Climate and transport planning: a messy junction

Luciano A. Pana Tronca

Orcid: 0000-0002-9228-8288

IUSS Pavia & University of Trieste

Luciano.panatronca@iusspavia.it

Abstract:

The European Green Deal's ambition for climate neutrality by 2050 necessitates robust action at all levels of governance. This paper examines the intersection of climate planning and transport actions in European cities, emphasizing the critical role of local authorities in driving sustainable urban development. Drawing on data from 50 European climate plans, the analysis reveals geographical disparities in climate planning efforts. Methodological variations in climate planning approaches are identified, alongside gaps in linking actions to emission reduction targets. Priority transport actions, categorized under the Avoid-Shift-Improve framework, highlight a focus on active mobility, electrification, and public transport enhancements. Recommendations for integrating climate and transport planning underscore the need for clearer target-setting and stakeholder engagement. Future research directions include exploring the efficacy of public participation methods and assessing planning system legitimacy. Overall, this paper contributes insights into advancing climate action agendas in European cities, crucial for achieving the objectives of the European Green Deal and fostering sustainable urban futures.

Keywords: climate plans, transport planning, strategic planning

The EU Parliament and Commission agreed to the European Green Deal in 2020 (EU, 2019), aiming to be climate-neutral by 2050. While National governments are required to develop national long-term strategies, cities and local authorities are the ones dealing with actions to decarbonise urban transport, housing, and waste at the local level.

Transport in particular plays a very important role. The global transport sector is responsible for a quarter of EU CO2 emissions, and while most sectors have started a downward trend to decarbonise, we find that in road transport this is not the case (European Environment Agency, 2022).

Since 2020, with the new net zero vision and the declaration of climate emergencies from local authorities, planning processes aimed at dealing with the emergency have surfaced (Gudde, et al., 2021). Some cities are implementing measures to try to achieve some reductions, but these are scattered, and a systems approach is needed, not only to think about the technological or

operational solutions (innovations) but also to be more democratic and include stakeholders views.

Moreover, all sectors need to be working in collaboration to achieve a net zero goal for the whole city. Therefore, at the strategic level, transport-specific planning tools such as sustainable urban mobility plans (SUMP), transport strategies, and local transport plans need to be integrated into climate plans. Such integration and the implementation of actions within the plans depend on local capabilities and resources (Lee, 2024). A interesting initiative born in Germany in the 1990's called the A-S-I approach can be used to structure policy to reduce the impact of transport on the environment. This is done through a three-pillar strategy: avoiding/reducing the need for motorized travel and trip length by improving the efficiency of the transport system as a whole, shifting/maintaining towards more environmentally friendly modes of transport to improve individual trip efficiency, and improving vehicle and fuel efficiency as well as the operational efficiency of public transport while introducing renewable energy sources (Bongardt, et al., 2019).

Some planning tools such as the Sustainable Energy and Climate Action Plans from the Covenant of Mayors, do include transport as one of their main sectors. This initiative has been growing gathering more than 7,000 local and regional authorities across 57 countries. In 2016 the 5,403 CoM signatories' overall commitment for 2020 was a reduction of the total GHG emissions of 27%, 7 percentage points above the minimum requested target of 20 %. Results from the plans monitoring reported, reveal an already achieved 23% overall reduction in emissions (Bertoldi, 2018).

In turn, the SUMP Guidelines prioritise accessibility and quality of life. Environmental quality is mentioned in the guidelines as one of several sub-goals (Rupprecht Consulting, 2019). Further, the SUMP Guidelines do not mention that the EU 2030 and 2050 climate targets are (or will soon be) legally binding for all Member States, requiring urban GHG emission reductions. Carbon emission reduction is discussed alongside other objectives of sustainable urban mobility planning, such as visioning, targets, and measure appraisal (steps 5-7 of the SUMP cycle). The lack of climate goals has been identified as one of three gaps, alongside framework conditions and enabling actions for long-term implementation and guidance on short-term measures (Smeds & Jones, 2020).

However, the planning tools mentioned above are just some of a few available to cities. They have the freedom to choose how to plan according to their ways.

In this context, we can ask ourselves:

- What are the main standards in city climate planning in European cities?
- Is transport planning considered a main topic in city climate planning?
- What are the prioritized transport actions in European cities within the context of their climate plans?

In section 2 I present the Climate Plans and Transport Actions database and explain the methodology to answer the research questions. In section 3 I present the analysis of the database and in section 4 I discuss the main findings as well as provide policy recommendations for the integration of climate and transport planning.

2. Methods

The Climate Plans and Transport Actions database is a set of Excel spreadsheets that contains information from 50 European cities' action plans. It is based on the Carbon Disclosure Project 2021 Cities Mitigation Plans database (CDP, 2022).

The CDP database has more than 1300 entries. The database was simplified by using the following criteria:

- Geographical scope: CDP region Europe
- Time scope: year of adoption of the plan: from 2020 onwards (included)
- Duplicate entries were excluded, for example iterations of plans
- Regional-level plans were excluded: to the best of our understanding only city-level (or unitary) plans were selected. Metropolitan level accounts as city level.
- Faulty entries: entries with no links or faulty links were excluded. Four exceptions to this rule were added to the database: Athens, Sofia, Ljubljana and Izmir. These entries didn't have links, however as they represented countries that were not included in the database until that moment, it was decided to look for the links and include them to enlarge the sample (14 countries and 1 city state).

The Climate Plan and Transport Actions database is a set of spreadsheets that contains data on 50 European Climate Plans approved after the EU net-zero targets. The user can search for transport actions and identify which cities are planning to apply them. Once the city/cities are identified, the user can use the third sheet to get a link to the Climate Plan, with further information about that action. The goal of the database is to help cities to identify suitable transport actions to include in their climate planning strategies.

The database is made of 3 sheets:

1. Grouped actions: this spreadsheet includes the list of aggregated transport actions from 50 European climate plans. Categories were created to aggregate similar actions from different cities. Actions are categorized using the Avoid-Shift-Improve approach. This sheet can be used to search for categories/actions and identify which city is planning to implement them.
2. Individual actions: this spreadsheet includes the full list of actions from 50 European cities' action plans without being aggregated.
3. Cities Climate Plans: this spreadsheet is based on a CDP database (CDP, 2024). The spreadsheet was completed by reviewing all Climate Plans. It includes a weblink for each plan. User cities can assess whether the actions and cities are closer to their local environment or landscape by using a city with a similar population, similar strategic planning background, level of autonomy index, etc.

The Cities Climate Plans includes columns where the assessment was done:

- LOAI: level of autonomy index: is based on a study by Heinelt (Heinelt, 2017) and the study of the University of Agder (Baldersheim, et al., 2019).The index has 11 variables: institutional depth, policy scope, effective political discretions, fiscal autonomy, financial transfer system and self-reliance, borrowing autonomy, organizational autonomy, legal protection, administrative supervision and central or regional access.
- Strong strategic planning background: (yes/no) based on mention of previous plans related to mitigation, energy, and environment.

- Socioeconomic environmental analysis: based on data on considerations and/or the impact of climate change on humans, the economy, and the environment.
- Quantify the impact of change: (yes/no) depending on whether the plan has some level of quantification of how climate change will imply a change in the city or the change is exemplified.
- Includes M&E or KPIs: (yes/no) whether it includes a monitoring and evaluation framework, even if general or if it includes specific KPIs to measure the plan.
- Target date: the date by which the city is expected to achieve carbon neutrality. Not all plans have the level of detail on projects or measures to get to net zero (non-demonstrable that the city will achieve the target).
- Mention of Sustainable Urban Mobility Plans or Transport Plan (yes/no).

3. Analysis

There is a good representation of cities of varying sizes that have produced a Climate Plan and disclosed it, according to the analysis of the Database (table 2). When we take a look at the geographical representation, we can see that the cities in the United Kingdom are at the forefront of climate planning in the two years after the year 2020 (table 1). These cities account for 32 percent of the entries.

Many of the cities have some level of experience in the planning process. Only 12% of cities listed no prior experience in their plans (figure 1). There appears to be no relationship between previous experience and level of autonomy. Surprisingly, most of those cities with no previous climate planning were from the UK, which also have a low level of autonomy. When it comes to planning, the degree of autonomy that a city has can be connected to the authority that it possesses to carry out the plan. Climate plans from UK cities frequently distinguish what is a local, regional, or national responsibility, or highlight actions that rely on other bodies such as electricity, water, and waste companies.

Table 1 Geographical distribution of climate plans

Country	**Count**
United Kingdom	16
Denmark	8
Italy, Sweden	5
Norway, Portugal, Spain, Switzerland	2
Bulgaria, Finland, Gibraltar, Greece, Iceland, Netherlands, Slovenia, Turkey	1

Figure 1 Experience in climate strategic planning

Table 2 City size distribution

Size	Count
Very small (less than 50,000)	6
Small (50,000-100,000)	4

Medium (100,000-250,000)	13
Large (250,000 – 500,000)	11
X-Large (500,00 – 1,000,000)	8
XX-Large (1,000,000 – 5,000,000)	8

The main methodologies used for the plans can be grouped into three, those who use SECAPs, those who use the Tyndall Centre methodology (Tyndall Centre, 2024) ,and a third larger group who uses an ad hoc methodology. Thirty out of 50 plans include a comprehensive social, economic and environmental assessment, and 12 plans have at least some assessment (either economic, social or environmental) (figure 2). About 80% of the cities have quantified the impact of climate change at some level, however when we look at the actions within the plans, we see there is no clear indication as on how much those actions will help get to the targets proposed. This means that cities understand the impacts but don't have a clear idea of how the actions in their plans will be enough to get to their goal. This is demonstrated as 36% of plans don't have monitoring and evaluation frameworks nor strong key performance indicators. With uncommitted actions, not linked to reduction targets or an estimation of reductions from those actions, some plans could be deemed as a narrative with a menu option with low certainty it can be implemented. The challenge around implementation and evaluation is not new. Prior studies on climate plans have identified that there is a lack of importance placed on this stage of the planning process (Aboagye & Sharifi, 2023).

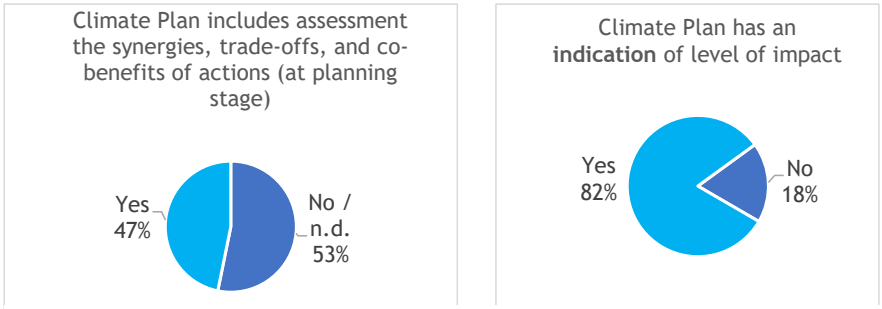

Figure 2 Climate plans availability of assessments (left) and indication of impact (right).

From the analysis of the Climate Plans included in the database, several baselines assessments have been identified as good practice for the development of such plans.

Crucial to the development of a sound transition pathway, climate action plan or strategy, is to understand the local context, gather information and determine what methodologies (or questions) will be guiding the discussions that stakeholders will have in order to prioritise strategies and policies.

The following assessments could be considered secondary processes done by the technical staff and feed into a bigger narrative of a climate plan. However, the technical baselines can also inform about the applicability and feasibility of the implementation of specific actions.

A. Emission assessment

▪ How high are the consumption-related emissions of the city? Are these distributed among the various consumption areas?
▪ What are the most influencing variables for greenhouse gas intensity of the individual consumption areas (e.g. electricity mix in the producing countries,trends in agricultural production, technology development, etc.)? What other important aspects have an influence here (e.g. proportion of animal products in the demanded diet)?
▪ What developments can be expected for the exogenous context factors and the other aspects realistically expected by 2050 (for example, investment in electrification)?
▪ Which opportunities and risks or synergies and conflicting goals with regard to ecological, social and economic aspects must be taken into account?
▪ Which administrative level owns the power to influence emission sources?

Emissions reporting is becoming a standard practice and most cities will have their methodology. Organisations such as international banks or third sector parties would have also developed methodologies (Greenhouse Gas Protocol, 2024). Alignment between them could streamline finance flows and improve accountability of climate projects financed by multilateral organisations.

B. Climate impact assessment

There is an assessment of all significant climate risks in terms of frequency and severity as well as the extent of the consequences up to 2030, as well as an obligation to assess up to 2050. This assessment includes:

- Risk scenarios are, where possible, based on local standard methods or on typical discharge scenarios (eg the IPCC's representative concentration course culminating at 4.5° C in 2100). For a general risk assessment cities could use the IPCC regional map (IPCC, 2024).
- A qualitative assessment of the impact on the city's systems, sectors and vulnerable social groups is prepared based on the climate risk assessment.
- Consequences for the city's inhabitants and necessary infrastructure (e.g. utility companies, hospitals) are seen in relation to how exposed they are and their ability to adapt.

C. Socio economic assessment.

This assessment is used to understand critical points and groups that are relatively more vulnerable to climate change impacts. It includes:

- Description of the existing administrative and physical geography, which is relevant to climate change (coastal proximity, flooding areas, topography, elevation)
- Social analysis to identify demographic changes and resilience (focus on disadvantaged groups likely to be impacted by climate change)
- Analysis of the economic mix of the city, including major economic activities, economic strengths related to climate supply chains (technical schools that could support upskilling for green jobs, manufacturer of sustainable materials, availability of entrepreneur and innovation environments, etc).

D. Technology assessment

Technology is considered a key factor in every climate plan, however it is mostly considered as the availability of certain technology without a long term consideration of its impacts or its regulatory needs.

- Which technology trends may have the greatest impact on emissions from transport, for example batteries, sensors, big data, drones? In the short, medium and long term
- What do we know today with a certain degree of certainty about technological changes in the transport sector (2030-2050)
- Will new technology require the development of new regulations, and what kind of regulation if any?
- What kind of new infrastructure must be developed to adopt new transport technology?
- What can the city do to facilitate the use of key technology?
- What kind of competence and capacity does the municipality need more towards 2030 to facilitate technological change in the transport sector?
- Are there any areas that the city can focus on in particular, which will be valuable in the global environment perspective?

E. Institutional and policy assessment

This entails a two stage assessment. The first stage should be done before the visioning step (SUMP-PLUS, 2021, Halpern, et al., 2022). This stage includes:

- Identification of relevant national and regional obligations: includes the overview of goals and initiatives that are shared with or owned by other bodies and actors
- The municipality's structure and scope of the plan
- The municipality's powers and capacity: An assessment is prepared of the powers that the municipality has with regards to other relevant sectors, assets and functions or measures, which also determines where it is necessary to further cooperate to accelerate the implementation of climate action
- Review of the integration of the plan into existing regulations, plans, statutes, policies and local institutions necessary to accelerate implementation and involved in the development of the plan

A second stage of institutional assessment can be used after high level strategies and actions have been selected to determine gaps in policy and linkages between vulnerable groups, emission reducing, strategies and economic opportunities.

The second stage should is designed to match the local authority institutional capacity at the baseline with the institutional capacity needed to deliver on the high level strategies that are selected. To do this, the Strategies selected need to be reviewed and assessed in light of the local environment. This second stage is closely related to the assessment of weaknesses, strengths and barriers that were researched in the previous assessments and the concept of enabling actions.

Following their technology and institutional assessments, Oslo considered Data to be of upmost importance to achieve its transition (City of Oslo, 2024). The city is working to identify its own role with regard to the ownership and operation of data. It will also be useful to go through the data sources that the municipality actually already owns, and assess how this data can be used to develop services and tools that contribute to reduced emissions. The development of the

platform itself for sharing data is probably something that should be located somewhere other than at the Climate Agency, but the agency can represent a good case for the utilization of current data with its clear goals of reducing emissions from the transport sector. Smart use of data can make a major contribution to streamlining the transport business and form the basis for the development of good services and products.

Citizen support and public participation

Climate plans surfaced as a consequence of a varied of causes, mainly the real impacts of climate change but also because of the perception of the citizenship and the policy push by the EU. The 2021 barometer shows that the most serious problem facing the world is climate change above poverty, hunger and the spread of infectious diseases. The same survey saw an increase in allocating responsibility for tackling climate change for all political strata. National governments, businesses and the European Union are seen as the main responsible. However, local governments have seen the bigger increase in perception of responsibility going from 33% to 43% in 2 years (European Union, 2022).

Climate plans can be seen as a policy response in the sense that they have yet a short trajectory. These type of plans are not statutory as it are National Determined Contributions or SUMPs or Local Transport Plans in the transport sector (for cities above a threshold). Even SECAPs which have a longer trajectory are not subject to a regulatory obligation. This brings shadow on the role of the citizenship role. About half of the plans in the database do not include public consultation, which represents a gap between one of the main driving force of plans and the planning in itself.

About 8% of plans have some type of public participation as they include a bigger range of stakeholders including universities, faith groups and industry professionals (figure 3). Some cities have developed digital tools to support the development of the plan like Stockholm. Developing such tools can be help bridge the gap mentioned before. Other public participation tools mentioned are calls for evidence (pre plan participation), regular engagement through communication channels, climate talks, and ad hoc events such as Climathon's or People's Assemblies.

An avenue for future research could be to link public participation methods, the efficacy of the plans and the legitimacy of the planning system.

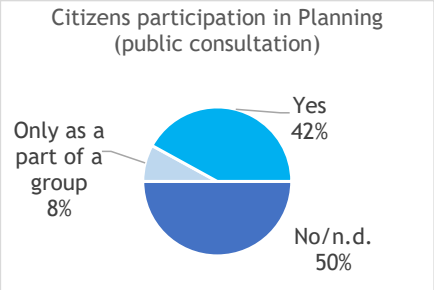

Figure 3 City plans and public consultation

Priority transport actions

It was previously mentioned that the link between climate and transport planning is not always clear at least at the strategic level. The analysis of the database shows that while all plans have at least some transport actions included, only 60% mention SUMPs and LTPs. 373 transport actions were identified and classified in 148 groups. Actions were also classified on whether they belong to any of the A-S-I categories. Two additional categories were created: avoid/improve (for example alignment of land use planning for sustainable mobility) and shift/improve(for example low emission zones). The majority of actions correspond to shift and improve actions (figure 4). Even when shift actions represents the majority of actions, the top 5 actions include improve cycling and walking infrastructure (S), E-charging infrastructure, hydrogen and EV public transport, the electrification or decarbonisation of public fleets (I), Improve accessibility and frequency of public transport (S) and car sharing (S). This result validates previous research looking at the candidate cities for the EU programme Climate Neutral and Smart Cities (Christidis, et al., 2024).

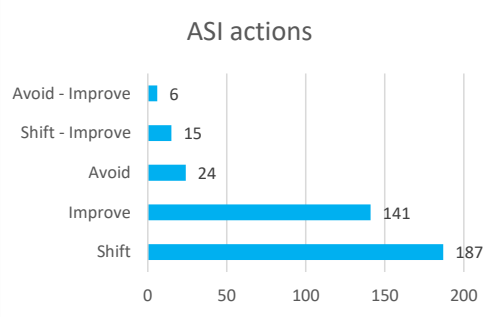

Figure 4 Transport actions A-S-I distribution

The level of detail of the actions is uneven. For example, within cycling we find the development of cycling strategies, monetary incentives for cycling uptake, road redistribution for active mobility, improvement of cycling infrastructure and promotion of cycling operations. On the freight side we find options such as the use of drones for freight, promotion of sustainable freight, electrification for urban boat freight, incentives for green freight, a roadmap for freight decarbonisation and “last mile and freight”. As shown actions can be very specific or high level according to each plan.

Considering prioritised actions according to level of autonomy, we see that active mobility improvements, electrification and infrastructure and improved public transport are the main actions considered (figure 5). We can see more collaborative actions prioritised in the low level of autonomy group with the inclusion of park and rides with other municipalities and car sharing schemes. For the high level of autonomy group we can highlight operational improvements for public transport (while in the low level of autonomy group we find infrastructure improvements) and hydrogen or EV public transport.

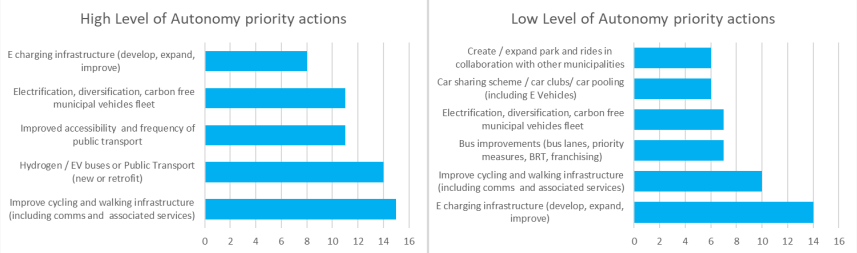

Figure 5 High (left) and Low (right) level of autonomy prioritised actions

4. Discussion

Despite the novelty of city climate plans, local authorities possess some prior knowledge and expertise in this particular planning methodology. Considering the methodologies employed, this does not appear to be related to the quality of the plans. While 88% of cities have some experience, the majority do not use a systematic approach that includes an assessment of synergies, trade-offs, and co-benefits among various urban systems. There is an opportunity to provide additional training to the employees of the local government in order to enhance their ability to make policies based on scientific evidence and to use methods that consider the impact of climate change and systemic factors.

Also, baseline assessments range from simple narratives to doing very in-depth analyses and numbers-based calculations of effects. Regarding the transport section of the plans, it would be interesting to connect the technical work required to establish baselines to the overall narratives of climate plans.

Recent endeavours have been made to establish a connection between these two aspects and address the obstacles identified in implementing plans and managing the transition (Geels, 2011, Sovacool, et al., 2020). The European Union has released new guidelines that can enhance the relationship between climate and transport planning by focusing on the bottom-up approach, specifically from transport to climate (Polis & Rupprecht Consult, 2021, EIB/Jaspers, 2022) . From climate to transportation, specific strategic links should be included in climate plans. Stakeholders should also be told to think of urban systems as being linked, such as water, biodiversity in cities, and transportation and urban planning. Still, the fact that some cities are making their plans public is a good start, and it could be seen as a response to the public's growing awareness of climate risks.

As a main takeaway from this research, it is important to evaluate the institutional capacity and level of autonomy in terms of the actions that need to be done first. Additional research that establishes a connection between climate plans and their actual effectiveness in reducing emissions presents a valuable opportunity to enhance monitoring and evaluation frameworks. Enhancing public engagement through conventional or innovative approaches could also enhance the credibility of plans.

Regarding prioritised actions, electrification, public transport, and active mobility appear to be the highest-ranked items on the list.

Avoid actions that are overlooked in favour of shifting and improving policies. Reducing the demand for trips and tackling trip generation by collaborating with sectors that produce the demand for trips can be a good approach (OECD, 2022).

Generally, climate plans are well-received and indicate progress in planning capabilities, although they have not yet attained the level of being legally enforceable and methodologically rigorous. Local authorities play a crucial role in addressing climate change due to their citizenship, which entails the responsibility to both mitigate and adapt to its effects. Granting cities enhanced authority and financial resources to address the issue could lead to improvements, alongside fostering partnerships with research institutions to oversee the process and integrate evidence-based approaches and objectives into practical measures.

References

Aboagye, P. D. & Sharifi, A., 2023. Urban climate adaptation and mitigation action plans: A critical review. *Renewable and Sustainable Energy Reviews,* Issue 189 (2024) 113886.

Baldersheim, et al., 2019. *Local Autonomy in the Nordic Countries,* s.l.: UNIVERSITETET I AGDER.

Bertoldi, P., 2018. *(SECAP)', Guidebook 'How to develop a Sustainable Energy and Climate Action Plan,* s.l.: EU.

Bongardt, D., Stiller, L. & Wagner, A., 2019. *Sustainable urban transport: avoid-shift-improve (A_S_I),* s.l.: GIZ.

CDP, 2022. *CDP Cities, States and Regions Open Data Portal.* [Online]
Available at: https://data.cdp.net/

Christidis, P., Ulpiani, G., Stepniak, M. & Vetters, N., 2024. Research and innovation paving the way for climate neutrality in urban transport: Analysis of 362 cities on their journey to zero emissions. *Transport policy,* Volume 104, pp. 107-123.

City of Oslo, 2024. *Oslo's new Climate Strategy.* [Online]
Available at: https://www.klimaoslo.no/oslos-new-climate-strategy/#:~:text=1.,by%20vans%2C%20lorries%20and%20buses.

EIB/Jaspers, 2022. *Guide on decarbonisation of urban mobility,* s.l.: EIB/Jaspers.

EU, 2019. *Green Deal.* Brussles: EU.

European Environment Agency, 2022. *Greenhouse gas emissions from transport in the EU, by transport mode and scenario.* [Online]
Available at: https://www.eea.europa.eu/data-and-maps/daviz/greenhouse-gas-emissions-from-transport-5#tab-chart_1

European Union, 2022. *Eurobarometer.* [Online]
Available at: https://europa.eu/eurobarometer/surveys/browse/all

Geels, F., 2011. The multi-level perspective on sustainability transitions: response to 7 criticisms. *Environmental innovations and societal transitions,* pp. 24-40.

Greenhouse Gas Protocol, 2024. *GHG Protocol for Cities.* [Online]
Available at: https://ghgprotocol.org/ghg-protocol-cities

Gudde, P. et al., 2021. The role of UK local government in delivering on net zero carbon commitments: You've declared a Climate Emergency, so what's the plan?. *Energy policy,* p. 10.1016/j.enpol.2021.112245.

Halpern, D., B., P., R. & M., A., 2022. *The role of governance and capacity building transition pathways,,* s.l.: H2020 CIVITAS SUMP PLUS Deliverable 3.3, Sciences Po, CEE, Paris..

Heinelt, H., 2017. *The role of cities in the institutional framework of the EU,* s.l.: EU.

IPCC, 2024. *Regional climate projections.* [Online]
Available at: https://www.ipcc.ch/report/ar4/wg1/regional-climate-projections/

Lee, H., 2024. Strategic types, implementation, and capabilities: Sustainability policies of local governments. *Public administration,* 102(10.1111/padm.12917).

OECD, 2022. *Redesigning Ireland's Transport for Net Zero,* https://doi.org/10.1787/b798a4c1-en: OECD.

Polis & Rupprecht Consult, 2021. *Topic guide: planning for more resilient and robust urban mobility,* s.l.: - Forschung & Beratung GmbH.

Rupprecht Consulting, 2019. *Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan,* Cologne: s.n.

Smeds, E. & Jones, P., 2020. *Developing Transition Pathways towards Sustainable Mobility in European Cities: Conceptual framework and practical guidance.,* s.l.: SUMP-PLUS Horizon 2020 Civitas.

Sovacool, B. K. et al., 2020. Sociotechnical agendas: Reviewing future directions for energy and climate research. *Energy research & social science,* p. Volume 70.

SUMP-PLUS, 2021. *The SUMP PLUS SelfAssessment Scheme and Guidelines,* Antwerp: SUMP-PLUS.

Tyndall Centre, 2024. *Reaching Zero Emissions.* [Online]
Available at: https://tyndall.ac.uk/research/reaching-zero-emissions/

Acknowledgements:

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 814881. The sole responsibility for this product lies with the SUMPPLUS project and in no reflects the views of the European Commission".

This paper and related research have been conducted during and with the support of the Italian national inter-university PhD course in Sustainable Development and Climate change (link: www.phd-sdc.it)