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EXPLORING OPTIONS TO MEASURE THE CLIMATE CONSISTENCY OF REAL ECONOMY INVESTMENTS: THE TRANSPORT SECTOR IN LATVIA - ENVIRONMENT WORKING PAPER N° 163

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Abstract

Mitigating climate change requires aligning real economy investments with climate objectives. This pilot study measures the climate consistency of investments in transport infrastructure and vehicles in Latvia between 2008 and 2018, estimated at EUR 1.5 billion per year on average. To do so, three complementary mitigation-related reference points are used. Applying the criteria defined by the European Union Taxonomy for Sustainable Activities results in 4.2% of investments assessed as making a substantial contribution to climate change mitigation. Comparing actual greenhouse gas trajectories for each transport mode to a 2°C scenario from the International Energy Agency's for the European Union and to projections from Latvia's 5th National Communication to the UNFCCC, indicates 32% climate-consistent and up to 9% climate-inconsistent investments. The majority of investments volumes could at this stage not be characterised due to limitations relating to the granularity or coverage of the reference points. Comparing current trends to 2030 and 2050 decarbonisation targets nevertheless highlights future investment and financing challenges, especially for road transport. The methodology piloted in this study can be replicated and scaled up across countries and sectors, using different or complementary reference points specifically aligned to the temperature goal of the Paris Agreement.

Résumé

L'atténuation du changement climatique nécessite d'aligner les investissements dans l'économie réelle avec les objectifs climatiques. Cette étude pilote mesure l'alignement des investissements dans l'infrastructure et les véhicules de transport en Lettonie entre 2008 et 2018, estimés à 1,5 milliards EUR par année en moyenne. Pour ce faire, trois points de références complémentaires sont utilisés. L'application des critères définis par la Taxonomie des Activités Durables de l'Union Européenne résulte en une estimation que 4.2% des investissements ont contribué de manière significative à l'atténuation du changement climatique. La comparaison des trajectoires de gaz à effet de serre pour chaque mode de transport vis-à-vis d'un scénario 2° de l'Agence Internationale de l'Énergie pour l'Union Européenne et des projections incluses dans la troisième Communication Nationale de la Lettonie à la CNUCC, indique 32% d'investissements climatiquement cohérents et jusqu'à 9% d'investissements climatiquement incohérents. La majorité des volumes d'investissement n'a, à ce stade, pas pu être caractérisée, dû à des contraintes liées à la granularité et au périmètre couvert par les points de référence. Une comparaison des tendances actuelles avec les objectifs de décarbonisation pour 2030 et 2050 souligne cependant des défis futurs en terme d'investissement et de financement, particulièrement pour le transport routier. La méthodologie pilotée dans cette étude peut être répliquée et élargie à d'autres pays et secteurs, en se basant sur des points de référence différents ou complémentaires visant spécifiquement un alignement avec l'objectif de limitation de la hausse de température fixé par l'Accord de Paris.

Acknowledgements

This paper has been prepared by Alexander Dobrinevski and Raphaël Jachnik from the Climate, Biodiversity and Water Division of the OECD Environment Directorate, under the supervision of Jane Ellis. The work was overseen by the Working Party on Climate, Investment and Development (WPCID) of the Environment Policy Committee (EPOC). The paper is the second of an intended series of pilot studies exploring options for measuring the climate consistency of real economy investments in tangible assets, following a first similar pilot completed for the manufacturing industries in Norway. It is a contribution to the body of work of the Research Collaborative on Tracking Finance for Climate Action. The Research Collaborative is a technical research network and platform to advance and share knowledge for improving the tracking of climate-relevant finance, including towards addressing and informing finance-related discussions under the United Nations Framework Convention on Climate Change (UNFCCC). This is done on the basis of dedicated work by Research Collaborative staff as well as through joint initiatives and co-operation with other parts of the OECD, external analytical partners, financial institutions, and countries.

The report benefited from inputs from and interaction with a number of Latvian stakeholders. Ilze Prūse and Raimonds Kašs, from the Ministry of Environmental Protection and Regional Development (MEPRD) were instrumental for making this study possible, at each step from inception to completion. Tatjana Titareva, who was contracted by the MEPRD to work on the project, provided invaluable support to establish contacts with all relevant stakeholders in Latvia and thereafter collect information and data from them. A working session in Riga in June 2019 kicked off the stakeholder engagement and data collection process. Between July 2019 and January 2020, the following Latvian entities provided valuable data and qualitative information: Aviasabiedrība „Liepaja" Ltd.; Bank of Latvia; Central Statistical Bureau of Latvia; Consumer Rights Protection Centre; Development Finance Institution Altum; Finance Latvia Association; Institute of Physical Energetics; Investment and Development Agency of Latvia; JSC "Daugavpils satiksme"; JSC "Pasažieru vilciens"; Latvenergo; Latvian Authorised Automobile Dealers Association; Latvian Railway; Liepaja City Municipal Agency "Liepaja Public Transport"; Liepaja Special Economic Zone Authority; "Liepājas Tramvajs"; Maritime Administration of Latvia; Ministry of Economics of the Republic of Latvia; Ministry of Interior of the Republic of Latvia; Ministry of Transport of the Republic of Latvia; Riga International Airport; Riga Municipality Ltd. "Rīgas Satiksme"; Road Traffic Safety Directorate; State Agency Civil Aviation Agency; State Railway Administration of the Republic of Latvia; State Revenue Service; The Freeport of Riga; The Register of Enterprises of the Republic of Latvia; Ventspils Freeport Authority. Special thanks for reviewing and commenting on multiple drafts go to colleagues from the MEPRD's Climate Change Department: Elīna Baltroka, Agita Gancone, Ilze Podniece, Gusts Zustenieks.

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Executive Summary

This report explores options for measuring the consistency of real economy investments with climate change mitigation objectives, focusing on the transport sector in Latvia. It follows a first similar pilot study on the manufacturing industries in Norway. Both studies focus on investments in physical assets, which can lock in or help reduce future greenhouse gas (GHG) emissions. Such focus complements other initiatives that take financial markets and investors' portfolios as starting points.

The study, which relied for a great part on a dedicated data collection exercise from Latvian stakeholders, encompasses investments in transport infrastructure and vehicles in Latvia. The research covers the period 2008-2018, making it possible to balance data availability limitations with the need to account for annual variations. This scope corresponds to an estimated average annual volume of investments of EUR 1.5 billion (USD 1.6 billion), of which on average EUR 0.9 billion (60%) for vehicles and EUR 0.6 billion (40%) for infrastructure. These investments target predominantly road transport (70% of total investments), followed by air (13%), rail (10%), and water (7%).

There is for the time being no standard approach to measure the consistency of investments with climate change mitigation objectives. This is in part due to the challenge of estimating the contribution to global GHG emission reduction goals by particular countries or sectors at given points in time. In this context, the present analysis tests the use of three readily available and complementary reference points:

- The European Union Taxonomy for Sustainable Activities (EU Taxonomy), aimed at establishing criteria for economic activities that make a substantial contribution to a set of environmental objectives;
- a 2°C scenario from the 2012 Energy Technology Perspectives (ETP) by the International Energy Agency (IEA), which includes a GHG emission trajectory for the EU for 2010-2050 aimed at limiting the average global temperature increase to 2°C;
- the 5th National Communication (NC5) that Latvia submitted in 2010 to the United Nations Framework Convention on Climate Change (UNFCCC), which includes GHG emission projections for 2010, 2015 and 2020.

In testing these reference points, the study does not presume which investment and GHG emission trajectory should be followed. It further acknowledges that they do not necessarily correspond to the level of ambition needed to achieve the temperature goal of the 2015 Paris Agreement. For instance, since 2017, the IEA ETP include a "Beyond 2°C Scenario" that is more ambitious than the earlier 2°C scenario used here in order to cover the 2010-2018 investment period being looked at.

The EU Taxonomy defines screening criteria for economic activities with significant climate change mitigation benefits. Based on the available data, approximately 4% of all investments within the scope of this study satisfy these criteria and can be classified as "sustainable". Such investments are mainly in electrified rail transport, electrified public transport, and electric vehicles. The remaining 96% could not be classified as either "sustainable" or "not sustainable" due to three design features of the EU Taxonomy. First, it currently does not further characterise activities that do not satisfy its criteria. In particular, it does not distinguish activities without significant climate benefits from activities that undermine climate objectives. Second, the EU Taxonomy's current coverage of transport-related activities is limited. Most notably, aviation and shipping are not covered. Third, applying the technical criteria requires access to granular investment and GHG emissions data often unavailable to third parties. The study on the manufacturing industries in Norway showed a similarly high share of investments that could not be addressed by the EU Taxonomy.

A complementary approach for measuring the consistency of investments with climate objectives relies on climate change mitigation scenarios. Such an approach is tested here by comparing subsector-level actual GHG emission trajectories to the IEA 2°C scenario for the EU and to Latvia's domestic projections from their NC5. This allows for a characterisation of a much larger share of investments than the current EU Taxonomy. The consistency with the scenarios' GHG emissions trajectories is determined for each subsector (road, rail, air, maritime) as a whole. This aggregate categorisation can, in principle, be applied to investments in both transport infrastructure and vehicles. Although infrastructure does not result in direct GHG emissions, it plays an enabling role for the corresponding mode of transport as a whole. As a general limitation, consistency with GHG emission trajectories is influenced not just by investments in improved technology and efficiency, but also by activity volumes as well as other factors unrelated to investments. Decomposing these influences and establishing causal links between investments and GHG emissions requires a deeper analysis outside the scope of this study.

The two scenario-based analyses of climate consistency give similar results. Both the IEA's ETP and Latvia's NC5 projected increases in road and rail GHG emissions for 2010-2018, whereas actual GHG emissions in these subsectors decreased. Hence, corresponding infrastructure investments (32% of the total tracked) are considered consistent with both reference points. Approximately 9% of investments were in air and water transport infrastructure, whose GHG emissions grew quicker than foreseen in the IEA 2°C scenario. On the other hand, the NC5 projection did not cover international aviation and shipping and hence cannot be applied to these subsectors. Investments in transport vehicles, which account for the remaining 60% of total tracked investments, could not be classified as consistent or inconsistent based on this approach. Doing so would in any case require more granular GHG emission data in order to separate out different subsets of vehicles, notably new and used. The pilot study on the manufacturing industries in Norway describes a number of further general limitations of such scenario-based analyses.

Transport infrastructure in Latvia is financed largely through public funds: domestic and EU funds each financed over a quarter of total investments in such infrastructure over the period considered. Future investments in low-carbon infrastructure will likely need to rely on complementary financing sources. Investments in transport vehicles involve a wide range of economic actors including households and enterprises outside the transport sector, as well as leasing companies. For final users of vehicles, leasing is an alternative to purchasing a vehicle. This study highlights the importance of this mechanism, especially for aircraft and for road vehicles purchased by companies.

Road transport represents a particular challenge to decarbonising the Latvian transport sector given that second-hand diesel and petrol vehicles still represent the majority of recent investments. A scalable and rapid shift to zero- or low-emission vehicles requires innovative financing solutions in order to address affordability constraints. Green car leasing or debt financing combined with some degree of carefully-designed public subsidy could be explored. Furthermore, achieving potential modal shifts away from road requires a broader strategy covering all transport modes. For example, investments to extend public transport infrastructure may reduce the need for individual passenger cars.

Findings from both the Latvia and Norway pilot studies highlight that the choice of reference point(s) has a significant impact on the results of the consistency measurement. Follow-up research work to help draw more general and robust conclusions for systematic measurement of the climate consistency of investments would be useful in three directions. First, further country studies for other sectors could shed light on the availability of data and consistency reference points in different contexts. Second, the scalability of the proposed approach could be tested by conducting such analyses across countries. Third, the inclusion of reference points relating to resilience to climate change would establish links to analyses of physical risks, which investors and financial regulators are increasingly undertaking.

1. Scope and rationale for the pilot project

1.1. Why such a study?

Reaching the goal of the 2015 Paris Agreement of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C" requires rapid and far-reaching transformations in all sectors of the economy (UNFCCC, 2015[1]). This, in turn, is only possible if investments and financing are aligned with this goal. Making finance flows consistent with such temperature goals, as called for in Article 2.1c of the Paris Agreement, requires the mobilisation of investments and finance for activities that contributes to climate objectives, but also shifting investments and finance away from activities that undermine these objectives.

A prerequisite for designing and monitoring the efficiency of these actions is, however, to measure the climate alignment of current investment and financing across the entire financial value chain. In this context, the analytical work pursued by the OECD-led Research Collaborative on Tracking Finance for Climate Action – including the present study – focuses on real economy investments and linking these investments to underlying sources of financing. The aim in doing so is also to produce results that are primarily of relevance to climate-related policy makers, and to complement finance tracking initiatives that take financial markets and investors' portfolios as starting point.

This work follows the methodology outlined in (Jachnik, Mirabile and Dobrinevski, 2019[2]) and first tested in a parallel pilot study of the manufacturing industries in Norway (Dobrinevski and Jachnik, 2020[3]). It aims at capturing primary investments in the creation and refurbishment of infrastructure and vehicles, a scope close to what the System of National Accounts defines as "tangible fixed assets" (UN, 2010[4]). Considering such long-lived assets is especially relevant, since they are responsible for a majority of the current greenhouse gas (GHG) emissions and lock in emissions for the following decades (NCE, 2016[5]). This lock-in effect makes it important to include in the analysis infrastructure that may have little direct climate impact but may influence the technological platform for other investments (e.g. roads and railways in the case of the transport sector) (OECD, 2017[6]).

GHG emission reduction objectives as well as possible trajectories to meet such objectives can be set on the level of individual institutions, countries, and internationally. Abatement potentials can also be assessed at different geographical and sectoral aggregations. These different reference points may not always be consistent with one another. Hence, as outlined in (Jachnik, Mirabile and Dobrinevski, 2019[2]), the present work estimates the consistency of investments in relation to climate change mitigation from multiple viewpoints, rather than suggesting one specific characterisation. As detailed in Section 3.1.2 and Annex C, reference points used include available working definitions of "green" and "sustainable" activities, sector-specific GHG emission and transition pathways at global or regional level, as well as national-level GHG emission reduction scenarios, potentials or objectives.

Measuring the climate consistency of investments and financing yields policy-relevant benefits both for individual countries and in an international context. At country level, Latvia in the case of the present study, finance tracking efforts complement physical indicators of progress on climate change mitigation and contribute to assessing the current state of consistency with national climate goals and the effectiveness of existing policies. These efforts can also inform both national policies aimed at shifting investment, and long-term national climate strategies. Sub-section 1.2 and Section 2. highlight the rationale for, and relevance of the present study in the specific Latvian context, including the choice of focusing on the transport sector.

In an international context, such measurement efforts allow the identification of potential indicators and data sources relevant for measuring progress towards climate change mitigation at a global level. This could be useful input to UNFCCC processes, notably the Standing Committee on Finance's Biennial Assessments (UNFCCC, 2018[7]), which have been mandated to inform finance-related elements of the future Global Stocktakes of collective progress (first one in 2023). Finally, in the context of broader OECD work, such tracking initiatives may be a first step towards filling an existing gap on investment- and finance-related indicators within the framework of OECD green growth indicators (OECD, 2020[8]).

While the focus of this analysis is on climate change mitigation, climate change adaptation is an essential component for achieving climate goals. However, obtaining data and devising methodologies for measuring the consistency of investments and financing with climate-resilient development is more difficult than for mitigation (Jachnik, Mirabile and Dobrinevski, 2019[2]). Measuring the consistency of investment and financing flows with adaptation objectives, therefore, deserves a complementary mapping and analytical effort to the present one.

1.2. What and how?

The present study is the second of an intended series of pilots to explore options for estimating the climate consistency of investments and financing for different sectors, in different country contexts and at different geographical scales. It focuses on the transport sector in Latvia for the period 2008-2018. The first pilot focuses on the industry sector in Norway during a similar period (Dobrinevski and Jachnik, 2020[3]). This ten-year period was chosen to balance data availability limitations with the need to smooth out annual fluctuations (e.g. following the 2007-2008 financial crisis). Considering the transport sector is relevant since, as detailed in Section 2.3, transport-related GHG emissions represent a significant share of the Latvia's total emissions and have not decreased significantly in recent years, despite a decline in population.

The scope of tracking encompasses all modes of transport, notably rail transport, road transport, air transport, inland and maritime shipping, and non-motorised transport, including both passenger and freight transport. The relevant assets can be categorised as transport infrastructure on the one hand, and transport vehicles on the other hand. Transport vehicles comprise new and second hand vehicles across all transport modes. In the transport infrastructure category, this study includes not just roads and railways, but also investments by transport-related companies (e.g. in warehousing and passenger/freight terminal buildings, related machinery, and equipment other than vehicles). On the other hand, investments in fuel production and pipelines are considered part of the energy sector and not included here. Annex A provides further details on this scope.

The mapping and analysis of investments (Section 3.1) covers in principle all actors investing in the aforementioned assets, whether public institutions (public authorities and state-owned enterprises), private enterprises, or households. As explained above and further explained in (Jachnik, Mirabile and Dobrinevski, 2019[2]), the point of measurement is set at the primary investment in infrastructure and vehicles. Such primary investment includes both creation of new assets, and refurbishment of existing ones. The sources of financing for these investments are then identified[1], differentiated between infrastructure and vehicles as these are typically financed in very different ways. These include financing from public actors (e.g. via subsidies, including EU funds, or loans from public banks), private actors (e.g. via loans from commercial banks), and own funds of investors (e.g. company retained earnings, household savings). While a large share of the financing mix underlying the tracked investments could be analysed in this way, some gaps remain (see Section 3.2).

The Ministry of Environmental Protection and Regional Development of the Republic of Latvia (MEPRD) requested and sourced the inputs required for the analysis from over 30 public and private sector actors. This included both financial data (e.g. statistics on government subsidies, financial statements of private companies) and non-financial data (e.g. vehicle registrations). The latter are used to estimate investment flows where granular financial data was not available (e.g. spending by households on different types of vehicles). The report also relies on qualitative information and expert judgements from local transport sector actors (e.g. associations) to verify the plausibility of estimates and findings as well as to complement the quantitative analysis. Annex B provides a detailed description of the data sources and estimation methods on investment and financing.

The analysis then explores methodological options for estimating the consistency of investment and financing flows in relation to climate change mitigation, by testing the use of three complementary reference points. The first one is the eligibility of specific activities with respect to the EU Taxonomy (EU Technical Expert Group on Sustainable Finance, 2019[9]). The other two consist in comparing the actual trajectory of 2010-2018 GHG emissions (on the level of modes of transport) to possible transition pathways at both national level (based on Latvia's 5th National Communication to the UNFCCC) and international level (based on an IEA 2°C scenario for the European Union). Section 3.1.2 and Annex C provides a detailed description of the references points used for measuring the climate consistency of investments.

The analysis also relies on qualitative information and expert judgements from relevant stakeholders (e.g. associations, government actors) to fill data and methodological gaps as well as verify the plausibility of and complement quantitative results. To this end, a working session was organised in Latvia with major public and private sector actors, along with in-depth discussions during bilateral meetings with the providers of specific data sets. Furthermore, consultation took place with transport sector experts at the OECD, the IEA, the International Transport Forum (ITF), and other relevant organisations, as further detailed in the Acknowledgements.

[1] Only the first-level sources of finance are considered. Analysing multiple levels of the financing and ownership hierarchy, in particular tracking refinancing and securitisation within the financial sector, requires separate dedicated work.

2. The transport sector in the Latvian context

2.1. Economic and environmental characteristics of Latvia

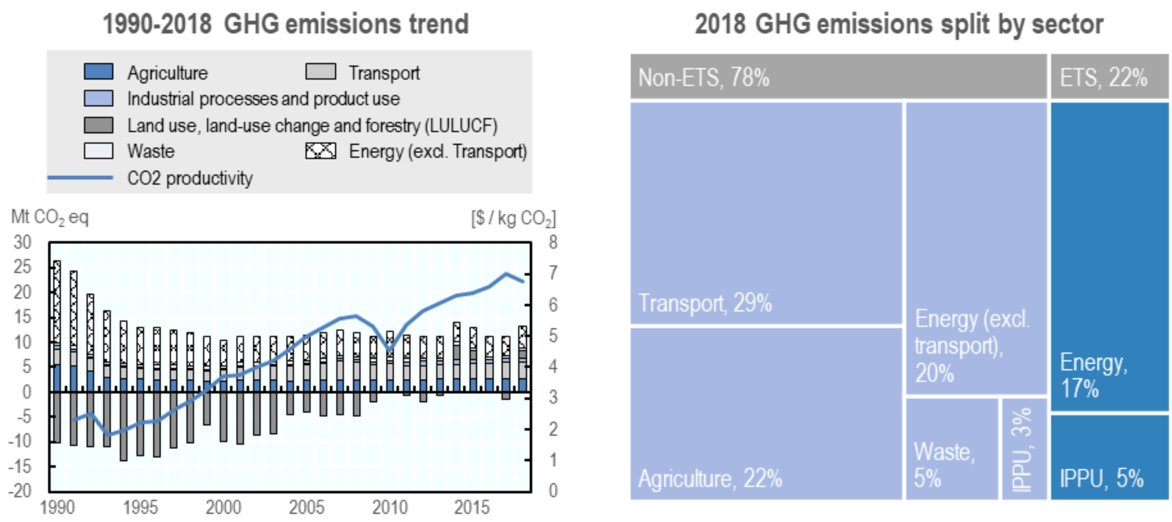
Latvia is a high-income and, based on the UNDP Human Development Index, a very highly developed country in the Baltic region (UNDP, 2018[10]). Latvia is a member of the EU (and of the Eurozone since January 2014), NATO, the Council of Europe, the United Nations, CBSS, the IMF, NB8, NIB, OSCE, WTO and OECD. A full member of the Eurozone, it began using the Euro as its currency on 1 January 2014. The strong performance of Latvia's economy in recent years has been highlighted in the 2019 OECD economic survey (OECD, 2019[11]). This includes, in particular, continuous GDP per capita growth since 2010, low unemployment and sound macroeconomic policies. Nevertheless, challenges like reducing income inequality and increasing productivity growth remain to be addressed.

A number of demographic characteristics have an impact on the demand for transport in Latvia. The country's total population is decreasing. Population density, at 31 inhabitants per km^2 is significantly below EU average (121.1) as well as below OECD average (37.8). With a 68% share of urban population as of 2018 Latvia is also slightly less urbanised than EU average (76%) and OECD average (81%) (World Bank, 2019[12]).

From an environmental perspective, Latvia is among the OECD leaders in the use of renewable energy sources, with a 40% in total primary energy supply, compared to an EU average of 14% and an OECD average of 10% (IEA, 2020[13]). However, 90% of the population remains exposed to fine particulate matter (PM2.5) concentration higher than WHO guidelines. Further, there is still potential for considerable energy efficiency improvements, stronger price signals, and more eco-innovation (OECD, 2019[14]).

Since 2013, Latvia has improved the GHG intensity of its economy: GHG emissions in Latvia (excluding land use, land-use change and forestry (LULUCF)) have remained broadly constant despite sustained economic growth, thereby highlighting progressive decoupling between the two (Figure 2.1). In 2018, Latvia's production-based CO_2 productivity was 6.7 international dollars (2010 PPPs) per kg CO_2, compared to an EU average of 6.0 and an OECD average of 4.4 (OECD, 2020[8]). Long-term GHG emission reductions in Latvia are highly dependent on sectors not covered by the EU emission trading scheme (ETS). These non-ETS GHG emissions represent almost 80% of Latvian GHG emissions in 2018, including close to 30% attributed to transport, 22% to agriculture and 20% to energy (Figure 2.1).

Figure 2.1. Latvia's domestic greenhouse gas emission profile and trends



Note: Production-based CO_2 productivity is measured as GDP per kg of energy-related CO_2 emissions. IPPU stands for Industrial Processes and Product Use. In line with the UNFCCC methodology, transport sector GHG emissions in these figures do not include international aviation and maritime shipping.
Source: UNFCCC National Inventory Reports (UNFCCC, 2020[15]), OECD Green Growth indicators (OECD, 2020[8]), Latvia's submissions to the European Environmental Agency under the Monitoring Mechanism Regulation (MMR) (EEA, 2019[16]).

On a European and on a national level, the following climate change mitigation objectives and commitments are of relevance for Latvia:

- Under the Kyoto Protocol, the European Union and its member states committed to reduce GHG emissions by 20% in the second commitment period (i.e. by 2020), compared to 1990 (UNFCCC, 2012[17]). In addition, the EU Effort Sharing Decision (EU, 2009[18]) stipulates a target for non-ETS emissions to increase by less than 17% compared to 2005. Achieving these 2020 targets appears feasible for Latvia according to current projections ((OECD, 2019[14]), (MEPRD, 2018[19])).
- Within the Paris Agreement under the UNFCCC, the European Union and its Member States committed to reduce its total GHG emissions by at least 40% by 2030, compared to the base year 1990 (EU, 2015[20]) . This 2030 EU climate and energy framework is translated to a national context in Latvia's National Energy and Climate Plan (NECP) 2021-2030 (Republic of Latvia, 2018[21]). The NECP contained a preliminary national target of 55% reduction of GHG emissions (excluding LULUCF) compared to the base year 1990. It also included a specific target of 6% GHG emission reduction for non-ETS sectors compared to the base year 2005.
- The European Union Emissions Trading Scheme (EU ETS) caps the yearly EU-wide GHG emissions across a range of emission sources from different sectors. It covers large parts of the energy and industry sectors, and also includes aviation within the European Economic Area (EEA). By 2030, GHG emissions across the EU ETS will have to be reduced by 43% compared to 2005 levels (EU, 2018[22]).
- On a long-term horizon, the European Commission proposes aiming for GHG neutrality[2] by 2050 (European Commission, 2018[23]). Translating the implementation of this goal in a national context will be part of Latvia's strategy for achieving climate neutrality by 2050, which was adopted by the

[2] According to a net-zero emissions principle

Cabinet of Ministers in January 2020. This strategy may raise the overall GHG emission reduction target to -65%, compared to 1990.

The above objectives are embedded in Latvia's policy planning through a number of other policy documents. These include:

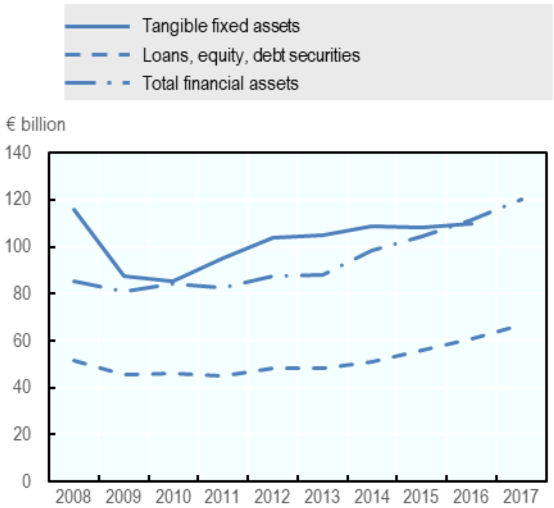
- Sustainable Development Strategy of Latvia until 2030
- National Development Plan of Latvia for 2014-2020
- Latvia's national reform programme for EU2020 strategy implementation
- Environmental Policy Guidelines 2014-2020

While the focus of the present study is on climate change mitigation, climate change adaptation is an essential component of the Paris Agreement. In this context, the main challenges and approaches in Latvia are summarised in the 'Latvian National Plan for Adaptation to Climate Change until 2030', adopted in July 2019 (MEPRD, 2019[24]). As described in Section 1.1, measuring the consistency of investments and financing with climate-resilient development deserves a complementary mapping and analytical effort.

2.2. General investment and financing characteristics in Latvia

This study focuses on transport infrastructure and vehicles in Latvia, which are part of the stock of tangible fixed assets as measured in the national accounts. Investments in excess of the depreciation of these physical assets led to a growth of the stock of tangible fixed assets between 2010-2016. As highlighted in Figure 2.2, the total stock of financial assets in Latvia grew roughly in parallel to these real economy investments. However, the growth in financial assets also includes effects such as valuation gains or losses of Latvian investors on domestic and foreign financial markets, evolution of household indebtedness (outstanding mortgages and consumer debt), and changing levels of financial intermediation activity, all of which are not within the scope of this analysis.

Figure 2.2. Stocks of tangible fixed assets and financial assets in Latvia



Note: Total financial asset stocks include loans, equity and debt securities outstanding and, in addition: financial derivatives, insurance pension and standardised guarantees, currency and deposits, monetary gold and SDRs and other accounts receivable.
Source: (OECD, 2020[25]).

Latvia has an overall favourable environment for business activities as indicated, for example, by its 19th place (out of 190) in the 2018 World Bank's Doing Business ranking (World Bank, 2019[26]) and by its above-OECD-average business confidence index (OECD, 2019[27]). In line with this, business investment in fixed assets contributes a significant share to the Latvian GDP and GDP growth, particularly in 2017 and 2018 (OECD, 2019[11]). However, volatility in the European and global business and trade climate could adversely influence future external demand, as well as investments in Latvia (Bank of Latvia, 2019[28]).

In addition to mapping investment volumes, this report analyses the contributions (or lack thereof) by different sources of finance enabling these investments. For both public and private investments, EU funds are currently an important source of (co-)financing. Under the European structural and investment funds (ESIF)[3], in the 2014-2020 programming period, Latvia received EUR 5.6 billion. This is equivalent to 3% of Latvia's annual average GDP and 65% of national public investments (OECD, 2019[11]). As these funds are particularly important for transport-related investments, uncertainty over sectoral- and country-distribution of future EU fund programming periods can have an impact on long-term financing strategies.

Another commonly-used source of financing for large investments is the issuance of debt in form of loans or bonds. The low interest rates of the Bank of Latvia and the ECB facilitate overall favourable debt financing conditions. However, tight credit standards introduced after the financial crisis still limit the amount of new lending. In particular access to finance for SMEs remains difficult, including due to the relatively low availability of venture capital ((OECD, 2019[11]), (OECD, 2019[29])). In line with this, the debt of private households and non-financial corporations is low compared to other European countries (OECD, 2019[11]). The role of nonbank financial institutions in providing lending to the economy, and in particular in leasing financing for transport vehicles, is significant and increasing (Bank of Latvia, 2018[30]). Section 3.2 provides a quantitative view on how these general economic conditions are mirrored in the transport sector.

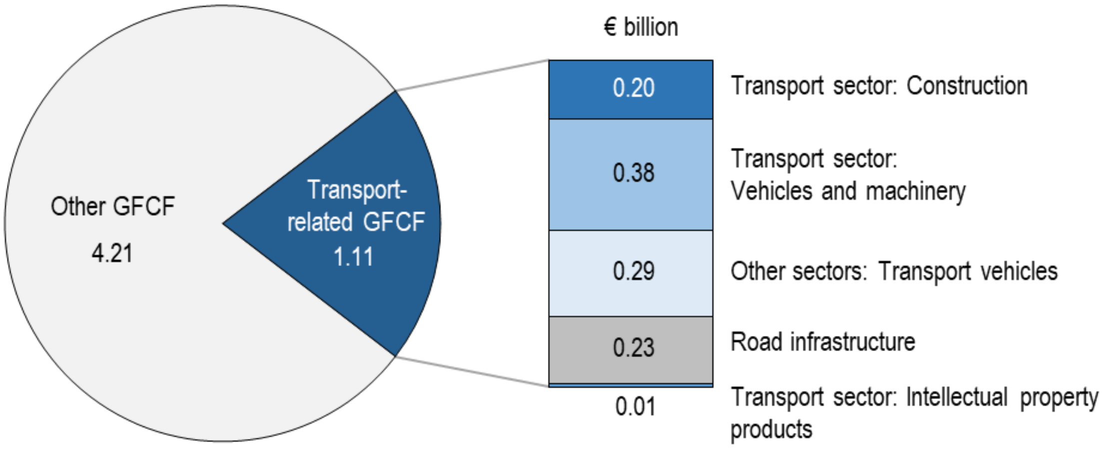
2.3. Characteristics of the Latvian transport sector

The transport sector is an important part of the Latvian economy in general. It contributes approximately 7% to the Latvian GDP and employs approximately 8% of the Latvian workforce. It also constitutes a major area of investment: gross-fixed capital formation (GFCF) in transport (including transport vehicles by actors in other sectors) was approximately 16% of Latvian GFCF in the period 2008-2016.

From the perspective of climate change mitigation, transport was responsible for approximately 27% of the Latvian GHG emissions between 2008 and 2018 (excluding LULUCF, and excluding international aviation and shipping as above). This share is higher than the EU average of 21% and Estonia and Lithuania with 12% and 24% (which may also be linked with the particularly low GHG intensity of the energy sector in Latvia). Transport was also a major source of air pollutants in Latvia (OECD, 2019[14]). Apart from aviation (flights within the EEA), GHG emissions in the transport sector are currently not subject to the EU ETS (see also Figure 2.1).

[3] The European Structural and Investment Funds (ESIF) include the European Regional Development Fund (ERDF), Cohesion Fund (CF), European Social Fund (ESF), Youth Employment Initiative (YEI), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime & Fisheries Fund (EMFF).

Figure 2.3. Average yearly gross fixed capital formation in Latvia (2008-2018 average, € billion)



Source: (OECD, 2019[31]), own analysis.

Transport-related GFCF in Latvia (see Figure 2.3, and Annex A for details on the link to national accounts) consists mostly of investments in transport vehicles and machinery in the transport sector, transport vehicles and machinery in other sectors, road infrastructure and transport-related buildings. Investments in intangible assets (intellectual property products) are less than 2% of the transport-related GFCF and are not considered in detail in the present study.[4] GFCF as measured in the national accounts does not include household spending on transport vehicles (cars, motorcycles, bicycles). Since household spending is a significant part of the overall spending on vehicles, it is included in the present study, based on other sources of data (see Figure 2.3 and Annex A).

The different components of the transport infrastructure in Latvia include (Central Statistical Bureau, 2019[32]):

- Roads. This includes state roads, local roads and streets. Road is the most important mode of transport both in terms of the number of passengers carried and in terms of the tons of freight traffic.
- Railways. Latvia has the longest railway network of the Baltic States, enabling over 75% of freight to travel by rail. This is much higher than for Europe as a whole, where freight rail has a modal share of about 12% (Eurostat, 2019[33]). Latvia's railways are mostly single-track, broad-gauge lines connecting the country to Estonia, Russia, Belarus and Lithuania. Electrified lines constitute about 14% of the total line length, and are used only for regional passenger transport. Non-electrified lines, which mostly run on diesel, are used for both passenger transport (national and international) and cargo transport (predominantly importing coal and petroleum products).
- Ports. The major ports of Riga, Ventspils and Liepāja are used for cargo shipping (predominantly coal and petroleum products). While some passenger ferries also run at these ports, they do not play a significant role in terms of the number of transported passengers.
- Airports. The major international airport is Riga and is used mainly for international passenger transport. Air transport does not play a significant role in terms of tons of cargo transported.
- Urban public transport infrastructure. This includes tramway, trolleybus, and bus infrastructure in the major cities of Riga, Daugavpils, and Liepāja; in other cities, mainly buses.

[4] In particular, this means that for the purposes of this study, no care will be taken to disentangle investment in intellectual property products from investment in tangible fixed assets e.g. when considering capital expenditures of companies. This is justified due to the overall very low share and impact of intellectual property investment in this sector in Latvia.

The public sector directly or indirectly influences a significant share of the transport sector in Latvia. As in many countries, the national government plays a major role in infrastructure investment (e.g. in state roads) and contributes to financing transport-related expenditures of municipalities. The latter invest in local transport infrastructure and public transport. In addition, large state-owned enterprises are present in all transport modes, accounting together for 24% of the transport sector in terms of employment. This includes, in particular, the state-owned railway company *Latvijas dzelzceļš*, the state road company *Latvijas Valsts ceļi*, and a majority share in the airline *airBaltic*.

Latvia has developed a number of policy documents and plans for the transport sector up to 2020. These include an Alternative Fuels development plan 2017-2020, a Transport development guidelines 2014-2020 (aiming notably at intermodal passenger transport network, as well as electrification and development of railway), an Electromobility Development plan 2014-2016, a Bicycle traffic development plan 2018-2020, and an Indicative Railway Infrastructure Development Plan 2018-2022.

Policy instruments targeting or relevant to the transport sector include taxes, regulations, and subsidies:

- **Transport-related taxes for vehicles and fuels**. All vehicles are subject to an annual operation tax. Since 2017, this tax includes a CO_2 component for vehicles, which were first registered starting from 2009. Like other countries, Latvia applies a general excise tax on fossil fuels (gasoline, diesel and gas), although a few types of activities benefit from reduced tax rates or exemptions. Such exemptions apply, for example, to diesel fuel used in agricultural transport. Despite recent increases, effective tax rates on CO_2 emissions from energy use in road transport remain among the lowest in OECD Europe (OECD, 2019[14])
- **Regulation enforcing a biofuel quota**. Fuel traders have been obliged to sell petrol and diesel containing at least 4.5% biofuels.[5] Additionally, the use of biofuels is encouraged through exemptions from the excise tax or reduced rates. With 3% of transport fuel consumption from renewable sources (including biofuels), the country is, however, for the time far from reaching the EU target of 10% (OECD, 2019[14]).
- **Subsidy programmes and incentives, mainly towards electrification in the road and rail sectors**. In the rail sector, until 2016, major grants contributed to the modernisation of railway infrastructure and rolling stock (see also Section 3.).[6] In the road sector, electrical passenger cars are exempted from the registration fee and annual vehicle operation tax (since 2015), and benefit from a reduced company car tax (since 2016). Municipal authorities provide additional incentives to electric vehicles, such as free parking (Riga since 2016, Liepāja since 2015) and entrance in toll areas (Jūrmala since 2010). In 2014, the government also organized open project tender within the Climate Change Financial Instrument for the deployment of electric cars and their charging infrastructure. To date, as illustrated in Section 3.1 and Annex A, such deployment as well as household and company investments in electric vehicles remain very limited.

[5] This was increased to 10% for petrol as of January 2020 and will be increased to 7% for diesel as of April 2020.

[6] Since July 2019 the charging of railway infrastructure has been changed - the net cost price principle (which provided that railway undertakings should bear the full cost of maintaining and renewing the railway infrastructure) was replaced, and further the charging of railway infrastructure has been set as the direct cost of providing rail transport services.

3. Results

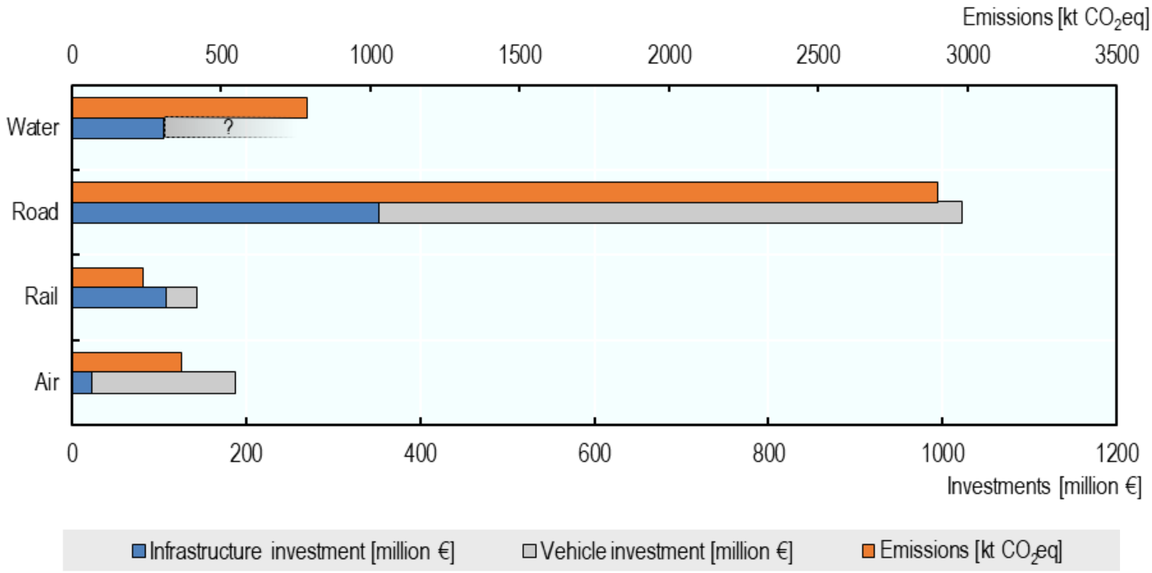
3.1. Overview of current investments flows, financing and of their climate consistency

3.1.1. Relevant subsectors in terms of GHG emissions and investments

This study considers in detail the transport subsectors listed in Figure 3.1. For detailed analysis of investments and sources of financing, as well as for the measurement of climate consistency, the subsectors are further subdivided between vehicles on the one hand, and other tangible fixed assets on the other hands (infrastructure, buildings and machinery) on the other hand. For brevity, the second category is called “infrastructure” in the following. The total volume of tracked investments is on average EUR 1.5 billion per year, of which on average EUR 0.9 billion (60%) are invested in vehicles and on average EUR 0.6 billion (40%) are invested in infrastructure. Further information about the categories of assets and the delineation of subsectors is available in Annex A.

GHG emissions from transport in Latvia, as reported to the UNFCCC via National Inventory Reports (NIR) (UNFCCC, 2020[15]), amount to an average of 3.2 Mt CO_2eq per year over the period considered. These emissions consist mostly of direct GHG emissions from road transport (92%) and a small share of rail transport (7.5%). GHG emissions from air and water transport are mostly due to international aviation and shipping. While such GHG emissions are, in line with UNFCCC methodology, not counted in Latvia’s NIRs, they are included in the remainder of the present chapter as they relate to investments in Latvian transport infrastructure. Furthermore, the 2030 GHG emission reduction target of the EU covers international aviation within the EEA, via the emission caps for the EU ETS (EU Council, 2017[34]). Including international aviation and shipping from Latvia increases the total amount of analysed GHG emissions to 4.3 Mt CO_2eq per year on average (an increase by about 36%, compared to considering domestic Latvian transport GHG emissions only). The large volume of international shipping GHG emissions attributable to Latvia, compared to domestic Latvian GHG emissions, was also noted in another recent study (Transport & Environment, 2019[35]).

Figure 3.1. Overview of transport subsectors (2008-2018 annual average)



Note: Investments and emissions are annual averages over the period 2008-2018. GHG emissions from air and water transport include both domestic aviation/navigation, and outgoing international aviation/shipping (as reported in the UNFCCC GHG emissions from international bunkers). Investments in vehicles include both new vehicles and used vehicles. Investments in international shipping vessels could not be estimated (see Annex A), indicated by the question mark in the vehicle investment bar in the water sector.
Source: Investment data provided by public and private stakeholders, (UNFCCC, 2020[15]) for GHG emissions data. See Annex A and Annex C for details on data sources and methodology.

As shown in Figure 3.1, road transport is the most significant mode of transport in terms of investments (70%) and GHG emissions (68%) over the period considered. Around 10% of investments go towards rail transport, which generates comparatively few GHG emissions (6% of total). Conversely, water transport (mostly international shipping) is responsible for around 18% of total transport GHG emissions with only few investments in this sector (7% of total). Investments in air transport are approximately 13% of the total, and this mode of transport is responsible for approximately 9% of the tracked GHG emissions.

As is the case for most tangible fixed assets, investments in transport vehicles and infrastructure lock-in GHG emissions for significant periods of time due to the expected life expectancy of such assets. For road transport infrastructure for instance, bridges are typically designed to last for 75 to 100 years, pavement (roads) for 5 to 35 (ITF, 2018[36]). Estimates of average project lifetime for infrastructure indicate 25 years for roads, ports and airports, and 30 years for railways (Jones, Moura and Domingos, 2014[37]). The average lifetime of vehicles using such infrastructure can vary significantly across sectors and geographies, but can extend to similar periods than those quoted above for infrastructure, including through domestic and international used vehicles markets.

The data on investments which underlies Figure 3.1 and the following discussion was compiled via three approaches:

- Detailed data on investments and financing was collected from major transport sector actors via the MEPRD. This data covers around 70% of the total infrastructure investment volume and around 7% of the total vehicle investment volume.
- The remaining 30% of infrastructure investments were estimated by comparing the detailed data above to aggregate investment volumes for the relevant subsectors, as shown in the national accounts and structural business statistics. Such investments are aggregate capital expenditures

of small and mid-sized transport companies, such as freight logistics and cargo handling companies.

- The majority of vehicle investments (over 90%), where detailed data was not available, were estimated based on vehicle registration data (provided by the Latvian Road Traffic Safety Directorate) and vehicle price estimates (provided by the Latvian Association of Authorised Automobile Dealers).

Annex B explains additional details on data sources and methodology.

3.1.2. Measuring the climate consistency of investments

In the following, the investments in different transport subsectors in Latvia are categorised according to three different inputs for measuring consistency in relation to climate change mitigation:

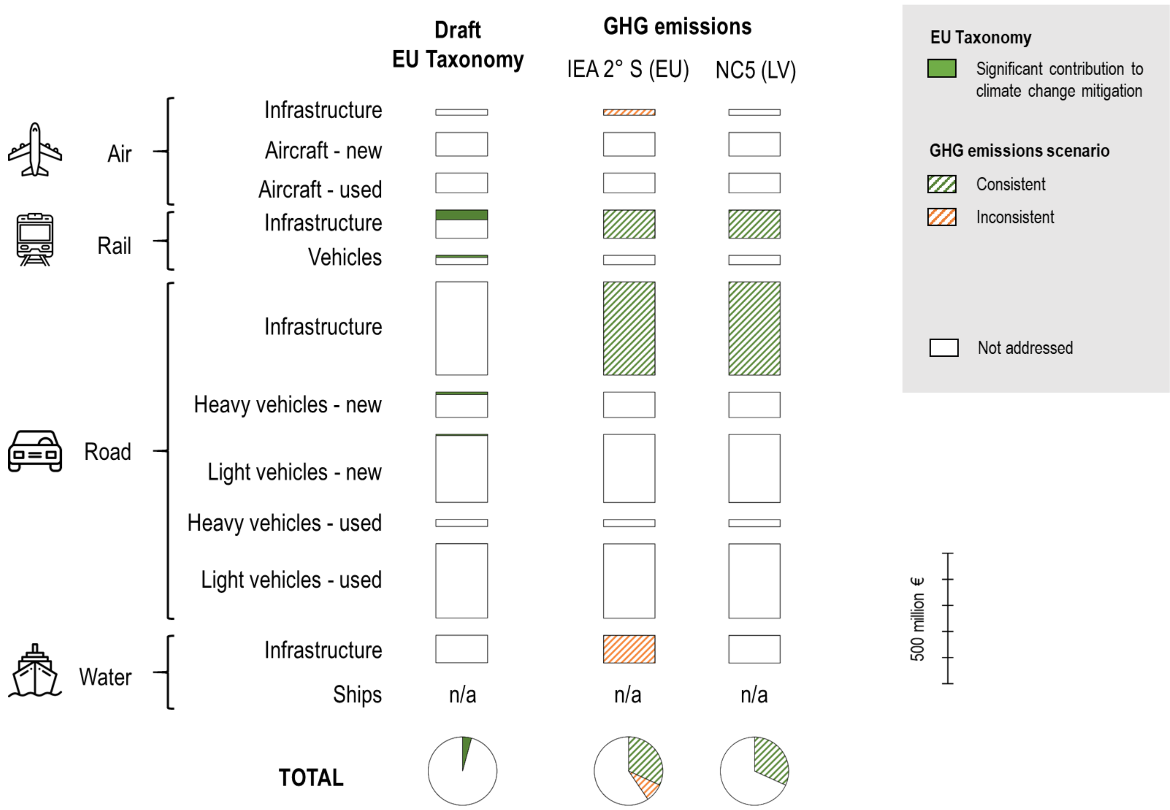
- **The EU Taxonomy for Sustainable Activities** (EU Technical Expert Group on Sustainable Finance, 2019[9]). This initiative aims at establishing legal criteria for investments that make a substantial contribution to different environmental objectives. Such criteria can, for instance, be based on best-available technology or GHG emission intensity thresholds of best performers within a given subsector. Currently, the EU Taxonomy only provides criteria for defining activities that are clearly climate beneficial but not for defining those that are detrimental to climate objectives, or have no significant climate impact. At this stage, the EU Taxonomy is primarily aimed at investors in financial assets (institutional investors, asset managers) in order to provide transparent standards for environmentally sustainable investment products. The present measurement explores how the technical screening criteria for climate change mitigation (as per the latest EU Taxonomy technical report (EU Technical Expert Group on Sustainable Finance, 2019[9])) can be applied on the scale of an economic sector.
- **The 2°C scenario for the EU from the 2012 IEA ETP** (IEA, 2012[38]). In general, this scenario for 2010-2050 outlines a GHG emissions trajectory with an "80% chance of limiting average global temperature increase to 2°C". While more recent editions of the ETP provide updated scenarios[7], here the older scenario is used intentionally, in order to compare forecast GHG emission reduction potentials in the studied period to actual GHG emission reductions in that same period. In general, the IEA scenario models macroeconomic developments (e.g. GDP growth) as well as supply and demand evolution in a number of sectors (energy, transport, industry) consistent with such a GHG emissions trajectory. This scenario is based on the current state of technological development and does not assume breakthrough innovations. It does, however, assume incremental technological progress and improvements in cost-effectiveness. As a broad guideline, this scenario allows estimating possible contributions from different modes of transport in the relevant region (in this case, the EU) to global GHG reductions. In particular due to the required modelling assumptions and uncertainties, this is not a prediction or a prescriptive trajectory, but rather an example of a possible development compatible with a below-2° future.
- **The transport GHG emission projections from the 5th National Communication that Latvia reported to the UNFCCC (NC5)** (UNFCCC, 2010[39])**.** These projections correspond to a plausible pathway of how the GHG emissions of different transport subsectors in Latvia may evolve between 2008 and 2020, assuming existing policies as of the time of modelling (2009). It complements the EU-level reference points above by taking into account the specific Latvian context. Like the IEA scenario this is an indication of possible developments of the transport sector and associated GHG

[7] In particular, the 2°C scenario from the ETP 2014 onwards aims for a 50% chance of limiting the global temperature rise to 2°C, an example of how the 2°C scenario itself evolves over time in terms of methodology and scope. Further, the ETP 2017 includes a more ambitious "Beyond 2°C scenario" that is consistent with a 50% chance of limiting average future temperature increases to 1.75°C.

emissions, rather than a prescriptive pathway. Newer projections were published in the subsequent 6th and 7th National Communications, which, like the NC5, project an overall growth in transport GHG emissions, however with smaller growth rates and total GHG emissions. These variations are largely due to revised assumptions of stronger population decrease and lower GDP growth. Here, as with the IEA scenario, the older NC5 scenario is used intentionally, in order to compare forecast GHG emission reduction potentials in the studied period 2008-2018 to actual GHG emission reductions in that same period. Newer projections are used for the forward-looking analysis in Section 4.

Figure 3.2 provides an overview of the consistency measurement of 2008-2018 investments based on these three inputs. The perspectives taken in the two viewpoints are different as explained above, and hence the results are not directly comparable, but rather complementary. The variation in results illustrates that the choice of reference points has a significant impact on the share of total investments coloured as "consistent" and "inconsistent". In order to provide a forward-looking view, these results would need to be matched with GHG reductions and/or investment needs required in different transport subsectors, in order for the sector as a whole to contribute to Latvia meeting its 2030 and 2050 GHG emission reduction objectives. Such a break down is not available from Latvia's NDC or other relevant official objectives. While recent Latvian GHG emission projections include a breakdown of expected future GHG emissions by transport subsector, it is not clear how to establish the link to specific required implementation measures.

Figure 3.2. Overview of the consistency of investment flows in 2010-2018 with climate change mitigation benchmarks



Note: Infrastructure includes all tangible fixed assets except vehicles; in particular roads, railways, machinery, and buildings. For vehicle investments, only new vehicles are considered. The height of the bars is proportional to the annual investment volume (average over 2008-2018), as indicated by the scale on the right. The measurement of consistency with GHG emission scenarios relies on sector-level total GHG emissions in the period 2008-2018, comparing them to the corresponding scenario trajectory.
Source: See Annex A and Annex C for details on data sources and methodology.

The latest EU Taxonomy technical report (EU Technical Expert Group on Sustainable Finance, 2019[9]) defines technical screening criteria to determine economic activities with significant climate change mitigation benefits. Based on the available data, over the considered period on average EUR 62 million per year (corresponding to 4.2% of the total investments in scope of this study) satisfy these criteria and can be classified as “sustainable”. These investments consist of several types of eligible activities, covering both the “greening of” transport and the “greening by” enabling activities outside the transport sector. While enabling activities outside the transport sector (such as manufacturing of electric vehicles) are not in scope of this study, relevant “greening of” activities include:

- **Zero direct emission vehicles** (e.g. electric, hydrogen). Within the scope of the study, these investments correspond to on average EUR 23 million per year (or 38% of the overall EU Taxonomy-eligible investments) and consist mostly of investments in electric public transport vehicles (tramways, trolleybuses, buses).
- **Low-emission vehicles**, subject to strict emission intensity thresholds. Such vehicles are included in the current EU Taxonomy screening criteria as a transitional technology, and are only classified as “sustainable” until 2025. While a precise evaluation of the intensity thresholds is not possible in all cases with the available data, investments in this category are estimated to be insignificant. For passenger cars, the Worldwide harmonised Light vehicles Test Procedures (WLTP) threshold of 50 g CO_2eq/vkm required by the current screening criteria is only reached by highly efficient hybrid technologies. Only a few such vehicles are part of the car fleet in Latvia (see also Section 3.1.3). For non-electrified passenger road or rail transport, compatibility with the screening criteria would require significantly above-average occupation factors and/or advanced hybrid technology. Evaluating this in depth would require additional data on usage of individual transport providers.
- **Enabling infrastructure for low- and zero-emission transport** (e.g. electrified rail infrastructure, charging stations for electric vehicles). Within the scope of the study, these investments correspond to on average EUR 38 million per year (or 62% of the overall EU Taxonomy-eligible investments). These consist mostly of investments in infrastructure for electric public transport (tramway tracks) and electrified passenger rail transport.

It is worth noting that the current criteria specifically exclude freight transport dedicated mostly to the transport of fossil fuels, even if compatible with the criteria above. This restriction applies equally to zero direct emissions vehicles, low-emission vehicles, and enabling infrastructure. The current EU Taxonomy technical screening criteria only provide guidance for a small subset of the total investment volume. This is due to multiple reasons, similar to those identified in a parallel case study for the manufacturing industries in Norway (Dobrinevski and Jachnik, 2020[3]):

- The focus is on activities that provide a substantial contribution to environmental objectives (in this case, climate change mitigation). Hence, the relatively low share of eligible investments as estimated here can be taken as an indication that the current EU Taxonomy screening criteria are relatively stringent and help avoiding “greenwashing”. However, the individual criteria are not explicitly positioned against a level of ambition consistent with the Paris Agreement temperature goal. Further, the current EU Taxonomy does not distinguish activities without a significant climate impact from activities potentially inconsistent with climate objectives.
- In addition, the criteria developed to date only cover certain economic sectors, and within these sectors only certain production processes. Activities and products, which are not covered by the EU Taxonomy will not be eligible, regardless of level of GHG emission intensity. For example, the current technical screening criteria do not (yet) cover aviation and maritime shipping.
- A small subset of the investment volumes could not be addressed due to data limitations in the present study. The EU Taxonomy’s intended usage is initially as a tool for investors and companies. Investors routinely request granular data for assessing their investment projects from the non-financial companies receiving the financing, and can use such data e.g. for applying the

detailed technical screening criteria as formulated in the EU Taxonomy. For the present analysis, such granular data (for example, on the GHG emissions intensity of public bus transport in terms of GHG emissions per passenger kilometre) is not always available. Such investments are conservatively counted as "not addressed" in Figure 3.2.

A complementary approach, as highlighted in the parallel case study on the manufacturing industries in Norway, is a scenario-based analysis. Such analysis identifies both climate-consistent and climate-inconsistent investments, by comparing subsector-level actual GHG emission trajectories to a possible transition pathway that is compatible with long-term climate objectives. This allows for a characterisation of a much larger share of investments than the EU Taxonomy. In the present example, actual GHG emission trajectories of the different transport subsectors in Latvia for the period 2008-2018 are compared to the IEA 2°C scenario for the EU.[8] Approximately 32% of investments within the scope of this study were in road and rail transport infrastructure; in Latvia, the GHG emissions of these sectors evolved in a manner consistent with the 2°C scenario. Approximately 9% of investments were in air and water transport infrastructure; the GHG emission trajectories of these sectors were inconsistent with the 2°C scenario i.e. grew faster.

Similarly, subsector-level GHG emission trajectories can be compared against the Latvian NC5 forecast referenced above.[9] The road and rail sectors' GHG emissions between 2008 and 2018 were below this forecast trajectory as established at the start of the considered period. Hence, the infrastructure investments in these subsectors in Latvia are considered consistent with the NC5 forecast from a climate change mitigation perspective. Analysing the consistency of the air and water transport sectors against the Latvian NC5 forecast is not meaningful, since the investments in these sectors are geared mostly towards international aviation and shipping, whereas the NC5 GHG emission forecasts cover domestic aviation and navigation only.

Investments in vehicles (new and second hand) represent 60% of the total tracked (Figure 3.1). Their consistency cannot be estimated based on a sector-level GHG emission trajectory, whether from the IEA scenario or the NC5 projection. This is due to two main reasons:

- Transport vehicles are mobile, meaning that the location of the investor, the location of the vehicle (i.e. the associated environmental impact) and the official registration of the vehicle do not necessarily coincide. For instance, freight trucks may be registered in Latvia but serve largely transport routes outside of the country. In such cases, these trucks would fuel outside of Latvia's boundaries, thereby driving GHG emissions accounted for by other countries. Conversely, cargo ships registered in offshore locations may be serving Latvian ports frequently and fuelling there. Hence, GHG emissions are driven not just by Latvian transport vehicles, but also by foreign vehicles using Latvian infrastructure.
- Both new and used vehicles drive GHG emissions. Whereas investments in new vehicles are clearly linked to creation of new physical assets and associated GHG emissions lock-in, this is less obvious for purchases of used vehicles, which at most prolong the lifetime of the vehicles (see Box 3.1). For this reason, investments in used vehicles need to be assessed separately (Figure 3.2). At the same time, the GHG emission trajectory could not be disaggregated to allow a separate analysis of new vehicles.

[8] Published in 2012, it provides a GHG trajectory for the period 2010-2050 for the EU, at the level of subsectors. It is based on 2011 assumptions for policy and economic development.

[9] Published in 2010, it provides a forecast of GHG emissions for the period 2008-2020 at subsector level. It is based on 2009 assumptions for policy and economic development.

- Actual GHG emissions of transport vehicles depend both on the technical characteristics of the vehicle (which can be influenced by investments) and usage patterns (which are less closely linked to investments).

These challenges prevented a meaningful comparison of the vehicle investments in the scope of this study to climate change mitigation scenarios. They, however, apply differently to the individual transport modes in Latvia:

- GHG emissions from air transport, water transport, and rail freight transport in Latvia are mostly due to international transport. This means that the vehicles responsible for these GHG emissions are not necessarily registered in Latvia or purchased by Latvian owners.[10] Hence, for these subsectors no link between vehicle investments and the Latvian GHG emission trajectory can be established. An international-level study would make sense instead.
- GHG emissions from rail passenger transport in Latvia are mainly due to domestic transport. However, the granularity of actual GHG emission inventories, and of the possible GHG trajectories used here as reference points, are insufficient to estimate the climate-consistency of this subsector. The available data for actual GHG emission trajectories in the UNFCCC NIR, the IEA 2°C scenario, and the NC5 GHG forecast all consider rail transport GHG emissions as a single category and do not distinguish passenger from freight rail transport. This limitation would remain in different geographies.
- GHG emissions from light road vehicles are largely due to new and second-hand passenger cars in Latvia. For new passenger cars, GHG emissions can be estimated based on the CO_2 intensity recorded in vehicle registrations data. However, such data is not available for a large share of older second-hand passenger cars.[11] Expert estimates on fuel usage and mileage data indicate that GHG emissions of new passenger cars are only a small share (below 5%) of total passenger car GHG emissions. However, deriving GHG emission trends from such data is challenging, since the decreasing availability of data for older vehicles requires extensive analysis to avoid biasing estimates. Hence, this study does not attempt a scenario-based analysis of the climate consistency of passenger car investments. This limitation would likely remain in different geographies.
- Heavy road vehicles include buses used for passenger transport as well as trucks used for freight transport. Between these two categories, the actors responsible for vehicle investments, and the transport volume trends, differ significantly. However, official data on actual GHG emissions do not distinguish different categories of heavy road vehicles. Furthermore, in contrast to light road vehicles, registration data for buses and trucks so far usually does not contain estimated CO_2 emission intensities per kilometre. Accurately evaluating the GHG emission trends of each heavy vehicle type is, therefore, challenging. Hence, GHG emission scenarios could not be used for a meaningful evaluation of the climate-consistency of bus and truck investments within the scope of this study. For new heavy road vehicles, this issue will be alleviated by a recent EU regulation on CO_2 emission performance standards (EU, 2019[40]).

For the investments that can be categorised with respect to the two GHG emission reference points above, the consistency or inconsistency is driven by multiple factors. Total GHG emissions are influenced not just by investments leading to changes in transport-related GHG emissions, but also by overall demand for each mode of transport (Figure 2.1). Notably:

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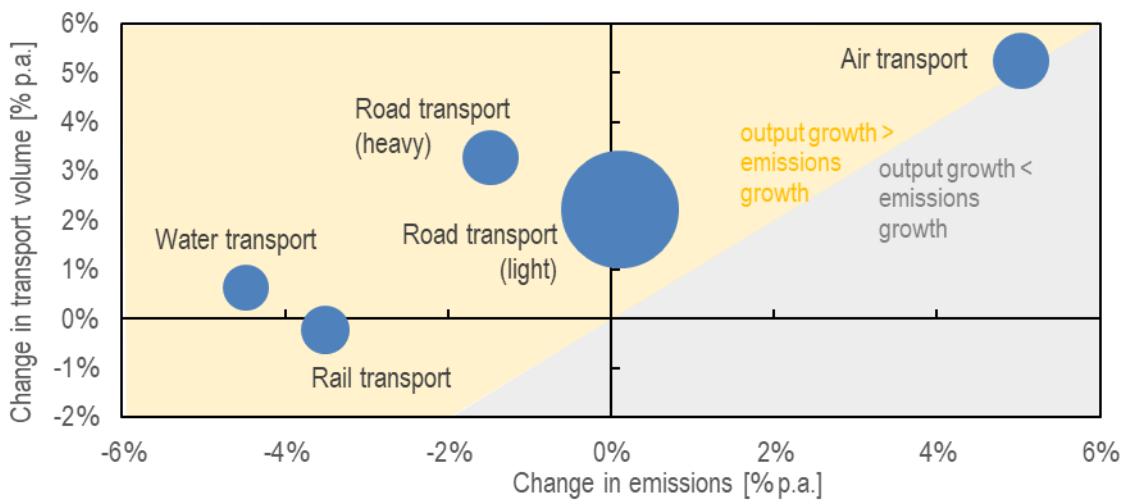
[10] This is also reflected by the GHG emissions for international aviation and shipping (international bunker emissions), which are estimated from refuelling activity in Latvia, irrespectively of the origin and registration country of the vessel.

[11] CO_2 emission data is available for over 95% of the passenger cars registered in Latvia and manufactured in 2009 and later. For passenger cars built before 2009, the availability of CO_2 data decreases rapidly with increasing age. Among all passenger cars registered in Latvia and manufactured before 2009, only for 26% CO_2 emission data is available.

- The rise in aviation GHG emissions (and their inconsistency with the IEA 2°C scenario) coincides with a strong growth in passenger air traffic turnover (approximately 4% per year). On the other hand, GHG emissions from this sector only grew by 2.5% p.a.
- Both the IEA 2°C scenario and the Latvian NC5 projection expected a significant rise in road and rail GHG emissions, largely linked to rising demand. Such demand increases are visible e.g. in passenger car transport since 2011 (Figure 3.5). However, in part due to the economic downturn after the financial crisis, when considering the entire period 2008-2018, transport turnover for light road transport and for rail transport did not rise significantly, or even decreased. Hence, the consistency of these transport modes with the considered GHG emission scenarios is linked not just to potential investments in reducing their GHG emission intensities, but also to stagnating demand.
- GHG emissions from heavy road transport decreased despite a 4.5% rise in road freight turnover. This may indicate that investments played an important role in reducing GHG intensities in this subsector.
- GHG emissions from international shipping increased despite largely constant transport volumes. However, this may be influenced by the data used to estimate shipping volumes, which only accounts for the cargo volume but not for the shipping distance.[12] Furthermore, such variations in international bunker emissions attributed to a given country may be linked to changes in fuel prices and resulting fuelling behaviour and location. In such cases, studies on an international level are necessary to establish the link to trends in actual GHG emissions (see also Section 5.).

Figure 3.3. Trends in GHG emissions and in output volumes (2008-2018 annual average)



Note: Disk sizes are proportional to investment volumes. Transport volumes are estimated based on passenger and freight turnover (in passenger-kilometres and ton-kilometres, respectively) from the Central Statistical Bureau of Latvia. Air transport and light road transport is assumed to be mostly passenger transport; the other transport modes are assumed to be mostly freight transport. The trend in light road transport volume is based on passenger cars turnover data from Eurostat for 2009-2018. The trend in water transport is based on the volumes of loaded and unloaded cargo. Trends in emission volumes are estimated based on UNFCCC NIR data. Above (below) the diagonal line, output growth is larger (smaller) than emissions growth.

Source: (UNFCCC, 2020[15]) for emissions, (Eurostat, 2020[41]) and (CSB, 2020[42]) for transport volumes.

[12] This is in contrast to the estimates for road, rail and air transport, which use the passenger turnover (in passenger-kilometers) and freight turnover (in ton-kilometers). For water transport, the closest proxy for the transport volume that could be identified is the volume of loaded/unloaded cargo.

The analysis based on GHG emission scenarios and projections has several limitations, similar to the limitations identified when conducting the parallel case study for the manufacturing industries in Norway:

- Any chosen scenario or projection is only one possible trajectory out of a wide range of different transition scenarios compatible with the same long-term climate targets. Especially in the short term, different scenarios can imply different GHG emission trajectories.
- Any scenario model relies on assumptions on overall economic development, including the demand for different products and resulting production volumes. The scenario estimates for the shares of emission reductions implemented in different geographical regions and sectors depend on additional assumptions, such as optimising for least-cost trajectories. Actual economic developments can be very different in all of these aspects.
- As the above examples show, inconsistency with a GHG emission reduction scenario could have different reasons. There could be insufficient investment in new technologies, but also increased transport demand and activity. Likewise, consistency of total GHG emissions with GHG emission reduction trajectories could be linked not only to investments in reducing GHG emission intensities, but also to decreases in activity volumes.
- A regional scenario, such as the EU-level IEA ETP 2°C scenario does not provide a breakdown on country level. Comparison to this scenario can be seen as a benchmark within the EU. However, structural differences and trends between different EU countries are not captured in this scenario, and could contribute to some of the observed consistencies or inconsistencies. Even country-level projections, such as those from the NC5, although more accurately reflecting national circumstances, only yield an aggregate assessment of per (sub)sector rather than for individual investment projects. As a result, portions of climate-consistent investments within a subsector, that as a whole evolves inconsistently with the chosen reference point, cannot easily be identified with this approach (and vice versa).
- An issue specific to the transport sector is the granularity of available data on actual (historic) GHG emissions. As described above, actual GHG emissions of individual vehicle categories (new or second-hand vehicles, buses or trucks as part of heavy road vehicles) can only be estimated approximately. Hence, it is difficult to deduce GHG emission trends and evaluate the consistency with mitigation scenarios on such granular level.
- Limiting the analysis of GHG emissions to actual transport activities may miss related upstream or downstream activities in the economic value chain. For example, an increase in the production of exported commodities can drive demand for freight transport. However, it is not straightforward to take into account such cross-sector interactions.

Additional details on data sources, methodology and resulting limitations for the consistency measurement are provided in Section 5. and Annex C.

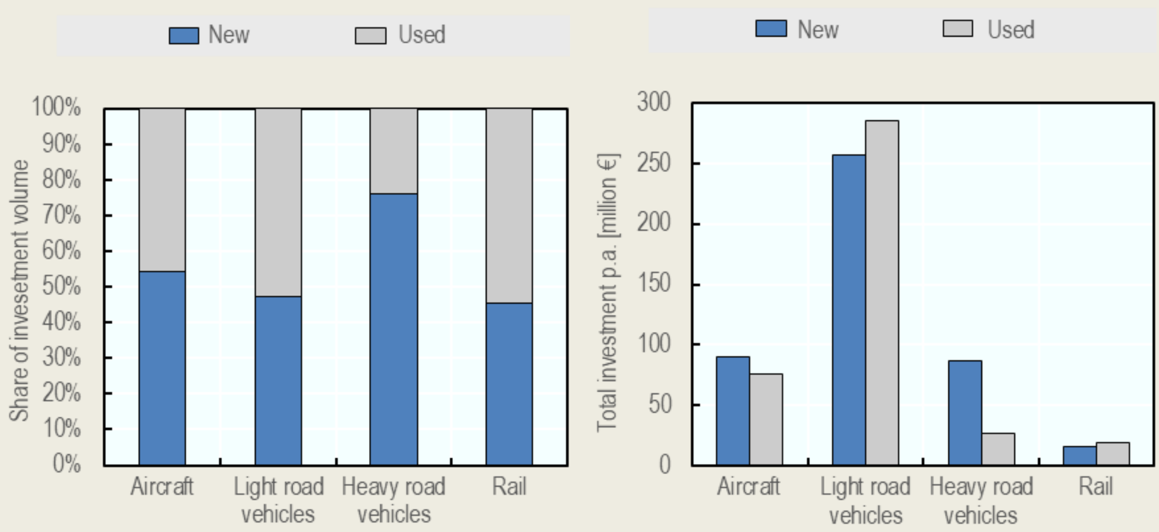
Box 3.1. New and used vehicles

The scenario-based reference points for the consistency analysis in Figure 3.2 are not conclusive with respect to vehicle investments. This is due to the need to disaggregate new and second-hand vehicles in such scenarios and treat them differently:

- On a global level, formation of new fixed assets is the main contribution to lock-in of future GHG emissions. Therefore, the methodology proposed in (Jachnik, Mirabile and Dobrinevski, 2019[2]) focuses on investments in new assets and refurbishment of existing ones, and excludes financial flows purely related to transfers of ownership. While import of used vehicles does increase the GHG emissions within Latvia's boundaries, it only affects the global GHG emissions if this transaction extends the lifetime of the vehicle.
- Separating out and estimating the relevant investment flows in used vehicles is difficult. While purchases can be easily identified, it is less clear how to define the volume of investment when a used vehicle is leased.[13]
- Analysing the climate consistency of investments in used vehicles would require tailored reference points. Such reference points would need to account for the lifecycle impact of the used vehicles, i.e. capture the balance between the avoided GHG in the manufacturing phase, the potentially worse GHG performance in the use phase than a new vehicle, and the potentially extended lifetime. An existing evaluation tool that could be used in this way could not be identified in the course of this study.

Figure 3.4 shows the investments in new and used vehicles across the different modes of transport. The very significant share represented by investments in used vehicles underline that such vehicles may represent a particular challenge in decarbonising the Latvian transport sector (see Section 4.).

Figure 3.4. Investment volumes in new and used transport vehicles (2008-2018 average)



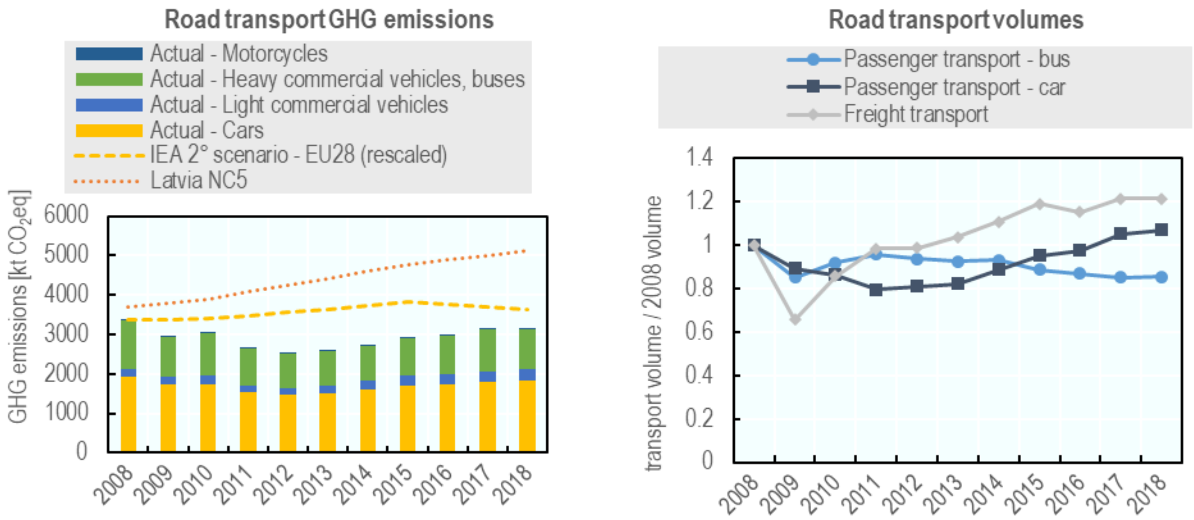
Source: Investment data provided by Latvian transport stakeholders and own estimates, see Annex A and Annex B.

13 In the road sector, leasing is used mostly to finance new vehicles. However, in the air sector, leasing is a common form of financing both for new and for used aircraft.

3.1.3. Deep-dive: road transport and vehicles

As previously highlighted, road transport represents 68% of the GHG emissions tracked in this study. It also represents close to 70% of transport-related investments tracked for the period 2008-2018. Figure 3.5 shows that for the period 2008-2018, the overall GHG emissions trajectory of road transport in Latvia has been below the IEA 2°C scenario and the Latvian NC5 projection. Hence, investments in road transport are categorised as consistent in Section 3.1.2. However, while GHG emissions from road transport fell sharply between 2008 and 2012, they have been steadily rising since then. Continued growth of road transport GHG emissions in the future would lead away from trajectories towards 2°C compatibility, and away from Latvia's projected pathway to 2030 (see Section 4.).

Figure 3.5. Road transport GHG emissions and volumes in Latvia, 2008-2018

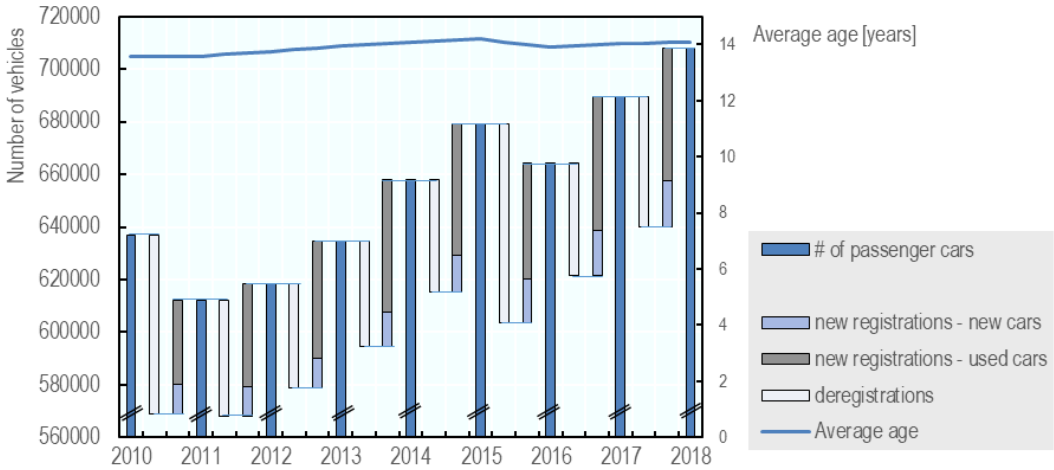


Source: GHG emissions: (UNFCCC, 2020[15]). Transport volumes: (Eurostat, 2020[41]), (CSB, 2020[42]).

Figure 3.5 further shows that passenger cars are the main GHG emissions driver, being responsible for over 50% of the road transport GHG emissions. Figure 3.6 details the evolution of the stock of registered passenger cars in Latvia. Around 60% of the stock has been renewed since 2011. In 80% of the cases, such renewal consisted in investments in purchases of used imported vehicles. The average age of a passenger car has remained constant between 2010 and 2018, at around 14 years.[14]

[14] Data on the total stock and average age of registered vehicles prior to 2010 is not comparable due to a change in the registration rules, leading to the de-registration of a large number of old vehicles in 2010.

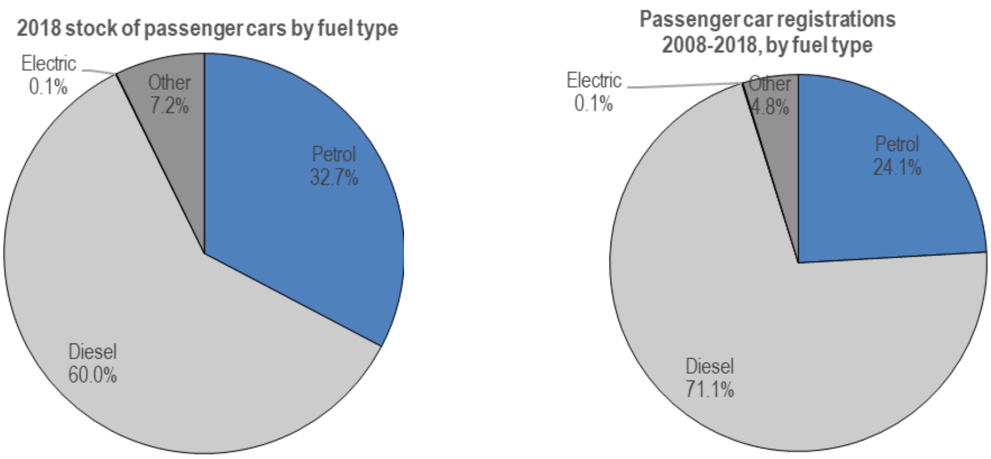
Figure 3.6. Renewal of Latvian passenger car stock



Note: Passenger cars are road vehicles classified in the M1 category.
Source: CSDD, CSB.

The most frequently used fuel for passenger cars (EU vehicle category M1), both in the stock and in newly registered cars, is diesel. This highlights that recent investments do not differ from historic ones. Among new cars, a higher share uses petrol fuel; however, as indicated above new cars were only around 20% of the additions to the Latvian vehicle stock during the considered period. As discussed in Section 4. , future GHG emission reductions needed to decarbonise the sector will require investments in alternatives. For instance, at the end of 2018 there were only around 440 registered electric passenger cars in Latvia. These correspond to 0.1% of the total number of registered passenger cars, and 0.2% of the investment volume. This is connected to the higher estimated investment costs (prices) for electrical vehicles than for the average Latvian car fleet (also see Figure 4.2 in Section 4.), and thus likely affordability and financing issues (also see Section 4.).

Figure 3.7. Fuels used by passenger cars in Latvia

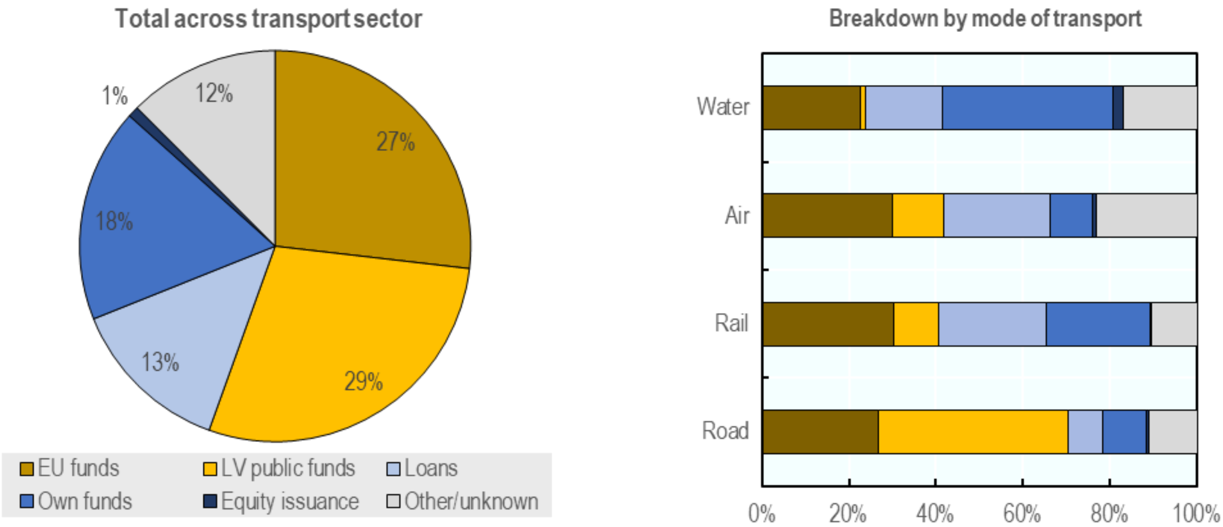


Note: The left chart shows the total stock of registered passenger cars (EU vehicle category M1) at the end of 2018. The right chart shows passenger cars (EU vehicle category M1) registered between 2008 and 2018. Both charts include new and second-hand cars. “Other” includes in particular hybrid vehicles such as petrol-electric hybrids and petrol-LPG hybrids, as well as various types of LPG and CNG cars.
Source: CSDD.

3.2. Sources of finance and public support

Figure 3.8 shows that public financing plays an important role for transport infrastructure in Latvia. Grants from EU funds financed over a quarter of Latvian transport infrastructure investment over the period considered. The largest contributions came from the Cohesion Fund and the European Regional Development Fund, with smaller volumes from other EU funds. Another 29% of infrastructure investments was financed by Latvian public funds, including national and municipal budgets.

Figure 3.8. Overview of financing for transport infrastructure in 2008-2018



Note: LV public funds includes both national government and municipal budgets. Own funds include, in particular, retained earnings from companies' operating activities.
Source: Data provided by Latvian stakeholders and own analysis, see Annex B for details.

In addition to such grants and subsidies, transport companies can use their own funds (retained earnings from operating activities) to finance investments. This contribution is estimated to be around 18% of total investment volumes. Furthermore, companies can raise funds by issuing equity (new shares) or raising new debt. Based on the available data, approximately 13% of the infrastructure financing was provided in form of loans (including loans by commercial banks and the state-owned development finance institution). This is consistent with the low level of debt observed economy-wide (see Section 2.2). Equity issuance is estimated to play a very small role as a source of finance (1% of total investment volume). Based on screening available commercial financial databases, no relevant transactions involving other financing mechanisms such as bond issuance, project finance, and public-private partnerships were identified in the course of this study.

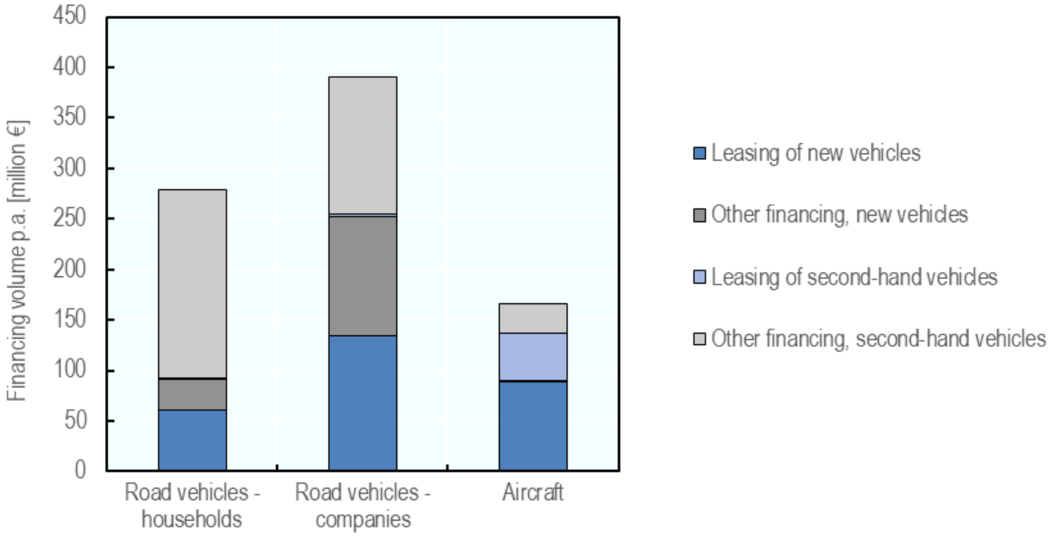
As highlighted in Section 3.1.1, over two thirds of the total infrastructure investment volume is covered by detailed investment and financing data collected from individual transport sector stakeholders. The remaining 30% are aggregate investments of small and mid-sized transport companies (e.g. freight logistics and cargo handling companies). For such aggregate investments, the shares attributed to different financing mechanisms were approximated by analysing the balance sheets of companies from the corresponding sectors, obtained from the Latvian Register of Enterprises. In general, it is difficult to identify the contributions of different financing mechanisms to balance sheet investments by private companies. The approach taken here is to match investments with coinciding increases in long-term liabilities (for details, see Annex B and (Dobrinevski and Jachnik, 2020[3]). Due to the approximations inherent in this method, as well as some data gaps, approximately 12% of the total investments could not be linked to specific sources of financing.

A detailed and comprehensive analysis of the financing mechanisms underlying investments in transport vehicles is more challenging than for infrastructure investments, due to multiple reasons:

- Companies from all economic sectors invest in vehicles. For many companies, vehicle investments do not form a major part of their total investment volume. Hence, the overall balance sheet structure of companies does not allow for conclusions on the sources of financing underlying vehicle investments specifically.
- A large share of investments in road vehicles are due to households. For financing vehicle investments, households typically rely on a combination of different sources of financing such as the sale of an old car, savings, debt and leasing. However, detailed data to estimate the share represented by these different sources could not be identified.

The only vehicle financing mechanism, for which comprehensive granular data was available is leasing. Figure 3.9 shows the estimated share of investments in road vehicles and aircraft financed through leasing in 2008-2018. A large majority (over 80%) of aircraft investments are estimated to be financed through leasing. For road vehicles, the importance of leasing is lower and varies depending on investor, vehicle type and age. The share of leasing is higher for new vehicles than for old vehicles, higher for light vehicles than for heavy vehicles, and higher for investments by companies than for households.

Figure 3.9. Role of leasing as a financing source for new and used vehicle investments (2008-2018 average)



Note: Investment volumes were estimated based on vehicle registrations and prices data. Volumes include both new and used vehicles. For road vehicles, all vehicle categories are included.
Source: Vehicle registration data (CSDD, CAA), road vehicle prices and leasing data (LAAAD), own analysis.

4. Financing future mitigation actions

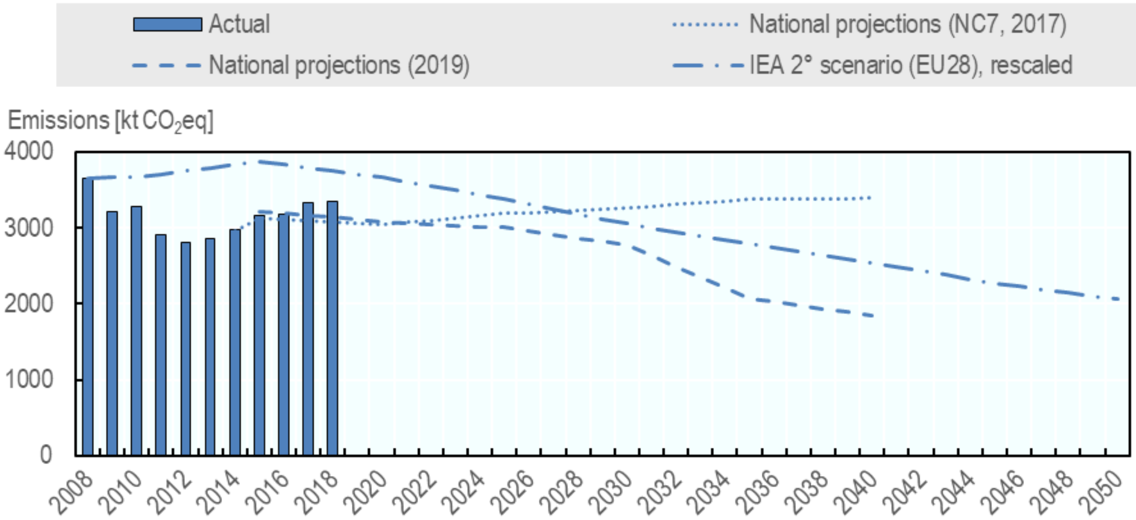
The analysis in Section 3.1 highlights that during the considered period 2008-2018, a significant share of investments were made in subsectors or technologies that developed consistently with the considered climate change mitigation reference points. However, further reduction of total GHG emissions and GHG emission intensities appear necessary in order for the Latvian transport sector to contribute to reaching national- and EU-level mitigation objectives for 2030 and 2050, and to align with the level of decarbonisation needed globally to achieve the Paris Agreement temperature goal.

In the coming years, a number of important demand-side trends will pose a challenge to reducing absolute GHG emissions in the Latvian transport sector. These include rising income levels, suburbanisation and low population density of rural areas, which are already leading to a growing vehicle fleet despite declining population (OECD, 2019[14]). In addition to rising demand for passenger mobility, other foreseen global trends in the transport sector are likely to materialise in Latvia, such as an increase of international maritime transport and international air traffic (ITF, 2019[43]).

Although not accounted for in national GHG inventories and forward-looking objectives, these two sectors involve domestic-level investments in ports and airports infrastructure. Relevant investments in Latvia, therefore, need to take into consideration supranational policy processes (e.g. inclusion of aviation within the EU in the EU ETS), industry initiatives (e.g. by the International Maritime Organisation) and technological innovations (e.g. alternative vehicle types and fuels). In case such developments curb future growth of international aviation and shipping, the corresponding infrastructure investments may be at risk of becoming stranded assets.

At EU level, an assessment of the impact of current policies indicates that transport is likely to become the largest CO_2 emitting sector from 2020 onwards (29% in 2020, 41% in 2050). Such projection owe to a slower pace of GHG emission reductions than in the power sector and more generally than in sectors covered by the ETS (European Commission, 2018[23]). At the Latvian level, Figure 4.1 highlights a clear discrepancy, from 2028 onwards, between the evolution of transport-related GHG emissions projected in Latvia's seventh National Communication to the UNFCCC (dating from 2017) and the GHG emission levels that would place the sector on a consistent pathway based on assumptions from the IEA scenario for the EU.

Figure 4.1. Forward-looking GHG emission scenarios for the Latvian transport sector



Note: The scope of emissions here is limited to the GHG emissions attributed to Latvia in the UNFCCC NIR methodology, i.e. it excludes international maritime and air transport.
Source: (UNFCCC, 2020[15]), (EEA, 2019[16]), (IEA, 2012[38]).

However, most recent national projections (reported in 2019 under the EU Greenhouse Gas Monitoring Mechanism Regulation (MMR)) indicate, on the contrary, a foreseen decrease of GHG emissions with a notable increase in the pace of such decrease after 2030. Latvia's existing strategic policy orientations that may support such trend include the following action areas:

- Improve energy efficiency, promote the use of alternative fuels and renewable energy in transport.
- Promote the growth of low and zero emission vehicles in public procurement and public transport.
- Improve the use of public transport in cities.
- Develop the infrastructure to support the electrification of road and rail transport.
- Facilitate cycling through the development of bicycle paths and parking.
- Facilitate access to remote work, study and other services.
- Promote the creation of multimodal hubs for public transport.

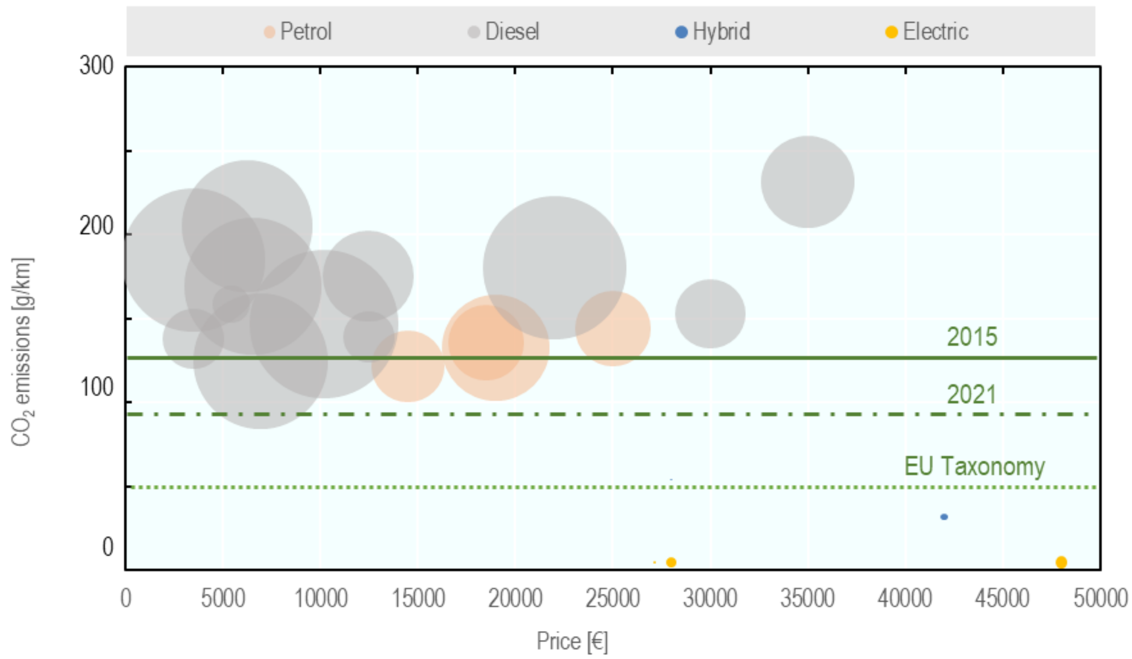
These orientations are well aligned with potential solutions identified by the ITF, which stresses a particular role for enhanced role for shared mobility (especially in urban areas) and for electrification on the supply side (ITF, 2019[43]). They are further coherent with the EU 2050 long-term strategy for achieving climate neutrality by 2050, based on four main action areas for the transport sector: low- and zero emission vehicles, vehicle efficiency and infrastructure; the use of alternative and net-zero carbon fuels; improving the efficiency of the transport system; societal and consumer choices (European Commission, 2018[23]).

Recent Latvian GHG emission projections include a breakdown of expected future GHG emissions by transport subsector. However, these do not have the character of official targets for GHG reductions and do not specify activity shifts in the different action areas listed above. For implementing the reductions projected in the 2019 MMR reporting, and in particular making finance flows consistent with these objectives, it would further be beneficial to link these GHG emission trajectories to corresponding investment needs or potential cost estimates.

Section 3.1.3 illustrated that road transport represents a particular challenge. Figure 4.2 demonstrates that the current car fleet is far from being consistent with the 2021 EU's fleet-wide average CO_2 emission target for new passenger cars, and even further from the current technical screening criteria of the EU Taxonomy.

Hence, a scalable and rapid shift in investments is needed compared to the trend observed for 2008-2018, during which the majority of car investments were in second hand diesel and petrol vehicles (Figure 3.6 and Figure 3.7).

Figure 4.2. Passenger cars' registrations in Latvia, 2015-2018: average CO_2 emissions and consistency with EU CO_2 emission targets and draft EU Taxonomy criteria



Note: Disks show the most frequent passenger car models, scaled according to the number of cars whose first registration in Latvia fell in the period 2015-2018. This includes both new and second-hand vehicles. The 2015 and 2021 lines are EU fleet-wide average CO_2 emission targets for new passenger cars. The dotted line is the criterion for low-emission vehicles according to the current technical screening criteria of the EU Taxonomy.
Source: CSDD (registrations), Latvian Authorised Automobile Dealers Association (prices).

Investments in and financing of alternative vehicles and fuel options to renew the Latvian car fleet decarbonise Latvia's road transport sector could go in multiple directions. A possible scenario was commissioned by the Transport Ministry (PricewaterhouseCoopers, 2018[44]). This scenario quantifies the required developments of alternative fuels (electricity, liquefied natural gas (LNG), compressed natural gas (CNG), and others) on the economically most efficient trajectory to a 70% reduction of transport-related energy consumption and halving of corresponding GHG emissions by 2050 compared to 2017.

The bulk of such decrease and of underlying fuel shifts happen post-2030 and involve: dividing by more than three the reliance on diesel and gasoline, creating a domestic or import supply chain allowing CNG and (to a lesser extent) biodiesel to play a significant role, as well creating the conditions for the development of electric vehicles. While alternative fuels such as CNG and LNG may play a transitional role towards zero-emission vehicles, the extent of their environmental benefits compared to traditional fuels is uncertain (Transport&Environment, 2018[45]). In any case, whether to thermal engines compliant with future GHG emission targets or electrical vehicles, a renewal of the Latvian car fleet requires innovative financing solutions in order to address affordability constraints. Green car loans and green car leasing combined with some degree of public subsidy are products in development.. More broadly, such scenarios should be modelled across transport subsectors. This would allow to fully leverage the possibilities for modal shifts e.g. for freight traffic from road to rail, and to provide a coherent roadmap for investment and financing needs across different modes of transport.

Transport infrastructure not only has a very long lifetime, but also directly impacts the potential for modal shifts as well as the demand for different types of vehicles. Hence, investment decisions over the next decade will be critical to avoid locking in GHG emissions at a level inconsistent with 2050 objectives. Notably, Latvia needs to invest in upgrading its transport infrastructure and public transport services linking Riga to its sprawling surroundings. While EU funds are likely to continue playing an important role in this context, domestic taxation could provide a stronger price signal and help raise revenue to finance such spending needs (OECD, 2019[14]).

5. Implications for data, methods and further tracking efforts

This study has been developed largely using investment and financing data provided specifically for this project by major transport sector actors in Latvia. The transport sector is particular in that vehicle investments are distributed across many actors in all economic sectors. Hence, the data collection for this study followed two different approaches for transport infrastructure and transport vehicles:

- For transport infrastructure, data on investments and sources of financing was obtained directly from major transport companies, the Ministry of Transport, and the Central Statistical Bureau of Latvia.
- For transport vehicles, while major transport companies did provide data on investments and sources of financing for their own vehicles, the bulk of vehicle investments was estimated based on registration data for aircraft, road vehicles, and rail vehicles. The corresponding vehicle prices, as well as estimates for sources of financing (leasing volumes) were obtained through expert analyses and desktop research.

The collection of primary data from relevant stakeholders involved significant efforts, but was essential for quantifying investments with the required level of technological granularity. For example, separating electrified from non-electrified rail investments would not have been possible using readily available data. This contrasts with a similar pilot conducted for the manufacturing industries in Norway (Dobrinevski and Jachnik, 2020[3]), where the structure of the sector allowed for an analysis based largely on publicly available data (e.g. structural business statistics and annual reports from companies).

In addition to the collection of primary data, existing official statistics (national accounts, structural business statistics, foreign trade statistics) from the Central Statistical Bureau of Latvia played a crucial role in this study. Such official statistics were used to obtain a high-level picture of the relevant subsectors, compare the investment volumes of individual actors to economy-wide totals, as well as to fill data gaps on aggregate investments from a large number of small actors (e.g. logistics companies). This was complemented by an analysis of the companies' financial statements (obtained from the Register of Enterprises), in particular to identify the sources of financing for companies' investments. The experiences of this study highlight the usefulness of official statistics and business registers for analyses of climate consistency of investments and financing, even if such data sources are not tailored towards climate-related questions initially.

The combination of data sets described above results in a comprehensive picture of transport investments and financing in Latvia, covering both infrastructure and vehicles. However, the estimated investment volumes are less precise than e.g. official statistics. This is linked to constraints in the data collection, as well as approximations in the estimation of investment volumes from vehicle registrations and typical prices (see Table A.2). Furthermore, the broad coverage entailed a significant effort on part of the MEPRD for requesting data from over thirty stakeholders and coordinating the data collection.

The consistency of the identified investments with climate change mitigation objectives was then measured based on three different readily available reference points: the current technical screening criteria of the EU Taxonomy for Sustainable Activities, the IEA 2°C scenario for the EU, and the GHG emission projections from the 5th National Communication of Latvia to the UNFCCC. Apart from providing three complementary perspectives on transport investments in Latvia, this analysis yields the following conclusions on the use of these reference points for measuring climate consistency.

The EU Taxonomy defines technical screening criteria for activities contributing significantly to climate change mitigation. While future developments of the EU Taxonomy may introduce further categories e.g. for investments inconsistent with climate objectives, the current screening criteria do not cover the vast majority of investments (96%). Evaluating some of the technical screening criteria also requires access to investment and GHG emissions data at a granular level (e.g. in the transport sector, GHG emission intensities of individual transport activities such as individual public transportation projects). However, such granular GHG emissions data are rarely publicly available. Further, the individual screening criteria of the EU Taxonomy are not explicitly positioned against a level of ambition consistent with the Paris Agreement temperature goal.

A complementary type of analysis for measuring the consistency of investments relies on climate change mitigation scenarios, in the present case the IEA 2°C scenario and the Latvian NC5 forecast. Such scenario-based analysis addresses a much larger share of total investments than the EU Taxonomy. In particular, this type of analysis makes it possible to estimate investments that are potentially inconsistent with climate goals, which is crucial for analysing GHG lock-in effects. However, scenario-based analyses have their own limitations (some of which were identified in a previous study on the Norwegian manufacturing industries):

- Identifying the underlying reasons for consistency or inconsistency of a subsector with the chosen scenario is not straightforward. Inconsistencies could be linked to insufficient investment in new technologies (e.g. electric vehicles), but also increased demand and use of transportation as well as modal shifts between transport modes. For example, a significant shift in transport volumes away from road and towards rail could mean that the road emissions fall below the chosen GHG scenario and the rail emissions rise above the chosen GHG scenario. In this case, the simplistic scenario analysis performed here would indicate that road transport is developing consistently and rail transport inconsistently with the chosen climate change mitigation scenario. This result does not correspond to the actual climate impact of the sectors, since typically rail transport is less emissions-intensive than road transport. Properly accounting for such cases requires further refinement of the scenario analysis methodology introduced here.
- A wide range of different transition scenarios may be compatible with a given set of long-term climate objectives
- Scenarios rely on uncertain assumptions on overall economic development and on the emission reduction measures implemented in different sectors/geographies
- Global or supranational scenarios providing GHG emission trajectories, such as those of the IEA, are often not granular enough to match country- and subsector-level investment and GHG emission data. Country-level projections, such as those from Latvia's National Communications to the UNFCCC, can reflect national circumstances more accurately. However, they typically only yield an aggregate evaluation of consistency for each (sub)sector as a whole, rather than for individual investment projects.
- While the scenario-based analysis could be applied on an aggregate level to the infrastructure investments for each transport mode, it was not conclusive with respect to vehicle investments. This is largely linked to challenges in identifying a suitable data source for GHG emissions of transport vehicles. The UNFCCC NIRs emission data covers all transport modes, however does not provide the required granularity to disaggregate individual vehicle subsets as selected in the analysis of investment volumes. For example, new vehicles could not be disaggregated from used vehicles, and trucks could not be disaggregated from buses. In principle, a data source with the required granularity would be technical characteristics of individual vehicles as specified e.g. in

vehicle registrations. However, registrations data only includes CO_2 emissions for recently manufactured passenger cars and not for other vehicle types.

- Furthermore, transport vehicles such as airplanes, ships and trucks may be registered in one country, fuelling and emitting GHG in another country, and owned by an entity in a third country. This mobility means that for countries and transport modes with a high share of international transport and/or international ownership of vehicles, a supranational analysis is required to evaluate climate consistency of investments and financing.

Further, neither the benchmarking for direct GHG emission reductions nor the current EU Taxonomy screening criteria take into account indirect GHG emissions (or their reductions) based on the full life-cycle of transport infrastructure and vehicles. A related challenge is how to account for upstream or downstream economic activities, which drive the demand for transport services. For example, understanding growth in freight transport might require looking at import/export activities (and related investments) of commodities producers. However, incorporating these aspects into a climate consistency assessment would require a cross-sectoral analysis at international level, and would pose challenges in attributing GHG emissions to underlying investments across the life cycle.

The approach pursued in this study further identifies the sources of financing underlying the measured investments. Establishing the role of financing conditions in investment decisions would require detailed data on financial transactions from companies and/or finance providers. Relevant data - such as loan terms, interest rates, as well as the expected revenues and operating expenditures associated with investments - is commercially sensitive and frequently confidential. Nevertheless, it would be interesting, particularly in the transport sector, to explore further the (expected) operating expenditures linked to different types of fuel, and their impact on the initial investment decision.

As observed in the parallel study on the manufacturing industries in Norway, the choice of reference point significantly affects all aspects of the climate-consistency measurement: the proportion of total investments that can be addressed, the categories to classify investments as consistent and/or inconsistent, and the subsector-level assessment results. Such variation calls for further discussions on what kind of reference points, or combinations thereof, to use for tracking progress towards Article 2.1c of the Paris Agreement by different actors.

The methodology followed in the Norway and Latvia pilot studies could be expanded to cover additional elements, such as investments in intangible assets, stocks of existing assets, and flows related to depreciation and decommissioning. In addition to that, further research work towards drawing more general and robust conclusions for systematic measurement of the climate consistency of real economy investments could follow three complementary directions:

- Further case studies for other sectors and countries. Such work would shed light on the availability of data in different contexts, and could explore additional data collection and estimation methods.
- Analysis of climate-consistency for one sector across multiple countries, or globally. Specifically for the transport sector, such analysis would address the ambiguity in assigning emissions from international transport to individual countries.
- Measuring resilience to climate change as part of the analysis of climate consistency. This would enable links to the evaluation of climate-related risks, including physical climate risks, which the financial sector (investors, financing institutions) and financial regulators are increasingly undertaking.

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Annex A. Sector, sub-sector and technology coverage

Table A.2 shows an overview of the subsectors and assets analysed for this study. As highlighted in Section 2.3 and Table A.1, the scope chosen here is broader than gross fixed capital formation (GFCF) by the transport sector as presented in the national accounts.

- The GFCF of the transport sector as defined in the national accounts (NACE codes 49-53) is in principle completely covered in Table A.2
- In addition, Table A.2 covers GFCF in transport vehicles by companies outside the transport sector, which, in the national accounts, is categorised in other sectors than transport.
- Furthermore, Table A.2 covers direct investment by the government in transport infrastructure, e.g. roads. This is part of the public administration sector GFCF in the national accounts.
- Finally, Table A.2 also captures household investments in transport vehicles, which, under the national accounts, are not included in GFCF but are part of household expenditures.
- There may be further scope differences with respect to leased vehicles, in particular aircraft. In this study, investments are estimated based on the registration of a vehicle in Latvia. This means, that if an airline leases an aircraft from a foreign lessor and registers it in Latvia, it is counted towards the estimates in Table A.2 irrespectively of whether the vehicle appears on the Latvian company's balance sheet or not.

Table A.1. Comparison of the scope of tracking with national accounts

	Gross Fixed Capital Formation			
Type of asset	Transport sector	Public administration sector	Other sectors	**Household Expenditure**
Transport vehicles	X	X	X	X
Construction (buildings)	X	partially (e.g. road infrastructure)		
Equipment, machinery	X			
Other				

Note: The orange highlighted cells indicate the investments tracked in this study and further broken down in Table A.2.

The categorisation of assts in Table A.2 was developed based on the granularity of data provided by the contacted transport sector stakeholders. For vehicles, the categories chosen here follow the UNECE vehicle classes (UNECE, 2017[46]). The classes are then subdivided based on fuel and on the age of the vehicle, which are important for the analysis of consistency with climate objectives in Section 3.1.2. Vehicles where the difference between first registration in Latvia and the manufacturing is at most one year are considered new vehicles.

Several elements listed in Table A.2 are excluded from the consistency analysis in Section 3.1.2, in particular:

- Investments in used aircraft and in used road vehicles (see Box 3.1).
- Investments in warehousing, logistics, postal services, and other transport investments that could not be disaggregated by mode of transport (last row with mode "OTHER" in Table A.2).

Table A.2. Overview of analysed investment volumes (estimated total 2008-2018, million €)

Mode	Type of asset	Coverage details	Method	Total investment 2008-2018 [mill. €]	Main uncertainties	Share of investment: Households	Share of investment: Companies	Share of investment: Government
AIR	Infrastructure - Airports	Riga, Liepaja airports	a)	212.1	3)	0%	100%	0%
AIR	New aircraft	Aircraft registered in Latvia in the considered period	b)	991.4	1)	0%	100%	0%
AIR	Used aircraft	Aircraft registered in Latvia in the considered period	b)	833.6	1)	0%	100%	0%
AIR	Other infrastructure	NACE code 52.23 (excl. where covered above): Air traffic control, ground handling, …	c)	33.7		0%	100%	0%
RAIL	Infrastructure - Electric public transport	Tramway infrastructure	a)	174.7	3)	0%	100%	0%
RAIL	Infrastructure - Rail (electrified)		a)	241.7	3)	0%	100%	0%
RAIL	Infrastructure - Rail (non-electrified)		a)	581.1	3)	0%	100%	0%
RAIL	Infrastructure - Rail (other)		a)	148.0	3)	0%	100%	0%
RAIL	Vehicles - Rail (diesel)		a)	257.0	3), 4)	0%	100%	0%
RAIL	Vehicles - Rail (electric)		a)	6.5	3), 4)	0%	100%	0%
RAIL	Vehicles - Rail (passenger)	Unclear electrification share	a)	39.9	3), 4)	0%	100%	0%
RAIL	Vehicles - Tram		a)	90.2	3)	0%	100%	0%
RAIL	Other infrastructure	NACE code 49.1, 49.2 (excl. where covered above): Aggregate investments by rail freight logistics companies and other interurban passenger rail transport companies (based on annual reports)	c)	42.9		0%	100%	0%
ROAD	Infrastructure - Bus	Riga and Daugavpils	a)	1.0	3), 4)	0%	100%	0%
ROAD	Infrastructure - Electric public transport	Trolleybus and electric bus infrastructure	a)	0.1	3)	0%	100%	0%
ROAD	Infrastructure - Road	State, regional and municipal roads (streets)	a)	2525.7	3)	0%	0%	100%
ROAD	Infrastructure - Road (electric)	Electric vehicle charging stations	a)	4.1	3)	0%	10%	90%
ROAD	New vehicles - Buses	M2 and M3 vehicle categories	a), b)	154.4	3), 1)	1%	99%	0%
ROAD	New vehicles - Buses, electric	M2 and M3 vehicle categories	a)	2.0	3)	0%	100%	0%
ROAD	New vehicles - Heavy trucks	N2 and N3 vehicle categories	b)	800.7	1)	0%	100%	0%
ROAD	New vehicles - Light trucks	N1 vehicle category	b)	384.6	1)	11%	89%	0%
ROAD	New vehicles - Light trucks, electric	N1 vehicle category	b)	0.6	1)	9%	91%	0%
ROAD	New vehicles - Motorcycles	L… vehicle categories	b)	43.3	1)	87%	13%	0%

ROAD	New vehicles - Passenger cars	M1 vehicle category	b)	2383.3	1)	39%	61%	0%
ROAD	New vehicles - Passenger cars, electric	M1 vehicle category	a), b)	9.5	1)	15%	85%	0%
ROAD	Used vehicles - Buses	M2 and M3 vehicle categories	a), b)	73.2	3), 1)	9%	91%	0%
ROAD	Used vehicles - Heavy trucks	N2 and N3 vehicle categories	b)	227.2	1)	7%	93%	0%
ROAD	Used vehicles - Light trucks	N1 vehicle category	b)	145.3	1)	41%	59%	0%
ROAD	Used vehicles - Motorcycles	L… vehicle categories	b)	41.0	1)	97%	3%	0%
ROAD	Used vehicles - Passenger cars	M1 vehicle category	b)	2945.6	1)	64%	36%	0%
ROAD	Used vehicles - Passenger cars, electric	M1 vehicle category	b)	2.2	1)	62%	38%	0%
ROAD	Vehicles - Bicycles		d)	39.8	2)	100%	0%	0%
ROAD	Vehicles - Trolleybus		a)	105.8	3)	0%	100%	0%
ROAD	Other infrastructure	NACE code 49.4 (excl. where covered above): Aggregate investments by road freight companies	c)	1194.7		0%	100%	0%
ROAD	Other passenger transport	NACE code 49.31, 49.39 (excl. where covered above): Aggregate investments by smaller (public) transport companies	c)	156.8		0%	100%	0%
WATER	Ships	Data gap - not estimated						
WATER	Infrastructure - Ports	Ports of Riga, Liepaja, Ventspils	a)	702.7	3), 4)	0%	0%	100%
WATER	Other infrastructure	NACE codes 50.20, 52.22, 52.24 (excl. where covered above): Aggregate investments by water freight companies, cargo handling	c)	461.3		0%	100%	0%
OTHER	Other	NACE codes 52.1, 52.29, 53: Aggregate investments by warehousing and storage companies and other companies not covered above	c)	565.2		0%	100%	0%

Note: Government includes only direct investment by the national government and by municipalities. Investments of state-owned enterprises are included under “companies”.
The different methods used to estimate investment values are summarised as follows:
a) Financial data directly provided by stakeholders. Estimated uncertainty is on the order of 25%
b) Estimation based on registration data and prices. Estimated uncertainty is on the order of 50% c) Estimation of gaps based on comparison to aggregate statistics. Estimated uncertainty is on the order of 50%
d) National statistics
The different sources for uncertainties are:
1) Uncertainty of price estimates
2) Uncertainty of household consumption survey estimates
3) Uncertainties in company financial reporting linked e.g. to tax treatment, cash-based vs. accrual-based accounting treatment, etc.
4) Uncertainty due to partial coverage of current estimates (e.g. only partial coverage of physical stock)
Source: See Annex B for details on data sources, validations, and on data gaps.

Table A.3. Sources of finance for transport investments (estimated total 2008-2018, million €)

Mode	Type of asset	Investment volume	Sources of finance						
			EU funds	LV public funds	Loans	Own funds	Leasing	Equity issuance	Other/unknown
AIR	Aircraft - new	991.4	0.0	0.0	0.0	0.0	980.0	0.0	11.4
AIR	Aircraft - used	833.6	0.0	0.0	0.0	0.0	521.5	0.0	312.1
AIR	Infrastructure	245.8	73.7	29.0	60.2	24.0	0.0	2.0	56.8
RAIL	Infrastructure	1188.3	360.7	123.2	292.5	284.5	0.0	2.3	125.2
RAIL	Rolling stock	393.6	20.6	3.2	90.7	239.1	0.0	0.0	40.0
ROAD	Infrastructure	3882.4	1039.7	1690.7	313.3	381.0	0.0	29.2	428.3
ROAD	Heavy vehicles - new	1106.3	3.0	0.2	35.9	6.3	288.9	0.0	772.0
ROAD	Heavy vehicles - used	341.4	0.0	0.0	0.0	0.0	12.7	0.0	328.6
ROAD	Light vehicles - new	2817.7	0.0	0.0	0.0	39.8	1856.3	0.0	921.7
ROAD	Light vehicles - used	3093.1	0.0	0.0	0.0	0.0	29.8	0.0	3063.3
WATER	Infrastructure	1164.0	264.4	14.3	205.3	456.3	0.0	25.6	198.1

Source: See Annex B for details on data sources, validations, and on data gaps.

Table A.4. Evolution of investment volumes over time (million €, estimated)

Mode	Type of asset	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
AIR	Aircraft - new	0.5	90.0	80.4	0.3	0.3	40.4	0.5	6.0	110.4	275.3	387.3
AIR	Aircraft - used	0.3	0.1	0.9	0.8	1.9	45.6	52.8	96.4	294.5	96.0	244.3
AIR	Infrastructure	27.9	7.8	6.9	7.5	14.8	46.0	54.0	35.3	21.0	13.0	11.5
RAIL	Infrastructure	67.2	71.4	89.8	80.4	154.3	133.5	172.5	271.6	39.3	48.9	59.3
RAIL	Rolling stock	13.7	54.7	26.7	55.2	83.1	51.7	30.7	12.2	32.0	8.2	25.4
ROAD	Infrastructure	503.2	231.7	245.9	341.1	376.1	306.9	323.8	331.6	325.6	474.6	421.7
ROAD	Heavy vehicles - new	121.9	59.4	34.2	77.2	77.9	80.2	60.2	126.6	168.3	133.5	166.9
ROAD	Heavy vehicles - used	24.1	12.3	24.3	36.9	35.9	36.0	30.0	32.8	29.4	36.5	43.1
ROAD	Light vehicles - new	368.2	78.6	95.9	187.7	232.4	236.1	268.5	280.4	317.6	371.2	381.0
ROAD	Light vehicles - used	256.1	78.3	132.9	227.4	300.8	329.2	375.0	365.7	324.5	354.4	348.7
WATER	Infrastructure	81.7	40.4	42.7	100.2	129.8	219.0	117.3	145.0	51.9	100.5	135.5

Source: See Annex B for details on data sources, validations, and on data gaps.

Annex B. Data sources on investments and sources of finance

To estimate the investment volumes as detailed in Table A.2, data on investments and financing from the following organisations was obtained via the MEPRD:

- Air: Airports of Riga and Liepaja, Civil Aviation Authority
- Rail: Latvijas dzelzceļš, Pasažieru vilciens, State Railway Technical Inspectorate, public transport authorities of Riga, Liepaja and Daugavpils
- Road: Ministry of Transport, Road Traffic Safety Directorate (CSDD), public transport authorities of Riga and Daugavpils, Latvian Association of Authorised Automobile Dealers
- Water: Ports of Riga, Liepaja, Ventspils
- Across all sectors: Central Statistical Bureau

This data covers around 70% of the total infrastructure investment volume and around 7% of the total vehicle investment volume shown in Section 3. . The remaining infrastructure and vehicle investments were estimated as follows:

- The 30% of remaining infrastructure investments are aggregate investments of small and mid-sized transport companies (e.g. freight logistics and cargo handling companies). Such companies were not analysed individually in the course of this study. Instead, their investments were estimated by comparing the detailed data provided by large Latvian transport organisations (see preceding paragraph), to aggregate investment volumes for the relevant subsectors, as shown in the national accounts and structural business statistics. The resulting rows are marked with "estimation method: gap to aggregate statistics" in Table A.2; this table also indicates the NACE codes to which the corresponding detailed data was compared. The aggregate statistics for the relevant 4-digit NACE codes were taken from the EuroStat Structural Business Statistics table sbs_na_1a_se_r2, except for NACE codes 4910 and 4920 which were estimated directly from companies annual reports obtained from the Register of Enterprises. It was verified that the 2-digit NACE code totals largely match the GFCF figures reported on 2-digit NACE code level in the national accounts.
- The majority of vehicle investments (over 90%), where detailed data was not available, were estimated based on vehicle registration data and vehicle price estimates. Estimated average vehicle prices for around 90 frequently used road vehicle models (covering different vehicle categories and ages) were provided by the Latvian Association of Authorised Automobile Dealers. This was extrapolated to the entire road vehicle fleet based on road vehicle registrations data from the Latvian Road Traffic Safety Directorate (CSDD). For aircraft, a similar approach was followed. Prices for frequently purchased new and used aircraft models were estimated based on manufacturer price lists and desktop research. Based on aircraft registrations data from the Civil Aviation Authority, an overall investment estimate for the aircraft fleet was derived.

In addition, for the analysis of the sources of financing the following data was used:

- Ministry of Transport, Investment and Development Agency of Latvia (LIAA): Projects financed from EU funds.

- Bank of Latvia: Leasing and lending volumes. Both the outstanding stock of leasing/lending volumes, and the volume of new transactions for each relevant subsector were obtained from the Credit register. However, due to multiple differences in terms of coverage and scope this data was not directly comparable to the estimated investment volumes:
  - The data reported on leasing transactions typically does not distinguish different types of leased assets. Hence, especially for companies, transactions for leasing transport vehicles cannot be disentangled from transactions for leasing other assets (e.g. non-transport-related equipment).
  - New leasing transactions may not be associated with new investments. For example, no new investments occur when an existing operating lease runs out and is converted into a financing lease, or when an existing vehicle is leased to a new customer. Such cases cannot be isolated based on the reported data.
  - Especially in small and medium-sized enterprises, leasing transactions may be signed or co-signed by managers in a personal capacity. Hence, the attribution of leasing transactions to households or legal entities may not always be accurate.
- European Investment Bank: List of financed projects in Latvia. No relevant projects were identified in the considered timeframe.
- Latvian Association of Authorised Automobile Dealers: Statistics and estimates on types of vehicle holders, as well as shares of leasing financing, for road vehicles' first registrations in 2015-2018. These data were used in particular to estimate the shares of investments in passenger cars by households and by companies (legal entities) respectively. To this end, the shares of first registrations in 2015-2018 by households and by companies are compared to the current shares of vehicles held by households and companies. This yields estimates for the share of passenger cars re-sold from companies to households each year (9.2% for new passenger cars and 26% for second-hand passenger cars). These estimates, in turn, are used to extrapolate the shares of first registrations by companies and households for the entire observation period, based on the current ownership data in the vehicle stock snapshot obtained from CSDD.
- Register of Enterprises: Firm-level balance sheet and cash-flow statement data for all transport companies in Latvia over the considered period.

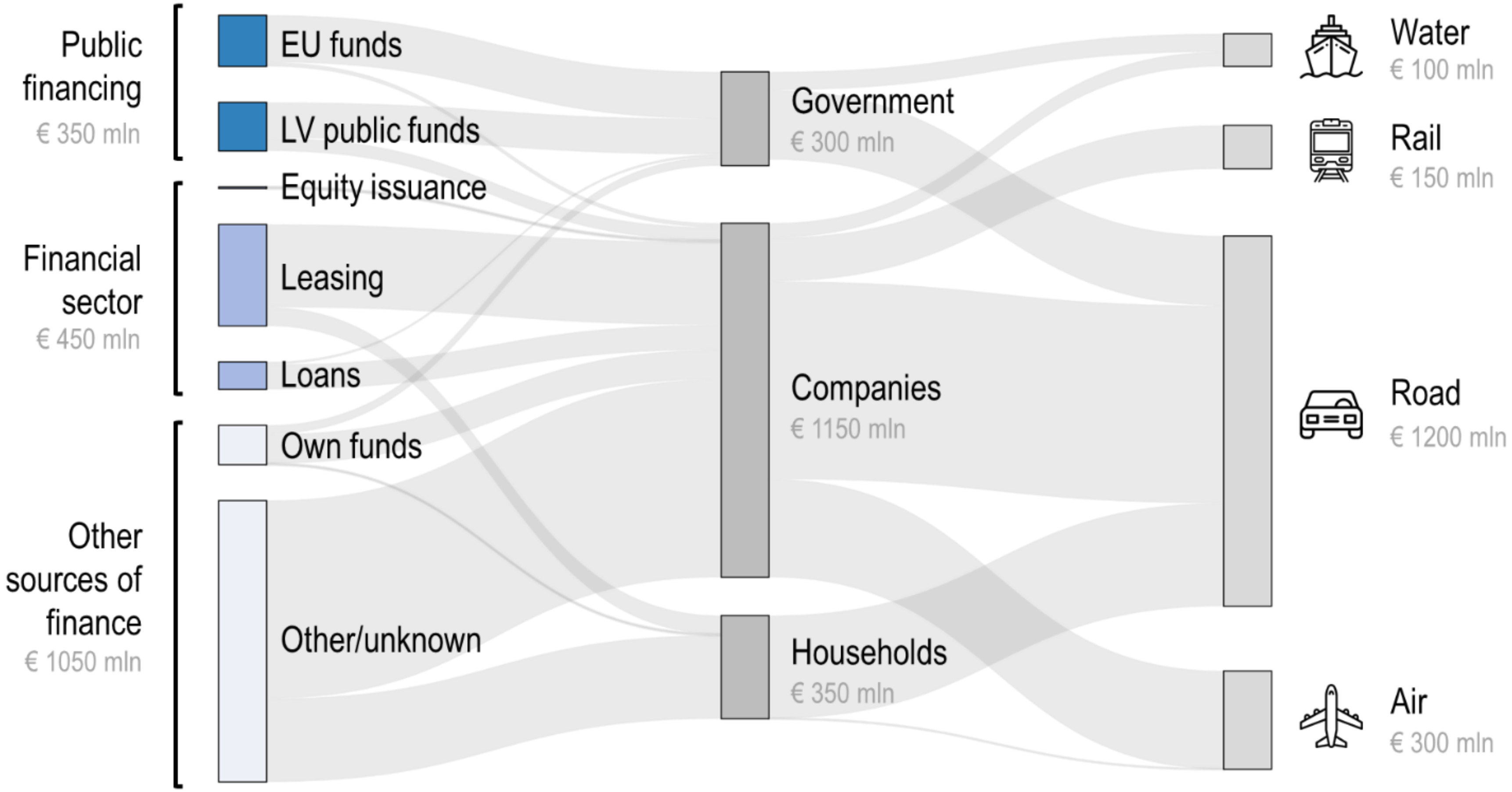
The estimates detailed in Table A.2 were compared against multiple aggregate reference points:

- Air, rail and water infrastructure investment broadly matches ITF statistics within the uncertainties indicated in Table A.2
- The investment by households in passenger cars, motorcycles and bicycles is mostly aligned with household consumption statistics by the Central Statistical Bureau of Latvia. A major difference was observed for investments in used passenger cars.
- Total investment volumes for different types of vehicles broadly match the total import values of the corresponding vehicle types in the foreign trade statistics. While there are significant differences for some vehicle types (e.g. goods vehicles), they can potentially be explained by the margin with which such vehicles are resold to consumers or companies.
- The aggregate GFCF within the transport sector (excluding transport vehicles) broadly matches the aggregate of the values in Table A.2 which fall in the corresponding scope.

The following major data gaps remain:

- The volume of investment in international shipping vessels (e.g. oil tankers) could not be estimated. In contrast to the other modes of transport, such vessels are not registered in Latvia and hence reliable financial or non-financial data on these vessels could not be obtained.
- Sources of financing for vehicles are challenging to identify, as detailed in Section 3.2.

Figure 5.1. Overview of financing and investments in the transport sector in Latvia



Note: Both infrastructure and vehicles are included in the investment and financing flows. Flow volumes are rounded to the nearest EUR 50 million, and represent average annual investment/financing over the period 2008-2018.

Annex C. Sources of information to measure the climate consistency of investments

The classification of investments according to the technical screening criteria of the EU Taxonomy for Sustainable Activities relies on qualitative and quantitative inputs. The screening of investments for consistency with the EU Taxonomy criteria, as performed in Section 3.1.2, is based on the technology underlying the investment. The identified EU Taxonomy-compliant investments include zero-emission transport vehicles (electric cars and buses, trams, trolleybuses, etc.) as well as the underlying infrastructure. This assessment relies on the technology-level granularity of the investment data provided by the Latvian transport stakeholders. Beyond zero-emission transport, the EU Taxonomy also includes screening criteria for low-emission transport based on thresholds for CO_2 emissions intensities. A precise evaluation of these GHG emission intensity thresholds is not possible with the available data. However, investments in low- but not zero-emission transport are estimated to be insignificant, since compatibility with the screening criteria would require significantly above-average occupation factors and/or advanced hybrid technology. Evaluating this in depth would require additional granular data on usage volumes and occupancy.

The measurement of consistency with climate scenarios presented in Section 3.1.2 requires data on GHG emissions. For the present study, historical GHG emissions were extracted from the Latvian National Inventory Reports as submitted to the UNFCCC (UNFCCC, 2020[15]). Table C.1 shows the GHG emission data used for this study.

For a scenario-based analysis of GHG emission volumes in general, the average (or total) emissions over 2008-2018 are rescaled to the 2008 baseline and compared between past forecasts and actual developments. This is more relevant than a comparison based on the last year only, since the global warming potential in a given forward-looking scenario largely depends on the cumulative GHG emissions ("carbon budget"). The analysis here takes into account if particularly large GHG emissions e.g. in the last year of the considered period were compensated by below-expected GHG emissions in previous years (or the other way around).

Table C.1. Latvian transport sector GHG emissions (2008-2018, kt CO_2eq)

Subsector	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average 2008-2018
Domestic aviation	2.0	2.8	0.3	0.4	0.6	2.2	3.4	3.4	1.7	1.9	4.5	3.7	2.3
International aviation	247.2	297.3	314.0	360.3	361.4	366.1	377.7	337.2	330.9	376.6	431.2	472.3	365.9
Aviation total	249.2	300.1	314.2	360.7	362.1	368.3	381.1	340.5	332.6	378.5	435.6	476.0	368.2
Rail total	276.3	276.3	258.6	234.1	262.9	280.4	252.0	241.6	231.2	195.3	183.1	187.0	236.6
Cars	2043.3	1913.5	1719.1	1738.1	1523.7	1458.6	1503.4	1595.2	1706.0	1737.1	1805.4	1840.8	1685.6
Light duty trucks	221.1	223.6	200.7	222.7	177.3	189.1	203.3	219.9	247.1	257.2	262.4	269.0	224.8
Motorcycles	2.1	2.8	3.3	2.3	2.7	2.0	2.3	3.2	4.7	5.6	6.3	6.5	3.8
Light road total	2266.4	2139.8	1923.2	1963.0	1703.7	1649.8	1709.0	1818.3	1957.8	1999.9	2074.1	2116.3	1914.1
Heavy duty trucks & buses	1325.2	1232.7	1010.2	1063.5	931.4	867.1	857.1	896.0	952.1	960.9	1048.2	1024.0	985.7
Road total	3591.6	3372.5	2933.4	3026.5	2635.1	2516.8	2566.1	2714.3	2910.0	2960.8	3122.3	3140.4	2899.8
Domestic navigation	4.0	7.4	14.5	18.0	18.0	14.5	28.8	14.6	11.0	15.1	16.0	22.8	16.4
International navigation	597.0	683.5	908.6	838.8	720.1	807.7	783.9	775.3	862.9	1070.9	883.9	133.9	770.0
Navigation total	601.0	691.0	923.1	856.7	738.1	822.2	812.7	789.9	873.9	1086.0	899.9	156.7	786.4
Transport total	4718.1	4639.9	4429.4	4478.0	3998.2	3987.7	4011.9	4086.3	4347.6	4620.6	4640.9	3960.1	4291.0

Note: All values are indicated in kt CO_2eq. International aviation and international navigation emissions correspond to airplanes or ships refuelling in Latvia, and are not counted towards Latvia's total GHG emissions in the UNFCCC inventory or the corresponding reduction targets. However they are included here due to their global GHG impact.
Source: (UNFCCC, 2020[15]).

For the measurement of consistency with the IEA 2°C scenario, the subsector-level GHG emissions forecasts from the 2012 ETP are used. The time resolution in IEA scenarios is 5 years; intermediate values are interpolated linearly based on the data points for the years 2005, 2010, 2015 and 2020. The comparison is based on the scenario's regional forecast for the EU-28, which is not further broken down on country level. Hence, to compare against the actual GHG emissions trajectory in Latvia, both the IEA GHG emission forecasts and Latvia's actual GHG emissions were divided by their 2008 values. In other words, the relative GHG emission reduction or increase with respect to the 2008 base value was considered. This relative GHG emission change, averaged over the period 2008-2018, is compared for each subsector to the corresponding relative GHG emission change from the IEA scenario. Subsectors where the relative GHG emission changes are below the IEA scenario values are considered consistent with the 2°C scenario. Subsectors where this is not the case are considered inconsistent with this scenario.

The measurement of consistency with the 2008-2020 pathway forecast in the 5th National Communication reported to the UNFCCC by Latvia in 2010 is based on the same approach as the consistency with the IEA 2°C scenario. Since here, the geographical and sectoral scope of the projection is fully aligned with the geographical and sectoral scope of the actual GHG emission values reported in the later NIRs, no rescaling is necessary and the absolute GHG emission values can be compared directly on subsector level.