Master's Thesis – Master Sustainable Business and Innovation

A shadow on Solar Mobility: the impact of failure on socio-technical system configurations

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Abstract

Introduction:
This thesis examines the societal challenge of transitioning towards sustainable mobility, emphasising the significant impact of individual actors on the transition's speed and direction. As the adoption of electric vehicles increases worldwide, different mobility niches start to emerge. Solar Electric Mobility, led by the Solar Electric Vehicle manufacturer Lightyear, sits between energy and transport as a potential next step in sustainable mobility. The bankruptcy of Lightyear, however, puts forth the question of how capabilities of a firm and its constraints lead to transition failure and what impact Lightyear's failure has on the direction and configuration of the solar mobility niche.

Theory:
The study's theoretical framework focuses on sustainable transitions with the multi-level perspective and the impact of business models and the business model design space on transitions. The thesis explores the interaction between the micro-level of the firm and the macro-level while recognising the underexplored role of failure in transitions.

Methodology:
A Socio-Technical Configuration analysis was conducted on the solar mobility niche before and after the failure of Lightyear. This semi-quantitative case study conducted expert interviews and built a document stock of internal and grey literature. The findings were coded and transformed into network models to understand the dynamics in transitions and reconfigurations after the failure.

Results:
Lightyear had a central role in the niche and was a major hub that connected most actors and concepts. The niche reconfigured after the failure of Lightyear and other (Solar) Electric vehicle manufacturers filled the void with less focus on solar electric vehicles' legitimacy through policy and more emphasis on Vehicle Integrated Photovoltaics throughout all niche dimensions.

Discussion/Conclusion:
This thesis contributes to understanding sustainable transitions' dynamics, particularly the impact of failures on a micro level and how they influence the macro-level socio-technical system configuration. The solar mobility niche highlights the importance of shared responsibility for a niche and finds that a niche can reconfigure in a more resilient structure better suited to be assimilated by the regime. Mission-oriented innovation policy should be adaptive to the needs of emerging pathways, whilst firm leadership should focus on aligning its mission with its capabilities.

Executive summary

This thesis critically explores the dynamics of failure in sustainable mobility transitions, focusing on the solar mobility niche exemplified by the bankruptcy of Lightyear. This research aims to understand how failures within solar mobility, on a micro-level, impact the broader macro-level socio-technical system and influence the direction of the transition towards sustainable mobility.

Key findings:

1. Lightyear's role in the niche was pivotal. However, the firm did not possess the capabilities and resources to fulfil that position, which led to its failure and significant reconfigurations within the niche.
2. The niche has shifted from differentiating from electric vehicles to assimilating into the electric vehicle regime as the focus shifts from Solar Electric Vehicles to Vehicle Integrated Photovoltaics.
3. The niche has stabilised to a more balanced reconfiguration where industry, market and policy actors are more equally involved and closer aligned to the cultural, technological, market, and industry concepts needed to grow a healthy niche.

Recommendations:

- Policymakers are advised to develop adaptive frameworks that can evolve with emerging technology and market dynamics that bridge between sectors of interest. This helps sectors like solar mobility, ensuring actors receive the required support and legitimacy.
- Policymakers need to provide adequate tools for firms who find themselves in the scale-up phase. Scale-ups can yield positive externalities and return the investments made to start-ups.
- Stakeholders within solar mobility need to diversify responsibility and not heavily rely on single key players. This can enhance resilience and encourage research and development that is more in line with the demands of society.
- Firms in solar mobility must periodically reevaluate their missions with their capabilities. This helps mitigate risks and ensures the sustainable growth of the niche and firm.

These findings and recommendations will help reduce the impact of failure on the health and direction of solar mobility and ensure a sustainable mobility transition that meets the needs of society. Lessons from failure will contribute to a more nuanced understanding of successful transitions.

1. Introduction

The mobility transition toward sustainability is a grand societal challenge that requires the collective effort of different actors (Voegtlin et al., 2022). However, the success or failure of individual actors can significantly impact the speed and direction of the transition (Bidmon & Knab, 2018). As innovations grow and develop into a mature niche, it can expand its boundaries and challenge or transform the existing regime, shifting the transition pathway. However, a niche can equally be rejected from the regime for various reasons, from institutional constraints to market failures or organisational challenges (Geels, 2006). Since a limited number of organisations are active in a niche, the rejection of a niche and reconfiguration of a socio-technical system can presumably be led back to the activities of a few entrepreneurs (Elmustapha & Hoppe, 2020).

Electric vehicles (EVs) are now well-established alternatives to fossil fuel cars and have seen a dramatic increase in adoption worldwide (Maybury et al., 2022). With the uptake of EVs slowly increasing and the socio-technical regime shifting through policies in place like the European Union ban on fossil fuel cars in 2035 or the increase in charging infrastructure, EVs could shift into the regime soon (European Parliament, 2022; Figenbaum, 2017). Nevertheless, transitions are a moving target, and new technologies and businesses emerge to create niches and sub-systems. Sharing platforms, different energy sources, alternatives to cars, and public transport innovations happen alongside each other, uncertain which innovations become the dominant design. Whether it is E-bikes, ride-sharing, service platforms, or personal vehicles, all have a differing sense of agency and conceptual basis to further a sustainable transition(Geels, 2020).

One example is Lightyear, a once highly awarded startup in the Netherlands that built the world's first commercially available Solar Electric Vehicle (SEV) (Lightyear, 2023). Lightyear was a widely praised and supported company seen as the leader in solar mobility and poised to bring solar technologies into the Electric Vehicle regime. Lightyear started production on its first exclusive series personal vehicle in November 2022, yet in January of 2023, with the production of the exclusive series underway and Lightyear's mass-market model announced, Lightyear unexpectedly filed for bankruptcy. With the loss of a leader in the niche, it will likely take several more years for SEVs to enter the market, creating a transition that might never happen or a failure.

Notably, Lightyear's experience is not unique within the context of sustainable mobility initiatives. GreenMo, the Dutch market leader in rental E-bikes and E-motor scooters, and VanMoof, the trendy E-bike manufacturer once hailed as the 'Tesla of E-bikes', both filed for bankruptcy in January and July of 2023, respectively. Similar to Lightyear, VanMoof envisioned a sustainable alternative to Internal Combustion Engine (ICE) vehicles but also encountered financial hardship. Despite their praise, leadership position, and technological and business success, the bankruptcy of these companies highlights a pattern of failures that ought to be further understood to clear up the underlying challenges and limitations facing actors in the mobility sector striving to further a sustainable transition.

Examining such failure is valuable and necessary to understand development as it provides a more holistic understanding of a transition (Bauer, 2014). Failure is often an overlooked area of research. There is a bias towards success even though failure, as the opposite of success, should receive equal attention. Failure, in its simplest definition, is the lack of success, the omission of occurrence or performance (Merriam-Webster Dictionary, 2023). Entrepreneurial failure is multifaceted, with more than one conceptualisation for failure (Jenkins & McKelvie, 2016). Failure in socio-technical transition research has multiple framings depending on the accounts. Transition failures are linked to dynamics of stagnation, destabilisation, and reconfiguration (Turnheim & Sovacool, 2020).

The scientific background of this research is rooted in transition studies and business model innovation (BMI) literature. The interrelation between transitions and business models (BM) remains an area that requires further research. Aagaard et al. (2021), in one of the first book-length studies of the role played by business models in sustainability transitions, acknowledge the literature gap and argue that further research is needed to clarify the relationship between micro-level actors and macro-level systems. Transition studies recognise the role companies, particularly, can play as vessels for the diffusion of technology and essential for societal transitions (Sarasini & Linder, 2018; Wells & Nieuwenhuis, 2012). Likewise, the socio-technical system influences how business models are designed and developed (Stubbs & Cocklin, 2008). However, the impact of an individual firm is yet to be fully understood. Furthermore, despite its importance, the role of failure in mobility transitions research is an underexplored topic (Turnheim & Sovacool, 2020)

This research aims to understand the impact of failure in transitions and how the failure on a micro level can influence the configuration of a socio-technical system on a macro level. What constraints do actors face, and how do they reflexively interact within the system? Why does an organisation fail, and how can the failure of one organisation have a consequence on the overall larger transition? This results in the following research question: *How do entrepreneurial capabilities and activities influence, and are influenced by, the dynamics of the solar mobility sector, and what is the impact of failures on the reconfiguration and overall direction of the socio-technical system?* By answering this question, this thesis will help provide insights into the impact of failure on the direction and speed of a transition and what interventions reduce the barriers for innovations to enter the mobility regime and improve niche development to prevent transition failure.

Turnheim and Sovacool (2020) highlight a tendency in the scientific literature to focus on realised or desirable transitions, often overshadowing the multifaceted nature and common occurrence of failure in sustainability transitions. The bias towards 'winners' may have inadvertently diminished the role of failure in transition studies (Bauer, 2014; Turnheim & Sovacool, 2020). This thesis seeks to address this gap by conducting a Socio-Technical Configuration Analysis on the failure of Lightyear in the context of Solar Mobility, aiming to enrich the literature and reduce the selection and cognitive biases by purposely examining a case of failure within a community. The underrepresentation of 'failed' transitions does not lessen their significance, as understanding why specific pathways are not realised is paramount (Rip & Kemp, 1998). The failure of a single initiative can influence systemic dynamics and trajectories, providing invaluable insights into the complex interplay of factors that hinder sustainable transitions. By studying success and failure comprehensively, this research aims to cultivate a more holistic understanding of transition dynamics, informing more effective strategies and interventions for future sustainable endeavours.

This thesis will first provide background information on the case of Lightyear and solar mobility, followed by a theoretical section on the Multi-Level Perspective, business models, and transition failures. The methodology will explain the socio-technical configuration analysis (STCA) that is used to present the results and, in the discussion and conclusion, will contextualise the thesis findings.

2. Background

This chapter will first define what an SEV is, then a brief overview of the macro and meso level system dynamics are given that provide information on external forces that affect solar mobility. Then a more detailed overview of the niche is given which is followed by a more detailed description of Lightyear and the events leading to its bankruptcy. Finally, other examples of failure in E-mobility in north western europe are given.

2.1 The solar mobility sector

SEVs have primarily remained in the realm of engineering challenges and prototyping with only universally agreed-upon definitions agreed upon after companies like Sono and Lightyear first sought to commercialise SEVs. In 2022, the European Parliament defined SEVs as; "highly energy efficient motor vehicles equipped with a powertrain containing only non-peripheral electric machines as energy converter with an electric rechargeable energy storage system, which can be recharged externally, also equipped with vehicle-integrated photovoltaic panels" (Groothuis & Grudler, 2022, p. 5). A SEV is a highly efficient EV that can use solar panels to charge itself and provide power to the drivetrain.

The transport sector generally shares the same macro-level landscape pressures with solar mobility. Factors of landscape changes include the increasing importance of sustainability considerations, urbanisation, climate awareness, uptake of low-carbon solutions, stricter environmental policies, rising oil prices, alternative modes of transport, supply chain shocks due to the Covid-19 pandemic, and increased demand for energy independence due to the Russian invasion of Ukraine (Köhler et al., 2020).

The meso level, or socio-technical regime, refers to the dominant actors, networks, structures, and institutions that dictate the socio-technical change in a pathway (Fuenfschilling & Truffer, 2014).

Although the dominant regime in mobility is still the ICE automobility, the EV vehicles transition pathway has the most substantial momentum to substitute ICE as the next regime as EV adoption is increasing steadily (Köhler et al., 2020; Statista, 2023). Relative to Solar mobility, Battery Electric Vehicles (BEV) are the socio-technical regime even though EVs are still a niche compared to the ICE industry. These regime actors and attributes include incumbent EV manufacturers, policies and regulations related to passenger cars, charging infrastructure, road infrastructure, electricity net, societal norms and practices, and branch organisations like the 'rijwiel-industrie' or RAI.

The micro level, or niche, is a protected space for new technologies to emerge and develop (Geels, 2006). Solar mobility is at the intersection of the Energy and transport systems and has actors from both the photovoltaic and EV sectors. The Alliance of Solar Mobility (ASOM) is the Trade Association for Solar Mobility, where researchers collaborate and advocate for solar mobility. The Partners of ASOM include the most active actors in the niche and provide a representative overview of the Solar Mobility Niche. An overview of all partners, including those who have left since February 2023, with their size, sector and country, can be found in Figure 1 (ASOM, 2023). Most of the companies active in solar mobility can be found in the Netherlands and Germany and are start-ups or small firms of less than 50 people. The majority of organisations originate from the Solar Energy sector and have branched off to develop PV solutions for the transport sector. Other organisations like Nissan, Toyota, AGC, and AGP are Multinational incumbents who have small research teams dedicated to solar mobility or are part of a supply chain in energy or transport.

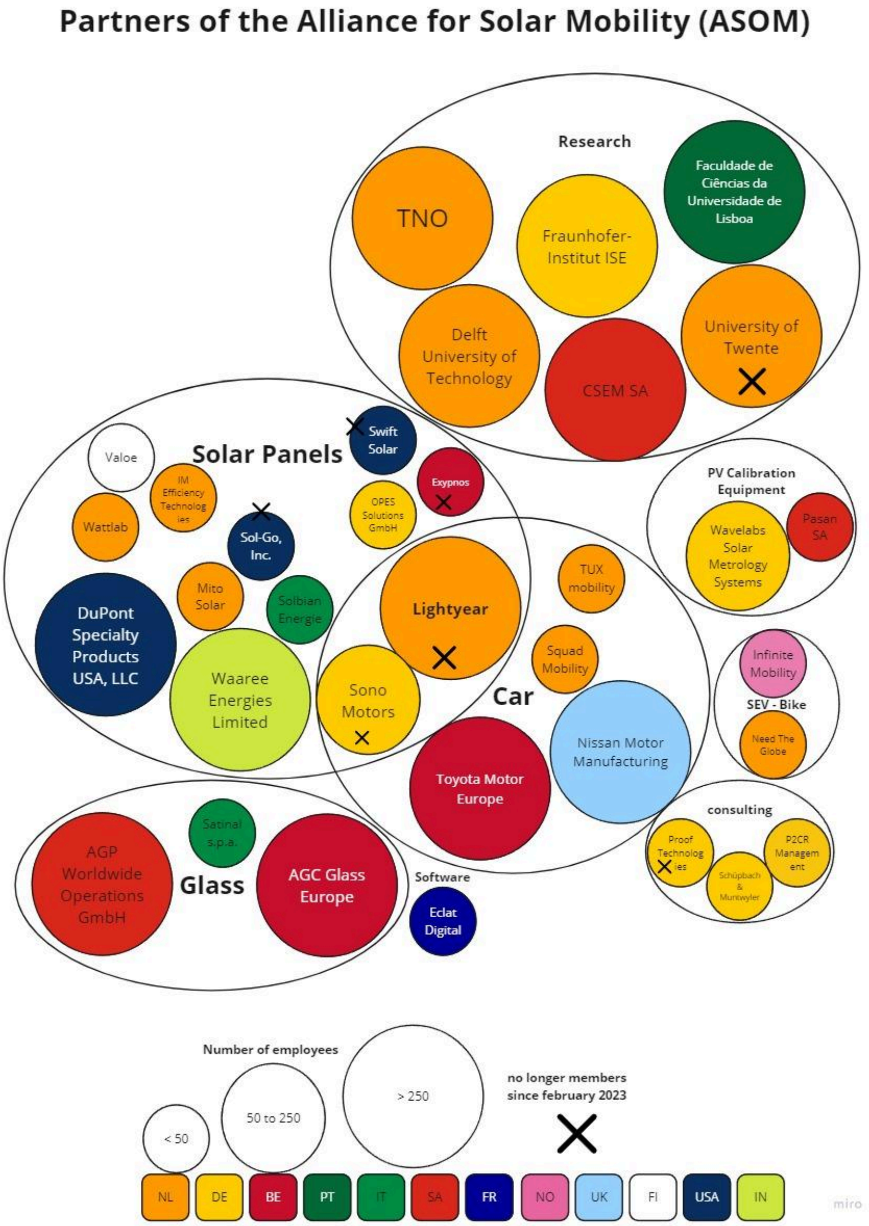

Figure 1. overview of the alliance for solar mobility (source. ASOM, 2023)

2.2 The case of Lightyear

Lightyear, a Dutch SEV manufacturer, was founded in late 2016 as 'Atlas Technologies BV' after its founders won the World Solar Challenge championships four times. With its parent company, Atlas Technology Holding, and its other subsidiary, Lightyear Layer BV, Lightyear focused on developing proprietary solar energy technology and building SEVs. Located in Helmond, the Netherlands, Lightyear's mission was to achieve "Clean Mobility for everyone, everywhere" through two commercial production solar-electric passenger vehicles, the *Lightyear Zero,* a limited edition luxury vehicle and the planned *Lightyear Two,* a mass market model. Lightyear also worked on Vehicle Integrated Photovoltaics (VIPV) for other vehicle manufacturers through *Layer*, and

Lightyear *Energy* was developing an energy system and smart charging solution for SEVs. The founders of Lightyear sought to commercialise these technologies and, after raising 200 million Euros in investments, proceeded to develop the first commercially available SEV. An overview of Lightyear's organisational structure can be found in Figure 2.

Figure 2. an overview of lightyear's organisational structure (Lightyear, 2022).

Lightyear Zero's design was focused on efficiency, featuring a 625km range on a 60-kWh battery and the ability to generate its energy through a 5m^2, 1.05 kW solar panel, potentially covering 1000 km between charges. Most of Lightyear's research and development efforts were put into these vehicles to differentiate themselves from regular BEVs through their focus on efficiency and energy generation, making them less resource-intensive and dependent on charging infrastructure. While SEVs represent an innovative step towards sustainable mobility, the road to diffusion and market success is as uncertain as any other novel approach to mobility.

Lightyear's development plan involved producing the limited-edition Lightyear Zero, a proof-of-concept vehicle that costs 250 thousand Euros, which would fund the development of the more affordable mass-market Lightyear Two. The Lightyear Zero started production in November 2022; at that time, a hiring slowdown and 6-month cash reserve with optimistic funding prospects were announced. In December 2022, Lightyear held several events for investors to unveil the first concepts of the Lightyear Two. In January 2023, however, when 'a handful' of Lightyear Zeros had been produced, the company became insolvent and was declared bankrupt on 26 January 2023.

2.3 Examples from the E-Mobility sector

While academic contributions provide valuable insights into the dynamics of transition failures and the firm's impact in niche and regime interactions, expanding on real-world business examples is essential. Some notable examples of companies have successfully carved out a niche for themselves. Internationally successful companies such as Tesla, Polestar, Rivian, and Uber and Dutch national successes like Felyx, Cowboy, and Biro have rapidly expanded and firmly established their presence in the market. However, alongside these success stories, it is crucial to expand on real-world business examples that faced hurdles. Recent failures offer lessons and insights that can further illuminate the challenges and intricacies of mobility transitions:

- GreenMo, an electric ride-sharing company with 35,000 vehicles across 7 European countries, filed for bankruptcy on February 15, 2023. According to the bankruptcy report, the cause is wrongly estimated growth expectations and an aggressive acquisition strategy in a stagnating market. Other underlying causes include poor financial and administrative organisation and insufficient consolidation and integration of acquisitions and expansions (Udink & Ebels, 2023).
- VanMoof was declared bankrupt in July 2023 after it had suffered an 81 million Euro loss in 2021 and a similar loss in 2022. According to the bankruptcy report, this was due to supply chain issues, the delayed launch of two new models, and technical design problems with its current models (Padberg & De Wit, 2023).
- Sono Motors was the second largest producer of SEV passenger vehicles and VIPV technology. Sono Motors cancelled its SEV passenger car program before it reached production in February 2023 after it failed to secure funding after 45,000 pre-orders, citing financial market instability and streamlining of the business (Sono Motors, 2023).

From a business perspective, the case of Lightyear is also interesting. GreenMo and VanMoof's failures are more discrete and framed as disappointing performances, breakdowns, or crises, yet ride-sharing E-mobility platforms and E-bikes persist. On the other hand, Sono and Lightyear's failures are more systemic or processual and framed as system weaknesses and reconfiguration dynamics (Turnheim & Sovacool, 2020). Although Sono managed to shift its focus to become a technology supplier, Lightyear went bankrupt, and its new business has focused on a mass-market passenger car SEV with no SEVs on the market until then.

Given the distinctiveness of Lightyear's situation, a focused case study on Lightyear and solar mobility is both relevant and necessary. Lightyear pioneered its niche, unlike other businesses, yet its failure lacks a clear and comprehensive explanation. A case study into Lightyear and solar mobility will offer a deeper, more nuanced exploration into the intricacies of its operational challenges, and the broader transition dynamics it navigated. This approach is innovative as it merges the concepts of transition failure and business model innovation, filling a critical gap in the existing literature. By delving into Lightyear's journey, we can gain invaluable insights into the complexities of niche innovation, regime stability, and the pivotal role of business models in transition success or failure.

3. Theory

To understand what socio-technical and entrepreneurial constraints led to failure of lightyear and the impact this has had on solar mobility, several key theoretical concepts need to be understood. First, the concept of sustainable transitions, with a focus on the multi level perspective, and transition failure will be reviewed. Secondly, BMs and the business model design space with its impact on transitions will be elaborated.

3.1 Sustainability Transitions

3.1.1 The concept of Sustainable Transitions

Rotmans et al. (2001, p. 16) define a transition as "*a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms.*" A sustainable transition builds upon this idea of a gradual, continuous change process but underlines the socio-technical system shift to a more sustainable mode of production and consumption. The transformations are multi-dimensional and long-term and can be technological, societal, and/or institutional (Markard et al., 2012). Sustainability transitions require a particular level of governance to guide the direction and form of the transition. Over an extended period, multiple actors need to coordinate and (re)distribute power and resources (Smith et al., 2005). Theories of transition ask how a system changes from one dynamically stable position to another. Asking then why a system is changing and why the original regime is moving from 'stability' to 'change' can be described as a 'failure' of the regime, whereas transition failure is characterised by the inability to establish or accomplish the desired system transition, despite the presence of potential changes or niches. (Aagaard et al., 2021; Turnheim & Sovacool, 2020).

3.1.2 The Multi-Level Perspective

The field of transition studies enjoys a plethora of contributions to transition management, technological innovation systems, strategic niche management, and the multi-level perspective (MLP) (Rotmans et al., 2001; Hekkert et al., 2007; Hoogma et al., 2002; Geels, 2002). Concepts such as the MLP have been expanded, critiqued, and developed to help explain the nature of multi-level interactions (Geels & Schot, 2007). These foundational concepts can form the basis of new concepts and approaches, offering exciting research areas that are yet to be explored (Truffer et al., 2022). These contributions have set out to explain how parts of a more extensive system interact.

These concepts, for example, help policymakers govern more effectively or allocate resources to parts of a system that are not functioning correctly.

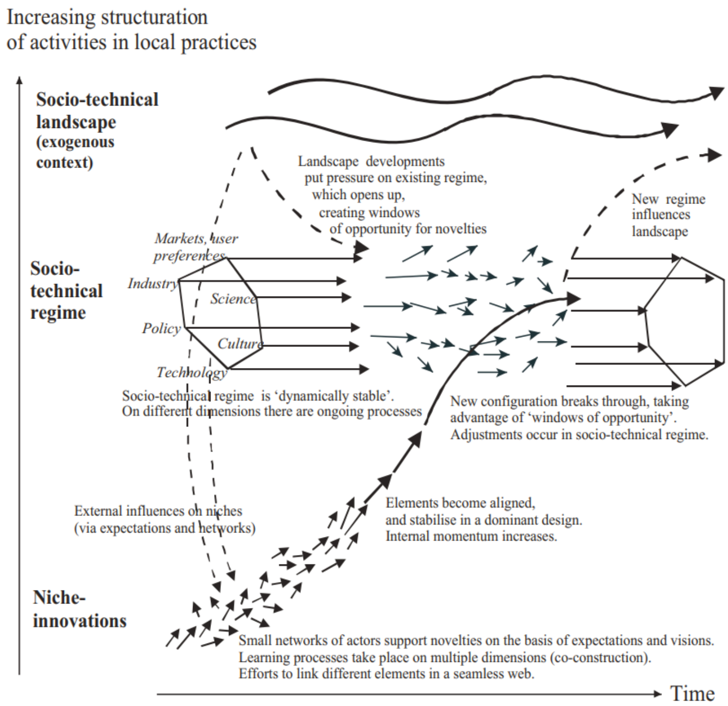

Figure 3. the Multi level Perspective (Geels, 2002).

The MLP, as seen in Figure 3. analyses change across three distinct levels: the socio-technical regime, the landscape, and the niche. "*The socio-technical regime forms the 'deep structure' that accounts for the stability of an existing socio-technical system. It refers to the semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems*" (Geels, 2011, p. 27). The regime is the network of various actors such as users, producers, suppliers, authorities, and financiers, along with the infrastructures, patterns of behaviour, cultural values, and policies that link them.

Niches are protected spaces where entrepreneurs and start-ups can develop radical innovations. Emerging innovations are supported with the hope of introducing systemic change when the niche merges with or replaces the existing regime. Niche development contains three processes: 1) articulating expectations or visions to guide innovation and attract attention; 2) building of social network and increase of actors; 3) learning and articulation processes of dimensions such as market demand, design, infrastructure, organisational constraints and business models. Niches gain momentum when expectations are more precise, processes align to form a stable configuration, and the network grows (Geels, 2011).

The macro landscape level refers to "*aspects of the wider exogenous environment, which affect socio-technical development*" (Geels, 2006). It is the backdrop and broader context in which the regime and niche are embedded and are long-term gradual changes to the socio-technical system which exert pressure on the regime (Geels, 2006).

Transition pathways within the MLP refer to the different patterns and trajectories through which socio-technical systems transform. MLP identifies several types of transition pathways that can occur during system change. These pathways are characterised by specific patterns of interaction and dynamics between different levels of the socio-technical system. The MLP framework distinguishes between different types of transition pathways, including transformation, de-alignment and re-alignment, technological substitution, and reconfiguration. Each pathway represents a different pattern of change and can occur at different stages of the system's development.

Transformation pathways involve significant changes and reconfiguration of the socio-technical system when moderate landscape pressure and niches are not yet mature. The regime will change its direction and innovation activities. De-alignment and re-alignment pathways occur when an intense (and sudden) pressure from the landscape increases problems within the regime and weakens the regime. This allows multiple niches to emerge and exist together until one innovation becomes dominant and forms the core of the next regime. Technological substitution pathways occur when niche technologies are sufficiently developed, and the landscapes exert a significant and sudden shock to the regime, which allows the niche to replace the existing regime. Reconfiguration pathways occur when niche innovations are adopted in the regime and trigger adjustments to the system regime components (Kanger, 2021).

3.1.3 Failure as an Underdeveloped Research Area

A company is more likely to fail than it is to succeed. Because a company's success is so rare, it is understandable that transition studies mainly study success. However, the rarity of success should not take away from the potential knowledge gained from understanding failure.

Transition research contributions have focused on realised or desired transitions rather than failed or undesirable ones (Turnheim & Sovacool, 2020). Analysing what could have been is equally important as analysing what is; the impartiality between successful and unsuccessful development is necessary to model what has happened accurately (Rip & Kemp, 1998). The impact of failures on individual actors can be painful and may carry a stigma. These factors may disincentivise disclosure of the failure's details, making it harder for outsiders to capitalise on the learning opportunities that these failures present (Collins, 2020).

Further, an individual actor's failure can also have a cascading effect on the broader system and transition progress (Turnheim & Sovacool, 2020). Turnheim and Sovacool (2020, p272) offer nine distinct perspectives on failure in transition research across three types of failure accounts: discrete, processual, and systemic failure. Among these, failures attributed to elements beyond mere engineering challenges—such as politics, governance, economics, or overarching complexity—hold particular relevance for transition studies. While some failures might be mundane or inherent to innovation, understanding them provides invaluable context to a transition narrative that might otherwise remain obscured. (Turnheim & Sovacool, 2020).

This perspective aligns with the Social Construction of Technology (SCOT), which says that human behaviour shapes technology rather than vice versa (Pinch & Bijker, 1984). This influential Science and Technology Studies theory offers insights into technological success or failure determinants. The principle of symmetry, rooted in social constructivist thought, further underlines the importance of examining failure and success through the same lens (Harrison & Laberge, 2002, p502).

Braun (1992, p214) contends that integrating the study of failed innovations offers a more grounded perspective on technological evolution. As Geels & Raven (2006, p1) articulate, technological trajectories are inherently non-linear, steered by cognitive rules and expectations shifts. Both failed and successful innovations traverse the transition process, evolving from a state of flux to relative stability (Geels, 2019).

There are several ways in which transition research can engage with failure. Firstly, by legitimising and funding research into failures. For example, 'Failed transition' case studies could give more context and deepen the understanding of paths not taken in specific sectors (Turnheim & Sovacool, 2020), and also by taking up the symmetry principle and rebalancing the empirical base of transition studies.

Studying success is interesting because it is an anomaly. For a company to thrive, all conditions must align perfectly. On the other hand, the intrigue in examining failure lies in that the absence of a single condition can lead to failure. This intricacy should be examined further. Delving into such complexities can unearth invaluable insights, understand the reflexivity of the industry and preserve vital tacit knowledge that might otherwise fade into obscurity.

3.2 Business Models

3.2.1 Business Models in transitions

A Business Model (BM) is a tool used to explain the rationale behind how a firm operates and how an organisation creates, delivers, and captures value (Osterwalder & Pigneur, 2010). The BM gained popularity in the mid-1990s as a tool to assess and compare emerging businesses and revenue streams that came with the Internet (Zott et al., 2011). Teece (2010) further highlights that *"In essence, a business model [is] a conceptual, rather than financial, model of a business."* A BM represents the logic used and tells how a business captures value. According to Teece (2010), despite superior technologies, people, leadership or other resources, a business is unlikely to be viable if its BM is not adapted to its environment. The BM helps construct the narrative of a business that is required to convince investors, especially when there is no precedent and no indicators to compare, as is the case for Solar mobility (Nielsen, 2014). As such, in the case of companies who depend on investments to prevent failure, such as Lightyear, when a BM fails to persuade investors of the plausibility of the business, it can lead directly to the company's failure.

BMs are not only a tool to create innovation; they can become strategic innovations and improve a firm's performance (Schaltegger et al., 2012). Business model innovation (BMI) happens when the entire or parts of the BM change to have the best value proposition; rather than changing the product or service the business offers, it changes how it works, not what it does.

“at its core, a business model describes the value proposition, the value network, and value capture of a business” (Wesseling, et al. 2020). A BM can analyse and assess the firms' performance, management, sustainability, innovation, and more. BMs are interwoven into the economy and society, making them a particularly interesting field concerning mobility transitions. An anticipated direction for future research pertains to examining the interactions between BMs and the broader system within which they operate (Najmaei & Sadeghinejad, 2023).

3.2.2 Business model design space

Wesseling et al. (2020) conceptualise a business model design space (BMDS) through a case study of EVs in the Netherlands to connect the firm- and system levels. Huijben et al. (2016) first introduced the BMDS to contextualise BM's in regulatory regimes and later expanded to include all regime dimensions of the socio-technical system by Wesseling et al. (2020). The BMDS is a framework to contextualise the interactions between micro and macro scale influences, which help to identify constraints and openings for niche technological development. It is a way to discuss BM in the context of transitions (Huijben et al., 2016). The BMDS has five dimensions: policy, science and technology, market, culture, and industry. Policy refers to the regulatory conditions and policy landscape. Science and technology are the technology and knowledge available to capture value. Market refers to the user preferences of value propositions and financial models. Culture is the alignment of cultural values with the value proposition. Industry is the niche's value network and collaborative or competitive efforts (Wesseling et al., 2020).

The BMDS can help niche BM development overcome constraints or exploit opportunities for niche expansion. Overcoming constraints is done through developing products and services that conform to the regime, which allows the niche to expand and assimilate into the regime. Exploiting opportunities is done through further development of the products and services to meet the needs of the landscape pressure, which stretches and transforms to replace the current regime (Wesseling et al., 2020).
The influence of BMs on each dimension may vary, for which Wesseling et al. 2020 propose a 'soft' and 'hard' edge. Culture, Market and Industry regime dimensions have soft edges which BMI can directly affect through new value networks, propositions and captures. On the other hand, policy science and industry have a hard edge, and entrepreneurs cannot change the boundary of the

dimension through BMI. Instead, strategies such as lobbying and R&D need to be applied to influence the regime (Wesseling et al., 2020).

4. Methodology

The methodology chapter will first provide an overview of the general research design followed by the data collection process. Then the STCA will be explained in depth as well as the operationalisation of the analysis. Finally, the reliability, validity, ethical issues, and limitations of this thesis are highlighted.

4.1 Research Design

Understanding the Socio-Technical configuration of the system is essential to understand what constraints of a firms capabilities led to the unrealised transition of solar mobility, how the solar mobility niche has re-configured itself, and which recommendations can be given to policymakers and business people to prevent another failure. This semi-quantitative case study on Lightyear and the solar mobility niche allows an in-depth investigation into the context and complexity of transition failure (Miörner et al., 2022). Therefore, this research consists of four phases:

- Phase 1 consists of data collection to build the document stock in the form of semi-structured interviews with people familiar with the Lightyear bankruptcy and the collection of grey literature and internal documents on the functioning of Lightyear and solar mobility.
- Phase 2 will code the data collection findings in Nvivo per the STCA coding procedure and split through the BMDS dimensions to quantify the results. The coded document stock is then exported as a matrix, transformed through Rstudio, and modelled into networks in Visone.
- Phase 3 will apply a socio-technical configuration analysis on the solar mobility sector before and after the bankruptcy of Lightyear and contextualise the impact of failure on the dynamics in transitions.
- Phase 4 will discuss and conclude the findings of the SCTA to develop recommendations to reduce the impact of institutional and firm failures on mobility transitions and provide advice on the business development for new entrepreneurial activities for solar mobility.

This thesis is a descriptive and exploratory case study with a substantive focus that uses deductive reasoning to select empirical frameworks and theories and inductive reasoning to adjust the frameworks mentioned earlier throughout the data collection and analysis process. While there is a need to increase the number of case studies about failure to reduce the selection bias, case studies are difficult to replicate and generalise to the broader field of study. The STCA offers a more standardised semi-quantitative approach that addresses this weakness (Miörner et al., 2022).

4.2 Sampling strategy

This research used a Purposive Sampling strategy to select the sample of interviewees who were most likely to aid in answering the research question (Palinkas et al., 2015; Bryman, 2016). Purposive sampling was chosen because only a small group of people knew firsthand the events leading up to failure. Senior management in solar mobility companies or Lightyear employees responsible for strategy and business were preferred candidates, as the people in these roles are intimately familiar with Lightyear's BM and the automotive industry. Externals familiar with solar mobility, such as academics and investors, were also preferred. 7 interviews were held to reach data saturation.

4.3 Data collection

4.3.1 Grey and Internal documents

The document collection will be conducted systematically per established methodologies for literary reviews and the STCA methodology to provide a comprehensive, objective, and reliable review (Petticrew & Roberts, 2008; Miörner et al., 2022). The document stock was built through a multi-source approach, utilising multiple databases, such as Google, Google Scholar, Lightyear's database, and ASOM's proprietary Google Drive data. The internal documents were selected by relevance and found using the following keywords: "business model", "Multi-Level Perspective", "stakeholders", "relations", "partnership", "investor", "socio-technical system", "public affairs", "business development", "strategy", and the dutch translations. The internal documents include various documents such as Meeting notes with ministers and political parties, market reports, business cases, investor presentations, consultant reports, and working group minutes.
Adding grey literature such as news articles, industry reports, and bankruptcy reports is justified as it provides valuable insights and perspectives, according to Adams et al. (2017). In addition, relevant non-technical scholarly articles on solar mobility are scarce. Lastly, adding grey literature is part of the STCA methodology (Heiberg et al., 2022). The grey literature was found using the search terms: "Solar Mobility", Lightyear", "Atlas Technologies", "Sono Sion", "Sono Motors", "ASOM", "Solar Panels", "Photovoltaic Integration", "Vehicle Integrated Photovoltaics", "VIPV", "Solar Electric Vehicles", "SEV", "Solar Cars", "High-Efficiency Electric Vehicles", "Sustainable Automotive Technologies", "Renewable Energy in Transportation", "Electric Mobility", "Solar Energy in Vehicle Design", "Green Vehicle Technology", "Photovoltaic Efficiency in Transportation", "Eco-Friendly Vehicles", "Solar-Powered Transportation", "Electric Vehicle Innovation", "Sustainable Mobility Solutions", "Solar Technology in Automotive Industry", "Clean Energy Vehicles", "Zero-Emission Vehicles", "Solar Energy Applications in Mobility" and its dutch equivalents. The query yielded 44 articles from 33 sources, as seen in Table 1. Including grey literature in the document stock is vital because a socio-technical configuration cannot be observed directly but can be analysed through the narratives and storylines around the system (Miörner et al., 2022). The date range of the document stock is between January 2016 and

September 2023, with the 26th of January being the divider between the post and pre-bankruptcy articles.

4.3.2 Semi-structured interviews

Semi-structured interviews are a well-established method to collect data due to their flexibility, depth, and ability to capitalise on individuals' experiences (DiCicco-Bloom & Crabtree, 2006; Bryman, 2016). Key stakeholders, including former employees, investors, and experts in the (solar) electric vehicle industry, are interviewed in this thesis. Through purposive sampling, the interviewees will be selected based on their relevance and knowledge of Lightyear's business and the socio-technical system in which it operates (Palinkas, et al. 2015). This selection criteria yielded Interviews with current and former Lightyear employees and ASOM Lightyear board members, all with differing levels of seniority, to yield a richer dataset. The interviewees include senior leadership and relevant people from varying departments to help balance the differing points of view and experience and improve data saturation (Fusch & Ness, 2015). The interviews were conducted face-to-face or through video conferencing and recorded with informed consent from the interviewees. The recordings are subjected to denaturalised transcriptions to ensure the accuracy of the informational content (Oliver et al., 2005).

The focus of the interview varies depending on the expertise of the interviewee. First, interviews with junior-level people are held to triangulate the findings from the documents and provide a broad overview of the solar mobility sector. Then, as the data becomes more rich, interviews are held with more senior people and more focused on their expertise, experience, and critical events to give a more refined and accurate image of the sector. This order is done in consideration of the time of the interviewees. Because junior employees can provide the general information needed, the more senior people can offer their unique insight, share experiences, and provide context to the decision-making process. The interview can be divided into different sections. First, the interviewees' reconstruction of events leading to the failure is asked. Secondly, the interviewee is asked to give their perspective and experience on the internal operations and business model. Finally, there is a discussion on the external influences of the socio-technical system and the state of solar mobility in general.

Table 1. Data collection overview

Data collection overview	*type of literature*			
pre / post bankruptcy	grey	internal	interview	Total
post	30	7	7	45
pre	14	54		68
Total	**44**	**61**	**7**	**114**

4.4 Socio-Technical Configuration analysis (STCA)

The data collected will be analysed using the STCA method described by the STCA guidebook (Miörner et al., 2022). Due to the complex and dynamic interactions between variables, there is a need to capture and visualise the patterns and interdependencies (Furnari et al., 2020). Equally, it is a challenge for case studies to generalise their findings in a broader context due to their unique and interrelated environment (Alkemade, 2019). Therefore, Heiberg et al. (2022) propose the Socio-Technical Configuration Analysis methodology *"to map and measure socio-technical alignment processes across time and space. STCA provides a configurational and dynamic perspective on how social and technical elements get aligned into "configurations that work", allowing for the identification of differentiated transition trajectories at and across spatial and sectoral contexts. "*(Heiberg et al., 2022, p1).

The STCA has its roots in Discourse Network analysis, which connects actors of different beliefs and arguments to build relational data structures (Leifeld, 2017). The STCA applies these principles of network analysis to the socio-technical system and thus considers all institutional discourses relevant to the transition, such as the public, political, industrial, societal, and market discourse. The STCA includes three types of networks: a two-mode network containing actors and concepts with their relational information and one-mode Actor and concept congruence networks.

These networks show organisations' evaluation of technologies, policies, infrastructure, and sectoral norms and paradigms (Heiberg et al., 2022). Actor congruence networks show clusters of actors who share similar beliefs, norms, rules, values, and visions, whilst concept congruence networks show the level of similarity and alignment between concepts (Heiberg et al., 2022). Mapping the configuration of the networks mentioned above, in turn, allows for a visual representation of a changing socio-technical system over time.

The STCA can measure the level of institutionalisation through degree centrality and frequency of use, or the amount of linkages between concepts and the frequent usages of a concept. A radar plot's position and size of nodes and edges visualise the information on institutionalism and alignment. Understanding how many concepts are aligned can be done through cosine similarity normalisation and visualised through the width of the linkages between the nodes (Heiberg et al., 2022; Real & Vargas, 1996). The data matrixes and network visualisations then give a comprehensive overview of the networks, which are then analysed through descriptive statistics and visual inspection. Concepts and actors can cluster together or have a strong link or central position, all indicating that the niche is splintered or monolithic, that concepts are closely related or that certain actors play a key role in the niche (Heiberg et al., 2022).

4.5 Operationalisation

This research employs the BMDS and STCA frameworks to comprehensively understand niche actor dynamics in Lightyear's bankruptcy and the broader solar mobility system. The BMDS captures businesses' opportunities and constraints in leveraging niche technologies. It sets the stage for understanding Lightyear's challenges in navigating the solar mobility market (Wesseling et al., 2020). Complementing this, the STCA offers insights into how social and technical elements converge, highlighting shifts in stakeholder beliefs and market dynamics post-bankruptcy (Heiberg et al., 2022).

The data collected was coded through an interactive abductive approach and applied a specific STCA structure through Nvivo as per the STCA guidebook (Miörner et al., 2022). It is important to note that in STCA, variables are not independent of each other but interrelate to form an outcome. It distinguishes between four types of variables: mapped variables, associating variables, partitioning variables, and complementary variables. Mapped variables include 'clean mobility', 'efficiency', or 'incentives for renewable energy'. Associating variables include 'the EU', 'Fleet Managers', or 'Lightyear'. Partitioning variables allows for comparing configurations of different sub-sets across, for example, time. Time will be a partitioning variable for this research, namely between configurations before and after the Lightyear bankruptcy. Finally, complementary variables allow for the comparison of additional information, for example, the frequency of actors and concepts or the similarity between concepts (Miörner, et al., 2022).

The Iterative abductive coding approach helps identify, analyse, and report patterns, or themes, within the transcripts, improving the data interpretation (Braun & Clarke, 2006). Each data fragment must be coded with at least a mapped and associated variable. Additionally, this thesis applies a substantive focus on the system reconfiguration dynamics, meaning that text fragments are coded when an actor does an activity or applies a concept like a fleet manager ordering a fleet of vehicles. The BMDS serves as a foundational framework to contextualise the factors related to the failure of Lightyear. The STCA further explains the role of failure in the dynamic configuration of transitions. The document stock was coded based on the five dimensions of the BMDS, categorising actors and concepts into five domains: Culture, Industry, Markets, Policy, and Science and Technology. After some iterations, 12 actors and 27 concepts emerged from the document stock, which can be found in Appendix A, along with definitions for each code.

Multiple co-occurrences within one file in the dataset are only counted once since the existence of a link is interesting. However, the frequency of that link occurring across different documents can provide valuable information as to the importance of that link. As such, a weighted two-mode network is chosen for the STCA. A Cosine similarity is applied to the weighted two-mode network through Rstudio, which results in two normalised one-mode networks for actors and concepts. Cosine similarity is used to calculate the cosine of the angle between two non-zero angles irrespective of their size, which is needed for a weighted two-mode network and is expressed as:

$$Cosine\ Similarity\ =\ \frac{A \cdot B}{||A|| \times ||B||}$$

The cosine similarity is the product of A and B divided by the product of their length, or since it is a vector, the magnitude of A and B (Egghe & Leydesdorff, 2009). This formula transforms a weighted two-mode matrix, reflecting the frequency of concept mentioned by actors, into a normalised one-mode data matrix, ensuring that the similarity measure between two codes is the sum of normalised similarities that are proportional co-occurrence across different elements rather than the total number of documents in which the associations occurred.

Due to the network's number of actors and concepts, there can be ‘noise’ in the network visualisation. Therefore, to improve the accuracy of the presentation of the results due to the number of edges, a backbone layout was applied in Visone, where the weakest links were removed from the visual representation to ensure a more accurate visual inspection without altering the statistics of the matrix (Nocaj et al., 2015).

The results from the two-mode networks will be presented using Visone, which provides all the visuals and descriptive statistics such as the degree, betweenness and closeness, and link weight distribution. The degree represents how concepts the actors subscribe to and provides insight into how central a particular actor or concept is in the network. The betweenness centrality shows how much a node acts as a bridge between nodes and connects the network that would otherwise be disjointed (Girvan & Newman, 2002). Conversely, closeness provides information on the path length between nodes or how close actors and concepts are to each other (Liu et al., 2019). These metrics can help understand which actors can interact and influence other nodes. Link weight distribution can reveal information on the strength and significance of the relationship between nodes. These help understand the dynamics, fragmentation or cohesion and provide depth to the observed network (Heiberg et al., 2022).

The one-mode actor networks show how close actors who refer to the same concept are to other actors. Concept networks show how often concepts are mentioned together. Concept networks explain how the concepts or ideas are grouped and can justify actions to change the system, whilst actor networks show the similarities between the ideas and values of actors. The level of institutionalisation is represented through the size and position of the node. The node's size represents the number of actors who have endorsed the concept, whilst the node's location in the radar plot represents the number of other concepts the concept is linked to, with more well-connected nodes taking a central position. The width of the linkage between concepts and actors represents the alignment or similarity between concepts and actors. The same descriptive statistics from the two-mode network can be applied to the one-mode networks.

4.6 Reliability & Validity

Several measures have been taken to improve the reliability of the research. Firstly, even though our semi-structured interviews are adapted based on the expertise of the individual participant, a set of core topics was consistently addressed with all experts. This approach ensures that there is uniformity in the collected data. Additionally, denaturalised transcriptions accurately captures our interviews' informational content, as Oliver et al. (2005) suggested. Beyond this, the research does not rely on singular sources of information. Data is integrated from grey literature, internal documents, and conducted interviews. This triangulation approach strengthens the reliability of the findings by allowing cross-validation of information from different publicly available sources. However, including internal documents reduces the replicability of this thesis.

Several steps are taken to ensure the research's validity. Firstly, existing frameworks and methodologies like the BMDS and STCA are designed to help connect a system's micro and macro levels and generalise the findings. Using said frameworks ensures that the relevant and general concepts of business models and transitions are covered. The broad range of grey literature in multiple languages and from many different sources makes the results more representative of the entire sector. However, there is likely a skew towards Lightyear as internal documents from Lightyear are included in the document stock. Although not all documents are specific to Lightyear and relate to the solar mobility sector in general, the documents exist in the first place out of interest for Lightyear. Moreover, while the research delves deep into the specific case of solar mobility, it is designed to ensure that the findings are coherent and consistent. While solar mobility is the primary focus, using the STCA, which has a semi-quantitative nature, ensures the findings may be applied to the broader industry.

4.7 Ethical Issues

In conducting this research, ethical considerations have been taken into account to ensure the safety and well-being of all participants. Informed consent has been obtained from all interviewees, who were informed of their right to withdraw from the study at any time. Consent was given by the former company that longer exists to use the internal documentation. This research has been done in good faith and with any future entities' best interest in mind. The research was conducted with respect for the privacy and confidentiality of all participants, and their identities will be kept anonymous to ensure their protection from potential litigation.

4.8 Limitations

While this research aims to provide valuable insights into the reasons for Lightyear's failure and its effects on the mobility transition, there are limitations. Firstly, the qualitative nature of the data collection limits the generalisability of the findings. However, a semi-quantitative STCA method is used to increase the generalisation of the findings. Secondly, the semi-structured interviews may be subject to bias. Interviewees may have personal biases or selective memories, affecting the information's accuracy.

Additionally, interviewees could alter their statements due to the current lawsuits to protect themselves from litigation. The research will triangulate data sources and cross-check information obtained from interviews with the data collected to mitigate the subjectivity of the interviewees as much as possible. Thirdly, while the BMDS and STCA are promising approaches to examining case studies in the context of sustainability transitions, they are still relatively new, and alternative frameworks or theories may offer different insights. However, the combination of the BMDS and STCA in this research is applied to provide a novel perspective and contribute to the ongoing development of the frameworks in the field. Fourth, proprietary data can skew the results in favour of the visions of Lightyear and ASOM. Finally, the purposive sampling strategy may limit the diversity of perspectives included in the research. The research will strive to include a diverse group of stakeholders as much as possible.

5. Results

The results section is divided into two sections, the first half contains the STCA of solar mobility before the failure of Lightyear. The second half has the STCA of solar mobility after the failure of Lightyear. Each STCA includes a two mode network, a one mode concept network, and a one mode actor network. The interpretation of the results and context will be elaborated on further in the discussion.

5.1 Socio-Technical Configuration before the bankruptcy of Lightyear

Table 2. descriptive statistics of the two mode network before Lightyear's failure

Node	Degree Centrality	Node	Betweenness	Node	Closeness	Node 1	Node 2	Edge Weight
Lightyear	0.5	Lightyear	0.265	Lightyear	26.5	Lightyear	Value chain SEV	22
SEV industry	0.447	SEV industry	0.261	SEV industry	25.167	Lightyear	Niche Legitimacy	20
Dutch State	0.316	SEV	0.123	SEV	22	Lightyear	SEV	20
EU	0.316	Dutch State	0.122	EU	21.833	EV industry	EV	18
SEV	0.237	Value chain SEV	0.1	Dutch State	21.833	SEV industry	Niche Legitimacy	17

5.1.1 Two mode weighted network

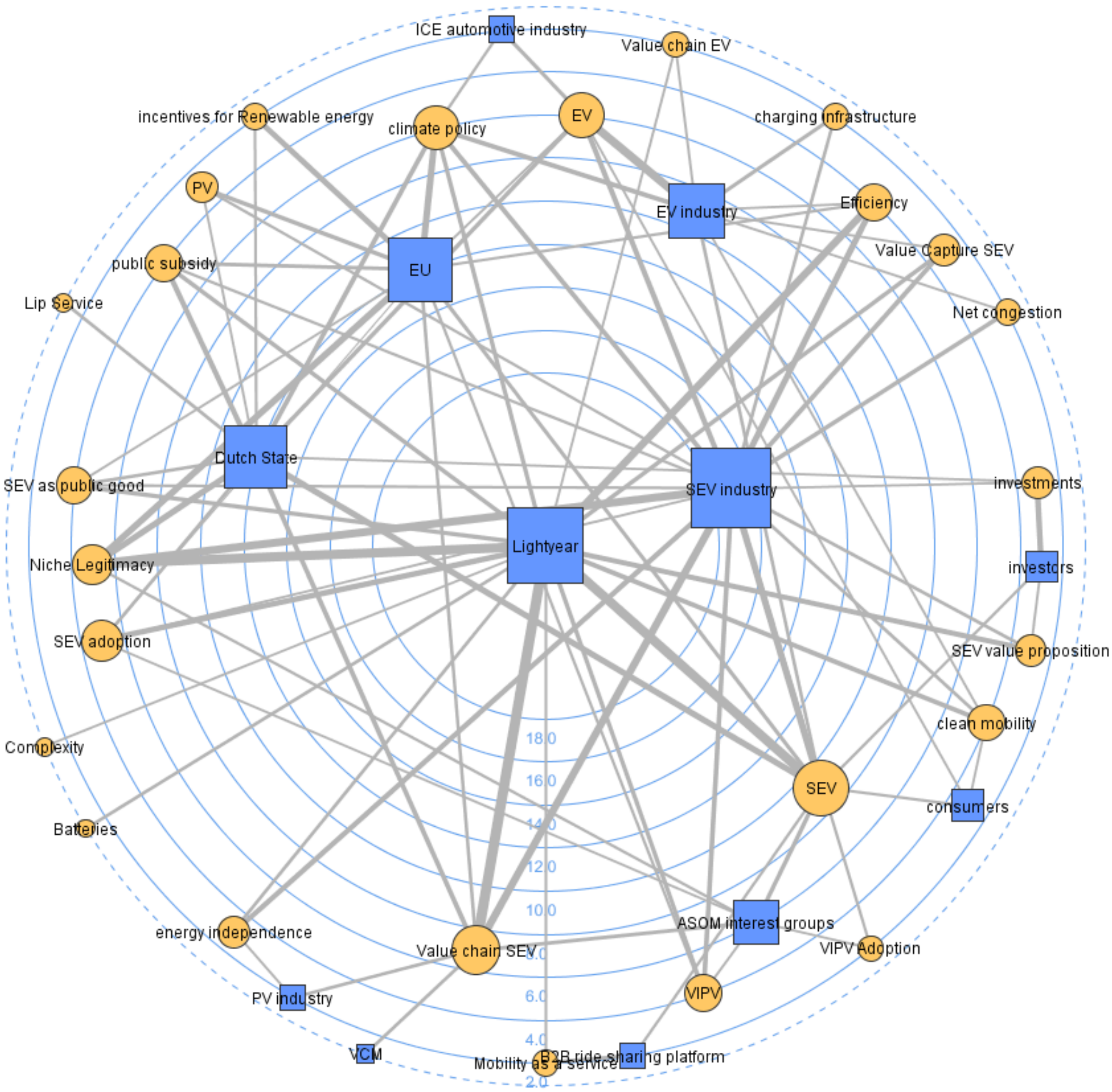

figure 4. two mode weighted network with centrality plot before Lightyear's failure

In the pre-Lightyear bankruptcy landscape of the solar mobility sector, the STCA reveals distinct patterns of centrality and connectivity among various actors and concepts. First, the average degree is 4.757 at an average density of 0.132. Lightyear emerges as a pivotal entity, with the highest values in terms of Degree Centrality (0.5), Betweenness Centrality (0.265), and Closeness Centrality (26.5). This underscores Lightyear's central role in the network, acting as a major hub that connects diverse actors and concepts and highlighting its ability to influence and influence the network's dynamics. The SEV industry also plays a similar crucial role, with a Degree Centrality of 0.447 and a Betweenness Centrality of 0.261, positioning it as another central actor in the network. The Dutch State and the EU have a strong connection with each other and also play a similarly central role and are well connected to the concepts in the policy dimension, such as public subsidy and climate policy, with Degree Centralities of 0.316, indicating the policy actors as central in the solar mobility sector as can be seen in Table 2.

Regarding relationships, the link between Lightyear and the Value chain SEV is the strongest in the network, with an edge weight of 22, signifying a robust and significant connection, as seen in Figure 4. The relationships between Lightyear and Niche Legitimacy and Lightyear and SEV also stand out with high edge weights of 20, highlighting the importance of these connections in the network. The EV industry's relationship with the EV concept also proves significant, with an edge weight of 18.

These results paint a picture of a network where Lightyear and the SEV industry are central hubs, connecting various actors and concepts and playing pivotal roles in the solar mobility sector. The strong relationships identified also indicate key areas of interaction and influence, providing a nuanced understanding of the sector's dynamics prior to Lightyear's bankruptcy.

The centrality of the Actors in this network is higher than the concepts in the network, with the highest concept SEV at a degree of 0.237, less than half of the degree Lightyear has. This variation between concepts and actor centrality could be because there are twice as many concepts as there are actors, which, when combined with the fact that each concept must be connected to at least one actor, the actors will have a more central position in the graph due to that ratio. It also shows that actors were generally engaged in multiple different concepts. For example, trade associations like ASOM show links with SEVs, VIPVs and their adoption, and niche legitimacy, which, considering ASOM consists of multiple working groups, including technology research and a governmental affairs working group, is accurate.

5.1.2 One mode concept Congruence Network

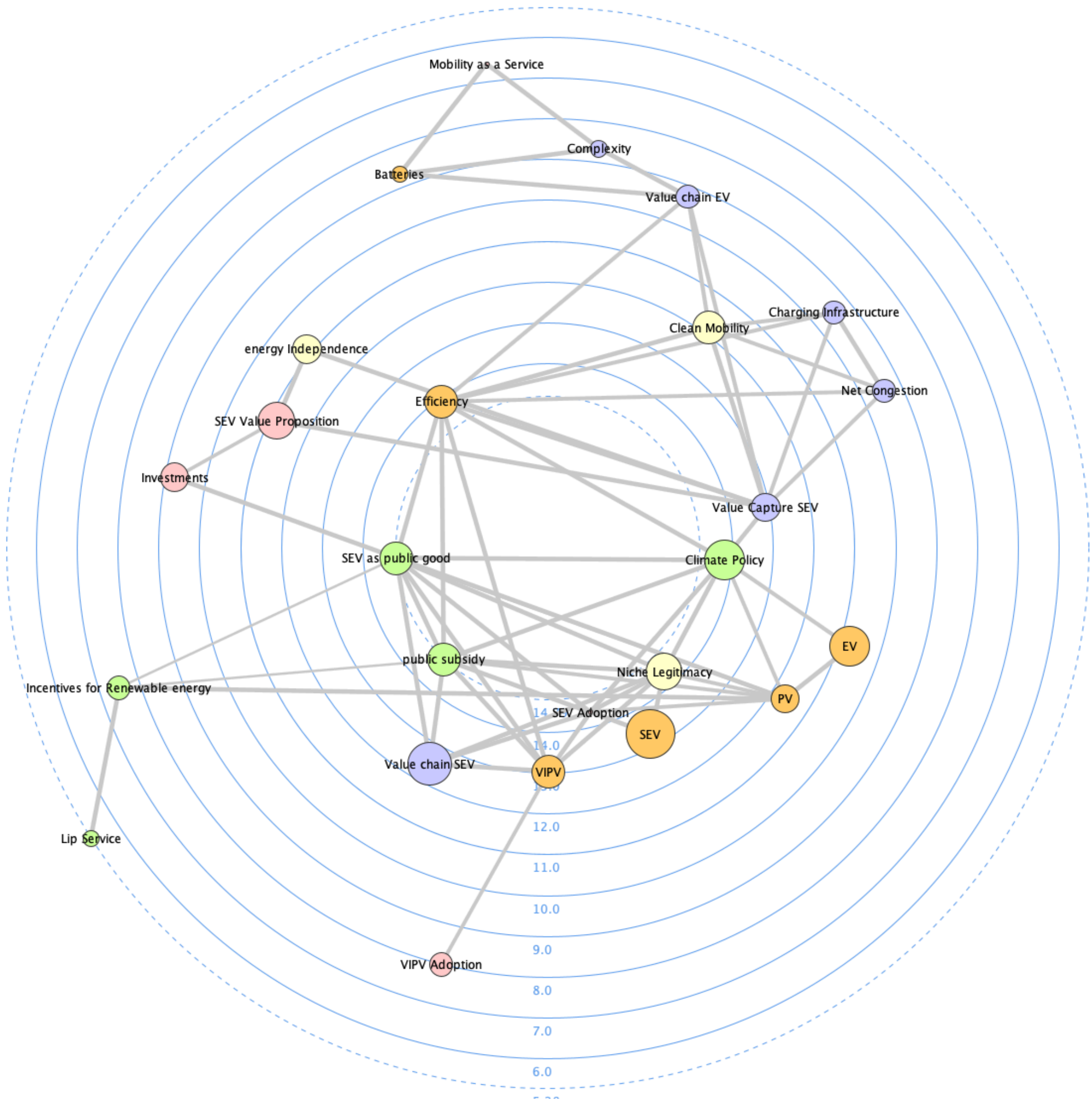

Figure 5. one mode cosine normalised concept network before the Lightyear bankruptcy.

The one-mode cosine normalised concept congruence network first underwent a backbone layout where the bottom 10% of values were removed for clarity and focused on the most frequent co-occurrences. This network shows which link in this network is formed when one actor uses both concepts. The average degree is 20.4 with a density of 0.84 and an average number of actors using a concept of 3.26. First, the most central concepts most actors use are SEV, Climate Policy, public subsidy, niche legitimacy and SEVs as a public good, as seen in Figure 5. These concepts are the most institutionalised in the solar mobility niche as they have above-average degree and actor frequency values. Whilst VIPV has an actor count of 4 and a degree of 13.05, SEV has an actor count of 9 and a degree of 13.3, indicating that SEV is a more central concept and is used by more actors in connection with other concepts. Except for Lip service and incentives for renewable energy, the policy concepts appear central to the network with above-average degrees and actors used, making policy and regulation institutional concepts in the niche. Niche legitimacy also appears to be well connected to other concepts with a degree of (14.3) and used by several actors (5).

On the other hand, the industrial concepts are less institutionalised. Despite the SEV value chain being the second most mentioned concept by actors (7) with a degree value of 12.5, the other industry concepts, such as charging infrastructure and net congestion, only have two actors using the concept with a degree of 9.45, making the discourse around the electricity demand more peripheral compared to the other concepts and dimensions.

Similarly, the concepts of the market dimension display varying levels of institutionalisation. With SEV Adoption only being used by one actor but congruent with many other concepts, it has a high centrality of 14.3. The other market concepts of SEV value proposition, investments and VIPV adoption play a more secondary role in the discourse.

Although the edge weights are visually similar, the concepts display varying levels of similarity in coherent storylines. Two links hold the value of one, meaning they are always mentioned together. These are Charging infrastructure and Net congestion, Public Subsidy, and SEV as a public good. The alignment within the dimensions shows that policy has the highest intra-similarity with an average of 0.46, followed by industry at 0.45, and Culture and Market with the lowest intra-alignment of 0.34 and 0.31, respectively. This indicates that the policy and industry concepts are more similar than the culture and market concepts. When looking at the inter-alignment between dimensions, it shows that the highest inter-similarity is S&T and Culture with 0.56, followed by S&T and policy, industry and Culture and S&T and Industry and Market scoring 0.54, 0.54, 0.54, 0.47, and 0.45 respectively. The lowest alignment between dimensions is Industry and Policy, with a score of 0.339.

Niche legitimacy shares a high similarity with SEV adoption, SEV as a public good, and VIPV, which also share a high similarity, indicating that a coherent storyline exists between those concepts. Another story emerges around Efficiency as it seems strongly connected to Policy and funding mechanisms through Climate policy, public funding, and Value capture SEV whilst also well aligned with Clean Mobility and VIPV, which shows high alignment with policy concepts like Climate policy, and public subsidy, Value capture SEV, VIPV, and clean mobility. EV seems highly aligned with climate policy and PV, likely indicating a story of PV applied to EV for sustainability. Clean mobility aligns with industrial concepts and Efficiency, indicating a storyline centred around practical and logistical aspects of sustainable transport.

The overall composition of the network shows a high level of interconnectedness with an average degree of 20.4 and density of 0.84, indicating a close relationship between concepts. At the network's core, there are highly institutionalised concepts where SEV and VIPV stand out as central technologies, with Efficiency playing a crucial role in enabling and connecting these technologies.

Alongside these, concepts related to policy and legitimacy form a significant central cluster, showing the role of governments and established institutional concepts in the niche, which is a policy-driven innovation pathway and niche protection by government concepts. Incumbent technologies in this niche, such as PV and EV, even though the combination of these technologies created the niche, have taken a secondary role as VIPV and SEV rise to the centre. The dimensions of industry and market exhibit a slower pace in their journey towards institutionalisation, revealing a lag in alignment compared to their policy and technology counterparts.

5.1.3 One mode actor Congruence Network

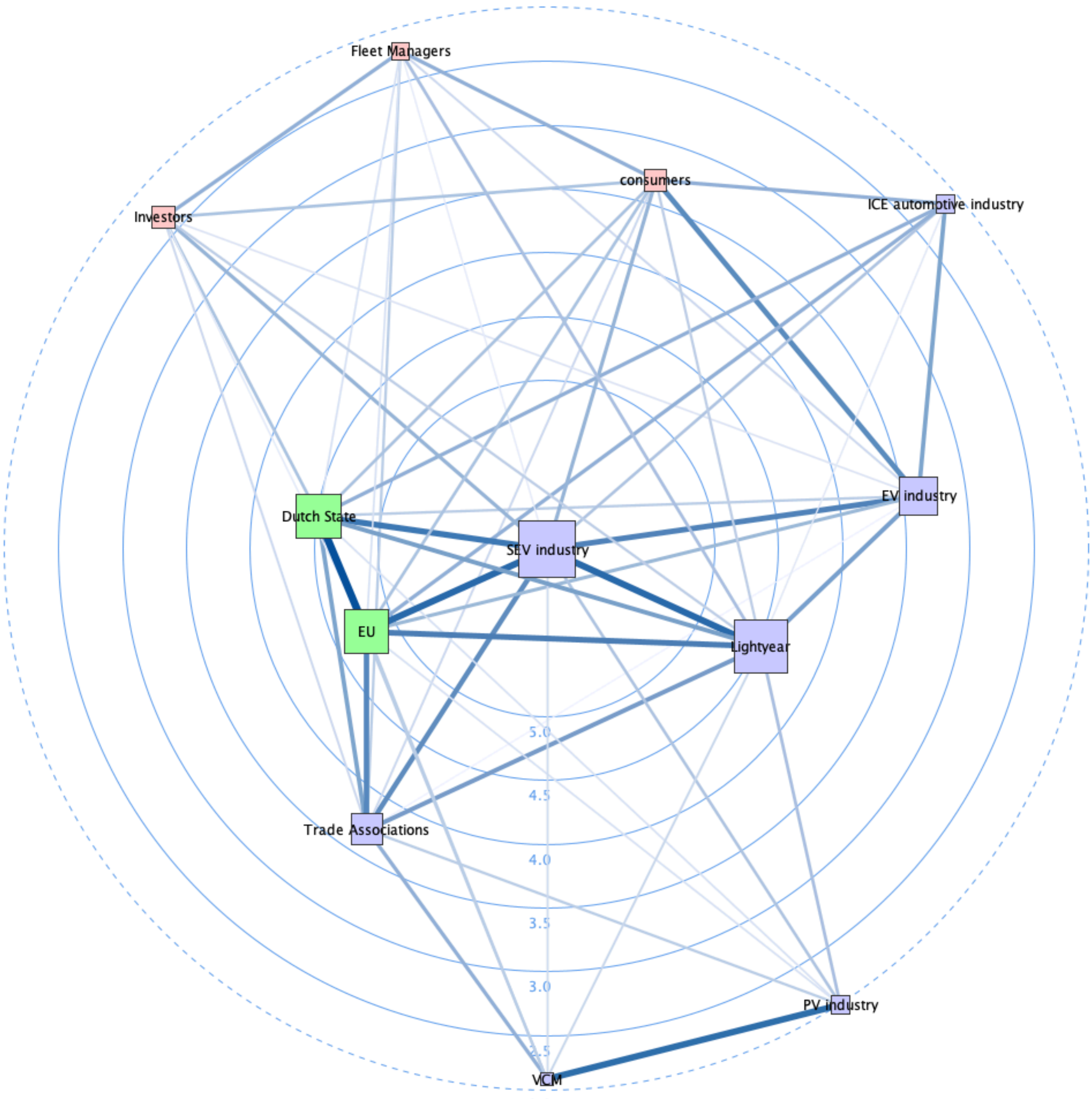

Figure 6. One mode cosine normalised Actor Network of before the Lightyear bankruptcy.

The average centrality degree across all actors is 4.417. At the centre of the plot, with a degree of 5.123 and using 19 concepts, the SEV industry is the most central and institutionalised actor of solar mobility and acts as a significant channel of relational information, as seen in Figure 6. The following most central actors are the EU and Dutch State, with 4.771 and 4.518-degree values, respectively, and both using 17 concepts indicating that policy actors also play a significant role in the network. Lightyear has a centrality degree of 4.484 but has the most concepts used at 19, indicating that this single company is more involved in more concepts and almost as central as the rest of its competitors in the SEV industry combined. Noticeably, the market actors of the investors, fleet managers and consumers have a below-average degree of centrality with only a limited amount of concepts, indicating that their involvement in solar mobility is minor and focused on specific issues.

The EU and Dutch states have virtually identical statistics and the highest edge weight, making them highly aligned and similar. Next, the SEV industry exhibits high similarity scores to the policy actors and Lightyear and a similarity with the EV industry that is twice as strong as the ICE industry, indicating some moderate alignment between the niche SEV and the more incumbent EV industry. The alignment between consumers and the EV industry (0.577) is higher than with consumers and the SEV industry (0.397) and Lightyear (0.28). There appears to be a substantial similarity between VCMs and the PV industry (0.707). The PV industry seems much less aligned with and similar to the rest of the network, with relatively weak links between actors. The trade association shares a moderately weighted link with every industry and policy actor except for the ICE industry.

The EU, Dutch State, Lightyear and the SEV industry all have the highest and similar betweenness, closeness and eigenvector values, indicating that these actors form the core of the solar mobility network and, as such, set the storylines. Their role is one of connectivity, and their importance is partially due to being well-connected to other essential nodes, thus strengthening their cluster. The overall composition of the network is highly interconnected and dense, with a value of 0.803, indicating that the actors are well connected. The main actors are the industry and policy, with the market actors having less influence on the network. On average, an actor uses 8.07 concepts, which indicates that actors are involved in many different concepts. However, this varies wildly, with VCMs only focused on one concept and Lightyear focused on 19. The knowledge institutes are missing from the network's centre, which seemingly has no connection to the network except for the Trade association, indicating that they hold a limited role in the discourse.

5.2 Socio-Technical Configuration Analysis after the bankruptcy of Lightyear

5.2.1 Two mode weighted Network

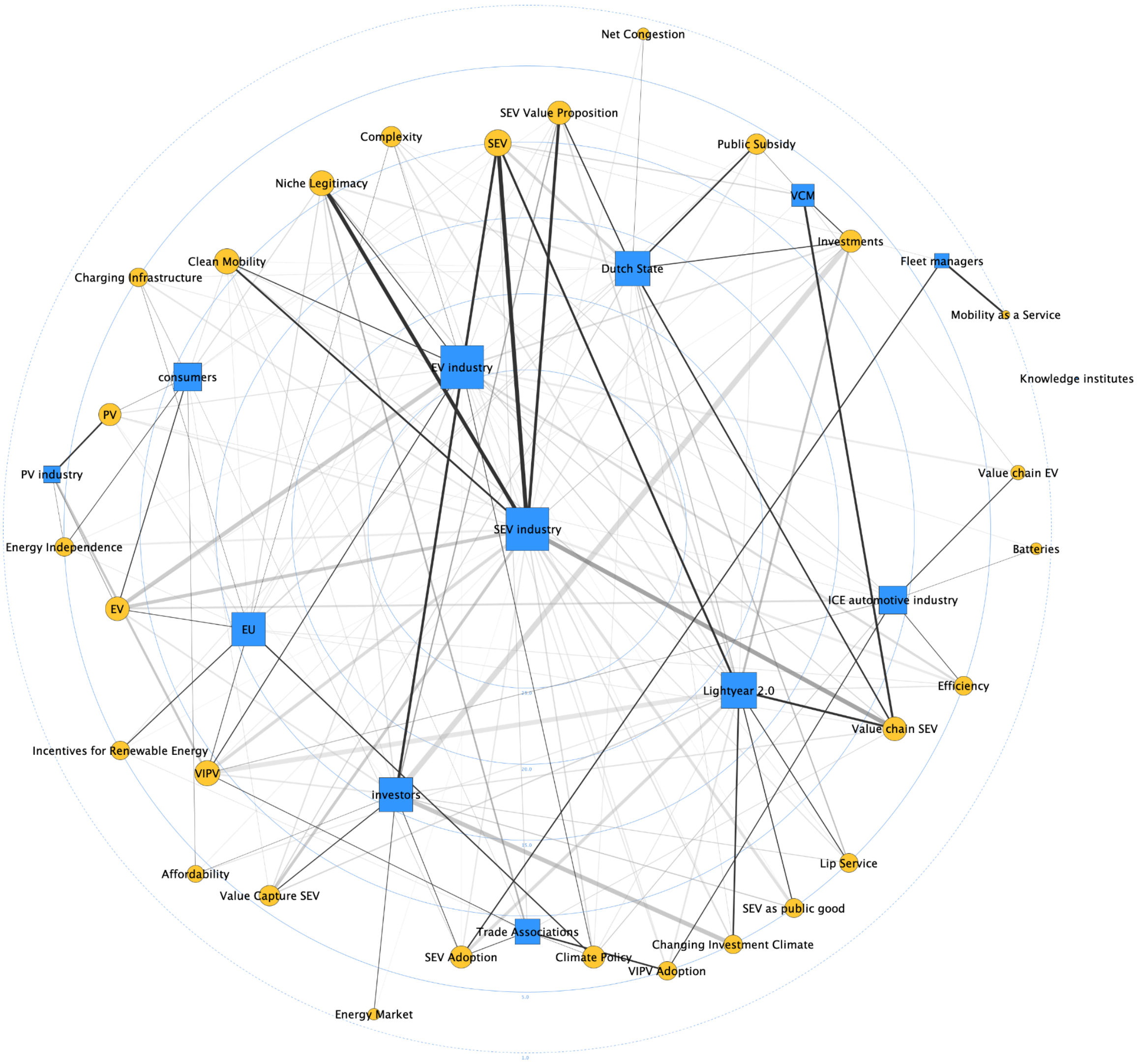

Figure 7. the two mode weighted undirected network of solar mobility post Lightyear bankruptcy.

In the post-bankruptcy landscape of the solar mobility sector, the network indicates a shift in patterns of centrality and connectivity among various stakeholders, as seen in Figure 7. The average degree has increased to 7.854, and the network density has grown to 0.196, suggesting a more interconnected network than before Lightyear's bankruptcy. This indicates an adaptive response from the sector, fostering stronger ties and forming new alliances to maintain stability and momentum in solar mobility initiatives.

The SEV industry has replaced Lightyear at the centre of the centrality plot, with the restarted Lightyear taking a more peripheral position in the network as other companies in the SEV industry fill the void Lightyear left behind. The EV industry has increased its involvement as it has now taken a more central role after increasing the amount of concepts it is connected to. The EV industry also has one of the highest closeness centralities, indicating that it can interact with other nodes more quickly and strategically take advantage of opportunities, respond to threats, and influence others.

Table 3. descriptive statistics of the two mode weighted network post Lightyear bankruptcy

Node	Degree Centrality	Node	Betweenness	Node	Closeness	Node 1	Node 2	Edge Weight
SEV industry	25	SEV	119.075	SEV industry	0.017	Investors	Investments	18
EV Industry	24	Lightyear 2.0	109.67	EV industry	0.016	Lightyear 2.0	VIPV	15
Lightyear 2.0	18	Investors	100.3.75	SEV	0.014	SEV industry	SEV value chain	14
Dutch State	18	Dutch State	99.288	Lightyear 2.0	0.014	Investors	Change invest clim	18
Investors	16	EU	80.293	Dutch State	0.013	SEV industry	SEV	17

Lightyear 2.0, with its more secondary position in the network, is less connected to other concepts than before, with a degree centrality of 18. It is still one of the best-connected actors in the network but is now more focused on SEV, VIPV, building a SEV Value Chain and the changing investment climate. One of the most significant changes is that Lightyear 2.0 only has a weak link to Niche Legitimacy and the Dutch State, and Lightyear 2.0 has lost its link with the EU.

The Dutch State and the EU as policy actors are now less central while still having a high betweenness centrality, as shown in Table 3. This indicates that these actors still act as bridges in the network with significant influence and control of the information; they are less influential than before. The EU has shifted and is now more connected to incumbent concepts like PV and EV, whilst the Dutch State has maintained its connections with SEV and its value chain and value proposition.

Niche legitimacy has become a much less central concept and is now best connected to the SEV industry rather than Lightyear. Likewise, efficiency is less widely discussed and has a similar weight for both the SEV and the EV industry, indicating that efficiency has become more prevalent in EVs. On the other hand, Investors and investments have become more central in the network, indicating that funding has become more critical and influential in solar mobility. Trade associations have moved from niche legitimacy and SEV adoption and value chain towards VIPV and its adoption, climate policy and SEV adoption.

5.2.2 One mode concept congruence network

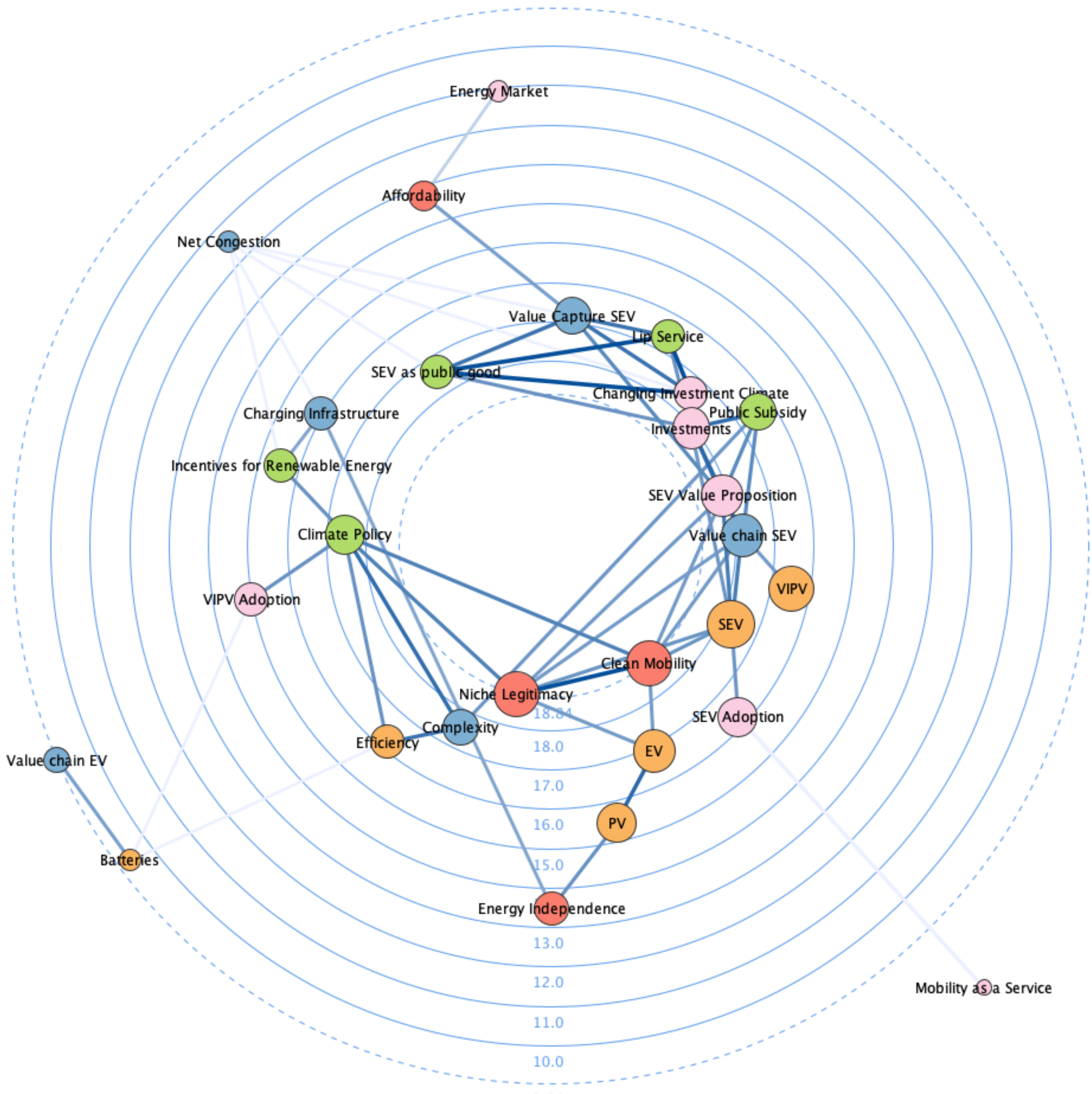

Figure 8. one mode concept network of solar mobility post Lightyear bankruptcy

The configuration of concepts has shifted considerably since the bankruptcy of Lightyear, as seen in Figure 8. The network has an average centrality degree of 15.783 with a density of .918 and an average of 5.75 actors per concept. This is an increase of over 4 degrees and .078 more dense. This shows a highly connected network, with almost every node being connected to every other node, and it has grown in connections after the failure.

There is no singular concept at the centre of the network. Instead, the top 5 most central concepts are now Clean mobility (18.839), Niche Legitimacy (18.839), SEV Value Proposition (18.169), Investments (17.887), and Value Chain SEV (17.841). Figure 8 shows that most concepts have a centrality degree between 15 and 18. This homogeneity would suggest that concepts have similar importance in the network. The concepts that most actors use are SEV (10), Clean mobility (9), Niche Legitimacy (9), and VIPV (9). The most institutionalised concepts are those with both a high centrality degree and used by most actors. Clean Mobility and Niche legitimacy are the most institutionalised concepts post-bankruptcy, but SEV, VIPV, SEV value proposition, value chain SEV, and investments are all still above-average institutionalised. Compared to before the failure, climate policy, public subsidy, and SEVs as a public good have become less important, and SEV as a concept has become less central.

Where previously, the policy concepts had a high degree of institutionalisation and alignment, the policy concepts have now become less prominent, with Climate policy still the most used and well-connected node. Lip services, however, has grown from one actor using the concept to 5, and it has grown in linkages as well, now connected to concepts outside of policy. Where the cultural concepts were more peripheral before the failure, Niche Legitimacy and Clean Mobility are now the most central and frequently used concepts, and affordability is now present in the network.

The most considerable relative increase in actor usage and degree centrality are the Market concepts. The SEV value proposition and Investments are now core concepts in the network, and SEV adoption has grown from 1 actor to 7. VIPV adoption is now more aligned to climate policy than VIPV as a technology. Mobility as a Service remains a secondary concept.

The industrial concepts have also gained prominence compared to before the failure of Lightyear, with Value Chain SEV now being one of the most insitutionalised concepts and the value capture of SEVs more strongly linked to concepts other than the industry concepts. The technology concepts remain similar to before the failure, with SEV still the most central concept, followed by VIPV. Notably, Efficiency is now less connected to the rest of the network and most connected to complexity and climate policy.

Most concepts have a betweenness centrality of less than 2, except for SEV and SEV adoption, which have a betweenness centrality of 60.736 and 58.801, respectively. This would indicate that SEV and SEV adoption are important nodes for the flow of information, acting as a control point or bridge between most other concepts as the shortest path between concepts flows through these concepts.

There are five edges with a value of 1, meaning that the two concepts are always used congruently; these are Niche Legitimacy and SEV, Changing Investment Climate and Lip service, Changing Investment Climate and SEVs as a public good, Lip Service and SEVs as a public good, and Niche Legitimacy and Clean mobility. The edge weights of each concept explain the similarity and build congruent storylines. After the bankruptcy, the alignment between concepts has shifted from a policy orientation to a more market orientation.

With Niche Legitimacy, clean mobility, and affordability having an above-average alignment, Solar Mobility now follows a storyline centred around legitimising the niche through affordable and clean mobility to the consumer rather than the technology proof of concept as it was before, similarly before Lightyear's failure Niche Legitimacy was connected to the policy concepts. Whereas now it seems more aligned to concepts in different dimensions, indicating that there is a story of legitimacy through culture, industry, policy, market and technology.
A second storyline emerges around the changing investment climate and investments; these two concepts strongly align with most concepts and have become more institutionalised than before the failure. This could mean financing has become more influential in the solar mobility niche. Overall, the composition of the network is a more balanced hierarchy between concepts, with more concepts institutionalised and new concepts that were previously left out.

5.2.3 One mode Actor congruence network

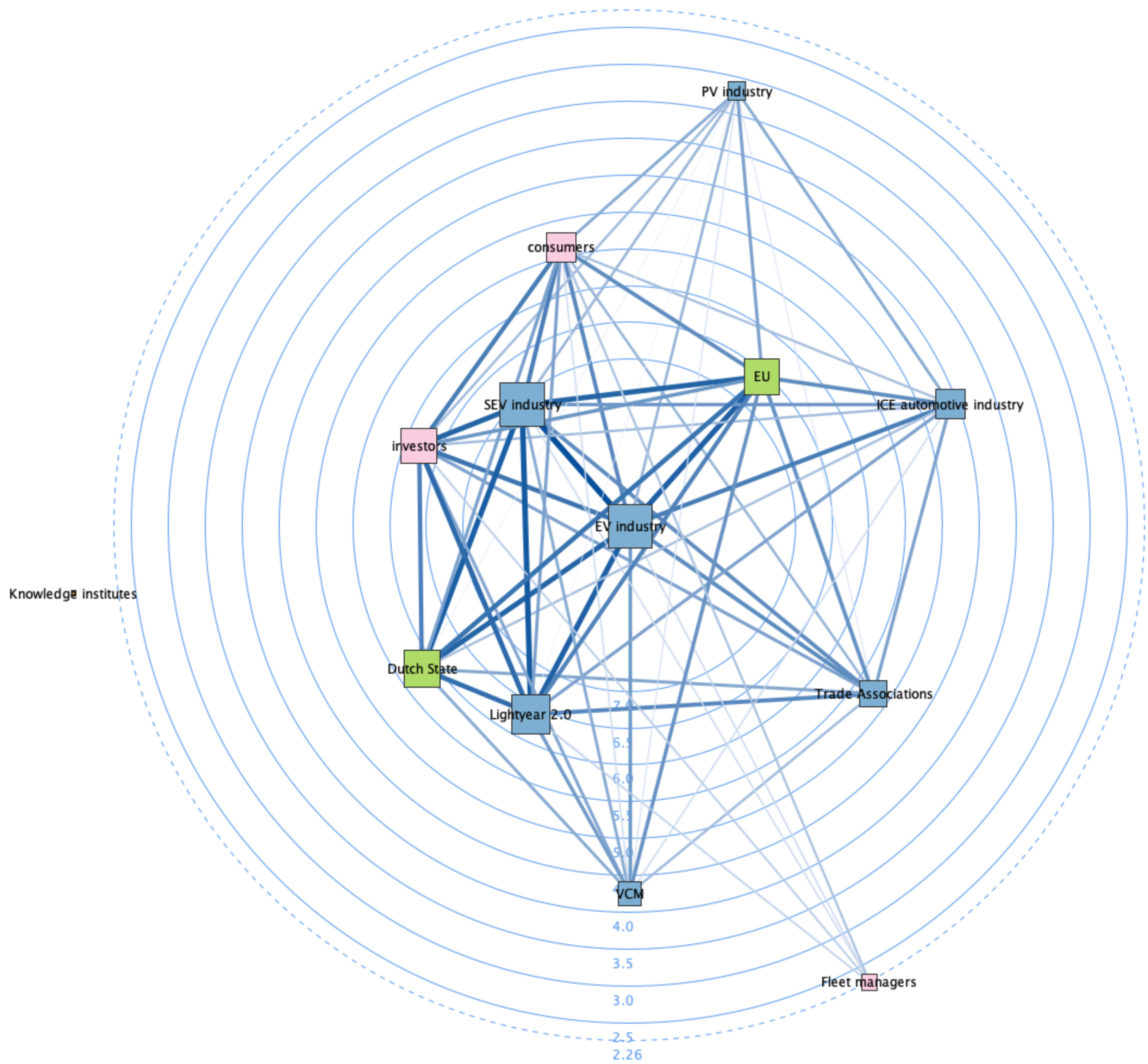

Figure 9. One mode actor congruence network post Lightyear bankruptcy.

The one-mode actor congruence network after the failure of Lightyear, as seen in Figure 9, shows a network with an average degree of 4.930 at a density of 0.769, and the actors, on average, use 12.380 concepts. This is an increase in average degree from before the failure and a slight decrease in density, yet still highly connected. The SEV industry has been replaced at the centre with the EV industry with a degree of 7.128, and using 24 concepts, making it the most institutionalised actor. The SEV industry, however, is second with a degree of 7.062 and 25 concepts, showing an above-average level of institutionalisation still. The alignment between the two industries has risen significantly from 0.61 before the bankruptcy to 0.89 after the bankruptcy, indicating that the EV and SEV industries are now highly aligned and that a storyline exists between industry actors.

Lightyear 2.0, with a degree of 6.3 and 19 concepts, is still a somewhat institutionalised actor and is now more closely connected to the EV industry and investors with a respective edge weight of 0.82 and 0.76, a nearly 0.4 increase for both edges compared to before the failure indicating a higher level of alignment. Overall, Lightyear 2.0 shows a higher alignment with all other actors except for the PV industry, indicating that Lightyear is now more closely connected to the main storyline.

The EU and Dutch state were prominent and highly institutionalised actors before the failure, which has remained with above average centrality degree and concept usage; however, rather than having virtually identical descriptive statistics, the EU now has a 6.555 centrality degree whilst the Dutch State has 5.837 degrees meaning that the EU has overtaken the dutch state in terms of channelling relational information between actors. The alignment between the Dutch state, the EU, and other actors in the context of solar mobility has also shifted as the policy actors are now more closely aligned to the EV and SEV industry, again revealing a story where other companies in the EV and SEV industry have aligned with the policy actors.

The Market actors have undergone a reconfiguration as well. Before the bankruptcy, investors and consumers played only a peripheral role in the network but now have an above-average degree of centrality with 6.201 and 5.364 and 16 and 11 concepts used, respectively, making them more institutionalised actors. Equally, the alignment has risen with every other actor, with the Investors now most closely aligned with the SEV industry and consumers most closely aligned with investors. Fleet managers remain a loosely connected peripheral actor, and the absence of connections with the knowledge institutes has also remained.

6. Discussion

The following discussion contains the interpretation of the results and provides context to the findings through examples from the document stock and interviews. Additionally, the findings are discussed in the context of transition and innovation literature.

In the pre-bankruptcy landscape of the solar mobility sector, Lightyear's case provides a nuanced understanding of how entrepreneurial capabilities and constraints in business strategies can contribute to transition failure. The STCA reveals a complex configuration where the incumbent institutions of the EV experience destabilisation, yet there is no sufficiently developed SEV industry and market to overtake EVs.

Lightyear's strategy to create niche legitimacy through policy, such as differentiating SEVs from EVs, was undermined by the insufficient development of the industry and market. This misalignment suggests a premature push for policy changes without a corresponding market readiness, reflecting a disconnect in the innovation lifecycle where the technology's maturity did not match the sector's commercial and industrial development. The Multi-Level Perspective underscores the need for alignment across different system levels – niche, regime, and landscape – for successful transitions (Geels, 2002). Lightyear's experience illustrates the challenges of achieving such alignment when few other forces drive the change. Equally, this highlights the 'hard edge' of the policy dimension of the business model design space, showing that policy cannot be changed through business activity alone (Wesseling et al., 2021).

This finding is relevant for companies in the sector and extends to other industries. A firm's strategy might align with the needs of stakeholders and even the demands of policymakers, yet there is a level of alignment required between firms in the same sector. A firm's position as a 'thought leader' is a valid way to help legitimise the niche whilst also giving the firm a competitive advantage. Yet, that leadership position in the niche is only effective when other firms follow that leadership. On the one hand, you need a niche leader to advance niche development. On the other hand, niche development also relies on the rest of the organisations. One organisation might champion one dimension of the system, yet it might have adverse effects if no other organisation can keep up that development in other dimensions. Future studies could examine the effectiveness of thought leadership on a transition further.

The automotive industry's reliance on regulation and public actors for innovation is well-documented (Smith & Crotty, 2008). However, the sector's dependence on the government for niche protection and the transition from startup to scale-up phase required a broader commitment than was available. Lightyear's dominance paradoxically became a deterrent for government support, which ideally should have been more inclusive of other niche actors. The need for governmental support reflects the Multi-Level Perspective's emphasis on the role of government in providing stability and guidance during the niche development phase (Smith & Raven, 2012).

Solar mobility needed more effective policymakers willing to put similar protections in place for the niche compared to the push for EVs a decade ago. Granted, SEVs were in a much earlier state of readiness. The policy actors remained optimistic in their messaging yet hesitant and non-committal in their actions towards niche protection. This highlights a ‘waiting game’ that other sectors may face as well. An institution like a government is perfectly positioned to stimulate niche development and can take much larger risks compared to private institutions. Market actors are unwilling to move until there is government support and a government is not interest to act until there is a market force. This mutual dependence is a delicate balance required for a functioning system but also limits the systems functioning to the trust and ambition of individual decision makers.

Most of the resources in terms of human, social and financial capital were with Lightyear, which led to a situation where Lightyear's leadership role made it look like Lightyear was the niche, which made policy actors hesitant to protect the niche further because "*We, the government, won't support a single company*" (translated from an interview in dutch).

Despite its academic origins, the underrepresentation of knowledge institutes in the sector points to a gap between innovation and its application in commercial and policy contexts. While knowledge institutes focused on fundamental VIPV research, their efforts did not translate into large-scale implementation. This gap highlights a lack of alignment between knowledge institutes and the industry in this socio-technical configuration. However, the lack of information on knowledge development activities in the document stock can also explain the misalignment of knowledge institutes.

While a valid societal concern, Lightyear's narrative on net congestion and charging infrastructure did not align with broader consumer demands, reflecting a niche-centric approach rather than a market-driven one. The lack of a strong connection between energy independence and the industrial challenges of net congestion and charging infrastructure suggests a misalignment of user values with industry problems. Where Lightyear sought to stretch and transform the regime, it may have benefitted from fitting and conforming to the EV landscape through, for example, a stronger emphasis on efficiency rather than PV (Wesseling et al., 2021).

ASOM's moderate betweenness within the network highlights its limited role as a bridge among actors. While it connected various stakeholders, it did not fulfil its potential as a cooperative platform to unify the sector's efforts. This shortfall reflects a missed opportunity in strategic niche management and governance, where collective action can significantly impact and legitimise the sector's trajectory (Kemp et al., 1998). Niche development requires a level of governance to guide the direction and vision. Multiple actors must coordinate and distribute power and resources over an extended period (Smith et al., 2005). While ASOM and Lightyear tried to fulfil this governance duty with the support of government actors, there was not enough governance and less distribution of power and resources.

While indicative of its pioneering status, Lightyear's central position in the network also exposed its overextension. The company's attempt to manage multiple facets of the niche without sufficient resources and expertise led to a loss of focus and direction. This situation exemplifies the challenges of strategic management, where a firm must balance its mission with operational capabilities. Lightyear did not have the dynamic capabilities required for its leadership position in the niche (Teece, 2019). Lightyear's experience suggests that a more focused approach, possibly starting as an Original Equipment Manufacturer for VIPV or in-wheel technology, could have provided the necessary experience and financial stability to support its broader mission. In general, a firm's capabilities and the difficulties it might face lead to externalities in the system. When an organisation overextends itself, regardless of its intentions, it may lead to adverse and unintended consequences on the functioning and legitimacy of the niche. A system is strength depends on its firms' organisational strengths. Future research could improve the understanding of the balance and impact between organisational capabilities of a firm and the overall capabilities of the sector.

The pre-bankruptcy phase of Lightyear and the solar mobility sector demonstrates how organisational failures, such as overextension and resource mismanagement, combined with institutional constraints, like policy support and industrial and market misalignment, can hinder the transition to the development of a technological niche. The case underscores the importance of strategic alignment and balanced effort across policy, industry, and market narratives to support innovative sectors' successful institutionalisation and scaling.

In the aftermath of Lightyear's failure, the solar mobility sector has undergone a significant socio-technical reconfiguration, impacting the overall direction of the mobility transition. The bankruptcy of Lightyear marked a pivotal moment for the solar mobility sector and reshaped the socio-technical landscape. Lightyear's shift from a central to a more peripheral role has led to a redistribution of activities among solar mobility actors, creating a more balanced division and a robust network less susceptible to the failure of any single entity. Considering Turnheim and Sovacool's (2020) typology of failure shows that Lightyear's failure is indeed a processual account of failure. While specific events like managerial shortcomings or failed negotiations are discrete and systemic failures, the failure is ultimately shaped by the broader systems and processes and, in the case of solar mobility, inherent to the transition journey and key to future development.

Despite its reduced centrality, Lightyear remains more involved than might be expected, which could be attributed to several factors: the company's relatively large workforce post-bankruptcy, the increased attention drawn to the company by its financial collapse, and a document stock potentially skewed towards Lightyear's activities. Nevertheless, Lightyear's focus has narrowed to mass-market SEVs and VIPV mass production, reflecting a strategic recalibration in line with the literature on strategic niche management (Kemp et al., 1998). Lee et al. (2022) found that failed niches reinforce the regime stability, the case of solar mobility shows that despite its failure, the structure of the niche is more stable as well. The failure of a central actor leading to a more robust, balanced, albeit smaller, niche is an interesting area of further exploration in the niche management literature and should be investigated across other sectors.

The diminished role of policy actors in the post-bankruptcy landscape is notable, likely due to Lightyear's previous active and public corporate lobbying, which other companies have not matched. ASOM's shift towards adopting VIPV and a stronger link to climate policy may indicate that ASOM has taken over the role of governmental affairs, potentially filling the void left by

Lightyear. Trade associations like ASOM can be key actors to connect the micro with macro level as it is a hub for actors to connect and act as representatives of an entire sector. Such hubs are key to Niche management and governance as a trade association with an democratically elected leadership hold a level of trust and legitimacy, holds relatively more power to set a direction of the niche compared to individual organisations. Nonetheless, an association needs active participation from its member to function correctly which is difficult as maturing niches may not have the resources needed to participate in such associations and in the governance of the niche. Future research into the role of cooperative platforms and trade associations in niche governance could improve the understanding of strategic niche management further.

Efficiency, once a unique selling proposition of SEVs, has become a shared attribute with EVs, suggesting a convergence of values between the two sectors. This could imply that while the SEV industry identified the trajectory towards efficiency earlier than EV, it could only capitalise on the trajectory partially. The EV industry's centrality in the post-bankruptcy network suggests the rejection of the niche from the regime or a strategic absorption of niche technologies into the mainstream.

In 2023 some notable EV manufacturers have shifted to include the technological principles of efficiency and VIPV into their products. The 2023 Toyota Prius now includes a VIPV option and the Fisker Ocean in the US as well. Although these vehicles have likely been in development for years it does show the potential for the adoption of VIPV. Whether or not the activities of the solar mobility niche have induced a regime shift or if the landscape pressure was already pushing towards efficiency and solar mobility was quicker to adapt remains inconclusive and could be an interesting area for future research.

Investors have emerged as more influential in the direction of innovation within the solar mobility niche. Their closer alignment with consumer needs and the SEV industry suggests a market-oriented innovation landscape where consumer acceptance and financial backing are critical in shaping the sector's future. This shift reflects a narrative realignment within the sector, moving from policy-driven legitimacy to a more balanced decision making process that includes industry, market, technology, and policy dimensions. However, the increase of investor involvement could also be because investors became more vocal and investments more public after the bankruptcy. A recurring cause for the failure of Lightyear is the increasing interest rates of central banks making investors more risk averse, the diminishing interest in E-mobility start ups, and the lack of due diligence from Lightyear and investors. The failure of Lightyear could have made investors more cautious to invest and under the condition that investors gain greater control and insight into a firms operation. Future research should examine the influence of investors on technological development through the lens of social construct of technology as the demands of investors might not align with the needs of potential users.

Finance remains a critical element of the success of any firm. One problem faced by Lightyear was the cyclical and sometimes irrational nature of private equity. Lightyear was essentially forced to spend all its raised money on activities that the investors demanded to increase the company's value as much as possible while diluting its ownership as little as possible. For example, as investors became less interested in EVs and became more risk averse while investors were also looking for 'the next big thing', Lightyear was essentially forced to differentiate itself further with properties like autonomous driving, smart charging, a collective smart energy storage system, bidirectional smart charging, an accompanying app etc. These properties made the company more valuable than the sum of its investments and attracted more investors; it also made it significantly more challenging to deliver on the promises made to investors and made the allocation of resources more difficult beyond the management capabilities of the top management. Meeting investor requirements while maintaining control over a company without altercating the original vision proved too difficult. The intricate play of power and influence of market dynamics and firm capabilities has led to failure in the past. It will continue in other sectors in the future and, as such, requires a more profound academic understanding in future studies.

A multifaceted approach now establishes the niche's legitimacy as it no longer solely relies on the policy dimension. This balanced approach is healthier for the growth of the niche, as it aligns with the strategic niche management literature, which emphasises the importance of coherence across various dimensions for niche development. Equally, the three processes for niche development, as outlined by Geels (2011), show positive development. There is now a new expectation that guides innovation, namely VIPV; the network of firms and organisations active in solar mobility is stable and increasing, and the niche reconfiguration shows that firms have collectively learned from market and infrastructure demands. Although a niche is inherently fragile, there is some resilience and adaptability. Where a niche is generally seen as a protected space less susceptible to external pressures, this thesis shows that niche actors may not be as protected from external pressure, which, combined with entrepreneurial constraints, can lead to significant reconfigurations of the niche.

The post-bankruptcy alignment between the EV and SEV industries suggests the potential of the SEV conforming to the regime, with SEVs increasingly viewed as EVs with solar integration rather than a distinct category. The solar mobility sector after Lightyear's bankruptcy illustrates a narrative of adaptation, resilience, and strategic transformation. The sector's evolution underscores the importance of strategic alignment and the interplay between policy, industry, market forces, and consumer needs in shaping sustainable transport technologies. The increased influence of investors and the convergence of SEV and EV values reflect a socio-technical subsystem in transition with the potential to redefine the trajectory of the mobility sector. This realignment could signal a strategic adaptation to market realities, emphasising the critical role of market acceptance and financial narratives in sustaining innovation and sector growth. The realignment of EVs may also explain the emphasis on VIPV as VIPV is now a means of overcoming the transition restraints, and the niche is now more focused on developing products that conform to the regime, which will help solar mobility assimilate into the EV regime.

The semi-quantitative nature of the data introduces subjectivity in the interpretation of the document stock during the coding process which can impact the reliability of the findings as different people can categorise the same information differently. However, converting qualitative data into standardised quantitative data also reduces the subjective interpretation compared to purely qualitative research. Therefore, the coding procedure and scheme with definitions can be found in Appendix A to improve replicability and reliability. Equally, with semi-quantitative methods, there is a balance between qualitative richness and quantitative precision, which makes the results more precise. The numerical nature of the dataset makes it easier to compare across different studies and easier to confirm. Nevertheless, the comparability of the findings is limited to the consistency of the initial coding and data collection processes.

The semi-quantitative methodology allows for a more in-depth exploration of complex phenomena, thus increasing the content validity as the presence and intensity of variables are considered, giving a closer reflection of the real world. The external validity, however, is limited by the depth of the research as it is challenging to generalise findings specific to the niche. Theoretical constructs of transition studies and BMI and the data collection require a level of interpretation, which lowers the construct validity of this thesis. Quantifying the results takes a step towards improving the validity, but this highly depends on the initial accuracy. However, the consistent usage of business models and transition literature and terminology throughout the data collection process may help improve the validity.

This thesis contributes to the academic discourse by methodologically integrating Socio-Technical Configuration Analysis and Business Model Design Space. This integration addresses a notable gap in the literature where the interaction between the micro-level intricacies of business models and the macro-level dynamics of socio-technical transitions has been underexplored. Traditionally, these fields of study have developed in parallel, with limited interconnections. Previous studies focusing on the meso-level may not sufficiently capture the subtleties inherent in the interaction between individual business strategies and broader systemic transitions. Only recently have transition studies and business models begun to converge with explicit efforts to combine the micro with the macro level (Aagaard, et al. 2021).

By employing this novel integrated approach, this research sheds light on the multifaceted nature of transitions, highlighting the importance of considering both the strategic actions at the firm level and the overarching societal and technological shifts. The findings from this study, particularly regarding the impact of failure on reconfiguring niches, offer a nuanced perspective that enriches the understanding of transitions. Future research should explore developing a more robust framework that integrates business models and transition theories into a methodology that allows findings to be more consistently generalised. This novel approach could be employed by business developers, managers and policymakers to better understand the socio-technical systems that they operate in or try to support key areas of weakness in the system.

This research has limitations. The document stock is potentially skewed towards Lightear, emphasising the role of Lightyear in the network, which affects the reliability of the conclusions and might not accurately portray the solar mobility niche. The research only accounts for the first eight months after Lightyear's failure. However, the niche could still be a reconfiguration process, and the results might not accurately reflect that current state. While the document stock, specifically the news reports, is to be assumed as truthful, specific instances of contradicting information and heavily altered accounts of events also influence the results.

Despite these significant limitations, this thesis contributes to a more nuanced understanding of transition failures and the resilience of socio-technical systems. The case of solar mobility adds value to the literature on socio-technical systems and the multi-level perspective by providing a rare insight into how failed niche actors can destabilise and influence transition pathways. The findings underscore the importance of strategic alignment across actors and concepts in socio-technical configurations.

7. Conclusion

This thesis sought to understand the complexities of transition failure in the solar mobility sector by asking the question: *How do entrepreneurial capabilities and activities influence, and are influenced by, the dynamics of the solar mobility sector, and what is the impact of failures on the reconfiguration and overall direction of the socio-technical system?* Through a case study of Lightyear's bankruptcy within the Solar Mobility niche, the theories of the Multi-Level Perspective and Business Model Design Space formed the theoretical background. The document stock of this thesis included internal documents from Lightyear before the bankruptcy, ASOM, grey literature, and interviews with experts from the sector. A Socio-Technical Configuration Analysis was performed on the solar mobility niche before and after the failure of Lightyear. The findings show that the niche has reconfigured in a more stable composition and that the failure of Lightyear can be led back to the firms ability to allocate resources and define its operational capacities. Firms are recommended to focus on building core competencies, be diligent with their resources and seek collaborative partnerships to provide mutual benefits. Policymakers should seek to improve support mechanisms for scale-ups and be more reflexive towards changing alignements of the industry developments and market demands.

The main findings indicate a significant reconfiguration of the solar mobility niche, characterised by a decrease in the size and ambition of the niche but an increase in its robustness, a more balanced division of activities, and a strategic pivot towards VIPV over SEVs. Lightyear's failure resulted from its inability to allocate resources effectively and overextending its strategy, lacking the dynamic capabilities necessary for the sector's pioneering role. Consequently, the EV industry has reasserted itself as the central institutional force within the solar mobility landscape, reflecting a 'Transformation' transition pathway where the niche was underdeveloped, and incumbent actors steer the direction of innovation towards incremental changes, such as the shift towards efficiency.

The dynamic capabilities of Lightyear and the constraints faced by entrepreneurs in the solar mobility sector have instigated a transition towards a more pragmatic and less complicated sector. Solar mobility is now more attuned to market demands, and its most ambitious actors, such as Lightyear, have adapted by transitioning towards becoming a component supplier within the broader EV category. The socio-technical configuration of the niche has become more resilient, with decreased governmental involvement and a more balanced distribution of activities among actors. The solar mobility sector is no longer perceived as a distinct category of vehicles but rather as an integral subset of the EV landscape. Without direct SEV competition, the EV sector emerges as the de facto competitor. The misalignment of a central actor's business model within the niche can lead to a profound reconfiguration and disruption, underscoring the delicate balance between innovative niches and the socio-technical landscape.

The mission-oriented innovation policy approach should be more adaptive to the needs of emerging transition pathways. Emission-free mobility centred around efficiency is one of the missions of Dutch innovation policy. SEVs are a mixture of key technologies like Photovoltaics, energy materials, Software technologies and computing, and systems engineering that are combined to achieve the mission of the energy transition. SEVs are not sufficiently differentiated from EVs to receive policy stimuli, yet SEVs diverge from solar energy too much to receive solar energy-associated benefits. Not only should governments set these ambitious agendas that allow a niche to develop, but a government should also complement that ambition with more substantial support to maintain and grow that niche to maturity.

Protecting a niche means the development of support mechanisms that are suitable for both start ups and scale ups. This gap, commonly referred to as ‘the valley of death’ where scientific research moves towards commercialisation (Ellwood, et al., 2022). While the focus of financiers and policymakers has predominantly been on start ups, scale ups require more support mechanisms, especially endeavours with high initial investments that take a long time for a return on investment, like an automotive industry. The Lightyear Zero was seen as a ‘Proof of Concept’ which formed the narrative around the innovation process around the company, while in actuality Lightyear as a company should have focussed more on the integration and assessment of skills, routes to markets, and other commercialisation strategies. he support of scale-ups, at the size of Lightyear, could result in positive externalities but require specific mechanisms of support from public actors that aren’t available through existing mechanisms like start up grants. For example, VDL Nedcar and Lightyear were close to partnering to produce Lightyear's mass-market model in the Netherlands but required support from the government. When this partnership did not happen, Lightyear was declared bankrupt, and VDL no longer had a contract to produce; this has led to 600 people losing their jobs at Lightyear and 3500 employees of VDL Nedcar losing their jobs.

Government policies should be closely aligned with market and industry development to ensure that policy initiatives support the current state of technology and consumer readiness. For example, Energy Labels that provide benefits to consumers who drive a more efficient electric car. As opposed to the current legislation, which measures 'tailpipe emissions' even for EVs. Another example is the fact that consumers only receive a VAT exemption for the solar panel on the roof of their house but not the roof of their car.

Leadership should prioritise building in-house capabilities before scaling up. This involves a strategic focus on core competencies, such as mass-producing VIPV panels, which can provide the valuable experience it takes to mass-produce complex goods and align with the broader industry's trajectory towards efficiency and integration with EVs. Firms should develop dynamic capabilities to sense and seize opportunities in a rapidly changing market. This includes reconfiguring internal and external competencies to address emerging technologies and consumer trends.

Managers must allocate resources effectively and avoid overextension. Improved resource allocation can be achieved by adopting a more incremental approach to innovation, focusing on achievable targets, and ensuring the company's mission aligns with its operational capabilities. For companies that rely on investments rather than revenue with long development cycles, the company's mission must remain focused with clear boundaries on the end of the development cycle and functionality of the goods or services produced.

Firms should seek collaborative partnerships with incumbent firms to leverage their experience and resources. Using the example of VIPV mass production again, it could be more beneficial towards the company's mission to sell components to future competition first as it brings the technology to the market and provides a source of revenue whilst the firm also builds up its industrial capabilities. Collaborative partnerships could facilitate a smoother transition into the market and enable niche companies to benefit from the incumbents' established capabilities and market presence.

Lightyear's failure has significantly impacted the speed and direction of the solar mobility niche. The transition failure of solar mobility is a rejected transformation of the innovation pathway. Solar Mobility without Lightyear as its central actor has reconfigured itself to be more resilient, more realistic and positioned to grow sustainably as the principles of hyper-efficient electric vehicles and vehicle-integrated Photovoltaics are likely to diffuse into the electric vehicle regime in the coming years. While the transition of solar mobility may have 'failed', it is still an active niche with great potential to progress sustainable mobility. Analysing what could have been is equally important as analysing what is. Lightyear showed the world a different view of mobility and acted as a catalyst for innovation and growth. The efforts and hardship in solar mobility should be studied further because the lessons learned from this unrealised transition will likely influence the next transition attempt. Celebrate failure as it provides a chance for continuous learning.

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8. References

Aagaard, A., Lüdeke-Freund, F., & Wells, P. (2021). Introduction to business models for sustainability transitions. In Business Models for Sustainability Transitions: How Organisations Contribute to Societal Transformation (pp. 1-25). Cham: Springer International Publishing.

Adams, R. J., Smart, P., & Huff, A. S. (2017). Shades of grey: guidelines for working with the grey literature in systematic reviews for management and organizational studies. International Journal of Management Reviews, 19(4), 432-454.

Alkemade, F. (2019). 17. Sustainable innovation research methods. *Handbook of Sustainable Innovation*, 299.

ASOM: Alliance for Solar Mobility. (2023). https://asom.solar/

Bauer, R. (2014). Failed Innovations—Five Decades of Failure?. Icon, 33-40.

Bidmon, C. M., & Knab, S. F. (2018). The three roles of business models in societal transitions: New linkages between business model and transition research. Journal of Cleaner Production, 178, 903-916.

Bolton, R., & Hannon, M. (2016). Governing sustainability transitions through business model innovation: Towards a systems understanding. Research policy, 45(9), 1731-1742.

Braun, H.-J. (1992). Introduction. Social Studies of Science, 22(2), 213–230. https://doi-org.proxy.library.uu.nl/10.1177/030631292022002002

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.

Bryman, A. (2016). Social research methods. Oxford university press

Collins, B. (2020). “It’s not talked about”: The risk of failure in practice in sustainability experiments. Environmental Innovation and Societal Transitions, 35, 77-87.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. Medical education, 40(4), 314-321.

Egghe, L., & Leydesdorff, L. (2009). The relation between Pearson's correlation coefficient r and Salton's cosine measure. Journal of the American Society for information Science and Technology, 60(5), 1027-1036.

Ellwood, P., Williams, C., & Egan, J. (2022). Crossing the valley of death: Five underlying innovation processes. Technovation, 109, 102162.

Elmustapha, H., & Hoppe, T. (2020). Challenges and opportunities of business models in sustainable transitions: Evidence from solar energy niche development in Lebanon. Energies, 13(3), 670.

EU ban on sale of new petrol and diesel cars from 2035 explained | News | European Parliament. (2022, March 11). https://www.europarl.europa.eu/news/en/headlines/economy/20221019STO44572/eu-ban-on-sale-of-new-petrol-and-diesel-cars-from-2035-explained

Figenbaum, E. (2017). Perspectives on Norway's supercharged electric vehicle policy. Environmental Innovation and Societal Transitions, 25, 14-34.

Fuenfschilling, L., & Truffer, B. (2014). The structuration of socio-technical regimes—Conceptual foundations from institutional theory. Research policy, 43(4), 772-791.

Fusch Ph D, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8-9), 1257-1274.

Geels, F., & Raven, R. (2006). Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). Technology Analysis & Strategic Management, 18(3-4), 375-392.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research policy, 36(3), 399-417.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental innovation and societal transitions*, *1*(1), 24-40.

Geels, F. W. (2019). Socio-technical transitions to sustainability: A review of criticisms and elaborations of the Multi-Level Perspective. Current opinion in environmental sustainability, 39, 187-201.

Geels, F. W. (2020). Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neo-institutional theory. Technological Forecasting and Social Change, 152, 119894.

Girvan, M., & Newman, M. E. (2002). Community structure in social and biological networks. Proceedings of the national academy of sciences, 99(12), 7821-7826.

Groothuis, B., Grudler, C., & European Parliament. (2022, September 7). A9-0208/2022. Europarl.europe.eu. Retrieved February 27, 2023, from https://www.europarl.europa.eu/doceo/document/A-9-2022-0208-AM-026-034_EN.pdf

Harrisson, D., & Laberge, M. (2002). Innovation, identities and resistance: The social construction of an innovation network. Journal of Management Studies, 39(4), 497-521.

Heiberg, J., Truffer, B., & Binz, C. (2022). Assessing transitions through socio-technical configuration analysis–a methodological framework and a case study in the water sector. *Research Policy*, *51*(1), 104363.

Hekkert, M. P., Suurs, R. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological forecasting and social change, 74(4), 413-432.

Jenkins, A., & McKelvie, A. (2016). What is entrepreneurial failure? Implications for future research. International Small Business Journal, 34(2), 176-188.

Kanger, L. (2021). Rethinking the Multi-level Perspective for energy transitions: From regime life-cycle to explanatory typology of transition pathways. Energy Research & Social Science, 71, 101829.

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology analysis & strategic management, 10(2), 175-198.

Köhler, J., Turnheim, B., & Hodson, M. (2020). Low carbon transitions pathways in mobility: Applying the MLP in a combined case study and simulation bridging analysis of passenger transport in the Netherlands. Technological Forecasting and Social Change, 151, 119314.

Lee, J., Park, G., & Kim, K. (2022). Transition failure strengthening regime stability in socio-technical systems: A case study of shared mobility market in South Korea. Telematics and Informatics, 70, 101814.

Leifeld, P. (2017). Discourse network analysis. *The Oxford handbook of political networks*, 301-326.

Lightyear — Solar Electric Vehicle. (2023). Lightyear. https://lightyear.one/

Liu, W., Tao, Y., Yang, Z., & Bi, K. (2019). Exploring and visualizing the patent collaboration network: A case study of smart grid field in China. Sustainability, 11(2), 465.

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research policy, 41(6), 955-967.

Maybury, L., Corcoran, P., & Cipcigan, L. (2022). Mathematical modeling of electric vehicle adoption: A systematic literature review. Transportation Research Part D: Transport and Environment, 107, 103278.

Merriam-Webster Dictionary. (2023). Definition of failure. In Merriam-Webster Dictionary. https://www.merriam-webster.com/dictionary/failure

Miörner J., Truffer T., Binz C., Heiberg J. & Yap X.-S. (2022) Guidebook for applying the Socio-Technical Configuration Analysis method. GEIST – Geography of Innovation and Sustainability Transitions 2022(01), GEIST Working Paper series.

Najmaei, A., & Sadeghinejad, Z. (2023). Green and sustainable business models: historical roots, growth trajectory, conceptual architecture and an agenda for future research—A bibliometric review of green and sustainable business models. Scientometrics, 128(2), 957-999.

Nielsen, C. (2014). The investor perspective on business models. In The Basics of Business Models (pp. 85-104). Ventus.

Nocaj, A., Ortmann, M., & Brandes, U. (2015). Untangling the hairballs of multi-centered, small-world online social media networks.

Miörner J., Truffer T., Binz C., Heiberg J. & Yap X.-S. (2022) Guidebook for applying the Socio-Technical Configuration Analysis method. GEIST – Geography of Innovation and Sustainability Transitions 2022(01), GEIST Working Paper series.

Oliver, D. G., Serovich, J. M., & Mason, T. L. (2005). Constraints and opportunities with interview transcription: Towards reflection in qualitative research. Social forces, 84(2), 1273-1289.
Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers (Vol. 1). John Wiley & Sons.

Padberg, J. A. H., & De Wit, R. P. A. (2023, September 7). Faillissement Vanmoof B.V. te Amsterdam (F.13/23/204). https://www.faillissementsdossier.nl. Retrieved September 7, 2023, from https://www.faillissementsdossier.nl/nl/faillissement/1747989/vanmoof-b-v.aspx

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and policy in mental health and mental health services research, 42, 533-544.

Petticrew, M., & Roberts, H. (2008). Systematic reviews in the social sciences: A practical guide. John Wiley & Sons.

Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. Social studies of science, 14(3), 399-441.

Real, R., & Vargas, J. M. (1996). The probabilistic basis of Jaccard's index of similarity. Systematic biology, 45(3), 380-385.

Rip, A., & Kemp, R. (1998). Technological change. Human choice and climate change, 2(2), 327-399.

Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. Foresight.

Sarasini, S., & Linder, M. (2018). Integrating a business model perspective into transition theory: The example of new mobility services. Environmental innovation and societal transitions, 27, 16-31.

Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: the role of business model innovation for corporate sustainability. International journal of innovation and sustainable development, 6(2), 95-119.

Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. Research policy, 34(10), 1491-1510.

Smith, M., & Crotty, J. (2008). Environmental regulation and innovation driving ecological design in the UK automotive industry. Business strategy and the Environment, 17(6), 341-349.

Smith, A., & Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. Research policy, 41(6), 1025-1036.

Sono Motors. (2023). Sono Motors Commits to Focus Exclusively On Solar Tech Company, and Has Terminated the Sion Program. Sono Motors. https://sonomotors.com/en/press/press-releases/sono-motors-commits-to-focus-exclusively-on-solar-tech-company-and-has-terminated-the-sion-program/

Statista. (2023). Electric Vehicles - Europe | Statista market forecast. https://www.statista.com/outlook/mmo/electric-vehicles/europe

Stubbs, W., & Cocklin, C. (2008). Conceptualizing a "sustainability business model". Organization & environment, 21(2), 103-127.

Teece, D. J. (2010). Business models, business strategy and innovation. Long range planning, 43(2-3), 172-194.

Teece, D. J. (2019). A capability theory of the firm: an economics and (strategic) management perspective. New Zealand Economic Papers, 53(1), 1-43.

Truffer, B., Rohracher, H., Kivimaa, P., Raven, R., Alkemade, F., Carvalho, L., & Feola, G. (2022). A perspective on the future of sustainability transitions research. Environmental Innovation and Societal Transitions, 42, 331-339.

Turnheim, B., & Sovacool, B. K. (2020). Exploring the role of failure in socio-technical transitions research. Environmental Innovation and Societal Transitions, 37, 267-289.

Udink, M. C., & Ebels, E. S. (2023, April 7). Faillissement Greenmo Rent B.V. te Waardenburg (F.09/23/50). https://www.faillissementsdossier.nl. Retrieved September 19, 2023, from https://www.faillissementsdossier.nl/nl/faillissement/1708181/greenmo-rent-b-v.aspx

Voegtlin, C., Scherer, A. G., Stahl, G. K., & Hawn, O. (2022). Grand societal challenges and responsible innovation. Journal of Management Studies, 59(1), 1-28.

Wesseling, J. H., Bidmon, C., & Bohnsack, R. (2020). Business model design spaces in socio-technical transitions: The case of electric driving in the Netherlands. Technological Forecasting and Social Change, 154, 119950.

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. Journal of management, 37(4), 1019-1042.

Appendix A. Coding Scheme

Codes	Code description
Actors	
industry	
SEV industry	Manufacturers of Solar Electric vehicles and components
Trade Associations	Alliance for Solar Mobility and other interest groups such as the 'nederlandse vereniging duurzame energie' where members can collaborate, share information or coordinate PR efforts
EV industry	Manufacturers of Electric Vehicles and components
ICE automotive industry	Manufacturers of ICE vehicles and components
PV industry	manufacturers of solar cells and components
VCM	Vehicle Contract Manufacturers such as Valmet and VDL Nedcar with a manufacturing as a service for SEV's
Lightyear	Atlas Technologies BV and all other spin off companies collectively known as Lightyear from before the bankruptcy
Lightyear 2.0	Atlas Technologies BV and all other spin off companies collectively known as Lightyear after the restart of the company
Market	
Fleet managers	ride share and fleet management organisations such as Leaseplan or arval who own fleets of vehicles available for private or company leases
consumers	a person who purchases a vehicle for personal use
investors	household or institutional investors who invest capital in the solar mobility sector
Policy	
Dutch State	The Dutch government including all ministeries, chambers of government, provinces, municipailties and other organisations related to the governance of the Netherlands
EU	The European Union including the European Commission, Parliament, Council and other relevant European institutions

S&T	
Knowledge institutes	Universities or research institutes involved in the SEV industry

Concepts

Culture	
Affordability	Perceptions of the public on the price of SEV technology
Clean Mobility	Consumer values related to sustainable and environmentally, or clean, mobility technologies
Energy Independence	Statements related to off the grid user energy needs
Niche Legitimacy	Statements on building and maturing the SEV niche as a differentiated category

Industry	
Charging Infrastructure	Statements on the EV charging infrastructure in Europe
Net Congestion	The propotional increase of EV electricity consumption as pressure on the existing electricity network
Value Capture SEV	How solar mobility companies make money and incur costs and can capitalise on other forms of value
Value chain SEV	The activities required to bring solar mobility products to market
Value chain EV	The activities required to bring EVs to market
Complexity	Statements related to the organisational and system complexities of commercialising SEVs

Market	
VIPV Adoption	Statements related to the (hypothetical) uptake and diffusion of Vehicle integrated photovoltaics
SEV adoption	Related to the (hypothetical) uptake and adoption of Solar Electric Vehicles
Changing investment climate	Statements related to changing sentiments and investment trends of investors in the automotive industry
Energy market	Statements on the commodity markets for fuel and electricity
investments	Statements on investments made and capital raised
Mobility as a Service	Mobility solutions offered as a service such as lease agreements or ride sharing
SEV value proposition	The unique offer SEVs provide to users

Policy	

Climate policy	Rules, regulations and policy made to combat climate change and promote sustainable development
incentives for Renewable energy	Policies and benefits to promote the energy transition
Lip Service	Statements that epress support of SEVs without any actual commitments
Public Subsidy	Funding or financial benefits from governments to Solar mobility
SEV as public good	The consideration that the technology of SEVs should be available for everyone and be non rivalous

S&T	
Batteries	Statements on battery technologies
Efficiency	Statemtens on efficient energy use
EV	Statments on the technology of EVs
PV	Statements on the technology of PVs
SEV	Statments on the technology of SEVs
VIPV	Statements on the technology of VIPVs