Greening Transport Infrastructure: The Role of EU Regulation, Financing and Taxation

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The renewed interest in infrastructure spending as a means to foster job creation and economic recovery in the aftermath of COVID-19 presents a unique opportunity to accelerate Europe's transition towards climate neutrality. As both contributors to climate change and victims of its consequences, transport infrastructure assets are an illustrative example of the multiple angles greening can take throughout the different phases of an infrastructure's lifespan, from planning to construction, operation and decommissioning. The highly interdependent nature of these phases underscores the need for a holistic approach to greening of infrastructures. This article examines, in particular, the ability of infrastructures to serve as enablers for wider sectoral, but also cross-sectoral, greening, and argues that this function can and should be amplified by means of a conducive and coherent EU regulatory, financing and taxation framework, which engrains sustainability at its core.

Confronting the dual challenges of decarbonisation and economic recovery post-COVID-19

The free movement of people and goods across national borders is a fundamental freedom of the European Union (EU) and its single market. The transport sector contributes 5% to the European Gross Domestic Product (GDP) and directly employs around 10 million workers, making it decisive for economic development, as well as for the social well-being and cohesion of populations (European Commission, 2020). However, reaping these benefits depends on the existence of adequate infrastructure, which supports the provision of high quality and efficient transport services. Already back in 2011, the European Commission's Roadmap to a Single European Transport Area – Towards a competitive and resource-efficient transport system acknowledged that '*Infrastructure shapes mobility. No major change in transport will be possible without the support of an adequate network and more intelligence in using it. Overall, transport infrastructure investments have a positive impact on economic growth, create wealth and jobs, and enhance trade, geographical accessibility and the mobility of people. It has to be planned in a way that maximises positive impact on economic growth and minimises negative impact on the environment*'.

More recently, the European Green Deal set the ambition of transforming Europe into the world's first climate neutral continent by 2050: a commitment, which places a particular responsibility on the transport sector and the infrastructures it relies on. A collective 90% reduction in CO_2 emissions will need to be achieved by mid-century from the transport sector, which today accounts for a quarter of the EU's total greenhouse gas (GHG) emissions. The Commission's subsequent Sustainable and Smart Mobility Strategy reiterates that '*greening mobility must be the new license for the transport sector to grow*' (European Commission, 2020).

In parallel to facing growing pressures to decarbonise, the transport sector and its underlying infrastructure assets have undoubtedly been among the worst hit by the COVID-19 pandemic. Because of the crisis, significant public funds have been channelled towards struggling businesses, such as public transport operators, hit by persisting drops in ridership. While this has meant that less funding is available for spending on new projects, the pandemic recovery measures proposed by governments worldwide, have been characterised by a renewed interest in infrastructure spending as a means to boost economic growth. For instance, whereas US president, Joe Biden, has pledged to spend $2 trillion on roads, electricity grids and railways, the EU has announced that 30% of its €750 billion recovery fund will be dedicated to green projects, including renewable energy and electric vehicle recharging infrastructure. In fact, spending on climate-resilient infrastructure is found to create five times more jobs per $1 million invested than spending on fossil fuels (UNEP, 2021). The greening of infrastructure assets is thus not only a strategic post-COVID-19 recovery measure, but also presents a unique opportunity for governments to accelerate the transition towards climate neutrality.

Transport infrastructure and its tight link to the environment

Transport infrastructure, be it publicly or privately owned, consists of the physical structures, such as highways, railways, bridges, tunnels, airports and ports, among others, which enable the provision of transport services, vital to facilitating, sustaining, or improving the

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social condition of living (Hossain, 2019). In addition, infrastructure can encompass the facilities necessary for the propulsion and refuelling of transport vehicles, as well as the coordination, monitoring and management of transport to ensure safe operations and the transfer of passengers and freight (European Commission, 2017). In other words, transport infrastructure is an integral part of the overall transport system, regardless of the transport mode in question.

The construction of new infrastructure, the upgrading of existing but also the eventual decommissioning of infrastructure, entail significant investment, often rely on the use of carbon-intensive materials, and lead to negative impacts on the environment, such as health-damaging air- and noise pollution, the release of CO_2 emissions, the generation of waste, as well as damage to local wildlife habitats and water bodies. While the distinction between the GHG emissions attributable to the different phases of an infrastructure's lifetime may not always be straightforward, it should be noted that the vast majority of emissions arise from the operation of the infrastructure, i.e., emissions stemming from vehicles using the infrastructure in question (European Commission, 2017).

At the same time, their fixed nature makes infrastructures particularly prone to the consequences of climate change. To recall, the Intergovernmental Panel on Climate Change (IPCC) estimates that if GHG emissions continue on a business-as-usual trajectory, global sea-levels could rise by one meter by the end of this century (IPCC, 2019). This, in turn, could entail particularly high risks for airports, many of which are located near large bodies of water. In fact, according to the World Resources Institute, 80 airports worldwide could be underwater if current emission trends continue. It goes without saying that such a scenario would have detrimental socio-economic and connectivity implications. The environmental and climatic impacts of infrastructures, coupled with their particular vulnerability to the consequences of climate change, underscore the need to incorporate sustainability and resilience throughout the entire lifecycle of transport infrastructures.

The different angles to the greening of transport infrastructure

Those infrastructures, which are conducive towards a zero-emission transport sector will have to be enhanced (e.g., bolstering public transport and micro-mobility infrastructure), while other, polluting infrastructures, will have to be restructured or entirely replaced by new types of infrastructures, which are in line with the net-zero emissions trajectory.

There are multiple angles to the greening of transport infrastructure. Firstly, greening may focus on measures to minimise the emissions embedded in construction and arising from maintenance. This, in turn, may take the form of using less CO_2-intensive, recycled and recyclable materials, boosting the energy efficiency of physical assets, and the installation of photovoltaic (PV) facilities onsite, among others. Subsequently, greening measures can also be applied at the end of an infrastructure's lifespan to ensure that its decommissioning has a minimal impact on the environment. Some ageing infrastructure, such as oil and gas platforms, wells and pipelines, for instance, can be repurposed for CO_2 transport and storage, thereby possibly helping to reduce the hefty upfront costs linked to the development of Carbon Capture and Storage technology. Furthermore, the integration of circular economy principles in the initial design process can later enhance resource recovery during decommissioning. Conversely, poorly designed infrastructure can lead to high long-term maintenance or replacement costs during operation and may have implications for decommissioning (UNEP, 2021). This interdependence between the different life phases of infrastructure assets calls for a holistic approach to their planning, financing and regulation.

What is more, infrastructures can have a much larger, albeit indirect, contribution towards overall emission reductions by inducing their users to shift towards more sustainable modes and practices. While highways, for instance, cannot be considered 'green' infrastructures per se, they can help advance broader decarbonisation objectives if linked to a credible sustainability plan. Carefully designed road charges, for example, can serve as an instrument to stimulate the uptake of zero-emission trucks, and conversely, to discourage polluting ones. Furthermore, highways and core networks can be equipped with electrical charging points to promote the uptake of electric mobility. The ongoing review of the Commission's Alternative Fuels Infrastructure Directive (2014/94/EU) offers a significant opportunity to ramp up the deployment of an interoperable publicly accessible recharging infrastructure, along the trans-European transport network (TEN-T), urban and sub-urban areas, with a view to reaching the targeted 1 million public recharging points by 2025 (European Commission, 2019).

In a similar fashion, airports can provide synergies for the entire aviation value chain, from ground handlers to airlines, suppliers of sustainable aviation fuels (SAFs), and innovative technologies manufacturers. Though indirectly, airports can stimulate the uptake of new aircraft technology related to electrification or hydrogen by securing the appropriate airport infrastructure, associated services, and, not the least, by setting the right incentives. To this end, airports can make use of several instruments at their disposal to incentivise cleaner and quieter aircraft, including airport charges, incentives, operational rules, and slot regulations. Many airports are already modulating the charges paid by airlines based on environmental criteria, for example, by reducing charges for aircraft producing less noise and emitting fewer air pollutants (Finger, Serafimova and Montero, 2021). This ability of infrastructures to serve as 'enablers' for wider sectoral, but also cross-sectoral, greening can and should be amplified through an overarching EU regulatory, financing and taxation framework, which, in turn, is discussed below.

Linking investment decisions to robust sustainability indicators

Their capital-intensive nature, coupled with the long operational lifetimes of transport infrastructure, means that regulatory and investment decisions taken today will have implications for the decades to come. Indeed, the built environment is constrained in how quickly it can change. This is further complicated by the fact that different transport modes and infrastructures have different life spans (Rodrigue, 2020). To put things into perspective, while it could be possible to renew the bulk of the car fleets with more efficient vehicles within a decade, road infrastructure could take as much as a quarter of a century to replace (Rodrigue, 2020). In the spending-cautious aftermath of COVID-19, this places a particular responsibility on investors and infrastructure planners to ensure their decisions not only improve the quality and resilience of the transport system, but also help to advance the EU's climate and sustainability objectives.

All new infrastructure construction, expansion and decommissioning will have to be clearly justified and preceded by comprehensive environmental impact assessments. The planning phase for new infrastructure has till now primarily focused on the emissions stemming from the initial construction phase, whereas the lifecycle GHG emissions, including those arising from operations, maintenance and subsequent decommissioning of infrastructure, have not been consistently factored in (European Commission, 2017). The inclusion of lifecycle emissions is key to securing the most accurate assessment of infrastructure projects' environmental performance. Here, it is also essential to distinguish between short- and long-term considerations pertaining to infrastructure-related investments. In other words, whereas infrastructure construction projects can be particularly emission-intensive in the short run, they can deliver substantial emission reductions in the long run. One illustrative example of this is high-speed rail, which is likely to grow in significance as the aviation sector undergoes restructuring and short-haul flights are increasingly replaced by rail. Under most circumstances, investment in high-speed rail reduces GHG emissions from traffic compared to a situation where the line was not built, but the reduction may initially be small, and it could take decades for it to compensate for the emissions caused by construction.

In view of this, the definition of common international rules for assessing the environmental performance of infrastructure projects is of crucial importance in guiding scarce financial resources towards 'green investments' and, equally important, in preventing 'stranded assets'. A first step in this regard was already taken in the EU, with the entry into force of Regulation (EU) 2020/852 (the so-called 'Taxonomy Regulation'), which seeks to provide uniform criteria for companies and investors to determine whether an economic activity is to be deemed 'environmentally sustainable'. The Taxonomy covers activities responsible for up to 80% of the EU's GHG emissions. As such, it may play an important role by setting performance thresholds for these activities, thereby informing investors' decisions and preventing greenwashing (Schuetze and Stede, 2020).

Having said that, it is of utmost importance that a robust and science-based approach is applied in establishing the criteria, which the Commission is set to finalise in the coming months. This, in turn, will be instrumental in determining whether pending EU and national fiscal recovery packages foster the development of a more integrated, smarter and sustainable mobility system. A number of existing EU funding programmes, such as the Connecting Europe Facility (CEF) and the Cohesion Funds, including the European Regional Development Fund, already support the construction of transport infrastructure between and within EU countries. It is equally critical that this public funding supports the development of climate-proof infrastructure projects.

Local authorities, in particular, are central investors in green infrastructure, such as buildings, transport, water and waste. While private sector investment and technical expertise will be increasingly needed to close the infrastructure gap, public policy and procurement of infrastructure, have a key role in channelling investment into sustainable infrastructure projects and creating positive impacts on the ground. Today's procurement practices and tender specifications, however, do not always provide the necessary incentives for industry actors to invest in zero-emission technologies and infrastructures. The recast of EU regulatory frameworks to introduce minimal environmental standards will be key. More specifically, the shift away from procurement practices which prioritise the lowest-cost bid will be needed towards ones that consider life-cycle costing, including the costs of environmental emissions and other externalities over the entire infrastructure lifecycle. Furthermore, the Commission's ongoing efforts to develop a common EU framework for sustainable urban mobility indicators (SUMI), stands to not only enable cities to better evaluate the performance of their mobility systems, benchmark and replicate best practices, but also ensure that funding is channelled towards sustainable mobility projects.

Getting users and polluters to pay the true environmental cost

The cost of providing transport infrastructure is paid either directly through user charges or indirectly through taxation. In closed systems, namely railways and aviation, transport users pay for the use of infrastructure as a part of their overall transport charge (e.g., ticket price). For open systems, such as road, on the other hand, there is either no direct infrastructure charge or the infrastructure charge is levied directly to the user in the form of a toll.

There is a long-standing agreement that transport charges and taxes must be restructured so as to ensure the implementation of the 'polluter-pays' and 'user-pays' principles. The Commission's recent Sustainable and Smart Mobility Strategy sets out that all external costs of transport within the EU shall be covered by the transport users at the latest by 2050. The provision of cost-reflective price signals is considered the most effective incentive mechanism to influence more sustainable transport user choices. Such incentives can include carbon pricing, taxation, and infrastructure charging but should be complemented by improved information to users (European Commission, 2020). Pricing can facilitate the switch to cleaner vehicles, optimise capacity utilisation, and manage demand, thereby reducing congestion during peak hours. Adequately designed infrastructure charging (e.g., road tolls) can foster the creation of a level playing field between the different modes and fuels while generating a source of revenue for the public budget for the cross-financing of railways and other green infrastructures.

Notwithstanding, infrastructure charging, financing and taxation frameworks in the EU today fall short of promoting decarbonisation. While best practices can be observed, infrastructure charging approaches are not homogeneous across modes or countries, whereas some European countries are not imposing any road charges at all (European Commission, 2017). The ongoing revision of the Eurovignette Directive (1999/62/EC) is an opportunity to address this by putting in place a uniform approach to road charging Europe-wide. Smart, distance-based road charging, with varied rates for the type of vehicle (based on CO_2 performance, air pollutants) and the time-of-use, can effectively incentivise efficient choices, manage traffic and reduce congestion (European Commission, 2020).

While green infrastructure projects may be linked to lower operational costs, they often entail higher upfront costs, which, in turn, raises questions pertaining to how these additional costs of greening should be financed. The concept of charging for environmental purposes can be unpopular, and social acceptability issues can risk hampering fiscal reforms in the road sector for instance, as these oftentimes result in a disproportionate burden for the working and middle classes. The introduction of charges will thus have to be preceded by careful planning and design, complemented by awareness-raising campaigns among taxpayers as well as measures to enhance transparency and accountability in revenue use.

Cross-sectoral policy coherence

The design and implementation of coherent, cross-sectoral policies can enable infrastructures to stir the greening beyond their own sector. One illustrative example of such cross-sectoral greening is the installation of electric charging infrastructure in buildings, which entails close interactions between several sectors, namely transport, buildings and energy. The latest revision of the Energy Performance of Buildings Directive (2018/844/EU) introduced new provisions to ensure that parking spaces in residential and commercial buildings are progressive-

ly equipped with recharging points for electric vehicles. This stands to offer synergies for the progressive greening of all three sectors by encouraging the uptake of cleaner mobility, optimising energy efficiency in buildings, and reinforcing electricity grids.

Transport infrastructure and energy networks have historically been designed independently yet are wholly interdependent for many years of subsequent operation. Sector coupling is increasingly observed both within sectors (e.g., Mobility-as-a-Service) as well as across sectors (e.g., the coupling of transport and energy with the growing penetration of electricity and hydrogen-based powertrains). These trends bring about additional challenges related to regulatory approaches and regulatory bodies and call for the enactment of appropriate incentive schemes, be these financial or reputational, so as to ensure that infrastructure is designed in a way that allows it to interact synergistically with its environment. In particular, within the transport sector, improvements in inter-modality, interoperability, and integration of transport systems would facilitate the greening of the transport by favouring a shift to the most appropriate mode, reducing congestion, and improving efficiency and coordination in the use of the infrastructure.

One key challenge to the greening of infrastructures will be to ensure a systemic approach and coherence across the different EU legislative pieces, from the EU taxonomy and State aid guidelines to ongoing efforts to internalise the external costs of transport and implement effective charging for infrastructure use, among many others. The future regulatory framework needs to reflect the fact that transport infrastructures are complex systems of interrelated facilities and assets, which, in turn, has important implications for the assessment and regulation of their sustainability performance.

Digitalisation can provide a means to better coordinate these increasingly complex and interrelated systems, and as such facilitate sector coupling. Importantly, digital tools in transport can enable more flexibility and better operational practices thereby optimising the utilisation of existing capacity. For example, smart mobility systems which make efficient use of data on mobility patterns and integrate multiple transport options, including both individual mobility and mass transit, can help to improve network management, traffic congestion, accessibility and environmental performance. This, in turn, can also help to reduce investment needs into new physical infrastructure and support infrastructure greening objectives.

Conclusions

The greening of transport infrastructures can strengthen systems' resilience to climate change and support the transition to a low carbon economy, while also stimulating economic growth. In view of this, the increased appetite for infrastructure spending in the aftermath of COVID-19 presents a strategic opportunity for policymakers and investors to accelerate Europe's transition towards climate neutrality.

A range of greening measures can be applied throughout the typically long lifetimes of infrastructure assets, including the reduction of emissions embedded in construction and maintenance, those stemming from infrastructures' operations, but also at the end phase of infrastructures' lifespan, when they are undergoing decommissioning. Though possibly decades apart, the different phases – design, construction, operation and decommissioning – are highly interdependent and thus need to be regulated holistically.

Infrastructures can play a pivotal role in overall emission reductions by supporting their users as well as other operational stakeholders along the value chain in their greening efforts. This ability of infrastructures to serve as 'enablers' for wider sectoral, but also cross-sectoral, greening needs to be amplified by means of a conducive EU regulatory, financing and taxation framework, which engrains sustainability throughout the entire lifecycles of infrastructures.

All new infrastructure construction, expansion and decommissioning will have to be preceded by comprehensive environmental impact assessments, which take into account lifecycle GHG emissions. To this end, the development and coherent application of common science-based rules for the measurement and assessment of infrastructures' environmental performance will be paramount in stirring investments towards climate-neutrality compliant projects. In line with this, cost-reflective pricing and charging will be key to informing both investor and consumer decisions. Transport charges and taxes will have to be restructured so as to ensure the internalisation of external costs in a socially just manner. Last but not least, all of these policies and regulations will have to be implemented in a coherent manner, which reflects the growing coupling within and between sectors, and allows for mutually-reinforcing greening efforts.

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