzer & Versteeg, 2019) or, in light of the paragraph on resources in the prior section, de-growth theories may prove to be most valuable.

In what way would these theories suggested then be useful? Consider that these theories cannot be immediately linked to the MIS in a structural way as the MLG theory used in this study was. A mere vague gesture towards an assemblage of theories can only be considered as of little help for further studies. Thus, when suggesting theories for future research, a more descriptive attempt must must be made to avoid producing 'scholarly bullshit' (Kirchherr, 2022). Consider the MIS framework as both

- a methodology in the sense of a qualitative (case) study with a 'structural-functional approach' (Wesseling et al., 2020) providing a step-by-step guide; and
- a framework providing a boundary in the sense of a scope – being that of a selection for granting or denying the quality of being mission-oriented and, thus, being relevant for the study in question.

What remains in this conceptualisation is the issue of directionality in the sense of an interpretative framing, or simply put, a perspective: If system change towards mission achievement is to be assessed, what then is the measure by which the efforts are judged? Naturally, this question points back to the indicators used. Herein lies the answer to the 'how?' of using various theories: as indicators for function or mission fulfilment, essentially present in the interview guide. The challenge remains to establish the appropriate relevance of a theory or indicator in the respective case or system function.

Second to last, a few grains of salt must follow these suggestions large enough to be their own point. If done well, a full MIS analysis is insanely big and barely ever complete. Especially with more additions – MLG theory, continuous conceptualisations, (in-)formal institutional change, de-growth theories, incumbents' institutional strategies – it will become unhandlable. Similar to these sustainability targets, such research projects should be broken down into multiple sub-studies and in turn, a MIS analysis consist of multiple such studies as a meta-analysis. Furthermore, a full MIS analysis would most likely not fit the page limit of a journal and would thus be a format more fit for, e.g., governmental reports, not academia. Furthermore, the MIS is not complete but in a conceptual state

in a long tradition of innovation systems. With the system function not being 'holy' but heuristic, much experimentation is needed on, e.g., what system function may be relevant for what kind of missions. By now, there exist a number MIS studies as student theses of varying quality that may be of use for such studies. Perhaps, a systemic review or meta study beyond a single mission could also be attempted to assess the respective change propositions. This way, propositions and suggestions for truly systemic – in contrast to the respective mission-level (at best) or sector-level (at worst) – changes and suggestions to implementations could be derived.

Lastly, Elzinga et al. (2021) acknowledges many of these points and suggests, with reference to an irretrievable article by the Joint Institute for Innovation Policy, a distinction between '"transformer" missions [which] are in more need of newcomers than "accelerator" missions in which incumbents may take a prominent role' (p. 18 et seq., idem.) to discern between necessary MIS and mission arena compositions for better results. Again, these would be ideal-typical conceptualisations but the missions at hand show problems with these types as both would apply: The transformation must occur and much quicker so. Hence why the authors struggles with seeing the analytical value in this case and proposes another thought as a mere suggestion: As has been established, the indexes used could only accidentally grasp concepts like de-growth, sufficiency, or reduction. This makes further refinement in system functions undebatable, possibly after the aforementioned meta studies of MIS analyses. Furthermore, it has been established that the technological parts are no barrier and developments made merely incremental. The targets, knowledge and particularly ideas were reported to be old and well-known. Thus, the role of innovation – if equated with the process of developing something new – does not seem too strong in this context compared to the other words: The framework of the

Mission-oriented Innovation System

consists of three parts. With the results in mind, doubt is sparked in the eyes of the author about whether 'innovation' is of equal conceptual importance in this case as the quality of being mission-oriented or the inherent systemness. Rather, when only few innovative challenges remain and particular when time is as scarce, more attention should be put on conversion into practice. Thus, a perspective of a

Mission Conversion-oriented System

is deemed valuable, too, possibly as a third mission type next to transformer or accelerator missions though this would seem conceptually close to the accelerator mission. Regardless,

innovation is not at all disregarded in this perspective, on the contrary. Rather, this conceptualisation expresses doubt in innovation as the *main* driver for change when problem, solution, and the possible paths are known. It further regards innovation in its many forms as vital and yet, not the most important part. Innovation would thus become a mean, not a self-referential sake. The perspective stresses, due to scarcity of time, action as an alternative to, put exaggeratedly, paralysis by analysis in search for an optimal, unanimously agreed-upon solution when, when faced with the alternative of no solution, a near-optimal one does the trick sufficiently well, too.

An effort has been made to not exert any alarmism or prevent accusation in that direction. On the contrary, this chapter worked towards pointing out systemic failures to internalise externalities through a stringent derivation from the results encountered. The intention was to end with a mere suggestion as to what other focal points future research could take, what alternatives could be 'mindfully deviated' (Garud, Karnøe et al., 2001) towards. With this in mind, the thesis is closed. Thank you for reading!

A | Appendix

In this chapter, I will provide theoretical backgrounds and other detailed elaborations that are deemed important but too lengthy or not important enough to be stated in the text of the thesis.

A.1 | Comparisson of System Functions

The following table portrays the system functions employed in (Hekkert et al., 2007) and earlier works of Joeri Wesseling, namely (Wesseling et al., 2020). This choice has been made to compare not only between authors but also to shed light on the development of the MIS methodology. In their latest version and as employed in this thesis, all the system functions acknowledge a degree of both building up and breaking down.

Table 8: The System Functions as applied in the functional analysis of (Wesseling et al., 2020) and (Hekkert et al., 2020) in comparison. If the functions are comparable, the are in the same row – this is based on the author's own analysis.

System Functions as defined in...	
(Wesseling et al., 2020)	(Hekkert et al., 2020)
Entrepreneurial Activity: Experiments with (clusters of) solutions to enable learning; entering markets for new solutions; engaging in business model innovations to the diffusion of solutions	*Entrepreneurial experimentation*: The innovative activities of entrepreneurs. Their role is to turn newly developed technologies into products or services that represent a business opportunity
Knowledge development: Learning by searching and by 'doing', resulting in development and better understanding of new technical and social knowledge on problems and solutions, through R&D, social and behavioral science research.	*Knowledge development*: New knowledge production pushing the boundaries of technological possibilities. It can be the result of entrepreneurial activities, but it is mainly done by scientists, universities and research institutes

System Functions as defined in...	
(Wesseling et al., 2020)	(Hekkert et al., 2020)
Knowledge diffusion: Stakeholder meetings, conferences, governance structures, public consultations, mission progress reports and other forms of disseminating technical and social knowledge for the mission's solutions and societal problems	*Knowledge exchange*: Network activity that facilitates diffusion of knowledge to relevant actors, such as entrepreneurs
Providing Directionality, subdivided into *Problem Directionality*: The direction provided to stakeholders' societal problem conceptions and the level of priority they give it.	*Providing Directionality*: Does the mission impact the innovation activities (4a) and are the options to realize the mission clear and attractive (4b)? and *Coordination*[2l.b]: Alignment of activities by a wide variety of actors through coordination processes.
Solution Directionality: The direction provided to the search for technological and social solutions, as well as the coordination efforts needed to identify, select and exploit synergetic sets of solutions to the mission.	
Reflexivity: Reflexive monitoring, anticipation, evaluation and impact assessment procedures, which provides the analytical and forward-looking basis for redirecting the system's problem framing and search for solutions based on lessons learned and changing context. It can be seen as second order directionality.	
Market Formation: Creating niche market and upscaling support for technical and social solutions; phasing out or destabilizing markets for practices and technologies harmful to the mission.	*Market Formation*: The activities focussed towards the creation of a market for use of novel technologies and business models

System Functions as defined in...	
(Wesseling et al., 2020)	(Hekkert et al., 2020)
	Change in Regime Practice[21.c]: Next to the creation and diffusion of novelty, it is important that the existing production and consumption systems change their routines and practices in line with the mission objective. [...] three dimensions of change: Increasing awareness that change is necessary, experimentation with novel technologies, business models, new modes of governance in line with mission objective, abandoning practices that are not in line with mission objective
Resources mobilization: Mobilization of human, financial and material resources to enable all other system functions.	*Resource mobilisation*: The present and available physical, human and financial resources within the system that are available for innovation
Creation of legitimacy: Creating legitimacy for prioritizing the problem and the development and diffusion of its solutions.	*Creation of legitimacy*: The creation of legitimacy for the mission and the options to reach the mission

A.2 INTERVIEW GUIDE

The questions of the interview guide are based on the examples of diagnostic questions provided in (Wesseling et al., 2020, table 2, 3, 4). After every interview, I will furthermore ask the interviewee if there is an aspect that they deem important and that I have not touched upon yet. The interview will run as follows:

[21.a] Implicitly stated in (Wesseling et al., 2020) and sorted in here to stress the directionality provided by the mission arena.

[21.b] Text shortened by the author. This function overlaps with Market Formation and with parts of Reflexivity in (Wesseling et al., 2020).

Greeting, thanking the interviewee for taking the time, asking how much time they have, and whether recording the interview would be okay after presenting the privacy details and explaining how the data will be analysed. Second follows the introduction of the project, research question and MIS approach. If the interviewee has no further questions, the recording and interview starts.

For every system function the follow-up questions 'Are there factors that hinder this system functions?' and 'What influences these aforementioned factors?' will be asked and are thus skipped in the table below.

Table 10: Interview guide for the semi-structured interviews intended to conduct.

Target area	Interview Questions	
	English	German
Problem-Solution Diagnosis	What societal or technological wants or problems are related to the mission? What solutions are pursued to achieve the mission? Which are the most prominent or promising solutions?	Welche sozialen oder technologischen Wünsche oder Probleme sind mit der Mission verknüpft? Welche Lösungen werden verfolgt, um die Mission zu erreichen? Welches sind die bekanntesten und vielversprechendsten Lösungen?
Structural Components	What is the most important legislation, practices, or infrastructure relevant for your organisation and the mission? What types of organisations are in your network and for what reasons?	Was sind die wichtigsten Gesetze, Praktiken, oder Infrastrukturen für Ihre Organisation und die Mission? Welche Typen von Organisationen ist in Ihrem Netzwerk und warum?
Entrepreneurial Activity and Disruptors	How would you assess the amount, speed, and quality of experimentation with technologies, business models, and destabilising solutions?	Wie beurteilen Sie die Menge, Geschwindigkeit und Qualität von Experimenten mit Technologien, Geschäftsmodellen, und destabilisierenden Lösungen?

Target area	Interview Questions	
	English	German
Knowledge Development and Unlearning	To what extend is there research and development of new knowledge relevant to the mission, understanding societal problems or harmful effects of practices, and unlearning harmful practices?	Zu welchem Grad wird an der Forschung und Entwicklung neuen Wissens gearbeitet, das der Mission zuträglich ist, soziale Probleme oder schädigende Effekte von Praktiken aufdeckt?
Knowledge Diffusion and Breakdown	How lively is the knowledge exchange – about societal problems or the development and use of solutions – through networks or events? To what extend do networks support the breakdown of harmful practices?	Wie lebendig ist der Wissensaustausch – über soziale Probleme oder die Entwicklung und Einsetzung von Lösungen – durch Netzwerke und auf Veranstaltungen? Zu welchem Grad unterstützen Netzwerke den Phase-Out schädlicher Praktiken?
Providing Directionality	How effective is the governance structure set up in influencing and mobilising the MIS? Do the differently levelled governance structures vary in their approach taken? With what governance levels are you in contact with and are there problems?	Wie effektiv ist die Governancestruktur bei der Einflussnahme auf und Mobilisierung des MIS? Unterscheiden Governancestrukturen auf unterschiedlichen Ebenen in ihrem Herangehensansatz? Mit welchen Governanceleveln sind Sie in Kontakt und gibt es Probleme?
Problem Directionality	How much are the mission's societal problems prioritised in relation to other societal problems and wants?	Wie sehr werden die mit der Mission verbundenen gesellschaftlichen Probleme priorisiert, verglichen mit anderen gesellschaftlichen Problemen und Wünschen?

Target area	Interview Questions	
	English	German
Solution Directionality	To what extend is there a shared understanding of the solutions necessary to achieve the mission, real or in development? What solutions are part of a dominant set of solutions? Is the interrelatedness of solutions acknowledged and understood well enough?	Zu welchem Grad gibt es ein geteiltes Einverständnis über die notwendigen Lösungen, um die Mission zu erreichen; real oder in Entwicklung? Welche Lösungen sind das? Ist die Abhängigkeiten der einzelnen Lösungen unter- und voneinander anerkannt und verstanden?
Reflexive Governance	How and to what extend is mission progress evaluated? For outer MIS actors: To what extent does your organisation participate in mission progress measuring? For mission arena actors: How easily could the mission itself, its supporting measures, or indexes be redesigned?	Wie und zu welchem Grad wird das Erreichen der Mission evaluiert? Für Outer MIS-Akteure: Zu welchem Grad trägt Ihre Organisation zum Messen des Fortschritts mit der Mission bei? Für Mission Arena-Akteure: Wie einfach kann die Mission selbst, unterstützende Maßnahmen, oder Indizes neu designed werden?
Market Transformation and Destabilisation	To what extend is there a market (forming) that enables the mission? To what extent do (in-)formal institutions facilitate this transformation? To what extend are harmful practices abandoned or phased out?	Inwiefern formt sich ein Markt, der die Mission begünstigt? Zu welchem Grad erleichtern (in-)formelle Institutionen diese Transformation? Werden schädliche Praktiken unterlassen, unterbunden, oder ‘phased-out’?

Target area	Interview Questions	
	English	German
Resource Reallocation and Search for Alternatives	To what extent are resources – human capital, financial and material – mobilised, available, or withdrawn to achieve the mission?	Gibt es genügend Ressourcen – menschlich, finanziell, materiell – und werden genügend zur Verfügung gestellt bzw. abgezogen, um die Mission zu erreichen?
Legitimacy Creation and Withdrawal	To what extend is there vocal support for the mission, its problems, and solutions? By whom and to what extend is lobbying carried out? To what extend are there power shifts away from the regime?	Zu welchem Grad gibt es unterstützende Stimmen für die Mission sowie die dazugehörigen Probleme und Lösungen? Von wem wird zu welchem Grad Lobbyarbeit betrieben? Zu welchem Grad und wohin gibt es Machtverschiebungen weg vom 'Regime'?

To state it explicitly and remembering the pinch of salt in the formulation at the end of section 2.5, the MLG questions used in this interview guide are the following:

- What types of organisations are in your network and for what reasons?
- How effective is the governance structure set up in influencing and mobilising the MIS?
- Do the differently levelled governance structures vary in their approach taken?
- How easily could the mission itself, its supporting measures, or indexes be redesigned?

A.3 | Intercodal Reliability

Translated Statement	Original Statement	Coded	R1	R2	R3
So I think BIM was certainly, is certainly one of the greater impacts that we have received and that are now slowly arriving in reality, but then at the same time, you still have a public sector that is years behind. We still have partly defined standards, but on the other hand the world is developing too fast, so that this interface cannot catch up fast enough. You need the common interface so that you can really communicate. And the world is not quite as simple as one always imagines. Actually, the public sector, as the largest client, should also drive such processes, could do so, but of course is hopelessly lagging behind.	Also ich denke, BIM war sicher, ist sicherlich eines der der größeren Impacts, die wir bekommen haben und die jetzt so langsam so in der Wirklichkeit ankommen, aber dann haben Sie halt gleichzeitig noch eine öffentliche Hand, die da Jahre hinterherhinkt. Wir haben immer noch wir haben zum Teil definierte Standards, aber auf der einen anderen Seite entwickelt sich die Welt zu schnell weiter, sodass diese Schnittstelle nicht schnell genug wieder hinterherkommt. Sie brauchen ja die gemeinsame Schnittstelle, damit Sie auch wirklich kommunizieren können also. Und da ist halt die Welt nicht ganz so einfach, wie man sich das immer vorstellt. Eigentlich müsste die öffentliche Hand als der größte Auftraggeber solche Prozesse auch treiben, könnte es auch aber hinkt da natürlich hoffnungslos hinterher.	SF 1 SF 5	✓ ✓	✓ ✓	✓ ✓
One always asks oneself the question: is there a disruptor in construction? And then some people are afraid that one day Amazon will also build cities and Google – no, there are worries like that. I don't see it that way. I think the disruptor in construction comes from below. These are small start-ups that do things differently, such as [. . .] who map old houses and simply write down what resources can be reused, [. . .].	Man stellt sich immer die Frage gibt es ein Disruptor beim Bau? Und dann haben manche Angst ja irgendwann wird Amazon auch noch Städte bauen und Google – ne, solche Sorgen gibt es ja, ne?, so. Das sehe ich nicht so. Ich glaube der Disruptor im Bau der kommt von unten. Das sind kleine Start ups, die Dinge anders machen, wie zum Beispiel [. . .], ne?, die alte Häuser kartieren und einfach mal aufschreiben, was man da an Ressourcen wiederverwenden kann, [. . .]	SF 1	✓	✓	✓
And in fact the standardisation system is a great hindrance to many experiments because the standards have a tendency to clarify everything in great detail and this detailed clarification means that the standards are very extensive and there are two and a half thousand standards that affect the building sector, 500 of which are so relevant that many architects actually come into contact with these 500 and they sometimes overlap and sometimes contradict each other; in other words, it is indeed necessary to purify the standards system, but many people have already failed because of this.	Und tatsächlich ist das Norm-Wesen bei vielen Experimenten sehr hinderlich, weil die Normen eine Tendenz haben, sehr detailliert alles zu klären und durch diese detaillierte Klärung ist es so, dass die Normen sehr groß sind und es gibt zweieinhalbtausend Normen, die den Baubereich betreffen 500 davon sind so relevant, dass viele Architekten mit diesen 500 auch wirklich in Berührung kommen und die überlappen sich manchmal und widersprechen sich dann manchmal; also tatsächlich eine Entschlackung des Normwesens, aber daran sind schon sehr viele Leute gescheitert.	SF 1	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
The construction industry did not fare well in the 1980s and 1990s until the first decade of this millennium. Many companies went out of business. The big construction companies closed their already small research departments. And university research should not have neglected the questions of how we build in a recycling-friendly way, how we keep emissions to a minimum. Only in the past ten years has this come onto the agenda, partly because politicians are now thankfully making research funds available on a large scale to work on precisely these issues. But the research results come slowly, these things take time.	Der Bauindustrie ging es in den 1980er- und 1990er-Jahren bis ins erste Jahrzehnt dieses Jahrtausends nicht gut. Viele Firmen haben ihren Betrieb beendet. Die großen Bauunternehmen haben ihre ohnehin schon kleinen Forschungsabteilungen geschlossen. Und die universitäre Forschung hätte die Fragen, wie wir recyclinggerecht bauen, wie wir Emissionen minimal halten, nicht vernachlässigen dürfen. Erst in den vergangenen zehn Jahren ist das auf die Agenda gekommen, auch weil die Politik jetzt dankenswerterweise Forschungsgelder in großem Umfang zur Verfügung stellt, um genau diese Themen zu bearbeiten. Die Forschungsergebnisse entstehen aber langsam, diese Dinge brauchen Zeit.	SF 2	✓	✓	✓
Interviewee: Well, these, all these extremely experimental building projects, I find them super interesting, but there is always one thing that must not be forgotten: these are always pilot projects that are usually heavily subsidised because they are somehow seen as a pilot project as a sign. But they are usually not suitable for the masses because they are … Researcher: So as a feasibility study? Interviewee: Exactly such a feasibility study. But if you add it up hard and hard and look at the construction costs for its conversion, then you know very quickly that if someone has to do it, a private person, who wants to build a flat that he can offer for a reasonable rent, then it is usually not feasible, not financially, economically, not sustainable. And if it is, then only with massive state funding, as is the case with most pilot projects somewhere.	Interviewee: Also ich- diese, diese ganzen extrem experimentellen Baugeschichten, ich find die super interessant, aber man darf immer eine Sache nicht vergessen: das sind immer so Pilotprojekte, die in der Regel stark subventioniert laufen, weil sie halt als irgendwie als so Pilotprojekt als als Zeichen gesehen werden. Die sind aber in der Regel nicht massentauglich, weil sie … Researcher: So als Machbarkeitsstudie? Interviewee: Genau, so eine Machbarkeitsstudie. Aber wenn man das hart auf hart zusammenrechnet und was die Baukosten für seinen Umbau wieder sind und man sich das mal anschaut, dann weiß man eigentlich ganz schnell, dass man sagt ja, wenn das jetzt jemand machen muss aus, also ein Privatmensch, der da sozusagen Wohnung rein bauen möchte, die er für einen angemessenen Mietpreis anbieten kann, dann wird das in der Regel bei vielen dieser Projekten sind wir im Thema ja, ja nicht machbar, also nicht finanziell, wirtschaftlich, nicht tragbar halt. Und wenn, dann nur mit staatlicher massiven Förderung, wie es den meisten auch bei Pilotprojekten irgendwo ist.	SF 1 SF 5	✓ ✓	✓ ✓	✓ ✓
Buildings have always been an important topic for us in research – and energy efficiency in the building sector. I also have the feeling that this is a theme that runs through everything. I also have the feeling that in the funding landscape that I know, or many, yes, calls, tenders in this area are on practical topics. I, yes, I don't know at all, I can, it can also be a subjective impression. I have the feeling that there is also- There is also a lot happening in the technical area right now, especially serial renovation.	Gebäude für uns in der Forschung – und Energieeffizienz im Gebäudebereich – immer ein wichtiges Thema gewesen. Ich habe auch dieses Gefühl, das ist ein Thema, was sich durchzieht. Ich hab auch das Gefühl, dass es in der so in der Förderlandschaft, die ich kenne, oder viele, ja, calls, ausschreibungen in dem Bereich da ein Thema, praktisch sind. Ich, ja, ich weiß gar nicht, ich kann, es kann auch ein subjektiver Eindruck sein. Ich habe das Gefühl, das ist auch- Es wird- Im technischen Bereich passiert auch gerade viel, ne?, so gerade serielles Sanieren.	SF 2	✓	✓	

Translated Statement	Original Statement	Coded	R1	R2	R3
'I want to become climate neutral' and 'I don't want to need gas any more' – ok, that's a nice wish, right?, and it's very pious and positive, right? Alright, but the discrepancy to the actual task and to the actual detailed regulations to the actual consequences in the complexity, right?, is for most outside their area and for me also outside my area. When I talk to my managing director colleague from the municipal utilities, right?, it's such a big challenge in the to-do, in the consequences, in the process conversions, in the billing of electricity and whatever, or in the planning. So, for me it is now a question, I would say, of the middle-area, of communication, and of mediation, and of setting up manageable or manageable, conceivable packages, right? if I only have the renovation quota, that's why I emphasised it earlier, right? this monster, I can put everything and nothing into it, right?, and then I say, 'It's nice that you have that, but we hadn't even understood what it actually means, right?, and who is supposed to pay for it?' Not at all in the sense that money can't be printed, it can always be printed, but then I have to paralyse everything else, right?, then there will be no more new construction, right?, because we only have the construction industry once, right?, or because we don't get any heat pumps or because we don't get any photovoltaic modules at the moment, ok, special topic still, delivery problems, ne? So this translation from the political, social topic to the detailed planning technology, to the detailed execution in the construction industry with engineers – and who can calculate everything – these are two extremes, right? And this translation into the middle area in sufficiently rough but still sufficiently fair packages, I'll call it renovation packages, renovation areas, right? that's missing! And even if the public sector says 'I want to become climate-neutral in 2030' and then realises 'it's not possible, I can't do it myself', and 'Factually, I can't, even if I want to. I can twist and turn as I like, it doesn't work', so even if the person who sets the rules can't do it, how do you want to communicate that socially? For me, that means implementation in building, in craftsmanship, in ownership, in financing, in the order, in setting priorities, so that is- this is initiated, it is being initiated, photovoltaic is made, we don't have the power grids – so it's all, initiative or regulation, no matter how, in the two basic attitudes. And I'm not so technically enthusiastic that I say 'as an engineer I can organise everything' or we in Germany can, no, we won't manage that either. There are a lot of imponderables. But we don't really have a line of action that everyone understands, do we?	'ich will klimaneutral werden' und 'ich will kein Gas mehr brauchen' – ok, das ist ein schöner Wunsch, ne, und der ist sehr fromm und positiv ne so, aber die Diskrepanz zur eigentlichen Aufgabe und zu den eigentlichen Detailregelungen zu den eigentlichen Folgen in der Komplexität, ne?, ist für die meisten außerhalb ihres Bereichs und für mich auch außerhalb meines Bereiches. Wenn ich mit meinem Geschäftsführerkollegen von den Stadtwerken sprechen, ne?, das ist so eine große Herausforderung im To-Do, in den Folgen, in den Prozessumstellungen, in der Abrechnung des Stroms und schießt mich tot, oder in den Planungen. Also, für mich ist es eine Frage inzwischen, ich sag mal, des Mittelbereiches, der Kommunikation, und der Vermittlung, und der Aufstellung handhabreicher oder handhabbarer, vorstellbarer Pakete, ne?, wenn ich nur die sanierungsquote hab, deswegen hab ich so betont vorhin, ne?, dieses Monstrum, da kann ich alles und nichts reindeuten, ne?, und da sage ich 'Schön, dass ihr das habt, aber wir hatten noch gar nicht begriffen, was es eigentlich heißt ne und wer soll das bezahlen?' Gar nicht in dem Sinne, dass das Geld nicht gedruckt werden kann, das kann immer gedruckt werden, aber dann muss ich alles andere lahmlegen, ne, dann gibt es halt keinen Neubau mehr, ne weil wir nur einmal die Bauwirtschaft haben, ne?, oder weil wir keine Wärmepumpen kriegen oder weil wir momentan keine Photovoltaik-Module kriegen, ok, Sonderthema noch, Lieferschwierigkeiten, ne?, so und diese Übersetzung von dem politischen, gesellschaftlichen Thema hin zur detaillierten Planungstechnik, zur detaillierten Ausführung in der Bauwirtschaft mit Ingenieur – und die alles rechnen können – das sind ja so 2 Extreme, ne? Und diese Übersetzung in den Mittelbereich in hinlänglich grobe aber doch noch hinlänglich faire Pakete, nenne ich's mal, Sanierungspakete, Sanierungsbereiche, ne?, das fehlt! Und selbst wenn die öffentliche Hand sagt 'ich will 2030 klimaneutral werden' und dann feststellt 'es geht nicht, ich selbst kann's ja nicht!', ne?, und 'ich kann es faktisch nicht, auch wenn ich es will. Ich kann mich drehen und wenden wie ich will, es geht nicht', also selbst wenn der, der die Regeln setzt, es nicht kann, wie will man das dann gesellschaftlich vermitteln? Also das heißt, das ist für mich die Umsetzung im Bauen, im Handwerk, im Eigentum, in der Finanzierung, in der Reihenfolge, in der Prioritätensetzung, also, das ist- es wird dieses losgetreten, es wird jenes losgetreten, es wird Photovoltaik gemacht, wir haben die Leitungsnetze nicht – also, es ist alles, initiativ oder regelnd, egal wie, in den beiden Grundhaltungen. Und ich bin jetzt nicht technisch so begeistert, dass ich sage 'als Ingenieur kann ich alles organisieren' oder wir in Deutschland, ne?, werden wir auch nicht hinkriegen. Das sind ganz viele Unwegbarkeiten. Aber eine Handlunglinie, die auch jeder versteht, ne, fehlt mir eigentlich, ne?	SF 4b	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
So, it's a highly dynamic field and yes, that's actually what it looks like in concrete terms, that we put studies out to tender, that is, we do contract research. We consider which fields we would like to have researched in order to approach this question. In concrete terms, this should result in things such that we – well, we advise, that's our function in practice, the Ministry of Construction and they now have, for example, exactly such a question 'What kind of renovation rate do we actually need in order to get closer to this goal, the neutral building stock?', right? and then it's like this that we consider 'yes, in which areas do we need to research?' So, do we want a general study that examines the German building stock using simulation models? – We recently did something like that, and it's actually going on all the time. **Comment:** It was discussed here with one coder whether or not 4c would be a good fit but discarded as it was agreed upon that the main theme of this question is research and the process of research being directed, not so much the direction taken.	Also, es ist ein hoch dynamisches Feld und ja, das sieht eigentlich das konkret so aus, dass wir dazu Studien ausschreiben, sprich, wir betreiben Auftragsforschung. Wir überlegen uns, welche Felder wir beforscht haben möchten, um uns dieser Fragestellung zu nähern. Ganz konkret sollen dabei solche Sachen rauskommen, dass wir – also wir beraten ja, das ist unsere Funktion praktisch, das Bauministerium und die haben jetzt beispielsweise auch genau so eine Fragestellung 'Was für eine Sanierungsrate brauchen wir eigentlich, um diesem Ziel, das den neutralen Gebäudebestand näher zu kommen?', ne? und dann ist das so, dass wir überlegen 'ja, in welchen Bereichen müssen wir forschen?' Also, wollen wir jetzt mal eine allgemeine Studie, die den deutschen Gebäudebestand anhand von Simulationsmodellen untersucht? – sowas haben wir haben wir jetzt kürzlich gemacht, läuft eigentlich auch durchgehend	SF 2	✓	✓	✓
We actually manage to transfer knowledge relatively well. The problem is not so much the transfer of knowledge within the individual professional groups, i.e. within the architects, within the engineers, within the construction companies, but the problem is actually the transfer of knowledge between the groups and, of course, to the many small individual owners. Yes, so a Deutsche Wohnen, a Vonovia as a large real estate portfolio holder, a Signa as a large commercial building or office building, they already have a certain expertise, yes, but the many individual owners do not.	Wissenstransfer gelingt uns eigentlich relativ gut. Das Problem ist viel stärker, nicht der Wissenstransfer innerhalb der einzelnen Berufsgruppen, also innerhalb der Architekten, innerhalb der Ingenieure, innerhalb der Bauunternehmen, sondern das Problem ist eigentlich der Wissenstransfer zwischen den Gruppen und natürlich hin zu den vielen kleinen Einzeleigentümern. Ja, also eine Deutsche Wohnen, eine Vonovia als großer Immobilienbestandshalter, ne Signa als großer Gewerbebau oder Bürobau, die haben schon eine gewisse Expertise, ja, aber die vielen Einzeleigentümer nicht.	SF 3	✓	✓	✓
So what I'm saying is that in the last thirty years that I've been observing this, there have only been very, very few energy-efficient renovations that have paid off economically.	Also, was ich damit sagen will, ist, dass in den letzten dreißig Jahren, die ich das beobachte, gab es nur ganz, ganz wenige energetische Sanierungen, die sich betriebswirtschaftlich gerechnet haben.	SF 5	✓	✓	✓
[. . .] I also believe that we are already beyond this point in time, that we don't think in silos anymore. So, I think this "Energy Transition Building" is a very good example. There are also many real-laboratory projects that try to somehow bring together many different streams of thought and disciplines. Ultimately, all of our projects always connect with ecological questions, economic questions, social questions, behavioural questions, always mixed in new constellations. So I think we have really made progress in this area [. . .]	[. . .] ich glaube auch, dass wir über diese diesen Zeitpunkt, dass man nicht, dass man in Silos denkt, schon hinaus ist. Also ich finde da dieses "Energiewende Bauen" durchaus ein ganz gutes Beispiel. Es gibt auch viele Reallabor-Projekte, wo man irgendwie versucht, ganz viele verschiedene Gedankenströme und Disziplinen zusammenzubringen. Letztendlich sind auch alle unsere Projekte verbinden, immer ökologische Fragen, ökonomische Fragen, gesellschaftliche Fragen, Verhaltensfragen, also auch in immer wieder neuen Konstellationen gemischt. Also ich glaube, da haben wir wirklich einen Fortschritt hinter uns [. . .]	SF 3	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
[. . .] Yes, they try to take everyone into account somehow, and everything has to be be very... which is also correct here, but one have to think about it too. So, of course, it makes sense to build every third flat barrier-free, so that people with walking disabilities have a wide choice of living space, so they have the possibility, when they are looking for a flat, to simply choose between different flat designs, maybe sometime when there is no longer a housing shortage, to be able to choose a flat like that, but not like 'I don't the style, but I have to take it, because the other flats are not barrier-free'. But the question is, could – well, this is a pure luxury we are talking about here because we say, on the one hand, we want to take into account that we have people with disabilities who need this, but to say that this person should then also have the choice between five different flat designs that are just available, that are offered – it is just the question, are we able to afford this luxury? In other countries we talk about the fact that people can't afford housing, that is, they can't afford to build, and we talk about such things, so I find it interesting how the worlds diverge, yes, on the issues, that is . . .	[. . .] ja, es wird halt versucht, irgendwie alle sollen halt berücksichtigt werden und das soll halt alles sehr.. was hier auch irgendwo richtig ist, aber es muss halt drüber nachgedacht werden. Also natürlich macht es Sinn, wenn man jetzt jede dritte Wohnung barrierefrei baut, dass Leute mit Gehbehinderung eine große Auswahl an an Wohnraum haben also die Möglichkeit haben, wenn sie eine Wohnung suchen, einfach sich zwischen verschiedenen Wohnungsschnitten eventuell irgendwann mal, wenn es dann Wohnraumknappheit nicht mehr gibt, auch mal eine Wohnung so aussuchen zu können, sondern nicht so 'Mir gefällt der Schnitt nicht, aber ich muss dir das nehmen, weil die anderen Wohnungen nicht barrierefrei sind.' Aber die Frage ist, könnte – also, das ist 'n reiner Luxus, von dem wir reden, sozusagen, weil wir ja sagen, auf der einen Seite wir wollen auf jeden Fall berücksichtigen, dass wir Menschen mit Behinderungen haben, die das brauchen, aber zu sagen, dass das dieser Mensch dann halt auch noch die Wahl haben soll zwischen fünf verschiedenen Wohnungsschnitten die gerade frei sind, die angeboten sind – es ist halt die Frage, sind wir in der Lage, uns diesen Luxus zu leisten? In anderen Ländern reden wir darüber, dass Leute sich keinen Wohnraum leisten können oder bauen können, und wir reden halt über solche also so die ich finde aber interessant interessant wie die Welten auseinandergehen, ja, bei den Themen, das ist immer also. . .	SF 4a	✓	✓	✓
There is actually not yet a uniform definition of renovation rate. We usually assume full refurbishment equivalents, but then of course someone else comes around the corner and says we currently have, let's say, a roundabout refurbishment rate of 1.0. The study says we have to somehow get above 2. The construction industry is actually currently you can say at full capacity, right?, I think the capacities are 85% occupied and, well, that's not a figure I want to be nailed down to, because I think roughly you talk about full utilisation at over 80% and that's where we are in the construction industry. And then, of course, what does that mean? So, do we need more craftsmen? How could we stimulate this so that we get more craftsmen, for example? The other thing that we take into account, of course, is that we also like to make recommendations to the Ministry of Economic Affairs or together with the Ministry of Economic Affairs on how subsidy programmes should be designed, but of course you can imagine that if we simply go along and say that we are now going to increase the subsidy rates for all kinds of things, this could possibly lead to the craftsmen simply raising their prices by 30% [. . .]	[. . .] so eine einheitliche Definition von Sanierungsrate gibt es ja eigentlich noch gar nicht. Wir gehen jetzt meistens von Vollsanierungsäquivalenten aus, aber dann kommt natürlich jemand anderes um die Ecke und sagt wir haben aktuell, sag ich mal, roundabout eine Sanierungsrate von 1,0. Die Studie sagt, wir müssen irgendwie auf über 2 kommen. Die Bauwirtschaft ist eigentlich aktuell, kann man sagen voll ausgelastet, ne?, ich glaub die Kapazitäten sind zu 85% belegt und, also das ist keine Zahl, auf die ich festgenagelt werden möchte, weil ich glaub ganz grob spricht man bei über 80% von Vollauslastung und da sind wir in der Baubranche. Und dann resultiert natürlich daraus ja, was heißt das jetzt? Also, brauchen wir mehr Handwerker? Wie könnten wir das anreizen, dass wir da mehr Handwerker kriegen beispielsweise, ne? Das Andere, was wir was wir natürlich mitberücksichtigen, wir geben ja auch gerne Richtung Wirtschaftsministerium oder mit dem Wirtschaftsministerium zusammen Empfehlungen dafür, wie Förderprogramme designed werden sollten, ne?, aber jetzt kann man sich natürlich vorstellen, wenn wir da jetzt einfach stupide hergehen und sagen, wir erhöhen jetzt die Fördersätze auf alles Mögliche, kann das unter Umständen dazu führen, dass die Handwerker einfach nur ihre Preise um 30% erhöhen [. . .]	SF 4c SF 5	✓ ✓	✓ ✓	✓ ✓

Translated Statement	Original Statement	Coded	R1	R2	R3
If I now say that I would like to generate twice as many renovations as we have up to now, then the only question is: ok, how do renovations come about, i.e. how do renovations of old houses come about? The bottom line is that owners decide to invest money in order to implement modernisation measures and that this decision is made by the owner, who in this case is also an investor, so to speak, so that it is somehow economically worthwhile for him.	wenn ich jetzt sage ich möchte doppelt so viele Renovierungen erzeugen wie wie wie bis jetzt, dann ist jetzt nur die Frage ok wie kommen Renovierung denn zustande, also wie kommen Sanierung von alten Häusern zu stande? Im Endeffekt ist es so, dass Eigentümer sich entscheiden, Geld zu investieren, um Modernisierungsmaßnahmen umzusetzen und damit diese Entscheidung von dem Eigentümer, der in dem Fall ja auch Investor dann ist, sozusagen ja damit sich das aufgrund gesagt, es muss sich für den ja irgendwie wirtschaftlich lohnen	SF 5	✓	✓	✓
We don't have any documentation about our buildings, we don't know anything, I start there, that's- We don't have anything, it's like an archaeological excavation, every building is 'oh is very interesting, I didn't know that, I didn't know that was there' and then they start messing around and experimenting there. Then the- there is no continuous planning. Now I can't exactly say that the Americans do it better than us here, but what they do is they plan first and then start building, and we have this wretched agile planning which means we don't know what the roof looks like yet, but we're already on the third floor. And- yes, that's what we do here. And that means planning first, really planning through and then we start building and then we should have a register of the findings. **Comment:** The researcher disagreed, saying that 4a would be a better fit. 4c has been coded for the monitoring aspect, 4a has been argued to show the directionality of a problem.	Wir haben keine Dokumentation über unsere Gebäude, wir wissen gar nichts, ich fang da an, das ist- Wir haben gar nichts, das ist wie eine archäologische Grabung, jedes Gebäude ist 'Oh ist sehr interessant, das wusste ich gar nicht, das wusste ich ja nicht, dass das da ist' und dann fangen die da an rumzumachen und zu experimentieren. Dann ist die- gibt es keine durchgehende Planung. Jetzt kann ich nicht gerade sagen, dass die Amis besser bauen als hier, aber was die eben machen, die planen erst und fangen dann an zu bauen und wir haben dieses elende baubegleitende Planen, das heißt, wir wissen noch nicht, wie das Dach aussieht, wir sind aber schon im dritten Obergeschoss. Und- ja, das machen wir hier. Und das heißt erst planen, richtig durchplanen und dann fangen wir an zu bauen und dann müssten wir ein Register haben von den Erkenntnissen.	SF 4b SF 4c	✓ ✓	✓ ✓	✓ ✗
So we're also having this discussion, right?, about using recycled concrete. Firstly, it is possible in principle. The first question: how does it compare in terms of price? Well, recycled concrete runs against new concrete, right?, fresh concrete, right?, it's simply a question of the market, right? And what's more expensive, uhm, that's not taken, right? Then the public sector can still say 'I'm deliberately making it expensive, I'll take the more expensive one, I feel obliged to do so myself', but you can't impose it on the private citizen.	Also die Diskussion führen wir auch, ne?, Recycling-Beton zu nehmen. Erstens ist es grundsätzlich möglich. Die erste Frage: wie es preislich, ne? Ja, also, Recycling-Beton läuft gegen Neu-Beton, ne?, Frisch-Beton, ne?, das ist einfach schlichtweg eine Marktfrage, ne? Und was teurer ist ähm, das wird nicht genommen, ne? Dann kann die öffentliche Hand noch sagen 'ich mach's bewusst teuer, ich nehme das teurere, ich fühl mich selbst verpflichtet', aber dem Privatmann können Sie es nicht auftragen.	SF 5 SF 6	✓ ✓	✓ ✓	✓ ✓
And I believe that the only way we can make progress is to link the sectors with each other in a dialogue, to create the best possible role model function at all levels and to make optimal progress through our common wealth of knowledge that results from this. So, ivory tower thinking does not help there.	Und ich glaube, die einzige Möglichkeit, wie wir da weiterkommen, ist eben die Sektoren miteinander gedanklich zu verkoppeln in den Dialog zu bringen, bestmöglich dann daraus Vorbildfunktion zu schaffen auf allen Ebenen und über den gemeinsamen Wissensreichtum, der sich dadurch ergibt, optimal weiterzukommen. Also Elfenbeinturmdenken hilft da nicht weiter.	SF 3	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
The dilemma at the time was actually more that people said the whole thing had to pay for itself. So, 'I'm doing the energy transition, but it has to be economical', and that was the big dilemma, because installing and using renewable energies or also taking structural precautions to be CO2-optimal, to use material that has a higher resource efficiency, that was first of all not yet an issue at the time, resource efficiency, nor necessarily expressing it in CO2 equivalents. But the big dilemma is that it had to be economical, and I believe that in 2019, when it came to looking at energy efficiency, the federal government adopted the principle of thriftiness, which in my view ultimately removed a relatively large hurdle, namely that I can install renewable energies, In the end, I can get a gas heating system cheaper, but the principle of economy is not considered in the classical sense, but the principle of thriftiness is central, and thus, I can also justify the use of renewable energies under the principle of thriftiness, even if the gas heating system would be cheaper. And perhaps if we hadn't had this dilemma back then, in the 90s, 2000s, with all the rules that existed back then and all the guidelines that existed back then – there were already guidelines on sustainable building back then, they already existed back then – but if we hadn't always linked it to the issue of 'it has to pay for itself, it has to be economical', then I think we would already be much further ahead at this point. **Comment:** One coder disagreed at first, pointing out that the ex post reflection the interviewee elaborates here is not strictly part of the original definition of 4c. The author considered this a valid point and thus edited the definition of the system function description to stress the deliberate reflection that is part of the evaluation that 4c encompasses The author is of the opinion that this poses but a minor change in the definition and the coding has not to be reworked.	Das Dilemma war zu der Zeit eigentlich eher, dass man gesagt hat das Ganze muss sich amortisieren. Also, 'ich mache die Energiewende, aber sie muss wirtschaftlich sein' und das ist das große Dilemma gewesen, weil regenerative Energien einzubauen und zu nutzen oder auch bauliche Vorkehrungen zu treffen, um eben CO2-optimal zu sein, Material zu verwenden, das eine höhere Ressourceneffizienz hat, das war damals erstens noch nicht Thema, die Ressourceneffizienz, auch nicht unbedingt das Ausdrücken in CO2-äquivalenten. Aber das große Dilemma ist, es musste wirtschaftlich sein und da ist der Bund ja eben 2019, glaube ich, als es darum ging, die Energieeffizienz dann in den Blick zu nehmen, auf das Sparsamkeits-Prinzip gegangen und damit letzten Endes ist aus meiner Sicht eine relativ große Hürde genommen, nämlich dass ich eben regenerative Energien einbauen kann, dass ich im Endeffekt zwar eine Gas Heizung billiger kriege, aber nicht das Prinzip der Wirtschaftlichkeit im klassischen Sinne betrachtet wird, sondern das Prinzip der Sparsamkeit im Mittelpunkt steht und damit kann ich eben unter dem Prinzip der Sparsamkeit auch den Einsatz regenerativer Energien begründen, selbst wenn die Gas Heizung günstiger wäre. Und hätte man vielleicht damals dieses Dilemma nicht gehabt, in den 90er, 2000 er Jahren, mit all den Regeln, die es damals schon gab und all den Leitfäden, die es damals gab – es gab damals schon Leitfäden zum nachhaltigen Bauen, also die hat es damals schon gegeben – hätte man es aber nicht immer an das Thema 'es muss sich amortisieren, es muss wirtschaftlich sein', geknüpft, dann, glaube ich, wären wir an der Stelle schon deutlich weiter.	SF 4b SF 4c SF 5	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Researcher: So there is a relatively large legitimacy or support for an increase of one or for a remediation obligation, are there also opposing voices? Interviewee: Yes, only. Researcher: Only dissenting voices? Interviewee: Yes!	Researcher: Also es gibt eine relativ große Legitimität oder Unterstützung für eine Erhöhung einer oder für eine Sanierungspflicht, gibt es auch Gegenstimmen? Interviewee: Ja, nur. Researcher: Nur Gegenstimmen? Interviewee: Ja!	SF 7	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
Skilled labour is definitely a huge issue. A shortage of skilled workers is something I notice in every film, regardless of the topic, but especially in the entire construction industry, and not only in the companies that carry out the work, but also in the planning stage, right? So, when you go into the area of urban property or schools or whatever, you're probably more concerned with flats or, ne? It's not just about flats, but about buildings in general? Okay. But that's where the people who plan things, who put the contracts out to tender and so on, that's where it starts. Well, I can say it for Berlin now. For example, there are also vacancies in the civil engineering and building construction offices that can't be filled and so on, but also in construction, right? Who is there at the end? Who does any manual work? and so on. And I think that's a very big limiting factor in the whole construction sector [. . .].	Fachkräfte ist auf jeden Fall das Riesenthema. Fachkräftemangel das ist was, was mir bei jedem Film, egal zu welchem Thema eigentlich, aber halt besonders in der ganzen Baubranche, aber auch eben nicht nur bei den ausführenden Unternehmen, sondern ja schon bei der Planung, ne? Also, wenn du in Bereich der städtischen Eigentums gehst oder Schulen oder was auch immer, dir geht es wahrscheinlich eher um Wohnungen oder, ne? Es geht nicht nur um Wohnungen, generell um Gebäude? Okay. Aber genau da überhaupt Leute, die die Sachen planen, die die Aufträge sozusagen Ausschreiben und so, da geht es ja auch schon los. Also, ich kanns jetzt für Berlin sagen. Da ist zum Beispiel auch in den Tiefbau- und Hochbauämtern, auch jeweils offene Stellen, die gar nicht besetzt werden können und so, aber eben auch auf dem Bau, ne? Wer steht da am Ende? Wer macht irgendwelche Handwerksarbeiten? und so. Und das ist glaube ich ein ganz großer limitierender Faktor beim ganzen Baubereich [. . .]	SF 6	✓	✓	✓
So very subjectively, my impression is that the influence of lobby organisations, which in the case of building materials are the building materials industry, which exerts its influence very cleverly, has increased even more. For example, by awarding funding contracts to universities, but they live off the fact that they get money from whoever commissions and then I can also control the result, although it is never said so, but I could also control the result, so under certain circumstances, the result is what I actually hope for, because otherwise there are no more new contracts. So the universities are not always completely free of this. And they are not so sovereign that they say, 'll do the research and that's the result of the research', but I do the research and then I make sure that what comes out of it suits the client, so to speak.	Also sehr subjektiv, nämlich mein Eindruck also mein Eindruck ist, dass der Einfluss eher noch gestiegen ist, von Lobby-Organisationen, das sind in dem Fall von Baustoffen sind sind es eben ist in die Baustoff-Industrie die ihren Einfluß ausübt, das macht sie ja auch sehr geschickt. Zum Beispiel, indem man Förderaufträge erteilt an Unis, aber die Leben davon sozusagen, dass sie da Geld kriegen von demjenigen, der sind beauftragt und dann kann ich das Ergebnis auch, wird zwar nie so gesagt, aber ich könnte das Ergebnis auch steuern, also da kommt auch und unter Umständen das raus, was ich mir eigentlich erhoffe, weil sonst gibt es ja keine neuen Aufträge mehr. Also da ist die Unis auch nicht immer ganz frei davon. Und da sie sind eben nicht so souverän, dass sie sagen, also ich forsche und ausm Forschen kommt eben raus das ist das Ergebnis, sondern ich forsche schon und dann guck ich schon, dass es sozusagen dem Auftraggeber auch passt, was da rauskommt	SF 2 SF 7	✓ ✓	✓ ✓	✓ ✓
Interviewee: No one is hindering that either, but it is simply not feasible in terms of resources. Researcher: Is that the consensus, is that- well, it wasn't clear to me, I have to say, but of course I'm not an expert, so that's- Interviewee: Well, it's clear among us experts. **Comment:** The disagreeing coder acknowledged that this quote is about legitimacy in the broader sense but neither an answer to the questions in interview guide nor fitting with the system function definition in the strict sense. Instead, they suggested SF 3 as the quote implicitly stated a knowledge diffusion problem from experts to the public.	Interviewee: Das behindert auch keiner ne, sondern es ist von den Ressourcen schlichtweg gar nicht darstellbar. Researcher: Ist das Konsens, ist das- also, mir war das nicht klar, muss ich sagen, aber ich bin ja auch natürlich nicht vom Fach, also ist das- Interviewee: Also unter uns Fachleuten ist das klar.	SF 6 SF 7	✓ ✓	✓ ✗	✓ ✓

Translated Statement	Original Statement	Coded	R1	R2	R3
The problem with recycling is that most building materials are not 100% recyclable. This means that if you now say I want to build a building with recycled concrete. Then the admixture is a maximum of 55%. When you build the building, you can use 55% old concrete but you need 45% new concrete to make it work. There is- aluminium is one hundred percent recyclable. There are building materials that are recyclable but many are not, and then we have another problem that of course the existing buildings that we have, so if we want to demolish them and recycle them, often they can't be recycled because they get composites and adhesives. You can't recycle a thermal insulation composite façade at all because they have mixed different materials. You can only burn it or dispose of it as hazardous waste. That's the big problem, yes, that means recycling is not the optimal way at all and nevertheless, it is done. **Comment:** It was remarked by one coder that 4a would also be a fit here as – implicitly – the interviewee criticises the fact that recycling is focused on. Seeing the full context of the quote, however, this thought was discarded as the overall context did not provide further ground for that conclusion. The author acknowledges that this is a valid thought and comment. However, as this is not the main statement, the quote has not been coded for this system function.	das Problem beim Recycling ist, dass die meisten Baustoffe sich nicht hundertprozentig recyceln lassen. Das heißt, wenn du jetzt sagst, ich möchte ein Gebäude mit Recycling Beton bauen. Dann ist die Zumischung maximal 55%. Wenn du das Gebäude baust, kannst du 55% alten Beton verwenden aber du brauchst 45% neuen Beton, damit das funktioniert. Es gibt- Aluminium ist zu hundert Prozent recyclebar. Es gibt Baustoffe, die recyclingfähig sind, aber viele sind es nicht, und dann haben wir noch ein Problem, dass natürlich die bestehenden Gebäude, die wir haben, wenn wir sie also abbrechen und recyceln wollen, lassen sich häufig deswegen nicht recyceln, weil sie Verbundstoffe und Klebstoff erhalten. Du kannst eine Wärmedämmverbundfassade gar nicht recyceln, weil sie verschiedenen Materialien gemischt haben. Du kannst nur noch verbrennen oder als Sondermülll entsorgen. Das ist das große Problem, ja, das heißt Recycling ist gar nicht der optimale Weg und nichtsdestotrotz wird es gemacht.	SF 6	✓	✓	✓
But I'm going to make a very big leap, I'm no longer in specialist networks. Well, I'm still invited to the BIM cluster and whatever, I'm now interested in networks outside my job, no? I'm interested in networks in the construction industry, in the building industry, I'm very interested in networks in logistics, so I'm looking for networks that tie in with that, not in the sense of specialisation, maybe I'm not deep enough into that any more, but I'm interested in interdisciplinary networks, interdisciplinary networks, that's actually the most important thing, because we're all sitting in our networks, highly positioned, very isolated and really and some colleague always has great ideas and his ear to the professional development. For me, interdisciplinary, the interdisciplinary networking is the be-all and end-all of understanding why the energy industry doesn't deliver my buildings.	Aber ich mach mal einen ganz großen Sprung, ich bin inzwischen nicht mehr in Fach-Netzwerken also, ich bin immer noch eingeladen, BIM-Cluster und schieß mich tot, mich interessieren inzwischen Netzwerke außerhalb meines Jobs, ne?, mich interessieren Netzwerke der Bauwirtschaft, der Bauindustrie, mich interessieren sehr Netzwerke der Logistik, also ich suche Netzwerke, die da anknüpfen nicht im Sinne der Fachlichkeit, da bin ich vielleicht auch nicht mehr tief genug drin, aber mich interessieren Netzwerke fachübergreifend, interdisziplinäre Netzwerke, das ist das Wichtigste eigentlich, weil wir sitzen alle hochgradig in unseren Netzwerken, hochgradig aufgestellt, bestens isoliert und wirklich und irgendein Kollege hat immer tolle Ideen und sein Ohr an der fachlichen Entwicklung. Für mich ist die interdisziplinäre, das interdisziplinäre Netzwerken das A und O, um zu verstehen, warum die Energiewirtschaft nicht meine Gebäude liefert.	SF 3	✓	✓	✓

Translated Statement	Original Statement	Coded	R1	R2	R3
Everything that makes housing more expensive is of course also a problem at the moment. Where I have to create living space, and because of the population structure, I also have to create affordable living space. On the other hand, what good is housing that I can no longer heat if there is no more gas? So this is a dilemma that I think is becoming very clear and very transparent at the moment and where we have to think about something very intelligently.	Alles, was den Wohnungsbau verteuert, ist natürlich im Moment auch ein Problem. Da, wo ich halt eben Wohnraum schaffen muss, und zwar eben aufgrund der Bevölkerungsstruktur, eben auch günstigen Wohnraum schaffen muss. Auf der anderen Seite: Was hilft mir den Wohnraum, den ich nicht mehr beheizen kann, wenn es kein Gas mehr gibt? Also das ist so ein Dilemma was im Moment, glaube ich, sehr deutlich und sehr transparent wird und wo wir uns ganz intelligent was überlegen müssen.	SF 4a	✓	✓	✓
[...] on the building side, there are actually, let's say, 3-4 actors in Germany who try to block anything that tightens the requirements for new buildings or existing buildings, that is the Zia, the GDW, the housing industry association and a few others, and who say, "No, all our buildings are already super and we have to talk about automation and user behaviour and hydrogen". That tends to be the path, whereas in the building industry, I think we have to look a bit more closely.	[...] auf der Gebäude Seite sind es eigentlich vor allem ich sag mal 3-4 Akteure in Deutschland, die sozusagen alles was an Verschärfung von Anforderungen an Neubau oder Gebäudebestand eben versuchen zu blockieren, das ist der Zia, das ist der GDW, der Verband der Wohnungswirtschaft und noch paar andere und die sozusagen sagen, "Ne, unseren Gebäude sind alle schon super und wir müssen über Automatisierung und Nutzerverhalten und Wasserstoff reden" sagen. Das ist dann eher der Pfad, während in der Bauwirtschaft, da müssen wir glaube ich, ein bisschen genauer hingucken.	SF 7	✓	✓	✓

For further transparency, the code used for the calculation of Krippendorff's Alpha is put below.

```
library(irr)
intercoder_data <- read.csv("/path/to/intercoder_data.csv")

intercoder_data[] <- lapply(intercoder_data, function(x)
  gsub('4a', '11', # replace 4a–4c with 11–13 to avoid
       gsub('4b', '12', # conversion errors as only numeric
            gsub('4c', '13', x))) # values can be handled
  )

matrix <- t(as.matrix(intercoder_data[,2:5])) # select relevant data as transposed matrix

kripp.alpha(matrix) # calculate value
```

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Declaration of Authorship

I hereby certify that this thesis has been composed by me and is based on my own work, unless stated otherwise. No other person's work has been used without due acknowledgement in this thesis. All sources of information have been acknowledged.

Acknowledgements

First and foremost, I would like to thank my supervisors Nick Verkade and Joeri Wesseling for the chance to work with both of them. Their expertise, critical thoughts, openness, patience, experience, and guidance have proven invaluable to me many times. I want to thank Matthijs Janssen in advance for his willingness to become my second reader. I look forward to our discussion during my presentation! I am grateful to Remi Elzinga who found the time to share his expertise as well as order thoughts I had in an inspiring discussion! Without him, this discussion would neither have become as coherent nor supported by and woven into the current discourse.

My interviewees deserve my utmost gratitude: As a qualitative study, this work builds on people willing to get interviewed, being available, and on hints and material they send. Even more so since this is a favour of them to me. This favour and their generosity is not what made my work complete, but what made my work possible. I thank them for the time they took for me, the knowledge they shared with me, the patience they had with my questions, and the many perspectives, information, and thoughts that I was allowed to take from our interview.

My gratitude for their interest in my work and many useful suggestions goes – in alphabetical order – to Anna Winter, Cornelius Holler, Emi(le) Ponson, Nicole Neuser, Stefan Geavert, Yoram Schroll and many others, friends and family who supported me over the course of this project.

Dedication

I would like to dedicate this thesis to a few teachers I had: Klaus Lockenvitz, Hartmut Tödt, Regina Klose, Regina Nagel, Martin Müller-Olm, Volker Mengers, Diedrich Pape-Middendorf and Guido Kanschat. You – and others that are not named here – have more than educated me, you have shaped me in the past years and continue to do so immensely. I could not have become who I am now without you or your guidance.