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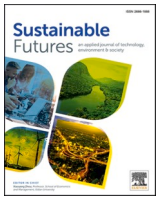

Digital platforms in Zero Emission Vehicle transition: A stakeholder engagement and policy strategy for the UK's net-zero future

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ABSTRACT

The digitalization of net zero strategies is integral to global commitments to achieve mid-century carbon neutrality, as set by the 2015 Paris Agreement. The UK's Department for Energy Security and Net Zero has outlined a digital action plan to advance this goal. This plan aims to optimize energy use, integrate low-carbon technologies (such as solar panels, heat pumps, and electric vehicles), and promote flexible energy consumption through data-driven insights, benefiting consumers and supporting the net zero target. Central to this strategy is the concept of a "Just Transition," which addresses the fiscal and social impacts of shifting to a low-carbon economy, ensuring disadvantaged communities and carbon-intensive industry workers are not left behind. This research emphasizes understanding the cost distribution of net zero pathways, fostering consensus among policymakers, and achieving equitable progress.

However, the role of digital platforms in supporting net zero initiatives, particularly in promoting zero-emission vehicles (ZEVs), remains underexplored. This study addresses this research gap by analyzing how digital platforms influence public opinion, policy formulation, and stakeholder coordination while identifying the potential of digital tools in mobilizing support and organizing efforts. The research employs methodologies such as Gephi network analysis, sentiment analysis, and content strategy assessment to quantify the impact of digital engagement. Key findings reveal that YouTube serves as the primary medium for narrative-driven ZEV promotion, while Platform X facilitates real-time policy discussions. Facebook (ERR: 6.2) and YouTube (ERR: 29.2) exhibit the highest engagement rates, whereas Instagram (ERR: 1.0) and X (ERR: 29.2) demonstrate varied effectiveness. Moreover, videos with text ($n = 136$) emerge as the most engaging content format, followed by images with text ($n = 122$), influencing platform-specific engagement strategies.

Stakeholder analysis reveals that government bodies, industry leaders, and tech providers act as central nodes in driving policy discourse on digital platforms. High modularity in engagement patterns indicates the formation of tightly connected stakeholder communities that shape public opinion and policymaking. Despite strong engagement, challenges such as data privacy, technological reliability, and equitable access persist. Addressing these barriers within the Just Transition framework is vital for inclusive participation in net zero policies. Aligned with the Fair and Just Transition, this study presents policy recommendations, including enhancing digital engagement with underrepresented groups, upskilling workers, promoting circular economy practices, integrating climate risks into strategies, and ensuring transparent progress measurement. These measures are critical for improving energy literacy, fostering public understanding, and advancing the UK's net zero ambitions.

1. Introduction

As the impacts of climate change intensify, countries worldwide are actively promoting Net Zero policies to align with the long-term goals of the Paris Agreement [1]. According to the agreement, signatories of the Climate Convention (COP) are required to submit the third edition of their Nationally Determined Contributions (NDC 3.0) by February 2025, ensuring that their emission reduction actions over the next five years meet global climate mitigation needs.

In 2024, the United Nations Framework Convention on Climate Change (UNFCCC) formally established the UAE Just Transition Work Programme (JTWP), emphasizing the importance of integrating Just Transition principles into climate policies, including NDCs, National Adaptation Plans (NAPs), and Long-term Low Emissions Development

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Strategies (LT-LEDS) [2]. Additionally, the International Labour Organization (ILO) released a report during the COP29 summit, analyzing the latest versions of NDCs from 193 countries to assess how they incorporate Just Transition principles into their national climate plans [3].

As a leader in climate policy, the UK has developed a comprehensive strategy to achieve Net Zero emissions by 2050. The key components of the UK's Net Zero strategy include:

1. Energy Transition: The UK aims to phase out fossil fuel-based power generation, increase the share of renewable energy—particularly wind and solar power—and invest in nuclear and hydrogen technologies to ensure energy security [4].
2. Electrification of Transport: The UK government has pledged to ban the sale of new petrol and diesel vehicles by 2030 and is accelerating the development of electric vehicle charging infrastructure [1].
3. Industrial Decarbonization: The UK is promoting Carbon Capture and Storage (CCS) technology and encouraging industries to adopt low-carbon manufacturing processes [2].
4. Buildings and Housing: The government is providing subsidies to enhance building energy efficiency, including the adoption of heat pump technology and the implementation of stricter energy-efficient building standards [3].
5. Carbon Markets and Policy: Through carbon pricing mechanisms such as the Carbon Border Adjustment Mechanism (CBAM), the UK ensures that the cost of carbon emissions is internalized, motivating businesses and market participants to actively reduce emissions [4].

Digital transformation plays a crucial role in global Net Zero policies, as many countries integrate digital technologies into climate strategies to improve carbon monitoring, reduce energy waste, and enhance industrial efficiency. Here are some international examples:

Digital transformation plays a crucial role in global Net Zero policies, as many countries integrate digital technologies into climate strategies to improve carbon monitoring, reduce energy waste, and enhance industrial efficiency. The UK is advancing Smart Grid technology, leveraging AI and big data to optimize electricity distribution. Additionally, it is implementing blockchain to track renewable energy certificates, enhancing transparency and accountability in energy trading [2]. Under the European Green Deal, the EU is promoting a Digital Carbon Footprint Tracking initiative. This initiative requires companies to report carbon emissions across their supply chains, ensuring transparency and strengthening regulatory oversight [3]. China is utilizing 5 G, the Internet of Things (IoT), and cloud computing technologies to optimize industrial energy consumption. These digital advancements are critical in implementing intelligent solutions for its dual-carbon goals—carbon peaking and carbon neutrality (NDC Partnership, n.d.). The US is advancing the digitalization of its carbon market. By leveraging blockchain technology, the country aims to improve the transparency and security of carbon credit trading, reducing fraud and enhancing the effectiveness of emission reduction efforts [1].

This study follows a logical structure from global trends to the UK's Net Zero strategy, ultimately leading to the key research question. The discussion begins with an overview of international Net Zero policies to establish the broader context. It then narrows down to the UK's specific strategies, emphasizing its ambitious goals and the role of digital transformation in achieving them. Given this foundation, the major research question is: How can digital platforms be leveraged to effectively promote the adoption of zero-emission vehicles (ZEVs) and ensure a 'just transition' in the context of the UK's Net Zero strategy? By addressing the questions, this research aims to provide insights into how digitalization can facilitate a more effective and inclusive transition to Net Zero, aligning with both national and international climate objectives.

As countries implement Net Zero policies, digital transformation has become an essential driver of climate action. The UK, through smart grids and digital carbon market integration, is enhancing emission reduction efficiency, while other nations are also leveraging digital technologies to address climate challenges. Moving forward, further integration of digital innovations into climate policies will be a key focus for the global community. The digitalization of the net zero strategy reflects ongoing efforts by nations to meet mid-century net zero carbon emissions targets, as stipulated by the 2015 Paris Agreement [5]. The UK government's action plan, outlined by the Department for Energy Security and Net Zero [6], details a strategy to digitise the energy system, essential for achieving net zero emissions. This plan includes three key features:

1. Harnessing data and digital technology to optimise energy use and consumer engagement.
2. Integrating millions of low-carbon technologies, such as solar panels, heat pumps, and electric vehicles.
3. Encouraging flexible energy consumption and reducing costs for consumers through data-driven decisions.

A critical aspect of this strategy is promoting zero-emission vehicles (ZEVs), which are central to reducing transportation emissions. The plan underscores that digitalization of the net zero strategy is more than an ambitious catchphrase; it is supported by clear, systematic short-term and future plans. As a global leader, the UK presents a vision, approach, and suite of actions for digitising the energy system, setting a specific model to achieve net zero goals. The UK government announced a world-leading climate change target (the sixth Carbon Budget) to reduce emissions by 78 % by 2035 compared to 1990 levels, aiming for net zero greenhouse gas emissions by 2050 [7].

Addressing the 'Just Transition' and broader fiscal and distributional challenges associated with net zero ambitions is crucial. A Just Transition ensures that the shift to a low-carbon economy does not disproportionately affect disadvantaged communities and workers in carbon-intensive industries [8]. Addressing these challenges is essential for gaining public support and ensuring equitable economic opportunities during the transition. Turner, Katris, and Race [9] proposed five key Net Zero Principles:

1. Understanding who bears the cost of any given action/pathway or combination thereof, and what gains can balance this is fundamental.
2. Policymakers and stakeholder communities need to build consensus around pathways that allow regions and nations to sustain and grow prosperity equitably.
3. Finding options and pathways that can deliver near-term economic returns is crucial, especially in challenging economic contexts.
4. 'Off-shoring' is not a solution if it merely shifts emissions, jobs, and gross domestic product overseas.
5. Net zero is a societal and public policy challenge more than a technological one.

These principles emphasise understanding the distributional impacts of net zero policies and building consensus among stakeholders to sustain equitable prosperity. Without addressing these issues, net zero strategies risk exacerbating social inequalities and facing resistance from affected communities [10].

This study focuses on how digital platforms can promote the adoption of ZEVs and explores the role of digital publics in enhancing public engagement and stakeholder coordination to meet net zero goals. Bedford, Catney, and Robinson [11] found that distinct approaches to the net zero transition had varying levels of success. However, these approaches were not always informed by a deep reflection on the possibilities and challenges of net zero. A comprehensive understanding of net zero requires considering various dimensions, including technological feasibility, economic implications, social acceptance, and policy coherence. For instance, while technological advancements in renewable energy and electric vehicles are crucial, their successful

implementation depends on supportive policies, adequate infrastructure, and public willingness to adopt new technologies [12]. Furthermore, the transition to net zero often involves significant upfront costs and long-term investments, which can be challenging in the context of limited public budgets and economic uncertainties [13]. Without a thorough examination of these interconnected factors, net zero strategies may face obstacles that undermine their effectiveness and sustainability. Therefore, it is essential to integrate multidisciplinary perspectives and engage in holistic planning to address the complexities of achieving net zero emissions.

Despite advancements, previous research has not sufficiently focused on digital publics and the digital deliberative sphere. The role of digital publics in establishing net zero emissions is crucial as they can significantly influence public opinion, policy implementation, and stakeholder coordination through online engagement and deliberation. Concrete actions towards achieving net zero emissions have seen successes in specific fields such as energy system improvements and the adoption of electric vehicles. These successes illustrate the potential of digital platforms to mobilise public support, disseminate information, and facilitate coordinated efforts among diverse stakeholders. However, the potential of digital publics to enhance and expedite net zero strategies remains underexplored in existing studies. Most reports and studies focus on single industrial areas, such as energy consumption reduction [14,15] or net zero energy buildings considering economic conditions [16,17]. Studies on zero-emission vehicles [18–20] also suggest establishing efficient smart electric vehicle charging policies. These studies indicate barriers to accelerating the net zero emission goal due to insufficient cooperation among stakeholders and a lack of public attention to digital publics. Moreover, there is a notable gap in the literature, as no studies have specifically examined the role of the public sphere in this context. This omission highlights the need for research focused on how public engagement through digital platforms can influence and support the transition to zero-emission vehicles and broader net zero strategies.

A significant barrier currently hindering the digitalization of the UK's net zero strategy is the lack of understanding of customer behaviours, identifying their responsibilities, and fostering a conscious construction of their roles. The public, as key stakeholders, plays a crucial role in accelerating net zero goals by:

1. Participating in energy systems: Households and businesses can increasingly engage in the energy system.
2. Implementing data sharing: Improved data transparency is hampered by incomplete integration and a lack of incentives, which undermines decision-making and progress.
3. Optimising policy: Enhancing policies related to information sharing, infrastructure development, and social welfare can improve government-public communication and participation [7].

The public, as a flexible part, emerges and chooses organisations to focus on, organising themselves when they recognize issues and take action. Thus, the public can be identified in the Expanding Circle, receiving information and acting based on stakeholder actions or plans.

As global attention to sustainability and climate change increases, governments worldwide are actively implementing environmental policies and leveraging digital technologies to enhance policy execution. Digital transformation plays a crucial role in environmental policy, including data-driven decision-making, smart monitoring, and blockchain-based carbon tracking. Additionally, the promotion of Zero-Emission Vehicles (ZEV) integrated with digital platforms can enhance public engagement and optimize policy effectiveness.

Recent studies on the intersection of digital transformation and environmental policies have primarily focused on the following aspects. Analyzed the importance of skills deployment for a just net-zero transition, highlighting the need to address regional skill disparities and workforce reskilling [21].Explored the epistemic politics and social mobilization challenges in Taiwan's net-zero transition, emphasizing that strong socially robust knowledge (SRK) facilitates environmental policy advancement, whereas weak SRK delays policy implementation [22].

Despite the existing research emphasizing skill reskilling and social knowledge construction for environmental policy and net-zero transitions, several gaps remain at the intersection of digital public engagement and policy execution. While some studies investigate the impact of data and technology on environmental policy execution, limited research explores how digital platforms enhance public engagement, policy transparency, and implementation effectiveness. Current research primarily focuses on ZEV technological development and policy promotion, with limited discussion on how digital transformation (e.g., blockchain, smart monitoring) can enhance market acceptance and public participation in ZEV initiatives. Existing studies mainly focus on public participation through social mobilization and protests rather than systematically analyzing how digital tools (e.g., social media, open data platforms) facilitate policy formulation and implementation. Research indicates that local governments face governance challenges in driving net-zero transitions, but studies on leveraging digital technologies to strengthen interactions between local authorities and the public for better policy implementation are lacking.

The primary objective of this study is to address the aforementioned research gaps by exploring the role of digital public engagement in environmental policy and proposing specific digital transformation strategies to enhance environmental action execution. The academic contributions of this study include providing a new framework for integrating digital platforms with environmental policy, fostering interactions and collaboration between governments, businesses, and the public. It also enhances the understanding of ZEV promotion strategies, particularly in the context of digital transformation and improving policy acceptance and market penetration. Additionally, it deepens research on local environmental governance and digital technology applications, offering precise policy recommendations for different government levels. Research on platforms like Youtube, X and Instagram is essential for advancing the UK's net zero strategy, as these digital platforms are crucial for public participation in the digital sphere. Understanding their mechanisms can improve agenda-setting and public engagement, addressing current gaps in policy implementation. By leveraging the advantages of online deliberative spheres, stakeholders can accelerate the digital transformation necessary for achieving net zero goals. This approach will complement existing policy recommendations and provide detailed, actionable suggestions to enhance policy implementation through digital media.

Despite reports highlighting discrepancies between net zero action plans and their implementation, surveys show increasing public awareness and changing attitudes toward net zero goals [23,24]. This gap between net zero action plans and their implementation is further complicated by studies on the adoption of smart metering technologies, which highlight a disconnect between user comprehension of energy data and its implications for daily life [25,26].

Digital platforms play a crucial role in driving a just transition and achieving net-zero emissions. This process can be understood through the lens of Just Transition Theory, Digital Public Sphere Theory, and Socio-Technical Transition Theory. These theoretical foundations collectively influence policy implementation, public participation, and technological transition, positioning digital platforms as essential tools for facilitating the energy transition. According to Fig. 1, the three theoretical perspectives together form a comprehensive framework for understanding how digital platforms drive net-zero emissions. By integrating digital tools into policy execution, businesses and governments can implement climate regulations more effectively, track progress transparently, and adjust strategies based on real-time data. For instance, corporations can leverage big data analytics and artificial intelligence to develop sustainable business models that align with circular economy principles and climate risk assessments [27]. Furthermore, digital platforms empower consumers to make informed

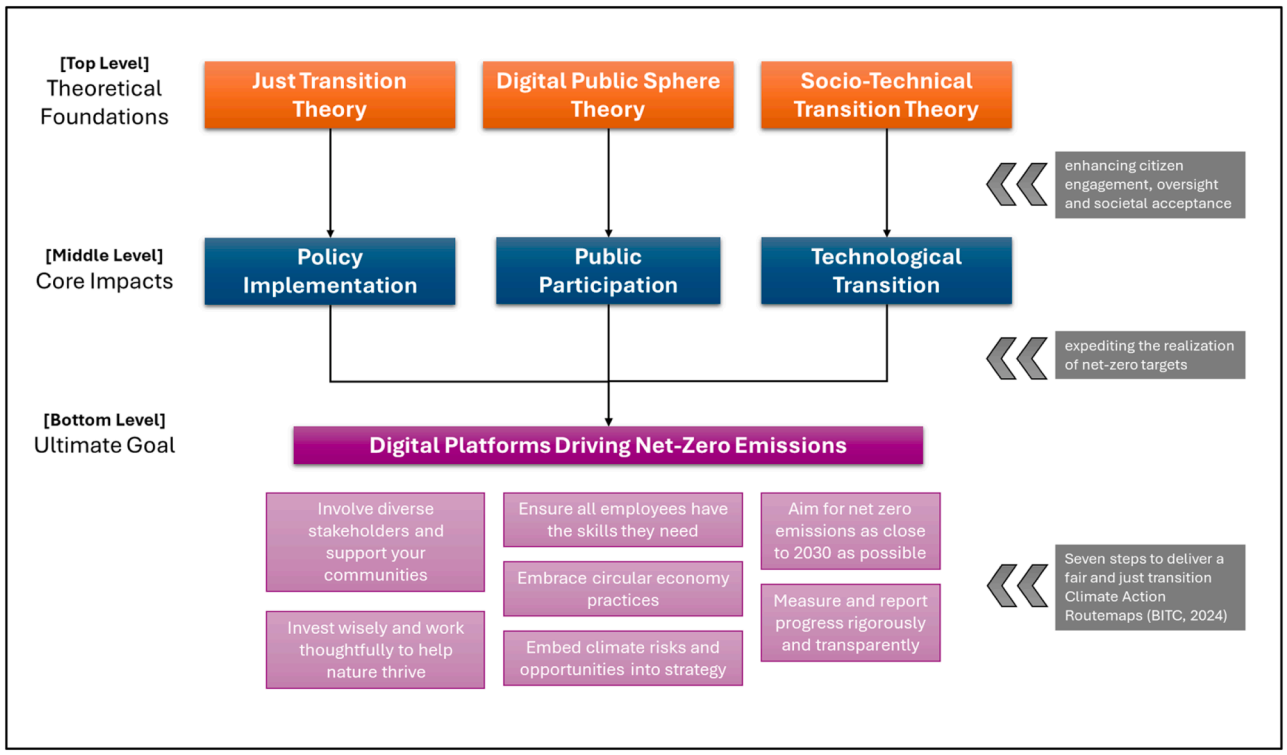

Fig. 1. Theoretical framework: digital platforms driving a just transition.

choices through carbon footprint tracking apps and sustainable product certifications, reinforcing behavior change at the individual level. Overall, the convergence of Just Transition Theory, Digital Public Sphere Theory, and Socio-Technical Transition Theory illustrates how digital platforms drive systemic change toward net-zero emissions. By facilitating policy execution, public engagement, and technological diffusion, digital platforms ensure that the transition is not only efficient but also socially inclusive and technologically feasible. This digital-driven transformation provides a more transparent, participatory, and just approach to achieving global climate targets.

This article argues that strengthening public discussions on digital platforms can help bridge gaps in policy implementation, encouraging collaboration and innovation. By leveraging online platforms, which offer broader access and diverse participation, digitalization can be accelerated through the inclusion of a wider range of voices and ideas. However, this article also acknowledges the challenges such as misinformation, echo chambers, and superficial interactions that can compromise the quality of engagement. To address these issues, robust mechanisms are proposed to manage and verify the vast amounts of data generated, ensuring effective deliberation. By understanding the vernacular and mechanisms of these platforms, stakeholders can improve agenda-setting and public engagement, addressing current gaps in policy implementation. Leveraging the advantages of online deliberative spheres can accelerate digital transformation, complementing existing policy recommendations and enhancing policy implementation through digital media.

This study aims to analyze the impact of digital marketing campaigns on the promotion of zero-emission vehicles (ZEV) through a mixed-methods approach and to explore how public engagement patterns influence policy-making and market acceptance. The study evaluates the effectiveness of digital marketing campaigns on various social media platforms by quantifying their influence on consumer awareness and purchase intentions. It also analyzes consumer interaction behaviors on digital platforms to identify key engagement groups and their response patterns to ZEV-related content. Additionally, it compares the effectiveness of different digital marketing strategies, such as content marketing, influencer marketing, and paid advertisements, in increasing ZEV adoption rates. Furthermore, it identifies key factors influencing public engagement and policy acceptance, providing targeted policy recommendations to bridge the gap between academic research and policy implementation. Lastly, the study validates the feasibility of data analysis methods to ensure that research findings can be applied to future ZEV promotion and policy design.

Through employs a mixed-methods approach that integrates both quantitative and qualitative analyses to comprehensively understand the impact of digital marketing campaigns on ZEV promotion and public engagement patterns. Data collection methods include social media data analysis, utilizing Gephi for social network analysis to examine public interaction patterns and influential nodes across digital platforms. Surveys are designed to measure audience attitudes, trust levels, and purchase intentions related to ZEV digital marketing content. Additionally, interviews and focus groups engage policymakers, industry experts, and target consumers to complement survey findings and provide deeper insights.

Data analysis methods consist of content analysis, conducting semantic analysis of discussions on social media to identify key topics and sentiment trends. Statistical analysis involves employing multiple regression analysis and structural equation modeling (SEM) to examine the relationships between digital marketing campaigns and consumer behavior. Comparative case studies evaluate the effectiveness of different digital marketing strategies to ensure that research findings have both policy and market application value. By employing these methods, this study not only provides empirical data for ZEV promotion but also offers actionable recommendations for policymakers and marketing professionals to enhance market acceptance and adoption rates of ZEVs. The article focuses on zero-emission vehicles (ZEVs) and outlines a specific pathway for their transition over the coming decade. According to the UK's plan, by 2035, 80 % of new cars and 70 % of new vans sold in Great Britain will be zero emission by 2030, increasing to 100 % by 2035 [28]. This transition hinges on two key considerations:

1. The timing and execution of a 'Just Transition' are critical. The promotion of smart metres in the UK has faced significant challenges, including privacy and data security concerns, reliance on stable technology and connectivity, complex installation processes, and the need for consumer education and acceptance. Similarly, promoting ZEVs via digital platforms will encounter these challenges if the principles of a 'just transition' are ignored. Issues like data privacy, technological reliability, consumer understanding, and equitable access must be addressed to ensure widespread adoption and support for ZEVs. Without a 'just transition,' marginalised communities may be left behind, and public support may wane, undermining the broader adoption of these sustainable technologies [29].
2. It is essential to examine the role digital platforms play in promoting the ZEV pathway within the broader Net Zero strategy. Identifying the role of digital platforms involves categorising content genres from various stakeholders regarding ZEVs. Following this, the discussion will focus on how to operate digital platforms as digital deliberative spheres (drawing from Chilvers' model of deliberation). Mature promotional strategies for ZEVs will be suggested, mainly focusing on adjusting content genres to avoid the "residual realist imaginary" [30]. The aim is to explore emerging topics derived from the digital deliberative sphere. This approach ties to the theoretical concept of addressing solid energy issues. The gap to be addressed involves identifying and categorising side issues within large communities, using evidence from modularity class analysis in Gephi. Ultimately, this methodology will help digitalize the promotion of ZEVs and achieve the goals set in the pathway.

1.1. Major research question

This study explores how digital platforms can drive the adoption of Zero Emission Vehicles (ZEVs) by facilitating stakeholder engagement and public discussion, ensuring a 'just transition' within the UK's Net Zero strategy. Specifically, it examines the role of digital platforms in enhancing policy implementation, improving public comprehension of energy data, and optimizing the UK's Action Plan for Digitalizing the Energy System. How can digital platforms be leveraged to effectively promote the adoption of zero emission vehicles (ZEVs) and ensure a 'just transition' in the context of the UK's Net Zero strategy? Sub-Research Questions

1. How can digital platforms enhance stakeholder engagement and drive policy implementation for the widespread adoption of Zero Emission Vehicles (ZEVs)?
2. How can digital platforms bridge the gap between user comprehension of energy data and its implications for daily life to support the adoption of ZEVs?
3. What specific content strategies can be derived from cross-platform analysis to refine and enhance the UK's Action Plan for Digitalizing the Energy System towards Net Zero?

As the world moves toward Net Zero, digital technologies are playing an increasingly vital role in policymaking and public engagement. This study examines how digital platforms can contribute to the promotion of ZEV adoption, facilitate policy implementation, enhance public awareness of energy-related issues, and refine strategic action plans to support a just transition in the UK. By integrating insights from digital engagement mechanisms and content strategies, this research addresses the intersection of environmental policy and digital public participation. Moreover, it provides practical recommendations for policymakers and industry stakeholders to leverage digital tools effectively in achieving Net Zero objectives.

2. The role of digital platforms in stakeholder engagement and policy implementation

Digital platforms construct the digital society, which can be seen as two-way deliberation in the net zero strategy, providing beyond superficial agenda setting, and offering a crucial channel for specific and effective deliberation. They centre on specific issues like Zero Emission Vehicles (ZEVs). Models of digital platforms, such as co-tagging, co-commenting and specific content layout, provide two-way communication and a mature deliberative sphere. Moreover, through their algorithms and mechanical characteristics, different digital platforms form specific forums.

This section delves into the collective participatory practices within UK digital media, examining the nuances of digital platforms on YouTube, X, and Instagram. It focuses on the Subjects—the digital publics that engage with these platforms—exploring each platform's unique user base and functional capabilities to understand their contributions to the digital deliberative sphere.

Recent research has increasingly utilised advanced computational methods to analyse public discourse and sentiment related to decarbonization and climate change, thereby enhancing the understanding and development of effective policies. Rizzoli, Norton, and Sarrica [15] demonstrated that social science literature on decarbonization can be systematically reviewed using lexicometric analysis to map the meanings and discourses surrounding decarbonization. Their work enhances understanding of decarbonization narratives and their implications for policy and practice. Similarly, Zhang, Abbas, and Iqbal [31] analysed public sentiments and attitudes towards carbon taxation across various countries, providing comparative insights that inform policy development. Bennett et al. [32]. proposed a machine learning framework to augment climate change opinion surveys with social media data, offering a novel approach to integrating real-time social media insights for improved policy framing and understanding of public opinion. Loureiro and Alló [33] analysed sentiments and emotions related to climate change and energy issues using social media data from the UK and Spain, providing valuable insights for policymakers in tailoring their strategies. Additionally, Morstatter and Liu [34] investigated the presence of data bias in social media research, proposing computational methods to enhance the reliability and validity of social media data analysis.

Drawing on the Collective Participatory Practices framework by Chilvers, Pallett, and Hargreaves [35], this section particularly addresses the interactions between the Subjects (the digital publics) and Objects (the content related to the ZEVs). As a precursor to research on the cross-platform digital deliberative sphere, it aims to first identify the models of participation to elucidate the cross-platform characteristics, then centres on how the platform vernacular engages with content related to the net zero transition.

The critical role of participatory appraisal experts in enhancing democratic processes and shaping science-policy interactions in environmental governance. Studies by Chilvers [35] have examined the rise of participatory appraisal experts in environmental governance, particularly in the UK's radioactive waste management. This research maps the network of these experts and analyses their influence on policy processes and deliberative democracy under conditions of uncertainty, highlighting the critical role of these experts in shaping science-policy interactions and enhancing democratic processes in environmental decision-making. Another study by Chilvers [35] has investigated the effectiveness of participatory appraisal processes in the evaluation of environmental risks, science, and technology. It emphasises the importance of incorporating diversity, difference, and uncertainty in participatory processes to avoid technocratic pitfalls and enhance democratic engagement.

Digital platforms have emerged as pivotal tools in promoting Zero Emission Vehicles (ZEVs) and advancing the net zero strategy in the UK. They enhance stakeholder engagement and facilitate effective policy implementation [36,37]. Despite growing awareness of net zero

initiatives, translating this awareness into action remains challenging. Additionally, unclear roles and responsibilities among stakeholders lead to fragmented efforts. Research shows that digital platforms can support the net zero strategy. For example, Kaluza's Intelligent Device Charging platform optimises smart device charging to support renewable energy integration, and BT's Digital Twin optimises energy usage for network upgrades and EV charger installations [7]. The Greater London Authority's Infrastructure Mapping Application (IMA) also improves infrastructure planning and coordination [7].

Despite these advances, most research has been descriptive, lacking exploration of the challenges in coordinating stakeholder actions and translating awareness into action [1,38]. It is unclear if digital platforms can clarify stakeholder responsibilities and enhance coordination towards the UK's net zero goals. This research aims to address this gap by analysing the role of digital platforms in stakeholder engagement and policy implementation, using tools like stakeholders and visual contents analyses to improve public engagement strategies.

The stakeholders involved in the UK's net zero strategy encompass a wide range of entities, including government bodies, energy companies, technology providers, and the public (see Table 1., [7]). Understanding the shape and influence of these stakeholders within the current digital deliberative sphere is crucial. The government's action plan for digitising the energy system outlines clear roles and responsibilities for each stakeholder, emphasising the need for a coordinated and collaborative approach. Effective utilisation of digital platforms can enhance the visibility and engagement of these stakeholders, facilitating the successful implementation of the net zero strategy.

Table 1
Roles and responsibilities of key stakeholders involved in the digitalization of the UK's net zero strategy [7].

Stakeholder	Responsibility
UK Government (BEIS)	Leads the digitalization strategy, provides policy direction, regulatory frameworks, and coordinates among stakeholders. Integrates digital platforms to enhance communication and collaboration among stakeholders, driving energy management and zero-emission vehicle adoption.
Ofgem	Regulates electricity and gas markets, ensures efficient digitalization and fair market operation. Uses digital platforms to monitor market activities, facilitate stakeholder engagement, and disseminate regulatory updates.
Innovate UK	Funds and supports innovation projects for technology development and deployment in digitalization and decarbonization. Leverages digital platforms to promote innovation challenges, share project outcomes, and engage with stakeholders.
Energy Systems Catapult	Provides expertise and support for integrating new energy technologies and systems, promoting innovation. Uses digital platforms to share research findings, best practices, and technological advancements.
Energy Network Association	Represents gas and electricity transmission and distribution network operators. Coordinates efforts to enhance data sharing and digital infrastructure, using digital platforms for data exchange, stakeholder communication, and operational coordination.
Local Authorities	Plan and implement local energy projects, aligning digitalization strategies with local decarbonization goals. Use digital platforms to engage with the community, gather feedback, and disseminate information about local energy initiatives and policies.
Energy Providers and Network Companies	Generate, transmit, and distribute energy. Adopt digital solutions to enhance efficiency, integrate renewable energy sources, and ensure reliable supply. Use digital platforms to manage operations, communicate with customers, and coordinate with stakeholders.
Technology Providers and Innovators	Develop and supply digital technologies and innovations necessary for transitioning to a digitalized, low-carbon energy system. Create tools and services that facilitate data sharing and system optimization. Use digital platforms for collaboration, product development, and dissemination of advancements.

The theoretical framework for identifying and prioritising stakeholders and publics, as outlined by Grunig and Grunig [25], is crucial in understanding the roles and influences of different stakeholders in the digital deliberative sphere. This framework categorises stakeholders into enabling, functional, normative, and diffused groups, and further classifies publics based on their level of activity and involvement. The situational theory of publics predicts their behaviour and helps prioritise communication strategies accordingly [3]. This model emphasises the importance of stakeholder management in achieving effective public engagement and policy implementation, supporting the transition towards a digitised energy system in the UK.

However, there has been less focus on Zero Emission Vehicles (ZEVs) and their impact on the energy transition. Recent studies have centred on the "border knowledge system" related to net zero. For instance, Chou, Lin, and Walther [39] have examined the challenges in transitioning to a socially robust knowledge system for net-zero emissions, identifying barriers and deadlocks that hinder the transition. Their study provides critical analysis and insights for improving knowledge systems and facilitating the net-zero transition. Similarly, Falcke, Zobel, Yoo, and Tucci [40] discuss the role of digital innovations in achieving net zero goals, offering a comprehensive overview of digital sustainability strategies and insights into how digital innovations can drive eco-friendly practices and support net zero objectives.

Recent evidence suggests that digital platforms can bridge significant gaps in stakeholder engagement and policy implementation by aligning digital agendas with official net zero strategies and enhancing communication. For instance, co-tag and visual contents analyses can determine whether digital platform agendas align with net zero action plans and assess public engagement levels, respectively. Visual contents analysis examines the interactions and visual contents made by users, providing insights into public sentiment and engagement levels. These tools help adjust communication strategies to better reflect strategic goals and improve public consensus and participation [7].

Specific stakeholders, such as the IT industry, are also exploring the role of digital solutions in supporting climate mitigation and adaptation efforts. The digital series "Net Zero: A Digital Journey" [41] highlights the instrumental role of digital solutions in addressing climate change. Additionally, Sonar et al. [42]. have examined the role of digital innovations in supporting MSMEs in achieving net zero goals, providing practical insights and strategies for leveraging digital innovations to support MSMEs in their journey towards net zero.

Previous studies have primarily focused on agenda setting through media sources, without providing in-depth suggestions for collaboration between different stakeholders, such as government entities and non-governmental actors [2,43,44]. Identifying the community is crucial as it represents practical daily life, a core component in achieving sustainable net zero transition milestones. Data from several studies suggest that daily practices are vital for progress towards net zero, as demonstrated by research on public behaviours in electricity usage. However, much of the research so far has been descriptive and has not adequately addressed these practical aspects.

The concept of a "Just Transition" is crucial in this context, ensuring that the shift towards sustainable technologies is equitable and inclusive. Recent research comparing different approaches to public engagement has found that promoting public engagement and education, addressing financial barriers, and ensuring that the benefits of advancements like ZEVs and smart metres are accessible to all can foster greater acceptance and trust in sustainable innovations. This approach aligns environmental sustainability with economic development and helps create new economic opportunities in green industries [45].

Stark, Gale, and Murphy-Gregory [46] have systematically reviewed the literature on Just Transitions (JT), highlighting the need for better

articulation of governance models to ensure justice and governance are central in JT. Similarly, Bray, Mejía Montero, and Ford [47] have explored the role of skill deployment in achieving a just transition to a net-zero energy system, offering insights and recommendations for policymakers and educators. In parallel, Zaidan et al. [48]. have examined the role of smart cities in achieving just and sustainable transitions, highlighting governance challenges and providing recommendations for fostering inclusive and sustainable urban development.

Focusing on community engagement, Potts and Ford [23] have emphasised increasing community participation in the just transition to net zero in the North-East of Scotland. Their study aims to empower communities through workshops and stakeholder engagement, demonstrating the importance of community involvement in achieving a just transition and offering practical strategies for enhancing engagement and support. In a broader context, Turner, Katris, and Race [9] have proposed a framework for understanding the policy, political economy, and societal consequences of net zero actions. Their work aims to establish common frameworks and languages for addressing the research requirements of net zero transitions, providing a foundational approach for integrating diverse research and stakeholder perspectives to enhance the coherence and effectiveness of net zero policy analysis.

Moreover, Hopke and Hestres [49] have analysed the visual framing of climate change on X during the Paris Climate Talks (COP21), providing insights into the visual strategies used by different stakeholders and highlighting the role of visual media in shaping climate change discourse. On a local scale, Weller, Beer, and Porter [24] have focused on place-based approaches to achieving a just transition towards net-zero emissions. They analyse the key domains, components, and costs associated with implementing just transition policies at a local level, offering detailed insights for policymakers and stakeholders involved in local sustainability initiatives.

Additionally, Hardey et al. [28]. have examined SME perspectives on net zero policies using social media data and the action case approach. Their study provides valuable insights into the role of social media in shaping SME attitudes towards net zero, offering recommendations for policy support and engagement strategies. Collectively, these studies underscore the multifaceted approach required to achieve just and sustainable transitions, emphasising the importance of governance, community participation, and effective communication strategies.

This prospective study was designed to investigate the potential of digital platforms to significantly enhance stakeholder engagement and policy implementation for promoting Zero Emission Vehicles (ZEVs) and advancing the net zero strategy. By aligning digital agendas with official strategies and employing innovative tools to assess public engagement, these platforms can bridge significant gaps in translating awareness into actionable steps.

Drawing upon two strands of research into stakeholder actions, this study attempts to identify how government entities, industry leaders, and technology providers utilise digital platforms to address key gaps in both public engagement and stakeholder coordination. This dissertation seeks to explain how these platforms facilitate better communication and collaborative agenda setting among stakeholders to drive energy system improvements and the adoption of electric vehicles as part of the UK's net zero strategy. This thesis intends to determine the extent to which digital platforms play a central role in enhancing stakeholder engagement and policy implementation, proposing mechanisms for better coordination among diverse stakeholders to promote ZEVs. Therefore, the sub-research question generated is: How can digital platforms enhance stakeholder engagement and drive policy implementation for the widespread adoption of Zero Emission Vehicles (ZEVs)?

3. User comprehension of energy data and public participation

In the previous section, we turn our attention to exploring the role of digital platforms in stakeholder engagement and policy implementation. It is crucial to understand how these platforms influence user interactions with energy data and public participation. To further investigate, we will delve into various case studies that highlight user interactions with energy data, such as User Comprehension of Energy Data. This section will explore these dynamics in greater detail, aiming to map out the landscape of user comprehension and public participation in energy discourse.

Different case studies, such as the smart metre issue, reflect the 'residual realist imaginary'. Chilvers, Pallett, and Hargreaves [35] argue that mainstream approaches to social engagement on energy issues usually adopt fixed, preordained means of participation, merely explaining discrete events or cases in broader socio-technical systems. This perspective highlights a significant gap in the offline deliberative sphere, particularly in identifying the responsibility of the online deliberative sphere. In theory, this study aims to draw an illustrative mapping of the "Digitalising our Energy System for Net Zero Strategy" in the UK.

Moreover, the concept of 'residual realist imaginary' in public participation [45] underscores stagnation within the field of Science and Technology Studies (STS), reflecting a constrained perspective on digital public engagement that often omits broader societal imaginaries. This study contends that the current framing of net zero transition narratives, particularly on digital platforms, frequently mirrors the limited viewpoints of content creators rather than fostering a rich, collective dialogue. This pattern harks back to earlier transitions dominated by consumerist ideologies, highlighting the need for a more inclusive and imaginative approach to public discourse on net zero targets.

A systematic review of energy transitions throughout the 20th century [26] further elucidates that successful shifts often hinge on the alignment of market structures, regulatory frameworks, political will, infrastructural support, and consumer practices. This historical dependency implies that overcoming the barriers to new, sustainable technologies and behaviours often necessitates active governmental intervention. However, the advent of digital media heralds a new paradigm, characterised by the simultaneous evolution and interaction of multiple socio-technical systems. This emergent ecosystem suggests a departure from traditional, linear models of technological adoption and adaptation, advocating for a more integrated approach that considers the complex web of factors influencing digital public engagement and policy development.

Understanding how users comprehend energy data and its implications for daily life is critical to supporting the adoption of ZEVs. Despite the potential of smart metres and eco-feedback interventions, a significant gap remains in translating energy data into actionable insights that promote energy-saving behaviours.

A growing body of literature recognises the critical role of user comprehension of energy data in promoting energy-saving behaviours. Chilvers and Kearnes [45] discuss the concept of 'residual realist imaginary' in public participation, highlighting a constrained perspective on digital public engagement. They emphasise the need for a more inclusive approach to public discourse on net zero targets, suggesting that current engagements often lack broader societal imaginaries. Waller et al. [45]. review the social and political dimensions of large-scale greenhouse gas removal (GGR) approaches, focusing on their feasibility from economic, societal, governance, and ethical aspects. Their review underscores the importance of responsible development and societal engagement in climate mitigation strategies. This highlights the necessity of moving beyond the 'residual realist imaginary,' which can limit innovative and inclusive approaches to public participation. Similarly, Moss and Coleman [33] critically review e-democracy policies in the UK, emphasising the need for inclusive and informed policy formation and decision-making. This also underscores the importance of broadening our societal imaginaries to foster more effective and democratic engagement with digital platforms.

Daily practices and public behaviours play a critical role in the sustainable transition towards net zero. Digital platforms are pivotal in this

regard as they enable the dissemination of energy-saving tips, sustainable living ideas, and serve as mediums for collective action and advocacy for environmental policies. However, there is a notable gap in translating digital discourse into tangible daily practices that contribute to net zero ambitions. Herrmann, Brumby, and Oreszczyn [50] highlight significant challenges in fostering energy-saving behaviours through smart metre data, pointing to a broader issue in energy literacy. Their findings suggest that while smart metres have the potential to provide valuable feedback, the practical utility of this information in promoting consistent energy-saving behaviours remains limited.

Several attempts have been made to enhance energy literacy and user comprehension of energy data. Herrmann, Brumby, and Oreszczyn [50] underscore the difficulties in promoting energy-saving behaviours through smart metre data, highlighting a disconnect between data availability and actionable insights. Andersson [51] offers valuable perspectives on strategic formation and realisation processes within public relations, which can be adapted to improve energy literacy and public participation. Andersson's work suggests that strategic communication is essential for transforming technical energy data into messages that resonate with and motivate the public.

My research aims to fill these gaps by analysing user interactions with energy-related content on platforms like YouTube and Instagram. By identifying specific actions and messages that resonate with the public, my study seeks to develop strategies that make energy data more comprehensible and actionable. Furthermore, this research will explore the cognitive aspects of energy information, addressing the disconnect between user comprehension and practical application, which limits the willingness to change behaviours.

Chilvers, Pallett, and Hargreaves [52] emphasise the importance of understanding interactions between digital publics and content related to the net zero transition. They argue that to foster meaningful public participation, it is essential to explore how digital platforms facilitate these interactions and how they can be leveraged to enhance energy literacy. By examining interactions on platforms like YouTube and Instagram, we can identify effective participation models and characteristics of the digital deliberative sphere that promote energy literacy and public engagement (see Fig. 2). This analysis can help develop targeted strategies that transform complex energy data into accessible and actionable information, thereby promoting more informed and sustainable public behaviours.

Moreover, the analysis of digital content and engagement can reveal underlying patterns and preferences in public discourse, providing insights into how digital platforms can be optimised to support the net zero transition. By understanding these dynamics, stakeholders can craft more effective communication strategies that not only inform but also inspire and mobilise the public towards sustainable practices. This approach recognizes the potential of digital platforms to act as powerful tools for social change, aligning public behaviours with the broader goals of the net zero transition.

The specific objective of this study was to evaluate how narratives around the net zero transition either align with or diverge from broader societal expectations and official communications. An objective of this study was to investigate dominant themes within the digital deliberative sphere to gauge the factors that most significantly drive public engagement and energy literacy. By leveraging network analysis tools like Gephi, this research examines the emerging role of these platforms in uncovering topics and tracking community dynamics within online discussions about Zero Emission Vehicles (ZEVs).

This study set out to investigate how digital platforms can bridge the gap between user comprehension of energy data and its implications for daily life to support the adoption of ZEVs. According to the discussions, the purpose of this investigation is to explore how these platforms can enhance user comprehension and promote energy-saving behaviours by providing intuitive and relatable energy feedback mechanisms.

The third research question evaluates how digital strategies bolster sustainable energy practices and accelerate the UK's journey towards net zero. This dissertation seeks to explain how addressing the gaps in energy literacy and public participation is crucial for supporting the adoption of ZEVs and advancing the net zero strategy. Therefore, this study systematically reviews the data for effective digital strategies, aiming to provide comprehensive insights that support the UK's net zero goals.

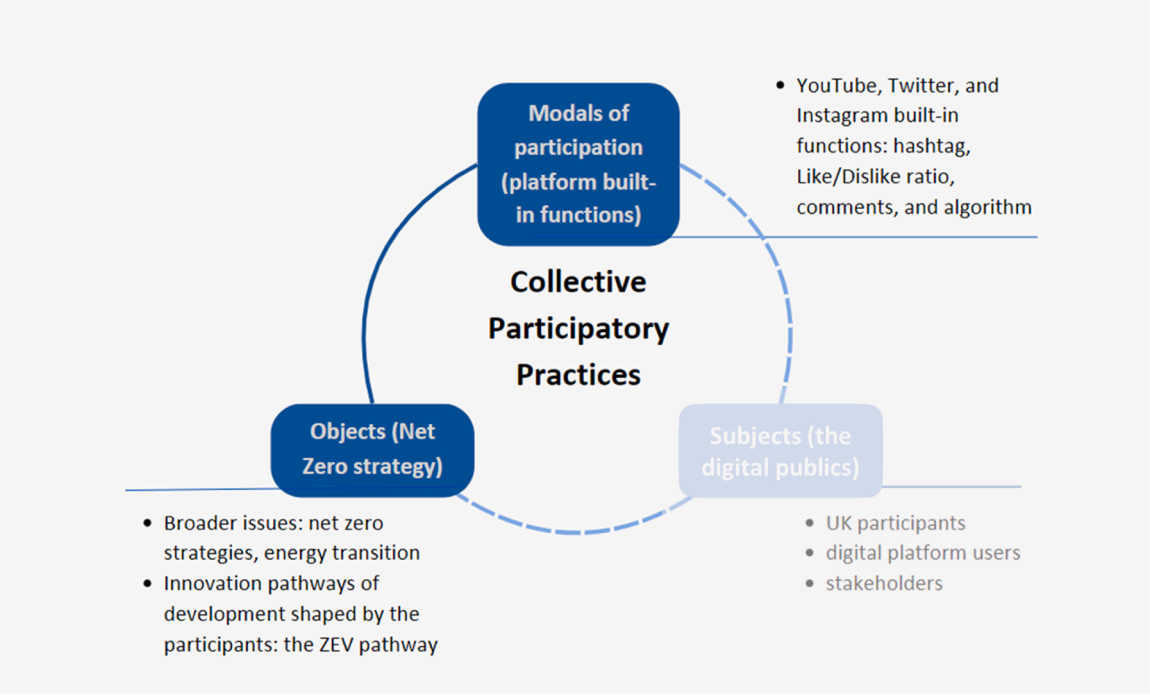

Fig. 2. A relational co-productionist framework for understanding digital participatory in socio-technical system in digital plaŋorm.

4. Cross-platform analysis: enhancing public discourse and content strategies

Digital platforms such as YouTube, X, and Instagram provide two-way communication, fostering a mature deliberative sphere through algorithms and mechanical characteristics that shape specific forums. These platforms facilitate diverse modes of interaction and engagement, significantly shaping public discourse on energy transitions. This section delves into the collective participatory practices within UK digital media, examining the nuances of these platforms. It focuses on the digital public engaging with these platforms, exploring each platform's unique user base and functional capabilities to understand their contributions to the digital deliberative sphere. Analysing the visual and textual content shared on these platforms helps us understand how public perceptions are formed and influenced. Issue mapping across digital platforms visually represents key themes, narratives, and discussions related to the UK's ZEVs pathway, identifying how cross-platform vernacular influences public perception and stakeholder engagement. Studies of digital communication highlight the importance of analysing cross-platform interactions to enhance public discourse on energy transitions.

The concept of calculated publics, introduced by Bruns and Burgess [21], explains how hashtags and digital media campaigns evolve from ad-hoc conversations to structured discussions, impacting public awareness and participation in the net zero transition. Extensive research shows that digital platforms can significantly influence public discourse. For example, Andersson [51] discusses public relations strategizing within the context of climate change, providing insights into the strategic formation and realisation processes within public relations. In this context, Herrmann, Brumby, and Oreszczyn [50] emphasise the disconnect between the provision of smart metre data and its practical utility in households, highlighting a broader issue in energy literacy.

Building on these ideas, Pearce et al. [53]. review literature on the role of social media in climate change communication and public discourse, offering a systematic and critical review of how social media shapes public understanding and engagement with climate change. They identify key gaps in existing literature, particularly the need for qualitative studies and visual communication analysis, and propose future research directions. Additionally, Pearce et al. [54]. introduce visual cross-platform analysis (VCPA) as a method to study social media images across different platforms, addressing the gap in social media research by incorporating visual and cross-platform analysis. The value of VCPA has been shown to provide a more comprehensive approach to understanding issue representation in digital society, moving beyond text-based content. These studies highlight the important role of digital platforms and calculated publics in shaping public discourse and engagement with climate change and energy transitions. By using methods like VCPA, researchers can better understand how visual and cross-platform interactions affect public perceptions and support for net zero initiatives.

Research on single platforms, such as X, includes Zarrabeitia-Bilbao et al. [55], who investigate X's role in green energy discussions, identifying key trends and topics in green energy conversations. Effrosynidis et al. [56]. present a comprehensive dataset of tweets related to climate change, providing a valuable resource for analysing public sentiment on X. Dellmuth and Shyrokykh [57] discuss the role of X in climate governance and public opinion formation, enhancing understanding of the interplay between social media, public opinion, and climate governance. Studies such as Lu [58] on the role of social media influencers in promoting the zero waste movement, Heidenreich et al. [5]. on migration discourses on Facebook, and Debnath et al. [59]. on social media's role in promoting climate action in the building sector further underscore the importance of platform-specific research. However, these studies highlight a gap in the literature, as they focus primarily on single platforms. My research addresses this gap by analysing how hashtags and digital media campaigns on platforms like YouTube, X, and Instagram influence public discourse and participation in the net zero transition.

The specific objective of this study was to map issues across digital platforms, visually representing key themes, narratives, and discussions related to the UK's pathway to Zero Emission Vehicles (ZEVs). This approach helps identify how cross-platform vernacular influences public perception and stakeholder engagement. By analysing visual data from platforms such as YouTube, X, and Instagram, this study uncovers patterns in public behaviour and daily practices that support or hinder sustainable transition efforts.

Given the high level of participation in the UK's unique digital media environment and its leading position in the net zero transition, this study investigates the cross-platform vernacular and its impact on the dissemination of information and communication styles across different platforms. This research examines how these platforms mobilise the public around energy-related issues, exploring their role in shaping public awareness and participation in the net zero transition. Employing the concept of the strength of weak ties, this analysis illuminates the spread of ideas and practices related to the net zero transition within digital communities, offering insights into the participatory practices that drive public discourse on net zero transition within the UK's digital domain.

The purpose of this investigation is to determine what specific content strategies can be derived from cross-platform analysis to refine and enhance the UK's Action Plan for Digitalizing the Energy System towards Net Zero. The second research question assesses the impact of content disseminated on platforms such as YouTube and Instagram on public energy literacy and engagement, specifically focusing on energy issues and zero-emission vehicles.

This study systematically reviews the data for the effectiveness of cross-platform communication in facilitating public engagement and shaping public discourse on energy transitions. By understanding the dynamics of cross-platform communication, we aim to enhance content strategies to promote public awareness and participation in the net zero transition. Therefore, the central research question is: What specific content strategies can be derived from cross-platform analysis to effectively refine and enhance the UK's Action Plan for Digitising the Energy System towards Net Zero, and how do these strategies impact public energy literacy and engagement, particularly regarding zero-emission vehicles?

5. Methodology

The dynamics of cross-platform communication are critically analysed to understand how different digital platforms facilitate public engagement with energy issues. Drawing on Bruns and Burgess's [21] concept of calculated publics, this analysis explores how hashtags and digital media campaigns evolve from ad-hoc conversations to structured discussions, influencing public awareness and participation in the net zero transition. A gap exists in identifying the small groups or nodes within larger communities that are undirected by edges. This research aims to complement the existing understanding of the role of digital platforms. Chilvers [52] only highlighted the position of digital platforms in the outer ring, indicating less weight and driving force in policy implementation. Our study seeks to address this by deeply analysing these platforms' roles in the digital public sphere.

Despite these efforts, recent research has not sufficiently addressed the challenges in translating energy data into actionable insights. This is a critical gap, as effective communication and user comprehension of energy data are vital for fostering behavioural changes necessary for the net zero transition. Additionally, identifying the small groups or nodes within large communities that are not directed by edges remains a challenge. By breaking out the hidden back operations of modularity in Gephi, we can improve the accuracy of community detection. This approach can address the "residual realist imaginary" by uncovering emerging topics from the digital deliberative sphere, particularly within

discussions on YouTube about energy policies. This method links to the theoretical concept of addressing solid energy issues by identifying and categorising side issues within larger communities via modularity class in Gephi.

5.1. Analysis of digital platforms: X, YouTube, and Instagram

The methodological approach taken in this study is a mixed methodology based on stakeholder analysis and visual network analysis to examine interaction patterns and information dissemination across various digital platforms. Visual network analysis facilitates the exploration of networks, such as stakeholders and key term associations, enabling a deeper understanding of how different elements within a network are related. The term "vernacular" is used to describe the unique language, symbols, or modes of communication that are specific to a platform, which are crucial for understanding the nuances of digital discourse.

X is chosen as a research object due to its rich text-based database and robust discussions on environmental and scientific topics. For example, Mouronte-López and Subirán [60] utilise X data to analyse global discussions on greenhouse and carbon monoxide emissions, uncovering unique patterns and insights into public environmental discourse. Similarly, Dubey et al. [6]. and Wei et al. [61]. extend the scope to broader environmental issues, using X to explore discussions on planetary boundaries, enhancing understanding of environmental challenges. Williams et al. [62]. focus on climate change discussions on X, examining user engagement and the formation of echo chambers, which provides insights into the dynamics of digital public discourse and its implications for climate change communication.

Comparatively, YouTube offers a dynamic, visual content-based platform for deliberation. Colás-Bravo and Quintero-Rodríguez [22] investigate YouTube's role in informal learning and sustainable education in Andalusia, Spain, highlighting how users select and evaluate content, which has implications for educational strategies.

Instagram, known for its static visual content and powerful co-tagging networks, is less studied, prompting my research to fill this gap by analysing cross-platform discussions on YouTube, X, and Instagram. This includes a thematic analysis of net zero-related content, revealing prevalent narratives and engagement patterns, and guiding stakeholders in enhancing communication strategies for the net zero transition.

The selection of X (formerly Twitter), YouTube, and Instagram is based on their audience reach, engagement trends, and influence on ZEV-related policies. These platforms provide diverse communication channels, making them essential for analyzing digital discourse on Zero Emission Vehicles (ZEVs).

X (Twitter) is widely used by policymakers, industry experts, and advocacy groups for real-time discussions on environmental policies. YouTube serves a global audience, making it a key platform for in-depth educational content on ZEV technology and policy initiatives. Instagram, with its strong visual appeal, is increasingly used for sustainability storytelling and influencer-driven campaigns, engaging younger audiences in climate-conscious behaviors. Each platform supports different interaction patterns. X fosters rapid discussions through retweets and hashtags, amplifying policy debates. YouTube enables deeper engagement through comments and long-form content, facilitating sustained learning and public discourse. Instagram leverages visual storytelling, using Reels, Stories, and co-tagging to promote ZEV adoption through social influence and brand advocacy. These platforms play distinct roles in shaping policy discussions. X serves as a key space for regulatory announcements and stakeholder engagement. YouTube bridges the knowledge gap, making complex ZEV policies accessible to the public. Instagram drives social acceptance, using visual campaigns and influencer advocacy to normalize sustainable transportation.

By examining these platforms, this study identifies how digital engagement strategies influence public perception, policy implementation, and ZEV adoption, providing insights for more effective digital communication in the Net Zero transition.

5.2. Data collection and analysis

In this study, we collected data from videos retrieved using specific search queries such as "zero emission vehicle," "EV," and "Net Zero" from public agencies' official accounts, including the Department for Transport (DfT) on X, Facebook, and Instagram (YouTube was excluded as there were no related contents), and the Department for Energy Security & Net Zero (DESNZ) on X, Facebook, Instagram, and YouTube. These data sources provided a basis to analyse the general performance of each keyword across these platforms. The tools used for data collection included YTDT (YouTube), Octoparse (X), and The 4CAT Capture and Analysis Toolkit (Instagram). Manual data validation was conducted to maintain the integrity of the research findings. The focus was on analysing data types such as post contexts (titles and descriptions) and visual contents (thumbnails).

The study applies the Pareto Principle, suggesting that approximately 80 % of effects come from 20 % of causes. In this context, focusing on the most significant sources of ZEV-related content should lead to substantial advancements towards achieving net-zero goals. Therefore, the top 20 % of posts from YouTube, X, and Instagram, sorted by relevance, were selected for analysis (see Table 2 for details).

This research timeframe is strategically chosen to assess the UK's progress towards its 2050 net-zero emission targets, aligning with interim goals as part of a broader commitment to eliminate net greenhouse gas emissions by mid-century. The focus is on exploring the expansion and integration of key renewable energy sources, such as wind and solar, into the UK's energy portfolio, which is pivotal in lowering the nation's carbon footprint. Despite challenges like grid modernization and incorporating fluctuating renewable energy sources, this period provides an invaluable opportunity to examine the progress and challenges the UK encounters on its journey to net zero by 2050.

Particularly, the role of digital platforms will be examined to understand their influence on shaping the perceptions and actions of the digital public. This analysis is expected to offer critical insights into the effectiveness of current policies and strategies, identifying areas needing further focus or modification to keep the UK on its path to achieving its net-zero target. Along with progress in energy efficiency and the electrification of sectors such as transportation, these elements constitute the foundation of the UK's strategy to meet its 2050 net-zero emission objectives.

5.3. Data analysis tools and visualization

The detailed methodology is demonstrated in Fig. 3. Data flow diagrams and visualisations will be used to illustrate the analysis process. Tools like Gephi will be used for data visualisation, including visual and stakeholder analysis. Specific cases will be selected to illustrate the analysis methods, emphasising the use of platform-specific vernacular in discussions about ZEVs. The results of the visual network analysis, including network structures, key nodes, and community identification,

Table 2
Data collection for Zero Emission Vehicles under the official accounts of public agencies (DfT and DESNZ).

Platform	Account	Total video/post amount	Top 20 % video/post amount
Facebook	**DfT**	29	6
	DESNZ	226	45
Instagram	**DfT**	340	68
	DESNZ	181	36
X	**DfT**	397	79
	DESNZ	189	38
Youtube	**DESNZ**	9	2

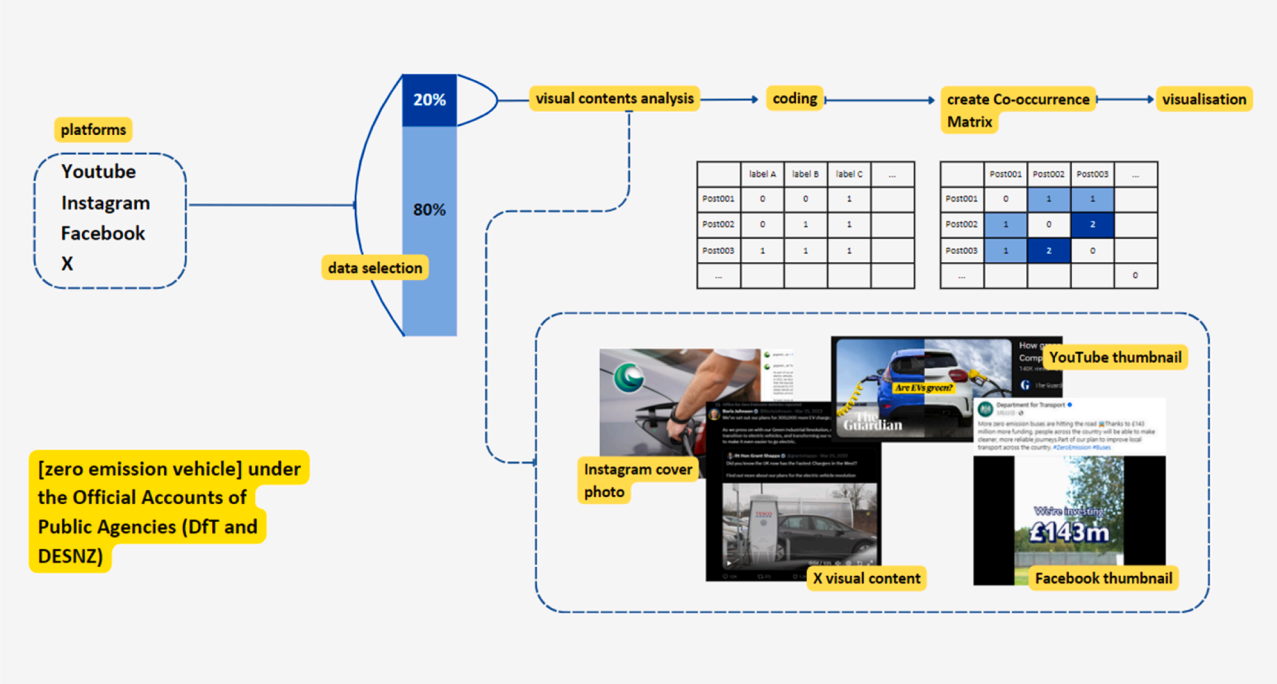

Fig. 3. Data flow diagrams.

will be highlighted. This comprehensive approach aims to delve into cross-platform discussions on energy justice, uncovering the complexities of digital public engagement and discourse dynamics in the digital realm. See Table 3 for the codebook for data visualisation.

Gephi enables the detection of engagement clusters by analyzing how users interact across different platforms. By mapping connections between users, hashtags, and shared content, it helps identify key actors, influential stakeholders, and thematic communities within the ZEV

Table 3
Codebook for data visualisation.

Code	Component	Categories	Code	Component	Categories
	Engagement Metrics	Comments counts	H01	**Contextual Factors**	Pre-Event
		Likes counts	H02		Post-Event
		Shares	H03		During Event
			H04		None
A01	**Content Type**	Videos+Texts	I01	**Compliance and Ethics**	Sponsored Content
A02		Images+Texts	I02		Partnership Disclosure
A03		Texts	I03		Independent Content
B01	**Platform**	Facebook	J01	**Issue Keywords**	UK Net Zero Strategy
B02		Instagram	J02		Public Zero Emission Vehicles (ZEVs) and Electric Vehicle (EV)
B03		X	J03		Personal Zero Emission Vehicles (ZEVs) and Electric Vehicle (EV)
B04		Youtube	J04		EV Charge Points
C01	**Sources**	Department for Transport (DfT)	J05		Conference of the Parties (COP)
C02		Department for Energy Security & Net Zero (DESNZ)	J06		Transport Decarbonization
			J07		Clean Energy Transition
D01	**Stakeholder Type**	Government Agency	J08		Electric Vehicle Infrastructure Strategy
D02		Private Sector	J09		Energy Data Analysis
D03		Non-Profit	J10		Electric Vehicle Grants
D04		Influencer	J11		Energy Policy
D05		Academic	J12		Renewable Energy Sources
D06		Public Service	J13		Climate Change
D07		Community Organization	J14		Carbon Emissions Reduction
E01	**Scenes**	Outdoor	J15		Lifestyle Changes
E02		Office	J16		greener vehicle (bike)
E03		Urban	J17		earth
E04		Rural			
E05		Graphical			
E06		Infographic			
F01	**Call to Action (CTA)**	Present			
F02		Absent			
G01	**Narrative Style**	Formal			
G02		Informal			
G03		Persuasive			
G04		Informational			

discourse. This process reveals patterns of public participation, advocacy efforts, and policy engagement, shedding light on how digital conversations shape public perception.

Gephi facilitates the graphical representation of digital networks, illustrating the relationships between different entities such as policymakers, advocacy groups, and general users. This visualization highlights central nodes, information flow, and the structure of public discourse, enabling researchers to examine how information spreads and which actors play a pivotal role in ZEV-related discussions. By analyzing network density, modularity, and cluster formations, Gephi uncovers echo chambers, cross-platform interactions, and the overall landscape of digital engagement.

By leveraging Gephi's visual network analysis, this study aims to provide a comprehensive cross-platform investigation into the complexities of digital public engagement and discourse dynamics surrounding energy justice and ZEV adoption.

6. Discussions

The mixed methodology applies the data which is built-in to the cross platform, standing the theoretical concept from Chilver [30] (see Fig. 2). The result shows the different role of each platform in the digital innovation, which shape the models of participation of ZEVs. By examining the actions of various stakeholders, the study will highlight best practices and areas for improvement in digital engagement strategies. The Sankey diagram (Fig. 4) reveals that there has been a clear difference of the Engagement Rate by Reach (ERR), that Facebook (ERR: 6.2) and YouTube (ERR: 29.2) have the highest engagement than Instagram (ERR: 1.0) and X (ERR: 29.2). Engagement Rate by Reach (ERR) is a popular social media metric that has evolved into an industry standard, which is widely used in measuring the effectiveness of actions so it can better understand how frequently your audience engages with your content and the quality of the posts. However, although YouTube has the highest engagement rate, it is meaningless as the dataset is limited ($n = 2$), which demonstrates that the account does not activate and operate frequently. Through the ERR we can observe the basic trend of the official accounts which help us to examine the role of the accounts in digital publics including building authority and remain relevant, it also allows us to optimise the content strategies, including gauge audience interest and assess the social media strategy's success. Fig. 4 also presents the summary statistics for contents types, the preferable content type is videos with texts ($n = 136$), the images with texts followed by ($n = 122$), it represents the platform modals.

6.1. The implementation stage of the stakeholders

Next, we visualise the implementation stage of the stakeholders (Fig. 5), and compare their roles and responsibilities in driving policy implementation for the widespread adoption of Zero Emission Vehicles (ZEVs). The analysis identified key stakeholders, including government entities, industry leaders, and technology providers, as central nodes within the network. These stakeholders are pivotal in driving the discourse on digital platforms. High modularity indicates that these stakeholders form tightly-knit communities, suggesting strong influence and frequent interactions within their respective clusters. This highlights their significant role in shaping public opinion and policy discussions. According to the content analysis across platforms, it is evident that the practices of each stakeholder play a crucial role in driving policy implementation for the widespread adoption of Zero Emission Vehicles (ZEVs).

Government agencies ($n = 91$) dominate the discussions on the UK's pathway to Zero Emission Vehicles (ZEVs). Their social media activity is most prominent on Instagram and X, with significant engagement on Facebook. Public services ($n = 56$) show significant engagement on Instagram, followed by a notable presence on Facebook and X. The private sector ($n = 27$) engages more on Instagram than on other platforms. Influencers ($n = 16$) and community organisations ($n = 9$) have the least engagement across all platforms, with a slight preference for Instagram. Non-profits ($n = 6$) and academics ($n = 1$) show very low engagement across all platforms. Each stakeholder represents specific roles and responsibilities in the digitalization of the UK's net zero strategy, responding to the governance pathway (see Table 1). For example, government agencies collaborate extensively with the private sector (such as car corporations, see Image 1) and support public service initiatives (see Image 2). They often engage with icons in visual content and lead the digitalization strategy, providing policy direction in texts. The private sector plays a positive role in cooperating with government agencies and public services in setting up plug-in systems in Tesco parking areas (see Image 3), which significantly supports the ZEVs goals. This stakeholder cooperation represents typical engagement practices in the deliberative sphere [52] (see Fig. 2).

Community organisations and academic institutions, pivotal in providing expertise and support for the integration of novel energy technologies and the promotion of innovation, demonstrate subdued engagement on digital platforms. Despite their critical role in the dissemination of research findings, established best practices, and technological advancements, their constrained presence on social media platforms indicates that their invaluable contributions may not be reaching an extensive audience. The implications of this limited engagement are substantial: essential insights and innovations risk remaining underexploited, thereby decelerating the adoption of new energy solutions. Furthermore, this disconnection may result in a discernible gap in public comprehension and support for sustainable practices, ultimately obstructing progress towards the goals of Zero Emission Vehicles (ZEVs). There is a pressing need for enhanced digital strategies to amplify their impact and ensure that their expertise significantly informs and influences a broader array of stakeholders.

Call to Action (CTA) is an important evidence for detecting

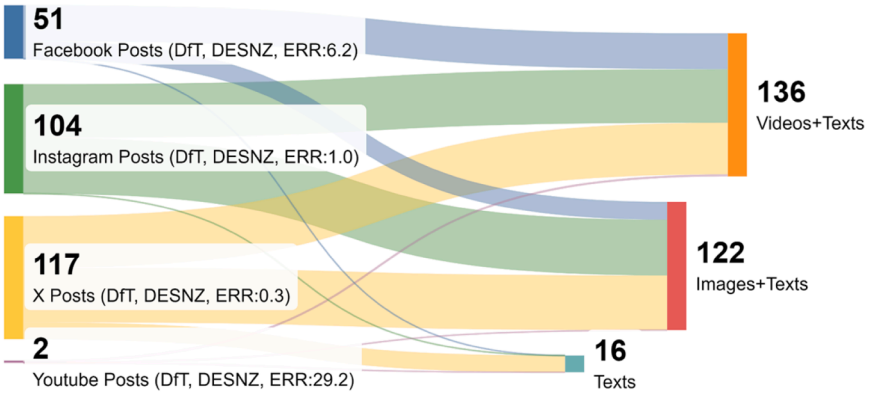

Fig. 4. The flow of the content types and engagement.

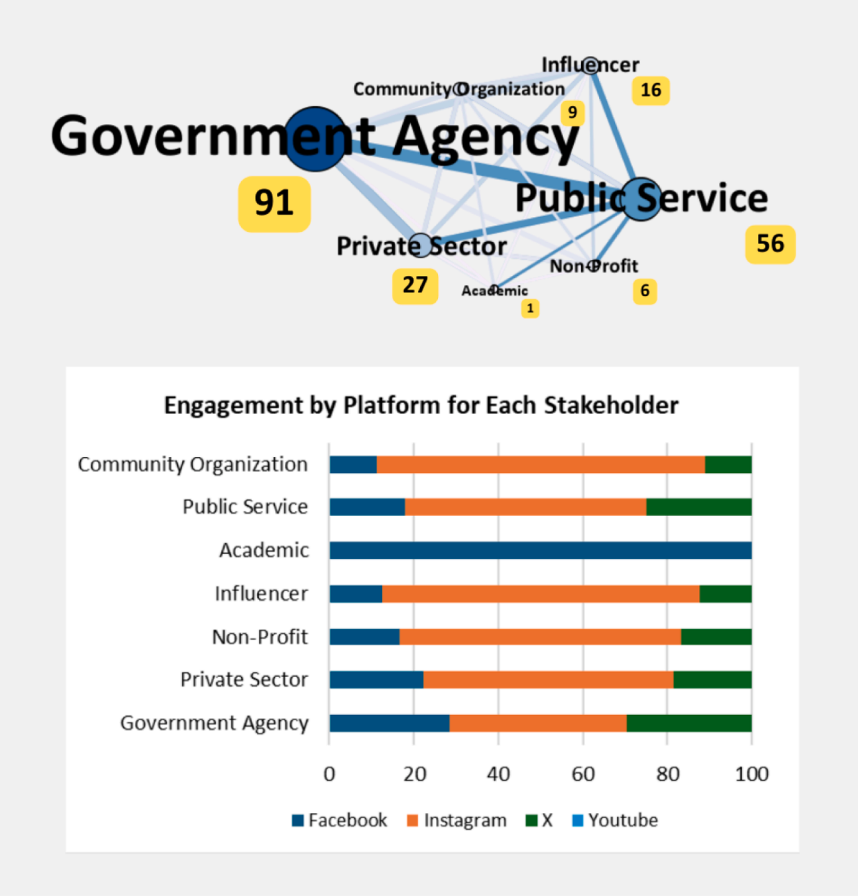

Fig. 5. Layout of the stakeholder engagement crossplatform.

Image 1. The cooperation between government agencies and private sector (I1024).

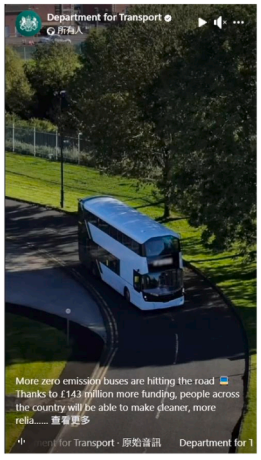

Image 2. The cooperation between government agencies and public service (F1005).

enhancement proposals, which recommends how to strengthen the digital engagement framework to better support the UK's net zero targets. This structured approach to your policy study will help in systematically exploring the role of digital platforms in advancing the UK's energy goals, guided by the strategic framework set forth in the provided document. The Sankey diagram (Fig. 6) offers a meticulous visualisation of digital engagement and narrative strategies utilised by various stakeholders in support of the UK's net zero targets. It distinctly quantifies the digital presence across different sectors such as government agencies, the private sector, non-profits, influencers, academics, public services, and community organisations. A notable result from the diagram is the active online presence of a majority of stakeholders, with 177 identified as 'present' (indicative of active persuasion action), compared to 116 'absent'. This differentiation not only illustrates the current engagement levels but also points out the significant disparity in digital participation. The larger number of stakeholders actively engaging suggests a robust digital call to action, while simultaneously highlighting the underrepresentation of potentially influential voices that are critical for a holistic net zero strategy.

The narrative styles depicted in the diagram—formal, informal, persuasive, and informational—reveal a predominant preference for informal communication, evidenced by 161 instances. This suggests a strategic choice by stakeholders to adopt a more relaxed and accessible communication style to effectively engage and resonate with the audience. Formal narratives, totaling 34 instances, show less prevalence, suggesting a shift away from rigid and conventional communication in favour of more relatable and engaging methods. The roles of persuasive

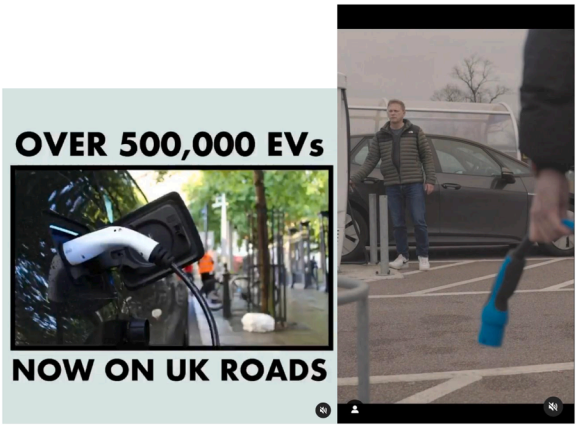

Image 3. The cooperation between private sector, government agencies and public service (I1016).

and informational content are also significant, particularly in shaping public opinion and disseminating in-depth information and research findings, respectively.In summary, the diagram and the analysis underscore a dynamic digital engagement landscape where various stakeholders implement diverse strategies to advocate for net zero initiatives. The insights gathered call for the enhancement of digital engagement frameworks to better integrate underrepresented groups and diversify narrative styles. This approach aims to ensure a comprehensive and inclusive strategy that effectively supports the UK's ambitions to achieve net zero targets, thereby fostering a more informed and engaged public discourse within the digital deliberative sphere.

6.2. *Advance understanding of cross-platform vernacular*

Next, we explore the detailed observation for the "objects" part of the deliberative sphere (see Fig. 2) via the heatmap of the engagement levels between topics and scenes, which represent the issue mapping for the ZEVs. The heatmap (Fig. 7) displays various topics related to ZEVs, such as "Wireless future for electric cars," "Self-driving vehicles," and impacts of these technologies on different domains like the economy and urban planning. Each topic is linked to images or infographics that likely

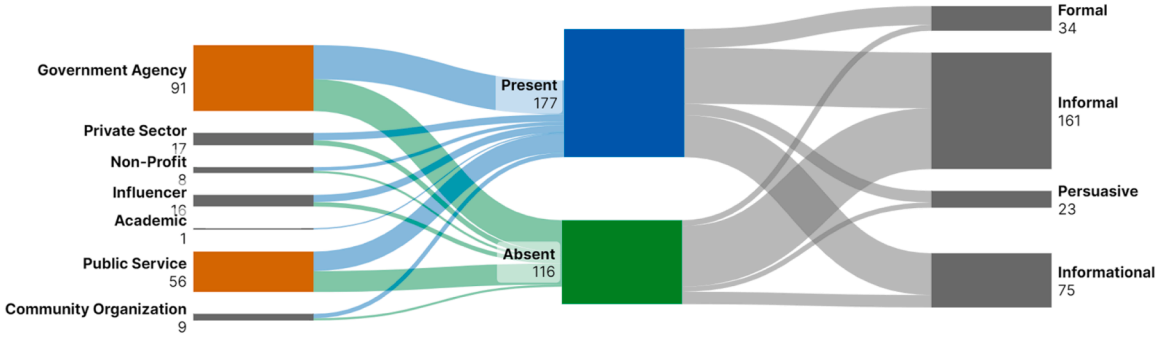

Fig. 6. The flow of the narrative styles and the content driver.

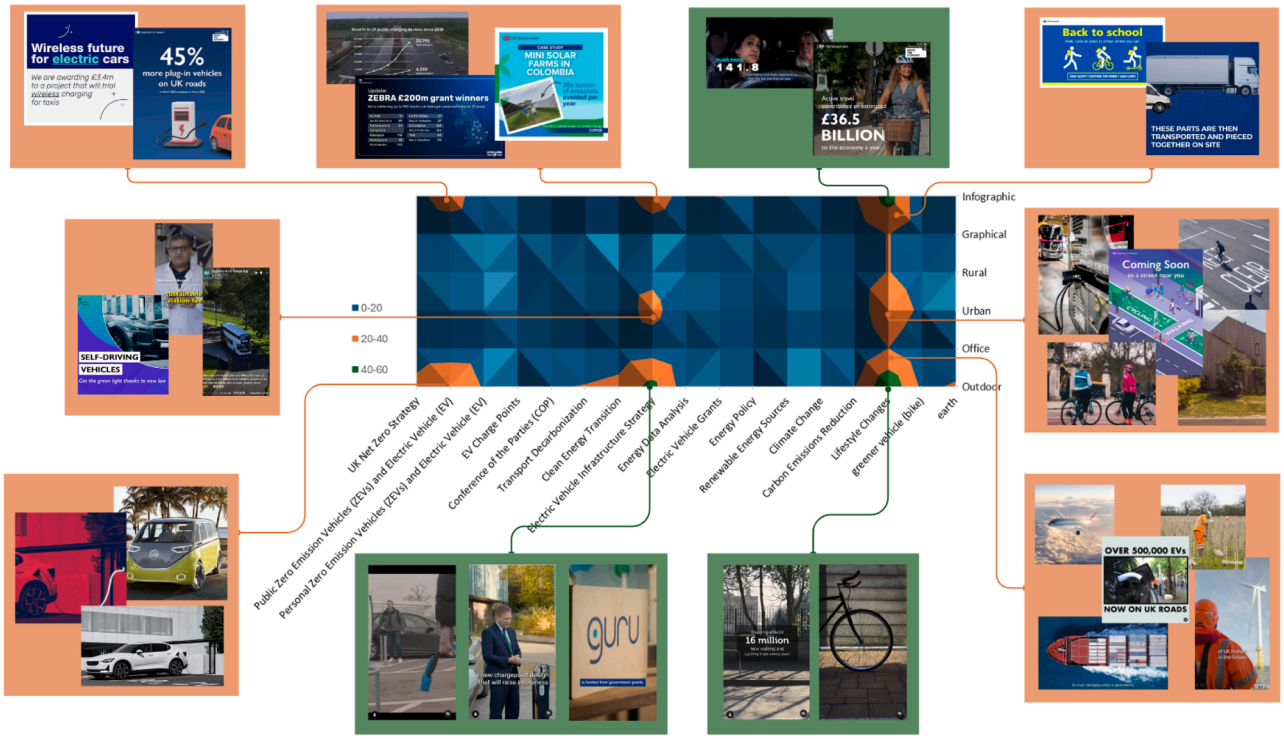

Fig. 7. The heatmap of the cross-platform vernacular.

represent data points or key messages, contributing to a narrative that supports the transition to net zero targets. The heatmap's structured approach helps in systematically exploring how digital platforms and physical settings can be optimised to advance the UK's energy goals. It also highlights the importance of cross-platform vernacular — understanding the specific communication styles that resonate on different platforms can enhance public engagement with complex policy issues like the net zero transition.

A deeper analysis of different platforms' roles in public engagement and policy implementation reveals distinct patterns. On X (Twitter), policy discussions and expert debates dominate, driven by real-time news cycles and political discourse, while YouTube serves as an educational platform where policymakers and industry experts provide in-depth videos offering step-by-step insights into ZEV adoption strategies. Instagram, on the other hand, emphasizes aesthetic-driven storytelling through visually appealing infographics and influencer endorsements, making ZEV-related discussions more accessible to younger audiences. The effectiveness of these platforms is evident in successful case studies, such as government-led public awareness campaigns on X that increase policy engagement or corporate initiatives on Instagram that drive consumer interest in electric vehicles. A cross-platform comparison further underscores how policy discussions initiated on X expand into broader awareness on YouTube and Instagram, reinforcing the need for tailored communication strategies across digital spaces. Quantitative data supports these findings, showing that government agencies (45.96 %) and public service organizations (28.28 %) play a dominant role in ZEV discussions, while informal communication (54.95 %) is the most prevalent, indicating that much of the discourse occurs outside structured or official channels. These insights highlight the necessity of adapting communication strategies to platform-specific engagement dynamics to maximize public outreach and policy impact.

A comparative analysis of content formats across platforms reveals significant differences in impact. Videos on YouTube generate sustained engagement, particularly through long-form educational content explaining ZEV incentives and infrastructure developments. Infographics on Instagram perform well in terms of shareability, making them effective tools for awareness campaigns. Hashtag-driven discussions on X enable rapid information dissemination, creating immediate spikes in public discourse but often lacking depth in sustained engagement. Additionally, platform algorithms shape how ZEV-related content spreads—YouTube's recommendation system favors long watch-time content, while X's engagement algorithm amplifies viral tweets, sometimes leading to the spread of misinformation. Understanding these dynamics is crucial for policymakers and stakeholders seeking to optimize digital outreach strategies and mitigate biases in online information dissemination.

6.3. Public/Zero Emission Vehicles (ZEVs) and Electric Vehicle (EV)

The heatmap indicates a significant engagement trend in topics related to Zero Emission Vehicles (ZEVs) and Electric Vehicles (EVs) across multiple platforms, particularly in urban and office settings. These posts often highlight technological advancements and policy implementations that support the transition to a zero-emission future. By analysing the scenes and settings depicted in these posts, we gain insights into the strategies used to communicate the benefits of ZEVs and the efforts to foster public support and policy alignment.

For example, in urban settings, the infographic titled "Wireless Future for Electric Cars" highlights the benefits of wireless charging technology for electric vehicles. By showcasing data on adoption rates and reduced downtime, it aims to engage urban planners, city officials, and the public in supporting this solution. The scene might depict a city street with wireless charging pads integrated into the road surface. Additionally, a short video demonstrates the benefits of self-driving vehicles in urban settings. It shows these vehicles navigating city streets, emphasising safety, efficiency, and reduced congestion. The scene could feature self-driving cars interacting with pedestrians and other vehicles.

Another example is a graphical representation of the ZEBRA (Zero Emission Bus Regional Areas) grant recipients. It details the geographical distribution of the £200 million in grants, the number of zero-emission buses each region will introduce, and the expected environmental impact. The scene could include a map of the UK with highlighted regions and images of new zero-emission buses.

6.4. Public EV charging points

The heatmap shows a high engagement trend for posts about public EV charging points, particularly in office settings. These posts typically focus on the expansion and benefits of EV infrastructure, emphasising the convenience and environmental advantages of switching to electric vehicles. The scenes often depict office environments with newly installed charging stations, highlighting their accessibility for employees. For example, an infographic for office environments highlights new public EV charging points in business districts. It shows locations, usage statistics, and environmental benefits, aiming to persuade corporate decision-makers and employees to adopt EVs. The scene might depict an office car park with multiple charging stations and employees using them.

6.5. Lifestyle changes and greener vehicle (bike)

The heatmap indicates engagement with topics related to lifestyle changes and greener vehicles, such as electric school buses and bike lanes, in both urban and rural settings. These posts focus on promoting sustainable transportation options and their benefits for health and the environment. The scenes typically show urban and rural environments where these green transportation initiatives are being implemented. For example, a campaign poster encourages parents in both urban and rural settings to use electric buses for school transportation, highlighting benefits such as improved air quality, reduced noise pollution, and enhanced safety. Additionally, an announcement about new bike lanes in urban areas promotes sustainable transportation by outlining their integration with existing infrastructure and the health benefits, aiming to engage residents, cyclists, and city planners in supporting a bike-friendly cityscape.

6.6. Electric vehicle infrastructure strategy and energy data analysis

The heatmap reveals strong engagement with topics related to electric vehicle infrastructure strategy and energy data analysis, especially in urban and office settings. These posts often present detailed reports and infographics that analyse the economic and environmental impacts of adopting ZEVs. The scenes typically include data visualisations and urban environments where these strategies are being implemented. For example, a report analyses the economic impact of adopting ZEVs in urban areas, presenting data on job creation, fuel savings, and health benefits to convince policymakers and investors of the advantages. Similarly, an infographic for office settings compares the latest EVs' battery life, cost savings, and performance against traditional vehicles, aiming to persuade corporate fleets to invest in EVs for long-term benefits and cost efficiencies.

6.7. Carbon emission reduction

The heatmap indicates notable engagement with topics related to carbon emission reduction, particularly in rural and outdoor settings. These posts often focus on the role of renewable energy sources in supporting EV infrastructure and the environmental benefits of reducing carbon emissions. The scenes typically depict rural landscapes with renewable energy installations and visual representations of emission reductions. For example, an article discusses how rural areas use

renewable energy like wind and solar to power EV charging stations, providing case studies to inspire similar practices. The scene might include images of solar panels, wind turbines, and community members using charging facilities. Additionally, a graphical representation on outdoor billboards highlights the projected reduction in carbon emissions from EV adoption, using clear visuals to raise public awareness and illustrate the environmental benefits. The scene could feature graphs of emission reductions and EVs on the road.

However, typical evidence is that the topics focus less on climate change and the earth and more on detailed topics—the specific collective pathway for ZEVs. This approach highlights specific actions and benefits, making the information more relatable and actionable for different audiences.

7. Contribution

This study contributes to understanding the role of digital platforms in promoting Zero Emission Vehicle (ZEV) policies within the UK's Net Zero strategy by examining their effectiveness in policy implementation, stakeholder engagement, and public discourse.

1. Policy Implications & Implementation

To strengthen the impact of ZEV-related policies, this study introduces a dedicated Policy Implementation Section that evaluates how digital platforms facilitate environmental policy execution. The research assesses the effectiveness of the current policy framework, identifying key challenges and proposing viable solutions. Through case studies, successful and failed policy implementations are analyzed to extract insights on optimizing policy communication and digital engagement strategies. The study highlights the role of digital platforms in shaping public perception, fostering accountability, and providing transparency in policy discussions, ultimately helping governments and industry stakeholders align digital strategies with regulatory goals.

2. Stakeholder Engagement

Effective stakeholder engagement is critical to ZEV adoption. This research explores how government agencies, businesses, and advocacy groups leverage digital platforms to advance policy initiatives. Case studies of successful stakeholder-led digital campaigns demonstrate how policymakers and private sector actors utilize platforms like X (Twitter), YouTube, and Instagram to mobilize public support, educate consumers, and influence policy direction. The findings highlight disparities in stakeholder representation and propose strategies to enhance inclusivity—such as amplifying the voices of underrepresented groups like community organizations and academics—to ensure that digital platforms function as effective deliberative spaces.

7.1. Strategies to enhance the UK's action plan for digitalizing the energy system towards ZEVs goals

According to the data, only 14 % of posts are made during events, often referencing COP, climate change, and carbon emissions reduction. However, the analysis indicates that climate change does not appear frequently in the content, suggesting the absence of a "residual realist imaginary" [35]. Given the imbalance in the amount of posts across platforms, it is essential to examine the role digital platforms play in promoting the ZEV pathway within the broader Net Zero strategy. This involves categorising content genres from various stakeholders regarding ZEVs and discussing how to operate digital platforms as digital deliberative spheres, drawing from Chilvers' model of deliberation. The goal is to suggest mature promotional strategies for ZEVs, focusing on adjusting content genres. This approach aims to explore emerging topics derived from the digital deliberative sphere and address solid energy issues. The gap to be addressed involves identifying and categorising side issues within large communities, using evidence from modularity class analysis. Ultimately, this methodology will help digitalize the promotion of ZEVs and achieve the goals set in the pathway.

7.2. Enhanced understanding and insights into community dynamics

The findings are anticipated to provide a deeper understanding of how digital platforms, particularly YouTube and Instagram, can be leveraged to foster public engagement and support for the UK's net zero transition. The research will reveal how digital deliberative spheres form around topics of energy transition, highlighting key influencers, emerging topics, and community dynamics that drive public discourse. This enhanced understanding will help identify the most effective ways to engage different audience segments and promote positive behaviour changes related to energy policies and practices.

7.3. Policy implications and recommendations for digital literacy

By elucidating the role of digital platforms in shaping public perceptions and behaviours related to net zero transition, the study will offer valuable insights for policymakers and stakeholders in crafting more effective communication strategies and policies. Additionally, the study will emphasise the importance of energy literacy within digital publics, providing recommendations on how to improve public understanding of renewable energy integration and the significance of net zero targets through digital platforms. These insights will aid in developing comprehensive strategies to better inform and engage the public, ultimately supporting the UK's net zero goals.

7.4. Call to action and enhancement proposals

Given the importance of a Call to Action (CTA) for detecting enhancement proposals, the data suggests several actionable steps: boosting the digital presence of underrepresented stakeholders like community organisations and academics through training and influencer partnerships; diversifying content strategies by incorporating more persuasive and informal content to better mobilise public support; and developing targeted digital strategies tailored to the strengths of each stakeholder group to maximise their impact on public discourse and policy advocacy. This structured approach, focusing on both quantitative aspects (presence and narrative style) and qualitative enhancements (engagement strategies), aligns with the goal of systematically advancing the UK's energy goals through optimised stakeholder interactions within the digital deliberative sphere.

The chapter integrates findings from data analysis to propose actionable strategies for enhancing the UK's Action Plan for Digitalizing the Energy System. It offers insights into digital public engagement, community dynamics, policy implications, and the importance of digital literacy. Additionally, it outlines specific enhancement proposals, such as boosting the presence of underrepresented stakeholders and diversifying content strategies, all aimed at achieving the net zero targets. By focusing on both quantitative and qualitative enhancements, the chapter aligns well with the research questions and provides a comprehensive approach to leveraging digital platforms for promoting ZEV adoption and supporting the UK's Net Zero strategy.

8. Limitations and future research directions

This study has several limitations. The data collection was conducted over a specific timeframe, potentially missing long-term trends and the evolving nature of digital engagement, influenced by seasonal events, policy changes, or major incidents. The focus on the UK's digital engagement strategies for ZEVs and net-zero goals may limit the applicability of the findings to other regions with different social, economic,

and political contexts, as the UK's digital landscape may not represent global trends. Additionally, the study emphasised quantitative data, such as the number of posts, likes, and shares, which might overlook qualitative aspects like sentiment and depth of engagement, necessitating a more qualitative approach to fully understand user interactions.

Future research should expand the scope to include a broader range of digital platforms, such as TikTok, LinkedIn, and emerging social media sites. This would provide a more comprehensive understanding of how different platforms influence public engagement and policy advocacy for ZEVs. Expanding the platform scope would also help identify how different digital deliberative spheres form and operate, enhancing our understanding of the diverse ways in which public discourse and engagement strategies are developed across various media landscapes. By studying these platforms, researchers can better address the residual realist imaginary concept by identifying how entrenched perceptions and traditional narratives are challenged or reinforced in new digital environments.

Additionally, conducting longitudinal studies would capture the dynamic nature of digital engagement, revealing how public discourse evolves in response to policy changes, technological advancements, and socio-economic shifts. Incorporating qualitative methods, such as interviews, focus groups, and content analysis, could provide deeper insights into user sentiments and motivations, addressing the vacancy of subjects (the digital publics) in the digital deliberative sphere. This approach would complement quantitative data, offering a more holistic view of digital engagement and its impact. Furthermore, future research should focus on assessing the real-world impact of digital engagement strategies on policy outcomes and public behaviour, linking digital advocacy to tangible changes in policy or consumer actions. This would provide valuable insights for policymakers and stakeholders, emphasising the importance of effective digital strategies in achieving the UK's net zero goals.

CRediT authorship contribution statement

Chuang Yu Ning: Visualization, Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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