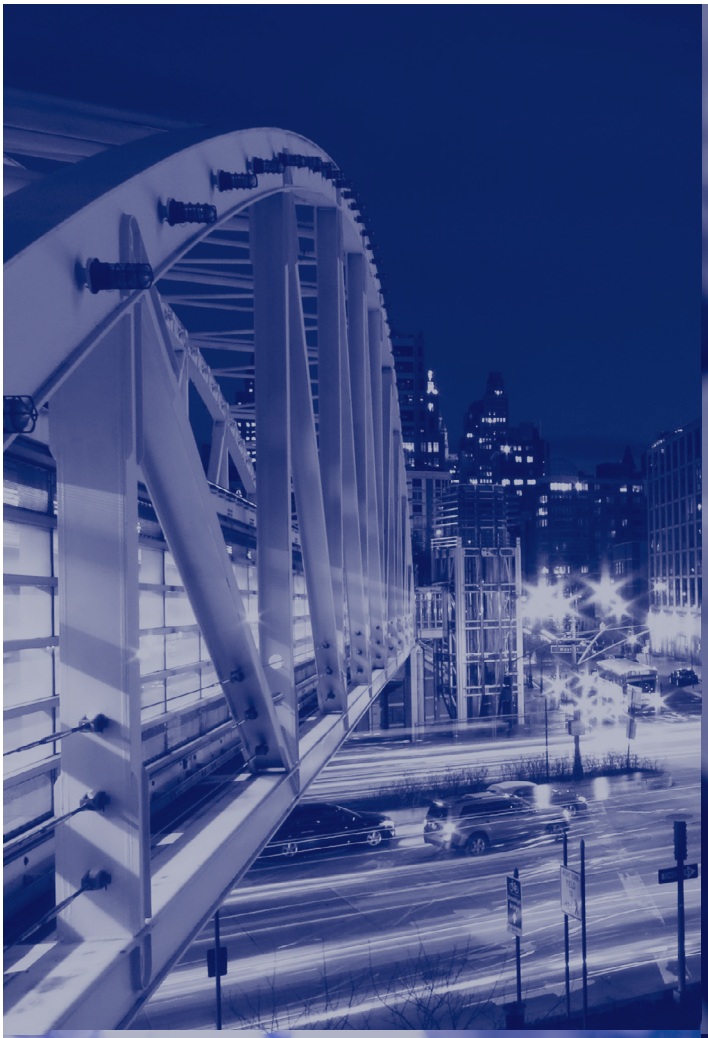

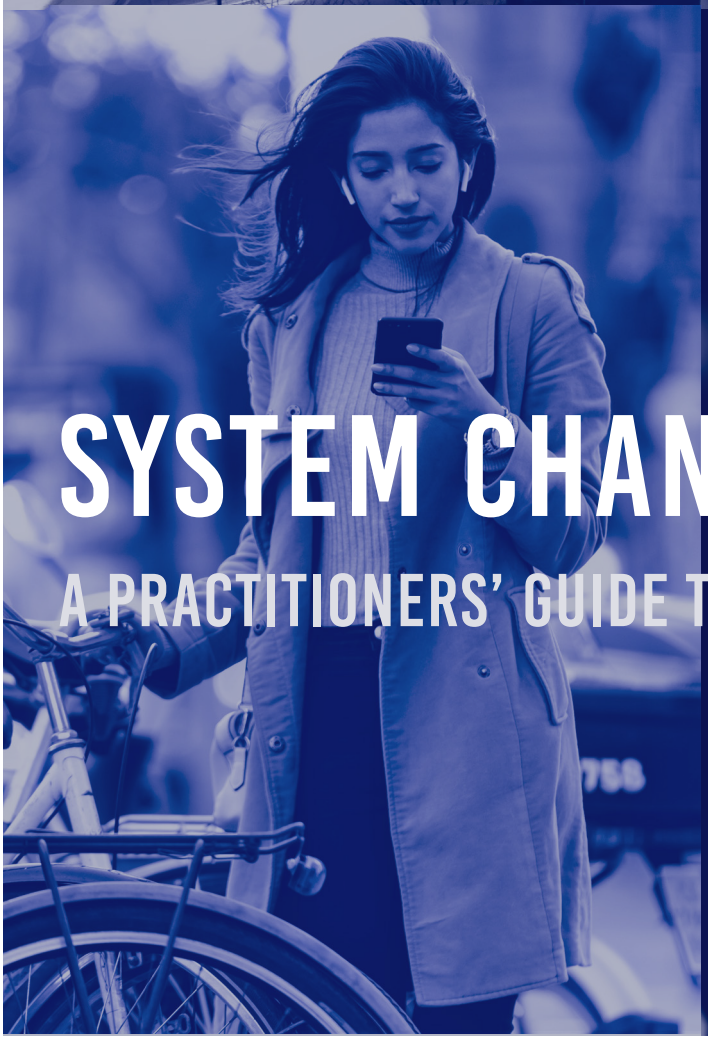

SYSTEM CHANGE COMPASS

A PRACTITIONERS' GUIDE TO SUSTAINABLE MOBILITY

BY THE CLUB OF ROME AND SYSTEMIQ

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System Change Compass: A Practitioners' Guide to Sustainable Mobility

SUSTAINABLE MOBILITY FOR PEOPLE THROUGH A SYSTEM CHANGE APPROACH[i]

Tilmann Vahle and Marie Wehinger

Key Insights

1. Past and current EU policy efforts to effectively drive the transition to a low-carbon, resource decoupled mobility system for people have not been sufficient. This policy brief argues that interventions need to be revisited according to a systems approach, aligned with the Club of Rome's and SYSTEMIQ's System Change Compass.
2. Systemic interventions are characterized by the following: they are radically science-based, consider demand-side interventions, take into account life-cycle effects and consider interventions that cross or actively integrate traditional sector silos.
3. In the mobility sector, such systemic interventions must aim to: 1) Reduce the need for motorised trips. 2) Reduce energy intensity and consumption of fossil fuels 3) Maximise the utilisation per vehicle and trip for freight and passengers, and 4) Prioritise the medium of transport that is easiest to electrify.
4. Systems interventions for the transition to a low-carbon, resource-efficient mobility system for people fall into two buckets: first, lowering the demand for cars by reducing mobility needs in general, increasing the utilization of vehicles, and supporting intermodal transportation integration; and second, on the supply side ensuring that the remaining vehicles are sustainable, with a focus on accelerating the electrification of all modes of transport and driving circularity to maximize the value of the materials used.
5. Three main barriers hinder effective policy-making for sustainable mobility in the EU: 1) The distribution of decision-making across different levels of policy (subsidiarity principle) complicates system-wide and complementary introduction of policy interventions, 2) Environmental performance measurements are not suited to drive the required transformations, and 3) Traditional industry voices and GDP-oriented member state governance defer progressive policy moves.
6. Overcoming these barriers can be achieved through the application of guiding principles: integrating policy interventions between different systems and sectors, adhering to a life-cycle-based perspective for decision-making, utilizing demand and supply measures, balancing technology specificity and neutrality, and coupling policy interventions with complementary measures to enable system-wide, scaled effects.
7. Five recommendations should guide systemic EU policy-making to move away from a carbon-intensive, car-dominated mobility system to a resource-efficient, intermodal mobility system:
    a. Transition to life-cycle-based environmental performance assessment
    b. Mobilize and strengthen European-wide action for sustainable urban mobility
    c. Reshape economic framework conditions
    d. Create a data fabric for sustainable value chains and multi-modal mobility
    e. Support scaled sector integration of mobility and energy

[i] Reference as: Vahle, T. and Wehinger, M. (2022). System Change Compass: A Practitioners' Guide to Sustainable Mobility. SYSTEMIQ and Club of Rome (hrsg.), Munich and Brussels

FUTURE VISION: MOBILITY THAT MEETS SOCIETAL NEEDS

Emissions from road transport are responsible for over 30% of Europe's overall CO_2 emissions[1] – and transport is the only sector that has not experienced any significant emission reductions in the past years. Coupled with its negative impact on biodiversity loss through excessive resource use[2] and critical influences on human health,[3] it becomes clear that the mobility system needs an overhaul: from a carbon-intensive, car-based system to one that is resource-efficient, low-carbon, barrier-free and affordable for all.[4]

This future mobility system will require less transport based on individual car ownership and offer more efficient transport options for people – while meeting societal mobility needs and creating economic value. **The System Change Compass outlines 10 principles that must be applied to transform current economic systems. For mobility, these translate into four policy orientations that should guide the way:**

1) Reduce the need for motorised trips
2) Reduce energy intensity and consumption of fossil fuels
3) Maximise the utilisation per vehicle and trip for freight and passengers
4) Prioritise the medium of transport that is easiest to electrify

This practitioners' guide applies these principles to road-based transport, with a focus on changing the car-dominant passenger transport paradigm. It outlines why policy action in the EU until now has not been enough to reduce the impact of transport systems and provides answers by linking the policy orientations to a concrete set of interventions that can help to facilitate a positive mobility transition. See Box 1 for a definition of systemic interventions.

Box 1: Defining systemic interventions

Systemic interventions…

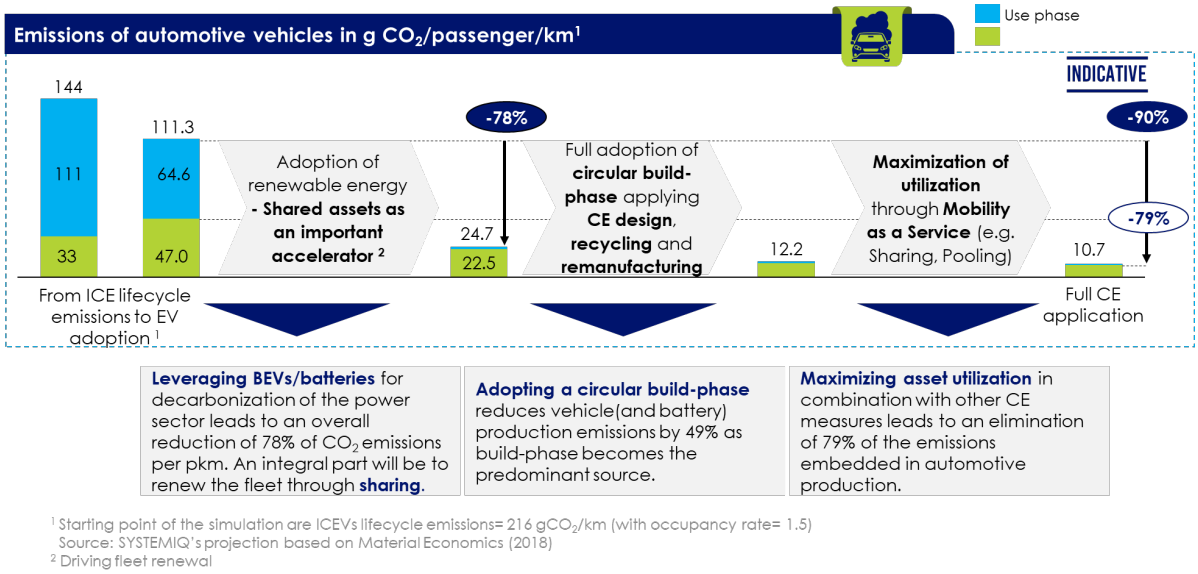
A. **consider outcomes** – they seek to achieve certain objectives, such as societal needs, and environmental outcomes, such as planetary boundaries.
B. **have a demand side focus** – demand controls everything in our economies
C. **consider feedback loops**, particularly rebound effects – the individual action is not as important as the behaviour of the entire system
D. **consider action from all stakeholders** – in our case industry action and developments
E. **de-silo action for impact** – taking into account requirements and effects beyond the focal ecosystem they intend to improve, for example by considering mechanisms with economy-wide impacts, acting on relevant conditions of related sectors, or consider lifecycle effects of measures.

The necessary solutions and technologies for a resource-efficient, low-carbon mobility system are well-known by now:[ii] electric and autonomous vehicles powered through a fast-charging infrastructure, managed in a circular fashion at their end of life and integrated with an effective public transport system, high-speed railways connected to a modern transit infrastructure and car- and ride-sharing offerings, digital infrastructure to improve traffic management, green aviation and shipping, and a convenient walking and cycling infrastructure.[5]

Despite the exponential uptake of electromobility, the overall pace of the development, implementation, integration, and industrialization of these sustainable mobility solutions is still slow.[6] **Past and current EU policy efforts to accelerate this transition have not been sufficient: especially the dominant reliance on car-based transport has not changed. Passenger transport**

[ii] More details on the solutions required for a sustainable mobility system for people can be found in the System Change Compass

is the main source of transport emissions and its sustainable transition needs to follow an ambitious policy plan.[7] The structural inefficiencies of this car-dominated mobility systems are profound: cars are parked for 92% of the time and occupancy rates average at 1.2 passengers. At the same time, streets, roads, and parking make up 50% of city spaces.[8] These problems can not be fixed by solely switching to alternative drivetrains. Transformational approaches to decarbonize and dematerialize transport must go beyond accelerating the electromobility transition to an intermodal mobility system in order to truly decouple road transport's impact from resource use, carbon emissions and other environmental impacts (see figure 1).



[1] Starting point of the simulation are ICEVs lifecycle emissions= 216 gCO2/km (with occupancy rate= 1.5)
Source: SYSTEMIQ's projection based on Material Economics (2018)
[2] Driving fleet renewal

Figure 1: Carbon emissions of automotive vehicles per passenger kilometre[iii]

Tackling the challenges stemming from the current functioning of the mobility system requires a general rethink: moving from individual car ownership to providing mobility for all – in line with a resource-efficient, low-carbon future. Mastering such a mobility system transition through the European Green Deal demands a system approach, as only tackling symptoms (e.g., by reducing fuel consumption of vehicles) or applying a silo-approach for improvement (e.g., focusing only on batteries and vehicles for circularity) will not be sufficient to fulfil the Paris Agreement and preserve biodiversity. The mobility ecosystem itself influences and is influenced by various other systems (see box 2). Changing its dominant way of operating must therefore be done by addressing all these interlinkages.

Box 2: Ecosystem Mobility and its interlinkages with the wider economy

The economic ecosystem mobility is characterized by various interlinkages with other ecosystems; among others at least with:

- **Energy:** charging electric vehicles, integrating vehicles with grids
- **Circular Materials**: producing transport vehicles (cars, trucks, trains, etc.)
- **Information & Processing:** providing data sharing and processing for efficient mobility systems or multi-modal mobility; enabling remote work setups
- **Built Environment:** designing cities and transport hubs

[iii] Demand-side levers are only included through increased utilization of cars, public transport or other alternative, active modes of transport are not included here.

POLICY APPROACH: SYSTEMIC SOLUTIONS INSTEAD OF INCREMENTAL CHANGES

Policy interventions targeted at the acceleration of a resource-efficient, carbon-neutral transport system for people have to focus on two key changes, in line with the policy orientations outlined above: the societal demand for mobility needs to be satisfied with fewer vehicles and the remaining vehicle supply needs to be produced, used, and recovered as sustainably as possible (see Figure 2). The levers to achieve these changes are available today – but must be deployed systemically and should be measured against their joint suitability in delivering societal utility (mobility) at minimum social and environmental burden.

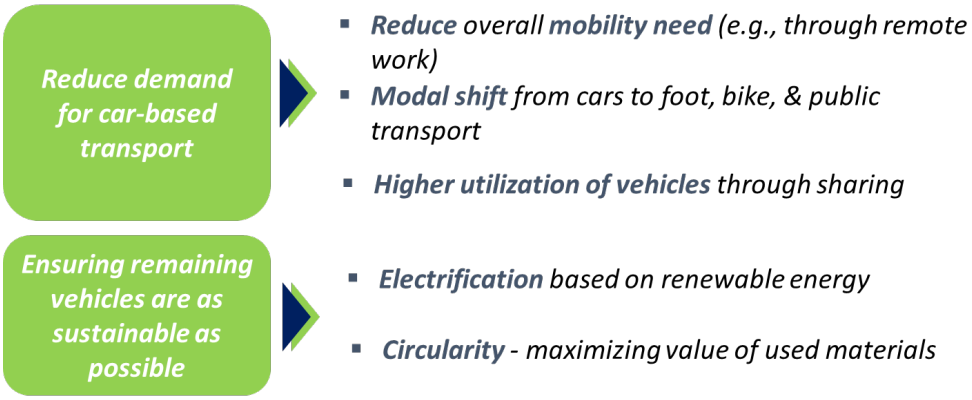


Figure 2: Five System Change Levers for Sustainable Passenger Transport

Three key challenges hinder harmonized and effective policy-making for sustainable mobility in the EU:

1) **Distribution of decision-making across different levels of policy (subsidiarity principle) complicates system-wide and complementary introduction of policy interventions:** Mobility-related policy-making is spread across EU, national, regional, and local authorities.
2) **Environmental performance measurements are not suited to drive the required transformations:** CO_2 performance standards on vehicles' tailpipe emissions have (so far rightfully) been in focus of policy-making. With increasing environmental burden in production and energy generation phases, this view must be broadened to include life-cycle-based assessments, resource implications, and most importantly a per passenger kilometre basis to optimize vehicle utilization.
3) **Traditional industry voices and GDP-oriented member state governance defer progressive policy moves**: Economic and societal opportunities of a green mobility transition (such as, reduced expenditures for fuels; improved air quality; reduced congestion and accident casualties) are often underestimated and thus necessary measures are underrepresented. Hereby, as economic recovery funds are being disbursed, decision makers may risk locking-in legacy structures unaligned with a resource-efficient mobility system.

It is now time that the European Union leverages the momentum of the European Green Deal, COVID-19 recovery and the new epoch forced upon us by the Russian war on Ukraine by utilizing systemic approaches to overcome the barriers that decelerate the sustainable mobility progress. Rather than focusing political and economic capital primarily on reducing vehicle tailpipe emissions, policy makers should introduce a more comprehensive policy mix: achieving life cycle CO_2 abatement that is comparable across transport modes, equitable mobility access, and low environmental footprints. To do so, policy makers should adopt science-based decision-making that puts the transport sector on a pathway to comply with a 1.5°C climate target and decouple its resource consumption. To this end, it is now crucial that mobility

decision-makers adopt a systemic approach to policy through adhering to the following principles:

- **System integration:** At the moment, sustainable mobility policy is mainly optimizing within the transport system (e.g., by improving seamless European-wide rail networks or BEV charging infrastructure). But to achieve systemic efficiency, policy-makers must consider effects and opportunities of the wider transport ecosystem. This includes adjacent industries, such as energy, to support, for example, the proliferation of smart and bi-directional charging, construction and infrastructure planning to design urban and rural spaces for sustainable and less mobility, and labour conditions, for example, by reducing mobility demand overall through remote work.
- **Life-cycle-based perspective:** Current policies for cars focus primarily on vehicle tailpipe emissions (e.g., the CO_2 performance standards for cars and vans) but do not take into account the complete life-cycle emissions of cars or vans nor do they calculate emissions on a passenger-kilometre level. However, both would be required to allow assessments and comparisons of carbon and resource impacts of different modes of transport – and thereby ensure objective and effective policy-making.
- **Demand and supply policies:** While vehicle electrification is a necessary requirement to decarbonize the transport system, greater attention should also be paid to demand reduction policies. Such policies aim at lowering mobility demand or shifting it towards forms of mobility that require fewer resources per passenger kilometre. This can be achieved especially by fostering communal mobility solutions, such as pooled mobility as a service, public transit, and in urban areas, biking or walking.
- **Balance technological neutrality and specificity:** Technological neutrality should not be used as argument to interfere with rapid expansion of proven, existing sustainable technologies. Dispersing funds and political capital due to the desire for technological neutrality (e.g. subsidizing FCEV or PHEV, both of which experts agree will not support meaningful decarbonization of mobility[9, 10]) slows down decarbonization. Increased support should be given to rapidly scaling a suitable ecosystem for wide-spread adoption of BEVs – including via charging infrastructure, expansion of renewable electricity, and power market regulations to support smart business models.
- **Complementary policy mixes:** Rather than limiting policy action to incremental approaches through existing mandates, more ambitious policy-making must be introduced. To do so, ambiguous policy signals through conflicting interventions must be reduced, the EU's capacity for providing guidance to member states should be leveraged, the EU mandate (e.g., to including urban & spatial planning, road pricing) should be expanded, as necessary and effective, and political programs of hitherto disconnected departments must be converged (e.g., transport and environment, and energy). This responds to necessities demanded by science and citizens' rights warranted by EU Member State national constitutions[11,12], as recently and increasingly confirmed by constitutional courts. Such rulings signal the need for what could be called "climate turnaround realpolitik".

Such systemic policy making would help prepare industries and companies for new competitive dynamics as transport is decarbonized. It will be critical to avoid the creation of further stranded assets as already happened in the power sector. Such policy making would send clear signals to transition European's workforce towards skills and capabilities needed in a future low carbon, resource-efficient transport ecosystem.

NEXT STEPS: BRAVE AND AMBITIOUS POLICY INTERVENTIONS FOR SYSTEM CHANGE

It is now urgent that effective and systemic policy action is taken to create the fundamental enabling mechanisms for a decoupled transport system – one that provides the EU's societal needs for personal mobility, while rapidly transitioning to carbon neutrality and minimizing resource consumption. This requires an overhaul of existing legislative measures, reshaping economic incentives and removing harmful subsidies. The following five recommendations (see Figure 3) can guide EU policy-making to rapidly accelerate the sustainable mobility transition for people. Vehicle electrification is intentionally not included in these five policy measures, as progress is already well underway, driven by ambitious EU policy measures and market dynamics.[iv]

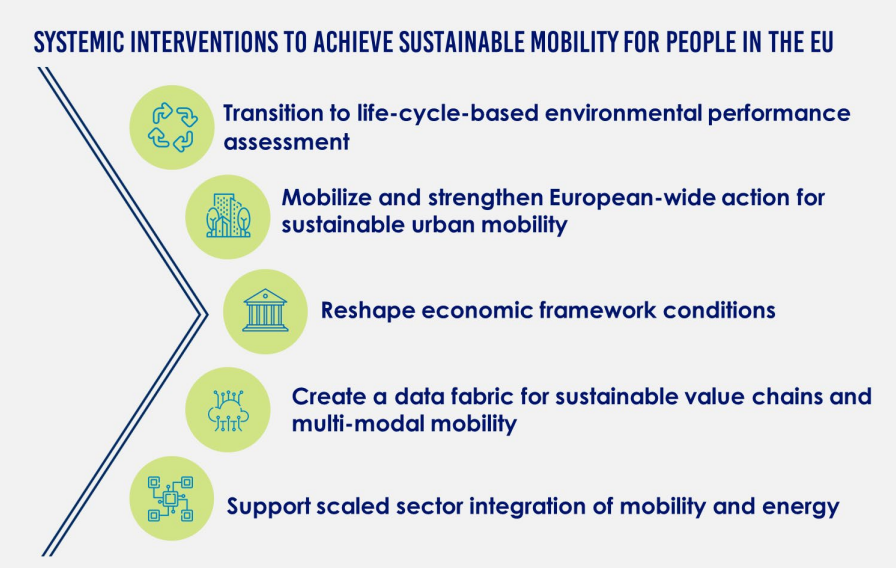


Figure 3: Overview of systemic interventions

1) Transition to life-cycle-based environmental performance assessment

Environmental performance assessment of vehicles should be based on life-cycle-based CO_2 assessments. This policy change is needed to avoid a shifting of emissions from the use phase to build and end-of-life phase, as BEV uptake accelerates: after all, this could increase the share of vehicle CO_2 emissions from production and materials from the current average of 20% to around 60% by 2030.[13] Such life-cycle-based assessments would result in beneficial outcomes in terms of resource use patterns, production processes, and end-of-life management as automotive players and material suppliers comply with the targets for life-cycle emissions. A life-cycle-based emissions assessment can also be conducted on a passenger kilometre basis which would incentivize higher vehicle utilization, allow comparability between different transport modes, and support rationale policy introduction. In the future, environmental assessments should go beyond CO_2 emissions and include resource use indicators.

[iv]Policy action for the acceleration of electrification includes, but is not limited to, stringent revision of CO_2 performance emission standards, integration of transport fuels in the EU ETS, and various types of subsidies for the purchase of BEVs. Moreover, market tipping points for BEV are almost reached: most OEMs and the majority of OECD member states already today have concrete plans for phasing out combustion engine vehicles in the next 10 – 15 years and cost parity between BEVS and ICEVs is expected to be reached before 2024. On the other hand, fuel cell electric vehicles are widely expected to achieve market shares in car sales of no more than 5% in the coming decades.

The Commission can facilitate:

- **Integrate disclosure of life-cycle-based CO_2 vehicle performance in the** upcoming revision of the **CO_2 performance standards for cars and vans** to prepare the legislation to incorporate full vehicle life-cycle emissions. In the future, streamline the CO_2 performance standards and the Battery Regulation's carbon footprint requirements in one life-cycle emissions performance policy.
- **Adopt the Battery Regulation proposal in its ambitious form**, in particular upholding the intended requirement for digital disclosure of recyclates content and location-specific product carbon footprints to kick-off life-cycle-based performance measurement for BEVs.
- **Identify possible policy options to allow for passenger-kilometre based mobility performance assessment** through a dedicated expert group. Such a tool would enable multi-mode comparison through providing accurate information on emissions per passenger-kilometre on varying scales of distances and hereby provide decision-support to policy-makers and users while avoiding the build-up of new, unsustainable transport offerings.

2) Mobilize and strengthen European-wide action for sustainable urban mobility

Besides the adjusting of framework conditions, a transition to more sustainable modes of passenger transport, especially in an urban context, requires on-the-ground action and incentives to change people's way of moving while improving the access, ease-to-use, and market entry for alternative mobility offerings. However, Europe's political toolbox to influence this is currently restricted due to the subsidiarity principle and limited ability to holistically use all types of political interventions. The European Commission must therefore use the newly revised Urban Mobility Package to execute and further expand its tools for wide-spread, effective sustainable mobility. These tools must target demand reduction for mobility in general and the improvement of circumstances for alternative forms of mobility, such as more active transport modes and collective mobility (e.g., public transport and shared mobility[14]). At the same time, European countries, regions, and cities must increasingly work together towards common goals that pave the way for more resource and carbon efficient urban movement.

The Commission can facilitate:

- **Utilize the Urban Mobility Package to advocate for new spatial planning approaches** that inherently reduce the demand for car-based travel. For example, **by providing further guidance and robust funding coupled to targets for member states and cities** to implement land use concepts that offer access to daily necessities without the use of a private vehicle (e.g., as done in Paris[i]); or by reducing the number of parking spaces for privately used vehicles.
- **Work with member states to ease remote working conditions and provide funding of ICT infrastructure for lower-income communities** with the goal to reduce work-related mobility demand reduction, while considering inequalities in telework access and mental health challenges.[i]

- **Promote the implementation of vehicle access regulations for European cities through the Urban Mobility Package to promote shared vehicle adoption.** Such measures can be the set-up of high-occupancy vehicle lanes (buses and cars), parking spaces dedicated to shared vehicles, or partially expanding zero emission areas with high-occupancy requirements.
- **Create conducive pricing systems together with the European member states** to use price signals as incentives to change people's mobility behaviour. This can be achieved through the utilization of VAT rates for sustainable products and services, by changing the pay scheme frequency between private and shared mobility to create a level-playing field, and increased financial incentives (e.g., higher registration taxes for high-emission vehicles).
- **Use the funding support in the Urban Mobility Package for the creation of progressive legal frameworks for passenger transport**, with a focus on paving the way for sustainable shared mobility solutions. Germany has recently renewed their passenger transportation act but still struggled to overcome traditional industry forces and remove barriers for mobility-as-a-service offerings (e.g., higher VAT for shared mobility and the so-called back-to-garage-rule).[i] Such policy revisions should be avoided to fast-track shared mobility adoption.

3) Reshape economic framework conditions

The fiscal incentives and conditions for companies and users of mobility are currently out of sync with the concept of a low-carbon, resource-friendly circular economy, as market failures lead to imperfect economic decision-making. Three key problems stand out here: unpriced negative externalities (e.g., CO_2 emissions or resource use), existing harmful subsidies (e.g., tax breaks for fossil fuels and company cars or public investments into fossil fuels) and the unleveraged potential of public procurement spending. EU policy-makers across decision-making levels and countries should therefore work together to create the right, complementary economic incentives that enable a large-scale sustainable mobility transition for people, both from a supply and a demand side.

The Commission can facilitate:

- **Implement an effective Carbon Border Adjustment Mechanism** including phasing out free allowances in the **EU Emissions Trading System** to ensure that the system effectively influences the uptake of circular materials and services. This requires a higher carbon price and removing exceptions so that costs are passed on across the manufacturing value chain to create the intended effects.
- **Work with member states to support collective action for revising company car taxation**.[i] Reduce incentives for the purchase of large and heavy cars and intensive individual car use while introducing more shared mobility options for employees and incentives for electrifying company fleets.
- **Co-create an EU expert group** that mobilizes member states **to shift income-based taxes to resources**[i] to reflect externalities in market prices and hereby enable competitiveness of labour-intensive circular products and services.

- **Remove subsidies and public investments for fossil-fuels and highways and re-direct these into enabling markets** for sustainable mobility. The COVID-19 recovery plans have failed to exclude all harmful subsidies.[i] EU policy-makers should continue negotiations with member states and companies to achieve green subsidies and investments (e.g. for bike lanes, shared mobility offerings and autonomous vehicles, multi-modal hub set-ups, battery recycling, etc.) based on an ambitious EU Taxonomy (for climate change mitigation and circular economy).
- **Channel public procurement into sustainable mobility by adopting new green public procurement criteria**. For example, public institutions can offer multi-modal mobility packages for employees, purchase only essential cars and these as low-emission vehicles with a certain amount of recycled materials, and repair of low-emission vehicles should follow a remanufactured-first principle.

4) Create a data fabric for sustainable value chains and multi-modal mobility

Sharing of standardized data between different stakeholders is a key requirement for the circular life-cycle management of materials, as well as better integration of various transport forms. In addition, policy tools rely on standardized, transparent data access to enable effective decision-making and threshold-related regulation. While various companies, cities, and multi-stakeholder initiatives have started own initiatives on data-sharing, the European Commission should now support the development of interoperable, cross-stakeholder vehicle life-cycle management platforms and multi-modal mobility data spaces. The EU Data Strategy[15] has set the right ambition for such developments: the set-up of a European Green Deal and Mobility data space will provide the required infrastructure for the needed data availability. The European Commission now has a critical role to play in ensuring these ambitions do not only promote economic value through data harvesting, but more importantly satisfy the requirements to make circular and multi-modal mobility a reality.

The Commission can facilitate:

- **Require the disclosure of essential data** for the life-cycle management of vehicle materials and multi-modal mobility platforms in the respective EU legislations. Especially the carbon footprint disclosure requirements set out in the Battery Regulation proposal should be adopted[i] and pan-European data sharing must be improved.[i]
- **Stipulate the development of interoperable, cross-company life-cycle management platforms and cross-country multi-modal mobility applications**. In the case of material life-cycle management, product passports should in the future be extended to cover the complete vehicle, including the battery.
- **Provide funding and guidance for the development of these data spaces** – ensuring the specific infrastructural set-ups and data collection requirements are well-suited for environmental performance assessment and improvement of resource and carbon efficiency.

5) Support scaled sector integration of mobility and energy

BEVs are an integral part of the power system as they are charged with and store electrical energy. Smart-charging (e.g., charging during phases with ample power generation capacity and avoiding charging during peak phases) and bi-directional charging (feeding power back into the grid as needed) of BEVS can help store and balance variable power supply. According to the Global Battery Alliance, smart and bidirectional charging (V1G and V2G) could provide

up to 65% of demand by 2030.[16] In doing so, it could create hundreds of dollars of economic value to the owner of an electric vehicle every year, thereby significantly lowering total cost of ownership. It could also lower costs for power grid updates for charging by up to 90%.[17] Benefits for climate protection are equally significant: the World Economic Forum estimates that smart and bi-directional charging of BEV could reduce as much as 2.6 gigatons of CO_2 annually by 2030.[18] However, power grids are not yet prepared to charge the upcoming large numbers of BEVs and are rarely technically capable of smart and bidirectional charging. In addition, regulatory conditions generally do not allow BEVs to be regular participants in power markets, effectively barring the corresponding business models from scaling.

The Commission can facilitate:

- **Enable smart and bi-directional charging** via the review of the Renewable Energy Directive, by establishing vehicles as market actors in the power markets, accelerating the uptake of smart charging infrastructure across the EU, completing the creation of a harmonized EU power market and taking public investments into smart charging infrastructure.
- **Support the expansion of vehicle smart-enabled charging infrastructure** via the review of the Alternative Fuel Infrastructure Regulation, especially for residential charging and public fast-charging for commercial operators and captive fleets, via direct public investments, incentives, revising planning processes, and generating harmonized standards.
- **Create a "right to charge" for captive fleets and commercial operators** of electric vehicles, to allow these actors to use the advantages in total cost of ownership of electric vehicles.
- **Mandate and support the creation of industry standards for technologies and technical protocols** for smart and bi-directional charging, in order to accelerate the dissemination of vehicles able to make use of smart and bi-directional charging.

In conclusion – The time is high to accelerate action for a low-carbon, resource efficient and circular transport system. The latest actions of the EU and member states to raise the climate targets to a chance to remain within a 1.5°C climate trajectory are applaudable. The above systemic approach intends to support this political drive by adding much needed facets for a more economically viable, ecologically sensible, and socially supportable transition.

We are looking forward to engaging with all decision makers from policy, industry, and civil society and sciences alike to bring about such a systems change for a joint prosperous future.

ENDNOTES

[1] The International Council on Clean Transportation, 2021, https://theicct.org/blog/staff/eu-carbon-budget-apr2021
[2] Circle Economy, Circularity Gap Report 2021, https://www.circularity-gap.world/2021
[3] https://ec.europa.eu/clima/policies/transport_en
[4] SYSTEMIQ and Club of Rome (2020), A System Change Compass, https://www.systemiq.earth/wp-content/uploads/2020/11/System-Change-Compass-full-report_final.pdf
[5] Ibid.
[6] 2° Investing Initiative (2°ii) Changing Gear: Alignment of major auto manufacturers with the goals of the Paris Agreement, https://2degrees-investing.org/wp-content/uploads/2020/06/Changing-Gear.pdf
[7] The International Council on Clean Transportation, 2021, https://theicct.org/blog/staff/eu-carbon-budget-apr2021
[8] Ellen MacArthur Foundation, Growth Within, 2015, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf
[9] International Council of Clean Transportation, 2020, Analysis of plug-in hybrid electric passenger car data confirms real-world CO2 emissions are two to four times higher than official values, https://theicct.org/news/press-release-PHEV-usage-sept2020
[10] Ricardo Energy Environment, Determining the environmental impacts of conventional and alternatively fuelled vehicles through LCA, 2020, https://ec.europa.eu/clima/sites/default/files/transport/vehicles/docs/2020_study_main_report_en.pdf
[11] Natlaw Review, Major Developments in EU and German Climate Change Legislation, 2021, https://www.natlawreview.com/article/major-developments-eu-and-german-climate-change-legislation#:~:text=The%20Federal%20Constitutional%20Court's%20ruling,Climate%20Change%20Act%20partially%20unconstitutional.&text=These%20key%20points%20include%20a,by%202045%20instead%20of%202050.
[12] New York Times, Shell Must Reduce Emissions, Dutch Court Rules, 2021, https://www.nytimes.com/2021/05/26/business/royal-dutch-shell-climate-change.html
[13] World Economic Forum, Raising Ambitions: A new roadmap for the automotive circularity, 2020, https://www.weforum.org/reports/raising-ambitions-a-new-roadmap-for-the-automotive-circular-economy
[14] UN IRP, Resource Efficiency and Climate Change, 2020, https://www.resourcepanel.org/reports/resource-efficiency-and-climate-change
[15] European Commission 2020, A European strategy for data, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN
[16] Global Battery Alliance (2019), A Vision for a Sustainable Battery Value Chain in 2030, http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf
[17] IRENA (2019), Innovation Outlook Smart Charging for Electric Vehicles, https://www.irena.org/publications/2019/May/Innovation-Outlook-Smart-Charging
[18] Global Battery Alliance (2019), A Vision for a Sustainable Battery Value Chain in 2030, http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf