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RESEARCH ARTICLE

Different interpretations of sufficiency in climate-protection strategies: a typology based on 40 pioneering municipalities in Germany

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ABSTRACT

Sufficiency is a crucial strategy for achieving climate targets by reducing energy and resource consumption in absolute terms through changed practices. While most climate-protection concepts focus almost exclusively on the technological strategies of efficiency and consistency (e.g., renewable energies), sufficiency is being increasingly considered in public policy as a social-organizational strategy, especially at the municipal level. However, given the diverse facets of this theoretical concept, the interpretations of the character of sufficiency vary widely. Using examples from the 40 German Masterplan municipalities, our qualitative study examines these different interpretations of sufficiency in municipal climate-protection concepts. In this study we analyze the general meaning and relevance of sufficiency in the concepts mentioned, work out the central dimensions of sufficiency and use them to distinguish between the different concepts, and present a typology, which allows the basic distinction between four municipal sufficiency types: *technophiles, privatizers, vision builders*, and *frameworkers*. The results show that sufficiency is gaining importance for municipal climate protection and can contribute to alternative future visions. However, sufficiency remains mostly subordinated to technological solutions and is hardly woven into the specific sectoral strategies and concrete measures. Furthermore, the transformative trajectories are limited through depoliticized understandings of sufficiency in many cases. We therefore argue for a more political, cross-sectoral, and transformative interpretation of sufficiency as a guiding principle in public climate policy that links tangible framework conditions for sufficiency practices with visions for alternative futures.

Introduction

In the wake of the energy crisis following the Russian war on Ukraine, governments worldwide have responded with various emergency measures to avoid energy shortages. These measures have included activities following sufficiency strategies that save energy through changed social practices (EEB 2022). For example, some countries like Ireland, Italy, and Germany have reduced public transport fares to minimize individual reliance on private automobiles (Climate Action Tracker 2022), while France even launched a national sufficiency strategy ("sobriety plan") to save resources (Government of France 2022). Successes in reducing energy consumption have shown the potential of these sufficiency measures. However, similar to the 1973 oil crisis, these initiatives were largely introduced as short-term and temporary strategies to deal with a sudden crisis, rather than as part of a well-designed long-term plan.

In the long term, governments are still predominantly focusing on technological interventions (Nightingale et al. 2020). However, it is becoming increasingly apparent that technical approaches alone will not be adequate to achieve the agreed-upon climate-neutrality targets (Alfredsson et al. 2018; Vogel and Hickel 2023). Rather, according to Göpel (2016) profound societal transformations in various sectors are necessary, including fundamental changes in social practices such as everyday routines, consumption habits, and shared values that extend far beyond technical optimizations of the status quo. Sufficiency can therefore be seen as central to overcoming the enormous sustainability challenges (Princen 2005; Sachs 1993).

Sufficiency is often distinguished from the technological strategies of efficiency and consistency (Pagliano et al. 2022; Toulouse et al. 2019; van den Berg et al. 2019). While efficiency seeks to optimize

the input-output ratio through technological improvements, consistency aims to close material cycles, avoiding negative environmental impacts (e.g., renewable energies, cradle-to-cradle-principles). In contrast, sufficiency can be defined as a "strategy for reducing, in absolute terms, the consumption and production of end-use products and services through changes in social practices in order to comply with environmental sustainability while ensuring an adequate social foundation for all people" (Lage, Böcker, et al. 2023).

The perspectives on what constitutes sufficiency vary widely due to different disciplinary lenses and research foci (e.g., Sandberg 2021; Spangenberg and Lorek 2019). Sufficiency can be considered both as a direction and visionary end itself or as a concrete means for achieving ecological and sometimes social goals (Jungell-Michelsson and Heikkurinen 2022). The objectives thus range from consumption corridors to comply with planetary boundaries (and social minimum limits) (Di Giulio and Fuchs 2014; Raworth 2018) to achieving a post-growth economy (Lage 2022). In this context, sufficiency can be operationalized both as a quantitative saving instrument (Profijt 2018) and a rather normative guiding principle to "the good life" (Paech 2016) or a more just society (Salleh 2009).

Sufficiency is closely associated with social change, which Lage (2022) distinguishes in the form of three different approaches. First, the *bottom-up approach* focuses "on changes in individual lifestyles, consumption patterns and cultural change" as incremental change (Lage 2022, 7). Second, the *policy-making approach* considers sufficiency as politically organizable through suitable framework conditions in a reform-oriented way (Schneidewind and Zahrnt 2014; Spengler 2018). Finally, the *social-movement approach* calls for more fundamental and disruptive change and describes sufficiency as something "that cannot be implemented within the current economic and social system" (Lage 2022, 10). According to Lage (2022) all approaches contain certain potentials and limitations. However, considering sufficiency as a political task is seen as an important basis for achieving ambitious climate targets, as hoping for the spread of small-scale changes in social practices at an individual level alone is often regarded as insufficient to bring about the necessary far-reaching structural, transformative changes (Alfredsson et al. 2018; Winterfeld 2016).

Despite its multifaced character, we argue that the concept of sufficiency can widen the space of opportunities for social-ecological transformation by not only challenging the dominant reductionist and techno-optimist paradigms but also including societal perspectives on desirable futures (Beck et al. 2021; Keck and Flachs 2022). However, the transformative power of these ideas is highly dependent on what priority is given to sufficiency and which interpretations of the concept prevail. In addition to various studies on the general (mostly marginal) consideration of sufficiency in policy papers, concepts, and scenarios, from national (Best et al. 2022; Callmer and Bradley 2021; Samadi et al. 2017; Zell-Ziegler et al. 2021) to local level (Hübler 2022; Ekardt and Hennig 2014; Leuser and Brischke 2018; Schmitt et al. 2015), there are also several recent studies which have investigated in more detail how factors such as transdisciplinary planning, visionary pioneers in local administrations, or arising conflicts affect the implementation of sufficiency policies in German municipalities (Böcker, Lage, and Christ 2022; Christ et al. 2024; Lage, Böcker, et al. 2023). However, these studies did not consider how different prioritizations and understandings of sufficiency shape concrete policy.

The aim of this study is to narrow this gap by analyzing the climate-protection concepts of 40 German so-called Masterplan municipalities. These local frontrunners received national funding in two consecutive funding periods from 2012 to 2020 to become role models for municipal climate protection in the country (Nagorny-Koring 2019). We argue that such a focus on the local scale is of particular relevance, as this is the level at which sufficiency policies are already being tested and become tangible on the ground (Schneidewind and Zahrnt 2014).

The guiding research questions of our study are as follows:

RQ1: What significance does sufficiency have as a strategy in the climate-protection concepts of German Masterplan municipalities and are there any changes noticeable between the two funding periods?

During our explorative study design two further questions evolved:

RQ2: What are the main characteristics of the interpretations of sufficiency in the analyzed climate-protection concepts?

RQ3: How can different interpretations of sufficiency of German Masterplan municipalities be converted into a typology?

The remainder of this article is structured as follows: First, we outline the relevance of municipalities for climate protection and the implementation of sufficiency and present the methodology of the study. Second, we introduce three dimensions for

different interpretations of sufficiency and propose a typology of four municipal sufficiency types as results of the study, before discussing the results, methodological limitations, and the need for further research.

Municipal climate protection in Germany and the role of sufficiency

The current study adopted a constructivist perspective that considers climate-protection concepts as the contingent, changeable, and discursive result of contested negotiations between different actors. It followed an explorative, qualitative, and inductive research design based on 40 climate-protection concepts of the German Masterplan municipalities in their role as climate pioneers. For our study, we initially took a very open and broad understanding of sufficiency as a basis and identified all approaches that the municipalities themselves have labeled as sufficiency. In addition to that we also included all those ideas that focus on changing lifestyles, social practices, and consumption and production patterns with the aim of achieving an absolute reduction in energy and resource utilization.[1] The selected material was identified as a promising object of study for analyzing how sufficiency is governed as a policy area for climate protection for the following reasons.

First, the municipality level is a valuable scale of analysis, as it allows for the investigation of variations between cases within one country under similar framework conditions (e.g., national regulations, access to funding schemes). Municipalities are places where the impacts of climate-protection measures become tangible for residents which makes them crucial for negotiating viable strategies and balancing tradeoffs (Bulkeley 2010). Although examples of the successful implementation of sufficiency policies are still rare, they have so far been identified in Germany in particular at the municipal level, where local actors can negotiate, test, and, if necessary, adapt individual sufficiency policies with local stakeholders according to the principle of trial and error (Lage, Böcker, et al. 2023).

Second, German municipalities have a comparatively high degree of legal room in which to maneuver with regard to implementing climate-protection policies due to institutional municipal self-government which often includes local control of energy supply or urban land-use planning. Although the overarching framework conditions (e.g., legal regulations, financial growth incentives) are perceived as an obstacle to the implementation of sufficiency policies in Germany, there is scope for municipalities to pursue alternative paths (Böcker, Lage, and Christ 2022; Lage, Böcker, et al. 2023; Leuser and Brischke 2018). Such circumstances make divergent strategic approaches more likely (Eckersley 2017).

Third, it is to be expected that frontrunner municipalities are most likely to consider innovative and potentially transformative approaches such as sufficiency. As those policies are often path-deviating, conflictual, experimental, resource-intensive, and sometimes located in legal grey areas, their implementation requires a high degree of commitment, courage, experience, knowledge and personnel, and financial resources, which are more likely to be found in already engaged, professionally supported, and additionally funded contexts (Böcker, Lage, and Christ 2022; Christ et al. 2024; Lage, Böcker, et al. 2023). For the second funding period of the Masterplan program the consideration of sufficiency was even obligatory (BMUB 2015; Solar Institut Jülich, Wuppertal Institut, and Deutsches Zentrum für Luft- und Raumfahrt 2016). Under these circumstances, municipalities can become important experimental settings for feasible climate-protection policies that can later be rolled out at higher administrative levels (Kern 2019).

Fourth, the Masterplan program provided consistent funding conditions for all participating municipalities, which makes different cases within the group more appropriate for comparison. Beyond that, the two succeeding funding periods allow the observation of changes over time (Goeke 2021).

Finally, municipal climate-protection concepts have been shown to be important guidelines for local administrations and decision-makers. Although concepts are never implemented in a one-to-one manner, they give valuable insights about preferred strategies and visions as the negotiation results of locally involved actors (Göpfert 2014).

Pioneering municipalities can be important drivers of climate protection, and their activities and aims often extend far beyond national efforts (Bulkeley 2010; Kern 2019). In Germany, municipalities started to organize (trans)national city climate-protection networks and to design energy-efficiency concepts for their cities beginning in the early 1990s. Much later, in 2008, the federal government created the National Climate Initiative (*Nationale Klimaschutzinitiative*), with the first systematic funding scheme that aimed to support municipalities in developing climate strategies and implementing measures (Abel 2021). Additionally, the government initiated the strategic funding program Masterplan 100% Climate Protection (*Masterplan 100% Klimaschutz*) as an excellence initiative for 41 already ambitious municipalities from 2012 onward, representing 11% of the German

population (the first funding period was from 2012 to 2016 and involved 19 municipalities and the second funding period was from 2016 to 2020 and involved 22 municipalities).[2] The special focus of the program was to create a top-level funding scheme designed to facilitate a close exchange between the participating municipalities, the federal government, and the accompanying scientific community to lay important foundations for the broader promotion of municipal climate protection in Germany (Nagorny-Koring 2019). For the selection of municipalities, the government aimed for a heterogeneous sample in terms of size, region, and type (municipalities (*Städte, Gemeinden*), districts (*Landkreise*), and regions (*Regionen, Regionalverbände*)). The objective of the initiative was to create role models and to show locally feasible ways in which to not only achieve greenhouse-gas neutrality by 2050, but also to halve energy requirements (Goeke 2021). For this purpose, the selected municipalities were supported in the preparation of Masterplans with financial and human resources. For these Masterplans, the municipalities analyzed the status quo in climate protection and developed scenarios and action programs for achieving greenhouse-gas neutrality in specific sectors with the participation of local civil society and specialized agencies (Nagorny-Koring 2019).

Methodology

Our analysis is based on 40 climate-protection concepts from different jurisdictional types (28 municipalities, eight districts, and four regions), supplemented by two accompanying strategy papers.[3] One of the original 41 Masterplans was not available and was thus excluded from the analysis.[4] Thus, a total of 10,866 pages of data were examined on the basis of keyword searches and the selection of relevant chapters.

We analyzed the material by using qualitative content analysis (Kuckartz and Rädiker 2023). As the initial research question (RQ1) aimed at investigating the overall relevance of sufficiency, it was set a priori as first analytic category. In the research process a further eight categories were found inductively and used to develop key dimensions for answering RQ2. These dimensions were spanned by diverging meaningful text passages and contents within the sectoral strategies, the proposed measures, the problem descriptions, and the overall visions of the underlying concepts. Eventually, a typology of sufficiency interpretations was elaborated to answer RQ3.

The methodological procedure was characterized by five partly iterative steps (see Figure 1) following the evaluative and type-building qualitative content analysis described by Kuckartz and Rädiker (2023, 123ff):

1. The review of the first concepts provided an initial overview of the concepts' structure and was the basis for identifying relevant chapters and initial keywords associated with sufficiency.[5]

2. As part of the first systematic text analysis, we extracted all sufficiency-related sections in the climate-protection concepts that we could find by keyword search and review of the most important chapters. For RQ1 we also analyzed the overall relevance of sufficiency in the concepts: Is the topic of sufficiency only mentioned once in passing? Is there a separate chapter or even an additional sub-strategy on sufficiency and to what extent is sufficiency woven into the various sub-areas (e.g., consideration in the scenarios, in the catalogue of measures, in the sectoral strategies, such as transport or buildings)? On this basis, we prepared summary-case descriptions for each Masterplan municipality. New keywords were derived from the frequent occurrence of certain topics in connection with sufficiency and were continuously (and iteratively) supplemented in the research process.

3. In the next step, we thematically clustered and categorized the coded segments and this process led to nine dimensions that elucidated various facets of sufficiency in different gradations (RQ1 and RQ2).

4. The coded dimensions spanned a multidimensional feature space derived from the material extending along two poles for each of the nine dimensions (see Table 1). The poles of each dimension represent the strongest characteristic found in the material or the logical counter-pair of a characteristic identified in the material. To map identified shades between the two poles, five gradations were defined on an ordinal scale for each dimension. During a renewed review of the material, each case was assigned to either one of the gradations or – if they could not be classified due to missing or ambiguous statements on the topic – to a residual category.

5. In the last step, the natural typing of the individual cases was carried out to derive ideal types for sufficiency interpretations from the material (Kuckartz and Rädiker 2023, 183f) (RQ3). For the typology, we essentially focused on three of the nine dimensions and their interconnections, as a particularly large number of statements and especially striking differences emerged from them.
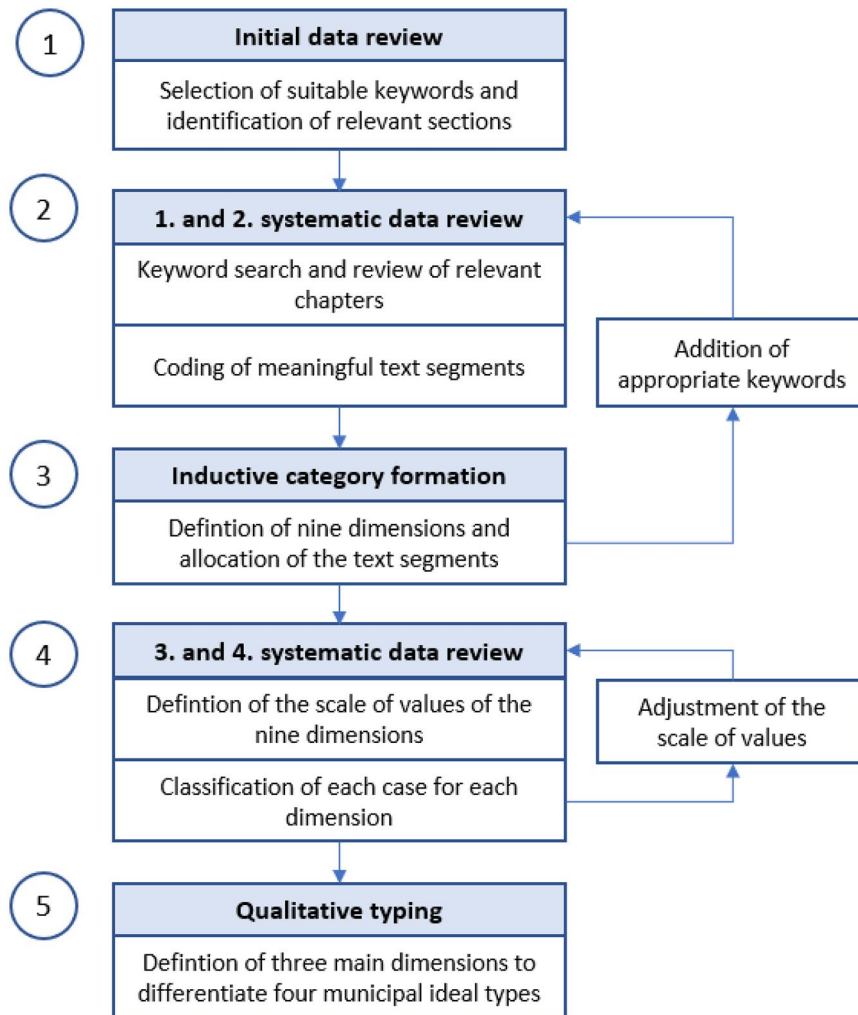
Figure 1. Overview of the qualitative approach to data analysis in the research design.

While the initial coding process was conducted by one author, the derived axial categories (dimensions) and the type building were discussed among the coauthors.

Results

Dimensions of sufficiency understandings

We identified nine dimensions, which characterize the importance and different interpretations of sufficiency in the municipal climate-protection concepts (see Table 1). In the following discussion, we focus on three of these dimensions (see Table 1, bolded text) as these are decisive for the typology, while significant aspects from the other six dimensions (see Table 1, see italicized text) are occasionally discussed as additional considerations.[6] In this context, we also compared the two funding periods in order to identify shifts in the relevance and interpretation of sufficiency over time.

The first dimension, *prioritization*, refers to the general importance of sufficiency compared to that of pure technological strategies (RQ1). The second dimension, *responsibilities*, relates to the different attributions of agency for the implementation of sufficiency. Is it primarily a structural framework that has to be created or are individuals called upon to autonomously integrate sufficiency into their own lifestyles? Finally, the third dimension, *trajectories of change*, assesses whether the municipalities present ideas of a fundamental social transformation or a "business as usual" scenario (RQ2).

Prioritization: technology or sufficiency?

The first dimension shows that more than 85% of the concepts addressed sufficiency either implicitly[7] or explicitly; however, in most of the concepts, the strategy had a supplementary function with a low priority level (see Figure 2 and Table 2). Only three municipalities (8%) assigned a high or very high importance to sufficiency in their concepts (values 4 and 5 on a five-point scale), while 24 municipalities (60%) assigned a rather subordinate or supplementary importance (values 2 and 3). Thirteen concepts

Table 1. Dimensions of sufficiency interpretations in the municipal climate-protection concepts (bold: focus dimensions, italics: other dimensions).

Dimension	Explanation
1) Prioritization: technology or sufficiency	**Sufficiency's overall significance compared to technological strategies:**
	Is sufficiency addressed at all? If so, is it regarded as a subordinate strategy or as a strategy of equal importance to purely technological approaches (e.g., in terms of time or content prioritization; degree of integration into the overall concept, such as scenarios, catalogues of measures or sectoral strategies)?
2) Responsibilities: individual or politics	**Addressed responsibility for sufficiency implementation:**
	If sufficiency plays a role: Who is addressed in the concept as responsible for the implementation of sufficiency? Is the focus more on individual residents or on decision-makers and the design of suitable framework conditions?
3) Trajectories of change: conformity or transformativity	**Degree of desired transformation or preservation of the status quo:**
	To what extent are transformative changes considered necessary to achieve the climate goals, such as profound changes to economic and social structures, practices, or norms?
4) Wish or feasibility	Prediction of an unlikely, possible, or automatic achievement of sufficiency:
	If sufficiency plays a role: Is the implementation of sufficiency seen as a wish that will automatically affect the municipality at some point as an external trend? Or is sufficiency a feasible, shapeable, and realistic option in the fulfillment of climate targets? Or is sufficiency seen as an unrealistic option that should not be strived for?
5) Necessity or morality	Justification for sufficiency as a necessary means or moral imperative:
	If sufficiency plays a role: How is the pursuit of sufficiency justified as a strategy in the climate-protection concept? Is it primarily seen as a necessary savings instrument to reduce greenhouse-gas emissions, or as a moral imperative, normative goal, and social vision?
6) Renunciation or benefits	Sufficiency framed as restricting renunciation or personal gain:
	If sufficiency plays a role: Is sufficiency associated with renunciation and restriction or with personal benefits (e.g., slowing down, happier life)? Or is neither the one nor the other or are both sides thematized?
7) Appeal or (infra-)structure	Type of sufficiency measures as either soft (voluntary) or hard (structural):
	If sufficiency plays a role: What kind of measures and strategic recommendations dominate in favor of sufficiency? Are only soft measures such as public relations and sensitization of the population considered? Or is sufficiency also being pursued with hard, structural measures, such as the planning and reorganization of infrastructures and the design of funding guidelines?
8) Growth or degrowth	Dealing with the economic growth paradigm:
	Is continuous economic growth anchored in the concept as an explicit goal or does it remain unquestioned? Or is the growth paradigm criticized or are alternative socio-economic models discussed and pursued?
9) Injustice or justice	Dealing with social justice issues:
	Are questions of social justice for climate protection discussed as relevant issues in the concepts (e.g., wealth distribution, gender justice, global justice)?
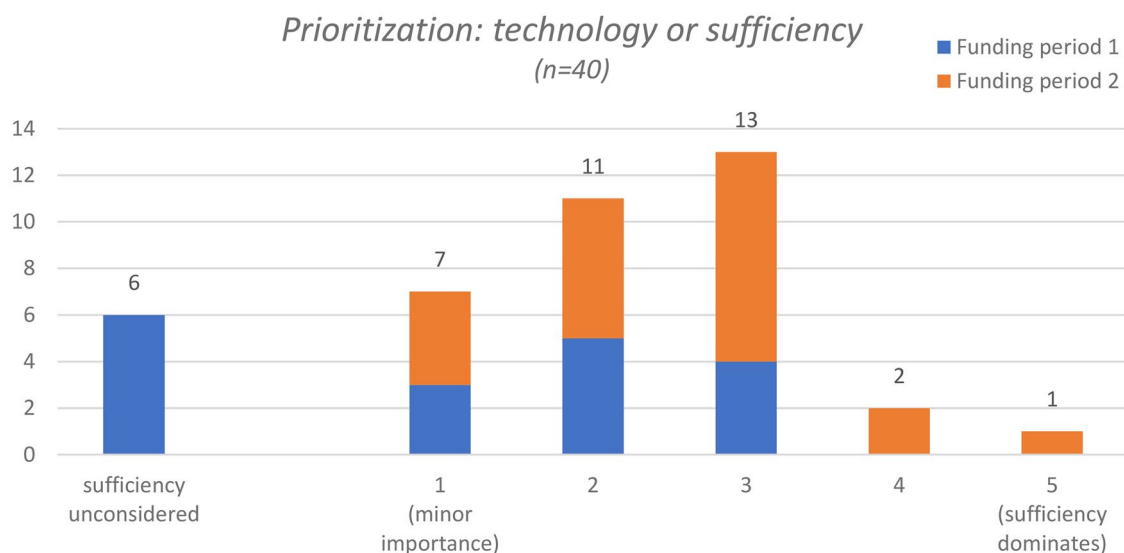
Figure 2. Distribution of the municipalities along the dimension (1) "Prioritization: technology or sufficiency".

(33%) included sufficiency either hardly or not at all (values 0 and 1).

What is striking here is the clear shift between the two funding periods. If sufficiency was accounted for in the first round, then it was mostly as an abstract future vision and not as a concrete maxim for current action (dimension *wish or feasibility*). Sufficiency was often discussed in isolation from the overall concept and was rarely integrated into specific sectoral measures. Sufficiency was given a lower priority level not only in terms of content but also in the temporal hierarchy. This is exemplified

Table 2. Classification of the values of the dimension (1) "Prioritization: technology or sufficiency".

Value	Explanation
0	*Sufficiency is unconsidered (neither explicitly in the term nor implicitly in the subject matter).*
1	Sufficiency is either hardly (or not explicitly) mentioned, with very little significance of the overall concept and has no separate section.
2	Sufficiency is mentioned selectively but has no separate section and/or is clearly subordinate to technological interventions.
3	Sufficiency is equal to technological strategies in the outline structure, but its significance is subordinate in terms of content and/or time, thereby serving as a complementary function.
4	Sufficiency is included with high importance across sectors and chapters, similar to technological strategies.
5	Sufficiency is prioritized over technological strategies in the overall concept.

by the following future vision, which can be found in the Masterplan of the Bavarian City of Kempten. In the electricity sector, the city plans to reduce power consumption in three phases: In the first "euphoria phase," the greatest possible potential of low-hanging fruits is to be raised (City of Kempten 2013, 92), followed by

> a continuous improvement of appliance efficiency (efficiency phase) [until about 2030] and **finally the completion of a lifestyle change through advanced cognition (sufficiency phase)** [from the mid-2030s]. (City of Kempten 2013, 93; translation and emphasis by the authors)

Beyond the temporal subordination of sufficiency, this example shows that, second, more comprehensive sufficiency measures do not seem to belong to the first-mentioned large existing potentials of the euphoria phase, and third, the expected sufficiency change will be triggered by a "rethink…at the individual level" (City of Kempten 2013, 102) instead of by supportive framework conditions (see *responsibilities*).

In the second funding phase, the significance of sufficiency increased. Although the pattern of a subordinate consideration of sufficiency persisted, all municipalities now took sufficiency into account, and significantly more municipalities recognized it as an adequate strategy (dimension *wish or feasibility*). Several municipalities explicitly problematized the fact that purely technological strategies had been prioritized over sufficiency principles in the past. For example, the concept of the Westphalian City of Rietberg stated as follows:

> Up to now, Rietberg has **mainly dedicated itself to the implementation of efficiency measures**. While the sufficiency principle is often reflected in these measures, it is to be established as an **inherent and**

equal part of the implementation of the Masterplan. Sufficiency should find expression **as a principle in the single measures** and be **considered in all areas**. (City of Rietberg 2017, 44; translation and emphasis by the authors)

This statement represents the increased importance and the more integrative understanding of sufficiency as a general guiding principle for concrete measures.

Responsibilities: individual or politics?

The second dimension refers to who is made responsible for the implementation of sufficiency and thus, what role the municipality ascribes to itself in this process. In addition to the six cases in which sufficiency was not mentioned, in two other cases no classification could be made because there was inadequate evidence in the material with which to attribute responsibilities (see Figure 3; Table 3).

Overall, the responsibility for sufficiency at the individual level of action was dominant within the sample, in which social framework conditions for sufficiency practices were completely or largely disregarded (59% of all cases with consideration of sufficiency with values 1 or 2). Only seven municipalities conceded more importance to structural sufficiency politics or, in other words, gave attention to the necessary framework conditions for sufficiency practices (21% with values 4 or 5).

In this dimension, we can observe particularly strong shifts between the two funding periods. In the first phase, the municipal plans regarded sufficiency primarily as a field of individual-level action and responsibility. The City of Kempten (2013, 101f), for example, demanded that the necessary "rethinking toward more sufficiency must arise at the individual level." The city and region of Hannover (2014, 11) understood sufficiency to mean "individual responsibility for one's own lifestyle," while for the City of Göttingen (2013, 44), sufficiency was defined as "the effort of each individual to consume as few raw materials as possible by consciously dealing with demands…or self-limitation." What all the above-mentioned statements have in common is that the responsibility for sufficiency was placed on individuals, while the municipality itself externalized competences and hopes for a bottom-up turnaround of sufficiency.

In the formulation of measures and strategies, this hope usually translated into soft and hesitant measures instead of structural approaches that aimed to enable and strengthen sufficiency (dimension *appeal or (infra-)structure*). As an example, for the small Lower Saxonian municipality of Steyerberg,
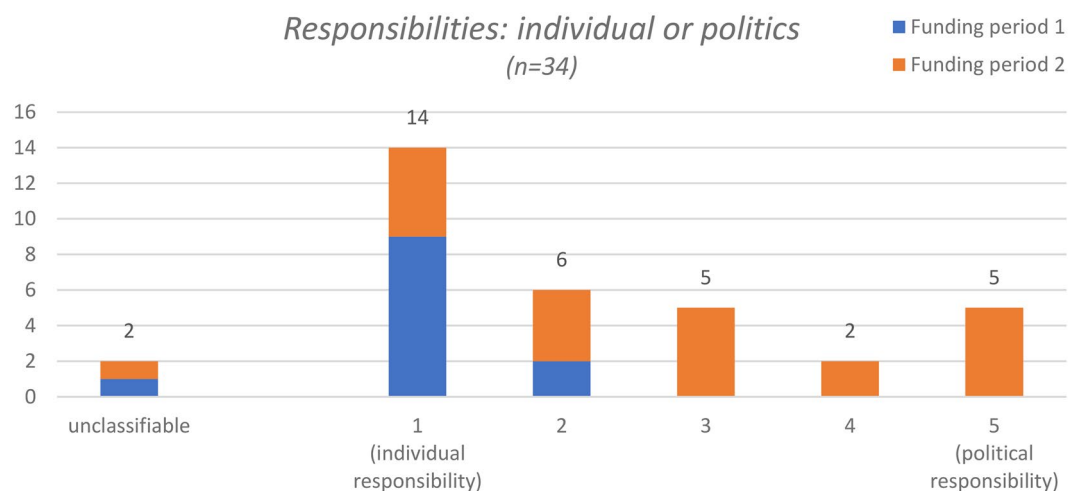
Figure 3. Distribution of the municipalities along the dimension (2) "Responsibilities: individual or politics" (without cases that do not take sufficiency into account).

Table 3. Classification of the values of the dimension (2) "Responsibilities: individual or politics".

Value	Explanation
0	*Unclassifiable (due to generally not mentioning sufficiency or missing text passages that address accountability)*
1	Individuals are seen as responsible for implementing sufficiency practices. Sufficiency is limited to private consumption, nutrition, or device use.
2	Framework conditions for individual sufficiency practices are mentioned.
3	Framework conditions are repeatedly thematized.
4	Framework conditions occupy a large space in the discussion of sufficiency.
5	Sufficiency is seen as a political field of action, similar to technological strategies, and framework conditions are seen as essential adjustments made by the municipality (e.g., separate section for sufficiency politics).

[S]ustainable lifestyles and a questioning of one's own consumption require a **slow and long-term approach**. This is not about demanding different behaviors but primarily about **information, communication and motivation**…Changes in personal behavior and lifestyles **cannot be forced** by legal or social norms, but only take effect the more an understanding of the interrelationships, the **responsibility of one's own actions** as well as advantages of changes become clear to **personal awareness**. (Municipality of Steyerberg 2017, 56; translation and emphasis by the authors)

In this statement, political interventions aiming to promote sufficiency were explicitly viewed critically, understanding them exclusively as restrictive, and not as enabling framework conditions. In this interpretation of sufficiency, the municipality is left with the roles of motivator and communicator. Similar to the first statement provided in the case of the City of Kempten, the transfer of responsibility to individuals was also accompanied by a temporal deferral, as cultural changes in values take place slowly. This approach to sufficiency is thus very cautious and does not plea for urgent

transformation with structural changes (see *trajectories of change*).

However, the second funding round also included some municipalities that explicitly viewed sufficiency as a political action field and considered structural interventions as enabling and spreading sufficiency practices. For instance, the City of Potsdam (2017, 244) explained that "sufficiency is not only an individual attitude but is even more dependent than efficiency on supporting institutions, infrastructures and social networks." The District of Lippe (2017, 90) emphasized the principle "create structures – change behavior" because "individual decisions on consumption and use behavior are…always in the context of social framework conditions and can be influenced… – among others by…political and economic…instruments, the design of products and services, technical and social infrastructures and by changing societal priorities" (District of Lippe 2017, 82).

From the perspective of the City of Münster, the attribution of the responsibility for sufficiency to the individual level is not enough to achieve the municipal climate goals. Especially in the area of consumption and nutrition, the "hurdles to the consumer to recognize and judge" are particularly high due, for example, to complex product information and entrenched routines. This is why the creation of favorable framework conditions is seen as the basis for successful local sufficiency implementation (City of Münster 2017, 23).

Finally, many municipalities in the second funding round with a more political understanding weave sufficiency more strongly into the overall concept and the specific sectors (e.g., buildings, mobility) and regard it less as a separate field of action. This often puts sufficiency on a much more equal footing with the technological strategies (see *prioritization*). However, this does not necessarily lead to more

transformative perspectives, as sufficiency is often seen as a concrete necessary emissions-savings instrument instead of a normative and visionary guiding principle for cultural change (dimension *necessity or morality*).

Trajectories of change: conformity or transformativity?

While the dimension *responsibilities* showed strong shifts between the two funding periods, this did not apply to the dimension *trajectories of change*, where the distribution is similar in both funding periods (see Figure 4 and Table 4). While all six concepts that did not take sufficiency into account identified (almost) no conflicts with the current economic system and lifestyle patterns for climate protection, this applies to half (50%) of the concepts with sufficiency consideration; thus, they did not formulate need for fundamental change (value 1 or 2). About a fifth of the concepts (21% of the cases with consideration of sufficiency) expressed a certain need for change (value 3), while more comprehensive needs for profound transformation processes were contained in 29% of the concepts, for example, by pointing out alternative visions for socioeconomic and/or cultural change (values 4 or 5).

There are indications that societal transformation considerations (including justice issues and criticism of economic growth) are almost exclusively taken up in connection with sufficiency, which demonstrates its transformative potential. This is exemplified in the concept of the City of Rietberg as follows:

> In order to be able to comply with the goals…from the Paris Climate Agreement, the focus **must move away from energy-related technical measures toward a social transformation process** of the consumer culture. This poses **major challenges for policymakers**. (City of Rietberg 2017, 44; translation and emphasis by the authors)

Rietberg not only linked the idea of transformation with sufficiency-oriented lifestyles and a critique of the focus on purely technological strategies but also saw this as a (challenging) political task. Accordingly, the statement differs from other views of social change in other concepts, which is often considered to be conflict-free and exclusively citizen-driven (see *responsibilities*).

An explicit political-structural understanding of sufficiency was not considered a prerequisite for transformative goals. For the City of Emden (2017, 126), municipal climate protection "also means a societal change in behavior in almost all areas of life," for which "multilayered communication is essential." Sufficiency and transformative change are thus to be achieved primarily through soft measures.

Table 4. Classification of the values of the dimension (3) "Trajectories of change: conformity or transformativity".

| Value	Explanation
0	*Unclassifiable*
1	The concept discusses no conflicts with recent ways of life or the economy. Terms such as "change" or "transition" are only used for specific technical systems (e.g., the energy system), but not for society or broader sociotechnical infrastructures.
2	Implications of recent ways of life or economy are vaguely discussed, and a need for (gradual) societal change is recognized.
3	Implications of recent ways of life or economy are critically discussed, and a need for societal change is concretely stated.
4	Comprehensive social transformations are considered necessary, the existing ways of life or economy are questioned, and concrete alternative guiding principles and social goals are discussed.
5	Profound social transformations are envisaged, including changes in the recent ways of life and the economic system, which must be overcome.
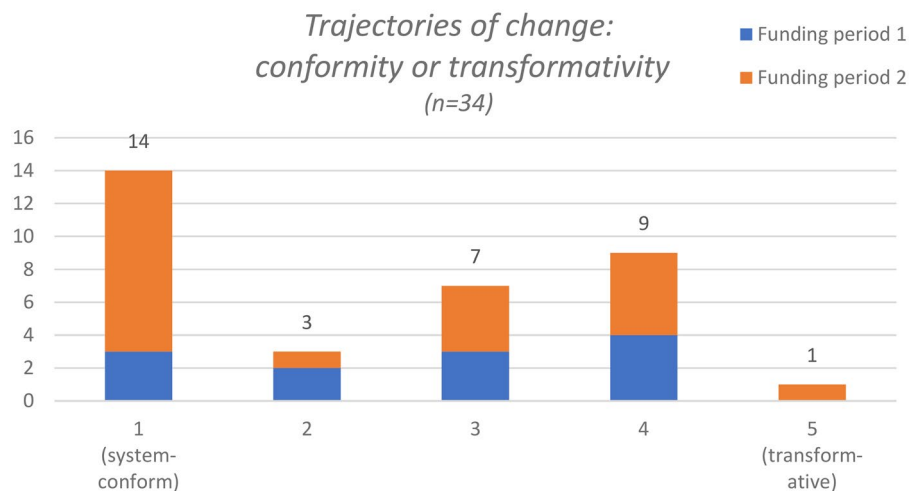
Figure 4. Distribution of the municipalities along the dimension (3) "Trajectories of change: conformity or transformativity" (without cases that do not take sufficiency into account).

The City of Göttingen (2013, 71) considered a "profound cultural change within the city society" to be necessary to "establish a resource-conserving way of living and doing business," thus focusing primarily on a changed set of values among residents, which seemed to lie largely outside the sphere of influence.

With the dimension *growth or degrowth*, the importance of economic growth and alternative economic goals was also considered in the concepts. While more than three-quarters of the concepts (78% with values 1 or 2) including all concepts without consideration of sufficiency did not question the growth paradigm, in the other concepts, the pursuit of sufficiency was taken as an opportunity to question this commitment. In this context, some municipalities proposed alternative social and economic visions, such as a degrowth society; however, such proposals usually only represented one possible development path among others (e.g., District of Osnabrück, City of Münster) or one whose achievements were postponed until the distant future (e.g., City of Kempten). Although transformative pathways were brought into the discussion, they were hardly reflected in the concrete sectoral strategies or measures.

Justice issues, as one crucial element for fundamental change, were also hardly discussed (dimension *injustice or justice*). While negative effects on social justice brought about by sufficiency measures were not discussed to a notable degree, a small group of nine municipalities (27% of all concepts with consideration of sufficiency with values 4 or 5), predominantly those from the second funding round that showed a more political understanding of sufficiency, expected to see justice-enhancing effects of sufficiency, for instance in the fields of gender or economic inequality.

Findings from the three dimensions

As an interim conclusion, we note the following relations:

1. The comparison of the funding periods shows an increase in the importance of sufficiency (first dimension) and a shift in responsibility from the individuals to the creation of favorable framework conditions (second dimension), but hardly any change in terms of social change (second dimension).
2. A strong implementation of sufficiency (first dimension) in the climate-protection concepts favors transformative perspectives (third dimension).
3. A pronounced political perspective (second dimension) on sufficiency contributes to a more integrative and comprehensive consideration of sufficiency in concrete policies. This, however, does not necessarily lead to radical transformative ideas (third dimension).
4. Concepts that have both a political-structural understanding (second dimension) and a transformative perspective of sufficiency (third dimension) view transformative processes as being both formable and in need of negotiation, which places the municipality itself in a more active and framing role.

Municipal sufficiency types

From the identified interconnections between the three dimensions, specific patterns emerge, which can be interpretatively expressed in four characteristic ideal types of municipalities (Kuckartz and Rädiker 2023, 176ff) (see Figure 5, Table 5). Not every municipality can be assigned to only one type because sometimes characteristics of different types can be found in one concept. Nevertheless, such typification helps to highlight key insights from varying sufficiency interpretations in the context of municipal climate-protection strategies.

Technophiles

We call the first type of municipalities *technophiles*. These are municipalities from the first round of funding that do not give sufficiency any or only a very marginal role in their concepts. In these cases, sufficiency is at the bottom of the hierarchy of strategies. Societal transformative goals are not found in the concepts of technophiles.

Privatizers

Privatizers like the Municipality of Steyerberg ostensibly give sufficiency greater importance in their climate-protection concept than do the technophiles. In many cases, sufficiency has been added as a stopgap function because it is not possible to realistically model the needed emission reduction in the scenarios with purely technological strategies. In this type, sufficiency is seemingly introduced on an equal footing with technical strategies. However, sufficiency is understood here as purely private action undertaken by individuals and measured in terms of energy savings, for instance as the electricity demand of a household. The responsibility for implementing sufficiency is delegated to private actors who are also not further differentiated as target groups (e.g., high-income households with higher energy consumption). In these climate-protection concepts sufficiency is rarely linked to normative goals of a more just society or a good life but is rather seen as
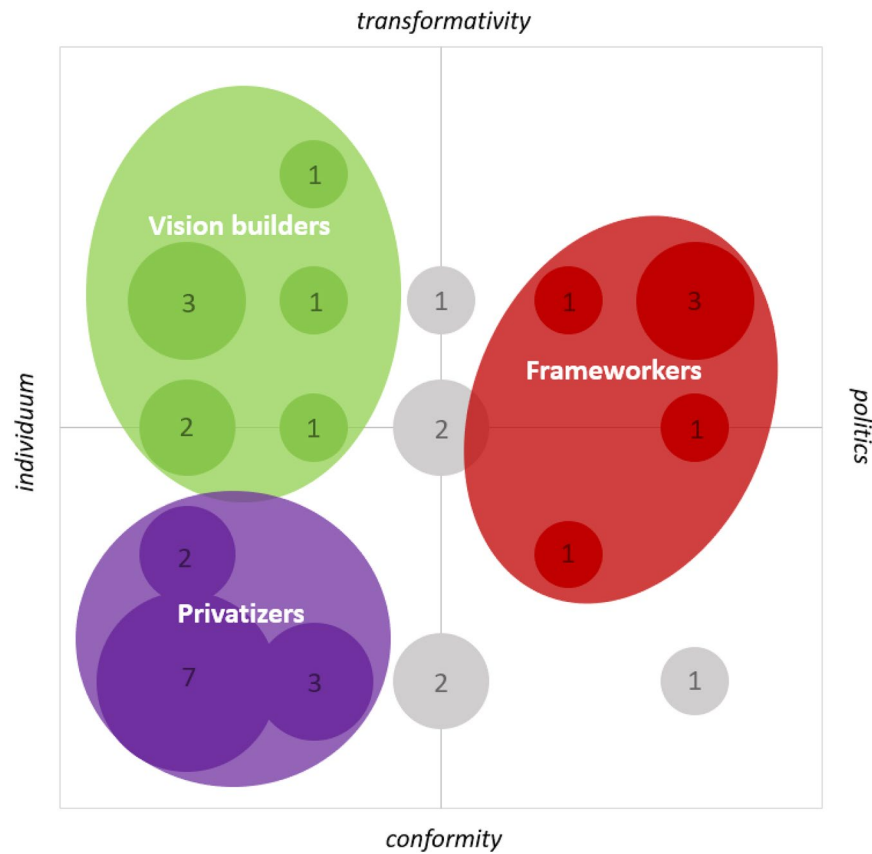
Figure 5. The types of municipal sufficiency illustrated by the dimensions "responsibilities" and "trajectories of change" (without unclassifiable cases for these dimensions, $n = 32$).
Note: The figure shows the distribution of the values along the two dimensions "trajectories of change" and "responsibilities." The size of the circles corresponds to the number of cases with the same value pairs. The colored areas show the grouping of the cases into the respective municipal types. Some cases (grey) were not assigned to a type because they contained elements of several types and could not be clearly distinguished. As a total of eight cases cannot be assigned to the "responsibilities" dimension, the seven cases of the technophile type and one untyped case are omitted from this figure.

Table 5. Characteristics of the four sufficiency types for the different dimensions.[a]

	Technophiles	Privatizers	Vision builders	Frameworkers
1) technology < > sufficiency				
2) individual < > politics				
3) conformity < > transformativity				
4) automatic < feasible > unattainable				
5) necessity < > morality				
6) renunciation < > benefits				
7) appeal < > (infra-)structure				
8) growth < > degrowth				
9) injustice < > justice				

[a]The table shows the distribution of the values in the dimensions for the respective sufficiency types on a scale of 1–5, ranging from left to right. The scale is reflected in the pair of terms mentioned on the left. The darker the color is, the more frequently this value can be determined for the sufficiency type.

■ >50% of the cases of that type; ▦ >25–50% of the cases of that type; ▢ >0–25% of the cases of that type; □ 0% of the cases of that type.

a rational means of modeling the necessary energy savings in the concepts' emission scenarios (dimension *necessity or morality*). This narrow understanding of sufficiency ultimately leads to low priority measures

that are limited to information and appeals, since the role of the municipality in such an understanding is inevitably largely passive (dimension *appeal or (infra-)structure*). Through depoliticization and the fading out

of the societal dimension of sufficiency, its transformative potential is forfeited.

Vision builders

Vision builders are primarily the municipalities from the first funding round like Göttingen or Kempten that started to attribute greater relevance to the topic of sufficiency. This group is dominated by normative considerations of sufficiency (dimension *necessity or morality*), which are closely linked to sufficiency-oriented visions of a bottom-up transformation (see *trajectories of change*). Sufficiency is usually found in a separate section on consumption, nutrition, or lifestyles and is hardly woven into the overall concept, the specific sectors, the quantitative scenarios, or the single measures. Sufficiency thus remains at an abstract level and – despite its societal consideration – is not (yet) seen as a political field for these municipalities. The *vision builders* desire a change in values that emerges out of the blue through a committed civil society (dimension *wish or feasibility*). The municipalities themselves have no active part in this envisaged change except as benevolent observers and at most motivators. Sufficiency is thus not suggested as an action-guiding principle for political or administrative decisions but above all as a normative target image of a cultural change that is morally legitimized. Often, this moral framing is also strongly underpinned with individual benefits, such as slowing down or "liberation from excess" (Paech 2016) (dimension *renunciation or benefits*).

However, in the concepts, a feasible translation of the target images into municipal action is largely missing. Formulated sufficiency measures are – similar to those of the *privatizers* – mainly limited to sensitization and motivation; however, increased levels of public participation and some structural measures are also taken up (dimension *appeal or (infra-)structure*).

Frameworkers

Frameworkers like Münster or Rietberg are municipalities that embrace the concept of sufficiency in a more application-oriented way. These jurisdictions mainly from the second funding round implemented sufficiency as an action-guiding, cross-sectoral, and sector-integrated principle that is steerable and is neither limited to private lifestyles (*privatizers*) nor to an abstract vision of the future (*vision builders*).

As with the *privatizers*, for *frameworkers* sufficiency is often rationally understood as a useful strategy that contributes to the achievement of the desired goals but does so on a more equal footing with technological approaches (dimension *morality or necessity*). However, unlike the *privatizers*, for *frameworkers* the responsibility is not delegated to individuals; rather, the focus is on foundational structures such as the built environment, providers of products and services, or fiscal instruments which shape the decision architecture for individual practices. Through the stronger concretization and operationalization of sufficiency, the local population is no longer understood as a monolithic block (*privatizers*) or a quasi-automatic source of a sufficiency turnaround (*vision builders*); rather, specific actors are addressed in various measures depending on the sector and goal. In this way, sufficiency is seen as a societal task that also addresses aspects of justice such as inequality and discrimination and does not only focus on general individual gains (dimensions *renunciation or gain*, *injustice or justice*). Although the societal transformation potential of sufficiency is emphasized, the rhetoric, unlike that of the *vision builders*, remains more reform-oriented and focuses on feasible options of municipal action (see *trajectories of change*). By doing so, the municipalities take the existing fiscal and legal frictions more into account, which partly limits transformative future visions but leads to more tangible sufficiency measures that extend beyond appeals and awareness-raising campaigns (dimension *conformity or transformativity*, *appeal or (infra-)structure*).

Discussion

Although all of the analyzed municipalities are climate-protection frontrunners, they focus on quite different priorities when it comes to dealing with the climate crisis locally; this highlights their importance as experimental fields for niche innovations and new approaches (Abel 2021; Kern 2019; Papin 2020). While in the first funding period only a few municipalities took sufficiency into account, in the second round the implementation became obligatory for the participants due to requirements of the donor agency (BMUB 2015). Accordingly, the importance of sufficiency has increased in the second funding period compared to that found in earlier studies on German climate-protection concepts (Ekardt and Hennig 2014; Leuser and Brischke 2018; Schmitt et al. 2015).

These findings confirm the general trend toward the greater consideration of sufficiency in public policy and debate, even if its importance remains significantly lower than that of technological strategies (e.g., Best et al. 2022; Callmer and Bradley 2021; Lage, Böcker, et al. 2023; Zell-Ziegler et al. 2021). At the same time, the range of prioritization

of sufficiency remains wide while the interpretations of sufficiency also show different characteristics, which corresponds to the finding of Nagorny-Koring (2019, 49) that "urban policies and measures to deal with climate change vary significantly between German cities."

Different interpretations and the consequences for climate policies

Our proposed typology of four sufficiency types reveals a range of dominant interpretations of sufficiency in municipal climate-protection concepts in Germany. As such, the typology provides a contribution to research on diverse perspectives on sustainability challenges and their possible solutions (e.g., Davidson 2014; Ferguson and Wollersheim 2023). Given that we were not able to show how the respective sufficiency policies were implemented as part of this study, we were still able to provide a few anecdotal references to concrete measures pursued by each municipal type (except for technophiles). In addition, we compared the types we developed with the classification of Lage (2022), whose three sufficiency-oriented approaches to social change largely correspond with our findings, but also show some differences. In this respect, the typification proposed in this study complements the existing classification with the specific focus on sufficiency in public policy. This can help to reveal and reflect consequences of the different, partially abridged (re-) interpretations for the actual implementation of sufficiency.

The *vision builders* are very much in line with Lage's "bottom-up approach" which describes the idea of cultural change initiated by the spread of more sufficiency-oriented individual lifestyles (Lage 2022). Municipalities of this type have focused in particular on the visionary character of sufficiency as a shift in social norms toward sustainable lifestyles. However, sufficiency is hardly woven into the specific strategies or proposed measures in the core sectors such as construction, mobility, or industry. Thus, the necessity of new strong frameworks, including on the supply side, remains largely unconsidered, as claimed by Schneidewind and Zahrnt (2014). Consequently, the bridge between abstract visions and concrete action for administration and decision-makers is missing. The municipalities take on a rather passive and observant role and see themselves at best as motivator or promoter of sufficiency (Kern et al. 2005). This can be exemplified by the City of Göttingen, which attributed an important role to sufficiency without taking it strongly into account in the Masterplans' catalogue of concrete measures. Many early implemented approaches regarding

sufficiency can be defined as soft measures, such as campaigning or supporting change agents in civil society niches (City of Göttingen 2015). Only in recent years has the city approached structural measures more systematically, such as implementing parking-space management or comprehensive measures for reducing the large living spaces of households (City of Göttingen 2020; Hörter 2019). The latter measures have been supported by a transdisciplinary research project which provided important resources and was initiated by pioneering decision-makers in local administration and science. The anchoring of sufficiency in the Masterplan represented an important starting point for today's policies, although it did not directly guide action (Bankert 2022).

The *frameworker* type closely corresponds with the "policy-making approach" in Lage (2022) which focusses on reforms of structural framework conditions in order to better enable sufficiency. Municipalities of this type anchored sufficiency as a guiding principle in various climate-relevant sectors and translated it into specific measures. Examples of the relevance of sufficiency for the *frameworkers* are the cities of Münster and Rietberg which introduced sufficiency measures quite quickly after the creation of their Masterplans. While Münster even conceived a specific sub-strategy for climate-smart decisions resulting in climate trainings for both users and providers, the City of Rietberg initiated a funding program for residents for repairing defective appliances, among other things (City of Münster 2017; City of Rietberg 2023). However, the normative character of sufficiency of some *frameworker* municipalities has receded compared to the *vision builders* which were mainly found in the first funding period; instead, sufficiency is used more as a means to an end and is not seen as worthy of moral justification. Due to the stronger orientation toward what is currently politically feasible, the visionary character of sufficiency is sometimes pushed into the background. Despite gaining importance and greater politicization of sufficiency, more radical ideas like fundamentally challenging the current economic and social system as described in Lage's "social movement approach" remain largely unconsidered. This lack in the Masterplans is hardly surprising given the involvement of very different and often incumbent stakeholders who participated in a rather compromise-oriented process. Yet, suitable strategies are urgently needed for local authorities to deal with the emerging conflicts that inevitably arise from structural sufficiency measures (Böcker, Lage, and Christ 2022).

The type of *privatizers* has framed a very narrow interpretation of sufficiency as an individual practice of energy saving without a societal dimension.

Consequently, due to its supplementary stopgap function, there is a lack of normative target images for transformative change. The *privatizers* attribute the responsibility to individuals, while structural measures are missing. This type of municipality is not directly reflected in Lage's typology but is very important to consider as it decouples sufficiency from social change by framing sufficiency as private micro-practice. This harbors the risk that the transformative potential of sufficiency and its contribution to achieving the climate targets will be lost (Spengler 2018; Winterfeld 2016). However, municipalities of this type, such as the City of Flensburg, can pursue more extensive sufficiency approaches. While sufficiency was seen as a rather private matter in its Masterplan, the city subsequently initiated the planning of a new sufficiency quarter in a transdisciplinary research process as an (infra)structural measure (Böcker et al. 2021; Christ et al. 2024). This shows that new developments can open windows for sufficiency despite the lack of a profound conceptual basis.

The fourth type *of technophile* municipalities focus, as noted above, solely on technical solutions. Rebound and growth effects are not accounted for; thus, the concepts contain serious gaps. Although selective savings can be achieved through technological strategies, there is a danger that these savings will not be sufficient to reduce emissions at the necessary speed and scale (Parrique et al. 2019; Vogel and Hickel 2023).

Following Winterfeld (2007) and Lage (2022), we suggest that an interpretation of sufficiency that combines both the political-structural basis of concrete action and a visionary perspective for normative change bears the greatest potential to work toward tackling the overall sustainability challenges like achieving climate neutrality. Still, only a few municipalities among those that attach greater importance to sufficiency have combined both dimensions to a significant extent in their Masterplans. Especially notable examples include the City of Münster or the Districts of Lippe and Lüchow-Dannenberg.

Methodological reflection and further research needs

The methodological approach that we applied in this project implies several limitations. First, as the coding was only carried out by one author, we cannot completely rule out subjectivity in the assignment of individual cases. However, the main objective of the analysis was not to achieve a completely objective classification of each individual municipality, but rather to identify dominant patterns in the different interpretations of sufficiency.

Second, the selection of Masterplan municipalities is not representative for municipal climate-protection strategies in Germany in general or beyond. However, since the explicit aim of the program was to represent a wide variety of German municipalities and to create role models, we think that the selected sample is of great importance for the discussion on sufficiency in German municipal-climate protection. The characteristics of the types might also help to reveal divergent interpretations of sufficiency for public policies that go beyond the municipal and German context.

Finally, the presentation of certain cases involving concrete implementation of specific measures highlights that the classification types should not be seen as static but rather a momentary snapshot. Changing framework conditions, such as new political majorities, civil society pressure, empowered change agents, powerful veto players, or funding programs can open or close windows of opportunity for comprehensive sufficiency measures (e.g., Bauer, Dingeldey, and Hertle 2018; Christ et al. 2024).

From the study's findings arises the need for further research in various areas, most importantly regarding the following:

- A better understanding of the influential factors that have an impact on the significance and interpretations of sufficiency in government action. These can, for example, be the role of change agents or veto players in administrations or civil society, the urgency of a current event (e.g., energy crisis), intermunicipal networks, administrative cultures, funding schemes, or civil society's degree of organization (e.g., Abel 2021; Bauer, Dingeldey, and Hertle 2018; Christ et al. 2024; Lage, Böcker, et al. 2023; Leuser and Brischke 2018).
- The interplay between legal and fiscal framework conditions at the different state levels, which currently impede structural sufficiency policies at the municipal level (e.g., Kern 2019; Knak 2021; Leuser and Brischke 2018).
- The actual implementation successes and challenges of concrete sufficiency measures in municipalities beyond those proposed in the concepts (e.g., Reckien et al. 2019). This study only analyzed proclaimed targets and names only a few exemplary actual outcomes of the announced policies. Although, according to Göpfert (2014), climate-protection concepts have a measurable effect on local implementation success, it is unclear whether and to what extent this also applies to (often controversial) sufficiency measures (Böcker, Lage, and Christ 2022).

Conclusion

Sufficiency is a crucial assemblage of strategies for not only addressing serious sustainability challenges but also for shaping transformative trajectories in climate policies. The municipal level is an important setting for negotiating, applying, and disseminating sufficiency. However, sufficiency has thus far played only a subordinate role both at the municipal and the national level.

While our analysis of 40 Masterplan municipalities in Germany shows that sufficiency seems to be becoming increasingly important, it remains to be seen whether and how this trend will continue to develop in the face of hard-fought conflicts over climate protection in many countries. In any case, the interpretation of how sufficiency is understood varies greatly, which affects the type of measures chosen. These interpretations of sufficiency differ particularly in regard to how the responsibility of actors and trajectories of change are addressed. Our results show that only a few municipalities have aspired to a profound social-ecological transformation; most of the municipalities that take sufficiency into account have addressed private households as being responsible for implementing sufficiency, while structural framework conditions are hardly taken into account.

As a result, we have identified four ideal municipal sufficiency types:

- For *technophiles*, sufficiency either plays no role or only a very subordinate role compared to technological strategies.
- *Privatizers* see sufficiency as a private practice for energy-saving purposes, which decision-makers can at best promote through information and appeals.
- *Vision builders* give sufficiency greater importance and consider sufficiency as a central element of social values changes. However, these visions are hardly translated into concrete action, and the role of the municipality is that of a rather passive, albeit well-meaning, observer of an externally-driven civil society transformation. Awareness-raising and the promotion of niche actors are the focus of many related measures.
- *Frameworkers* see sufficiency as a genuine political field in which framework conditions for sufficiency practices must be created. Transformative goals are translated into political practice by weaving sufficiency into the strategies of various climate-relevant sectors. However, such approaches tend to be reform-oriented, which means that more radical transformative perspectives on alternative futures sometimes take a back seat.

This study shows that the interpretation of sufficiency is of central interest when it comes to the transformative goals and the selection of proposed measures for climate-protection strategies. A depoliticized understanding of sufficiency can be easily integrated into technology-dominant paradigms, which risks marginalizing the idea in the sense of an individualized supplementary strategy and maintaining technological optimization as the tacit main goal. The mention of sufficiency in strategic concepts is therefore not enough to overcome the reductionist perspective of climate change as a challenge that can primarily be solved technically. Rather, overcoming such circumstances requires both a normative vision and a political understanding of sufficiency as a cross-sectoral, framework-setting guiding principle for climate protection.

Notes

1. A more sophisticated definition of which individual approaches were considered as sufficiency measures can be found in the Supplementary Material and is essentially based on Schmitt et al. (2015).
2. A list of participating municipalities can be found in the Supplementary Material. Each municipality only participated in one of the consecutive funding periods.
3. "Strategy for climate-friendly decisions" of the City of Münster and the "Sufficiency Report" of the District of Lüchow-Dannenberg, both of which deal explicitly with sufficiency and were developed in the context of the Masterplans.
4. Masterplan of Nalbach. According to Schmitt et al. (2015), this Masterplan does not address sufficiency issues.
5. The selected keywords are listed in the Supplementary Material. In the iterative process, they were continuously supplemented and are not only directly related to sufficiency, but also concern other topics that have emerged during the development of the various dimensions (e.g., "transformation," "growth," or "justice").
6. The results of the data analyses of all nine dimensions are made available in the Supplementary Material.
7. Occasionally, sufficiency strategies were mentioned without explicitly labeling them with the term "sufficiency" by calling for lifestyle changes or for changes in social practices in specific sectors. An overview of which measures were considered sufficiency in the Masterplans can be found in the Supplementary Material.

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Appendix A

List of the masterplan municipalities

Total regional authorities (Gebietskörperschaften)	41			
Municipality (Stadt / Gemeinde)	29			
District (Landkreis)	8			
Region (Kommunalverband)	4			
Municipalities	29			
Big cities (population >100.000)	11			
Medium-sized cities (20.000 – 100.000)	12			
Small municipalities (< 20.000)	6			
Funding periods	41			
1 (2012-2016)	19			
2 (2016-2020)	22			
Overall population	8,506,236			

Name	Type	Population	Federal State	Funding period
Beckum	Municipality	36,729	Nordrhein-Westfalen	2
Bensheim	Municipality	40,168	Hessen	1
Birkenfeld	Municipality	6,923	Rheinland-Pfalz	2
Braunschweig	Region (Kommunalverband)	1,130,000	Niedersachsen	2
Burbach	Municipality	14,815	Nordrhein-Westfalen	1
Cochem-Zell	District (Landkreis)	61,684	Rheinland-Pfalz	2
Emden	Municipality	50,486	Niedersachsen	2
Enkenbach-Alsenborn	Municipality	7,034	Rheinland-Pfalz	1
Flensburg (Stadt)	Municipality	87,432	Schleswig-Holstein	1
Flensburg (Region)	Region (Kommunalverband)	65,415	Schleswig-Holstein	2
Frankfurt am Main	Municipality	736,000	Hessen	1
Gießen	District (Landkreis)	267,056	Hessen	2
Göttingen	Municipality	119,177	Niedersachsen	1
Greifswald	Municipality	57,985	Mecklenburg-Vorpommern	2
Hannover	Region (Kommunalverband)	1,148,700	Niedersachsen	1
Heidelberg	Municipality	160,601	Baden-Württemberg	1
Herten	Municipality	61,669	Nordrhein-Westfalen	1
Kaiserslautern	Municipality	99,302	Rheinland-Pfalz	2
Kempten	Municipality	68,330	Bayern	1
Kiel	Municipality	247,441	Schleswig-Holstein	2
Lippe	District (Landkreis)	349,069	Nordrhein-Westfalen	2
Lüchow-Dannenberg	District (Landkreis)	48,825	Niedersachsen	2
Magdeburg	Municipality	238,478	Sachsen-Anhalt	2
Mainz	Municipality	213,528	Hessen	2
Marburg-Biedenkopf	District (Landkreis)	246,165	Hessen	1
Münster	Municipality	311,846	Nordrhein-Westfalen	2
Nalbach	Municipality	9,216	Saarland	1
Neumarkt in der Oberpfalz	Municipality	39,822	Bayern	1
Oberallgäu	District (Landkreis)	154,568	Bayern	2
Osnabrück Stadt	Municipality	165,000	Niedersachsen	1
Osnabrück Landkreis	District (Landkreis)	354,807	Niedersachsen	1
Potsdam	Municipality	171,810	Brandenburg	2
Rheine	Municipality	76,018	Nordrhein-Westfalen	1
Rietberg	Municipality	29,444	Nordrhein-Westfalen	2
Rostock	Municipality	207,513	Mecklenburg-Vorpommern	1
Sprendlingen-Gensingen	Municipality	14,441	Rheinland-Pfalz	2
St. Ingbert	Municipality	35,951	Saarland	1
Steinfurt	District (Landkreis)	357,400	Nordrhein-Westfalen	1
Steyerberg	Municipality	5,254	Niedersachsen	2
Stuttgart	Municipality	632,743	Baden-Württemberg	2
Weserbergland	Region (Kommunalverband)	377,391	Niedersachsen	2

Criteria for the selection of sufficiency measures

- Sufficiency-enhancing measures are understood as measures that aim to lead to absolute savings of energy or resources by directly or indirectly influencing consumption or production decisions, social practices, and everyday routines of residents (Schmitt et al. 2015).
- General education or information campaigns were not interpreted as sufficiency if they were not explicitly aimed at changing social practices to reduce emissions. In the case of infrastructural measures, the goal of changing social practices must be an explicit goal.
- Voluntariness or conscious decisions in favor of sufficiency practices are not necessary criteria for selection as a sufficiency measure; indirect incentive systems (e.g., through financial incentives or the redesign of building infrastructures) are also regarded as sufficiency measures, provided that the

aim of the measure is to reduce emissions by changing social practices.

- The mere mention of the necessity of individual practices (e.g., that it makes sense to switch off the lights) as abstract suggestions or ideas for private behavior were not included if they were not explicitly embedded in a municipal measure or as a strategic guiding principle.
- Technical devices like smart homes, smart meters, and so forth are not selected as sufficiency unless they are clearly aimed at regular social practices of the users that go beyond the installation and maintenance of the technology.
- All measures and strategies in which sufficiency was explicitly mentioned were selected (unless the classification clearly contradicts the above criteria, e.g., if the main focus is on solar boats, energy-efficient refurbishment, or electromobility).

List of keywords

(originally in German)

- Sufficiency, sufficient
- consumption, consume
- reduce, reduction
- culture, cultural
- behavior, practice
- lifestyle, way of life
- transformative, transformation, transform, transition
- change, changed
- fundamental, profound, radical
- just, justice
- niche
- pioneer
- growth
- economy