

# Transport decarbonisation in Romania: Beyond best practices national technical report

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# Summary

This national technical report analyses passenger transportation in Romania and highlights its significant contribution to carbon emissions. The transport sector's per capita emissions have nearly doubled between 2000 and 2019, primarily driven by the increasing share of passenger cars. While multiple plans exist to regulate emissions, the integration of climate concerns into national strategies remains inadequate. The National Energy and Climate Plan (NECP) sets targets for reducing transport emissions, including a goal to achieve a 14.2% share of final energy consumption from renewables by 2030. However, the General Transport Master Plan and the Recovery and Resilience Plan lack clear decarbonization targets and only touch on environmental aspects vaguely.

To address these challenges, this report suggests implementing best practices that are applicable to the Romanian context. These practices include supporting rail infrastructure by expanding hydrogen trains and night train services, as well as increasing the electrification of metro and regional trains. Improving cycling infrastructure and implementing Low Emissions Zones are also recommended measures to reduce car emissions. By adopting these practices and enhancing the integration of climate concerns into national strategies, Romania can work towards a more sustainable and low-carbon transportation system that aligns with its environmental goals and contributes to reducing carbon emissions.

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# Introduction

Passenger cars make up around 65% of passenger mobility in Romania and are a significant driver of the country's carbon emissions. Due in large part to the rising share of passenger cars, the transport sector's per capita emissions doubled between 2000 and 2021, reaching 763 kgCO<sub>2</sub> per capita in 2021. Multiple plans exist which set out the national strategy for the transport sector, including the NECP as the main policy regulating emissions. The NECP adopted in 2020 contains a range of measures to reduce transport emissions, of which the headline target is to achieve a 14.2% share of final energy consumption in the sector from renewables by 2030. Other key measures include facilitating a shift towards rail and supporting low emission vehicles (LEVs) through tax incentives. However, climate concerns are not sufficiently integrated across national strategies. The General Transport Master Plan and the Recovery and Resilience Plan touch on environmental aspects but do so vaguely and without clear decarbonisation targets.

Through an assessment of Romania's transport governance and the drivers of transport emissions, best practices are suggested which can be applied to the Romanian context. These include measures which support rail infrastructure, such as expanding the number of hydrogen trains and night train services, as well as increasing the electrification of metro and regional trains. Other selected practices include improving cycling infrastructure and reducing car emissions through Low Emissions Zones.

# Transport governance

Three core documents lay out the Romanian government's transport strategy until 2030. These are its NECP, which focuses specifically on environmental objectives, the General Transport Master Plan, and the Recovery and Resilience Plan. While the latter two documents cover impact transport sector emissions, neither integrate emissions reductions targets in any meaningful way. Nevertheless, they represent the Romanian government's transport strategy for the next decade, and so all three are the transport sector's central legislative pillars going into the medium term.

## National Energy and Climate Plan (2021-2030)

The Romanian NECP adopted in 2020 aims to be the framework policy that casts a net over all transport emissions in Romania toward 2030, including those from passenger transport. The plan acknowledges that although technology and EU policies have a role to play in slowing down the increase in transport emissions, additional measures are required to foster a change in transport behaviour, enhance people's options and reach the Effort Sharing Regulation (ESR) emissions target set for Romania (covering road transport, agriculture, buildings, waste and small industry) of emissions reduction by 2% between 2005 and 2030, a target which is poised to increase following the adoption of the EU's Fit for 55 package (Romania, 2020). In order to cut EU-wide emissions by 55% by 2030 in line with Fit for 55, Romania's proposed updated target will be a 12.7% cut in ESR emissions by 2030 (Council of the European Union, 2023). However, the plan falls short of providing a detailed description or quantification of measures and policies, such as implementation details and a timeline. Measures described in the plan that influence passenger transport lack environmental performance criteria and concrete data in terms of emissions savings.

Through the NECP, Romania aims to achieve a 14.2% share of renewables in the transport sector's final energy consumption by 2030. To put this in context, the 2020 starting point was 7%, primarily conventional biofuels, whereas renewable electricity in transport accounted for around 1.5% of final energy consumption (Romania, 2020). The methodology for calculating the trajectory past 2020 takes into account the multipliers set out in the Renewable Energy Directive and the current planned measures are unambitious. Since the ESR target for Romania will be set higher, all measures and policies must be adjusted to reach the updated target.

The plan sets out several policies and measures aimed at curbing emissions from passenger transport and impacting mobility. Firstly, emissions from passenger transport can be reduced by developing infrastructure for alternative fuels. This development can occur through supporting stakeholders to invest in electromobility infrastructure, imposing an attractive tariff for new applications in the electricity area, and fostering investments in RES infrastructure, energy efficiency, and electromobility. The plan also promotes development of production and of the infrastructure required for penetration

of alternative fuels, including LPG, CNG and LNG through measures such as streamlining the legislative framework, financial instruments and infrastructure investments.

Specific to road transport, the plan proposes a bonus-malus approach to car park renewal, through the continuation of current scrappage schemes. The plan also seeks to ban cars up to Euro 4 from registration, and introduce environmental fees to limit the purchase of used vehicles. Promoting the use of conventional and advanced biofuels in road transport by fostering investments in co-processing installations and refineries and in advanced ethanol production can also reduce emissions in the passenger transport sector. Additional ways to reduce emissions include: increasing the annual cost of ownership of motor vehicles for non-euro, Euro 1 and Euro 2 motor vehicles, restricting traffic of conventionally fuelled vehicles in city centres in order to improve air quality, and developing the cycling infrastructure.

The plan also seeks to encourage rail transport over road transport, which can be accomplished by increasing rail passengers through investments in infrastructure, equipment and intermodal terminals. These infrastructure investments can take the form of developing and extending the underground network and improving service quality by purchasing new low-consumption trains, modernising existing infrastructure, increasing accessibility of metro stations (passageways, access points, escalators, elevators), adapting traffic schedules by correlation with passenger traffic, integrating charging system with above ground public transport and arranging Park&Ride access at the end of routes. Furthermore, Romania can develop smart digital systems for road and rail traffic management as well as for urban transport management. In terms of mobility, the plan seeks to promote electromobility through continued subsidies for electric and hybrid cars, tax reductions and exemptions for the purchase and use of electric and hybrid vehicles, particularly for companies' fleets, and the introduction of special traffic lanes for both public transport and electric vehicles. Overall, the plan's goal is to increase the public transport usage rate by optimising public means of transport (buses, trolleybuses, tramways) and the necessary infrastructure for their good operation.

## General Transport Master Plan (2016-2030)

The Master Plan gives an overview of the Romanian transport system as it was in 2014 and its impact on the environment in different sectors. The plan sets out to increase national and transnational connectivity for society and the business sector. Its stated objective is the implementation of a transport system that is safe, efficient, sustainable and with a low environmental impact by developing the transport infrastructure along the Trans European Transport Network (TEN-T network) and modernising existing transport infrastructure. The plan outlines and prioritises infrastructure development projects, considers potential projects with available financial resources, and establishes the mechanisms for the implementation of selected projects (European Parliament. Directorate General for External Policies of the Union., 2015).

The plan aims to improve road connectivity between the main centres of economic growth in Romania, increase the attractiveness of rail transport by modernising rail infrastructure and developing services, grow the volume of freight and passengers transported on waterways by developing port infrastructure and routes along the Black Sea, the Danube and other waterways, increase the number of air passengers and freight by developing airport infrastructure and establishing new national and international routes and develop multimodal services by expanding regional multimodal infrastructure.

However, the environmental objectives are vague, and no clear targets are stipulated. The document notes transport projects with limited impact on the environment should be prioritised, but no concrete guidelines or indicators are offered. In terms of road transport, the plan mentions overall poor road conditions, rise of fuel consumption, rise of greenhouse gas emissions, high accident risks, high noise pollution, low traffic fluidity. Romania has 10,000 km of rail infrastructure, but only 37% is electrified, well below the EU average of 52% (European Parliament, 2015). The challenges identified in rail transport are low speeds, lack of recent investments, high fuel consumption and speed restrictions.

## Recovery and Resilience Plan (2021-2026)

The Recovery and Resilience Plan is set for the period through 2026 and is required under the Recovery and Resilience Facility of the EU to access funding for post-COVID-19 economic recovery. Romania's transport infrastructure is undersized, polluting and poorly maintained, with urban nodes that have poor connectivity to transport networks and a lack of inter-modality (European Commission, 2022b).

Railway investments include modernisation along two TEN-T Core and Comprehensive networks (signalling upgrades and electrification), and quick-win investments prior to modernisation to ensure safe operation on intensely circulated routes and acquisition of hydrogen and electric motors. In terms of reforms, the plan includes a target for the adoption of a rail development strategy for the years 2021-2025. The Plan aims to increase the efficiency of green urban mobility by developing metro transport through the acquisition of electricity consumption management systems, acquisition of new rolling stock and construction of new metro lines in the Bucharest-Ilfov and Cluj region.

In terms of horizontal implications, the planned investments partially contribute between 40-100% to the green transition by financing newly built or rehabilitated railways, green urban transport infrastructures and green rolling stock. Also, the planned investments covers 100% costs of the digital transition by financing the digitization of transport, the European rail traffic management system (ERTMS) and urban transport. The plans stipulates that the principle of not significantly damaging the environment must be carefully monitored.

The plan identifies several key road transport issues:

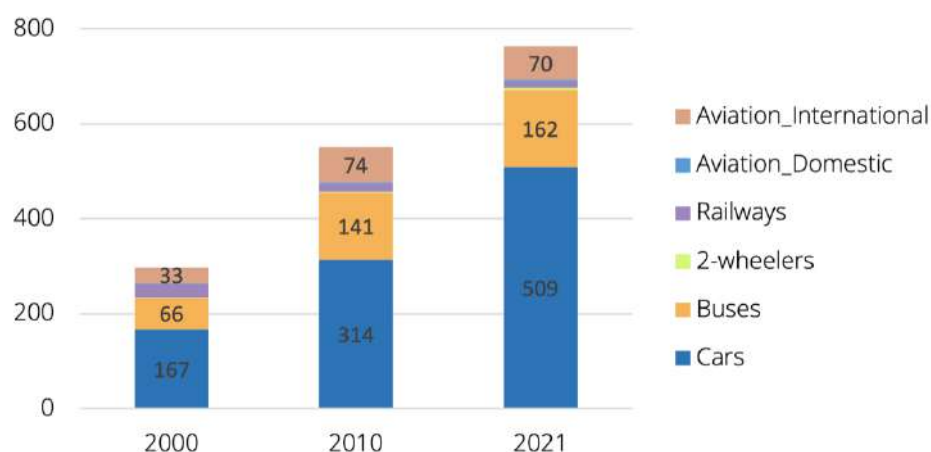
- Poorly developed transport infrastructure (with many single-lane roads) contributes to increased environmental pollution and an alarming number of road accidents.
- Urban nodes have low connectivity to transport networks, especially trans-European ones, and intermodality is lacking, all leading to traffic congestion, and low mobility for the population and the economy
- The lack of adequate traffic management systems has a negative impact on travel times.

The plan identifies several reforms and investments related to roads and motorways infrastructure. Investments should be more efficiently implemented and administrative capacity should be increased to oversee this. Green and digital policies and technologies in the transport sector should be introduced, including intelligent traffic management systems, road signs and signals. The taxation and control framework should be further developed and include integrated road control systems and charging based on the “polluter pays” principle.

# Romanian modal split and passenger transport emissions in numbers<sup>1</sup>

The total passenger activity in Romania has risen steadily over the past two decades from 86 billion passenger kilometres (pkm) in 2000 to 150 billion pkm in 2021 – an increase of 102%. Most of this increase took place after 2013 and accelerated in 2017 and 2018. Emissions from passenger transport increased faster than activity levels - by 157% between 2000 and 2021. During the same period, per capita emissions from transport in Romania have more than doubled from almost 300 kgCO<sub>2</sub>/capita to 760 kgCO<sub>2</sub>/capita.

**Romania passenger transport emissions 2000, 2010, 2021**  
(in kgCO<sub>2</sub> per capita)



*Figure 1 Romania passenger transport emissions*

Travels by car were the main driver of higher mobility rates. Between 2000 and 2021 activity levels from passenger cars increased from 2,271 kilometres per person to roughly 5,400 and satisfied 67% of mobility needs. At the same time, passenger cars saw a decrease in vehicle occupancy rates, moving from 2.49 persons/vehicle in 2000 to 1.71 persons/vehicle in 2021. Emissions intensity of passenger cars remained stable at between 180-190 gCO<sub>2</sub>/vkm until 2009, before decreasing to 161 gCO<sub>2</sub>/vkm in 2021.

<sup>1</sup> The data provided in this section have been calculated using the Transport Emissions Disaggregation Tool (TEDiT). Climate Analytics (2023). Transport Emissions Disaggregation Tool. Retrieved from <http://tools.climateanalytics.org/tedit/>

## Romania modal split 2000 (left) and 2021 (right)

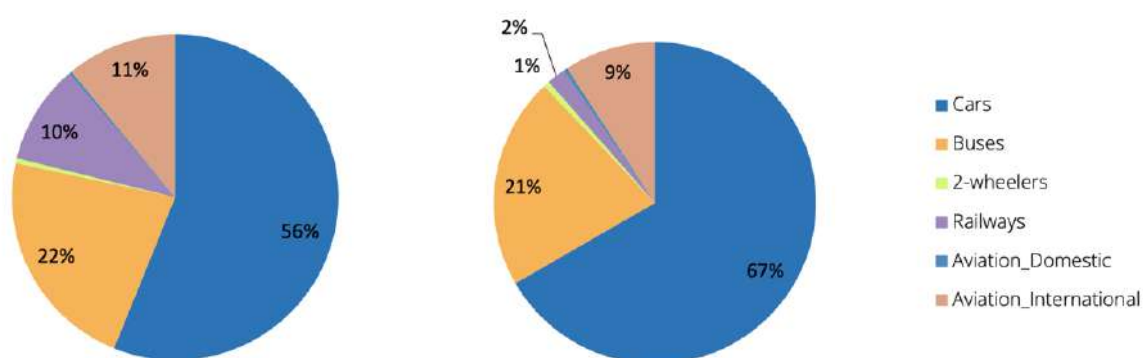


Figure 2 Romania modal split

Motorcycles represent a very small portion of overall mobility in Romania, with less than 70 pkm per capita annually in 2021. Emissions intensity has decreased between 2000 and 2021 from 142 gCO<sub>2</sub>/vkm to 84 gCO<sub>2</sub>/vkm.

## Romania passenger cars emissions and mobility (as % of total)

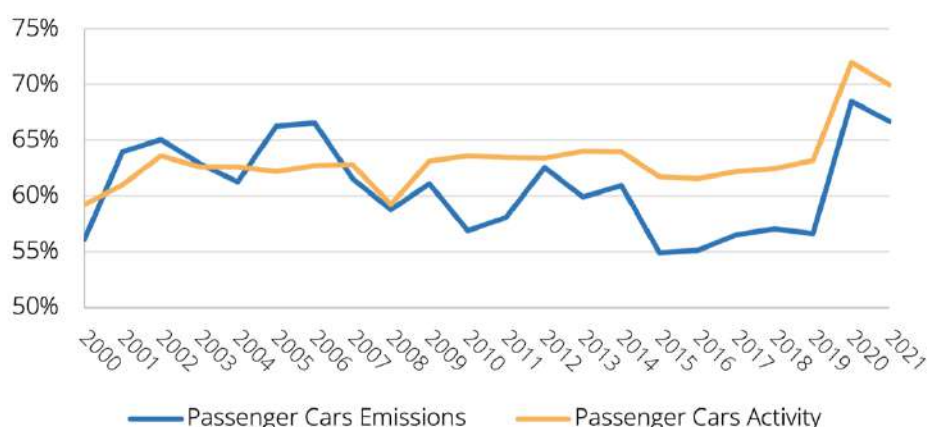


Figure 3 Passenger cars emissions vs. mobility

Romania differs from other countries in terms of the trends for activity level for buses: in the analysed period the average distance travelled by bus annually increased and reached 939 km per capita in 2021. Although pre-pandemic levels were higher, at roughly 1,300 km per capita in 2019, overall higher levels in 2021 as opposed to 2000 were not seen in most other countries of Eastern Europe. As a result, the share of buses in overall mobility increased from 9% in 2000 to 12% in 2021. Bus load factor remained the same, at roughly 9 pkm/vkm. On the other hand, the emissions intensity from buses has also declined – from above 1,800 gCO<sub>2</sub>/vkm to slightly below 1,500 gCO<sub>2</sub>/vkm. As a result, the share of overall emissions from this mode of transport increased much slower than the contribution to mobility demand. However, buses in Romania are among the most emissions intensive in the EU.

Between 2000 and 2021 the utilisation of railways in Romania decreased from 518 to 220 pkm per capita. When combined with a significant increase in overall mobility levels, as a share of total mobility railways have dropped over 10% from 13.5% in 2000 to 2.75% in 2021. Emissions intensity of railways has almost halved over this period, but remains relatively high at nearly with almost 4,500 gCO<sub>2</sub>/vkm indicating a low level of electrification.

For subways and trams, the activity levels increased from 267 pkm per capita in 2000 to 296 pkm per capita in 2021, slightly higher than pre-pandemic levels of around 250 pkm per capita.

Domestic aviation in Romania has been increasing, from 3 pkm per capita in 2000 to 13 in 2021. While domestic aviation has only 0.2% share of overall domestic activity, due to the high emissions intensity of this mode of transport, it is responsible for 0.4% of emissions from the passenger transport sector.

### International aviation emissions and mobility (as % of total)

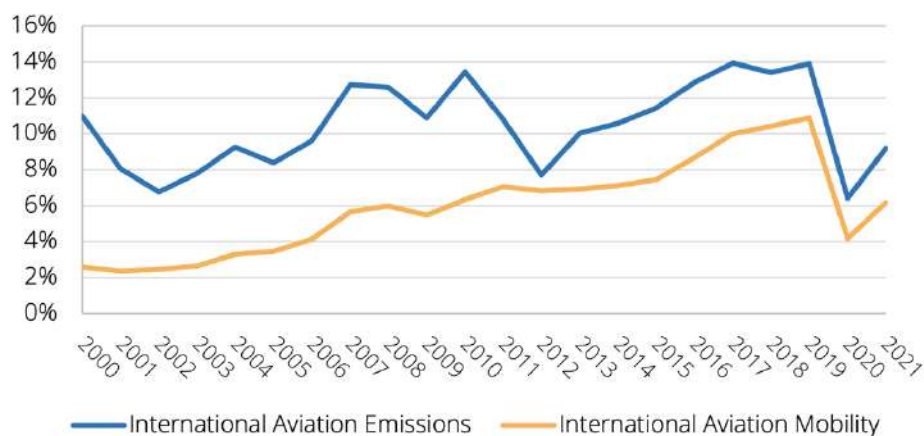


Figure 4 International aviation emissions vs. mobility

The distance travelled by international planes increased from 99 pkm per capita in 2000 to 477 pkm per capita in 2021, although this is quite a bit lower than the pre-pandemic high in 2019, which neared 1000 pkm per capita. With a 6% share in the overall activity levels, international aviation is the third largest means of transport in terms passenger kilometres and per capita emissions, behind cars and buses. Decreasing emissions intensity per vehicle-kilometre and increasing load factor to some degree mitigated an increase in emissions from this mode of transport. The share of international aviation in emissions from passenger transport decreased slightly from roughly 11% in 2000 to about 10% in 2021.

While there are no data for cycling and walking for Romania, we assume an average distance of around 100 km cycled and twice as much walking per person. This is based on the average available for Hungary at around 84 km per capita and between 85 and 491 km for Denmark, the Netherlands, and the UK. By nature, these modes of transportation have negligible emissions.

# Drivers of emissions from passenger transport

The link between economic development and the development of transport is very close and obvious. Eurostat reports that GDP grew at an average rate of 2.3% per year between 1995 and 2005. Volume of freight transported and the number of passengers did similarly. Transport volumes grow faster than the economy: this is explained by its flexibility and adaptability to consumer needs.

Raising income was and still is the main driver of emissions from passenger transport in Romania. Higher incomes make cars more affordable, support mobility and allow people to move to suburbs, which makes personal cars necessary for daily life. As suburbanisation increases, public transport costs increase and projects often become financially unfeasible to construct (World Bank Group, 2015).

Private car ownership is additionally supported by the availability of relatively cheap older used cars. At the same time, in the recent years the number of registered second-hand vehicles continues to drop, in 2022 just under 400,000 imported used vehicles were registered (Marica, 2023). These older vehicles tend to have higher official emissions levels in addition to potential increases in emissions due to ageing. The average age of the Romanian car fleet is now 17 years old, tied for last place in the EU with Lithuania, and well above the EU-wide average of 11.8 years (ACAROM, 2023).

In addition to its aged car fleet, Romania has an aged, struggling infrastructure and is consistently ranked among the least developed infrastructure-wise in the EU. Rail infrastructure is particularly lacking, suffering from years of underinvestment and lack of significant maintenance. The estimated average speed of passenger rail is 50km/h, with areas facing significant speed restrictions (EIB, 2023). Road infrastructure faces similar issues, with sporadic investment and low connectivity resulting in a fragmented series of roads in poor condition leading to significant bottlenecks, traffic jams, low speeds and lots of idling (Ibid.).

There has been movement in this area, particularly through the Recovery Fund and funding through the EIB, but new projects and maintenance continues to be slow. Following the COVID-19 pandemic, the government indicated significant political will to move projects put on hold forward and deal with the investment backlog (Geis, 2022). The government continues to move forward with infrastructure investment aimed at increasing road capacity and better connecting road infrastructure, and while rail investment is planned through the Transport Programme 2021-2027 the continued emphasis on road infrastructure may further lock in cars as the preferred mode of transport.

# Measures recommendations

## Railways electrification

Shifting passenger transport from road to rail is a major lever to reduce transport emissions. In December 2021 the European Commission published an Action Plan to move road transport to rail with the goals of doubling high-speed rail traffic by 2030 and tripling it by 2050 (European Parliament, 2021). However, while that Action Plan focused on long-distance travels, there is a significant potential for modal shift for regional and local connections. At the same time, contrary to long-distance connections which are fully electrified, many of the local connections are still using diesel trains. As a result, while more sustainable than most other modes of transport, they still contribute to GHG emissions: In Romania 2% of the travelled distance was done by this mode of transport, contributing 0.5% of emissions from passenger transport sector (Climate Analytics, 2023).

In 2020 only 37% of the Romanian railways were electrified, placing the country in the lower half of the EU average of 60% (European Commission, 2023). The Romanian railway network was significantly expanded up until the second world war, and during the socialist regime lines were doubled and electrified (Turnock, 2003). The Romanian railways system was in 2020 the 7th largest in the EU with a total lines length of 10,679 km. The density of the national network, 4.5 km of lines per 100 square km, is around the EU average of 4.8 km. However, only 4,030 km are electrified. Thus, a large part of the Romanian railway network can only be used by trains with diesel locomotives. Moreover, in 2016 almost over 9,900 km were in need of renewal, but only 19 km were renewed between then and 2020 (Ministry of Transport and Communications, 2020). Due to the conditions of the lines, speed restrictions are constantly imposed to meet minimum safety regulations.

Every year hundreds of kilometres of railways are affected by speed restrictions due to railway track maintenance caused by the underinvestment in its renewal. In 2016, a total of 992 km of lines were subject to the speed limits. In its 2020-2025 strategy document, Compania Națională de Căi Ferate "CFR" S.A. – Romanian National Railways Company (CFR) demonstrated that between 2012-2017 public funding covered only 2.5% of the annual needed funds for renewal, 19% for repairs, and 56% for maintenance.

Considering that a large share of the network's lines needs renewal, the funding priority is given to the renewal, making any other development programs of the railway system fall into the background as long as the restrictions are not exceeded, and the infrastructure is not completely rehabilitated. Thus, the infrastructure development strategy will have to target the lines with the highest potential for use and with the most speed restrictions. According to the strategies elaborated by CFR, the plan for 2020-2025 is to electrify additional 482 additional kilometres by 2030. However, given the

extremely small progress of railway electrification made between 2007-2020 (+75km) and the low priority given to this objective, the electrification plan for 2020 - 2025 is welcomed, but extremely unlikely.

The Romanian General Transport Master Plan (2016) recalls that the primary railway network has been classified into several types of railways: railways on the TEN-T Core Network, railways on the TEN-T Comprehensive Network, national railways, railways with potential for economic recovery, and railways with the potential for cross-border connectivity (European Parliament, 2015).

*Table 1 TENT-T Core, TENT-T Comprehensive, and Cross-border railway lines*

| TEN-T Core                                                                                   | TEN-T Comprehensive                                           | Cross-border connectivity            |
|----------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------|
| București- Craiova – Dr.Tr.Severin – Caransebeș – Lugoj – Timișoara – Arad                   | <u>Videle – Giurgiu (BG)</u>                                  | Timișoara – Jimbolia - Kikinda (SRB) |
| <u>Craiova – Calafat – Vidin (BG)</u>                                                        | <u>Cluj Napoca – Oradea – Ep.Bihor – Biharkeresztész (HU)</u> | Bârlad – Fălcu – Cantemir (MD)       |
| <u>Timișoara – Stamora Moravița - Vrsac (SRB)</u>                                            | Arad – Oradea – Carei – Satu Mare – Halmeu - Dyakovo (UA)     | Medgidia – Negru Vodă - Kardam (BG)  |
| București – Brașov – Sighișoara – Teiuș – Simeria – Arad – Curtici – Lokoshaza (HU)          | Buzău – Făurei – Brăila – Galați – Giurgiuilești (MD, UA)     | Salonta – Kotegeyan (HU)             |
| Teiuș – Cluj Napoca                                                                          | București – Pitești – Râmnicu Vâlcea – Sibiu – Vințu de jos   | Valea lui Mihai – Nyirabrany (HU)    |
| Cluj Napoca – Dej – Beclean – Vatra Dornei – Câmpulung M. – Suceava                          | Filiași – Rovinari – Tg. Jiu – Petroșani - Simeria            | Carei – Tiborszalas (HU)             |
| Ploiești – Buzău – Focșani – Bacău – Pașcani – <u>Suceava - Vișani</u> – Vadu Siretului (UA) | Filiași – Tg. Cărbunești – Tg. Jiu                            | Câmpulung la Tisa – Teresva (UA)     |
| Pașcani – Iași – Ungheni (MD)                                                                | Dej – Baia Mare – Satu Mare                                   |                                      |
| <u>București – Giurgiu - Ruse (BG)</u>                                                       | Ajud – Comănești – Siculeni – Gheorghieni – Deda - Beclean    |                                      |
|                                                                                              | Fetești – Țândărei - Făurei                                   |                                      |
|                                                                                              | București – Fetești - Constanța                               |                                      |

#### Proposed electrification lines

(Ministry of Transport and Communications, 2020)

Priority has been given to the TEN-T Core railways which will be upgraded according to European TSI standards and norms, with some derogations from them for short track sectors with geological or geomorphological problems. In order to attract new passenger flows, modern railway services will be introduced, such as the purchase of new rolling stock, real-time dynamic information systems, and buses for transporting passengers to and from stations. The aim is to connect the largest urban centres of

Romania with high economic potential, ensuring their railway connection with the European railway network and therefore connectivity with urban centres in Europe.

The lines proposed for electrification would complete the electrification of the TEN-T Core tracks. Railways on the TEN-T Comprehensive Network that facilitate international rail passenger connectivity are a second priority, whereas railways in the border areas that are not part of TEN-T and connect “cross-border” with railways in neighbouring countries are assigned a low priority. They can provide cross-border secondary links, as well as attract traffic from roads or generate new traffic, especially of the 'small border traffic' type.

Most of the proposed electrification lines are sectors from TEN-T Core lines or, to a much lesser extent, TEN-T Comprehensive (italicised in **Table 1**). However, the electrification of all these three categories of railway tracks must be a priority in order to truly link the Romanian railways to the EU and its non-EU neighbouring countries. Romania is not on the list of the current priorities of the European Commission to quickly finance the railway connections between large European cities. However, the European Commission explicitly invites applications for several corridors, whether TEN-T or not, which would open the possibility of financing the outdated and closed Budapest-Cluj link or the link between Bucharest and Sofia. Moreover, NextGenerationEU-funded electrification of railways concerns not only the replacement of diesel locomotives with electric ones but also wind or solar systems for the railway system that can reduce by up to 40% of the total energy consumed on the lighting of railway architecture or the operation of traffic management systems.

## Implementation

The main challenges to prioritising the electrification of the railway network are political and social. Currently, the transport master plan gives preference to road transport, which is one of the reasons for the fall in the usage of train transportation for both passengers and freight. On one hand, owning a car is a status symbol and reflects the rise of income since the 2000s. Increasing car ownership driving the shift from rail to road, was also driven by the opening of Romania to the EU used-car market. The flexibility and affordability of road public transport has also contributed to the popularity and increase of road mobility to the detriment of rail transport. On the other hand, the deindustrialization of Romania after the 1990s and the downsizing of production facilities made rail freight financially inefficient.

## Funding

The development of railways cannot be encouraged without massive EU co-financing and a geographically integrated approach based on the main routes in the Trans-European Transport Network (TEN-T). The new TEN-T Regulation and infrastructure is one of the main topics addressed for railway development in Europe. In terms of railways, intersections are important throughout the TEN-T network. These nodes

contribute to the local development and accountability of national and regional authorities for the identification of intermodal solutions.

For intermodal transport, local and regional authorities can use funds from the Cohesion Fund, the Fair Transition Fund (JTF), the European Regional Development Fund (ERDF), and the EU Recovery and Resilience Mechanism. However, these funds are not sufficient to enable the authorities to fulfil their role of making mobility sustainable.

With regards to rail transport, the European Interconnection Mechanism (CEF) is the key funding instrument to remove bottlenecks and improve and harmonise the interoperability of the TEN-T network, thus increasing the competitiveness and market share of the European rail system. CEF funds are needed to complete the TEN-T network or to expand it when needed, including for the timely completion of major ongoing TEN-T projects and to support the digital transformation of railway operations, particularly for the ERTMS railway signalling system.

The EU Recovery and Resilience Mechanism is another important financial instrument that could help the railways to become a coherent and efficient network at European level. It is also important to include relevant infrastructure routes and missing cross-border connections based on a case-by-case analysis in the TEN-T core network.

To facilitate shift from road to rail, the focus should be on the "last kilometre" of rail connections in urban areas. Adequate and interoperable rail connections with neighbouring third countries, such as the Balkans, Eastern Europe, and Asian countries, should be encouraged, as it is a precondition for uninterrupted rail freight and passenger traffic. The TEN-T policy must be extended to the Balkans. Funding for the development of railway infrastructure should also be made more predictable in order to ensure its use at full capacity.

## Stakeholders

The main stakeholders are the Government, the Ministry of Transport, the state-owner railway infrastructure manager CFR SA, the state-owned railway operators CFR Călători (passengers) and CFR Marfă (freight), as well as private operators for passengers and freight

*Table 2 Romanian railway operators*

| Passenger & Freight    | Freight                         | Passenger                  |
|------------------------|---------------------------------|----------------------------|
| Transferoviar Group SA | Unicom Tranzit SA               | Transferoviar Călători SRL |
| Vest Trans Rail SRL    | Grup Feroviar Român SA          | Interregional Călători SRL |
| Softtrans SRL          | Via Terra Spedition SRL         | Astra Trans Carpatic SRL   |
| Reloc SA               | Deutsche Bahn Cargo România SRL | Regio Călători SRL         |
|                        | Cargo Trans Vagon SRL           | CFR Călători               |

Constantin Group SRL  
Transblue SRL  
Rail Force SRL  
Rail Cargo Carrier România SRL  
CER – Fersped SA  
Tehnotrans Feroviar SRL  
Trains Rail SRL  
GP Rail Cargo SA  
Internațional Rail Transport și  
Construcții Căi Ferate SRL  
Tim Rail Cargo SRL  
LTE – Rail România SRL  
MMV Rail România SA  
Logistică Feroviară SRL  
Express Forwarding SRL  
Rofersped SA  
Prva Slovenska Železnica  
FOXrail zrt  
Trustul Feroviar Carpați  
CFR Marfă

*(Ministry of Transport and Communications, 2020)*

## Co-benefits

Electrification of trains, especially using renewable energy, would make this mode of transport carbon neutral. In addition, it would also reduce air pollution from diesel trains. While electrification of railways would result in high upfront costs, it would significantly reduce operation costs and price volatility.

## Conclusions

Although the electrification of railways is an important aspect of the transition to the green economy, Romania has been lagging behind, with less than 100 km electrified since the country became an EU member in 2007. While commitments to electrify almost 500 km by 2030 are ambitious meeting them is unlikely unless political will and access to the necessary funding are there.

Besides this, Romania needs to make the lines in the TEN-T Comprehensive and Cross-border categories also a priority for electrification. It also needs to include in its strategy the replacement of fossil-based sources of electricity with solar and wind alternatives. Co-financing from the EU is required to meet these priority investments, but also a challenging social and political disposition towards prioritising road infrastructure.

## Hydrogen trains

Next to electrification, acquisition of rolling stock based on fuel cell hydrogen will replace diesel trains on non-electrified railways as well support the shift from road to rail. Replacing diesel engines will lead to a significant decrease in CO<sub>2</sub> emissions as well as air pollutants such as NO<sub>x</sub> and PMs. These trains have one of the highest degrees of efficiency: fuel cells are three times more efficient than internal combustion engines.

In accordance with the EU's Hydrogen Strategy, in the first phase, early adoption of hydrogen can occur in captive uses, such as specific parts of the rail network, where electrification is not feasible (European Commission, 2022a). Hydrogen refuelling stations can easily be supplied by regional or local electrolyzers, but their deployment will need to build on a clear analysis of fleet demand.

Also, hydrogen trains can be deployed anywhere, on any track, and retrofitted into existing trains and lines. The main advantage if compared with electric trains is that they require no grand investment into infrastructure. Fuel cells on hydrogen trains are cost-effective and require low maintenance. The total lifetime cost of ownership is already comparable for trains running on diesel or on electrified lines.

## Implementation

In early 2022 the Romanian Ministry of Transport approved the technical-economic indicators for the acquisition of the first 12 non-polluting hydrogen trains. The pilot project with a value of almost one billion euros is to be financed partially by the National Plan for Recovery and Resilience (NPRR). Hydrogen trains will run on non-electrified and high-frequency lines in the Bucharest-Ilfov metropolitan area, in neighbouring counties, Argeş, Dâmboviţa, and Giurgiu, but also on the Bucharest-Piteşti-Craiova line. Within NPRR, in addition to financing the acquisition of the 12 hydrogen trains, the restoration and renewal of two train lines is also foreseen to make them compatible with the new rolling stock: Bucharest - Piteşti and Reşiţa – Voiteni.

Hydrogen fuelling of trains is already a practice that has caught on in different European states. The most noteworthy example lies in the Austrian railways in the mountain and remote areas of the country. Similarly, Romania has the opportunity to connect such areas, bypass impossible investments in electrification, and permanently part ways with diesel engines. Conventional electrification of traditional single rail tracks, not high speed ones, varies from 1 to 2 million EUR per km (European Commission, 2018).

Germany, The Netherlands, Italy, Austria, Great Britain, Poland, and Sweden are the European countries most interested in this technology. Alstom, Stadler, CAF and Siemens are the European companies that have developed hydrogen trains. Alstom, the French company, communicated the most, with the iLint model that has been tested in several European countries since 2018. The French company also held discussions with the Romanian authorities.

## Stakeholders

There are a variety of stakeholders involved in the hydrogenation of trains in Romania including the Government, Ministry of Transport, National Authority for Railways Reform, Bucharest Municipality, County Councils of Ilfov, Argeş, Dâmboviţa and Giurgiu. The Railway Reform Authority has moved forward with procurement documentation and is about to launch further procedures. The technical-economic indicators were also approved and, together with the Ministry of Economy, working groups were initiated to update the legislation and technical norms for the use of these trains. Amongst others, pressure vessels must be authorised, and future suppliers must build the charging station within European legal parameters – this matter will also bring the Parliament to the stakeholders' table.

A significant expansion of fuel-cell hydrogen trains usage is foreseen as 40 more rolling stock systems are to be purchased and, inductively, in Romania fuel-cell traction for trains has become a national public policy. Naturally, as a result the number of stakeholders is expanding. The new hydrogen trains will ensure the connection between Bucharest North Railway Station and Henri Coanda Airport, North Station Bucharest – Chitila – Săbăreni and Titu, Bucharest and Târgovişte, as well as any more 30-minutes to one-hour routes in the West of the country.

## Co-benefits

The main co-benefit is reducing emissions from the railways sectors on lines that are rarely used and thus the significant infrastructure investment in lines electrification would not pay for itself in the short term.

Hydrogen trains are presented as a "greener" alternative to diesel trains and can be a solution on non-electrified lines. In addition, hydrogen trains have several times more autonomy than battery trains.

## Critique

The disadvantages of hydrogen trains include high costs. In addition, the generation of green hydrogen – the only option to contribute to the main goal of emissions reduction – requires significant amounts of renewable electricity. Additionally, hydrogen is not suitable for high-speed trains, but merely for those that reach 120-140 km/h maximum speed.

### Green Hydrogen in Romania

Energy Policy Group, a Romanian think tank, analysed two modelling scenarios in a report named "Clean Hydrogen in Romania – elements of a strategy", based on the Fit for 55 package proposals regarding the use of clean hydrogen in industry and transport. Results show that between 1,470 MW and 2,350 MW of electrolyser capacity will need to be installed in Romania by 2030. This amounts to 3.7% and 6%,

respectively, of the EU electrolyser capacity by 2030 targeted in the European Commission's Hydrogen Strategy (Energy Policy Group (EPG), 2021). This might require between 3 and 4.5 GW of new renewables installed on top of the capacities included in the current National Energy and Climate Plan.

## Conclusions

Fuel-cell powered trains may complement electric trains on tracks where electrification is not economically viable. When compared to diesel engines, fuel-cell power trains can lead to emissions reductions.

Hybridization electricity – fuel-cell hydrogen engines might increase the quality of the ride and bring more efficiency in the perspectives of passenger/km. When an electric engine must be replaced with a diesel one on a route that leaves the electrified line, the engine change presupposes a long and arduous process; in the case of electric to fuel-cell hydrogen, just a switch will do the job.

Furthermore, embracing such technologies in the realm of railways gives an extra impetus to fuel-hydrogen research. National Research and Development Institute for Cryogenic and Isotopic Technologies is innovating in the area and augmenting the potential for more added value ("ICSI Energy," 2022; Wee, 2010, p. 201).

## Night trains

Long-distance travel within Romania is a key issue for passenger transport decarbonisation. Expanding night train services can help shift passengers from road and air travel to railways. Romania is a large country, and there are already several night trains travelling across Romania on internal and international routes. The international night trains transport passengers to Budapest, Hungary, Vienna, Austria, and from Bucharest.

While these connections constitute a step in the right direction, the number of night trains has declined dramatically in recent decades. There used to be a dense network of night trains across Romania, linking Moldavia and Transylvania with the south, whereas nowadays the services are not attractive and most rolling stock and infrastructure do not encourage using them. The necessary improvement and investments will take time, but this is one of the most important investments we can do in Romania to shift passengers to rail from road and air travel.

Night trains often cannot compete with low-cost airlines on ticket cost: airlines are exempt from kerosene taxes and from VAT on international tickets. Furthermore, in contrast to airlines, trains pay a toll (track access charge) on every kilometre and need to be adapted to the different rail networks and rules of each country, which often implies changing locomotives and train drivers at the border. New entrants, companies

operating night trains, find it difficult to purchase sleeping cars or couchettes. The second-hand market is weak and there is not enough capital for ordering new fleets.

To support the transition to cleaner, greener, and smarter mobility, in line with the objectives of the European Green Deal, the European Commission's Action Plan adopted in December 2021 suggested some measures to modernise the EU's rail transport system (European Parliament, 2021). One of these measures is the proposal to allow trains to run at 160 km/h or faster by 2040 on all TEN-T major passenger rail lines. This could help spur a revitalisation of Romanian night trains – Romania is at the confluence of the Rhine-Danube and East/East Mediterranean corridors and a critical transport hub. Additionally, a new corridor will connect the Eastern European Member States from north to south, from the Baltic Sea to the Aegean/Adriatic, which are new possible lines for night trains.

### **Night trains already operating in Romania**

The best night train in Romania is servicing the Bucharest-Arad route via Craiova-Caransebeș-Timișoara, operated by a private operator - Astra Transcarpatic. The train has 14 wagons at the highest standards, in two train-sets. Per train-set, it operates one sleeping wagon, two couchettes, one compartmentalised wagon and one salon wagon. For prices under 40 EUR, the company offers luxury sleeping compartments with private toilet with shower, free wi-fi and other amenities. Tickets can be purchased online, but also on the train at no extra cost.

Astra became known for the luxury sleeping cars introduced in February 2017 between Bucharest and Arad, some sleeping cars with showers. They are the only trains that are often cleaned on the outside, and the train staff wears impeccable uniforms, adding a clean-cut appearance to appeal to passengers.

## **Responding to current challenges**

As of 2023, the distances between the cities in the west of the country and Constanța, which is the furthest situated city in the east of Romania, can be covered in nine hours by car (from Cluj for example) or even in 15 hours by train, as is the case for the route between Oradea and Constanța. CFR Călători, the main passenger carrier on the railway, had a smaller number of passengers in recent years. It is estimated that CFR lost almost 20% of its turnover to domestic flight companies (Ban & Gog, 2021).

Issues related to infrastructure and investments are associated with insufficient public investment, corruption and instability of the project governance. Only 5 billion EUR were attracted under the previous EU budget with which Romania managed to modernise 500 kilometres of rail - absorbed from 2017 until today (at an absorption of only 33%). Furthermore, the attainable maximum speed of all passenger trains on average hits only 68 km/h, with the real average speed at around 55 km/h. Consequently, night trains lost the battle with domestic flights on long domestic distances, and road transport has become the only option for most regions in Romania.

## Implementation

Successful implementation of expanded night train routes within Romania will likely rely on the central government successfully de-risking and incentivising private actors to expand night train services. Following the very fact that night trains are supposed to be objects in public service contracts, two distinct solutions appear (Steer Davies Gleave, 2017). One contracting model is for the Ministry of Transport of Romania to require the contractor to provide a certain minimum volume of service, potentially measured in terms of seat-kilometres per annum, with the flexibility to reshape services to maximise revenues as a proxy for economic, social, and environmental benefit. This approach would allow state operator CFR as well as private operators to provide various services by time of week or year to reflect seasonality or changing demand patterns.

An alternate form of contracting is for the Ministry of Transport to offer the contractor a fixed compensation per passenger carried, or a percentage uplift on the passenger revenue, providing incentives to maximise either volume or revenue without specifying a particular service or timetable.

Astra Transcarpatic is a local business with Romanian capital, owned by the wagon factory in Arad and known for the yellow-green trains. Astra has few trains per day, and the market share in terms of number of trains operated, is 0.31%, while the number of employees was 83 in 2020, and the compensation for losses due to operating the route was 14.3 million lei (EUR 5 million). Despite the relatively poor state of the company, Astra could be a key target for support and revitalisation of night train routes. The state must support operators to purchase new sleeping cars, support the reduction of rail access charges to direct cost levels, and finally force the large national rail operators to sell tickets on their websites.

Romania can leverage renewed EU interest in night trains to compliment domestic investment. The European Commission has already committed to publishing an action plan on night trains and international passenger rail. Several member states, such as France, Austria and Sweden, have announced the relaunch of night trains. The Trans Europe Express 2.0 initiative initiated by the German government proposed new night train lines. In the same context, the services on the Bucharest-Vienna line must be improved. At the same time, night trains connecting Bucharest to Prague (towards Berlin) and Warsaw can be revitalised.

Although it would not be on TEN-T Core corridors, the seasonal night train Bucharest - Thessaloniki (and Bucharest - Istanbul) can be made permanent.

## Stakeholders

Critical stakeholders are the Government, Ministry of Transport, Bucharest Municipality, County Council of Arad, Astra Vagoane, and CFR.

## Regional policy and funding

As regards rail transport, the Connecting Europe Facility (CEF) is the essential funding tool to remove bottlenecks and to improve and harmonise the interoperability of the Trans-European Transport Network (TEN-T) network, thus increasing the competitiveness and market share of the European rail system. CEF funds are needed to complete the TEN-T network and expand it when demand exist, including the timely completion of ongoing major TEN-T projects and to support the digital transformation of rail operations, in particular for the ERTMS railway signalling system.

The EU's Recovery and Resilience Mechanism is another important financial instrument that could help railways transform into a coherent and efficient network at the European level. It is also important to include relevant infrastructure routes and cross-border connections that are missing on a case-by-case basis in the core TEN-T network.

The emphasis should be placed on the "last kilometre" railway connections, or the final leg of a journey to and from transit stations in urban areas. Adequate and interoperable rail connections with neighbouring third countries such as in the Balkans or Eastern Europe should be encouraged, as it is a prerequisite for passenger rail traffic, including night trains. The TEN-T policy must be extended to the Balkans.

As for the case of Astra Transcarpatic, resources are private and public, with operator's funds supported by public investments. The development of railways cannot be encouraged without massive EU co-financing and an integrated approach based geographically on the main routes of the TEN-T.

For railways, nodal points are important throughout the TEN-T network. These nodes contribute to local development and the responsibility of national and regional authorities for the identification of intermodal solutions.

For intermodal transport, local and regional authorities can use funds from the Cohesion Fund, the Just Transition Fund (JTF), the European Regional Development Fund (ERDF), and the EU Recovery and Resilience Mechanism. However, these funds are not enough to allow the authorities to fulfil their role of making mobility sustainable.

## Co-benefits

One significant co-benefit of night trains is that they reduce the heavy reliance on imports of Russian hydrocarbons. Moreover, night trains do not require important infrastructure investments as they can use the existing infrastructures. However, since they are a comfortable alternative to flying on distances up to 2000 km, with a significant decrease in emissions, this could increase the number of trips by tourists who would like to avoid flying for environmental reasons.

## Low emission zones

CO<sub>2</sub> emissions from transport sector is almost always accompanied with high levels of air pollution. Introduction of Low emissions zones could significantly mitigate both of these issues simultaneously, however, local authorities in Romania show little to no interest in setting up LEZs to reduce or outright ban polluting traffic with the purpose of increasing air quality. As a result, the problem has been taken to a national level. An initiative has taken shape in the Romanian Parliament – Senate's Environment Committee to design a law that would regulate Low Emission Zones at central/national level and local governments will be held responsible to enforce it.

In absolute terms, if there will be a brand-new law regarding LEZs, establishment will be regulated at the local level. However, it must adhere to several principles. An implementation schedule must be established to guide access to the low-emission zone and phasing out access of polluting vehicles to the parts of the city covered by the zone. The timeline must be approved following a public consultation, and authorities should consider introducing daily subscriptions and a maximum of annual days to allow access to vehicles for which access is normally prohibited.

Support schemes or exemptions for businesses and other special mobility needs should be considered. This could be special access hours, to support deliveries to low-emission businesses, and last-mile logistics. A system of derogations should be established at the national level, regarding the categories of special-purpose vehicles, such as ambulances, vehicles of the armed forces, public transport, or vehicles adapted for the transport of persons with mobility needs. Finally, systems of monitoring, control, enforcement, public consultation and review should be established.

## Feasibility

The impact assessment, which must lie at the basis of the local public policy, should include the distribution of LEZ beneficiaries and the introduction of transport alternatives. Authorities need to introduce support measures to ensure that the benefits are fair. This may include financial support for citizens and small businesses moving to cleaner vehicles and providing bus routes and bike lanes that reach, for example, low-income areas.

LEZ should be a central part of a city-wide strategy to promote access to and use of public transport, walking, and cycling. A LEZ will not work in isolation; residents and businesses need to have access to affordable, attractive, and convenient alternatives, especially in the form of public transport (European Commission, 2016). It must be accompanied by establishing access routes that are excluded from the low-emission zone, as well as certain transit parking lots (Park & Ride) or roads that allow access to the bypass for traffic coming from outside the area. The low-emission zone should be permanent and with some clear exceptions mentioned above, should apply to any vehicle that uses the public road in the mentioned area.

### LEZ Harmonisation: The Dutch Model

The Netherlands is the typical model used for designing low-emission zones top-down. It also serves as a model for Romanian legislators.

Until early 2020, there was no national Dutch policy on LEZs, so that in the communities where an LEZ was already in force, there was a plethora of different rules applying to either diesel passenger or delivery vans, as well as to cars. Many other municipalities were already designing mobility plans that were considering the introduction of LEZ, but each with its own set of norms and different ways of enforcement. Starting in January 2020, Dutch cities were able to choose from two types of low-emission zones.

Stakeholders, including municipalities, vehicle operators, and the automotive sector, were consulted and regulations were followed. As an underlying principle, all municipalities apply the European emissions standards, which rate vehicles based on the level of their emissions, as a fundamental basis for their LEZ.

LEZs have been categorised into two types, based on the emissions standards:

“Yellow zones” apply to diesel passenger cars and vans and only provide access to the LEZ for vehicles with an emissions standard Euro 3, after 2000, or higher.

“Green zones” apply to diesel-powered trucks and coaches and are accessible for vehicles with Euro 4 and higher. In 2025 the access regulations will be adjusted one Euro standard level upwards. Vehicles that use other fuel than diesel are allowed in all LEZs. Municipalities can enforce a yellow or a green zone, or both. They can also instate a “purple zone” for trucks, allowing access to lorries that comply with Euro 6 standards.

### Implementation

First off, the LEZ Law must pass on the national level, be promulgated, and then local authorities will be able to decide easily on the LEZ implementation and issue Local Council Decisions. LEZ is following a schedule of gradual implementation, that is, for a certain period different sorts of polluting cars and vans will be banned from the delimited area. The criterion should be the Euro standard for emissions of petrol and diesel.

On the local level, following passage of a national guideline, the local authorities must identify the size of the LEZ based on concrete evidence of the local problem, taking into consideration key indicators. Local indicators should include:

- major local pollutants and their sources,
- exposed population, including residents, workers, commuters, schools, and outdoor recreation centres,
- the extent and spatial extent of the congestion problem,
- local demographics and the car park, and
- public priorities around the atmosphere and air emissions.

## Stakeholders

Identification of stakeholders is one of the barriers to resolving the issue of urban air pollution from transportation. Normally, a national law for LEZ would unify norms that regulate such zones, however, without local initiatives it is rather hard to sort out local problems related to air pollution. The top-down approach proposed here may address this issue by clearly identifying actors in national government and guiding local implementation.

Stakeholders at this stage include the Parliament – both chambers – Senate and Chamber of Deputies, political parties, national civil society (Environmental and clean air coalition), and local authorities.

## Implementation challenges

The barriers can be divided into two groups: national and local. Nationally, it all depends on the agreement that the political groups can reach. At the local level, implementation will always be the problem, especially in terms of administrative capacity. However, the legal basis for such a local decision will exist.

### **Bucharest - a pilot project**

In Bucharest, a zone with low emissions will be established based on the model already implemented by many European cities (Trans.INFO, 2022). The measure is currently in the project stage, with Bucharest Municipal Council initiators planning a phased implementation starting 2023. There is going to be a main or central low emissions zone, generically called Zone A. It is to be delimited by the authorities.

Thus, in the current version of the proposed legislation, vehicles with Euro 4 or lower will be subject to an additional pollution tax; intervention vehicles, public transport vehicles, as well as road repair equipment will be exempted from paying the new tax, the news agency also notes.

It is important to note however that the plan does not differentiate between diesel and petrol cars and does not impose area bans on highly polluting vehicles, but rather implementing higher fee-levels.

## Co-benefits

The implementation of LEZs will force the scrapping of the oldest, worst cars and rejuvenate the car fleet. In addition, some citizens will move to low carbon modes of transport, such as walking, cycling, or public transport, thus resulting in lower emissions. Reduced traffic will also contribute to lower levels of noise pollution in the LEZ. However, the main co-benefit will be the reductions in public health costs in the long term as GHG and particle levels go down. In Romania alone, over 14,000 persons die annually because of traffic-related air pollution, and with successful implementation of LEZs and reductions in tailpipe emissions, this number will be slashed (European

Court of Auditors, 2018). Further reductions in circulatory/coronary and respiratory diseases are expected as GHG emissions decrease.

## Conclusions

The legislative project related to low-emission zones is completed and can be submitted to vote at any time. Currently, the legislative project should be submitted to further discussions in the governmental coalition.

Both, the Romanian Parliament as well as the Executive need to take bold action. First, there must be a technical identification of means of transport, of personal cars, depending on the degree of pollution. Although late, the political class in the country has come to the conclusion that when it comes to air quality, traffic is the most polluting sector and needs to be dealt with. Furthermore, invoking a lack of public funds is no longer an excuse; within the EU Recovery and Resilience Facility, cities will have real support for developing green mobility.

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