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Local carbon budgets as a tool for sustainability transitions

Three emerging narratives of change and governance

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Master of Science Thesis

Titel:	Local carbon budgets as a tool for sustainability transitions: Three emerging narratives of change and governance
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ABSTRACT

This study takes as a starting point that climate change must be seen as interrelated with other social, technological, political, and ecological challenges of our times, and that it is closely linked to the local arena of policy and planning. By this, the study is guided by the notion that sustainability transitions are needed to combat climate change. The aim of this study is to explore if and how local carbon budgets can be a tool for municipal governance in facilitating sustainability transitions. Through an analysis of narratives of change and modes of governing, the aim is pursued by studying how the local carbon budgets developed at the Climate Change Leadership node at Uppsala University approaches a framework for transition, and how these local carbon budgets have been received by municipal planning and policy actors in two case studies: Nyköping and Järfälla municipality. The study uses a qualitative case study approach with semi-structured interviews, document analysis and participatory observation as its methods. From the results and analysis, three narratives of change emerged: Tweak the system, Re-invent the system, and Shake the system. The three narratives suggest different pathways for sustainability transitions, as well as different approaches to local governance. In conclusion, the results of this study suggest that the local carbon budgets can be several different tools for sustainability transitions, and what kind of tool it becomes is dependent on what narratives of change and approach to local governance that shapes it. Finally, the study highlights the importance of using local carbon budgets to their full potential, allowing them to question, challenge and reimage what kind of change is needed and how it can come about, if more transformative sustainability transitions are to be reached.

Keywords: *sustainability transitions, narratives of change, local governance, carbon budget*

Examensarbete

Titel:	Lokala koldioxidbudgetar som ett verktyg för en hållbar samhällsomställning: tre narrativ om förändring och styrning
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SAMMANFATTNING

Denna studie tar som utgångspunkt att klimatförändringarna måste förstås som sammankopplade med andra sociala, tekniska, politiska och ekologiska utmaningar och att de är nära knutna till lokal policy och planering. Genom detta utgår studien från att hållbara samhällsomställningar behövs för att bekämpa klimatförändringar. Syftet med denna studie är att undersöka om och hur lokala koldioxidbudgetar kan vara ett verktyg för kommuner att facilitera hållbara samhällsomställningar. Syftet uppfylls genom att analysera vilka narrativ om förändring och lokal styrning som förknippas med de lokala koldioxidbudgetar som utvecklats vid klimatledarskapsnoden vid Uppsala universitet, samt hur dessa lokala koldioxidbudgetar har mottagits av kommunala planerings- och policyaktörer i två fallstudier: Nyköping och Järfälla kommun. Studien genomförs genom en kvalitativ fallstudie med semistrukturerade intervjuer, dokumentanalys och deltagande observation som metoder. Från resultaten och analysen framkom tre narrativ om förändring: *Justera systemet, Omskapa systemet* och *Skaka systemet*. De tre narrativen föreslår olika vägar för en hållbar samhällsomställning, liksom olika tillvägagångssätt för lokal styrning. Sammanfattningsvis antyder resultaten från denna studie att lokala koldioxidbudgetar kan utgöra flera olika verktyg för hållbar samhällsomställning, och vilken typ av verktyg de blir beror på vilka narrativ om förändring och inställning till lokal styrning som formar dem. Slutligen understryker studien vikten av att använda lokala koldioxidbudgetar till dess fulla potential, så att de kan ifrågasätta, utmana och omskapa vilken typ av förändring som behövs och hur den kan komma till, om mer transformativa hållbara samhällsomställningar ska uppnås.

Nyckelord: *hållbar samhällsomställning, berättelser om förändring, lokal styrning, koldioxidbudget*

Preface

Conducting a master's project is probably never a smooth sail, but riding through that storm at the kitchen table during a global pandemic for sure did not make it easier. This work had not been possible without continuous support from my supervisor Pernilla Hagbert: thank you for always inspiring me to go further, helping me to see new connections, and guiding me through the fuzzy territory of transition studies. Moreover, getting support from my affiliated researchers at the Climate change leadership node at Uppsala university has been crucial. Isak Stoddard, Martin Wetterstedt, and Anneli Ekblom: thank you for welcoming me into your uniquely progressive work on Swedish climate mitigation and sustainability. I also thank all respondents in this study for contributing with your time and engagement, both to this study and to your important work with sustainable development.

This thesis marks a milestone of my (first) ten years in academia. Little did I know, when I joined a course in sustainable development at CEMUS (Uppsala university) in 2011, that the creative, dynamic, and supportive learning environment of the center would shape my life in such a fundamental way. I am deeply grateful for all peers, friends, tutors, and colleagues that have crossed and joined my path during this decade. Mentioning you all would require an essay in itself, but special thanks to Lovisa Håkansson, Sara Andersson, Jakob Grandin, Alexis Engström, and Anna Bergentz.

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ABBREVIATIONS

CB	Carbon budget
CCL	The Climate Change Leadership Node
CO_2	Carbon dioxide
GHG	Greenhouse gases
LCB	Local carbon budget
MLP	Multi-level Perspective
ST	Sustainability transition

1. INTRODUCTION

Climate change has risen on both global and local agendas as one of our time's most urgent challenges. The year of 2015 marks a historic point in the work to mitigate climate change with both the launch of Agenda 2030, with Climate Action being stated as the Sustainable Development Goal number 13 (United Nations, 2015b), and the adoption of the Paris Agreement (UNFCCC, 2016). By this, 196 countries committed to strengthen the global response to climate change by "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (United Nations, 2015a, p. 3). However, despite these prominent global agreements, global temperatures and greenhouse gases are still rising (IPCC, 2018) and the quest to combat climate change is a debated and contested issue.

This study takes as a starting point that climate change must be considered a multifaceted and wicked problem that is interrelated with other social, technological, political, and ecological challenges of our times. Recognizing this entails acknowledging that there is a need for fundamental, long-term, and multifaceted changes, also known as transitions (de Haan & Rotmans, 2011; Ernst et al., 2016; Markard et al., 2012). Furthermore, this study pays particular attention to transitions aiming to generate a more sustainable future, generally labeled sustainability transitions (Geels, 2011; Loorbach et al., 2017). Due to their lack of competitive advantages in a free market economy, sustainability transitions require more active governance in order to occur (Geels, 2011; Markard et al., 2012). Thereby, it is of high relevance to study governance approaches in relation to sustainability transitions.

Furthermore, although climate change is a highly global issue, with greenhouse gases knowing no national or governmental boundaries, the local level of climate action is becoming more and more acknowledged. Municipalities and cities have a more direct and concrete connection and potential to impact key sources of emissions, such as transport and mobility infrastructure, energy use and supply, and construction of buildings (Romero-Lankao, 2012). This is particularly relevant in the Swedish context of this study, where municipalities have the exclusive right to plan and control land-use development and local transport infrastructure (Hrelja et al., 2015). Thus, the role of municipalities in facilitating sustainability transitions is one key interest of this study.

While the need for governing sustainability transitions is becoming increasingly recognized both in policy and research, there are a broad variety of different narratives of what a *sustainable* transition is and how it can come about (Luederitz et al., 2016). This calls for explorations of what narratives of change, governance and sustainability that are present in relation to sustainability transitions, in order to understand what kind of actions and strategies that are seen are desirable and feasible.

The complexity and urgency of climate change is generating an ever-increasing number of methods and tools promising to create or support actions for climate mitigation and sustainability transitions. However, there is a lack of knowledge around what type of change is implied and resulted from these tools. Therefore, this study sets out to explore how one emerging tool for local climate mitigation, *local carbon budgets*, can be seen to facilitate sustainability transitions. This is done in the context of Sweden, with a focus on what narratives of change and approaches to governance are embedded and perceived in relation to local carbon budgets.

1.1 Carbon budgets as a tool for climate mitigation

The carbon budget (CB) concept was introduced on the global climate agenda by the Fifth Assessment Report published by IPCC in 2013-2014 (IPCC, 2014). The introduction marked not just a change of terminology, but a conceptual change in how the climate change issue was discussed. With the carbon budget framing, climate change went from being discussed as a matter of 'climate stabilization' to being a question of cumulative emissions coming from human activity. This altered how climate change was being discussed in research and politics, and it sparked the demand for policies focusing on 'net-zero emissions' and more radical climate mitigation actions, seen for example in the later upcoming school strikes (Lahn, 2020).

Put simply, the global carbon budget is the total amount of carbon dioxide (CO_2) that can be emitted while limiting the global temperature to a set target temperature (Matthews et al., 2018). This target is often guided by the Paris Agreement's statement to keep global temperatures "well below 2°C above pre-industrial levels" (United Nations, 2015a, p. 3). Arguments provided for focusing on emissions of CO_2, and no other greenhouse gases (GHG) such as methane, is that CO_2 is the GHG that has had the largest impact on the global climate so far and that it stays in the atmosphere over long periods of time (Anderson et al., 2018; Matthews et al., 2018). Conceptually, the carbon budget provides a clear and attractive image of the challenge with climate change: that it can be solved by putting a set cap on global emissions and keeping to that cap (Matthews et al., 2020). This conceptual image is illustrated by the local carbon budget for Nyköping in Figure 1 below. However, when discussing carbon budgets, it is important to note that although they are based on robust scientific calculations, they are also the outcome of unavoidable methodological choices and assumptions (Anderson et al., 2020; Matthews et al., 2020). The selection of accounted emissions, the definition of what a 'fair' distribution between different territories is, and the prognosis for future technology are just some choices having to be made when calculating a carbon budget (ibid.).

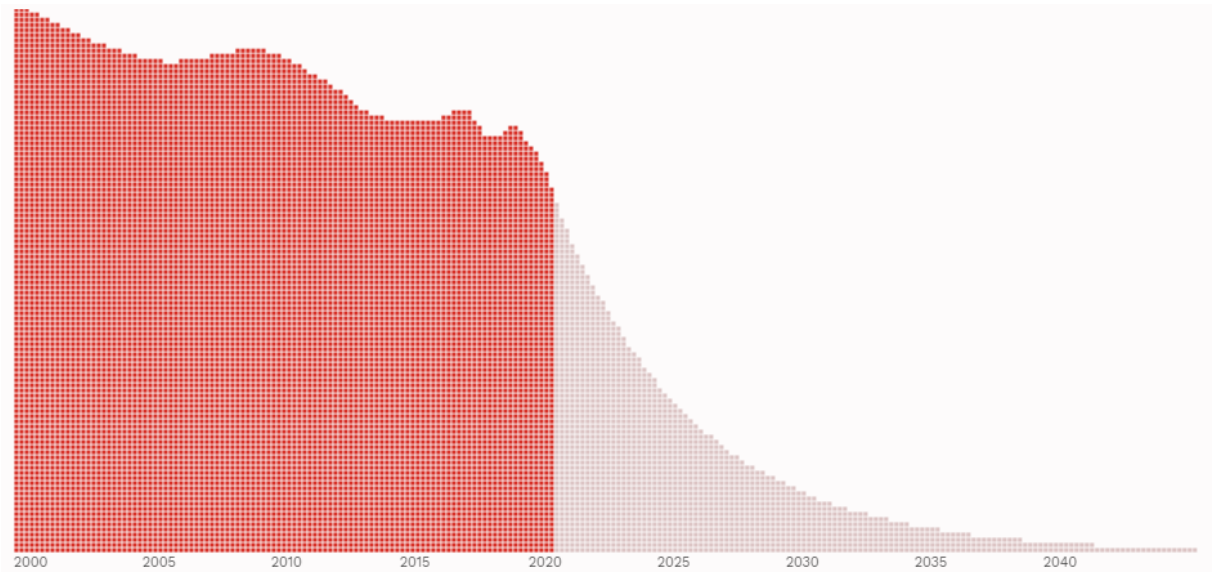

Figure 1: The local carbon budget for Nyköping municipality illustrated by ClimateVisualizer (2021). Every dot represents 576 ton of CO2 emissions

Sweden has a historically rooted reputation of being at the vanguard of sustainability and in the late 1990s sustainable development was stated to be an overarching national goal (Hilding-Rydevik et al., 2011; Lidskog & Elander, 2012). Since then, climate action has risen on the national political agenda and in 2017 Sweden adopted a climate policy framework, with the target to have net-zero emissions in 2045 (Naturvårdsverket, 2020). However, the measures taken to reach the targets have so far been insufficient and the current levels of emission reductions will not be enough to reach net-zero emissions in 2045 (Klimatpolitiska rådet, 2021). Furthermore, the targets in themselves have received critique for being insufficient in reaching the Paris agreement and that current climate governance lacks a science-based framing (Anderson et al., 2020). This latter critique has led to a request for, and development of, climate targets and frameworks that are closely based on climate science, the carbon budget framework being an increasingly prominent one.

In a Swedish context, no ambitions or attempts to develop a national carbon budget have been taken by the state. Instead, the work has been focused on local carbon budgets (LCB), where the Climate Change Leadership node (CCL) at Uppsala University has been frontrunners. In 2017, CCL developed the first local carbon budget in Sweden, targeting Järfälla municipality (Anderson et al., 2017). Since then, the methodology and calculations of the LCB have been developed and refined, with the latest budgets, launched in 2020, being based on the fourth edition (Anderson et al., 2020). CCL and the LCBs of Nyköping and Järfälla are further discussed in section 3.6 of this thesis.

As mentioned above, several methodological choices must be made when calculating a carbon budget. In the LCB by CCL, the carbon emissions included in the budget are limited to emissions based on energy use, which is motivated by the fact that 70% of the global CO_2 emissions arise from energy use (Anderson et al., 2018). Furthermore, the LCB is based on six explicit assumptions: a conservative reading of the Paris Agreement (giving a very optimistic amount of total carbon emissions that can be emitted), that all major emitters reduce their emissions in line with the Paris agreement, no negative emission technologies (NET) are included, no carbon cycle feedbacks (except those in the IPCC models) have been counted, uptakes and emissions from land use and forestry are assumed to compensate one another, and emissions from international transport (aviation, shipping, and military operations) based on bunker statistics have been included in the calculation of Sweden's carbon budgets (Anderson et al., 2018).

Generally, the LBC distributes the global emissions to a national and later local level. In this distribution, different ethical considerations can create very different results. The principle used in the national distribution recognizes a greater responsibility for global carbon emissions in industrialized countries, based on both their capacity to mitigate climate change today (financial, infrastructural, etc.) and their historically larger emissions of GHG. The local distribution of CO_2 emissions is mainly based on the local current share of national emissions, although is adjusted to economic demography and if large industries of national interests are located within the municipal territory. Emissions from international transport are divided on a per capita basis and allocated to the number of inhabitants in each municipality. In total, this creates a mixed approach where territorial emissions make up the basis of the LBC but are complemented with consumption-based emissions from international transport. (Anderson et al., 2018)

1.2 Aim and Research Questions

Building from the notion that climate change requires systemic and transformative change, the aim of this study is to explore if and how local carbon budgets can be a tool for municipal governance in facilitating sustainability transitions. Through an analysis of narratives of change and modes of governing, the aim is pursued by studying how the local carbon budgets developed at CCL approaches a framework for transition, and how these local carbon budgets have been received by municipal planning and policy actors in two case studies. The research questions addressed are:

- What narratives of change are embedded and perceived in relation to the local carbon budgets?
- How does the implementation of a local carbon budget connect to local governance approaches to sustainability transitions?

1.3 Scope and Delimitations

This study is a qualitative case study that explores the nuances and depth of a smaller empirical material. The empirical material was limited to respondents and documents from three contexts: The Climate Change Leadership node, Nyköping municipality, and Järfälla municipality. The scope of this study does not allow for a quantitative evaluation of results from the implementation of the local carbon budgets. Rather, it analyzes what narratives of change and approaches to municipal governance are embedded and perceived in relation to the local carbon budgets.

This study was carried out during the spring of 2021, the second year of the global pandemic Covid-19 that has restricted societies around the world. Naturally, this study has been affected by these restrictions. Social distancing made it necessary to conduct all interviews online, which risks limiting the nuances of the conversation. However, the rapid digitalization also allowed for multiple interviews to be carried out with respondents in other cities across Sweden, something that might have increased the availability of more respondents.

1.4 Thesis structure

Following this introductory chapter, the theoretical framework of the study is presented. This consists of a literature review of two research fields that are combined and make up the theoretical foundation of the study: transition studies and planning and governance studies. Further, the methodological considerations and research methods utilized in the study are presented and discussed, together with an outline of the case study context. Chapter 4 presents the results and analysis of this study. Here, three narratives of change and their related governance approaches are displayed, illustrated by selected quotes from the empirical material. In the Discussion-chapter, the analysis and the theoretical framework are put into dialogue, providing a discussion on how the narratives of change and governance approaches can be understood in relation to the local carbon budget's potential of being a tool for sustainability transitions. Finally, the study is closed with some concluding remarks.

2. APPROACHING AND GOVERNING TRANSITIONS

This chapter presents and discusses the theoretical foundations of this study, which brings together two strands of theoretical understanding, coming from two different fields of research. The first part is influenced by transition studies and encompasses different approaches to change, where a systems perspective and the concept of sustainability transitions are central to this study. The second part is based on planning and governance theory and contributes to an understanding of the Swedish planning context, which is put in relation to sustainable development. Furthermore, research on local governance of climate change is presented.

2.1 Approaching transitions

This study utilizes the concepts of systems perspective and sustainability transitions as two of its main theoretical concepts. Before examining these concepts, some foundations on different approaches to change and sustainability must be discussed. However, covering vast and complex topics, this section should be read as an introductory overview.

2.1.1 Approaches to change and sustainability

There is a historically rooted and ongoing debate about what kind of change is required to tackle contemporary challenges of sustainability and climate change. Opposing viewpoints from diverse fields of knowledge and science, defines the challenges at hand, and potential solutions, differently. In order to position this study within the field of transition studies, it is relevant to briefly consider different perspectives on change before exploring the foundations of transition theory and sustainability transitions.

One central distinction to make is regarding different views on the magnitude and scope of contemporary challenges. The two perspectives can typically be described as either seeing the challenges faced as symptoms of a mismanaged system or as intrinsic faults in systems and structures that require reconfiguration (Hagbert et al., 2020). Varying perspectives then come to different conclusions regarding whether the change needed is focused on incremental reforms and adaptation, or of a radical and transformative kind (Aall et al., 2015; Hopwood et al., 2005; Luederitz et al., 2016). Approaches to change are naturally connected to the perspective on sustainability that underlies them. The range and nuances of different approaches to sustainability is an extensive field in itself, so this section will only provide a brief introduction to some of them. One framework that provides an overview of approaches to change and perceptions of sustainability is provided by Hopwood et al. (2005). The framework (illustrated in Figure 2 below) provides a mapping of approaches to sustainability and change where the Y-axis represents the socio-economic dimension of sustainability, and the X-axis the environmental dimension. The further out on the axes, the more radical and transformative the perspective is seen to be. This creates a diagram that shows three approaches to change in relation to sustainability: *status quo, reform, and transformation*. First, status quo represents a perspective of change that sees that “adjustments can be made without any fundamental changes to society, means of decision making or power relations” (Hopwood et al., 2005, p.42). This approach is also identified as ‘neoliberal technocentric’ (Bailey & Wilson, 2009) or ‘managerial-technocentric' (Audet, 2014) and is characterized by optimism towards the potential for technological innovations to solve sustainability challenges on an open market by the support of economic incentives (Audet, 2014; Bailey & Wilson, 2009; Hopwood et al., 2005). The second approach in the framework, reform, recognizes that the sustainability challenges faced are severe. Those who take on this approach generally argue for large changes in lifestyles as well as policies, and are optimistic that these changes

can be achieved within current economic and social structures. Consequently, they do not see a need for fundamental changes to how social systems are organized (Hopwood et al., 2005). Finally, the transformation approach refers to a radical approach to change where the challenges faced are viewed as "rooted in fundamental features of society today and how humans interrelate and relate with the environment." (Hopwood et al., 2005, p. 45). The transformation approach comes in many forms, for example including those who argue for a 'radical ecocentrism' where bottom-up change based on personal values and sufficiency is emphasized (Audet, 2014; Bailey & Wilson, 2009). The three approaches to sustainability and change illustrate the diversity of perspectives present when exploring this field.

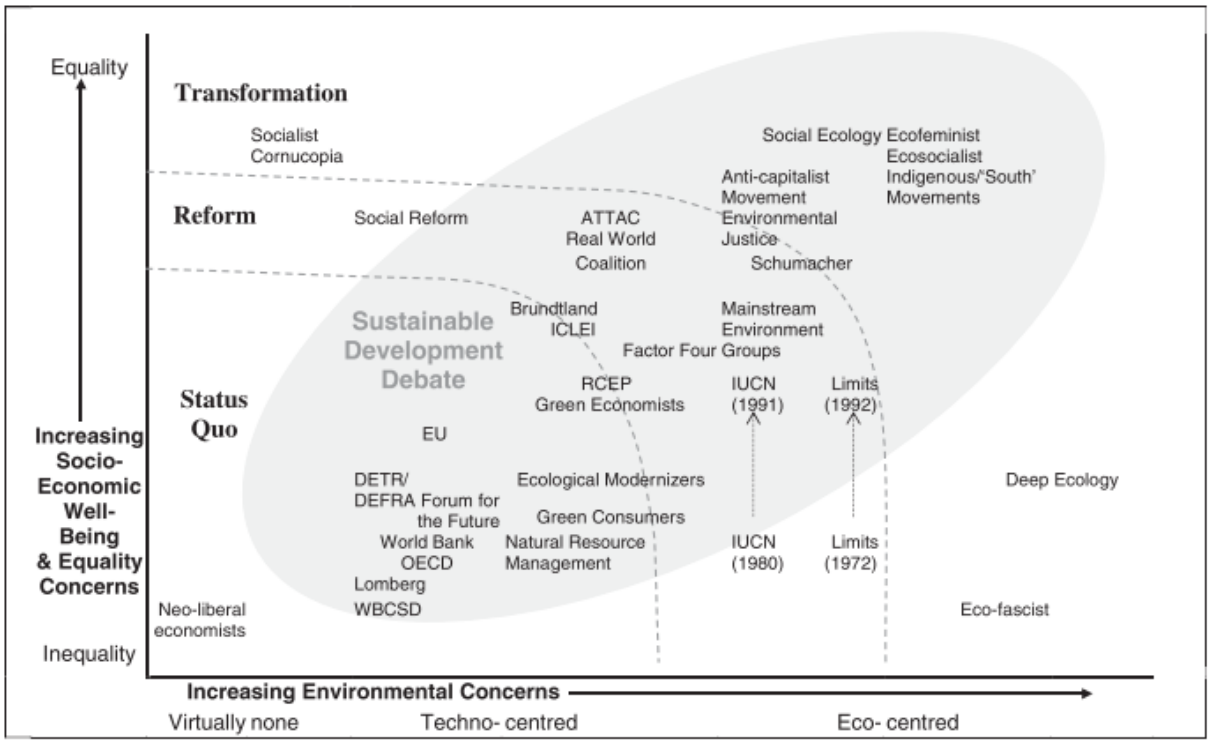

Figure 2: Framework of different approaches to sustainability and change, from Hopwood et al. (2005)

The debate on what change is needed to tackle contemporary sustainability issues naturally relates to the question of *whom* is responsible for creating the kind of change needed. In recent years, critique has been raised towards a too large focus on individual responsibility and action, particularly in relation to climate change. Newell et al. (2015, p. 537) state that "Individuals do not consciously decide to emit carbon. Rather, emissions are associated with the practices and routines of everyday life, from cooking to travelling." Similarly, Shove (2010) argues that climate change policy must go beyond a mode of governance that places responsibility for climate mitigation on individual behaviors and choices. By that, both Newell et al. (2015) and Shove (2010) argue that the responsibility to create a sustainable change does not lie with one single actor or sector, it lies within the interconnected web of structures, norms, institutions, etc. that make up the complex systems we call our world. This perspective, to change the unit of analysis from individual actors to systems, is a foundation of transition theory, which will guide this study. Building from this point of departure, the next section will cover some fundamental aspects of systems thinking and transition studies, setting the stage for a more in-depth exploration of the concept of sustainability transitions below.

2.1.2 Systems thinking and transition studies

One foundation of transition studies is that it recognizes that societies are made up out of complex systems that ought to be understood in order to understand change processes. Consequently, the concepts of systems and systems thinking must be discussed. Systems thinking was popularized by Donella Meadows in the late 1990s and early 2000s, primarily by her influential book "Thinking in Systems" (2009). One argument for applying a systems perspective that is often put forward is that contemporary challenges cannot be managed by a mechanistic way of thinking (Hjorth & Bagheri, 2006). Applying a systems perspective, or systems thinking, is primarily about shifting focus from a linear and mechanic way of understanding the world, to a way of thinking that emphasizes the relationships and interdependencies between different elements of a system (Hjorth & Bagheri, 2006). Put in the simplest way, a system is any collection of different parts that are interrelated and interdependent in some way, and it is these connections that are central to systems thinking (Kim, 1999). A model developed to illustrate how systems can be understood is the Iceberg Model, illustrated by the figure below. In the model, events and patterns are illustrated to be in the top of the iceberg, representing the system dimensions visible in society. The bottom of the iceberg, below the water, entails systemic structures and mental models which are invisible, but that shape the events and patterns (Monat & Gannon, 2015).

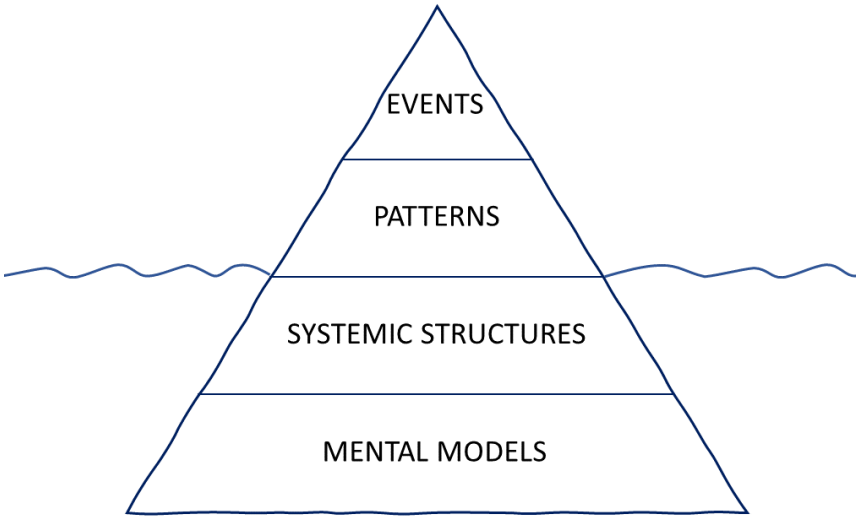

Figure 3: The Iceberg Model showing levels of systems thinking. Authors own, inspired by Monat and Gannon (2015)

During the past decades, different scholarly fields have developed separate understandings and definitions of what kind of systems ought to be explored. First, the fields of ecology and resilience science have developed and applied the concept of *social-ecological systems* (Folke, 2006; Folke et al., 2010). This system understanding puts the interrelations of human societies and ecosystems at its core (ibid.). Second, the field of transition studies has developed *socio-technical systems* as their main unit of analysis (Geels, 2002, 2005; Markard et al., 2012). Socio-technical systems have been defined as consisting of technological and material artifacts, actors at different scales, institutions, markets, infrastructure, as well as user behaviors and cultural meanings (ibid.). Finally, transition studies have in recent years been criticized for ignoring the importance of power dynamics and politics in socio-technical systems as well as in transitions (Avelino et al., 2016; Avelino & Rotmans, 2009). Based on

that, some researchers argue that a shift from understanding systems as socio-technical to instead defining them as *socio-political* is required (Avelino et al., 2016).

Transition studies typically adopts a particular way of understanding system dynamics, namely through the framework of the Multi-level Perspective (MLP). In MLP, any system is understood as consisting of three analytical levels: landscape, regime, and niches (de Haan & Rotmans, 2011; Ernst et al., 2016; Geels, 2005; Isaksson & Heikkinen, 2018). The landscape level refers to structural trends and slowly changing factors that cannot be influenced by actors of the system. The regime level refers to the dominant practices, structures, and actors of a system which typically provides stability and fulfills the functions of the system. Contrasting the regime is the niche level, which is typically referred to as a 'protected space' where more novel ideas and innovations can be developed (Ernst et al., 2016; Isaksson & Heikkinen, 2018). Typically, a transition is understood to be a fundamental change process where all three levels of the MLP are affected (ibid.). Although the MLP contributes with a systematic way of understanding the dynamics of a transition processes, it has been criticized for creating a false dichotomy between the niche and regime level (Avelino et al., 2016), as well as for not considering power relations within and between the levels (Avelino & Rotmans, 2009).

Being a relatively young research field, transition studies is still growing and being debated by different scholars. As a result, several coexisting definitions and understandings of transitions are to be found in the literature. However, several scholars agree that a transition entails fundamental changes to how a system at hand is organized (de Haan & Rotmans, 2011; Ernst et al., 2016; Geels, 2005, 2011; Isaksson & Hagbert, 2020). Markard et al. (2012, p. 956) provide a comprehensive definition stating that "A transition involves far-reaching changes along different dimensions: technological, material, organizational, institutional, political, economic, and socio-cultural." As mentioned above, studies in transitions have traditionally applied a socio-technical system perspective, interested in what and how transitions come about in these settings. Historical studies of socio-technical transition typically explore fundamental changes in water supply, the introduction of sewage systems, and the automobile (Markard et al., 2016). However, this study will heed the criticisms raised against the socio-technical system perspective and aim to apply a socio-political systems perspective. As the context of the study is a local policy and planning setting, the perspective of power dynamics among different actors and the perception in local policy and planning of who is to drive transitions are crucial aspects to consider.

2.1.3 Sustainability transitions

In recent years, transition studies have come to engage more with contemporary challenges of sustainable development, giving rise to the field of sustainability transitions (ST). The concept refers to transitions, as defined in the section above, aiming to solve current sustainability challenges (Geels, 2011; Loorbach et al., 2017). Research in sustainability transitions is normative in that it argues that contemporary sustainability challenges must be understood in relation to large-scale and complex system dynamics. According to Loorbach et al. (2017, p. 600) sustainability transitions can even be seen to "present opportunities for more radical, systemic, and accelerated change." Besides being normative, ST is different from other transitions in that they are less likely to occur naturally in a free market economy, as sustainable innovations serve the 'common good' and therefore do not have user or price benefits. This implies that ST must be more actively governed than other transition processes, emphasizing the relevance of studying the role of local governance actors (Geels, 2011; Markard et al., 2012).

Since sustainable development is a contested concept, this also affects the concept of sustainability transition. Here, it is important to note that sustainability transitions do not come with a set definition of the directionality of sustainability, or what the desired sustainable outcome of the transition should look like (Feola & Jaworska, 2019; Geels, 2011; Hagbert et al., 2020; Luederitz et al., 2016). In their respective studies Feola and Jaworska (2019), Luederitz et al. (2016), and Hagbert et al. (2020), illustrate how different understandings of sustainable development and change can coexist in the concept of sustainability transitions. In their empirical study, Feola and Jaworska (2019), demonstrate how civil society actors stating to work with sustainability transitions, have different views on for example the degree of radical innovation or reform, the role of the state, and how much they showed opposition to capitalism. Similarly, Hagbert et al. (2020) illustrate tensions between different transition narratives regarding economic growth, the potential of future technology, and the scope of change needed. Moreover, Luederitz et al. (2016) identify four archetypes of narratives within sustainability transitions; the green economy, low-carbon transformation, ecotopian solutions, and the transition movement. The four narratives all aim towards sustainability transitions, but what sustainability means and how to get there are understood differently. This diversity of approaches to and narratives of sustainability transitions highlights the importance of studying what ST is and can be in different contexts. This is where this study aims to contribute.

2.2 Local planning and governance of sustainability and climate change

This second section of the theoretical framework presents the Swedish context of policy and planning, which is discussed in relation to sustainable development. Furthermore, a framework of four modes of local governing of climate change is introduced.

2.2.1 Swedish policy and planning for sustainable development

As this study is situated in the context of Swedish municipalities, it is relevant to consider some aspects of the policy and planning environment in which they operate. Sweden has a highly decentralized policy and planning system, and since 1987 the local level of government, the municipalities, has the overall responsibility for planning and land use (Hrelja et al., 2015; Isaksson & Heikkinen, 2018). Furthermore, municipalities have the responsibility for the local road system. In Sweden, this is often referred to as the 'local planning monopoly' which indicates the municipal exclusive right to manage the use of land locally (Hrelja et al., 2015). This mandate is for example put into practice by regularly updated municipal comprehensive plans, where the long-term land-use in the municipal territory shall be specified (ibid.). However, Swedish planning and policy have, as in several other European countries, gone through a process of deregulation in favor of a neoliberal and growth-supportive development (Hrelja et al., 2015). Additionally, studies in a Swedish context have shown that generally weak municipal finances have led to an increased influence from private interests (Isaksson & Heikkinen, 2018). This development has created a shift in the municipal role and suggests that they must to a larger extent rely on collaboration with other actors, often referred to as the shift 'from government to governance' (Fredriksson, 2011, p. 87). Furthermore, the internal organization of the municipalities is complex, and the process of land-use planning involves several different administrative units. Departments responsible for city planning, infrastructure management, business development, and environmental protection are just a selection of municipal units active in land-use planning and development. This creates a process where goal conflicts and tensions around sustainability targets are common, as different departments have different priorities (Isaksson & Heikkinen, 2018).

Sweden is often considered a frontrunner in sustainable development, with a history of strong environmental protection (Lidskog & Elander, 2012). In the late 1990s, sustainable development was introduced as an overarching national goal in Sweden. The concept became closely connected to the social democratic vision of the Green Welfare State, a vision that includes "modernization, innovations, resource-efficiency and resource-saving technologies, new (green) jobs, growth and welfare" (Hilding-Rydevik et al., 2011, p. 173). However, in recent years Swedish sustainability policies and actions have been critiqued for institutionalizing an *eco-modernist* and *post-political* condition of sustainability (Hagbert et al., 2020; Hilding-Rydevik et al., 2011; Lidskog & Elander, 2012). The *eco-modernistic* perspective is critiqued based on its assumption that sustainable development can be achieved by economic growth and on that it portrays the challenge as a potential win-win situation, which obscures power relations as well as fundamental goal conflicts (Hilding-Rydevik et al., 2011; Lidskog & Elander, 2012). Similarly, the *post-political* condition is criticized for depriving sustainability of its political dimensions and thereby obscuring political controversies and conflict by creating a false consensus around what sustainability is and can be (Hilding-Rydevik et al., 2011; Swyngedouw, 2007). Recognizing the influence of eco-modernistic and post-political approaches to sustainability in Sweden is relevant when looking ahead on how governance for climate action and sustainability transitions is framed and carried out.

Local planning and policy, often discussed in the context of urban planning, has become increasingly recognized as a key arena for climate action and sustainability transitions to be developed and implemented (Bulkeley & Kern, 2006; Castán Broto, 2017; Isaksson & Hagbert, 2020; Isaksson & Heikkinen, 2018). Although being influenced by the eco-modernistic discourse at large, as discussed above, some research indicates that there are more 'radical' visions and ideas being developed in Swedish municipalities (Isaksson & Hagbert, 2020). On the other hand, some studies highlight that it is difficult for local governments to initiate and support a more radical sustainability transition in a context that is characterized by decentralization and market-oriented growth (Isaksson & Heikkinen, 2018). However, despite the challenges faced by municipalities, it is clear they have a central role in a decentralized planning and policy context facing major sustainability challenges.

2.2.2 Climate change governance

As illustrated above, the policy and planning landscape has changed during the previous decades, due to changes in ideology, external sustainability challenges, etcetera. This, according to Bulkeley and Kern (2006), calls for a more nuanced way of discussing governance in relation to climate change. In this study, the vast research field of climate change governance will be limited to the local or municipal (from here used interchangeably) level of governance, focusing on a framework originated from Bulkeley and Kern (2006) and refined by Bulkeley & Castán Broto (2011).

The framework of focus contains four municipal modes of governing climate change and has since its origin been developed and expanded into other related fields (see e.g. application to the sharing economy in Palgan et al., 2018 and Zvolska et al., 2019). The four modes of governing are descriptive in their character and were developed based on empirical findings from local climate governance in Germany and the UK (Bulkeley & Kern, 2006). The four modes were identified as *self-governing, provision, regulation, and enabling* (Bulkeley & Castán Broto, 2011; Bulkeley & Kern, 2006).

First, self-governing is an approach with a focus on governance of internal municipal operation, such as management of buildings and services as well as public procurements and 'leading by example'. This approach has shown to be attractive and the most dominating one among municipalities. Its popularity

is assumed to come from its cost-efficiency, that it can provide direct results, and requires little financial or political costs (Bulkeley & Castán Broto, 2011). However, the approach has been critiqued for focusing on an area, emissions stemming solely from the municipal organization, that represents a fairly small share of the total emissions in a municipality (ibid.).

Second, the governance mode of provision refers to the municipal development and delivery of low-carbon services and infrastructure. This mode of governance can have a large impact on decreasing GHG emissions by for example the provision of green energy and development of infrastructure that supports low-carbon mobility. It is dependent on the local government having control or ownership over infrastructure networks, such as energy, water, roads, and the built environment (Bulkeley & Castán Broto, 2011). However, with control over this infrastructure (as is the case in many Swedish municipalities), the impact on GHG emissions has the potential of being far-reaching.

Third, the regulation mode of governing contains for example taxation, demands in land-use planning, and local standards. This approach has been seen to have the potential to achieve effective emission reductions by targeting particularly carbon-intensive practices or technologies. However, it is also shown to be the least popular one among municipal governments, because of the potential opposition by affected actors and because of lack of institutional capacity (Bulkeley & Castán Broto, 2011).

Finally, enabling is an approach focused on supporting other actors to reduce GHG emissions, for example by information, incentives, and partnerships. It comes with low political and economic costs and can increase the legitimacy of local climate action by involving several actors. However, a critical limitation is that the approach is dependent on voluntary actions from other actors, which makes them dependent on collaboration as well as difficult to monitor (Bulkeley & Castán Broto, 2011).

Concluding this discussion on modes of governing, it is important to note that the four approaches often are combined and used side by side by municipalities. Furthermore, there is no single approach or combination of several, that can be seen as the key to success in combating climate change. Instead, the national and local conditions, as well as the actors present, will determine the contextual preferences (Bulkeley & Castán Broto, 2011; Bulkeley & Kern, 2006).

3. METHODOLOGY

This chapter presents and discusses the research design of the study. It provides reasoning around methodological standpoints, choices of methods, and selection of cases and their contexts. The process of gathering as well as analyzing the empirical material is discussed. In the final section, some limitations and ethical considerations are covered.

3.1 Research approach

In this study, the aim is to explore if and how local carbon budgets can be a tool in facilitating local climate transitions. This aim is pursued by exploring what narratives of change and approaches to governance that are embedded and perceived in relation to the LCB. This interest in non-numerical insights, narratives and approaches, thus calls for a qualitative research approach (MacCallum et al., 2019). Furthermore, the research approach of this study is guided by two central elements: a case study approach and narrative analysis. The case study approach guides this study to focus on a smaller setting where nuances and complexities can be fully explored, something that will be further discussed in the section below. Moreover, in this study, I use narrative analysis to understand what stories of change that emerge from the empirical material. The narratives of change are relevant because they say something about what pathways are seen as possible and desirable in combating climate change. The approach of this study is thus grounded in an understanding that how we talk about the world is part of creating the world, inspired by social constructionism (Alvesson & Sköldberg, 2009).

In this study, a combination of primary and secondary empirical data is used, aiming to gain a nuanced and rich understanding of the complex real-life setting of the local carbon budgets. Primary data was gathered through interviews and a participatory observation, complemented by secondary data in the form of documents. The process of gathering and analyzing the empirical material will be described and discussed in the sections below.

3.1.1 Case study

The case study approach is useful to gain in-depth knowledge about a phenomenon in a particular context. What is special about the approach is that it places focus on the complex interactions and relationships between a particular phenomenon and its context. The study is thereby interested in their inseparability; the phenomenon can not be studied outside the context, and vice-versa. Or as defined by MacCallum et al. (2019), a case study is "a study conducted within a particular setting where issues you are interested in can be observed and researched empirically" (p. 44). In this study, the case study approach is suitable as the phenomenon of interest (local carbon budgets as part of local sustainability transitions) must be understood in relation to the context from which they have been developed and later applied (the CCL node and two Swedish municipalities). Following that the case study approach is appropriate for in-depth inquiries, the setting of interest must be limited to allow for a rich material as well as analysis (MacCallum et al., 2019). This motivates the limitation to one developer of LCBs (CCL) and two users, Järfälla and Nyköping municipality. The reasoning behind not limiting the study to a single case was inspired by MacCallum et al. (2019, p. 49) who highlights that studying more than one case can shed light on "how a phenomenon plays out in different contexts", which can "highlight important issues that you might not have otherwise thought of.” Moreover, to obtain the richness of material and allow for the complexity of the case to be uncovered, it is recommended that both primary and secondary data is gathered and analyzed (ibid.). In this study, this is procured by utilizing interviews, participatory observation, and document analysis as methods.

A critique often raised against case studies is the limits to generalization of results from a few or single cases (Flyvbjerg, 2006; MacCallum et al., 2019). The critique is valid in that the purpose of a case study cannot be to make general claims about a population or predictions about the future. However, if done properly, the analysis of the results of a case study should be extended beyond the setting of the study (ibid.). This case study aims to contribute with in-depth knowledge about how LCBs and sustainability transitions play out in particular settings. However, by heeding to the potential of extending the analysis beyond this setting, it intends to say something about what this could imply for the bigger debates around these issues.

At the core of this study lies the case of the local carbon budgets developed by CCL. To understand both the origin of the LCBs and the implementation of them, the context of CCL was complemented with two cases of Swedish municipalities having implemented LCBs. At the time for selection of municipal cases, 21 municipal carbon budgets were identified as developed by CCL. From these 21, two municipalities were chosen for an in-depth inquiry: Nyköping and Järfälla municipality. The two municipalities were selected not with the purpose of comparing them, but with the aim that they together would provide a more nuanced understanding of how LCB are perceived. The context of the cases and the basis for selecting them are discussed further in section 3.6.

3.2 Semi-structured interviews

Semi-structured interviews were selected as the main method for gathering empirical material in this study. The benefits of interviews are that they can be used to obtain perspectives and information from people with special competence in a specific area, in this case local carbon budgets, and thereby generate “rich qualitative data” (MacCallum et al., 2019, p. 149). With this study seeking to explore narratives of change and approaches to governance, the reflections and reasonings of people engaged in the work with local carbon budgets are unique and unlikely to be found in written material. The semi-structured format allowed for flexibility and the possibility to further explore unexpected reflections raised by the respondent, while still focusing the conversation on topics relevant for the study (Brinkman, 2014).

The interviews carried out during this study can be categorized into two categories: developers of the LCB and users of the LCB. Regarding the first category, three interviews were carried out with representatives from CCL and Klimatsekretariatet, an external organization supporting the work with the local carbon budgets. The respondents were identified based on their expertise regarding the LCB and covered insights from the start of the work in 2017 until the ongoing work today. The purpose of the interviews was to explore what ideas of change and sustainability that has guided the work with LCB, as well as reflections on the role of LCB and municipalities in facilitating sustainability transitions. To reach this purpose, I was cautious not to ask my respondents to answer my research questions for me, as highlighted by MacCallum et al. (2019), but to develop an interview guide (see Appendix 1) that allowed them to share reflections on relevant topics.

The second category of interviews was carried out with users of the LCB in the form of representatives from the two case study municipalities of Nyköping and Järfälla. Representatives from the political sphere as well as municipal officials were interviewed to get a better understanding of how the local carbon budget and sustainability transitions are discussed and worked with at different levels. In both municipalities, the respective environmental strategist was initially contacted, being the person responsible for the LCB. From this initial contact, snowball sampling was carried out where the environmental strategists recommended additional municipal officials and politicians with insights into

the local work with the LCB. One of the benefits of snowball sampling is that the internal, and potentially hidden, knowledge networks can be utilized (MacCallum et al., 2019). This turned out to be an important factor in identifying respondents in an administratively complex organization such as Swedish municipalities. In total four respondents from Nyköping municipality and three respondents from Järfälla municipality were interviewed. The purpose of the interviews was to gather insights into how the respondents perceived the LCB and their work with sustainability transitions. Interview guides for both developers and users of the LCB took inspiration from the narratives of change framework developed by Wittmayer et al. (2019). Narratives of change are further explored in section 3.5, and the interview guides are to be found in Appendix 1.

In total ten interviews with developers and users of the LCB were carried out: three developers, four respondents from Nyköping municipality (two officials and two politicians), and three respondents from Järfälla municipality (two officials and one politician). Due to the circumstances of the global pandemic Covid-19, all interviews took place online, using the meeting tool Zoom. The interviews took place between February 24 and April 1 and lasted between 60 and 90 minutes. All interviews were recorded with audio and video, with informed consent from the respondents. The recording allowed for detailed transcription of the interviews, a lengthy but crucial step of the process where the empirical material could be explored more in-depth (MacCallum et al., 2019). Complementing the transcripts, each interview was followed by a direct moment of reflection where I, as suggested by MacCallum et al. (2019), took notes on initial impressions and thoughts sparked during the interview.

Table 1: Interviews conducted in the study

Role	Context	Respondent	Date	Length
Developer	CCL	Researcher 1	February 24	90 min
	Klimatsekretariatet	Practitioner	February 24	60 min
	CCL	Researcher 2	March 1	90 min
User	Nyköping municipality	Environmental coordinator	March 8	90 min
	Nyköping municipality	Politician 1 from the Green Party	March 17	60 min
	Nyköping municipality	Politician 2 from the Green Party	March 17	60 min
	Nyköping municipality	Urban planner	March 26	60 min
	Järfälla municipality	Politician from the Centre Party	March 30	60 min
	Järfälla municipality	Director of urban planning	March 30	60 min
	Järfälla municipality	Environmental strategist	April 1	60 min

3.3 Document analysis

Complementing the interviews, document analysis on municipal policies, carbon budget reports, and webpages were carried out. Document analysis was considered a suitable complement to the interviews, based on that it can provide a broader image of the municipal work that is less dependent on the potential biases of the respondent or the interaction with the interviewer (Grix, 2004). Moreover, texts and documents, particularly in a policy and planning context, say something about what ideas and concepts have been allowed to have an influence by being implemented in official documents (MacCallum et al., 2019). This is of key importance to this study as the influence of the LCB on municipal documents and texts can reveal how the narratives of the LCB have been perceived. Moreover, when conducting a document analysis, it is important to consider why the documents were written, by whom and for what target group (Grix, 2004). All documents in this analysis are written by the actors of focus in the study: developers and users of LCB. By this, the intention is that the documents will contribute with a broader perspective than the ones provided during the interviews.

The purpose of the document analysis was to gain a deeper understanding of what narratives of change and approaches to governance are embedded in and perceived in relation to the local carbon budgets. To meet this purpose, the local carbon budget reports for Nyköping and Järfälla municipality, written by the researchers at CCL, became an evident starting point for the analysis. However, to get a further understanding of how the LCBs have been perceived and implemented, the carbon budget reports themselves had to be complemented with relevant municipal documents and publications. As Nyköping municipality received their LCB in 2020, no municipal policies, plans, or strategies have been influenced by the LCB yet. However, two municipal documents on climate and energy were chosen based on their potential to contribute with insights into how sustainability transitions are approached, unaffected by the LCB. Concerning Järfälla municipality, their Climate and energy plan was updated after receiving their LCB, making that a key document to analyze. As the Climate and energy plan is based on the Environmental plan, that was chosen as a compliment in the analysis. For both municipalities, one webpage where they describe their work with climate and sustainability issues was chosen. All documents covered in the analysis is presented in the table below. The documents were analyzed using the method of analysis which will be presented in section 3.5.

Table 2: Document selected for the document analysis

Muni.	Type	Authors	Title
Nyköping	Local carbon budget Nyköping	Anderson, et al. (2020)	*Koldioxidbudget Nyköpings kommun 2020-2040: Del 1*.
	Climate and energy strategy	Nyköpings kommun (2016)	*Klimat- och energistrategi 2016-2020.*
	Action plan for energy and climate	Nyköpings kommun (2017)	*Handlingsplan med åtgärder för klimat - och energiarbetet under 2018.*
	Webpage on LCB	Nyköpings kommun (2021)	*Koldioxidbudget för Nyköping*

Järfälla	Local carbon budget Järfälla	Anderson, et al. (2017)	*Koldioxidbudget och vägar till en fossilfri framtid för Järfälla kommun*.
	Climate and energy plan	Järfälla kommun (2019)	*Klimat- och energiplan för Järfälla kommun och dess bolag 2020-2024.*
	Environmental plan	Järfälla kommun (2016)	*Miljöplan 2016-2024 för Järfälla kommun med bolag.*
	Webpage on environmental work	Järfälla kommun (2021)	*Järfällas Miljöarbete*

3.4 Participatory observation

Supplementing the interviews and document analysis, a participatory observation was carried out during a workshop organized by CCL. The workshop covered measures for the rapid decrease of carbon emissions in line with local carbon budgets. Participatory observation is a flexible research approach that can provide a rich understanding of behaviors and reasonings around an issue of interest (MacCallum et al., 2019). The method is often combined with interviews and documents, as in this study (ibid.). The workshop where the participatory observation was conducted was held online. A setting that naturally limited the possibility to obtain insights into body language, social relations, and other non-verbal forms of communication and expression. However, the online format allowed for audio and video recording of the full workshop, providing rigorous records from the observation which, according to MacCallum et al. (2019), are crucial. Ethical considerations in terms of voluntary participation of observations are usually a difficult matter (ibid.), something that was managed by written and oral information about my study, as well as informed consent from all participants.

The workshop took place on March 3rd and lasted for three hours. Seven participants from Swedish municipalities and regions attended to explore and discuss strategies to decrease local carbon emissions in line with the rate suggested in the LCB. Neither Nyköping nor Järfälla municipality attended the workshop, which contributed with additional insights from other contexts to this study. The participants who attended represented both municipalities with and currently without a local carbon budget. This made the observation particularly interesting as it exposed how the LCB is perceived by actors who do not have their own and thereby can be a bit more critical. Additionally, the purpose of the observation was to gain further insights into how the LCB is understood and discussed between the developers (CCL) and the users (municipalities and regions, in this case). By participating in the conversation without steering or prompting with my own questions, as in the interviews, additional arguments and reflections around both sustainability transitions and the role of municipal governance became visible.

3.5 Method of analysis

In order to gain deeper knowledge about what understandings, or narratives, of change that are embedded in the carbon budgets and their implementation in municipalities, this study uses a method of analysis that combines two frameworks. The analysis is based on the narratives of change framework, inspired by Wittmayer et al. (2019), as well as four modes of municipal climate change governing, inspired by Bulkeley and Kern (2006).

3.5.1 Narratives of change

As defined by Wittmayer et al. (2019), the analysis of narratives of change refers to the understanding of "sets of ideas, concepts, metaphors, discourses or story-lines about societal transformation" (p. 2). Thereby, narratives of change represent ideas of what a desirable future is, who is to create it, and by what means. The importance of studying narratives of change is clearly argued for by Luederitz et al. (2016, p. 394) stating that "narratives are not merely stories, but they function as justification for particular interventions, essentially creating pathways of change." Hence, studying what narratives of change that are present in a particular context can illustrate what potential actions, strategies, or choices that are seen as achievable and desirable.

Narratives of change are based in narrative research which contains a great diversity of approaches, spanning from understanding life-stories of individuals to narratives of social movements (Andrews et al., 2013; Squire et al., 2014; Wittmayer et al., 2019). Often, narratives are derived from a broad source of material, spanning from spoken narratives in interviews, written narratives in texts, and visual narratives in films and videos (Squire et al., 2014). It requires careful reading of the material and is therefore not suited for large quantities of data (MacCallum et al., 2019). The diversity and richness of the approach makes it interconnected with other types of qualitative research, but there are some important distinctions to make. First, narrative research is different from qualitative content analysis in general in that it is interested in themes that are created through stories, not themes that can be picked out from a story (Squire et al., 2014). Second, narrative research does not generally provide any starting or finishing point, or any given categories by which to focus the analysis (Andrews et al., 2013). According to Squire et al. (2014), most narrative researchers would say that they use an inductive approach where they "aim to start from and to be respectful of their data" (p. 13). However, there are cases of more deductive or abductive approaches where definitions of what narratives consist of support the analysis of them (ibid.). In this study, the method of analyzing narratives of change will be utilized through an abductive approach. This approach was chosen because of its potential of combining insights from both the empirical and theoretical material in a nuanced and reflexive way. Here, the framework of narrative components, as well as theories and concepts around societal and system change will be used in dialogue with the material, which will make up the analysis of what stories of change that can be identified.

Narratives of change are studied based on the *rationale, relevant actors*, and *plot* of the narratives at hand (Wittmayer et al., 2019), illustrated by Figure 4. First, the rationale of the narrative consists of the understanding of why the world needs to change: what the problem and desired future is. Second, the relevant actors refer to actors working towards as well as against the desired future. And third, the plot represents ideas about how the desired future is achieved, by contextualized activities and developments (ibid.). Together, the three components aim at revealing the narrative content: what or who needs to change?, why?, and how?

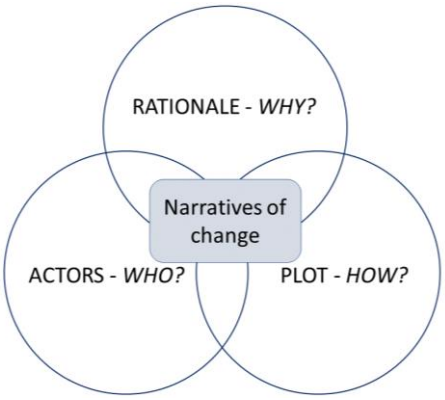

Figure 4: Components of analyzing narratives of change, inspired by Wittmayer et al. (2019), author's own

3.5.2 Four modes of governing

The method of analysis in this thesis combines the narratives of change with the perspective of four modes of municipal climate change governing. This creates a combined method of analysis which is illustrated by Figure 5 below.

As discussed in chapter 2, the policy and planning landscape has changed during the previous decades. This, according to Bulkeley and Kern (2006), calls for a more nuanced way of discussing governance in relation to climate change. In this study, the four modes of climate change governing discussed in section 2.2.2 (self-governing, provision, regulation, and enabling) will be used to understand what type of governance processes the carbon budgets inspire and get integrated in. The ambition is that the four modes of governing will enrich the analysis of actors and plot in the narratives of change framework. By understanding different approaches to the role of the municipality in relation to other stakeholders and governance tools, the responsibility and actions for change can be better tied to the socio-political landscape of planning and policy.

In this study, the four modes of governing will inform the narratives of change and create one method of analysis to more thoroughly display what narratives of change and governance that the carbon budgets carry and give rise to in the municipalities. By extension, understanding how the narratives of change and governance play out in particular settings will contribute to knowledge about what pathways that are seen as possible and desirable in working towards sustainability transitions. The analysis uses the empirical material gathered through the interviews, document analysis and participatory observation described in earlier sections. The narratives of the local carbon budgets will be studied both from the perspective of their origin (CCL), and from the local understanding and contextualization of the carbon budgets in the municipalities. This will, I argue, contribute to the understanding of the carbon budgets' potential contribution to sustainability transitions in municipalities.

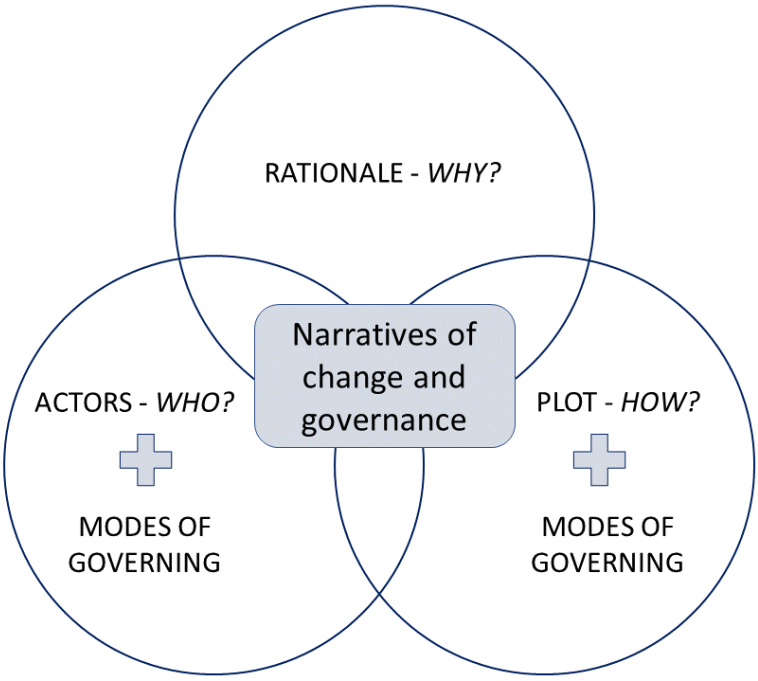

Figure 5: The method of analysis combining narratives of change and modes of governing, inspired by Wittmayer et al. (2019) and Bulkeley & Kern (2006), author's own

3.6 Case study context

The selection of cases for this study was guided by the local carbon budgets developed at the Climate Change Leadership node (CCL) at Uppsala university. It should be noted that other local carbon budgets have been, and are, developed in Sweden, mainly by local governmental actors themselves. However, CCL was selected for this study as they were pioneers in developing the first LCB in Sweden and thereby could be assumed to have significant experiences of this novel concept. Furthermore, they are one of the major external actors developing carbon budgets for Swedish municipalities and county administrative boards. CCL is a research node at Uppsala university located at the Department of Earth Sciences (Climate Change Leadership Blog, 2021). It was initiated in 2015, evolving from the 'Zennström Professorship in Climate Change Leadership', a visiting professorship co-funded by donations from Zennström Philanthropies. In 2021, CCL is visited by their fourth guest professor and over the years they have been engaged in research on rapid societal transformation, the role of education and academia in climate change, and climate justice. The second visiting Zennström professor was Kevin Anderson, a leading climate scientist who has conducted prominent research on carbon budgets. The work of Anderson laid the foundation of the local carbon budgets developed at CCL (ibid.).

The first local carbon budget to be developed by CCL was for Järfälla municipality in 2017. According to one of the researchers interviewed in this study, the process to calculate local carbon budgets was initiated by a municipal official from Järfälla contacting the team of researchers, based on a decision by the municipal council. Since 2017, the framework and calculations of LCBs have been developed and the LCB for Nyköping, published in 2020, is the fourth generation of local carbon budgets calculated by CCL. The calculations of the LCBs align with the type of carbon budget calculations presented in section 1.1. However, some elements are worth pointing out. The LCBs apply an accumulative perspective on carbon emissions and allocate them annually on a municipal level, with the target to reach the ambitions set by the Paris Agreement (UNFCCC, 2016). Today, the emissions that are accounted for in the LCB are all energy-related carbon emissions within the municipal territory, the municipal share of Swedish emissions from foreign shipping that refuel in Sweden, and the municipal share of Swedish emissions from foreign flights (Anderson et al., 2020).

For the two municipalities chosen for this study, their carbon budgets were developed at different points in time, providing them with slightly different results. According to the LCB for Järfälla municipality, the local carbon emissions must decrease by 10-15% annually (Anderson et al., 2017). However, for Nyköping the municipality's yearly carbon budget was set to a decrease of 16% of the local carbon emission, starting January 2020 (Anderson et al., 2020). Because this level of emission reduction was not met, the yearly emissions must now, in spring 2021, decrease by 19% annually (Nyköpings kommun, 2021). Furthermore, Nyköping was the first municipality to adopt a digital version of their carbon budget, allowing for yearly updates of the calculations and supporting easier communication with external actors according to the Environmental strategist. Regarding the largest sources of carbon emissions in the municipalities, the situation is rather similar in the two cases with transport (mainly private cars) and construction work being the two most carbon-intense sectors (Anderson et al., 2017, 2020).

Considering the local context of the two municipalities, they are representing somewhat different characteristics to this study. Järfälla has a larger number of inhabitants and is a more urbanized municipality with around 81 000 inhabitants and 34% of its land being occupied with settlements (SCB,

2020). Furthermore, Järfälla is part of the Stockholm Region and is identified as an important development node, a 'regional city center' in the regional development plan (Region Stockholm, 2018). This entails, among other things, that the municipality is an important location for regional growth and that it is subject to large infrastructure developments, such as a new metro station (Järfälla kommun, 2014). Nyköping on the other hand is a smaller municipality with 57 000 inhabitants (SCB, 2020). Although 84% of the citizens live in urban areas, the municipal land is rather rural. Only 5,2% of the municipal land is occupied with settlements, 64,1% is covered by forest and 23,3% is used for agriculture (ibid.). Both municipalities are located in the larger Stockholm area, with their geographical location being illustrated by the figure below.

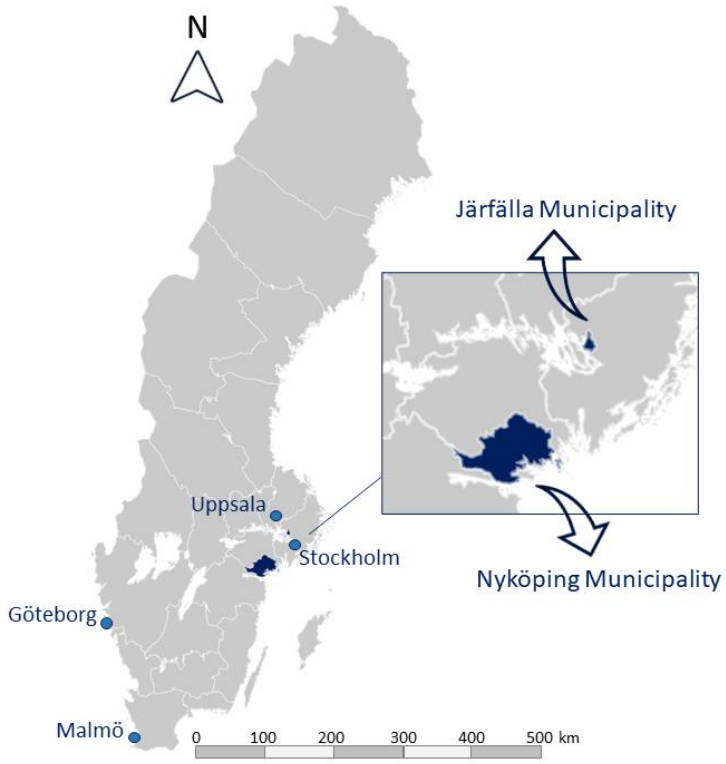

Figure 6: Map of Sweden showing the location of Järfälla and Nyköping municipality, authors own

3.7 Methodological limitations and ethical considerations

Being a qualitative case study that aims to explore the nuances and depth of smaller empirical material, the limitations of this study largely stem from the selection of methods and empirical context. First, qualitative methods of interviews, document analysis, and participatory observation come with the risks of lack of objectivity and limited capacity to make general claims about a larger population of phenomenon (MacCallum et al., 2019). However, this was attended to by a rigorous and structured analysis process which allows for more general conclusions to be drawn from the empirical material. Second, the selection of municipalities was limited to two municipalities in the larger Stockholm region. This is a potential limitation as more peripheral municipalities in Sweden might have other preconditions relevant to the study. However, as this study focuses less on the municipal context, and more on the narratives of the local carbon budgets, the municipal characteristics were seen as less decisive. Thirdly, one limitation of the empirical material is that solely internal municipal planning and policy actors were interviewed from the municipal context. In today's complex landscape of local governance, corporations and civil society organizations are important actors whose perspectives

could have enriched the study further. However, due to limitations in time and scope of this study, such explorations are left for future research. One final methodological limitation concerns the document analysis where updated climate policy documents for Nyköping municipality were difficult to find, as the municipality is in the process of revising them. This was to some extent attended to by using recently updated webpages and online communication from Nyköping municipality.

Regarding the ethical considerations of this study, they mainly relate to the empirical material gathered through human interactions. During both interviews and the participatory observation, informed consent was ensured with all participants. As recommended by MacCallum et al. (2019), information about the research project was shared both written and orally with participants before asking for their consent. Moreover, all quotes were shared with and approved by the participant before being used in this thesis. Throughout the thesis, all respondents are referred to by their professional title. This was agreed upon by all participants and put in place to establish a basic level of confidentiality. In a smaller context, such as the cases in this study, this level of anonymity is not full, and some respondents might be possible to distinguish by people familiar with the contexts. However, as no personal or sensitive issues were experienced as being covered during the interviews, the benefits of being able to connect the quotes to the professional role were seen as superior.

4. THREE EMERGING NARRATIVES OF CHANGE AND GOVERNANCE

In this chapter, the results and analysis are presented, consisting of three emerging narratives of change and governance: *Tweak the system, Re-invent the system,* and *Shake the system.* The narratives emerged from the empirical material, when being analyzed through the method of analysis based on narratives of change (Wittmayer et al., 2019) and four modes of governing (Bulkeley & Kern, 2006). The narratives were formed by identifying different ideas about why change is needed (the narrative rationale), how that change can come about (the narrative plot), who should drive that change (relevant actors), and what the role of the municipality and desired governing approaches are in relation to this.

It is important to note that no respondent or source alone is expressing or representing one single narrative. Rather, the narratives are intertwined and dispersed across the different sources: respondents and documents alike. With this analysis, the aim is to showcase the different narratives of change and governance that are embedded and perceived in relation to the carbon budgets.

4.1 Tweak the system

In the 'Tweak the system'-narrative, the rationale, why change is necessary, is based on an understanding of the climate change issue as being caused by a lack of science and fact-based knowledge around the issue. Considering the central actors in this narrative, the focus is on the municipality itself and its internal operation, leaning towards a self-governance approach. The lack of municipal authority over local climate emissions, as well as lack of resources, brings a situation where the municipality should focus its actions on its internal operation and self-governance. One central aspect of self-government in this narrative is to revise municipal targets and policies for climate mitigation, a process where the LCB is seen as important support. The plot, how change should come about, is mainly concerned with altering current practices by integrating environmental and sustainability dimensions more strongly. According to this narrative, the LCB complements the current climate government in the municipality and contributes with concrete and measurable facts, which makes the challenge less fuzzy and abstract. The narrative contains a central discussion of the importance of monitoring and measuring progress and emissions, a discussion where the respondents have different views. Finally, the role of the municipality is to some extent seen as including elements of providing services and infrastructure, such as bicycle routes, as well as elements of enabling change through informing its citizens.

4.1.1 The lack of science and fact-based knowledge

In this narrative, the climate change challenge is to a large extent understood to be a challenge based on a lack of science and fact-based actions and governance. This was put forward by one of the practitioners behind the LCBs who stated that current climate politics are not based on the scientific knowledge available and that the carbon budgets aim at being a counterpoint to this. Furthermore, respondents from both Nyköping and Järfälla municipalities echoed this notion and pointed out that climate mitigation requires concrete numbers and facts. Several of them experienced that their local climate governance is, or has been, lacking in this area, but that the LCB provides them with concrete facts about the climate change challenge. "We have it in black and white" as put by the Environmental strategist in Järfälla when describing what the LCB has contributed to in their work. Moreover, the LCB was described to contribute with 'neutral' and science-based knowledge by both researchers and officials, which makes the climate challenge less fuzzy and abstract. This was pointed out by the Director of Urban Planning in Järfälla who described it as a knowledge foundation to build on:

> Mostly as a knowledge-base and something to stick to, to say 'this is it'. It is not opinion or ambition or goal, but if you do this, you get this and that effect. As a kind of foundation, an overview plan almost, you have it as a kind of basic map for all development. *(*Director of Urban Planning, Järfälla)

However, the value of receiving calculations of the local carbon emissions was experienced as differently valuable by different respondents. One respondent described it as being an eyeopener, both for her and the local politicians. Contrasting this, the urban planner in Nyköping expressed that although the LCB makes the challenge more concrete, it was not news to him or his colleagues, stating that "we have known about those numbers and that transport is the biggest challenge, it's not strange."

4.1.2 Municipal limitations and self-governance

In the Tweak-narrative, the limitations that municipalities face in terms of limited authority over local carbon emissions, as well as lack of resources, were highlighted. Regarding limited authority, one of the practitioners behind the LCBs pointed out that "the authority that the municipality itself has covers 10% of the emission reductions, or maybe 20% in some cases". This was also highlighted during the participatory observation, where one of the workshop participants asked how the municipalities present could have adopted a carbon budget when they do not have full mandate or control over the emissions included. Regarding lack of resources, both politicians and officials from Nyköping municipality highlighted that they lack resources in terms of financial capital and staff. In relation to this, they expressed a concern that investments for sustainability must compete with other tasks of the municipality. As put by the Environmental strategist at Nyköping:

> We currently have a [required] reduction rate of 19% annually [in the LCB]. So it is clear that we will need quite sharp emission reduction measures linked to this. Then it is.. I can say what I think, but then it is the political balance linked to it, for example, elderly care, preschools, unemployment. So, I have a very hard time saying how we will get a handle on this. (Environmental strategist, Nyköping)

In this narrative, reducing climate emissions from the internal operations of the municipality is central. This is argued for on the grounds of cost-efficiency and on being the area in which the municipality has the greatest authority. "It may be that what we are already doing, we have to think about how we can do it in a more sustainable way. Rather than us showering money on emission-reduction innovations.", the Environmental strategist in Nyköping said when reasoning around the financial limitations faced by the municipality.

When considering how the municipality can work with its internal operation, respondents from both municipalities highlighted the need to truly integrate the environmental or climate perspective into current operations and that it cannot "lie as a parallel thing on the side as it may have done before" (Environmental strategist, Nyköping). In reasoning around this, several elements of self-government were mentioned by different respondents, such as being a role model, engaging its employees, and increasing environmental demands through public procurements. This was for example mentioned by one politician in Nyköping who reasoned around the potential of working with the municipal employees:

> We have also talked about that you could use the employees as a policy carrier. If you could put in the heart of as many as possible of the 4,000 employees that in Nyköping we are environmentally friendly. (Politician 1 The Green Party, Nyköping)

Furthermore, the Climate and Environment Plan for Järfälla municipality illustrated a focus on self-government by having a larger number of, and sharper formulated, targets for the internal municipal operation than for other sectors in the municipality. For example, in the sections on energy supply and energy demand where all targets are directed towards the municipal organization (Järfälla kommun, 2019). The Climate and Environment Plan in Järfälla is one example of a policy where the outcomes of the LCB have been integrated. Policies, strategies, and plans are one element of self-government that was commonly brought up in the material of this study. It is covered in greater depth below.

4.1.3 The carbon budget contributing to municipal targets and policies

When reflecting on the plot of how the carbon budget has, or will, affect the municipal work with climate mitigation, several respondents and documents highlighted the need for stronger climate targets and policies. As Järfälla has had their LCB since 2017, the municipality could revise and update policies based on the information presented. The Environmental strategist in Järfälla highlighted that key environmental plans and policies have been influenced by the LCB:

> It [the LCB] is the basis for everything we do. We have municipal-wide control documents, the environmental plan, and the climate and energy plan, where the goals are based on what has emerged in the carbon budget. So, it has been a very good study of the situation and what we must do to contribute to the two-degree goal of the Paris Agreement. (Environmental strategist, Järfälla)

Considering the LCB itself and related municipal policies in Järfälla, there are several connections to be made. The carbon budget report states that it is "intended to serve as a basis for the energy and climate plan" (Anderson et al., 2017), and the level of emission reduction stated in the LCB is referred to in the section 'Emissions within the municipal territorial border' within the Climate and energy plan (Järfälla kommun, 2019). However, that section does not contain any formulated targets. Throughout the plan, no targets are formulated in line with the rhetoric of the LCB (i.e. % emission reduction/year), instead, the targets are following the Swedish standard of stating % emission reduction until a set year, e.g. 2025, 2030, 2050 (ibid.).

In the case of Nyköping, the municipality is in the process of revising the environmental policies, with the support of the LCB they received in 2020. The Environmental strategist working with the revision stated that the LCB will "really set the tone for how we formulate it and the goals we will develop, measures, etc.". However, as the revising process is ongoing, there are no documents available where the impact of the LCB can be studied.

In addition to policies and targets, several respondents highlighted the need for monitoring, measuring, and keeping track of development over time as an important aspect of improving local climate mitigation. Officials from both Järfälla and Nyköping stated that there is a need for indicators and monitoring of targets and visions for change to happen. Additionally, one of the researchers behind the LCB states that the LCBs inherently require data and measuring in order to function:

> Built into the mindset is a very scientific approach, it is about finding numbers on what to achieve, and it also suggests that then we must monitor it and then we have to measure, measure, measure. Then we have to invest money and resources to get better at measuring. (Researcher 2, CCL)

The focus on measuring and targets is also seen in the LCBs themselves, where the LCB for Nyköping states that one part of the purpose of the LCB is to find relevant statistic measurements and calculate target levels (Anderson et al., 2020). Moreover, the Climate and energy plan for Järfälla highlights that relevant indicators will be used to track the progress on a yearly basis (Järfälla kommun, 2019).

However, the focus on monitoring and measuring was critiqued by both researchers and municipal respondents who highlighted that there are risks associated with placing too large focus on measuring. One of the researchers behind the LCB stated that “It is always the case that you have to be careful when you measure something, then you focus on one thing and maybe you miss something else” (Researcher 1, CCL), pointing to the risk of missing out on aspects of sustainability that are not easily measured. Another point of critique came from one of the politicians in Nyköping who reasoned around what conclusions one can draw from these measurements. And finally, respondents brought up the risk that an excessive focus on measuring can risk hindering action. This is illustrated below by the politician in Järfälla arguing that the solution does not lie in increased measuring:

> Measure, measure, measure all the time, that's not it! I think the change in a sustainable direction where we must reduce our emissions, where we must live in a way that does not burden the environment and the climate, I think that is the big picture that will affect the whole thing. (Politician The Centre Party, Järfälla)

As discussed above, examples from respondents as well as documents illustrate this narrative’s focus on self-governance. However, the impact of working with changing the internal operation was problematized by one politician in Nyköping, who stated that "I do not think that the municipal organization is, nor will prove to be, the big problem to get to work with what is left, but it is the rest! The whole municipality, companies, citizens." (Politician 1 The Green Party, Nyköping) This illustrates a notion that other modes of governing are needed as a complement to self-government, discussed in the final section of this narrative below.

4.1.4 The municipality as enabler and provider of services

Besides an emphasis on self-governance, the Tweak-narrative contains an understanding of the municipal role as being a provider of services and infrastructure for low carbon actions. The reasoning is that current services and infrastructure can be more sustainable, or that sustainable and already existing forms of infrastructure should be supported. Here, supporting bicycling, walking, and public transport were the most common examples mentioned. This was for example mentioned by the Environmental strategist in Järfälla who stated that:

> The municipality has an important role in planning our land in the municipality in a way that promotes sustainable modes of travel. We have invested a lot in our cycle paths in the municipality, to developed a good bicycle network. (Environmental strategist, Järfälla)

Complementing the role as a provider, this narrative contains a view on the municipality as an enabler and communicator for sustainability. The view of the citizen is displayed as a person that the municipality should inform, educate, engage, and inspire to live more sustainably. One example of this comes from one of the politicians in Nyköping who expressed that the citizens often demand more information from the municipality and that the municipality should meet that request:

> Nyköping municipality should be the big sibling who tells us, informs us about what is happening. I think there is a great demand for information ‘Tell us how we can help’. Information in a society needs to come in many different ways, written, oral, all sorts of information channels to be able to reach people who may want to, but cannot or do not understand how to do. (Politician 2 The Green Party, Nyköping)

Additionally, both municipalities have webpages where they inform and encourage citizens to take environmental responsibility and to decrease their carbon emissions. The webpages provide links to

online tests where citizens can measure their environmental impact and provide links to further readings and recommendations on how to live a more sustainable lifestyle (Järfälla kommun, 2021; Nyköpings kommun, 2021).

4.2 Re-invent the system

In this second narrative of change, the reasoning behind why change is needed (the rationale) is that climate change is tightly related to larger issues of sustainability. This is expressed through a focus on the interconnectedness between different aspects of sustainability, as well as a perspective on climate change that goes beyond the framing of the carbon budget. The plot and actors of this narrative is characterized by a focus on collaboration between multiple actors, where the governance approach should be influenced by that of being an enabler. Furthermore, a need for unknown and new ways of working and acting is identified. The actions proposed are systemic, multifunctional, innovational as well as based on technological advancements and behavioral change. Moreover, this narrative acknowledges citizens and civil society as important actors for change.

4.2.1 Sustainability is larger than climate change

In the Re-invent-narrative, the problem definition goes beyond a narrow understanding of climate change and acknowledges how different areas of sustainability are interrelated. This is shown in how the Environmental strategist in Nyköping argue for a more holistic approach to climate change, where the interconnectedness of different processes is recognized.

> I think about climate, biodiversity, water - everything is connected, the carbon cycle, and what happens in the different areas affect each other. There is a lot we need to adjust to make it sustainable. /…/ I would like people to take a holistic approach to these issues and understand how it is connected. (Environmental strategist, Nyköping)

Furthermore, this narrative acknowledges that the climate challenge spans beyond the carbon budget framing and includes consumption-based carbon emissions as well as the role of green areas. In both Järfälla and Nyköping, there are examples of an understanding of climate change that goes beyond the territorial emissions calculated in the carbon budgets. Both respondents and documents highlighted that consumption-based emissions are part of the challenge and must be included. The Järfälla Climate and energy plan (Järfälla kommun, 2019) as well as the Nyköping webpage connected to the carbon budget (Nyköpings kommun, 2021) highlight that carbon emissions based outside the municipality must be accounted for. The same notion was expressed by the urban planner in Nyköping who stated that consumption is the second largest challenge faced by the municipality, or in his own words "Consumption is an important part, besides transport, it is consumption. And that is where the next challenge is, how we consume, how we use what we own."

Another related example of a widened scope of climate change is the notion of protection and development of green areas, which was mentioned by officials in both municipalities. The Director of urban planning in Järfälla expressed that thinking about developing green structures to create carbon sinks is a new way of thinking that has emerged in the municipality in the previous years.

4.2.2 Need for systemic and technological change

The plot of the Re-invent-narrative, how change should come about, stresses the need for systemic and technological transitions that require new ways of working as well as innovations. Some respondents expressed that the magnitude of the challenges faced requires solutions that are unprecedented and currently unknown. Others experienced that the way the municipality is currently

working with sustainability must be reconsidered. This was for example highlighted by the urban planner in Nyköping who reasoned around the challenges of urban planning traditionally being based on a prognosis for the future, a mode of working that is not compatible with reaching sustainability ambitions. Moreover, this relates to a challenge faced by both municipalities, that they are growing but must do so in a sustainable way. In this narrative, sustainable growth is seen as a challenge that requires innovative solutions and new ways of working:

> We will do as a, now it will be a lot of clichés, but like a bumblebee, we will make this fly. To work as we have done and take care of such great growth, it is not possible to make it sustainable. But we need to work in new ways if we are to think about calling ourselves sustainable at all. Many think that it is not possible, that this with sustainable growth is just empty words and contradictory. But it is our challenge to find a way to make growth sustainable. (Director of Urban Planning, Järfälla)

The idea of systemic change in this narrative is illustrated by respondents expressing examples of solutions that go beyond traditional ways of local climate mitigation and that cover multiple levels of society. Examples of this narrative were commonly expressed concerning transport and mobility, the area where both municipalities today have their largest climate emissions. Officials from both municipalities expressed that they work with mobility from a holistic perspective where they, in the case of Nyköping for example, explore the potential for mobility services and multifunctional mobility hubs when developing new city district. Besides transport and mobility, measures to reduce or change consumption patterns are additional examples of a systemic view on climate mitigation and sustainability. Concerning this, actions to support the sharing economy were highlighted both during interviews with officials in both municipalities, as well as on Järfälla's webpage on their sustainability work (Järfälla kommun, 2021).

Furthermore, this narrative contains an understanding that technological advancements will be an important tool in combating the sustainability challenges faced. This is illustrated by the fact that technological developments and devices often were mentioned as a natural part of the new, holistic, or systemic solutions proposed. One example connected to the reasoning around the sharing economy above was provided by the Director of urban planning in Järfälla who described how digital applications can support the development of the sharing economy in the development of their new city-district Barkabystaden. Moreover, a generally optimistic view towards technological advancements was expressed by respondents from both Järfälla and Nyköping municipality. However, the Environmental strategist in Järfälla highlighted that there is already a lot of existing technology, but what is lacking is the implementation of it. She emphasized that dialogue and collaboration are necessary for implementation of new technology, which will be discussed further in the section below.

4.2.3 Widening the role of the municipality by increased collaboration and bottom-up change

Similar to the Tweak-narrative, the Re-invent-narrative realizes the lack of municipal authority over the local carbon emissions. However, the implication of this realization is rather different: although the municipality lacks authority over its carbon emissions, in this narrative, it seeks collaboration with other actors. This view was expressed in documents as well as by respondents from municipalities and researchers. The practitioner behind the LCB summarized it clearly by stating that the municipality must realize "'okay, we have almost no power over this!' This is really a situation to quickly put in place collaboration with business, civil society, create a climate council, a budget association in the

municipality, etc. Whatever, start spreading this!". He continued his reasoning by stating that the municipality must coordinate this required collaboration because they have the political mandate to do so.

This new role of being a coordinator, facilitator, and enabler of collaboration was discussed by, and familiar to, several respondents who argued for it being a new role that the municipality should take on. Moreover, they highlighted that collaboration must be voluntary and that the role of the municipality should be to enable other actors to engage. The politician in Järfälla stated that the municipality should coordinate the work and thereby be a leader in the local climate mitigation:

> Our role is more to coordinate; the whole society should be involved. To coordinate and set up 'this is our goal', as a leader in an organization or geographical area we have to show what we want and how to get there, then we have it clear, 'this is what we want', do you want to be involved? How can you contribute? How can we work together? (Politician The Center Party, Järfälla)

However, the municipal role in collaborations can take many forms, and the Director of urban planning in Järfälla reasoned around what the municipality should contribute with. She expressed two things to be of particular importance for the municipal role: to assure societal values and to provide real-life settings for trying out new solutions.

Concerning the local carbon budget, the Environmental strategist in Järfälla highlighted that the LCB fills an important function in supporting collaboration. She emphasized that the fact that the LCB accounts for all emissions in the municipality, not just the internal ones, helps communicate the relevance of the challenge to external actors, stating that:

> In that way it also becomes useful, because our own environmental plans are usually quite internal and link to the municipality as an organization, so this budget for Järfälla as a geographical area and really something that we as municipality must have help with, it is not something that we as a municipality can solve on our own. (Environmental strategist, Järfälla)

Besides emphasizing that the municipality must facilitate and coordinate collaboration, several respondents highlighted that citizens must be a driving force in creating the change that is needed. The expressed view of the citizens and civil society is that they are important and powerful actors. The practitioner behind the carbon budgets went as far as saying that he and his colleagues put their hope of rapid climate action in citizens, with local politicians following their lead, stating that "if you want to change the world for real, you have to change the public opinion."

4.3 Shake the system

In this third and final narrative of change, the rationale behind why change is needed is based on the notion that climate change is connected to the unsustainable foundations of modern society. The plot of this narrative consists of a fundamental rethinking and overhauling of contemporary norms, structures, and power relations. Moreover, the narrative questions economic growth and integrates a justice perspective in sustainability challenges. According to this narrative, the local carbon budget contributes with an increased sense of urgency that can motivate rapid and transformative climate action. The understanding of actors, modes of governing and the role of the LCB is varied. Some arguments for a stronger regulatory approach to governance are expressed, but complemented with an identified need for currently unimaginable governance approaches, where the LCB is seen as having the potential of shaking and challenging current ways of working. Lastly, the narrative calls for a change based on an inner transition in people.

4.3.1 Global power relations and unsustainable foundations of society

Central to the rationale of this narrative is an understanding that climate change is deeply tied to other fundamental and unsustainable structures and norms of contemporary societies. Both respondents and documents, particularly the carbon budget reports, point out that there is a need for fundamental changes to our societies and lifestyles. The politician in Järfälla municipality pointed to the need for drastic changes to contemporary lifestyles when stating that "[reducing emissions] would mean a major intervention or change in everyone's lives, yours and mine, etc. we have to leave so many things behind, and look at it again." Moreover, the LCB for Nyköping goes as far as to state that "It must be acknowledged that the challenge presented in this report is so far-reaching that it is very difficult to find contemporary examples where this type of rapid societal change and emission reduction has been implemented within a municipality, region or country" (Anderson et al., 2020). One argument provided by one of the researchers behind the LCB as to why the challenge faced requires fundamental changes to the norms and structures that shape our modern societies is that without doing this, there is a risk of recreating new problems when trying to solve the current ones.

Furthermore, one fundamental aspect of contemporary societies that is explicitly questioned in this narrative is the economic growth paradigm. One researcher behind the LCB pointed to this by stating that "It is the whole economic-political paradigm that is also the problem now. And you cannot solve these issues within the usual frameworks, such as expanding a market for carbon emissions trading and then it will be solved." (Researcher 1, CCL) Another researcher behind the LCB agrees, stating that he can see clear connections between degrowth-theory and the LCB, stating that "the only way to cope with this is that we cannot really have continued growth." (Researcher 2, CCL) Similarly, this argument was also found in the municipalities, where one official from Nyköping reasoned around seeing a need to adjust to the economic paradigm to allow for values beyond economic ones.

Another aspect of this narrative is the recognition of unequal power relations, local as well as global, that must be accounted for in climate action. A global justice perspective is included in the two carbon budget reports, which also state that the municipalities ought to take responsibility for emissions beyond the scope of the LCB itself (Anderson et al., 2017, 2020). Furthermore, one politician from Nyköping highlighted that unequal global power relations are a key sustainability challenge that must be tackled:

> We must somehow substantially change this world-order that prevails today, we cannot continue in this way. The rich world has created war, famine, poverty in poor parts of the world. In that this problem is global. So now it is not enough with just tiny Nyköping, now it is not enough with little Sweden, now it is global. We must find, as soon as possible, a fair distribution system so that resources can be shared more fairly than has been done so far. (Politician 2 The Green Party, Nyköping)

On a similar note, several respondents highlighted that it is the high-emitting countries and lifestyles in the global north that carries the responsibility for the climate challenge. The unequal impact on climate change emissions was for example highlighted by one of the researchers behind the LCB when stating that "about half of the emissions in the last 30 years come from richer parts of the world, even though we only account for around 20% of the world's population." (Researcher 1, CCL)

4.3.2 Carbon budgets contribute to an increased sense of urgency

A central understanding of the local carbon budget in this narrative is that it contributes to an increased sense of urgency by shifting focus from long-term goals to yearly decreases in emissions. "Now it is a

battle against the clock to limit climate change" states the carbon budget report for Nyköping (Anderson et al., 2020), and the two researchers behind the LCB agree, stating that it is "a goal that shows that it is urgent " (Researcher 2, CCL) and that "carbon budgets are more that we must act now, that has been the message" (Researcher 1, CCL). One of the researchers continued by reasoning around that he hopes that this "could contribute with the realization that you have to make decisions, which are a bit difficult now, but which in the long run pays off." (Researcher 1 CCL) Similarly, officials from both Nyköping and Järfälla declared that they experience that the LCB increased the focus on action now, not in a distant future. For example, the urban planner in Nyköping stated that the LCB contributes to "that you feel a greater responsibility, that you have to address the issue now. Yes, time goes by." However, one point of caution against an increased sense of urgency was put forward by one of the researchers who also stated that the increased sense of urgency can risk increasing the crisis mentality which can legitimize undemocratic actions.

In this narrative, the sense of urgency is related to an inherent critique of an over-belief in future technological advancements. One central assumption in the calculation of the LCB is that they do not account for potential future Negative Emissions Technologies, which was highlighted by the researchers behind the LCBs and stated in both carbon budget reports. The LCB report for Nyköping motivated it by stating that:

> When it comes to Negative Emissions Technologies (NETs), we have been very restrictive in including them. There are several reasons to be very careful about trusting NETs. One reason is that all solutions will in one way or another require energy, directly or indirectly, to remove and store carbon dioxide, and that is perhaps the biggest challenge. The scale of the problem makes a solution very unlikely. (Anderson et al., 2020)

A similar argument was put forward by the Environmental strategist in Nyköping municipality who also expressed doubting the over-belief in future technology, stating that future technology often is energy-intensive and requires a lot of resources to be implemented. In addition, during the participatory observation, one of the researchers highlighted that there is no time to exchange current unsustainable technology with new ones, referring to the urgency of rapid decreases of carbon emissions.

4.3.3 Governance approaches for transformative change

In this narrative, the understanding of central actors, the role of the municipality, and potential governance approaches is varied. Some arguments for a stronger regulatory approach to governance are expressed, but combined with an understanding that there is a need for currently unimaginable governance approaches and changes based on an inner transition in people. Based on the magnitude of the challenges faced according to this narrative, one of the researchers behind the LCB expressed that it is difficult to tell what kind of change that will be needed:

> Change... I think there is no right way to think about the type of societal change we are in now. It feels like we live in a time where no matter what happens, a lot of things will happen. Many changes will take place, both better and worse. It's hard for me to see. (Researcher 1, CCL)

As mentioned above, some respondents did however express a need for more regulatory governance approaches. One of the researchers behind the LCB reasoned around the need for policies and regulations that can make climate governance function more long-term, in contrast to the project-based way of governing that he can see today. He also stated that concerning the urgency of the challenge we do not have time for technological developments, as discussed above, when stricter

regulations could be a quicker way to create the change needed. One politician from Nyköping echoed this by stating that he thinks that a few more years of failure in climate mitigation, will eventually mean that the municipality must be tougher:

> I think that next year we will not be able to show very good figures when it comes to reducing carbon emissions. I think that when you do not succeed with that, then there may be a possibility for the municipality, that it will be tougher. But right now, it does not seem like it, not at all so, but eventually. (Politician 2 The Green Party, Nyköping)

Additionally, two officials from Nyköping municipality mentioned taxes and other financial policy instruments as a potential regulatory governance tool that can be used to steer and create demand in a more sustainable direction. Also, this was mentioned in the carbon budget report for Järfälla where "gradually rising tariffs, frequent flyer charges, personal carbon dioxide allocations" (Anderson et al., 2017) were suggested as potential measures.

However, the municipal respondents highlighted that they have very little mandate over regulatory policies and that those kinds of measures are dependent on the Swedish state. The urban planner in Nyköping expressed that the national level is essential and that "without a decision at a higher level, if it needs to happen drastically, it will not work." This hope on leadership from national actors was however not shared among all respondents. The researchers and practitioner behind the LCB expressed that the Swedish state is not doing enough to combat climate change and that they have very little belief in this changing within the coming years.

In this narrative, the need for stronger regulatory governance is only one part of the understanding of what change is needed and what the role of the municipality and the LCB can have in that. Secondly, this narrative demands a critical discussion around how climate mitigation is currently approached. Here, one central notion is that the LCB has the potential of contributing with just that: challenging current ways of working. The two researchers behind the LCB expressed similar thoughts on this, one of them stating that "what I think, is that it [the LCB] helps to shake around the system" and that it "opens up for a discussion" (Researcher 2, CCL) where difficult questions about contemporary climate action can be asked. The other researcher echoed this, expressing that he "has had this image, I do not know if it is a good image, but I have seen it as a kind of barge that drives into the imaginary world of modern society and breaks it up" (Researcher 1, CCL). The potential for the LCB to challenge current governance approaches is seen as being strengthened by the fact that the LCB can 'hack' into current governance systems, by taking the recognizable form of a budget. Again, one of the researchers behind the LCB offered his thoughts on this by stating that:

> People pick it up on it [the LCB] and so on, but it's strange that they do that. Because when you realize that if they really wanted to follow this budget, it would be extremely politically difficult. And ask lots of difficult questions and challenge lots of power interests and so on. There is such a latent potential in the carbon budget, that it has the power to be a 'Trojan horse' in some way. (Researcher 1, CCL)

A similar view on the potential of the LCB was expressed by one of the politicians in Nyköping who stated that "I think that in the beginning there are many who do not really understand what it is about, what such a carbon budget would mean for us, eventually they will understand that this will entail a cost anyway" (Politician 2 The Green Party, Nyköping). This view on the LCB as a 'Trojan horse' points to the perspective that it is a tool that can infiltrate current climate governance and unlock or radically challenge it from within.

Finally, a third understanding of what actors are central and how they can create change is that it must start with an inner transition within people. One politician in Nyköping expressed that people need to experience something that touches them in their core and that “it must be something that is really revolutionary to you” (Politician 1 The Green Party, Nyköping). The role of the carbon budget in creating this inner change is not obvious and several respondents highlighted that the LCB might need to be complemented with “other frameworks and understandings that open up people's imagination and thoughts and can break with the path of development that we set out on now” (Researcher 1, CCL).

How the change demanded in this narrative can come about is a question still open for exploration and discussion, according to the respondents. But the aim is quite clear and summarized by one of the researchers: “It is to realize that we can live differently.” (Researcher 1, CCL)

5. LOCAL CARBON BUDGETS AS A TOOL FOR SUSTAINABILITY TRANSITIONS

In this chapter, the analysis and empirical material will be put into dialogue with previous research presented in chapter 2. The first section covers how the three narratives of change can be understood from the lens of transition studies and different perspectives on sustainability. The second section discusses the governance aspect of the three narratives and how it can be understood in relation previous research on climate change governance and Swedish planning and policy.

5.1 Comparing narratives of change

Utilizing an analysis of narratives of change and governance, inspired by frameworks by Wittmayer et al. (2019) and Bulkeley and Kern (2006), this study of local carbon budgets in Sweden shows three emerging narratives of change. The narratives illustrate differences in how the challenge of climate change is interpreted and approached, as well as different views on what actions, strategies, actors, and governance approaches that are required to tackle this challenge.

Considering the Iceberg Model of systems thinking (Monat & Gannon, 2015), the different perspectives of the three narratives becomes clear. The 'Tweak the system'-narrative has a larger focus on the top of the iceberg, namely the events and patterns that can be observed and monitored. One of the foundations of the Tweak-narrative is a focus on fact-based knowledge and measurable results, a way of reasoning that illustrates a more linear and mechanical way of thinking which has been critiqued for being hard to combine with challenges in complex systems (Hjorth & Bagheri, 2006; Kim, 1999). However, within the Tweak-narrative there were some critical arguments raised against the focus on measuring. In a municipal organization with scarce resources, allocating time and resources for monitoring and measuring will leave less resources for other actions that might have a greater impact on emissions reductions. Considering the 'Re-invent the system'-narrative, it indicates a somewhat more developed systems perspective, recognizing the impact of systemic structures in society. This was for example illustrated by a focus on networks and structures that support behavior, going beyond a critiqued focus on individual behavioral change (Newell et al., 2015; Shove, 2010). Moreover, the deepest level of a systemic understanding was illustrated in the 'Shake the system'-narrative where the need for an inner transition was emphasized, which can be understood as recognizing the mental models that underlie each system.

The three narratives in this study furthermore have similarities with the three approaches to sustainability and change defined by Hopwood et al. (2005): status quo, reform, and transformation. Although this study does not engage with the relationship between social and environmental dimensions of sustainability, the degree of required change that is illustrated by Hopwood et al. (2005) is helpful to further see the differences between them. The three narratives of this study quite directly follow the structure of Hopwood et al.'s (2005) approaches. 'Tweak the system' has most similarities with status quo, realizing the need for change, but without fundamental changes to societies. 'Re-invent the system' can be resembled with the approach of reform, where a larger systemic change is seen as needed, but without questioning underlying structures. And last, 'Shake the system' is similar to the transformation approach, which radically challenges power structures and the economic growth paradigm of contemporary societies.

Additionally, similar to other studies of narratives in sustainability transitions (Feola & Jaworska, 2019; Hagbert et al., 2020; Luederitz et al., 2016), this study shows tensions between some elements of the

different narratives. Studies by Feola and Jaworska (2019) as well as Hagbert et al. (2020) concluded that economic growth is one area where narratives differ. This is mirrored by the results of this study that show three different approaches to economic growth in the three narratives. The Tweak-narrative displays the economic system and limitations as taken for granted and unquestionable, and the Re-invent-narrative has a positive outlook on sustainable growth as a future trajectory. In contrast, the Shake-narrative questions economic growth as a foundation of modern society and calls for more radical changes. Furthermore, the role of technological developments in sustainability transitions has been seen as an additional area of contrasting viewpoints (Hagbert et al., 2020). In this study, this was most visible between the Re-invent and Shake-narrative, where the first highlights technological advancements as a key component of a sustainability transition. This can be put in contrast with the Shake-narrative which emphasizes that the outlook for future technology is too uncertain and that the urgency of climate change calls for more rapid changes. Hence, seen from the institutionalized eco-modernistic approach of Swedish policy and planning, the two narratives of Tweak and Re-invent indicate reproducing the discourse by a focus on resource efficiency, modernization, and economic growth (Hilding-Rydevik et al., 2011; Lidskog & Elander, 2012). Conversely, the Shake-narrative offers a more radical approach challenging the eco-modernist norms of technological advancements and the economic growth paradigm.

One central theme of this study is how the different narratives perceive the role of the carbon budget and what kind of change it is thought to support. In the Tweak-narrative, emphasis is put on the role of the LCB as a source of fact-based knowledge and neutral information that can be integrated into the municipal organization and support science-based climate governance. On the other hand, the Re-invent-narrative displays the LCB as a tool that can support collaboration with other local actors outside of the municipality. And lastly, the Shake-narrative points to the potential of the LCB to disrupt and challenge current municipal practices. These different perceived roles of the LCB are not necessarily in opposition with one another. Conversely, they could potentially be combined in the same over-arching pathway towards change. However, important to note is that the roles are different and represents different views on what a sustainable future is.

This study has illustrated that multiple narratives of change can coexist in the same context, sometimes as close as in the same document or person, often being intertwined with one another. This furthers adds to the complexity of climate change, as people themselves are complex and even contradictory in how they understand the challenge and potential solutions. Identifying the differences in how sustainability and change are viewed in the different narratives can, hopefully, support a deeper understanding of different perspectives. However, this should not be read as an argument for a census approach where climate change and sustainability become de-politicized and thereby falls victim for an post-political approach (Hilding-Rydevik et al., 2011; Swyngedouw, 2007). Rather, the point is to bring light to the inevitable conflicts and discrepancies between different narratives of sustainability transitions related to the LCBs, and by that realizing that different narratives create conditions for different sustainability transition pathways.

From the perspective of socio-political dynamics of sustainability transitions, it is important to go beyond a narrow allocation of power to certain levels or sectors of society. Instead, power and agency must be understood to be dispersed through complex interrelations between multiple arenas and actors (Avelino et al., 2016; Avelino & Rotmans, 2009). The results of this study indicate that the three narratives of change and governance create diverging approaches to power dynamics in transitions.

Whereas the Tweak-narrative reveals a rather narrow focus on the power allocated to internal municipal operation, the Re-invent-narrative suggests a broader and more shared allocation of agency and power through increased collaboration with external actors. Moreover, the Shake-narrative contains two, potentially conflicting, views. On one hand, the municipal and state power is argued for being strengthened, but on the other hand the municipal role and governance approaches are suggested to be fundamentally questioned and reimagined. By this, the three narratives provide different starting points for how power and agency should be understood and allocated between different levels and actors of society. How this is reflected into different approaches to governance is further discussed in the section below.

5.2 Governing sustainability transitions

A central part of this study is the governance approaches discussed in relation to the local carbon budgets and sustainability transitions. In this study, the four modes of governing (Bulkeley & Castán Broto, 2011; Bulkeley & Kern, 2006) were used to enrich the analysis of narratives of change and provide a framework for further understanding the role of the municipality. By developing the 'actor' and 'plot' dimensions of the narratives of change framework with the four modes of governing, the socio-political dimension of sustainability transitions was made more tangible and nuanced. However, an unexpected outcome of the combined perspective was that it enriched the governance framework just as much. During the analysis it became apparent that the narratives of change and transitions perspective deepened the understanding of modes of governing. By exploring how the modes of governing are connected to different approaches to change, this study creates a starting point for discussing the transformative potential of different governance approaches.

In the empirical material, a commonly reoccurring governance issue concerned the lack of municipal authority or mandate in reaching the carbon emissions reductions proposed by the local carbon budget. The lack of mandate was experienced despite the highly decentralized planning and policy system in Sweden which, at least in theory, gives the municipalities a key role in areas relevant for sustainability and climate action, such as land use and transport planning (Hrelja et al., 2015; Isaksson & Heikkinen, 2018). This could potentially be explained, to some part, by the neoliberal shift from a focus on government to governance, where governance and responsibility has been communicated as shared between societal actors (Fredriksson, 2011; Hrelja et al., 2015; Isaksson & Heikkinen, 2018). However, irrespective of the reasons behind the experienced lack of governance, the strategies and approaches as to how it should be managed varied between the narratives showing signs of all four modes of governing.

An increased focus on self-governance was expressed as the main strategy to manage the lack of mandate in particularly the 'Tweak the system'-narrative. The municipalities expressed several examples of self-governing strategies that are highlighted by Bulkeley and Castán Broto (2011), such as reducing emissions from internal operations, being a role model, and working with the employees. The arguments for this approach expressed in the empirical material were, as well, mirroring the previous studies (ibid.), stating that it is cost-efficient and positive that the municipality can control its own operation. However, the disadvantage of self-governing as a governance approach is that the municipality typically directly contributes to a limited share of the local carbon emissions, which makes the efforts inadequate in reducing the overall emissions (ibid.). This critique was recognized in the Re-invent-narrative, where the approach of enabling was emphasized.

The municipal role of enabling was emphasized in particularly in the Re-invent-narrative as the most suitable strategy to manage the lack of mandate. By facilitating and coordinating collaboration between multiple actors, an increased legitimacy and engagement for local climate action among other actors can be achieved. Potential benefits highlighted by both the empirical material and the literature (Bulkeley & Castán Broto, 2011). However, Bulkeley and Castán Broto (2011) highlights that this mode of governance is highly dependent on voluntary actions by external actors. This limitation was to some extent recognized in the Re-invent-narrative, but with the counterargument that climate action must be voluntary, and that the municipal role is to coordinate efforts to get everyone on board. The approach of enabling fits well with the shift from government to governance in Swedish policy and planning (Fredriksson, 2011; Hrelja et al., 2015; Isaksson & Heikkinen, 2018), and it is clear that the Re-invent narrative is colored by and reproduces this shift.

Considering the governance approach of provision, two different versions of this approach were identified in the analysis. First, in the Tweak-narrative a provisioning approach similar to the one discussed by Bulkeley and Castán Broto (2011) was illustrated by a focus on the provision of low-carbon infrastructure. In the Re-invent-narrative however, a more radical provision approach was expressed where the respondents highlighted the need for a systemic change in which provision of new types of infrastructure and services will be needed. This illustrates how a transition perspective can contribute to the framework of modes of governing and deepen the understanding of what kind of change the different modes of governing can contribute to.

The fourth mode of governance, regulation, was less commonly expressed in the empirical material, which is similar to findings in earlier studies on local climate governance (Bulkeley & Castán Broto, 2011). The regulation approach was motivated in the Shake-narrative by its contribution to rapid decreases in carbon emissions by targeting high-emitting practices, an argument also highlighted by Bulkeley and Castán Broto (2011). However, the risk of facing opposition from local actors and the lack of municipal capacity and mandate makes the approach less attractive, both according to previous research (ibid.) and the results of this study. Furthermore, both the empirical material and previous research highlighted that local governments face a challenge in taking on a regulatory approach as the regulatory mandate often is placed on a national level. Several respondents highlighted that to create the large-scale change needed to combat climate change, regulations must come from a national level. A request that potentially can stand in a conflict with the decentralized ideal of Swedish planning and policy.

Furthermore, the Shake-narrative calls for a need to critically challenge and rethink the role and work of current climate governance. This suggests that the four modes of governing used as a theoretical and analytical foundation of this study are insufficient in imagining the role of local government in more radical sustainability transitions. Given that the framework of modes of governing is developed based on already existing governance practices, it is not surprising that future alternative modes of governing will need to complement it. However, it is far from obvious what these alternate governing modes could look like and what their potential could be. Although it is beyond the scope of this study to suggest alternate modes of governing, some initial reflections based on the empirical material and analysis should be shared. Given the interest and capacity for municipalities to facilitate collaborations shown in the results, it is relevant to consider which actors are invited to collaborations. As suggested by Isaksson and Hagbert (2020), creating spaces for and strengthening the municipal connection to networks and arenes with more radical approaches can increase the capacity of governing in this

direction. Moreover, alternate modes of governing ought to be prestigeless in creating spaces for transparent discussions and reimaginations of how radical sustainability transitions can be facilitated from a systems perspective. This could up for explorations beyond patterns and events, and instead make room for reconsidering what structures and mental models that ought to be supported.

Having explored the approaches to governance emerging in the narratives of this study, one key question must be addressed more explicitly: what kind of governance approaches are supported by the local carbon budgets? The answer to this question varies depending on the perspective applied. First, the focus on fact-based governing and monitoring calls for an approach that can lead to measurable results, typically a self-governing approach (Bulkeley & Castán Broto, 2011). Second, the emphasis on a lack of municipal mandate can support stronger self-governance, but based on this study's empirical material, seems more to encourage a stronger focus on coordinating and facilitating collaboration between different actors. Third, an increased sense of urgency can support a more regulatory approach, as well as a questioning of the potential of technological change. Last, the potentially provoking and unprecedented magnitude of emission reduction suggested in the local carbon budget could lead to the need to explore new ways of governing.

6. CONCLUSIONS

By exploring what narratives of change and approaches to governance that are embedded and perceived in relation to local carbon budgets, this study set out to explore if and how local carbon budgets can be a tool for municipal governance in facilitating sustainability transitions. From the analysis, three narratives of change emerged: Tweak the system, Re-invent the system, and Shake the system. The three narratives suggest different pathways for sustainability transitions, as well as different approaches to local governance. Moreover, the narratives demonstrate separate views on issues such as economic growth and the potential of future technological advancements. In addition, they display varying ideas of what the function of the LCB is, as well as what that implies for different actors and power relations.

Considering if and how local carbon budgets can be a tool for municipal governance in facilitating sustainability transitions, the answer must be that LCB indeed can be a tool, or in fact many different tools. The three narratives all show connections with the four modes of local governing suggested by Bulkeley & Castán Broto (2011). However, they also suggest that governance beyond this framework is needed. Consulting the "Shake the system"-narrative, there is an embedded transformative and radical potential in the LCB in calling for urgent and systemic change that questions the status quo and contemporary governance approaches. However, the potential of LCB to 'infiltrate' and challenge contemporary climate governance does not seem to have reached its potential in the implementation. Rather, the LCB is integrated into current structures and norms of planning and policy by supporting the monitoring of emission reduction as well as collaboration with external actors, as could be seen in the Tweak and Re-invent narratives. Nevertheless, the rapid emission reduction proposed by the LCB is a massive challenge for the municipalities and could, if taken seriously, lead to rapid and radical changes.

The results of this study indicate that there is more to explore within the field of local governance of sustainability transitions. Combining frameworks of narratives of change and modes of governing in this study proved to enrich the understanding of different approaches to transitions and governance, as well as how they are interrelated. Thus, further studies are needed to explore the role of local government, power relations, and political dimensions of sustainability transitions, as has been argued by several scholars before me (Avelino et al., 2016; Avelino & Rotmans, 2009). This is particularly relevant as transition studies previously have been mainly occupied with research on socio-technical systems and corporative actors. Furthermore, as this study focuses on narratives of change and approaches to governance, one relevant aspect that is beyond this scope is whether the LCB could be seen as contributing to actual emissions reductions. Therefore, it would be relevant for future studies on local carbon budgets to trace the progress of climate mitigation actions and their results more closely.

The starting point for this study has been the realization that climate change requires transformative change where system dynamics and power relations are acknowledged and re-imagined. A hasty conclusion would be that the Shake-narrative is a more desirable approach to take on. However, it is then important to emphasize that the different narratives are not necessarily competing, but rather should be read as complementing each other. The narratives of change and governance all come with different strengths and weaknesses, maybe most clearly in the case of applicability and transformational capacity. Whereas the Tweak and Re-invent-narratives can be critiqued for not acknowledging system dynamics and underlying structures, the Shake-narrative can face criticism for

being vague and overambitious. Reaching for more low-hanging results might be seen as attractive in a situation that requires rapid changes, or as put by Hopwood et al. (2005, p. 49) “Reform now is better than nothing and transformation may not be immediately feasible.” However, one must acknowledge the current dominance of reformistic agendas in sustainability transitions and thereby make sure to not stop there. The magnitude of the challenges faced by societies and the ever-increasing levels of carbon emissions must be taken seriously. Rather than asking the question ‘do we have time for radical transformations?’, maybe we need to ask whether we have time for incremental changes, as they do not seem to have delivered on the issue thus far. To acknowledge the extent of the situation we now find ourselves in requires us to act with urgency. One way to do that could be to use tools such as local carbon budgets to their full potential. Thereby allowing them to question, challenge and reimage what kind of change is needed and how it can come about.

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APPENDIX 1

Interview guide for developers of local carbon budgets

Background on local carbon budgets

- Tell me about your role and your work with local carbon budgets!
- How did the work and your contact with Swedish municipalities and county administrative boards begin?
- How did the contact with the municipalities work?
- What do you know about the process behind municipalities contacting you for a carbon budget?
- Can you describe what the communication between you and the municipalities looked like during the time when the carbon budget was produced?
- What has the process looked like after the municipalities received their budgets?

Narratives of change

- How would you describe your understanding of the problems that local carbon budgets aims to address?
- How would you describe your image of the desired future(s) or vision(s) that the LCBs strive for?
- How would you describe the work process behind the problem formulation and objectives?
- Which actors do you see as driving the work towards the desirable future?
- Do you see any actors that you think would oppose or oppose the desired future?
- How would you describe the process for reaching this future?
- What are your own thoughts on the story of change conveyed through carbon budgets?

- Is there anything else you want to tell me that I did not ask about?

Interview guide for users of local carbon budgets

Background

- Tell me about your background and role at X municipality!

Your work and approach to sustainability and sustainability transitions

- How would you describe your view of the biggest sustainability challenges in your municipality?
- How would you describe your vision or goals in relation to the sustainability challenges and / or climate challenges?
- What do you feel is needed to tackle these challenges and achieve the goals or vision?
- Which actors / parts of society do you see as central in this work?

The work with the local carbon budget

- Can you describe the process behind your choice to develop a local carbon budget?

- How do you work with the carbon budget today?
- What do you think is needed to achieve the emission reductions proposed in the local carbon budget?
- Based on your experience, do you feel that the local carbon budget is helpful in creating the change needed to achieve emission reductions? Why / why not?
- How do you feel that the local carbon budget relates to your other climate and sustainability work?
- Has the local carbon budget changed or affected how you work with climate or sustainability issues?
- Has the local carbon budget changed how you discuss / look at sustainability issues more generally in the municipality?
- How do you view the municipality's role in relation to working for a sustainable society and achieving the emission reductions that the carbon dioxide budget proposes?

- Is there anything else you want to tell me that I did not ask about?

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