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# Role Model or Chilling Example- the German Mobility Transformation

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# Abstract

This case study aims to evaluate the effectiveness of the German policy strategy to implement a sustainable transport system regarding the contributions Germany has to make to fulfill its responsibilities stated in the EU NDCs (United Nations, 2015) and stay within their carbon budget to make a good contribution to the limiting of global warming and prevention of an overshoot scenario (Glavovic et al., 2021).
This assessment will be done by assessing the following research question:

*To what extent does the German transport strategy meet the characteristics of an effective, radical sustainable mobility transition based on the planetary boundaries framework and transition science?*

To find an answer to this question, as a first step, the ideal transition case must be understood in detail based on a literature review and creating a coding table with the relevant categories of the integrated theoretical framework based on transition science and the planetary boundaries framework. It will be used for a qualitative content analysis of relevant policy documents.
Scientifically, the study is motivated by the realist assumption that the German government and its mobility strategy are under the influence of the German car industry, which aims for an incremental change process that does not compromise the incumbent power structures of the car-centric mobility regime in Germany.
The evaluation of Germany's mobility strategy highlights both strengths and weaknesses. While it shows some positive aspects, there are significant concerns regarding reinforcing the car-centric regime and the need for more ambition. Therefore, the German strategy lacks crucial characteristics of an ideal, radical transition, validating the stated hypothesis.

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# 1) Introduction

This case study aims to evaluate the effectiveness of the German strategy to implement a sustainable transport system regarding Germany's contributions to fulfilling its responsibilities stated in the Nationally Determined Contributions (NDCs) (United Nations, 2015) and staying within its carbon budget.
Germany's transportation sector significantly contributes to the country's total CO2 emissions, with road transport alone responsible for around 19% of the total amount of CO2 emitted in Germany (Clean Energy Wire, 2023). Therefore, greening the transportation sector is crucial for the overall transformation of the German economy, which Germany committed to by signing various agreements (UN, 2015).
The German government has set climate policy goals and developed strategies to transform the transport sector, promoting low-carbon, multimodal, and more efficient systems. However, implementing these policies has faced challenges, and the conflicting interests of different actors make the future of mobility in Germany highly uncertain (Bank, 2022).
This raises the question of whether the German policy strategy is extensively ambitious and, consequently, whether it will ultimately prove effective in fulfilling the pledges made by the NDCs (UN, 2015).
An in-depth sector-specific case analysis of the transport policies proposed by the German government based on the implications of the planetary boundaries framework has yet to be presented to the extent of the author's knowledge.
It is vital to consider the historic affiliations of the car industry with the German government (Böckers et al., 2012), as this raises questions about the effectiveness of the German strategy due to the influence of this powerful industry.
To achieve a transformation to the extent that is necessary, the government must, according to Hagedorn et al. (2019), prioritize modes of transport that are environmentally, socially, and economically sustainable and cause a systemic change, away from the focus on individual car ownership as the primary means of transportation.

Despite the availability of knowledge from several studies by climate experts (Mattioli et al., 2018; Brown et al., 2021), it remains to be seen how the German strategy will perform. Therefore, this study aims to evaluate the effectiveness of the German transport policy, aiming to forecast whether the German system can be expected to comply with the NDCs (UN, 2015).
The evaluation of the effectiveness of the German strategy to implement a sustainable transport system holds significant scientific relevance for public administration research (Scheiner, 2020). By defining qualitative criteria and themes, the paper provides a scientific foundation for additional mobility transformation implementation research in other countries, which adds to the field of public administration research and holds relevance for researchers and policymakers. Governments worldwide are confronted with the pressing need to tackle climate change and reduce greenhouse gas emissions, emphasizing the importance of comprehending the consequences of policy interventions for effective governance.
Therefore it broadens the knowledge base on mobility transitions and bridges the gap between theory and practice.
By examining the German government's efforts to transition towards a more sustainable transport

system, this case study contributes to the knowledge base of public administration in environmental policy. It provides insights into the challenges, successes, and areas with potential for improvement in formulating and implementing sustainable transportation policies.
Moreover, this case study underscores the significance of interdisciplinary collaboration within public administration, as addressing complex issues like sustainable transportation necessitates the integration of environmental science, economics, public policy, and social sciences.
The realist school of thoughts logic and resulting assumptions that powerful actors shape the world, thus also policy to align with their interests (Prinz, 2019; Singh, 2019) will be explained in more detail in the theory section. The broader scientific relevance of this paper lies in testing the applicability of the realist logic in the German policy context. Evidence that validates this expectation would showcase the applicability of realist assumptions in the German policy context.

The insights of this paper can, on the one hand, be utilized by Ns and advocacy groups focused on environmental and climate issues to educate civil society about the direction policy is moving toward, which is necessary to enable civil society to hold policymakers accountable (Newell, 2008). Therefore, the studied issue holds significant societal relevance; the results of this study can help educate society about the direction that Germany has chosen to move towards in terms of their transport sector and consequently help understand the necessity of more drastic action if the results imply a need for it.
On the other hand, industry stakeholders, such as automotive manufacturers, transportation companies, technology providers, sustainable entrepreneurs, and investors, can, according to Tian & Ye (2018), leverage the knowledge provided by this paper to steer their businesses into profitable territory. These stakeholders might benefit from the insights of this paper when deciding which technologies, business models & projects are keen to receive political support. They can be considered worthy of financial commitment (Tian & Ye, 2018). Toyota has already tapped into the Mobility as a Service market by launching its ride-sharing platform 'Kinto,' which might inspire German manufacturers to overthink their business model (Roe, 2022). German companies with a thorough understanding of the needs of the German mobility transition might even be able to leverage their knowledge by entering public-private partnerships.
According to Temitope (2023), public administrators play a crucial role in facilitating collaboration among diverse stakeholders, including government agencies, industry representatives, civil society organizations, and research institutions, to develop and implement effective and sustainable policies. Urban & spatial planners and other bureaucrats in decision-making positions can use the generated insights to adjust their course of action and prioritize sustainability in their decision-making process (Connor et al., 2003).

Overall, evaluating the German transport policy within the context of achieving climate targets and fulfilling international commitments provides valuable insights into the transformative potential and subsequent Germany's potential as a climate leader, thus making contributions to the field of public administration.

To dive into this issue and find out more about the effectiveness of the German mobility strategy, the following research questions will be assessed in this paper:

*RQ: To what extent does the German transport strategy meet the necessary characteristics stated by the planetary boundaries framework for an effective, sustainable mobility transition?*

The relevant theoretical concepts and themes will be explored through a literature review to find an answer to this question.
After a deep dive into the literature and the integration of the relevant concepts and themes into a theoretical lens, content analysis will be conducted by creating and applying a coding table, following the sub-question:

*S1: How does the German mobility strategy score in terms of the established criteria of 1) Regime level change, 2) Niche level change, 3) cross-sectorality, and 4) timeliness, and what are*

*the expected implications regarding compliance with international climate change mitigation agreements?*

First, answering these questions requires selecting and collecting the relevant policy documents, conducting the literature review, and creating and applying the coding scheme. Evidence will be gathered that will be evaluated to enable a more profound understanding of whether the German transition strategy matches the implications of the theoretical framework and consist of sufficiently radical policies or if a path-dependent development based on incremental change will result from the strategy's implementation.
As a first step, the relevant theoretical concepts will get introduced and implemented into a theoretical framework integrating criteria for the analysis that will be applied in this paper.
Secondly, the methodology section will elaborate upon the chosen research design, the methods of data collection & analysis, and the implications of the chosen processes for the results. This section will showcase the coding scheme that will serve as a tool for the study.
Thirdly, the evidence will be presented sorted in order of the developed criteria.
After that step, the gathered evidence will be evaluated regarding implications.
Finally, a conclusion will be drawn. The findings will be set into the context of their societal and scientific relevance, answering the research questions and returning to the hypothesis.

# 2) Theoretical framework

## 2.1 Realism

Realism is a school of thought in the social sciences that emphasizes the significant role of power in shaping the world and influencing social outcomes (Prinz, 2019). According to Prinz (2019), it recognizes that actors, whether individuals, states, or organizations, pursue their own interests and exert power to achieve their goals; therefore, realism contends that power dynamics play a central role in shaping international relations, politics, and societal structures.
Singh (2019) states that it originally perceives states as primary actors and asserts that the world is a competitive and anarchic system where actors strive to maximize their power. It argues that cooperation between actors is limited and primarily driven by self-interest. Realists focus on understanding how power is acquired, maintained, and exercised, often highlighting the importance of economic strength and geopolitical influence (Singh, 2019). In the case of the German mobility policy, applying realist logic would suggest that the German government's decisions in mobility policy are heavily influenced by the car industry and its economic impact. This is framed in the following assumption:

*The significant influence exerted by the German automobile industry leads to the expectation of an incremental transition that prioritizes the maintenance of the car-centric regime*.

The car industry is assumed to be a powerful actor and to play a significant role in shaping policy decisions, regulations, and investments related to mobility, which implies that the influence of the car industry prevents the formulation and implementation of a radical mobility strategy in Germany. Assuming that an incremental transition is the desired outcome of the car industry, the result of this study has the potential to falsify or validate the assumption that the car industry's interests manifest in the transition of the German mobility sector.

## 2.2 Transition science

Transition science is a field of research that focuses on understanding the facilitation of processes required to achieve holistic and large-scale societal changes in a sustainability context, including transitions towards more sustainable mobility systems (Kotilainen et al., 2019). Therefore, it provides a suitable theoretical framework for the mechanisms and processes of transitions.
A crucial conceptual differentiation that transition science establishes concerns the different types of change processes. The two opposing types of change processes will be elaborated upon in the following section:

*1) Incremental Change*

Incremental change builds upon existing systems and tries to achieve change by layering change through a step-by-step process, colloquially called the salami tactic (Hinterleitner, 2019).
The advantage of this type of change is a lower degree of uncertainty and high predictability of

outcomes, making them feasible to implement and generally politically well accepted (Rosenbloom et al., 2019).
However, incremental change can also lead to a lock-in situation. This concept refers to maintaining current systems despite the availability of alternatives that would better suit the situation's needs. This is due to path dependency, a concept originating from the school of historical institutionalism explaining how past events and choices create sets of rules, beliefs, and norms and thus form current developments and trajectories of systems and institutions. The concept describes the phenomenon of previous investments and decisions impeding a change of direction (Liebowitz & Margolis, 1995).
It can be seen in the context of German mobility policy, where the dominance of the automobile industry led to a car-centric infrastructure, despite increasing pressure to shift towards more sustainable modes of transportation from environmental activists that call for commitment to the pledges made in various international agreements (Buzogany & Scherhaufer, 2022). Therefore, while incremental change can be effective due to its industry support leading to high feasibility, its lack of ambition and ability to achieve a transition of the necessary scale is subject to criticism from environmental activists and concerned scientists.
An example of the manifestation of this phenomenon in the past has been the focus on diesel cars as a solution for reducing greenhouse gas emissions, which was applied as a strategy in the early 2000s by the German government (B., 1995), while being presented as a solution, reinforced the lock-in effect for car-centric infrastructure and turned out to have overpromised. The recent diesel gate around Volkswagen and other car manufacturers, which caught media attention in 2015, exposed the lack of effectiveness; however, at that point, the previous investments made a change in direction more complex than earlier due to the resulting path dependency (Liebowitz & Margolis, 1995).
An actual example is the focus on electric and hydrogen cars, which might potentially reduce emissions but, on the other hand, still reinforce the car-centered regime. Thus, the lock-in effect also creates the opportunity cost that the resources invested cannot be invested into less car-centered solutions.

*2) Radical Transitions*

Opposed to this, Rosenbloom et al. (2019) state the concept of radical transitions, which are characterized by fundamental and systemic changes in institutions and behaviors. While incremental changes build upon the existing structures, radical transitions break away from the established norms, significantly disrupting the status quo. However, according to Rosenbloom et al. (2019), this disruption also creates a high degree of uncertainty and political sensitivity, as it often involves a change in the distribution of power and resources, leading to significant challenges, including political and corporate resistance and uncertainty about the outcomes.
An example of a policy perceived as radical at its introduction was the introduction of low-emission zones in Berlin in 2008. This policy restricted the entry of older, more polluting vehicles into certain city areas by requiring drivers to display a green sticker certifying that their vehicle met specific emission standards (Jiang et al., 2017).
According to Jiang et al. (2017), the LEZ policy was considered radical because it required a fundamental change in how people thought about mobility, prioritizing the health and well-being of the city’s residents over convenience or personal preference. It also required a significant shift in the types of vehicles people were driving, as many older, more polluting vehicles were no longer allowed to enter certain city areas. The policy faced some resistance from drivers and businesses but ultimately significantly reduced air pollution and improved the quality of life for residents in the affected areas.
However, it is essential to mention that radicality is always a matter of perspective and context, and today's environmental activists might classify this policy as incremental in today’s situation.
The dichotomy between radical and incremental change processes will be the most crucial conceptual differentiation, guide the methodological approach, and provide the frame for categorizing policies.
Predictive models of various climate experts, including Kevin Anderson, make it clear that the

situation's urgency requires transformative actions that challenge the existing norms and structures, highlighting the insufficiency of the past trajectory of incremental changes (Anderson et al., 2020). According to Anderson et al. (2020), Said predictions lead to a growing recognition among experts that the window of opportunity for effective climate action is too short to rely on incremental measures to meet the scale of necessary emission reduction.

A range of criteria constitutes the difference between radical and incremental transitions.
Firstly, change processes within transition science take place on two levels.
The first level, constituting the first criterion for this analysis, is the 1) regime level, which refers to the dominant system or established practices and institutions in a particular sector, such as the mobility sector. At this level, incremental transitions involve gradual modifications and improvements within the existing regime, while radical transitions entail fundamental and systemic changes that disrupt and transform the entire regime.
The second level, constituting criterion number two, is called the 2) niche level, representing the space for experimentation and innovation outside the dominant regime. Niche-level activities involve the development of alternative approaches, technologies, and practices that have the potential to challenge and eventually replace the existing regime. These niche-level innovations often play a crucial role in driving radical transitions.
Furthermore, the transition cannot occur solely within the mobility realm. Still, it must be holistic, making 3) cross-sectorality the third criterion, meaning that multiple policy sectors (e.g., energy policy, mobility policy, etc.) must be changed in an integrated manner.
Lastly, due to the importance of preventing an overshoot scenario and reaching a point of no return where crucial natural systems irreversibly get out of balance, 4) timeliness is the fourth criterion considered in this analysis.

*1) Regime level*

The first level of importance for the analysis conducted in this paper is the regime level. It can be explained as the overarching, dominant practices of production, consumption, and governance, which are considered normal, thus, culturally and socially accepted at a given time (Rosenbloom et al., 2019). According to Rosenbloom et al. (2019), Incumbent regimes are supported by power holders who profit from upholding the status quo. Regarding mobility, the automobile and fossil fuel industry can be considered the incumbent regime, as individual car ownership is currently the dominant mode of transportation in Germany (Haas, 2020).
At the production level, the German automobile industry has a strong position in the global market and is a significant contributor to the national economy (Bank, 2022). The consumption patterns are characterized by high levels of individual car ownership and usage, supported by a comprehensive infrastructure of roads and highways. Governance in German mobility is fragmented, with multiple actors at different levels of government, leading to challenges in coordinating policy measures.
Changing the current regime in the mobility sector faces several challenges, including the incumbent industries' strong economic and political power, the infrastructural lock-in of car-oriented mobility, and the social norms and practices associated with individual car ownership. These challenges require fundamental changes at multiple levels of society to enable the transition toward sustainable mobility (Stoddard et al., 2021).

*2) Niche level*

The second relevant level is the niche. This level is the micro level at which experimentation can take place, protected from the pressures of the dominant and established practices of the regime, meaning that this is the level at which innovations are incubated (Smith et al., 2010).
The innovations that are developed at this level can be scaled up. This can be challenging because it requires interaction with the regime, leading to conflicting interests between the incumbent power holders and the aspiring innovators from the niche (Rosenbloom et al., 2019). Therefore, according to Smith et al. (2010), the facilitation of the scale-up process must involve the support of niche-level

innovations in combination with interventions at the regime level to mitigate the otherwise inevitable conflict that would prevent the innovation scale-up.
For this thesis, it is unnecessary to categorize policies into the level at which they apply because the levels are closely connected, and a precise categorization into niche or regime level would impose extra efforts without providing significant benefit for the analysis.
However, the introduction of these concepts provides a valuable framework for the categorization of the policies that foster mobility innovations and technologies into radical or incremental; contributing to the goal of this analysis is the collection of evidence that allows understanding the either rather incremental or radical nature of the transition to be expected. Furthermore, the multi-level differentiation is a crucial element of the way transition science understands change processes.
Policies that facilitate technologies and innovations submitting to individual car ownership's current dominant mobility regime can be understood as vehicles of incremental change. Examples of this could be policies fostering the development of new, more efficient car engines. Opposed to that, policies aimed at facilitating technologies and innovations breaking out of the dominant paradigm fall into the category of radical.

*Cross-Sectoral*

Cross-sectorality is a crucial concept in transition science, which emphasizes the need for transition policy strategies to address multiple sectors (Bogdanov et al., 2021). This approach promotes resource efficiency synergies and increases the likelihood of a successful transition towards sustainability (Boas et al., 2016), leading to increased innovation, better use of resources, and improved social inclusion by the provision of stakeholder platforms that enable inclusive governance.
For instance, in the case of urban mobility, cross-sectoral measures could include integrating spatial design improvements with the expansion and improvement of public transport infrastructure.
However, implementing cross-sectoral measures can face institutional constraints, conflicting interests among stakeholders, and political barriers. (Aguiar et al., 2018). Promoting stakeholder participation, building trust among actors, and ensuring transparent communication and collaboration are both essential to overcome these challenges.
Some examples of projects that successfully applied the concept of cross-sectorality include integrated urban development projects that combine mobility and energy systems and circular economy initiatives that involve multiple industries and sectors, such as the project 'Smart City Vienna' (Fernandez-Anez et al., 2018)**.**
Potential challenges to be faced by implementers involve increased complexity and a resulting necessity for high coordinative capacities**.**
In transitioning towards sustainable mobility, policymakers and stakeholders have a range of policy instruments available to support this goal.
It is essential to apply a combination of diverse policy instruments to effectively promote this transition (Shiftan & Geerlings, 2012) and increase the likelihood of achieving the desired outcomes.
For example, combining regulatory measures such as emissions standards with economic incentives such as taxes or subsidies for regime-outbreaking innovations could be an approach to create a more comprehensive and practical approach to reducing carbon emissions in the transportation sector**.**
Combining diverse instruments is crucial in promoting a successful transition towards sustainable mobility. It can enhance the effectiveness of individual measures and overcome potential challenges and limitations, which is why cross-sectoral is indicated by a range of policy domains and the choice of a wide range of policy instruments.

## 2.3 The Planetary Boundaries Framework

*Timeliness*

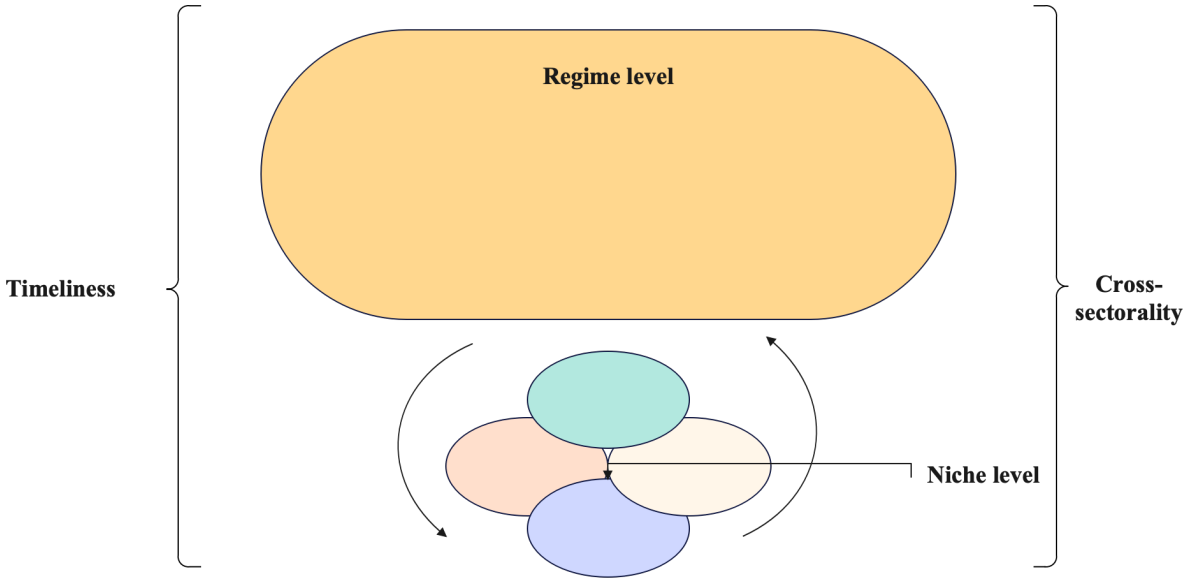
Another important criterion to identify policies as vehicles for incremental or radical change is the timeliness of transitions, which transition scientists often emphasize. They state the need for urgent action to address the environmental and societal challenges faced and argue that a longer waiting time increases the difficulty of achieving a sustainable future and increases the likeliness of exceeding critical thresholds, such as the planetary boundaries, which will be elaborated in the next section. Transition science highlights the importance of proactive, anticipatory measures to address sustainability challenges before they become crises and the need for transformative changes beyond incremental adjustments (Rosenbloom et al., 2019). The goal is the creation of a resilient and sustainable system that overcomes path dependency, which requires timeliness to avoid irreversible environmental damage. Thus, a radical transition towards climate neutrality requires timely action, which is hardly feasible through means of incremental change.
This highlights the importance of the time dimension as a critical success factor for achieving that goal.
Therefore, this paper will look closer at the time frame in which the German policy strategy will supposedly be implemented.
A helpful framework to provide concrete and measurable targets guiding the time frame of the transition process is the planetary boundaries framework (Steffen et al., 2015), which provides scientific insights into the environmental limits of the planet and the consequences that would result from exceeding these boundaries.
According to Steffen et al. (2015), nine crucial earth systems are connected to a set of natural boundaries critical to maintaining a livable planet. The boundaries of these systems are linked to the global climate goal of the Paris Agreement, which aims to limit global warming to below 2 degrees Celsius and, ideally, 1.5 degrees Celsius (UN, 2015). To achieve this goal, countries must submit their respective Nationally Determined Contributions (NDCs), outlining their policy strategies and targets to contribute to this process. The urgency to reduce Co2 emissions is highlighted by the fact that current emission forecasts show that signee governments' climate commitments and targets are insufficient to keep global warming to 1.5 degrees Celsius (Hagedorn et al., 2019). To stay within the planetary boundary and meet the Paris Agreement goals, a rapid emissions reduction of around 10% annually is, as previously mentioned, necessary. In this context, Germany's historically large polluter status and insufficient reduction rate emphasize the need for radical transitions in mobility and transport policy (Zimm & Nakicenovic, 2020).
In addition to providing concrete and measurable targets, the planetary boundaries framework can help policymakers prioritize their efforts by informing them about the consequences of different decisions and emphasizing the need for a radical transition, especially in countries with historically high polluter status.

## 2.4 Comprehensive theoretical framework

The theoretical lens developed and applied in this paper draws upon the principles of transition science to establish the relationships and interactions between the niche and regime levels while also emphasizing the overarching necessity of sector integration and cross-sectoral collaboration. Transition science provides a robust framework for understanding sustainability transitions and recognizes the importance of cross-sectoral dynamics in driving transformative change. Furthermore, integrating the planetary boundaries framework into the theoretical lens highlights the need to address environmental limits in a timely manner to ensure a sustainable future. This framework allows for the examination of the German mobility transition strategy comprehensively and holistically, considering the complex interplay between different levels and sectors. By synthesizing insights from the relevant academic literature, the theoretical lens applied in this paper provides a solid foundation for analyzing and understanding the nature of the policy strategy for the German mobility transition.

To visually represent the theoretical lens used in this study, the figure below illustrates the interconnectedness of the niche and regime levels, the importance of cross-sectoral collaboration, and the integration of the planetary boundaries framework:

*Figure 1*




Building upon these concepts, the following question will be addressed in this paper by applying the theoretical framework presented above:

*To what extent does the German transport strategy meet the four criteria based on transition science and the planetary boundaries framework for an effective, sustainable mobility transition?*

Sub questions:

*S1: What are the fundamental theoretical principles within transition science and the planetary boundaries framework are relevant for an effective, sustainable mobility transition?*

*S2: What can be said about the likely outcomes and impacts of the German policy strategy concerning international agreements, the German carbon budget, and the goal of 1.5/2 degrees?*

# 3) Methodology

## 3.1 Research Design

An exploratory single case study research design with an evaluative element is a suitable choice to answer the questions addressed in this paper. For this claim, there are several justifications. Firstly, the research aims to investigate the extent to which the German transport strategy meets the determined four criteria of the planetary boundaries' framework for an effective, sustainable mobility transition. This specific research objective requires an in-depth examination of a single case, which in this case is the German transport strategy.
According to Gerring (2004), a single case study design allows for a comprehensive exploration of the precise details and nuances of the German transport strategy (Abutabenjeh & Jaradat, 2018), enabling the researcher to delve into the complexities of the strategy's implementation, policies, and initiatives and assess them against the identified criteria of the planetary boundaries framework. By focusing on a single case, the researcher can gather rich and detailed data that provides a holistic understanding of the strategy's alignment with sustainable mobility transition principles.
After gathering the evidence, an evaluation will take place to understand the implications of the findings.
Germany is a suitable choice due to the strength of their economy and their international geopolitical influence, making them a political role model for other nations.
However, the focus on this single case inevitably leads to limits in terms of the generalizability of results. This is due to the unique historical context of Germanies' intertwinement with the car industry (Bank, 2022), which makes Germany an interesting outlier case.

## 3.2 Data Collection

The information used to form the hypothetically effective transition case criteria was collected from scientific papers, such as Kevin Anderson's papers about climate change and German mitigation policies, especially focusing on transport-carbon budgets, sustainable transport, and the planetary boundaries framework.
The data that is subject to analysis was collected from various policy documents published by the German government that contain
All documents besides 'The German Governments Climate Action Programme 2030 for the execution of the Climate Action Plan 2050' and the 'National Cycling Plan 3.0' were available and analyzed in English; the enumerated documents were only available in German.
The list of chosen documents can be found in the data appendix.

## 3.3 Data Analysis

The method of analysis chosen for this study is a qualitative content analysis of policy documents related to the German mobility transition strategy. To identify whether the policies facilitate incremental change or a radical transition, a coding scheme will be developed that applies the criteria of regime-level change, niche-level change, and cross-sectorality.
Multi-criteria content analysis is a suitable method for this research design because it allows for a systematic and rigorous analysis of policy documents based on multiple criteria, which can provide a comprehensive understanding of the policy landscape (Neuendorf, 2016). This method is particularly useful for identifying patterns and themes in large datasets of text, which can be difficult to discern through other qualitative methods (Krippendorff, 2013). A multi-criteria approach is also advantageous because it allows for a more nuanced analysis of policy documents likely to contain multiple dimensions and complexities. Overall, the multi-criteria content analysis method provides a robust and reliable means of analyzing the policy documents and generating insights into the German mobility transition strategy.

This analysis will allow an understanding of the potential of the German mobility strategy to reduce emissions in an effective and timely matter, determining if compliance with the German NDCs is likely to be achieved.

Based on the proposed research design and data collection methods, the following steps will be taken for the data analysis:

*1) Develop a coding scheme*

A coding scheme has been developed based on regime-level change, niche-level change, cross-sectorality, and timeliness criteria. The coding scheme is designed to ensure consistency in the analysis and to minimize potential biases.

| Category | Themes | Examples of Evidence |
|---|---|---|
| Regime level change | 1. Regime reinforcement (this would be interpreted as evidence for an incremental change process) | • examples/expected results for regime reinforcement evidence would be e.g.: the construction of new car infrastructure/streets, subsidies for or collaboration with fossil fuel industries, incentives for car purchases |
| | 2. Regime outbreak (this would be interpreted as evidence for a radical transition) | • an example for regime outbreak evidence would be e.g., a ban of cars within cities, higher financial burden on car ownership/use through various financial measures, the priorization/expansion of public transport systems, the priorization of sustainable individual transportation infrastructure (walking/cycling), integration with spatial planning |
| Niche level change | 1. Evidence of path dependent niche (this would be interpreted as evidence for an incremental change | • an example for a path dependent niche that facilitates incremental change would be a subsidy for a new, more efficient car engine or other car-centric |

| | | |
|---|---|---|
| | process) | technologies such as synthetic fuels, support for electric vehicles, support of other car-centric R&D activities |
| | 2. Evidence of innovative/experimental niche (this would be interpreted as evidence for a radical transition) | • an example for innovative/experimental niche development could be the support of e-scooters/alternative technologies, experimentation with on demand transportation solutions such as shared mobility services, seamless integration of multiple sustainable public/private transport modes |
| Cross sectorality | 1. Evidence of uni sectoral approach (this would manifest in policies that are solely targeted at mobility, show a lack of instrument diversity and integration, and would be interpreted as evidence for an incremental change process) | • an uni-sectoral approach could be constituted by e.g., solely implementing market-based measures (co2 certificate trade market), examples are not necessary here as the concept of uni-sectorality does not refer to specific instruments/goals, but rather results from a lack of diversity of targets/policies |
| | 2. Evidence of cross sectoral approach (this would manifest in policies targeting multiple sectors through a diverse choice of instruments, including a broad range of stakeholders and be interpreted as evidence for an radical transition) | • a cross-sectoral approach would include market-based measures combined with other instruments and addressed towards different sectors, e.g., spatial design measures combined with support of short distance transport technologies. The cross-sectorality concept refers to the integration of different goals/instruments and sectors in which these take place to ensure a |

| | | |
|---|---|---|
| | | holistic transition |
| Timeliness | 1. timely implementation | • a timely approach would, as elaborated upon involve the implementation of not only incremental measures/goals but a combination of incremental measures/goals with radical and transformative measures within the next 10 years, achieving a transformation that includes a major shift of dominant modes of transport toward sustainable private transportation modes/public transport modes within this time frame (this would lead to at least 65% emission reduction within ten years), therefore, the specific timelines for the implementation of measures will be gathered if present |
| | 2. late implementation | • a too late approach would be constituted by an implementation of transformative measures/goals which have the potential to achieve significant changes (at least 65% emission reduction) that takes longer than 10 years, leading to a breach of responsibilities |

*2) Code and analyze the policy documents*

Using the coding scheme, the policy documents will be analyzed for the presence of goals and policy instruments that are relevant to the German mobility transition strategy. The data will be

sorted, coded, and reviewed in an Atlas.ti project.
The coding process will be conducted manually, meaning it does not involve an automated coding process automatically looking for code words but rather relies on the researcher reading and manually coding the measures and goals.
This is advantageous considering the two languages of the documents and allows a deep and nuanced understanding of the data that does not rely on specific words.
To ensure reliability and consistency in the manual coding process, an intra-coder reliability test was conducted. A subset of policy documents was randomly selected (the 'National Cycling Plan 3.0' and the 'National Hydrogen Strategy'), and the same researcher who conducted the initial coding independently re-coded the subset without referring to the initial codes. This process aimed to assess the level of agreement between the initial coding and the recoding.
After comparing the initial codes with the recoded data, an agreement rate of approximately 80% was achieved. This level of agreement indicates substantial consistency in coding decisions. Discrepancies were carefully examined to identify potential sources of ambiguity or confusion in the coding guidelines.
The areas of disagreement were thoroughly reviewed, and discussions were held to refine the coding guidelines, clarify definitions, and provide additional examples where necessary. This iterative process allowed for the improvement of coding consistency and the development of a shared understanding of the coding scheme.
While this intra-coder reliability test cannot prevent bias to the extent that an inter-coder reliability test could have, it still reduces vulnerability within the feasible means of this project, which is why this measure has been chosen.

*3) Evaluate the findings*

The data analysis will be used to identify whether the policies facilitate incremental change or a radical transition and to what extent the German transport strategy meets the four determined criteria of the planetary boundaries framework for an effective, sustainable transport transition. The findings will be interpreted and discussed considering the research questions and sub-questions. For this matter, a qualitative content analysis will be used.

Overall, the data analysis involves a systematic and rigorous analysis of policy documents based on multiple criteria, which can provide a comprehensive understanding of the policy landscape and generate insights into the German mobility transition strategy.

# 4) Empirical Results

In this paragraph, the results generated by the analysis will be documented. They will be ordered per the previously developed categories from the coding table. For all categories, relevant evidence, or

absence of evidence for the different themes identified to be relevant will be listed. The applied method of analysis is content analysis, specifically a code document analysis conducted with the software Atlas.ti.

## 4.1 Evidence for Regime level Change

*Regime Reinforcement*

The selected documents include a multitude of evidence to reinforce the car-centric regime that could be found.
The 2014 published document 'The German Government's Climate Action Programme 2020' already provides evidence suggesting reinforcement of the car-centric regime. The section 'Climate change mitigation in the transport sector' sets the goal to 'significantly increase electric vehicles' market share to one million by 2020 and six million by 2030'. Furthermore, one of the measures proposed by this document to make the transport sector more climate-friendly is setting incentives for fuel-saving driving techniques 'by issuing vouchers for fuel-saving training courses for people buying a new car.'

In the document 'The National Hydrogen Strategy,' section 'Status quo, fields of action and markets of the future,' subsection 'International trade,' it is stated that in the future hydrogen market, 'current fossil fuel exporters may play a particularly prominent role if they offer great potential for hydrogen production,' suggesting the maintenance of power structures of the current regime.

The strategic plan 'Climate Action Plan 2050' provides evidence suggesting policies reinforcing the current car-centric regime.
First, it lines out that it 'does not contain any rigid targets; a technology-neutral and innovation-friendly approach characterizes the goals it sets,' implying that the phase-out of combustion engines will not necessarily take place. Furthermore, this section mentions that the strategy is 'seeking to instigate the changes needed without structural breaks.'
The strengthening of 'the role of technologies in the field of electric mobility in Europe' and 'the switch to alternative drives and fuels' also hints that cars will remain among the mainstream modes of transport, and the mentioning of 'the use of e-fuels/power-to-X, for example,' which 'mean, that the internal combustion engine remains an indispensable option' stress the validity of this assumption, alongside the statement that 'the use of lightweight body technology and the integration of alternative drive systems, in particular, electric drives' will be a technical and economic challenge for the automobile industry' validates the implication that the current players in the car-centric mobility regime will remain in positions of power.

This direction is underpinned in 'The German Governments Climate Action Programme 2030 for the execution of the Climate Action Plan 2050', which provides an overview of the measures to be implemented to achieve the 'Climate Action Plan 2050's goals and mentions the promotion of the development and market penetration of alternative fuels and electronic vehicles through financial incentives.

However, 'The 2030 Federal Transport Infrastructure Plan' also contains several examples of evidence suggesting a reinforcement of the current mobility regime.
The document mentions several times, the first time already in the foreword, that structural maintenance is given 'precedence over upgrading and new construction' and that 'Investments will be places where people and the economy derive the greatest benefit.'
The section 'National scheme of priorities for federal transport infrastructure that meets the current and future needs' states, ' The objective of the prioritization of the strategy is to use the available financial resources such that they represent value for money.'
In the section 'Effects of FTIP implementation - what benefit will the investment have, 'subsection 'Efficient, safe and secure passenger and freight transport,' it is mentioned that 'key priorities of the plan are to ensure mobility in the provision of passenger and freight transport services and to enhance

the competitiveness of companies in Germany.'
More evidence for a reinforcement of the current regime can be found under the section 'Tasks and objectives of federal transport infrastructure planning - what do we want to achieve?' under the subsection 'The objectives of the FTIP 2030'. Namely, it is stated that 'the evolution of transport infrastructure is not primarily a nature conservation and environmental protection measure.' Furthermore, it is stated that 'the deployment of alternative fuels infrastructure' will be created, suggesting reliance on cars as means of transport in the section 'Transport infrastructure beyond the FTIP - What else are we doing to evolve our transport system?' subsection 'Sustainable, ecological and safe mobility.'
As a last point of reference, the section 'The scientific foundation - the methodological basis for a transparent FTIP,' subsection 'Main results' predicts that 'Motorized passenger traffic will continue to increase.'

In the section 'Overarching measures,' subsection 'Research and Development' of the document 'The German Governments Climate Action Programme 2030 for the execution of the Climate Action Plan 2050', it is mentioned that a joint research initiative has been developed in collaboration with, among others, also the mineral oil companies, which further highlights the reinforcement of the current regime by allowing the incumbent power holders to exert their influence upon, and therefore integrate their interests in the future of transport in Germany.

The Federal Aviation Strategy provides evidence for a regime reinforcement of the current flying consumption patterns, suggesting 'Research and development in new, cleaner and lower-consumption technologies that can compete on the market as innovations' to reach the aim 'to make the air transport system efficient and safe, also for future needs and users' under the sub-section 'Investments in research and development.'
This evidence is complemented by proposals to 'Coordinate and sustain image campaigns both industry-wide and instigated by individual companies' among a range of measures to improve the aviation and tourism industry.

*Regime outbreak*

On the contrary, several instances of evidence hinting at an outbreak of the car-centered regime could be identified. Two of these are in the document 'Climate Action Plan 2050'. Both can be found in the 'Targets & Measures' section in the subsection 'Overarching Goals & Measures.'
The first evidence concerns the target of 'eliminating environmentally harmful subsidies,' suggesting reallocating these subsidies towards more sustainable national, European, and international endeavors. The second piece of evidence found in the same subsection of the same document refers to measures 'under the Programme of Sustainability Measures in the area of mobility, including video conferencing, "job tickets" (season tickets paid for by the employer under an arrangement with the local public transport provider), company bicycles, electric bicycles, offsetting schemes for unavoidable business trips and an energy-efficient vehicle fleet.'

Other evidence for an outbreak out of the regime can be found in the document 'The National Hydrogen Strategy,' under the section 'Hydrogen: status quo, fields of action and markets of the future,' and the subsection 'Hydrogen as a collaborative European project.' It suggests the application of hydrogen-powered mobility solutions 'In a wide range of sectors - such as local public passenger transport (buses, trains), parts of heavy-duty road transport (trucks), commercial vehicles (e.g., for use in construction work or agriculture and forestry) or logistics' to 'complement battery-powered electric mobility.'

Most evidence for an outbreak of the car-centric regime can be found in the document 'National Cycling Plan 3.0'.
The evidence is spread throughout the whole document making it unreasonable to cite every single one with remarks to their respective sections & subsections.

Targets include the development of an 'attractive cycling infrastructure that is understandable to everybody,' the construction of 'accessible and high-quality parking facilities, which should take place at the expense of motor vehicle traffic, 'education on the health benefits of cycling,' the establishment of bicycles for employees, the support of
Cycle tourism' to support sustainable urban economic development, the establishment of bicycles for 'Cargo and commercial transport,' and as primary means of transport for commuters integrated with public transport.
These changes should be supported by 'doubling subsidies' averaging 'around 30 Euro per person'.
Also, a 'central coordination office for the German cycling network' will be set up, which will communicate 'regularly with regional and federal states, tourist organizations and ADFC.'
Several measures will be conducted to progress the transition, such as funding programs, contract research, model and demonstration projects, innovation hubs/digital hubs, hackathons, and innovation awards.

However, while the promotion of biking and public transport indeed should be part of a holistic radical transition, 'The German Governments Climate Action Programme 2030 for the execution of the Climate Action Plan 2050' includes several pieces of evidence that imply a different understanding of the bigger picture and suggests that replacements of cars by these more sustainable means are not part of the strategy.
In the section 'Measures in the Sectors,' the sub-section 'Transport' states that the set reduction goal requires a technology-open strategy focused on leveraging innovation to make climate-friendly alternatives more attractive to ensure societal acceptance of the measures. Evidence for a clear roadmap for mobility to break out from a car-centered mobility approach through tough regulatory standards is absent in the document; the evidence hints at a rather market-based approach.

## 4.2 Evidence for Niche level change

*Path dependent niches*

The examined documents exhibit several cases of evidence where niches that suggest a path-dependent development reinforcing the current regime are part of the strategy.
Firstly, the 'Climate Action Plan 2050', the facilitation above of lightweight body technology, and the support of electric and alternative fuel vehicles provide evidence for the lack of ambition to overcome the current regime.
Also, 'The National Hydrogen Strategy' predicts a surge of demand for hydrogen by 2030, also resulting from the transport sector, mainly because of fuel-cell driven electric vehicles, mentioned in the section 'Hydrogen: status quo, fields of action, and future markets.'

This path-dependent development can be found in the 'National Cycling Plan 3.0', which mentions that an emphasis is put on the development of 'Safety technologies in motor vehicles,' which will 'be made mandatory in new vehicles,' mentioned in the section 'Living the vision: More, better and safer cycling,' subsection 'Cycling & people.'
This showcases that further technological dependency on the automobile industry is not tackled as an issue but rather reinforced through the German strategy.

But also, 'The 2030 Federal Transport Infrastructure Plan' suggests in the section 'The results - 269.6 billion euros for a network able to meet the challenges of the future', subsection 'Transport infrastructure beyond the FTIP - What else are we doing to evolve our transport system?' that the German strategy entails the deployment of 'charging and refueling infrastructure for electricity, hydrogen, and natural gas,' which,' would reinforce the dominance of the use of cars as a means for passenger transport.

*Experimental/innovative niches*

In the document 'Climate Action Plan 2050', two pieces of evidence can be found that give an insight into the experimental & innovative niches that will be a focus of the German mobility transition strategy.
Under the section 'Targets and measures', subsection 'Climate action in the buildings sector,' it is mentioned that 'Towns and cities and their surrounding regions must be more closely linked by green corridors that also act as fresh air corridors,' and 'that the instruments used are flexible and not limited to any one technology. They must be open to all to consider anticipated technological developments. While this is not a mobility measure, it is still indirectly related because greening cities will make sustainable individual transport modes more attractive, such as walking and cycling. The concrete experimental niches supported are, e.g., 'spatial planning pilot projects and experimental housing and urban development projects.'
Besides that, a particular emphasis is put on 'The potential of cycling as means of transport - both for short and long distances,' mentioned in the following section named 'Climate action and mobility.'

A more detailed elaboration with evidence showcasing the nature of these plans is provided in the 'National Cycling Plan 3.0'.
In the subsequent subsection, 'Cycling & business,' it is mentioned that 'The Federal Government, federal states and local authorities will support demonstration projects that enable all relevant target groups to get to know and try out innovative products and services as well as infrastructure solutions,' as well as that 'The Federal Government, federal states and local authorities will support model projects and innovation hubs.'

## 4.3 Evidence for Cross-sectorality

*Uni-sectoral*

No evidence suggesting a uni-sectoral policy strategy could be identified.

*Cross-sectoral*

Plenty of evidence gathered from the analysis of the selected documents suggests a cross-sectoral approach to the German policy strategy.
The summary section 'In the Climate Action Plan 2050, the German government has agreed for the first time on sectoral targets which set the framework up to 2030 for the proportional reduction of greenhouse gases in the areas of action considered'.
In the subsection 'Selected strategic measures,' it is outlined that 'The strategy will address emissions from cars, light and heavy commercial vehicles and issues related to GHG- (Greenhouse gas-) free energy supply, the requisite infrastructure and the interlinking of sectors (through electric mobility).'
In the section 'The path toward greenhouse gas neutrality in Germany,' subsection 'Transformation of the economy and society by 2050', this vision gets reinforced; it is stated that the transition requires technical and economic as well as societal and cultural changes, and that 'the German government will do its utmost to ensure the best possible coordination of all individual measures.'
In the section 'Targets and measures', subsection 'Climate action in the buildings sector,' the need for 'Modern technologies, use of sustainable building materials and intelligent spatial and urban planning' is underpinned, which 'must include providing environmentally friendly transport options that are (easily) accessible and within walking distance.'
The role of digitalization is also mentioned, named as 'the trend towards increasing networking, particularly using information and communications technology.'
In the section 'Climate action and mobility, the instrument choice, which includes funding of electric

mobility and financial incentives for choosing sustainable transport, can be found; remarkably, the selection of instruments does not have any ban on combustion engines.

In 'The National Hydrogen Strategy, in the section 'Governance for the National Hydrogen Strategy,' the appointment of a 'National Hydrogen Council' is mentioned, which is 'made up of 26 high-level experts from business, science and civil society who are not part of the public sector'.
This shows the ambition to work with a range of stakeholders that broaden the knowledge horizon of the German government, supporting 'the State Secretaries' Committee through proposals and recommendations for actions in implementing and enhancing the Hydrogen Strategy.

However, also 'The 2030 Federal Transport Infrastructure Plan' highlights the importance of cross-sectoral collaboration and the inclusion of private stakeholders in the first section called 'Challenges and problem-solving approaches - how do we fund transport infrastructure?' through the planning of a new batch of private-public partnership projects that are intended to serve infrastructural maintenance and creation needs effectively.

The importance of the integration of biking is highlighted in the 'National Cycling Plan 3.0'.
In the section 'Living the vision: More, better and safer cycling,' subsection 'Cycling & politics,' the strengths of biking are elaborated upon, which 'lie especially in shorter and medium distances.'
This creates a need for 'housing developments with connections to public transport and express bicycle links, thus making cycling attractive for commuters', highlighting the importance of integrating mobility and spatial development policy.
In the subsection 'Cycling and people,' the integration of biking with cultural and educational policy is pointed out 'to promote a bicycle-friendly mobility culture in politics, administration, business, academia, and society.'
In the section 'Fields of action,' subsection 'Innovation & Digitalisation,' the importance of ITC with the biking system is elaborated upon to utilize 'flexible forms of service and automated systems in public transport and at mobility service providers', as well as the necessity for integrated urban planning creating a 'city of short distances.'

## 4.4 Evidence for Timeliness

*Late implementation*

A multitude of evidence implying a late implementation could be identified. This evidence was found in 'The Climate Action Plan 2050'.
The first section, called 'Summary of the Climate Action Plan 2050', subsection 'The goal: extensive greenhouse gas neutrality by 2050', clarifies that the goal is to be climate neutral by 2050.
This is confirmed in the section 'The path toward greenhouse gas neutrality in Germany', subsection 'Target setting and description of the pathway up to 2050', where it is stated that 'The interim goal of reducing greenhouse gas emissions by at least 55 percent no later than 2030 is backed by milestones in the individual areas of action in the Climate Action Plan', confirms that the reduction follows a relatively slow speed compared to the ideal transition elaborated upon earlier.
Furthermore, the analyzed documents lack terms of clarity regarding clarity of the timeline of implementation. While various goals are set, the time frame for implementation is not explained in detail, making it hard to estimate the feasibility of the set goals.

*Timely implementation*
No evidence suggesting a timely implementation could be identified.

## 4.5 Overview of Evidence

*An overview of the frequency of evidence for the different criteria is presented below.*
*Although this paper does not conduct a quantitative analysis, it helps to understand the ambiguity of the evidence for regime- and niche-level change and what has been found regarding the clear evidence suggesting cross-sectorality and the lack of evidence for a timely transition.*
*It is essential to mention that these numbers can be misleading, e.g., they do not indicate the quality of the evidence found, which interprets ambiguous scores, such as the ones of the regime and niche level change, impossible without a closer look at the concrete evidence.*

*Figure 2*

| CRITERION | FREQUENCY OF EVIDENCE |
|---|---|
| REGIME REINFORCEMENT | 37 |
| REGIME OUTBREAK | 28 |
| PATH DEPENDENT NICHE | 19 |
| EXPERIMENTAL NICHE | 17 |
| CROSS-SECTORAL APPROACH | 29 |
| UNISECTORAL APPROACH | 0 |
| LATE IMPLEMENTATION | 10 |
| TIMELY IMPLEMENTATION | 0 |

# 5) Evaluation

## 5.1 Strengths

The evaluation of regime outbreak characteristics in the German government's mobility strategy reveals a notable strength in several areas. Firstly, the strategy demonstrates a commitment to taking sustainability seriously by providing evidence regarding regime-level change. This shows Germany's understanding of breaking out of the car-centric regime. Action in that regard can be seen in eliminating environmentally harmful subsidies. Additionally, the strong support for biking, evident through the doubling of biking infrastructures, showcases a proactive approach to prioritizing non-motorized transportation over car-centric options. Implementing this behavioural change is one of the four most impactful actions for reducing individual co2 emission footprints (Wynes & Nicholas, 2017). The ambition to make bikes the new company car further indicates a shift towards promoting more sustainable mobility choices. Integrating biking with public transport and emphasizing spatial planning and urban development highlight a comprehensive and interconnected approach to creating

sustainable and liveable cities. These characteristics collectively underscore the strength of the German government's mobility strategy in fostering a regime outbreak towards more sustainable and environmentally friendly transportation options.

The strategy showcases openness to various technologies instead of favoring one specific solution, which can accelerate technological innovation in the sustainable mobility sector (Turoń, 2022). Lastly, integrating information technology into the transportation sector underscores the strategy's commitment to leveraging technological innovations such as big data and the Internet of Things for sustainable and efficient mobility solutions within cities (Bibri, 2018).

Another strength is the strong evidence for cross-sectorality, which is shown by integrating mobility with information technology, which enhances the efficiency of transportation systems and promotes collaboration across different sectors. This integration signifies the recognition of the interconnectivity between technology and mobility. Moreover, the strategy's emphasis on integrating spatial design and urban development with mobility policy demonstrates a holistic approach (Boyle et al., 2021), promoting liveable and sustainable cities. Lastly, by acknowledging the multidimensionality of the transition, the strategy recognizes that the shift toward sustainable mobility requires not only technological and economic changes but also cultural and societal shifts.
The lack of evidence for a uni-sectoral transition underpins the cross-sectoral of German policy strategy.

## 5.2 Weaknesses

Besides its strengths, the German policy strategy also entails various weaknesses.
First, the evidence suggesting the maintenance of power structures mentioned in the context of the future hydrogen market makes the potential of the German strategy to lead to an outbreak out of the car-centric regime questionable.
This concern amplifies after considering the set priority of infrastructural maintenance over new construction, suggesting a reinforcement of the current regime.
The prediction of growth rates of motorized transport provides further insight into the high likelihood of this event's manifestation.

Another weakness is the evident facilitation of path-dependent niches that could further the difficulty of breaking out of said regime by providing incremental innovations leading to continued path dependency (Stoddard et al., 2021).
These niches entail the mentioned lightweight body technology for cars and the support of alternative fuels such as hydrogen and gas, and reliance on electric vehicles through the construction of infrastructure for these technologies.
These decisions can strengthen the path dependency and make a future outbreak out of the car-centric regime more costly and thus politically, socially, and economically less attractive due to high transaction costs.

One additional severe drawback of the analysed strategy is the aimed timeline. The targeted reduction rate of 55% by 2030 does not comply with the recommendations of experts who suggest a need for an annual reduction rate of around 10% (Anderson et al., 2020), and the goal of climate neutrality by 2050 underpins the lack of ambition for radical and timely action.

In general, the chosen documents provided an insight that allows a broad understanding of the German government's strategic goals, but the implementation's operational details still need clarification. This makes it hard to speculate about the feasibility of the goals.
However, even assuming the best case of a smooth and on-time strategy implementation, the choice of strategic goals makes the seriousness of the German government's action against climate change questionable.
The evidence clarifies that a roadmap with radical measures moving away from car-centric mobility

does not exist. The strategy is innovation focussed and techno-optimistically oriented. It prioritizes societal acceptance and political & economic popularity by sacrificing more disruptive and ambitious measures in favor of incremental steps to improve the efficiency of cars. This trade-off is ultimately bound to reinforce path dependency. This becomes clear from the evidence that clearly shows that infrastructure will incrementally be upgraded, that the research & development of car-centric technologies receives support, and that alternative fuels and electric mobility are presented as a clean solution that makes breaking out of the car-centric regime as well as changing mobility consumption attitudes in general, e.g., regarding aviation, unnecessary.

The strategy needs more ambition to challenge existing consumption patterns and power structures and prioritizes societal acceptance and economic benefit over the approval of the urgency to take radical action. Thus, it can be seen as an attempt to greenwash Germany's relatively unambitious climate change mitigation action.

By investing in improving the efficiency of cars, maintaining, and expanding car-centric infrastructure, and collaborating with the incumbent power incumbents, namely the big oil companies, a future break out of the future regime becomes more expensive due to previous investments. It makes further incremental efficiency improvement measures more attractive and logical to prevent occurring transaction costs resulting from a change of direction. Thus, it can be said that the oil and car industry in Germany successfully worked towards incorporating their interests into the German mobility strategy, leading to a politically supported lock-in situation.

# 6) Limitations

One area for improvement of the applied design & methods is the risk of oversimplification due to the straightforward operationalization of indicators through a qualitative coding scheme. Nevertheless, in this case, the benefits of a simple methodology outweigh a more complicated research design which would have resulted in a lack of time and low feasibility.
An area for improvement of the chosen scope is the need to consider the strategy's funding more. Analyzing the financial dimension is out of this project's scope, making it vulnerable.
In the worst case, the policies are effective regarding instrument choice and strategic direction, but the funding needs to be increased, leading to ineffective implementation.
Another consideration regarding scope is that only documents with a clear relationship with transport & mobility policy were chosen. However, this could lead to missing out on the bigger picture and possible hidden synergies or conflicts.
Additionally, due to the non-weighted design of the final evaluation, the results of the application of the content analysis are likely to not give a simple answer to the question of how the German strategy can be expected to perform. This is a strength and weakness at the same time, but worth to mention.
Another potential area for improvement is the reliance on the assumptions of the planetary boundaries' framework and its validity. The complexity of climate modeling makes it impossible for non-specialists to assess the correctness of these predictions, but this is a usual practice for incorporating the research of others.
A weakness connected to the reliance on the planetary boundaries framework must be acknowledged in terms of the too heavy focus on the environmental dimension, leaving social acceptance issues and economic considerations out of the equation (Kazancigil et al., 2013).
Moreover, social acceptance could be the bottleneck of ambitious and controversial plans, as the government in charge could be composed of entirely different actors than the actual one, making societal support necessary for the success of the German mobility transition.
Recent surveys by Statista (2023) rate the current 'Ampel' government composed of social democrats (SPD), the green party (Bündnis 90/ Die Grüne), and the liberal party (FDP) as rather unpopular. Recent discoveries of nepotism within the federal environment ministry involving high-level officials of the green party endanger the credibility and integrity of this vital institution and the reputation of the green party, thus leading to a decrease in trust in the Government and the policies it proposes

(WDR, 2023).
Recent surveys also predict a surge in the popularity of the right-wing party 'Alternative für Deutschland,' which criticizes climate protection efforts and questions the effect of man-made emissions on the extent of global warming (Statista, 2023). The reasons for these developments are multidimensional and complex. However, they stress the role of political uncertainty and how it makes predictions difficult.

# 7) Discussion & Concluding Remarks

Regarding sub-question *S1*, it can be said that the German strategy exhibits some strengths, especially regarding cross-sectorality, but includes significant weaknesses concerning the remaining criteria. The government supports spatial planning projects, cycling safety technologies, and demonstration projects for innovative products and services that could, combined with different measures, facilitate a radical and regime-outbreaking transition.
However, there is evidence that reinforces the path-dependent development of the current regime through the support of path-dependent, car-centric innovation, such as the promotion of lightweight body technology and the deployment of charging and refuelling infrastructure for cars.
The German policy strategy exhibits cross-sectoral, emphasizing the coordination and integration of various sectors, including transport, energy, buildings, and digitalization. Stakeholder engagement and the inclusion of private stakeholders are also mentioned.
In terms of timeliness, there is no evidence of timely implementation. The Climate Action Plan 2050 sets the goal of extensive greenhouse gas neutrality by 2050, with an interim goal of reducing emissions by at least 55 percent by 2030.

Therefore, returning to the main research question *RQ*, evaluating the German government's mobility strategy reveals a mixed picture regarding its alignment with the ideal transition towards sustainable mobility. While the approach demonstrates strengths such as support for biking, and integration of technological innovations and digitalization, it also exhibits significant weaknesses that hinder its transformative potential. The evident maintenance of power structures, emphasis on infrastructural maintenance, facilitation of path-dependent niches that reinforce the car-centric regime, and lack of ambition and timeline, in combination with unclear operational details, raise concerns about the strategy's ability to lead to a breakout from the car-centric regime and achieve the necessary emissions reductions.

In response to the first research question regarding the match with the ideal transition, it can be concluded that the German policy strategy partially aligns with some of the criteria defining an ideal transition. Still, it also contains significant elements of regime reinforcement and path dependency, which deviate from perfect growth and make it reasonable to say that overall the German transition resembles the concept of an incremental change process rather than a radical shift.

The scientific implications of this study regarding the hypothesis from the introduction hint that the automobile industry indeed operated as a powerful actor and succeeded in manifesting its interests in the German mobility policy strategy. Therefore, the realist assumption has yet to be falsified, validating realist logic to be suitable in making predictive assumptions about the actor and process dynamics of sustainability/mobility transitions, providing ground for further transition research based on realist assumptions.
Thirdly, due to the specific features of this particular research design, further research with a focus on the financial resources provided to the different means of transport would allow a more precise understanding of the priority setting of the German strategy, as the financial resources with which the policies are backed up are a crucial success factor, which has not been looked upon in enough detail due to the scope of this research.
Lastly, this paper opens the door to comparative case study research that sets the German strategy into comparison with other countries' policy plans, which could exhibit interesting differences due to the unique historical context of the German affiliation with the car industry, which would further test the hypothesis of the German car industries influence as a causal factor for the manifestation of the German strategy.

The practical and societal implications of these findings are alarming. The reinforcement of the car-centric regime favors those who can afford to own and operate vehicles while disadvantaging low-income individuals and marginalized communities. This exacerbates existing inequalities in access to transportation, limits mobility options for vulnerable populations, and contributes to social exclusion.

It sets incentives for investors to focus on car-centric innovation, which receives ongoing political support, leading to a favorable business environment for car-focused companies. This has the potential to slow down the development of alternative, more sustainable technologies & business models.
Due to Germany's significant role as a political & economic leader, this could lead to other countries using the German lack of ambition as justification not to implement transitions of necessary scale and radicality. In the worst case, this would lead to a globally significant noncompliance with international agreements due to the present prisoner's dilemma (Magli et al., 2021), resulting in the predicted consequences of warming exceeding 2 degrees.
NGOs and sustainability interest groups will be required to use these insights strategically in changing public perception by educating civil society about the reality of the German lack of ambition and the associated consequences.
Further collaboration between NGOs, researchers, and concerned policymakers focussing on evidence-based policymaking could serve as a strategy to counter the influence of the German automobile industry that hinders the facilitation of a radical transformation with the potential to comply with the pledges made in the NDCs.

# 8) References


Abutabenjeh, S., & Jaradat, R. (2018). Clarification of research design, research methods, and research methodology. Teaching Public Administration, 36(3), 237–258. https://doi.org/10.1177/0144739418775787

Anderson, K., Broderick, J., & Stoddard, I. (2020). A factor of two: how the mitigation plans of 'climate progressive' nations fall far short of Paris-compliant pathways. Climate Policy, 20(10), 1290–1304. https://doi.org/10.1080/14693062.2020.1728209

Bank, M. (2022, August 17). Die Macht der deutschen Autolobby in Brüssel | LobbyControl. LobbyControl. https://www.lobbycontrol.de/lobbyismus-und-klima/die-macht-der-deutschen-autolobby-in-bruessel-23194/

Bibri, S. E. (2018). The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability. *Sustainable Cities and Society*, *38*, 230–253. https://doi.org/10.1016/j.scs.2017.12.034

Boas, I., Biermann, F., & Kanie, N. (2016). Cross-sectoral strategies in global sustainability governance: towards a nexus approach. *International Environmental Agreements: Politics, Law and Economics*, *16*(3), 449–464. https://doi.org/10.1007/s10784-016-9321-1

Böckers, V. (1910). Pull-Forward Effects in the German Car Scrappage Scheme: A Time Series Approach. DICE.

Boyle, A. E., Leggat, G., Morikawa, L., Pappas, Y., & Stephens, J. C. (2021). Green New Deal proposals: Comparing emerging transformational climate policies at multiple scales. *Energy Research and Social Science*, *81*, 102259. https://doi.org/10.1016/j.erss.2021.102259

Brown, A. L., Sperling, D., Austin, B., DeShazo, Fulton, L., Lipman, T., Murphy, C. G., Saphores, J., Tal, G., Abrams, C., Chakraborty, D., Coffee, D., Dabag, S., Davis, A. S., Delucchi, M. A., Fleming, K. L., Forest, K., Sanchez, J. A., Handy, S. L., . . . Yang, A. L. (2021). Driving California's Transportation Emissions to Zero. RePEc: Research Papers in Economics. https://doi.org/10.7922/g2mc8x9x

Buzogány, A., & Scherhaufer, P. (2022). Framing different energy futures? Comparing Fridays for Future and Extinction Rebellion in Germany. *Futures*, *137*, 102904. https://doi.org/10.1016/j.futures.2022.102904

B., C. B. (2006). shaping environmental regulation through technology demonstration: evidence from the diesel vehicle industry. *Massachusetts Institute of Technology, Cambridge, MA 02139, USA*. 9th International Conference on Technology Policy and Innovation "SCIENCE, SOCIETY AND SUSTAINABILITY," United States of America

Climate change: No 'credible pathway' to 1.5C limit, UNEP warns. (2022, October 27). UN News. https://news.un.org/en/story/2022/10/1129912

Fernandez-Anez, V., Fernández-Güell, J. M., & Giffinger, R. (2018). Smart City Implementation and discourses: An integrated conceptual model. The case of Vienna. *Cities*, *78*, 4–16. https://doi.org/10.1016/j.cities.2017.12.004

Forsa Sonntagsfrage zur Bundestagswahl (RTL, n-tv) 2023 | Statista. (2023, June 27). Statista. https://de.statista.com/statistik/daten/studie/953/umfrage/aktuelle-parteipraeferenz-bei-bundestagswahl/

Germany's greenhouse gas emissions and energy transition targets. (2023, April 4). Clean Energy Wire. https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets

Gerring, J. (2004). What Is a Case Study and What Is It Good for? American Political Science Review, 98(2), 341–354. https://doi.org/10.1017/s0003055404001182

Glavovic, B., Smith, T. W., & White, I. (2021). The tragedy of climate change science. Climate and Development, 14(9), 829–833. https://doi.org/10.1080/17565529.2021.2008855

Global Monitoring Laboratory - Carbon Cycle Greenhouse Gases. (n.d.). https://gml.noaa.gov/ccgg/trends/

Global Warming of 1.5 ºC —. (2018). IPCC Report. https://www.ipcc.ch/sr15/

Guisinger, A., & Smith, A. (2002). Honest Threats. Journal of Conflict Resolution, 46(2), 175–200. https://doi.org/10.1177/0022002702046002001

Haas, T. (2020). Cracks in the gearbox of car hegemony: struggles over the German Verkehrswende between stability and change. *Mobilities*, *15*(6), 810–827. https://doi.org/10.1080/17450101.2020.1817686

Hagedorn, G., Kalmus, P., Mann, M. E., Vicca, S., Van Den Berge, J., Van Ypersele, J., Bourg, D., Rotmans, J., Kaaronen, R. O., Rahmstorf, S., Kromp-Kolb, H., Kirchengast, G., Knutti, R., Seneviratne, S. I., Thalmann, P., Cretney, R., Green, A., Anderson, K., Hedberg, M., . . . Hayhoe, K. (2019). Concerns of young protesters are justified. Science, 364(6436), 139–140. https://doi.org/10.1126/science.aax3807

Hinterleitner, M. (2019). Salami tactics and the implementation of large-scale public projects. Journal of European Public Policy, 26(11), 1696–1714. https://doi.org/10.1080/13501763.2018.1544654

Jakob, M., Lamb, W. F., Steckel, J. C., Flachsland, C., & Edenhofer, O. (2020). Understanding different perspectives on economic growth and climate policy. Wiley Interdisciplinary Reviews: Climate Change, 11(6). https://doi.org/10.1002/wcc.677

Jiang, W., Boltze, M., Groer, S., & Scheuvens, D. (2017). Impacts of low emission zones in Germany on air pollution levels. *Transportation Research Procedia*, *25*, 3370–3382. https://doi.org/10.1016/j.trpro.2017.05.217

Johansson, D. J. (2021). The question of overshoot. Nature Climate Change, 11(12), 1021–1022. https://doi.org/10.1038/s41558-021-01229-w

Kazancigil, A., & Makinson, D. (2013). World Social Science Report 2013. In OECD eBooks. Organization for Economic Cooperation and Development. https://doi.org/10.1787/9789264203419-en

Keleher, H. M. (2013). Policy scorecard for gender mainstreaming: gender equity in health policy. Australian and New Zealand Journal of Public Health, 37(2), 111–117. https://doi.org/10.1111/1753-6405.12027

Kotilainen, K., Aalto, P., Valta, J., Rautiainen, A., Kojo, M., & Sovacool, B. K. (2019a). From path dependence to policy mixes for Nordic electric mobility: Lessons for accelerating future transport transitions. Policy Sciences, 52(4), 573–600. https://doi.org/10.1007/s11077-019-09361-3

Kotilainen, K., Aalto, P., Valta, J., Rautiainen, A., Kojo, M., & Sovacool, B. K. (2019b). From path dependence to policy mixes for Nordic electric mobility: Lessons for accelerating future transport transitions. Policy Sciences, 52(4), 573–600. https://doi.org/10.1007/s11077-019-09361-3

Krippendorff, K. (2013). Content analysis: An introduction to its methodology (3rd ed.). Sage Publications. DOI: 10.4135/9781483381411

Neuendorf, K. A. (2016). The content analysis guidebook (2nd ed.). Sage Publications. DOI: 10.4135/9781483381480

Lahm, B. (2020). A history of the global carbon budget. Wiley Interdisciplinary Reviews: Climate Change, 11(3). https://doi.org/10.1002/wcc.636

Liebowitz, S. J., & Margolis, S. B. (1995). Path Dependence, Lock-In, and History. *The Journal of Lac, Economics and Organization*. https://doi.org/10.1093/oxfordjournals.jleo.a036867

Mattioli, G., Lucas, K., & Marsden, G. (2018). Reprint of Transport poverty and fuel poverty in the UK: From analogy to comparison. Transport Policy, 65, 114–125. https://doi.org/10.1016/j.tranpol.2018.02.019

Newell, P. (2008). Civil Society, Corporate Accountability and the Politics of Climate Change. Global Environmental Politics, 8(3), 122–153. https://doi.org/10.1162/glep.2008.8.3.122

Nie, P., Chan, W., & Hong-Xing, W. (2021). Technology spillover and innovation. *Technology Analysis & Strategic Management*, *34*(2), 210–222. https://doi.org/10.1080/09537325.2021.1893294

Prinz, J. (2019). Principles, practices and disciplinary power struggles in political theory. European Journal of Political Theory, 19(2), 270–280. https://doi.org/10.1177/1474885119857588

Rau, H., & Scheiner, J. (2020). Sustainable Mobility: Interdisciplinary Approaches. *Sustainability*, *12*(23), 9995. https://doi.org/10.3390/su12239995

Roe, J. (2022). Exploring the prospect of shared mobility solution focused on car sharing. 디지털예술공학멀티미디어논문지, *9*(1), 71–84. https://doi.org/10.29056/jdaem.2022.03.07

Rosenbloom, D. I. S., Meadowcroft, J., & Cashore, B. (2019). Stability and climate policy? Harnessing insights on path dependence, policy feedback, and transition pathways. Energy Research and Social Science, 50, 168–178. https://doi.org/10.1016/j.erss.2018.12.009

Shiftan, Y., & Geerlings, H. (2012). *Transition Towards Sustainable Mobility*. Google Books. https://books.google.com/books?hl=de&lr=&id=k8w36HNRQH8C&oi=fnd&pg=PR9&dq=transition+science+policy+instruments&ots=vE7v65xL6T&sig=hNTDlPJUkvNIw3i3UUS4hnQ_pPw

Singh, R. P. (2019). Liberal Theory in International Relations - A Realistic Assessment of the Era of Globalization. Jindal Journal of International Affairs, 7(1), 103–122. https://doi.org/10.54945/jjia.v1i3.87

Smith, A., Voß, J., & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy*, *39*(4), 435–448. https://doi.org/10.1016/j.respol.2010.01.023

Steffen, W., Richardson, K., Rockström, J., Cornell, S., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., De Vries, W., De Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223). https://doi.org/10.1126/science.1259855

Stoddard, I., Anderson, K., Capstick, S., Carton, W., Depledge, J., Facer, K., Gough, C., Hache, F., Hoolohan, C., Hultman, M., Hällström, N., Kartha, S., Klinsky, S., Kuchler, M., Lövbrand, E., Nasiritousi, N., Newell, P., Peters, G. P., Sokona, Y., . . . Williams, M. (2021). Three Decades of Climate Mitigation: Why Haven't We Bent the Global Emissions Curve? Annual Review of Environment and Resources, 46(1), 653–689. https://doi.org/10.1146/annurev-environ-012220-011104

Temitope, T. (2023). Investigating Innovative Models of Governance and Collaboration for Effective Public Administration in a Multi-Stakeholder Landscape. *International Journal Papier Public Review*, *4*(2), 18–28. https://doi.org/10.47667/ijppr.v4i2.209

Tian, X., & Ye, K. (2018). How Does Policy Uncertainty Affect Venture Capital? Social Science Research Network. https://doi.org/10.2139/ssrn.2910075

Turoń, K. (2022). Open Innovation Business Model as an Opportunity to Enhance the Development of Sustainable Shared Mobility Industry. *Journal of Open Innovation*, *8*(1), 37. https://doi.org/10.3390/joitmc8010037

Umweltbundesamt (2023). Treibhausgas-Emissionen. https://www.umweltbundesamt.de/themen/klima-energie/treibhausgas-emissionen

United Nations. (2015). UNFCCC Paris Agreement. UN Climate Change.

WDR. (2023). *Habeck und der Fall Graichen: Schmutzkampagne oder Vetternwirtschaft?* WDR.de.

Wynes, S., & Nicholas, K. A. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, *12*(7), 074024. https://doi.org/10.1088/1748-9326/aa7541

Zimm, C., & Nakicenovic, N. (2020). What are the implications of the Paris Agreement for inequality? *Climate Policy*, *20*(4), 458–467. https://doi.org/10.1080/14693062.2019.1581048

# 9) Appendix

## 9.1 List of documents

- The German Governments Climate Action Programme 2020
- The German Governments Climate Action Programme 2030 for the execution of the Climate Action Plan 2050
- Federal Transport Infrastructure Plan 2030
- Climate Action Plan 2050
- National Hydrogen Strategy
- National Cycling Plan 3.0
- Federal Governments Aviation Strategy for Germany