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TRACECA IDEA II

Transport Dialogue and Networks Interoperability II

Eastern Partnership regional transport study

Final report
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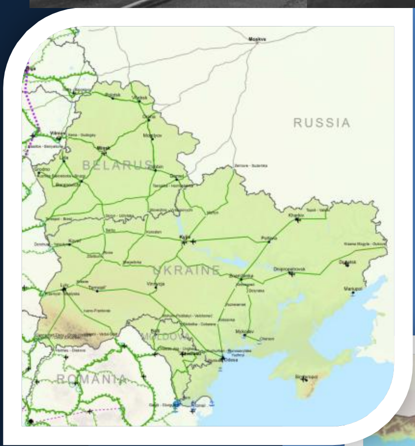

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LIST OF ABBREVIATIONS

EaP	Eastern Partnership
EC	European Commission
EU	European Union
GIS	Geographic Information System
IFI	International Financing Institution
LoS	Level of Service
NIF	Neighbourhood Investment Facility
Oblast	A type of geographical administrative division in the countries of the FSU
v/c ratio	Volume to capacity ratio for road transport links
TEN-T	Trans-European Networks – Transport

1 EXECUTIVE SUMMARY

The study objective and methodology

The present study is intended to provide the basic information regarding the characteristic of the **Eastern Partnership strategic transport networks** and also provide a first overview of the existing traffic flows and the demand forecast by 2030. This was elaborated along two main activities:

- Gather information on the characteristics of the modal networks in the six countries;
- Deploy multimodal freight and passenger model to reflect long distance flow patterns and their future development.

The data collection

The transport network data collected were organized in maps and **infographics fact sheets** along the EaP corridors for Railways, Roads as well as key Inland Waterways. The annexes encompass over 34 Info graphics for **Railways**, 35 for **Roads** and 21 for **Inland Waterways**. They reflect the characteristics of every corridor based on the collected data. These data have also been incorporated into a **GIS database** for further exploitation, where needed.

The transport scenarios

A strategic transport model was applied to estimate the long distance demand for the horizon year 2030. In the framework of this study, the TRACECA model was updated to include Belarus, reflect the base year of 2012 and include the passenger transport. Bearing in mind the level of aggregation of its results, the model validation shows high compliance with the modal split values versus official statistics and also comparing against the traffic volumes values received from the countries and the manual counts executed.

To provide a basis for the economic assessment of priority projects, the future development is considered along **three different scenarios** which are the following:

- **A Baseline** or Business as Usual scenario;
- An **Integration scenario**, where economic relationships within EaP and between EaP and EU are more developed;
- A **Stagnation scenario** where economic relationships between EaP and EU are less developed.

The objective of the three scenarios is to highlight the performance of the networks under different future demand levels and identify potential infrastructure and non-infrastructure bottlenecks. The scenarios are based on common assumptions about population development and transport supply. The baseline scenario builds on economic assessment by the World Bank and the International Monetary Fund for the year 2020 that was extrapolated until 2030, while what differentiate the Integration and Stagnation scenarios are the assumptions concerning the level of economic growth of the EaP countries, the level of (intra)integration within the region and of (inter)integration between the EaP countries and the EU.

The road network

The assessment of the infrastructure shows **homogeneous characteristics of the road network** elements. The Eastern Partnership strategic road network covers over 12,000 km of motorways, express ways and national roads with single carriageway. **Roads with one lane per direction are the majority of roads cross section**, while two lanes per direction roads are barely over 20% of the network. Roads over four lanes cross section are an exception found in Ukraine and Azerbaijan only. And the latter country, Azerbaijan, is the only one where more than half of the strategic road network is composed by motorways with two lanes per direction or more.

The design speed of 90 km/h prevails along the network of single carriageway roads, complying with the national regulations, as well as on over 55% of the total network. One third of the strategic network shows design speed above 90 km/h, while only 10% has a design speed below 90%, mainly on single carriageway roads or locations with speed limit on motorways.

The roads surface quality assessment shows differentiated results based on the road category and partially on the country, being the poor surface quality roads concentrated essentially in Armenia, Moldova and Ukraine. **The road surface of more than 50% of the motorways has high quality**, whereas less than 3% of motorways are of poor quality. On expressway, where the majority of roads lie within the medium quality surface, the ratio of poor quality rises to 8% and of high quality drops to 24%. **On single carriageway, only 23% have good surface quality** and the ration of poor and poor to medium reaches 27% of the total. The extension of the poor quality roads is proportional to the road network length. Due to poor quality the actual speed in many parts of the network is then well below the design one.

The railways network

The railways infrastructure assessment covered about 12,000 km of the Eastern Partnership network railways, almost **70% electrified and around 30% diesel operated**. The alignment is almost equally divided into single track and double tracks. The double track alignment is almost completely electrified, while for the single track only 40% is electrified. Armenia, Azerbaijan, have completely electrified networks while Moldova has entirely diesel based operation. At some border crossing the **coexistences of different traction systems** (diesel and electrified) might pose problems of interoperability and increase delays.

The traffic flow patterns

The transport model results confirm that the **freight flows pattern coincides to great extent with the EaP strategic network**. At some locations, reflecting the intra-regional flows, the model presents as well significant freight and passenger flows on roads and rail links that are not included in the strategic EaP network.

Comparing demand and supply on the EaP road network, the model shows a variable picture of the volume/capacity ratios with generally **higher level of service in Ukraine, Belarus, Moldova and Armenia and low level of services on some stretches in Georgia and Azerbaijan**.

As expected at 2030 **Baseline scenario**, it can be noted a general increase of both road and rail freight flows on the overall network in comparison to the base year. On the railway network this is particularly true for freight corridors in Belarus and Ukraine with increases of more than 50%. Growth rates are higher on some road freight corridors in Ukraine, Georgia and Azerbaijan.

The **Integration scenario** show a general further increase of freight flows along the main corridors on the whole network, more visible on the East-West rail corridors in Ukraine and Belarus as well as towards the Odessa port. Similar pattern is also for road freight transport, with the Odessa port attracting additional road freight traffic. Looking the EaP countries in the Caucasus region, the growth of freight flows for both rail and road is mainly concentrated on the EaP strategic network.

According to the assumptions, the reduction of exchanges between the EU and EaP, as well as between EaP countries in the **Stagnation scenario** determines a general decrease of freight volumes in comparison of Baseline 2030 on both road and rail networks.

In general, the comparison for passenger flows does not reflect any significant variation due to the small demographic change in the whole region.

At the year 2030 the level of service on the road network remains generally high in Ukraine, Belarus Moldova and Armenia in all scenarios while in Georgia and Azerbaijan some sections are expected to present low level of service, especially in the integration scenario.

2 INTRODUCTION

2.1 SCOPE OF THE ASSIGNMENT

Promotion of the development of transport infrastructures in the Eastern Partnership (EaP) region, which comprises Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine is one of the key elements of the European Neighbouring Policy. The transport network of strategic interest for the extension of the TEN-T network in the region has been defined and agreed with the EaP countries, yet detailed information on the status of such network is still missing. Such network data, together with passenger and freight flows estimates, are of key importance for the EC and the International Financial Institutions (IFIs) to assess priorities and urgency of the transport infrastructure projects proposed by the EaP countries.

The main objective of this Eastern Partnership regional transport study is therefore to understand the status of the strategic network, its bottlenecks and missing links in view of economic development along different scenarios.

2.2 STRATEGIC TRANSPORT NETWORK

The EaP strategic transport network for road, rail, maritime ports and airports is illustrated in the TEN-Tec maps shown below (Figure 1 and Figure 3). The inland waterways links are treated in Annex V, while this document focuses exclusively on road and rail.

Figure 1 – TEN Tec maps of EaP strategic railways network in Belarus, Ukraine and Moldova

Figure 2 – TEN Tec maps of EaP strategic road network in Belarus, Ukraine and Moldova

Figure 3 – TEN Tec maps of EaP rail and road strategic networks in Georgia, Armenia, Azerbaijan

2.3 LIST OF PRIORITY PROJECTS

The list of priority infrastructure projects on the Eastern Partnership regional transport network, as endorsed at the meeting of EU and Eastern Partnership Transport Ministers on 9 October 2013, is reported in Table 1. The table provides a classification of the priority projects (per country and mode) and a brief description of their nature.

Fifteen out of 20 priority projects are road projects, 4 are railway projects and 1 is a maritime project. Figures 4 to 7 over the next pages indicate the location of the priority projects on the strategic network. High resolution maps are available in Annex II.

Table 1 - List of priority infrastructure projects on the Eastern Partnership regional transport network

CODE	COUNTRY	MODE	PROJECT	DESCRIPTION
ARM_01	ARMENIA	ROAD	North-South road corridor: section Yerevan to Bavra	The project covers 145 km of the North-South corridor and would improve regional connections (Yerevan to the border with Georgia at Bavra).
ARM_02	ARMENIA	ROAD	North-South road corridor: Lifeline Roads Improvement Project - Interstate Road M6	Section in the Southern part of the corridor. The project concerns modernization of 96 km of Interstate Road M6 (Vanadzor-Alaverdi-Georgian border).
AZR_01	AZERBAIJAN	RAIL	Upgrade of railway on the East-West corridor	Renewal of track facilities (548 km). Upgrade needs mainly to focus on the railway infrastructure between Baku and Boyuk-Kasik, which is part of the Baku-Tbilisi-Kars railway. Financing need for this project is 370 mln EUR.
AZR_02	AZERBAIJAN	MARITIME	Construction of the international transport logistics centre in the New Baku International Maritime Trade port complex	The Master Plan of the centre has been submitted to the Ministry of Transport for consideration. Financing needs are approx. 38 mln EUR.
BEL_01	BELARUS	RAIL	High-speed railway passenger service between Minsk and Vilnius	The project focus is on electrification of rail track on a section from Lithuanian border to Maladzechno in Belarus. This section is on the high-speed rail link between Minsk and Vilnius. The project would facilitate also the movement of freight trains that transit goods from Ukraine and Russia to the ports at the Baltic Sea. The preliminary estimated cost of construction is 80 mln EUR and the implementation is planned for 2013-2015. The project has also been presented under the Northern Dimension Partnership for Transport and Logistics.
BEL_02	BELARUS	ROAD	Upgrade of road between Minsk and Vilnius and reconstruction of border crossing point "Kamenny Log"	The upgrade of the connecting road on the Lithuanian side is to be completed. A feasability study is to be carried out in 2014 and project implementation should start in 2017. The estimated project cost is 220 mln EUR. Lithuania and Belarus are exploring together the upgrade of the Border Crossing Point „Kamenyj Log" at this road section.
GEO_01	GEORGIA	ROAD	Tbilisi-Senaki-Leselidze road section (Chumateleti – Argveta)	Project of regional significance. Road section of app. 60 km on the East-West highway, which is the main corridor for transit through Georgia. The estimated project cost is 600 mln EUR. The pre-feasibility study has been completed and the feasibility study should be completed in 2014. The implementation is planned for 2015-2020.
GEO_02	GEORGIA	ROAD	Rustavi-Red Bridge Highway	This project of regional significance would improve connections with Azerbaijan. The estimated projects cost is 80 mln EUR and the implementation is planned for 2018-2020. The feasibility study has been completed.
GEO_03	GEORGIA	ROAD	Modernization of Tbilisi-Marneuli road section	This project of regional significance would improve connections with Armenia. The estimated project cost is 60 mln EUR and the implementation is planned for 2018-2020. A pre-feasibility study has been carried out for this 27 km road project.
MLD_01	MOLDOVA	ROAD	R33 Hincesti-Lapusna-M1	The project will rehabilitate a 37.2 km "R33 Hincesti-Lapusna-M1" section, road of national importance that helps to improve connections with the Eastern Partnership transport network and with Romania. This project is a continuation of two previous projects co-financed by the NIF facility. Total project is estimated at 315.5 mln EUR.

CODE	COUNTRY	MODE	PROJECT	DESCRIPTION
MLD_02	MOLDOVA	ROAD	M3 Chisinau-Giurgiulesti motorway, Porumbrei-Cimislia Section, 19 km (new construction)	A feasibility study has been carried out; the estimated project cost is 38 mln EUR and the project is planned for implementation in the time range of 2014-2021.
MLD_03	MOLDOVA	ROAD	M3 Chisinau-Giurgiulesti motorway, Comrat bypass	A feasibility study has been carried out; the estimated project cost is 17 mln EUR and the project is planned for implementation in the time range of 2014-2021.
MLD_04	MOLDOVA	ROAD	Construction of the bypass of 3 villages along the M3 National Road Chisinau-Giurgiulesti	A feasibility study has been carried out; the estimated project cost is 22 mln EUR and the project is planned for implementation in the time range of 2014-2021.
MLD_05	MOLDOVA	ROAD	Rehabilitation of National road M14, section Balti-Criva	A feasibility study has been carried out; the estimated project cost is 98 mln EUR and the project is planned for implementation in the time range of 2014-2021.
UKR_01	UKRAINE	ROAD	Reconstruction of Krakovets-Lviv-Brody- Rivne road	This project is located on the main road corridor and would improve connections with the EU. In Poland, the connecting road A4 between Rzeszow and Korczowa is being upgraded. The project would need a preliminary assessment and thereafter subsequent feasibility studies. The estimated cost for Lviv-Krakovets section of 84.4 km (Phase 1) is 400 mln EUR. The estimated cost for Lviv-Brody section of 79 km (Phase 2) is 366 mln EUR. The estimated cost for Brody-Rivne section of 95 km (Phase 3) is 450 mln EUR.
UKR_02	UKRAINE	RAIL	Electrification of railways: Dolynska–Mykolayiv section	This project is part of works on the electrification of Dolynska-Mykolayiv-Kolosivka and Volnovakha - Kamysh-Zorya –Zaporizhzhya railway lines. The project cost is estimated at 256.1 mln EUR. The EIB is already working on the electrification of sections Dolyns'ka–Mykolaiv–Kolosivka and Volnovakha–Kamysh-Zoria–Zaporizhzhia.
UKR_03	UKRAINE	RAIL	Beskyd Railway Tunnel (Beskyd-Skotarske section)	The tunnel is located on an important EU-Ukraine connection. The total project cost is 160 mln EUR.
UKR_04	UKRAINE	ROAD	Construction of a new Odessa-Reni road	This road connects Odessa towards border of Moldova. A pre-feasibility study is being carried out for the Reni-Monashi section and should be completed by the end of 2013. The estimated project cost is 818 mln EUR and the government plans to develop the 261 km road project in two phases: I – construction of the Odessa – Monashi road (total length 81 km, including the bridge crossing the Dniester estuary – length 5.7 km). II – construction of the Monashi – Reni road (total length 180 km).
UKR_05	UKRAINE	ROAD	Reconstruction of the Scherbakivka – Kharkiv road	This 49 km road section connects Kharkiv with the Russian border. The technical and economic assessment was prepared in 2001. Design estimates are in progress. The estimated project cost is 390 mln EUR.
UKR_06	UKRAINE	ROAD	Construction of the bridge over the Dnieper river with approaches to the Kyiv – Znam'yanka (H-01) and Gora – Rogoziv (Kyiv Great Ring Road) roads.	The estimated project cost amounts to 1.5 bln EUR. A feasibility study for the construction of a bridge across the Dnieper with approaches (25.7 km) has been carried out.

Figure 4 – Map of EaP Priority Road Projects Belarus, Ukraine, Moldova

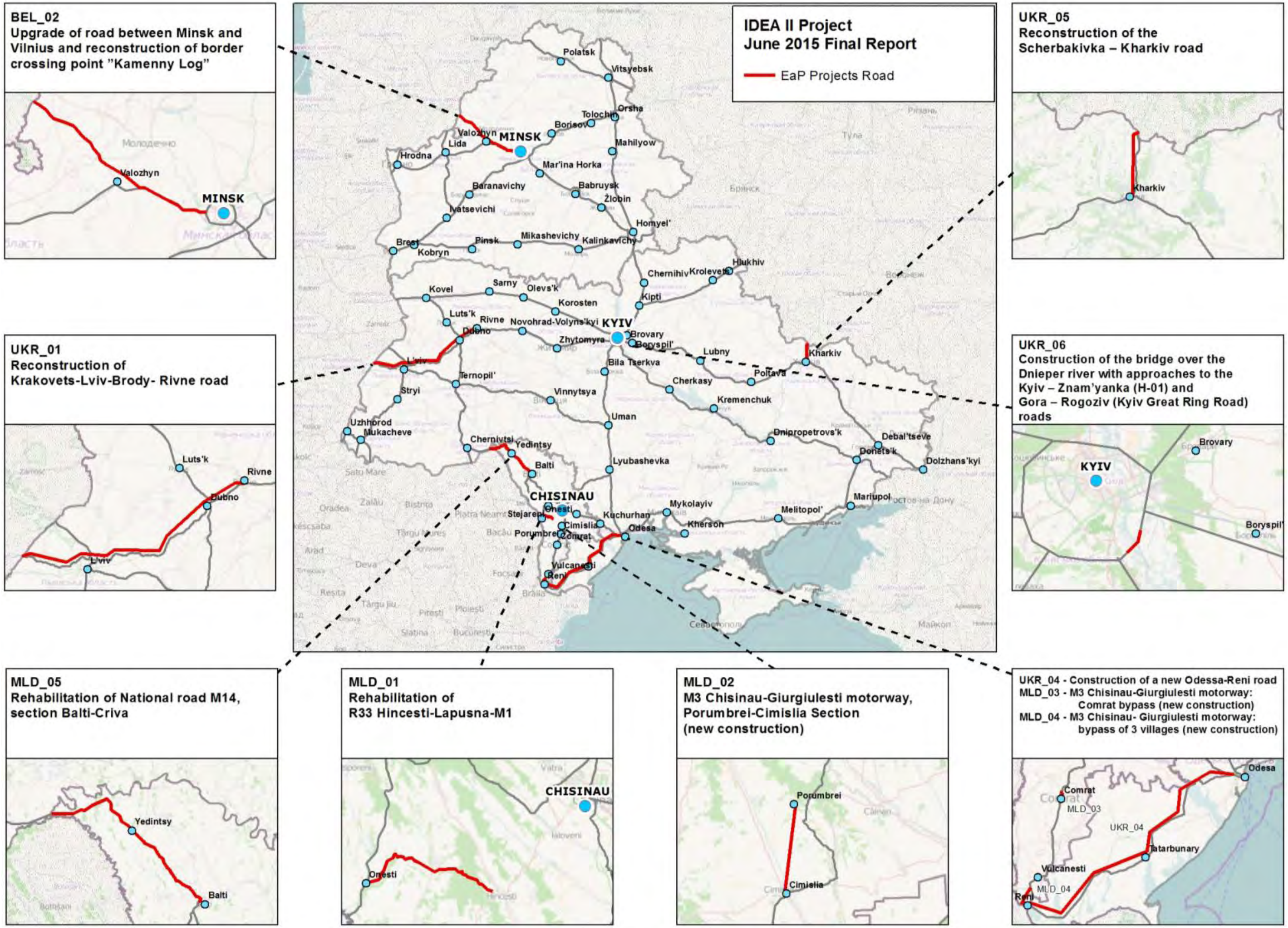


Figure 5 – Map of EaP Priority Road and Maritime Projects Georgia, Armenia, Azerbaijan

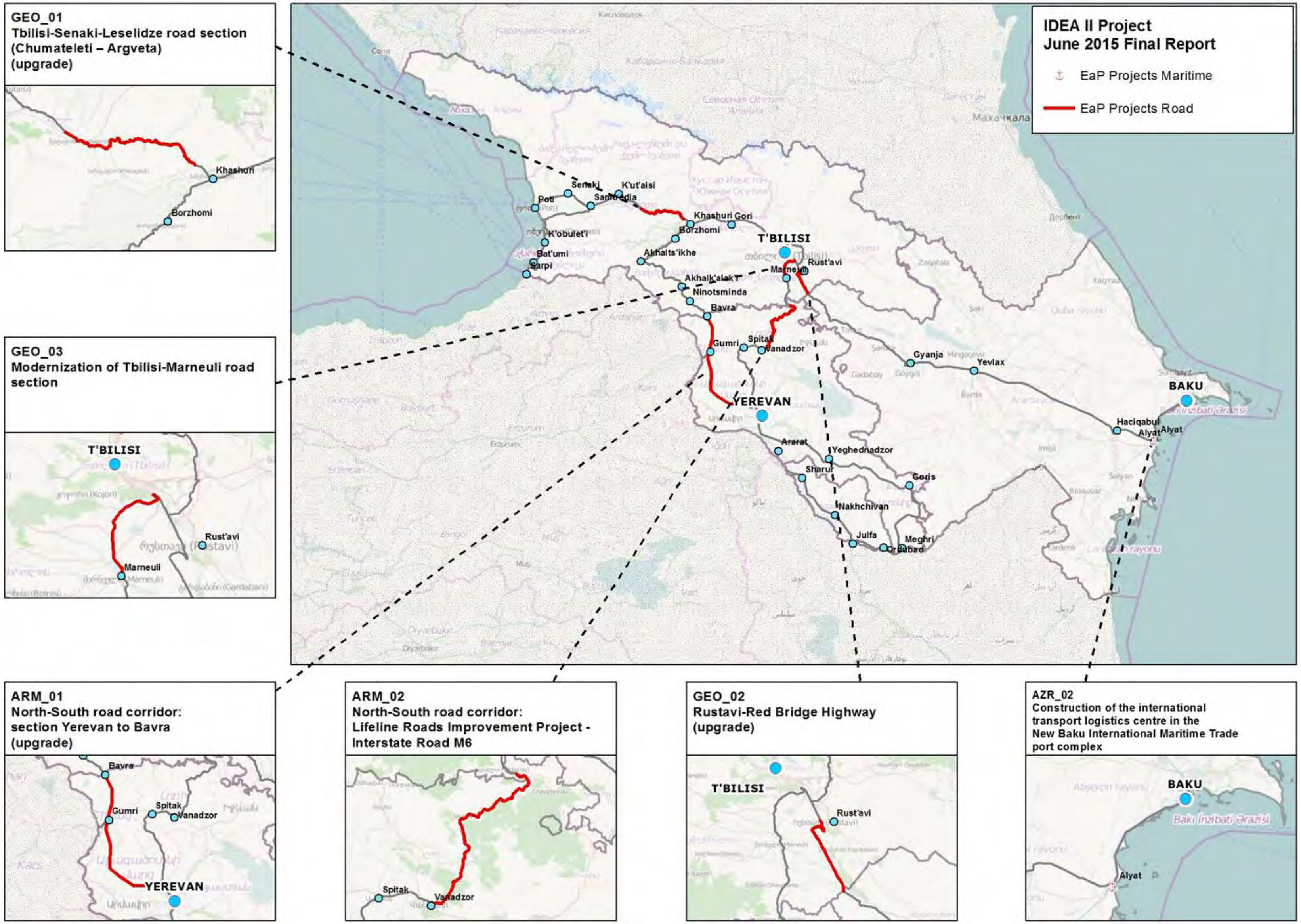


Figure 6 – Map of EaP Priority Rail Projects Belarus, Ukraine, Moldova

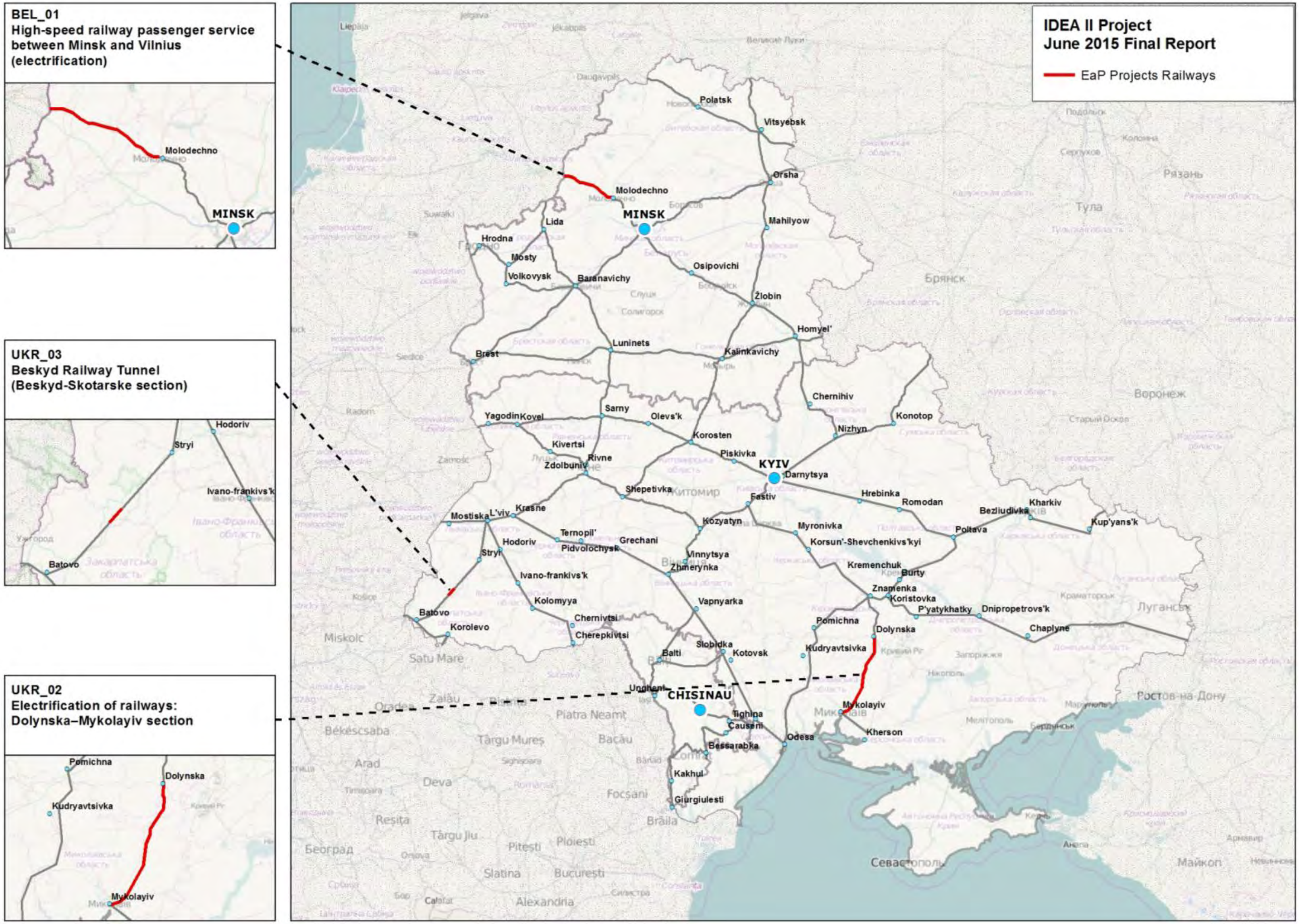
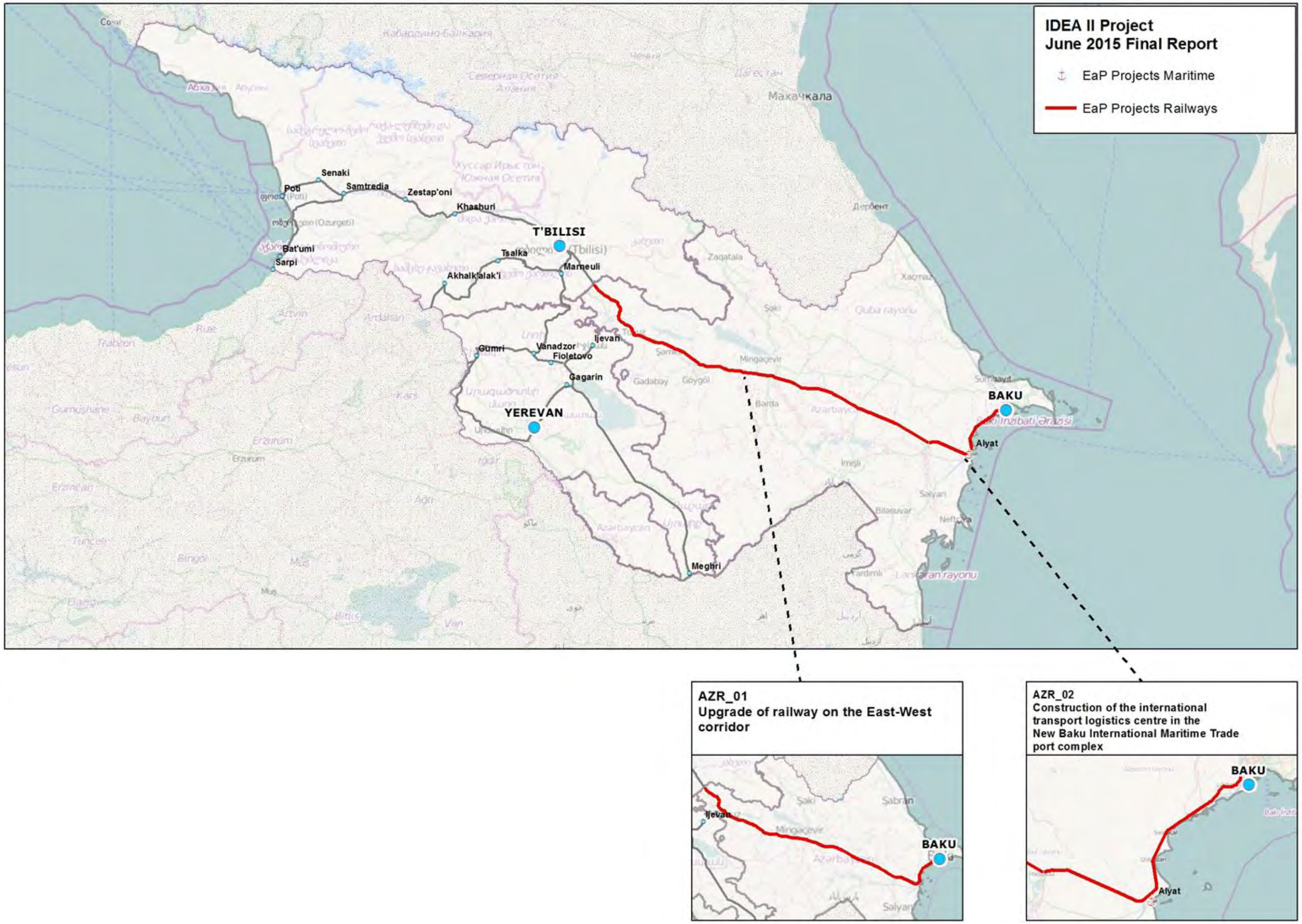


Figure 7 – Map of Priority Rail and Maritime Projects Georgia, Armenia, Azerbaijan



3 STUDY METHODOLOGY

The Eastern Partnership regional transport study was structured along two main activities:

- the data collection task aimed at gathering information on the characteristics of the modal networks in the six countries;
- the use of a multimodal freight and passenger model to analyse the main transport flow patterns and their future development.

In the sections below each activity is briefly described. More details can be found respectively in Annex I and Annex IV.

3.1 DATA COLLECTION

3.1.1 APPROACH

Data collection was based on active involvement of the IDEA II project national experts and EaP Transport Panel experts. The experts of the Secretariat of the Northern Dimension were identified as responsible for data collection in Belarus. The contact with the Secretariat was facilitated by DG MOVE.

Data collection encompassed a first preparatory stage performed by the IDEA II project team which covered the identification of key infrastructure and traffic flows indicators to be collected for each transport mode as well as the production of Excel templates and country maps to support and facilitate data reporting for EaP member countries.

After this preparatory step, templates (in English and Russian) and country maps were sent to the Ministries of the EaP countries along with official letters.

A national experts' group meeting was held by IDEA II in Kiev on 17-18 December 2014 to present the data collection program. Submission dates were foreseen by the end of January 2015 and data provision lasted until mid-March 2015.

After the meeting, a follow up process (via phone calls and e-mails) with national administrations was established on a regular basis to check the progresses on data collection. Despite the efforts posed, the cooperation level of the various national administrations was quite diverse: as an example, data collection for Armenia and Belarus revealed to be very problematic. Where possible, data gaps for key infrastructure indicators were filled in by the IDEA II project team using public sources and, in some cases, direct surveys. More specifically, during April 2015, IDEA II experts carried out a direct survey on the road network quality and traffic counts in Belarus and Armenia and on road quality only in Ukraine. All details related to these direct surveys are presented in Annex I.

As far as concerns data quality, infrastructure data collected for Ukraine, Moldova, Georgia and Azerbaijan are to be considered of overall good quality since they have been generally provided by the national administrations; only in some cases minor additional investigations were performed by the project team in fulfilling missing information.

Problems of poor quality data applied only on some traffic flows information received by the national administrations and are mainly related to the misinterpretation of measurement units. These inconsistencies were either clarified by country experts or solved by the project team.

3.1.2 INDICATORS

The tables include also the degree of data availability of each indicator on the whole EaP network. In fact the level of coverage varies between countries. Details per country are available into Annex I – Data Collection.

Table 2 - List of railways indicators

Indicator	Unit of measurement / Coding	Coverage
Status	Existing / planned / under construction / to be upgraded	100%
Length	Km	100%
Number of tracks	Number	100%
Activity	Passengers / freight / both	100%
Traction	Electrified / Diesel	100%
Design speed	km/h	60%
Max operating speed	km/h	62%
Max axle load	kN	66%
Maximum train length	m	14%
Maximum inclination	‰	64%
Freight traffic flow	net tons per year	62%
	trains per day	62%
Passenger traffic flow	pass per year	59%
	trains per day	59%

Table 3 - List of road indicators

Indicator	Unit of measurement / Coding	Coverage
National name	Name	100%
European route name	Name	100%
Status	Existing / planned / under construction / to be upgraded	100%
Type of road	Single carriageway / expressway / motorway with separated lanes	100%
Length	Km	100%
Lanes	numbers	100%
Design speed	km/h	100%
Condition of the road	high/medium/poor	100%
Freight traffic flow	trucks per day	65%
Passenger traffic flow	cars per day	25%

As it can be seen, data coverage is exhaustive for the main key infrastructure parameters, but is incomplete for some of them (i.e. rail speed) and for traffic flow data. The fact that data were not completed at all levels did not hinder a proper assessment of the network. The analysis presented in Chapter 4 utilizes those indicators with highest data availability to ensure fair comparison and assessment of the infrastructure. The data are fragmented or partially non-existent at the country level and its completion may require longer time span.

Results of data collection are delivered both in GIS based thematic maps (included into Annex II) as well as in form of infographics (included into Annex III).

3.2 TRANSPORT MODEL

This section presents the main features of the EaP transport model developed in the context of this assignment.

3.2.1 SCOPE OF THE MODEL

The EaP multimodal freight and passenger transport model has been developed as a strategic planning tool to calculate the transport volumes between the EaP countries Belarus, Ukraine, Moldova, Georgia, Armenia and Azerbaijan and from/to EaP countries and surrounding regions. Given the purpose of the model, the focus is on inter-regional and international demand. Local traffic is not reflected in the model forecasts.

The model allows for assessing the impact of large scale infrastructure measures in the EaP area and has been developed by updating the TRACECA freight transport model prepared in the context of the IDEA I project. In comparison to the TRACECA IDEA I model, this new version has a more recent base year (2012 instead of 2008), a longer forecast period (until 2030 instead of 2020), a larger model area (Belarus is included in order to have the whole EaP region), the coverage of passenger transport and a more updated calibration.

The transport model, implemented in VISUM software environment, consists of 3 main components:

- Network Model
- Freight demand model
- Passenger demand model

The design of the model and each component is briefly described in the following sections.

3.2.2 MODEL DESIGN

3.2.2.1 NETWORK MODEL

The network model contains all elements of the transport infrastructure supply represented in terms of traffic zones, connectors, nodes and links.

178 traffic zones represent the connection between the demand and the supply: 91 are internal (covering the core study area) and 87 are external (representing neighbouring regions, countries and groups of countries).

The transport network, as identified in this report, has a total of over 100,000 links and a length over 900,000 km. It covers the following transport modes: Road, Rail, Pipeline (remained dormant in the assignment), Ship and Inland waterways. Air transport was not included due to the negligible volumes of traffic compared with other modes of transport.

For each mode there is a separate network, while transfer links allow for transhipment of goods between different modes at transfer locations like ports and transfer hubs.

3.2.2.2 Freight demand model

The freight model follows the classical four stages approach. For each commodity type, transport freight demand is generated for each zone and then distributed to the various destination zones; the resulting matrices are split by mode of transport and assigned to the transport network.

- **Freight generation**. The generated volumes [tons/annum] per country are determined by relying on several international sources (i.e. UN Comtrade, Mineral Industry Yearbook, FAO, etc.). The import and export volumes per commodity for each country are determined from the UN Comtrade statistics, while local production and consumption are either given by statistics, calculated by multiplying land use data and generation factors or determined by the balance between local production / import and local consumption / export.
- **Freight distribution.** National production and consumption volumes are distributed among the traffic zones of the study area by using socio economic (population by prosperity groups, urban and rural areas) and land use data. The distribution process is based on a gravity model between the zones. The results are origin/destination (o/d) matrices for each commodity.
- **Assignment (i.e. mode and route choice).** Depending on the network parameters and transport costs, for each commodity and (o/d) relation the optimal route is chosen and such route can be a combination of different modes with transhipments within the transport chain. As a result, the ton flows per link and transport mode are determined.

3.2.2.3 Passenger demand model

The passenger demand model follows the same four stages approach separately for each demand category (business and leisure trips) split for urban and rural population.

- **Passenger Trip Generation**. This is the process of generation and attraction of passenger flows which is determined taking into account data of population and work places in the zone. The end result is an estimate of the number of movements exiting and entering each transport zone (vector of generation and attraction volumes).
- **Passenger Trip Distribution**. In this step volumes originated and attracted by each transport zone are distributed with a gravity model between the traffic zones by taking into account the impedances (i.e. travel time and cost) between zones. Origin/destination passenger matrices are then created for each demand category.
- **Passenger Mode Choice.** Based on the impedance matrices that take into account the generalized cost of travelling between o/d couples by each mode of transport, the origin/destination volumes (number of trips/movements) between all zones are calculated. These origin-destination matrices are by mode and demand category.
- **Assignment.** Modal matrices are assigned to the multimodal network through an equilibrium process. This procedure models the learning process of road users using the network. Starting with an "all or nothing assignment", drivers consecutively include information gained during their last journey for the next route search. The outcome of this step is the traffic flows per link on each transport network.

3.2.3 BASE YEAR AND FORECAST SCENARIOS

The model base year is 2012 and three different socio-economic scenarios have been developed. The three scenarios are:

- A Business as Usual (BAU) scenario;
- An integration scenario, where economic relationships within EaP and between EaP and EU are more developed;
- A stagnation scenario where economic relationships between EaP and EU are less developed.

Scenarios focus on defining realistic assumptions for alternative conditions that may arise, rather than appraising what will actually happen. In this case the assumptions concern:

- the level of economic growth of the EaP countries;
- the level of (intra)integration within the EaP countries;
- the level of (inter)integration between the EaP countries and the EU.

The approach used is more of back-casting, and less of a forecasting exercise. The socio-economic scenarios have been developed by means of the following steps, and the respective indicator:

1) Establish the assumptions for economic growth of the EaP area. The variable used here is the average growth rate of GDP in each EaP country.
2) Establish the assumptions for the level of integration within EaP and between EaP and the EU. The variables used here are the shares of EaP and EU partners on import and, respectively, export of each EaP country.
3) Estimation of absolute values of GDP, import and export of each EaP country in each scenario given the assumptions.

Each scenario has been quantified at two time thresholds – the year 2020 and the year 2030 – and for each of the six EaP countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine. Mode details on scenarios design and assumptions are available in Annex IV of this report.

4 ANALYSIS OF THE EAP STRATEGIC TRANSPORT NETWORK

4.1 INTRODUCTION

This section provides with an assessment of the status of the EaP transport network. The approach pursued builds on the main components of the study: the data collection and the transport model. The infrastructure condition assessment is based on the data collection track. The model delivers the patterns of traffic flow and the route choice. It also provides order of magnitude of international and domestic regional traffic. The scenarios developed with the model will reveal the future patterns for freight and passengers' flows for the years 2020 and 2030.

4.2 ANALYSIS OF COLLECTED DATA

This section presents some main features of the EaP strategic network that can be derived from collected data.

4.2.1 EAP ROAD NETWORK

The strategic EaP road network (Figure 8) covers about 12,000 km of European and National roads distributed between the six member countries as reported in the Figure 9.

Figure 8 – EaP strategic road network

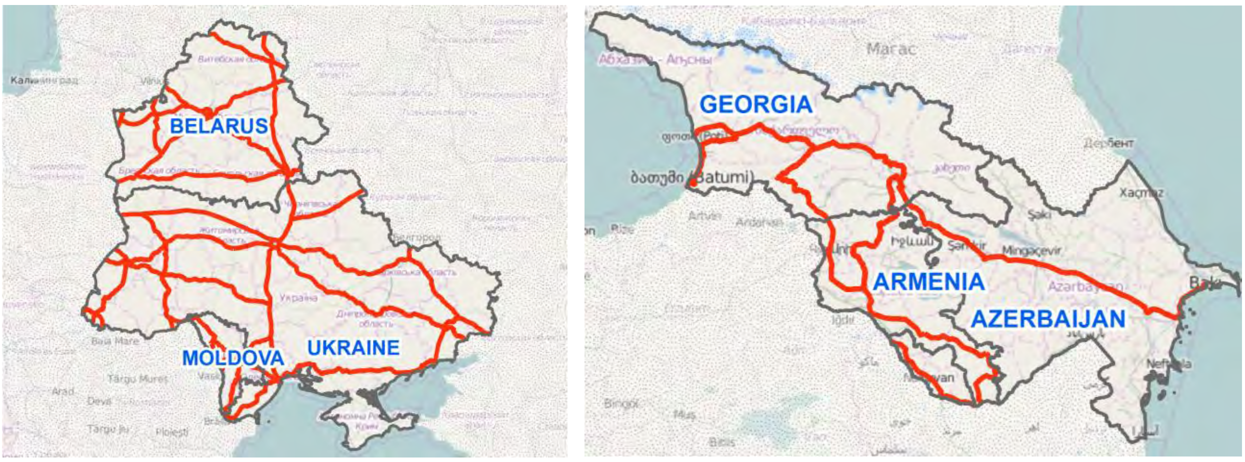
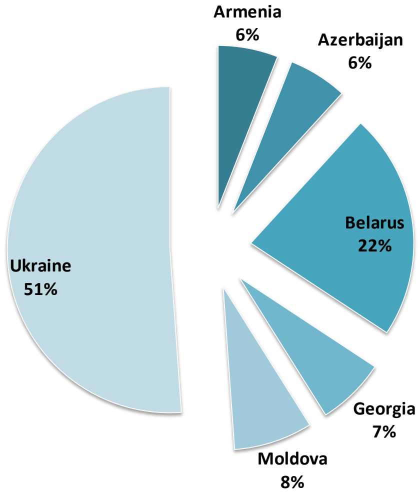


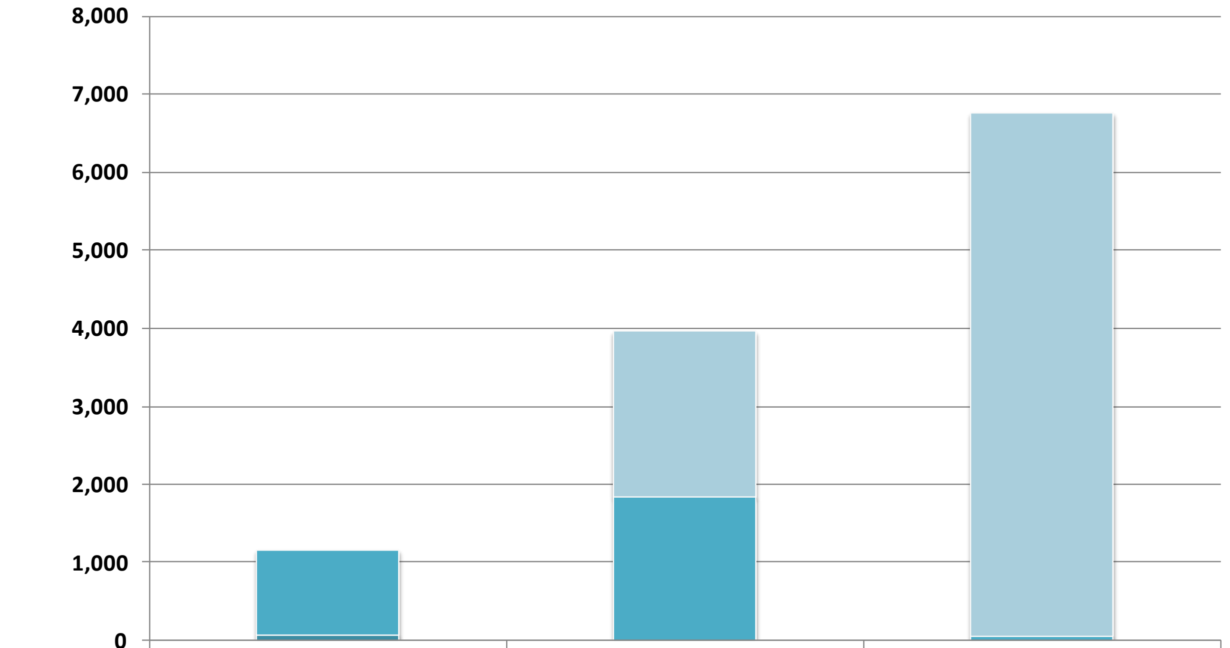
Figure 9 – Distribution of EaP road network length between member countries



Country	Length (km)
Armenia	707
Azerbaijan	690
Belarus	2,665
Georgia	806
Moldova	925
Ukraine	6,079
TOTAL	**11,873**

The extent of the distribution of the roads network length is compliant with the countries spatial size. Ukraine builds over 50% of the roads network. The EaP Roads form the main strategic corridor in each country with about 6,800 km of single carriageway roads, by about 4,000 km of expressways and by about 1,150 km of motorways with separated lanes. Most EaP roads have one lane per direction (about 9,000 km) while the multilane roads total about 3,000 km as illustrated in Figure 10.

Figure 10 – Distribution of EaP road network length (km) by type of roads and number of lanes

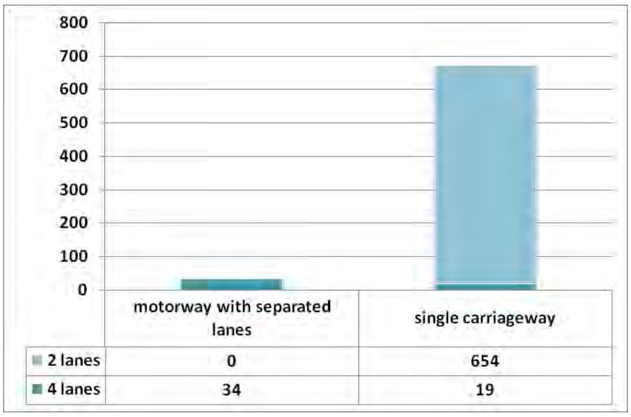


	motorway with separated lanes	expressway	single carriageway
2 lanes	0	2,122	6,700
4 lanes	1,083	1,838	59
> 4 lanes	72	0	0

Figure 11 reports the detail of the road network (type and total number of lanes) at country level. In correspondence with the road type, the design speed on the EaP network complies with the national speed regulation of the EaP network in the concerned countries. i.e about 56% of the EaP strategic network (about 6.700 km) has a speed of 90 km/h; 9.6% (about 1,150 km) has a speed lower than 90 km/k and the remaining 34% (about 4.000 km) has a speed higher than 90 km/h. As expected low speed occur mainly on single carriageway roads, as shown in Figure 12. Detailed statistics for type of roads and design speed at country level are reported in Figure 13.

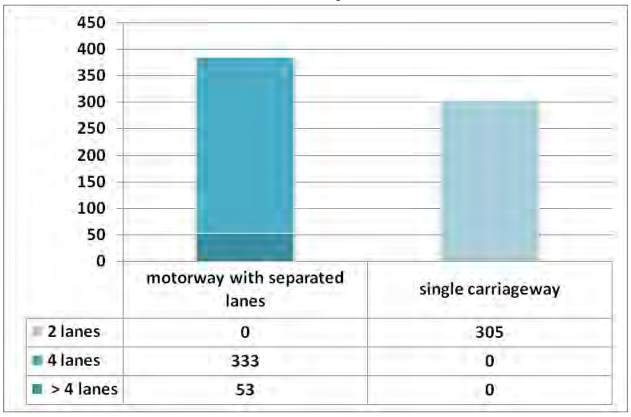
Figure 11 – Distribution of EaP road network length (km) by country, type of roads and total number of lanes

Armenia



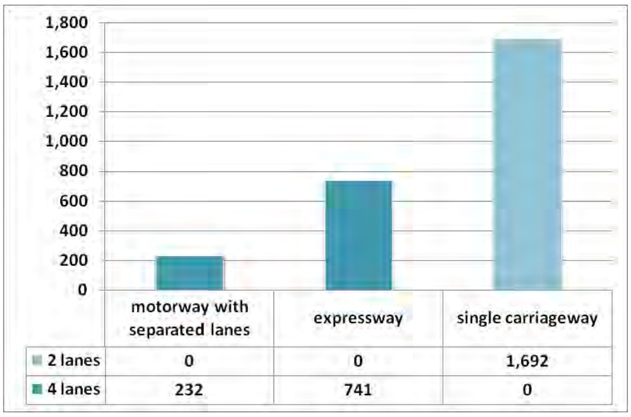
	motorway with separated lanes	single carriageway
2 lanes	0	654
4 lanes	34	19

Azerbaijan



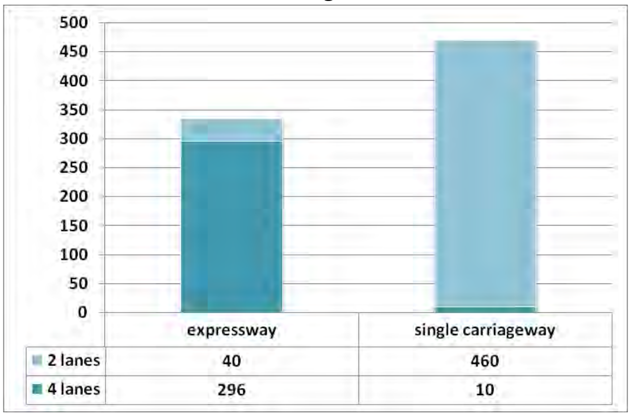
	motorway with separated lanes	single carriageway
2 lanes	0	305
4 lanes	333	0
> 4 lanes	53	0

Belarus



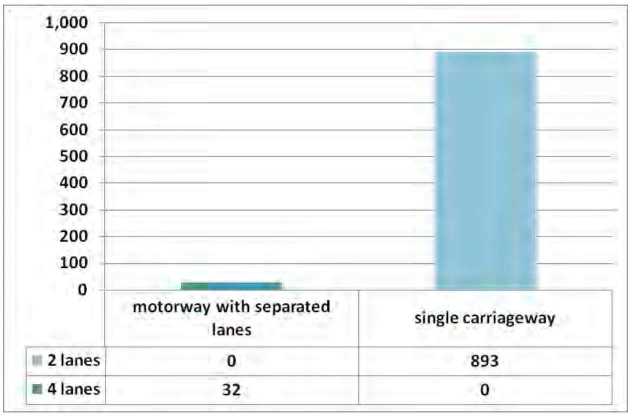
	motorway with separated lanes	expressway	single carriageway
2 lanes	0	0	1,692
4 lanes	232	741	0

Georgia



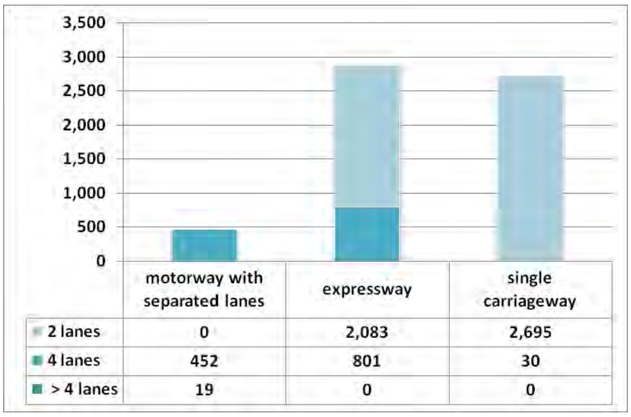
	expressway	single carriageway
2 lanes	40	460
4 lanes	296	10

Moldova



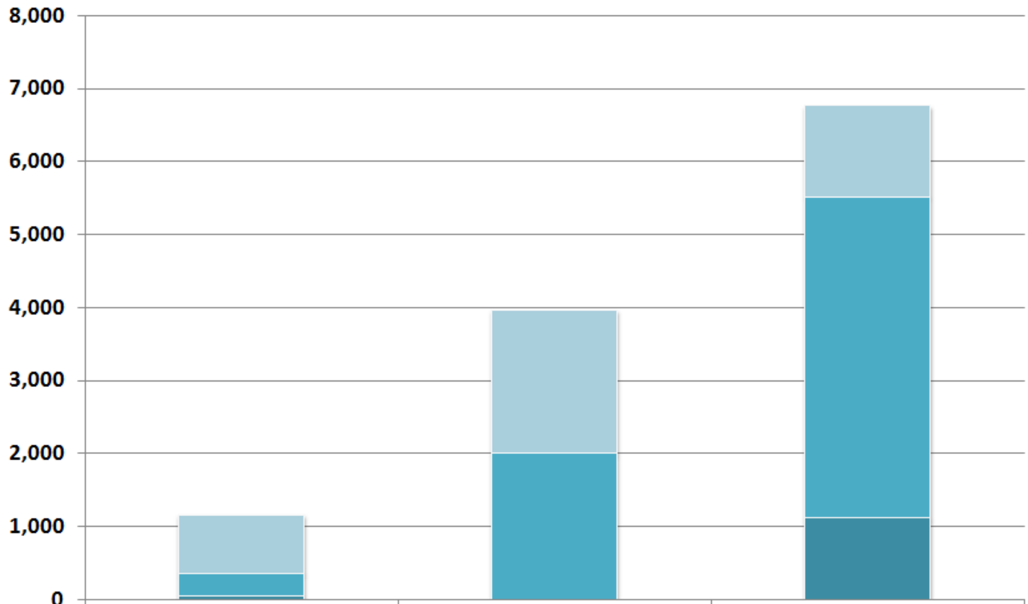
	motorway with separated lanes	single carriageway
2 lanes	0	893
4 lanes	32	0

Ukraine



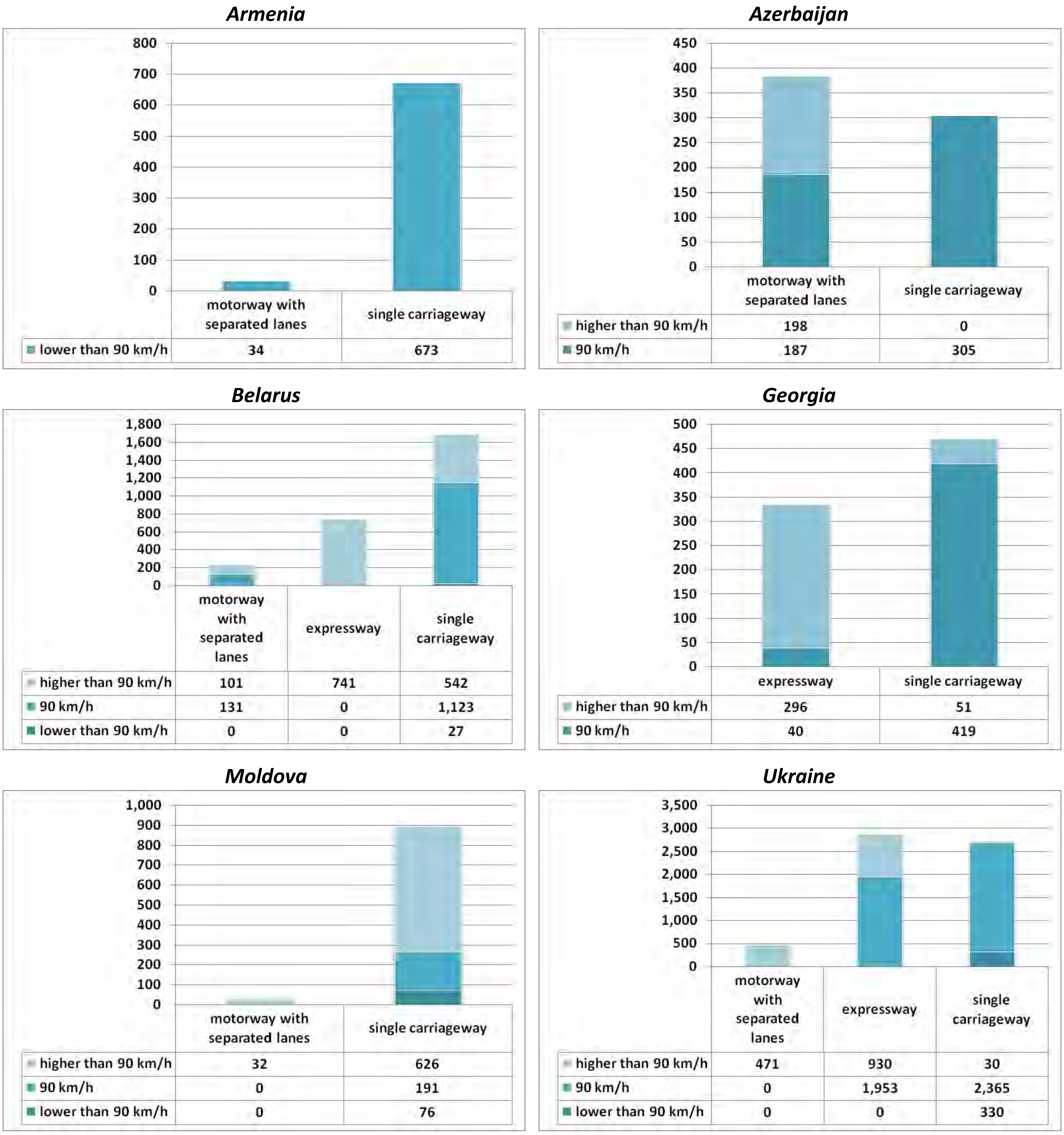
	motorway with separated lanes	expressway	single carriageway
2 lanes	0	2,083	2,695
4 lanes	452	801	30
> 4 lanes	19	0	0

Figure 12 – Distribution of EaP road network length (km) by road type and design speed



	motorway with separated lanes	expressway	single carriageway
higher than 90 km/h	802	1,967	1,249
90 km/h	318	1,993	4,403
lower than 90 km/h	34	0	1,106

Figure 13 – Distribution of EaP road network length (km) by country, type of roads and design speed



As far as concerns road conditions, they have been catalogued according to surface maintenance status, whereas:

- **High:** adequate surface condition with no hazard to traffic flow;
- **Medium**: acceptable condition, no immediate action is required as shown in the picture;

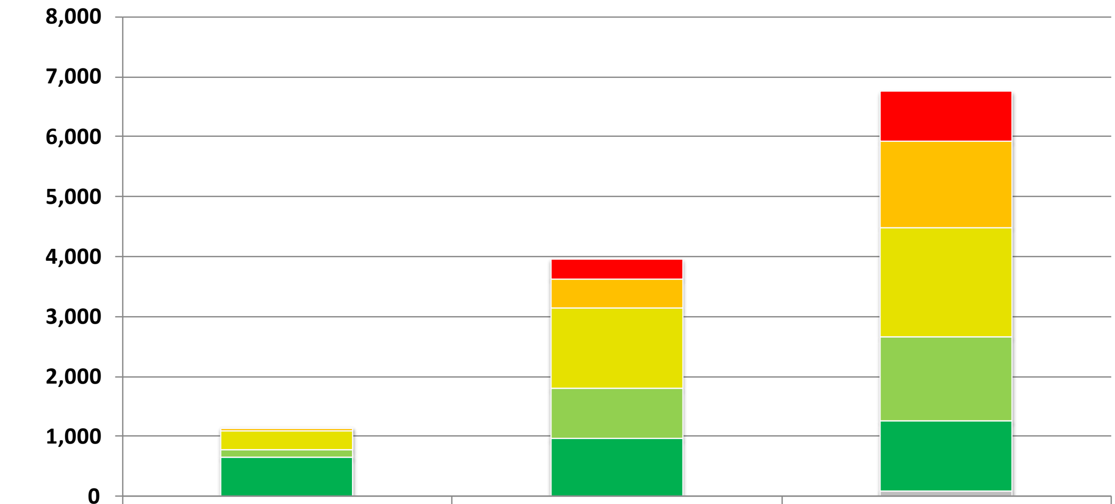
- **Poor:** the road surface condition may pose risk to traffic flow and increased safety hazard. Figure 14 below illustrates some examples of road conditions in Ukraine.

Figure 14 – Examples of road conditions

High **Medium** **Poor**

From data collected it emerges that 44% of the EaP strategic network presents high or medium-to high surface conditions (about 5,150 km); 30% of the network presents medium road condition (about 3,500 km) and the remaining 27% (about 3,180 km) presents poor or poor-to-medium road condition. This distribution may provide clues what the road surface condition is like on the roads below the EaP level. On those roads, the component of road surface condition with poor quality form the dominant majority of the roads.

Figure 15 – Distribution of EaP road network length (km) by type of road and road condition



	motorway with separated lanes	expressway	single carriageway
poor	33	334	839
poor to medium	33	500	1,437
medium	315	1,339	1,838
medium to high	135	837	1,403
high	638	949	1,160
unverified*	0	0	83

** Road conditions are not verified for 83 km (0.7% of the EaP network) in the Donetsk region*

Figure 16 provides with detailed statistics on road condition by type of road for each EaP country.

Figure 16 – Distribution of EaP road network length (km) by country, type of roads and road conditions

Armenia

	motorway with separated lanes	single carriageway
poor	0	54
poor to medium	0	600
medium to high	34	19

Azerbaijan

	motorway with separated lanes	single carriageway
medium	187	0
high	198	305

Belarus

	motorway with separated lanes	expressway	single carriageway
poor to medium	0	0	290
medium	0	56	177
medium to high	101	587	1,140
high	131	97	86

Georgia

	expressway	single carriageway
medium	0	33
high	336	438

Moldova

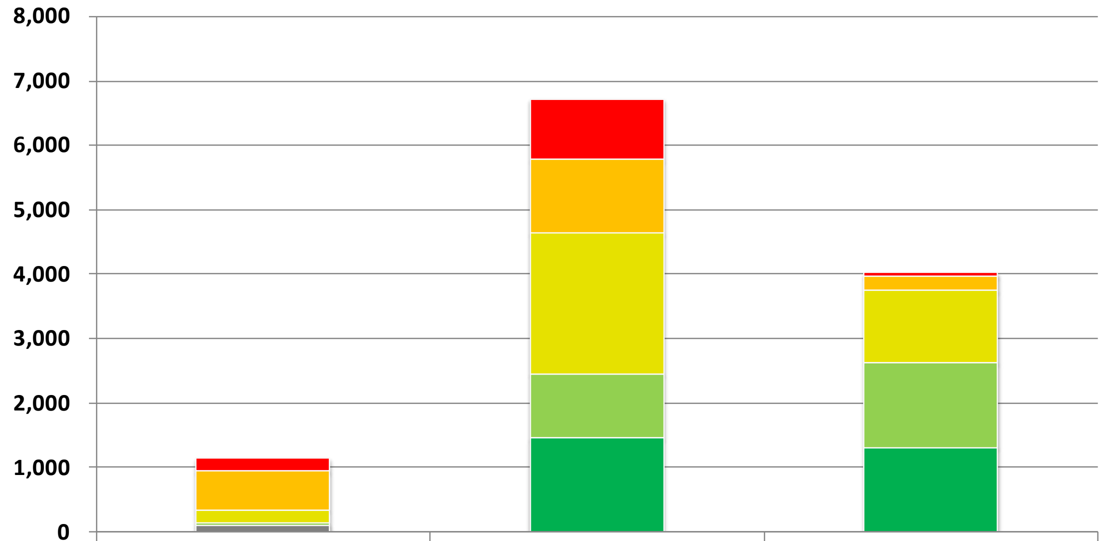
	motorway with separated lanes	single carriageway
poor	0	140
medium	32	660
high	0	93

Ukraine

	motorway with separated lanes	expressway	single carriageway
poor	33	334	645
poor to medium	33	500	547
medium	96	1,283	968
medium to high	0	250	244
high	309	516	238
unverified*	0	0	83

** Road conditions are not verified for 83 km (0.7% of the EaP network) in the Donetsk region*

Figure 17 – Distribution of EaP road network length (km) by design speed and road condition



	lower than 90 km/h	90 km/h	higher than 90 km/h
poor	204	945	57
poor to medium	600	1,145	225
medium	200	2,180	1,111
medium to high	53	1,000	1,322
high	0	1,444	1,302
unverified*	83	0	0

***** Road conditions are not verified for 83 km (0.7% of the EaP network) in the Donetsk region***

Moreover from data collected (see Figure 17) it emerges that poor or poor to medium road conditions apply:

- on 71% of the road network characterized by speed lower than 90 km/h (about 800 km);
- on 31% of the road network characterized by speed equal to 90 km/h (about 2.100 km);
- on 7% of the road network characterized by speed higher than 90 km/h (about 300 km).

Figure 18 and Figure 19 report the maps of road conditions and number of lanes of the EaP strategic network.

Figure 18 – EaP road network thematic map of road condition and total number of lanes - Belarus, Ukraine, Moldova

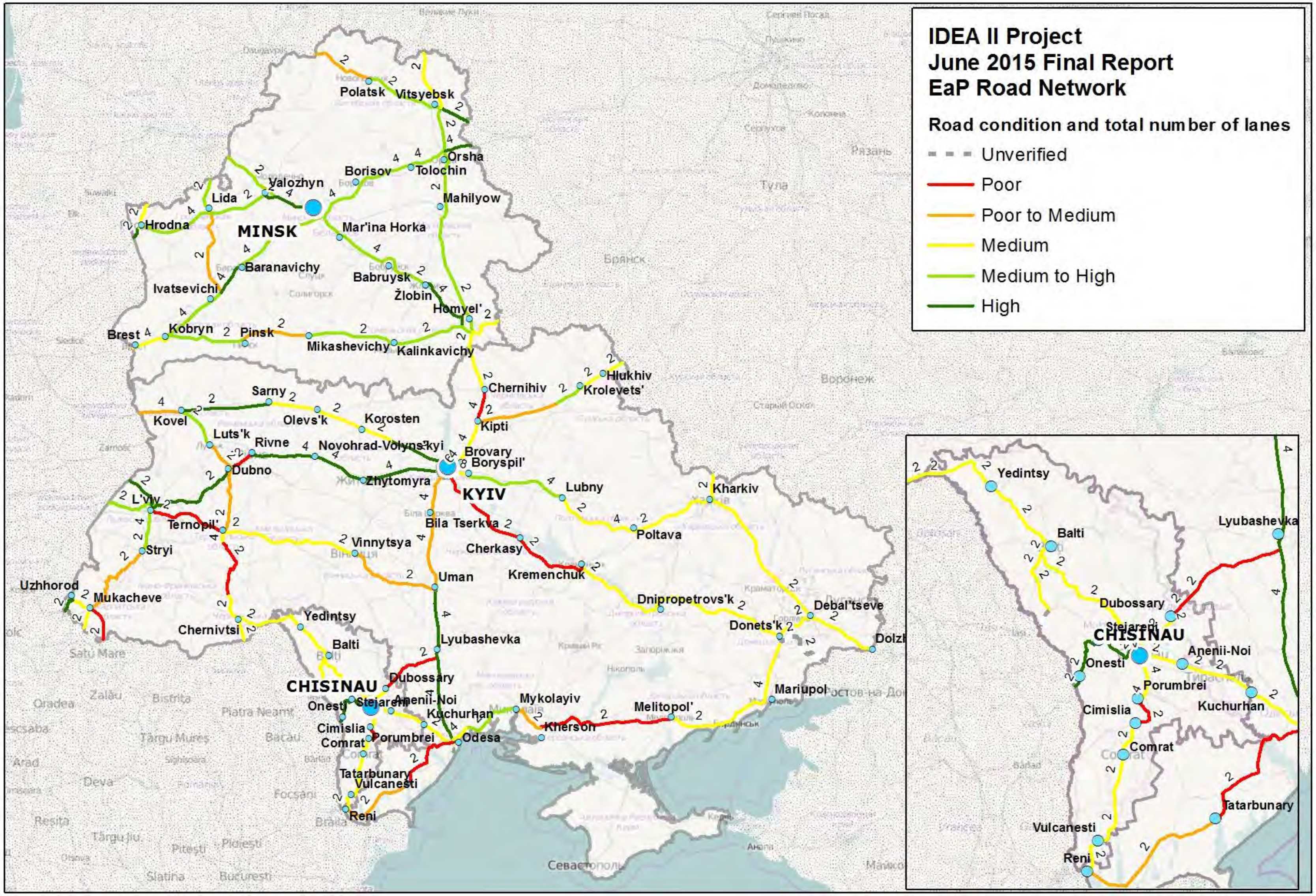
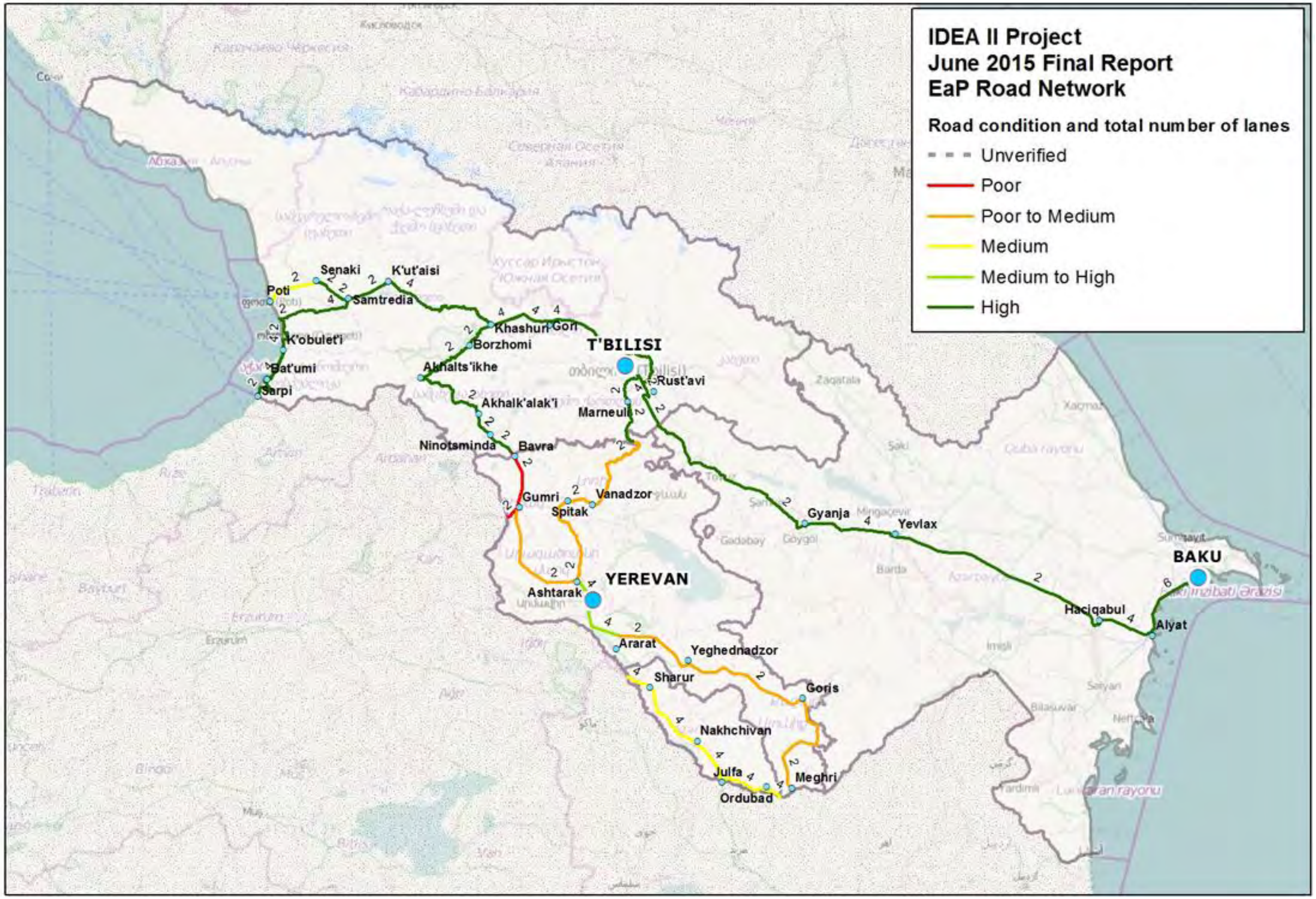


Figure 19 – EaP road network thematic map of road condition and total number of lanes - Georgia, Armenia, Azerbaijan

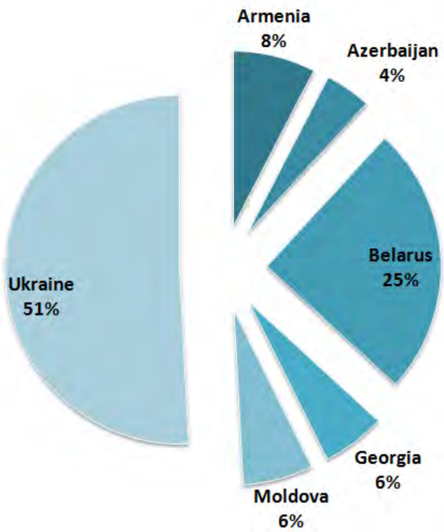


4.2.2 EAP RAIL NETWORK

The EaP strategic rail network (Figure 20) covers about 12,000 km or railways, distributed between the six member countries as reported in Figure 21.

Figure 20 – EaP strategic rail network

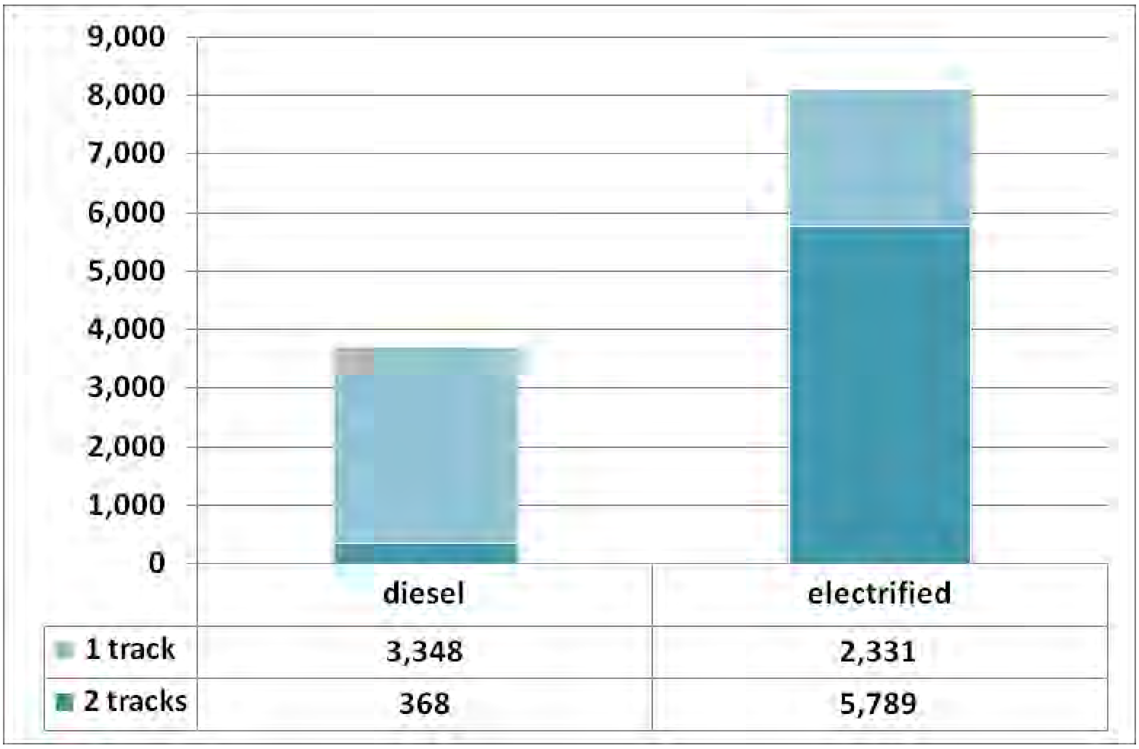
Figure 21 – Distribution of EaP rail network length between member countries



Country	Length (km)
Armenia	899
Azerbaijan	503
Belarus	2,954
Georgia	692
Moldova	770
Ukraine	6,018
TOTAL	**11,835**

The most of the rail network (about 8,150 km) is electrified (of which 264 km of Belarusian network is going to be electrified in 2015) and 31% of the network is not electrified. Moreover, data collection shows the network is equally composed by single track lines (5,680 km) and double tracks lines (about 6,160 km); more in detail, 90% of the not electrified network is single track, while the electrified network is 29% single track and 71% double track (see Figure 22).

Figure 22 – Distribution of EaP rail network length (km) by traction and number of tracks



	diesel	electrified
1 track	3,348	2,331
2 tracks	368	5,789

More detailed statistics at country level on number of tracks and traction are reported in Figure 23. As it can be seen, the EaP rail network of Armenia and Azerbaijan is fully electrified, while the Moldovan EaP network is fully diesel. Mixed traction systems apply in Belarus, Georgia and Ukraine.

A check of the voltage of the rail electrification system shows that Armenia, Georgia and Azerbaijan adopt the same voltage (3000 V DC); Belarus railways are generally electrified with 25kV 50 Hz (with the exception of the line Brest – Terespol that is electrified with 3000 V DC) and Ukraine railways adopts two different voltage systems with the western part of the country mainly electrified with 25kV 50 Hz (with the exception of the line Lviv – Batovo that is electrified with 3000 V DC) and the eastern part mainly electrified with 3000 V DC. Even though the rail voltage is not uniform among EaP countries, it is not expected that the presence of different voltage systems in Belarus and Ukraine might pose problems of interoperability since nowadays it is common practice for railway engines to support in a seamless way both voltages.

Figure 24 and Figure 25 illustrate the electrification and the number of tracks of the EaP strategic network.

Figure 23 – Distribution of EaP rail network length (km) by traction and number of tracks

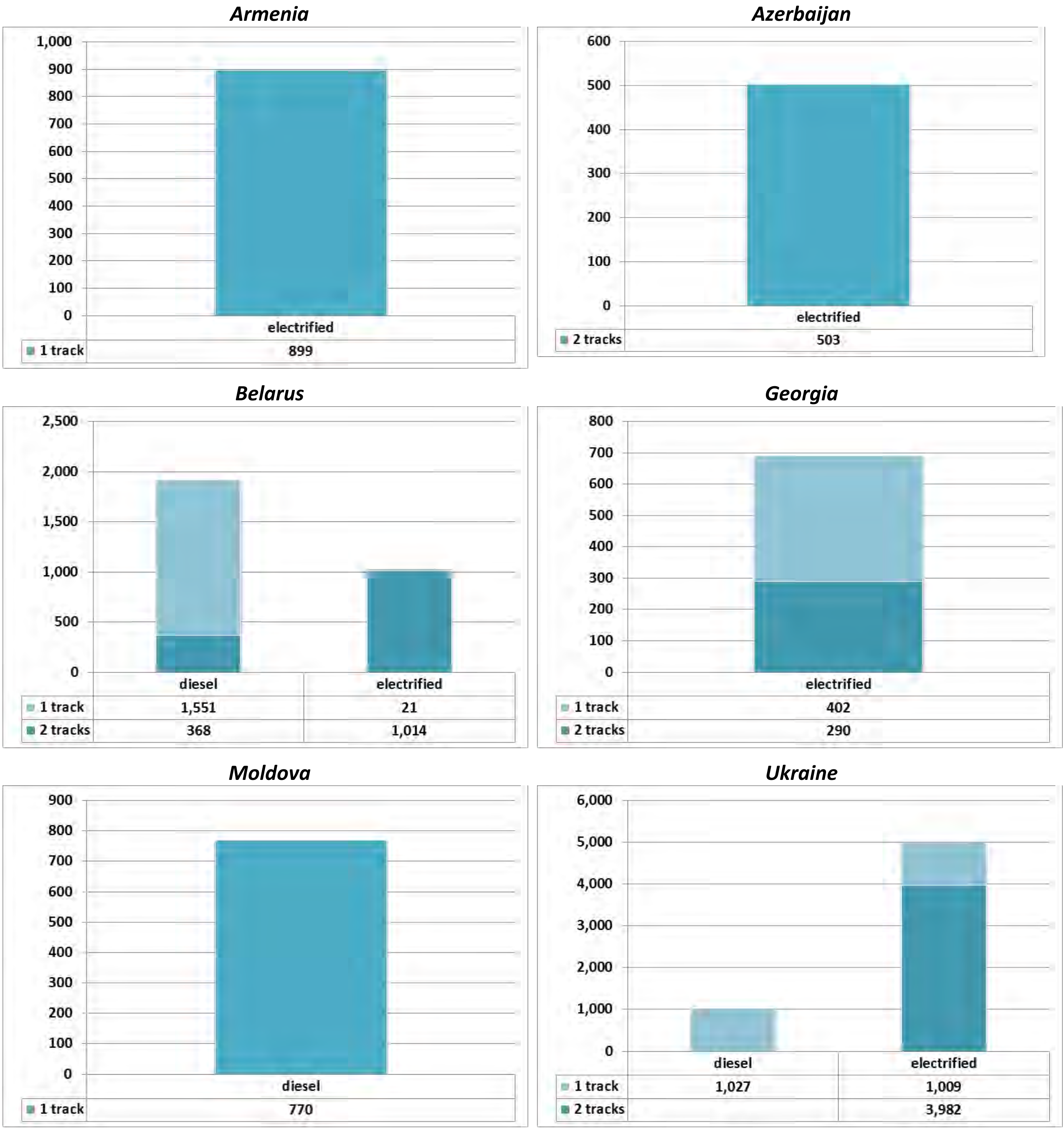
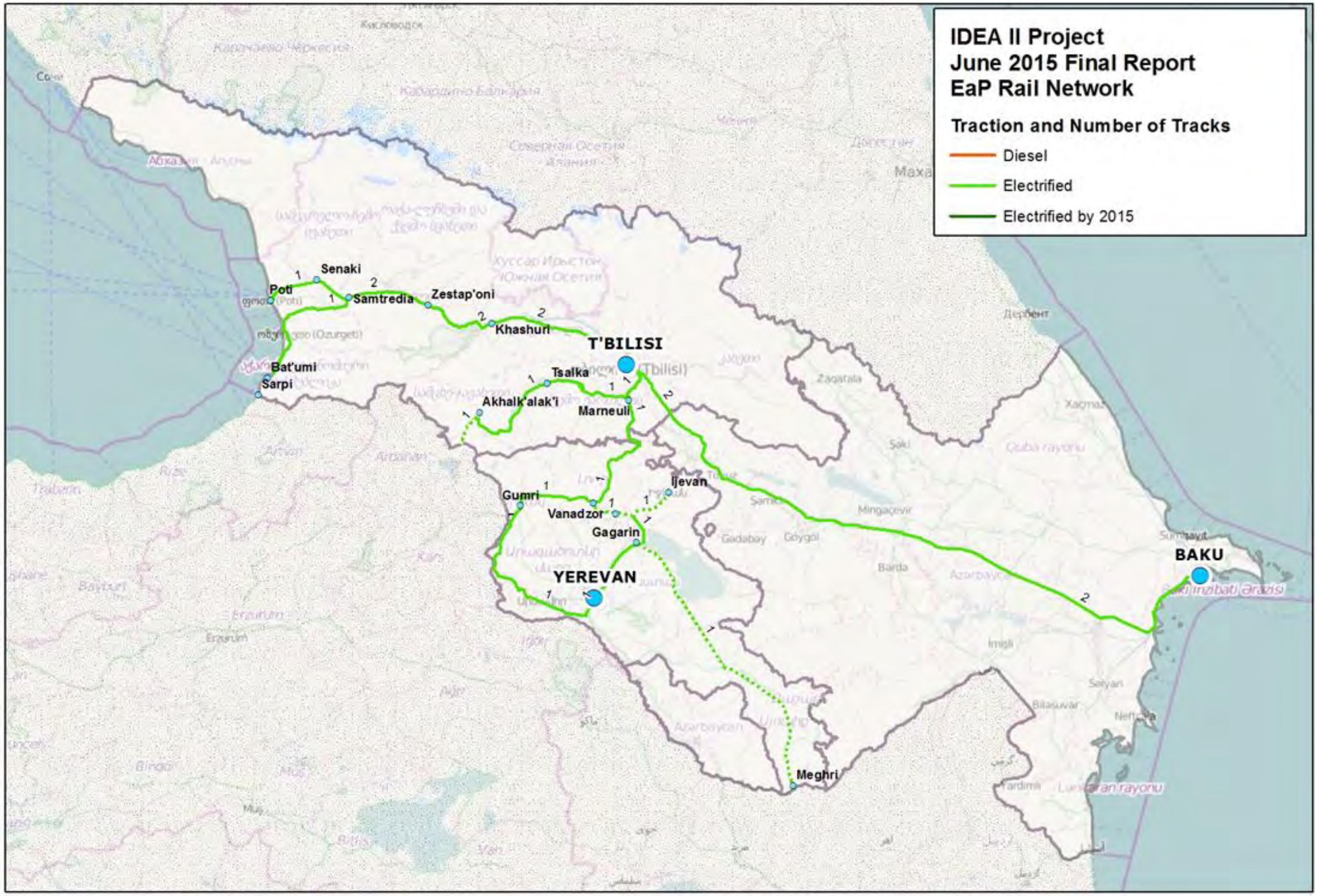


Figure 24 – EaP rail network thematic map of electrification and number of tracks - Belarus, Ukraine, Moldova

Figure 25 – EaP rail network thematic map of electrification and number of tracks - Georgia, Armenia, Azerbaijan



4.3 ANALYSIS OF TRANSPORT FLOW PATTERNS

The following pictures illustrate observation of transport demand patterns on the EaP strategic transport network. Due to its strategic nature, the transport model deals with long distance traffic at national and international scale and therefore its results may experience inaccuracy near major cities due to the influence of local traffic that cannot be simulated. The model extends in its spatial coverage well beyond the EaP strategic network and countries. It's important to mention that while for the EaP countries national (on regional level not local level) and international traffic is considered, for other countries like Poland or Romania national traffic is not taken into account except in the exchange with the EaP region. This needs to be kept in mind while interpreting the model results.

The model validation shows high compliance with the modal split values versus official statistics.

Table 4 – Model validation compliance

2012	Rail	Road
Statistical values	80%	20%
Model Results	79%	21%

The values comparison on the country level shows deviation between 3% in Armenia and Moldova and 7% for Ukraine and up to 12% for Belarus. The values are considered acceptable for the uncertainty in Belarus published statistics.

On the other hand, a GEH[1] test for observed and modelled values shows a value <5. The observed traffic volumes values used are those received from the countries and the manual counts executed in the framework of this study.

The following elaboration assesses the flow patterns calculated by the model for the base year and discusses the plausibility and validation with real world. Although the pictures show only the traffic flows on the EaP strategic network, the model transport network includes all main links and therefore it is more detailed.

4.3.1 RAILWAYS FREIGHT FLOW PATTERNS

Figure 26 shows the global patterns of rail freight volumes in Belarus, Ukraine and Moldova; it also identifies the flows in West-East direction mainly moving via the northern corridor from Europe through Belarus and Russia..

Another relevant corridor is the one in Southern Ukraine moving mainly from Donbas area and Dnipropetrovsk with a considerable movement also towards Odessa port and towards the EU

[1] GEH is a formula used in traffic modelling to compare observed vs modelled traffic data which avoids some pitfalls that occur when using simple percentages to compare data. For traffic modelling work a GEH of less than 5.0 is considered a good match between modelled and observed volumes.

Poland and Slovakia; this is notably passing through Rivne-L'viv-Uzhgorod corridor and partly through Kovel–Chelm corridor. Also it shows a corridor from Odessa via Ternopol and Uzhgorod / Chop. Major border crossing points in the western EaP are Brest, Kovel and Shegeni as well as Chop and Hlyboka in the south.

Figure 26 – Rail freight flow patterns in Belarus, Ukraine, Moldova

A similar picture is also obtained when looking at the daily rail traffic flow patterns between Azerbaijan and Georgia in the Caucasus region. It should be noted that the model is showing a high share of railway in the freight movement between Baku and the Georgia Ports, reflecting a core component of the TRACECA corridor.

Figure 27 – Rail freight flow patterns in Georgia, Armenia, Azerbaijan

4.3.2 RAILWAYS PASSENGER FLOW PATTERNS

Figure 28 shows the passenger flow patterns on the EaP network in Belarus, Ukraine and Moldova. The strategic network seems to be consistent with the flow patterns. The consistency of the EaP network is set forth also in the links in Azerbaijan, Georgia and Armenia. This is also plausible given that the railways network is of limited spatial coverage.

Figure 28 – Rail passengers flow patterns in Belarus, Ukraine, Moldova

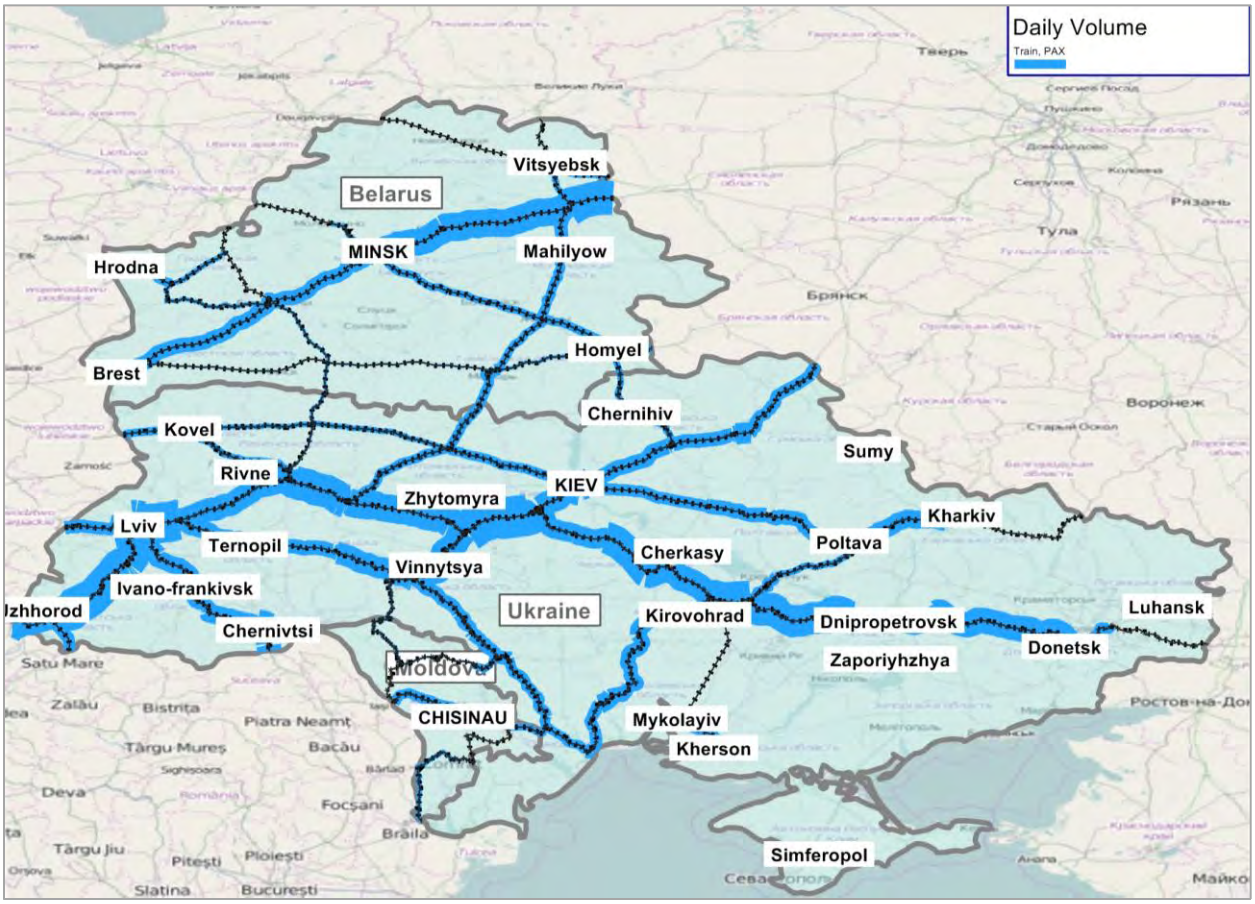
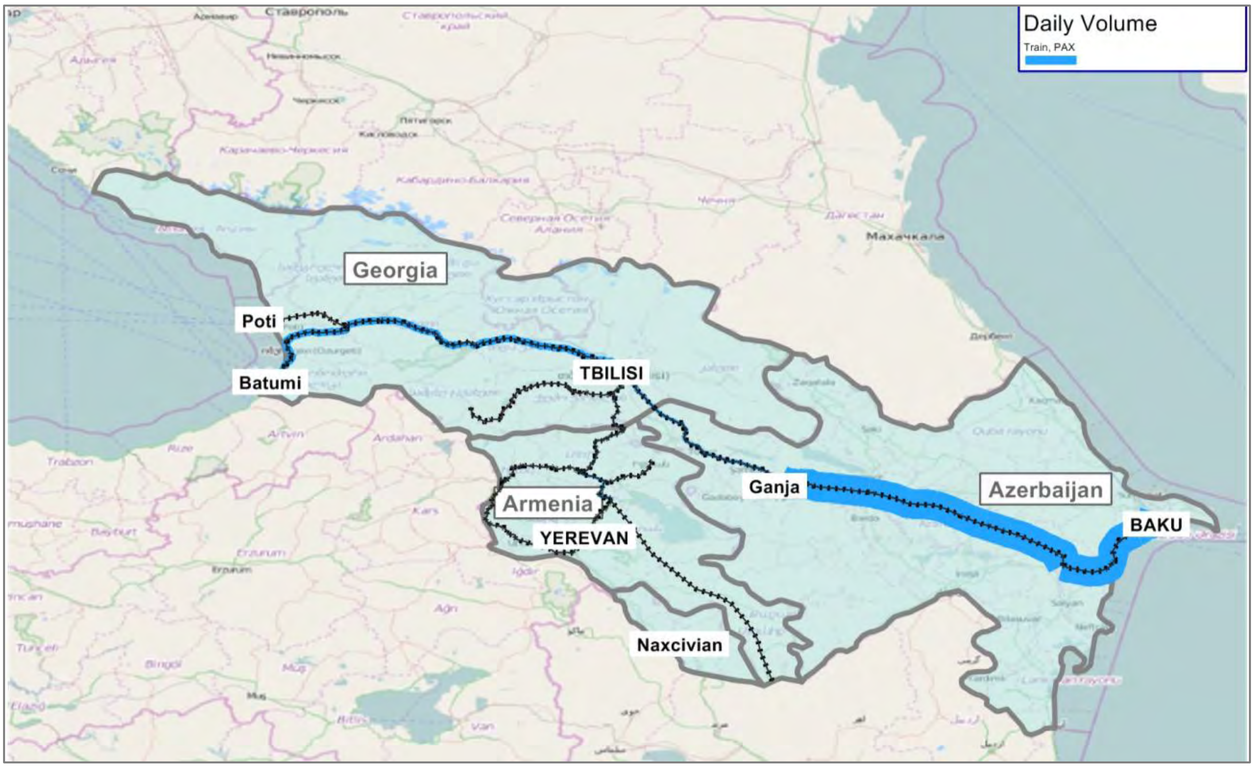


Figure 29 – Rail passengers flow patterns in Armenia, Georgia and Azerbaijan



4.3.3 ROAD FREIGHT FLOW PATTERNS

Focusing on the road mode in Belarus, Ukraine and Moldova, an element to highlight is the significant traffic flow from Odessa towards the western Border of Ukraine, going through the connection Uman, Vinnitsa, Ternopil, Lviv where the roads conditions on the section Uman-Vinnitsa and especially on Ternopil-Lviv are not particularly adequate. Other road sections presenting high traffic volumes and not adequate road conditions are Kipti–Chernihiv (M1), Kherson-Melitopol (M14), Uman-Bila Tserkva (M5).

Figure 30 – Road freight flow patterns in Belarus, Ukraine, Moldova

The figure shows as well the road freight volumes in Belarus. A pattern is observed of domestic traffic and less international / transit traffic in the East-West direction. International transit is showing as well in the North South direction through Kiev to the sea port Odessa.

In analogy to the rail pattern, the road freight between Azerbaijan and Georgia but also Georgia and Armenia follows the EaP corridor. This is also consistent with the observed values.

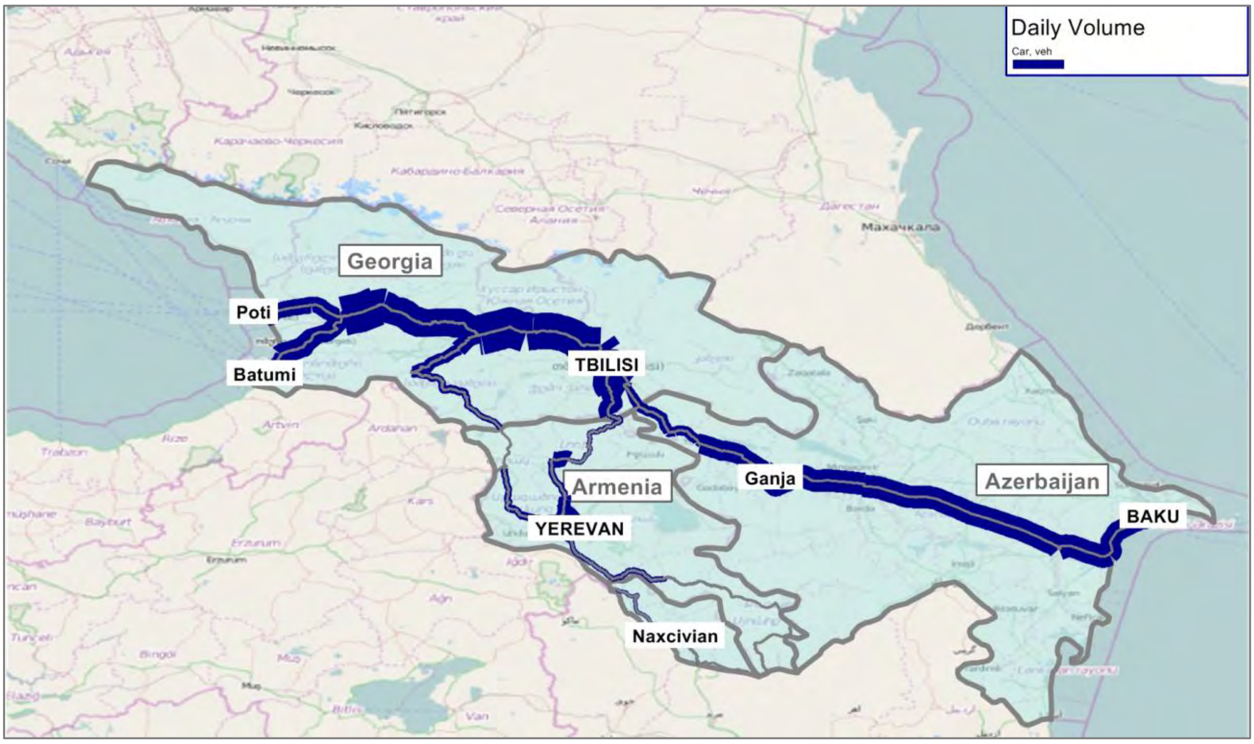
Figure 31 – Road freight flow patterns in Armenia, Georgia and Azerbaijan

4.3.4 ROAD PASSENGER FLOW PATTERNS

The passenger flows patterns shown in the two next figures again are consistent with the EaP network. Short distance flows around large cities are not fully represented in the model due to the regional level considered.

Figure 32 – Road passengers flow patterns in Belarus, Ukraine, Moldova

Figure 33 – Road passengers flow patterns in Armenia, Georgia and Azerbaijan



4.3.5 LEVEL OF SERVICE

The Level of Service (LoS) was calculated based on volume to capacity (v/c) ratio classification by the US Highway Capacity Manual. The level of service of a road cannot be simply calculated on the basis of the number of lanes and traffic volumes; given a particular type of road and a certain volume of traffic, the level of service may vary significantly according to the geometrical characteristics like for instance:

- Number and frequency of curves and their characteristics (radius of curvature, cross slope) and longitudinal gradients (%, length of the ramps)
- Visibility distance for two lanes road of at least 450 m (to allow overtaking)
- Number and type of junctions (intersection or interchange)

In addition to the geometric characteristics, there are other physical aspects that affect the speed and the maximum flow of a road:

- State of the pavement (including drainage);
- State of road markings;
- The embankments side (including maintenance).

Given the unavailability of such detailed information, in this study an approximate calculation of LoS has been performed on the basis of volume capacity ratios produced by the model.

In order to consider the quality of road conditions of the EaP network, the design capacity and speed of the roads have been readjusted in order to reflect the real status of the road reported from the surveys. In particular we have considered that in poor quality roads the capacity has been reduced by 50% and consequently the speed has been set at 30 km h, while for poor to medium conditions the capacity has been reduced by 20% and the speed at 60 km h. The classification of calculated LoS is made as described in Table 5.

Table 5 – Classification of level of service

A	**Free flow**	<= 0.33	LOS A
B	**Reasonably free flow**	<= 0.55	LOS B
C	**Stable flow**	<= 0.75	LOS C
D	**Approaching unstable flow**	<= 0.89	LOS D
E	**Unstable flow**	<= 1.00	LOS E
F	**Forced or breakdown flow**	> 1.00	LOS F

As it can be seen in Figure 34 the EaP network in Ukraine, Belarus and Moldova shows a balanced picture of volume to capacity ratio, only limited sections are attributed with high v/c ratio (i.e. low level of service), especially those close to large urban areas. Other roads are shown as low v/c despite their low roads surface condition. This is likely to be due to traffic avoiding poor quality roads.

Eastern EaP countries show a more variable picture (Figure 35) with some road sections presenting low level of service (from LoS D and LoS E) in Georgia and in Azerbaijan (in Georgia LoS F near the urban centres).

Figure 34 – Level of service on the EaP road network in Belarus, Ukraine, Moldova

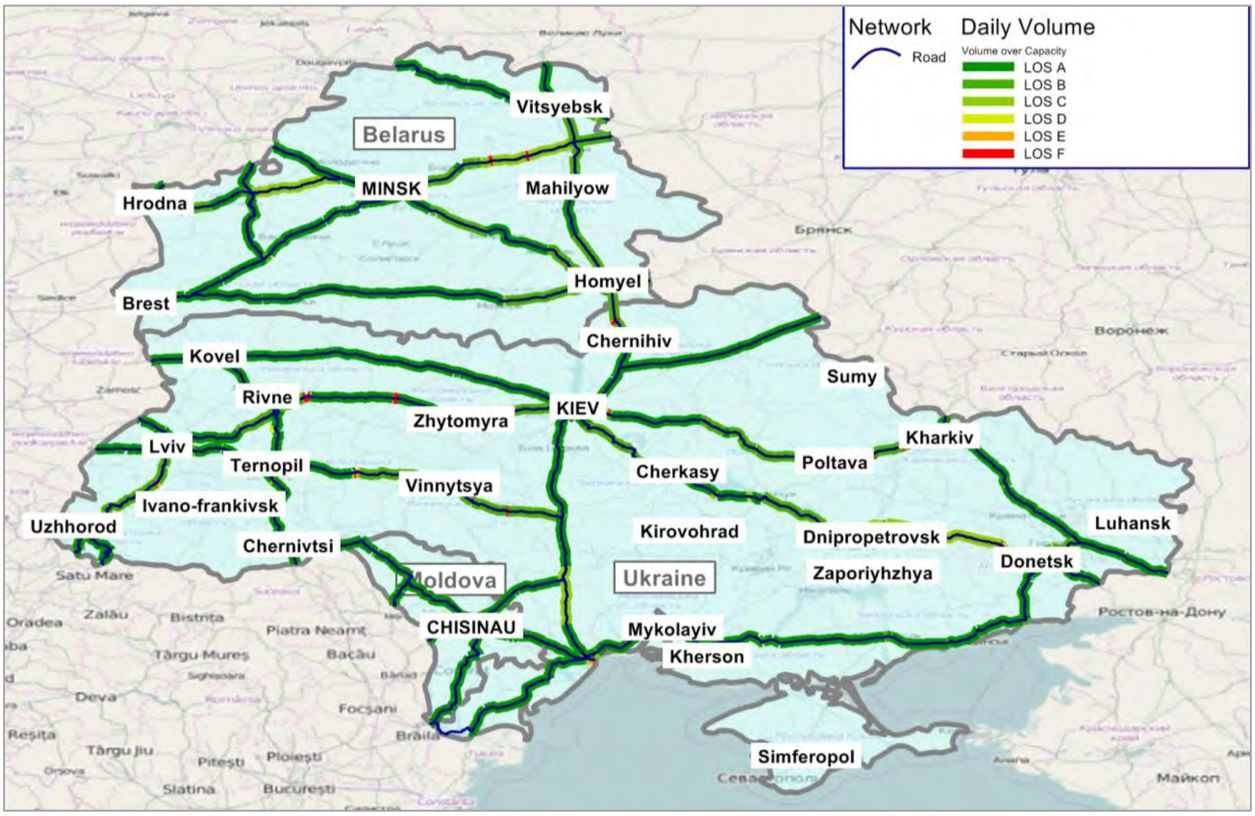
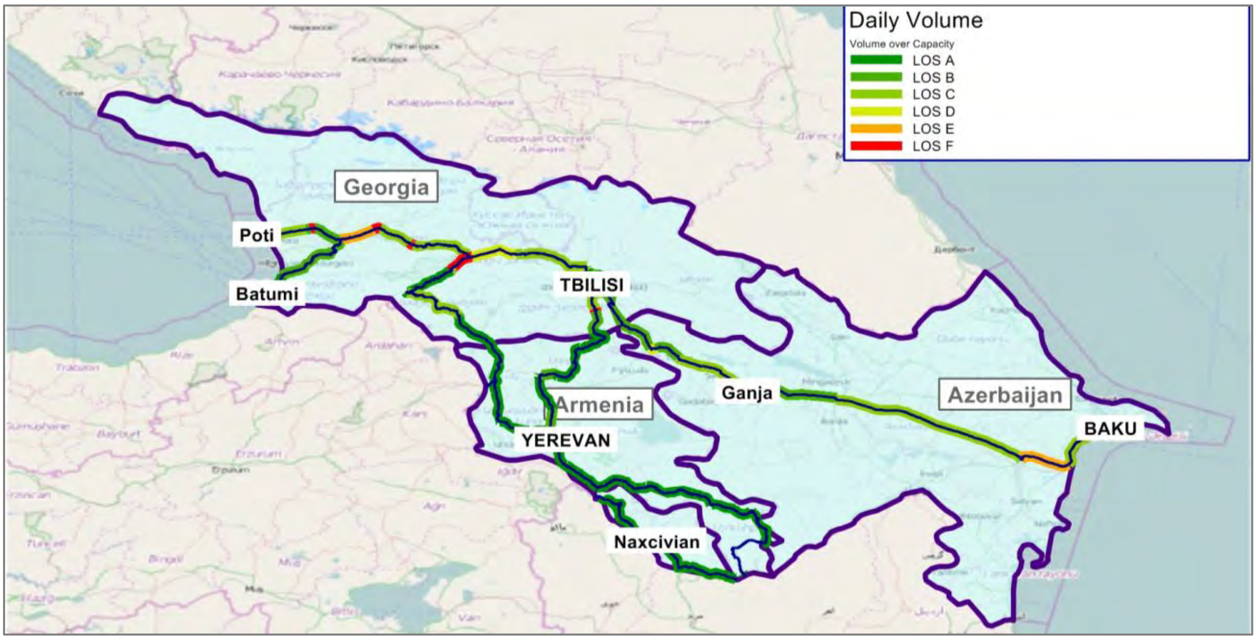


Figure 35 – Level of service on the EaP road network in Georgia, Armenia, Azerbaijan



The comparison of volume/capacity ratios with the information on current road conditions shows, as expected, that higher ratios do not apply on roads presenting poor or poor-to-medium road conditions.

4.4 ANALYSIS OF TRANSPORT FLOW PATTERNS IN THE BASELINE AND ALTERNATIVE SCENARIOS

4.4.1 COMPARISON BETWEEN BASE YEAR AND BASELINE 2030 SCENARIO

Figure 36 and Figure 37 provide a comparison of freight flow patterns in Belarus, Ukraine and Moldova for rail and road modes respectively. In particular the pictures display the difference between Baseline 2030 and Base Year traffic flow for rail (in green positive variations and in brown negative variations) and for road (blue, positive; red, negative). As expected at 2030 it can be noted a general increase of both road and rail freight flows on the overall network.

More visible growths can be observed on the EaP rail directions Brest–Minsk–Orsha–Russian border (which grows on average about 45%), on the direction L'viv–Rivne–Dnipropetrovsk–Donetsk (75% growth) and from Ternopol to Odessa (70% growth)

Figure 36 – Comparison between Base Year and Baseline 2030 scenarios rail freight flow patterns, Belarus, Ukraine and Moldova

When focusing on road (Figure 37), traffic flows are expected to grow more on the EaP direction L'viv–Rivne-Kiev (70% growth), Ternopil-Vinnytsa-Uman (75% growth), Kiev-Uman-Odessa (75% growth)

Figure 37 – Comparison between Base Year and Baseline 2030 scenarios road freight flow patterns, Belarus, Ukraine and Moldova

Figure 38 and Figure 39 below provide a similar comparison of freight traffic flows in Georgia, Armenia and Azerbaijan. It can be noted that the EaP rail connection from Baku to Poti is expected to increase on average of about 50% - 65% from Baku to Georgian border and of about 80% from Georgian border to Poti and Batumi ports. The rail link from Tbilisi to Kars (Turkey), not completed at base year, is completed and operational at year 2030.

When focusing on road mode, it can be observed that an increase is expected on the same route, with a more visible growth in Georgia. In particular the direction Samtredia-Tibilisi is expected to grow on average more than 50%, while from Baku to the Georgian border the increase is of about 60%.

Figure 38 – Comparison between Base Year and Baseline 2030 scenarios rail freight flow patterns, Georgia, Armenia, Azerbaijan

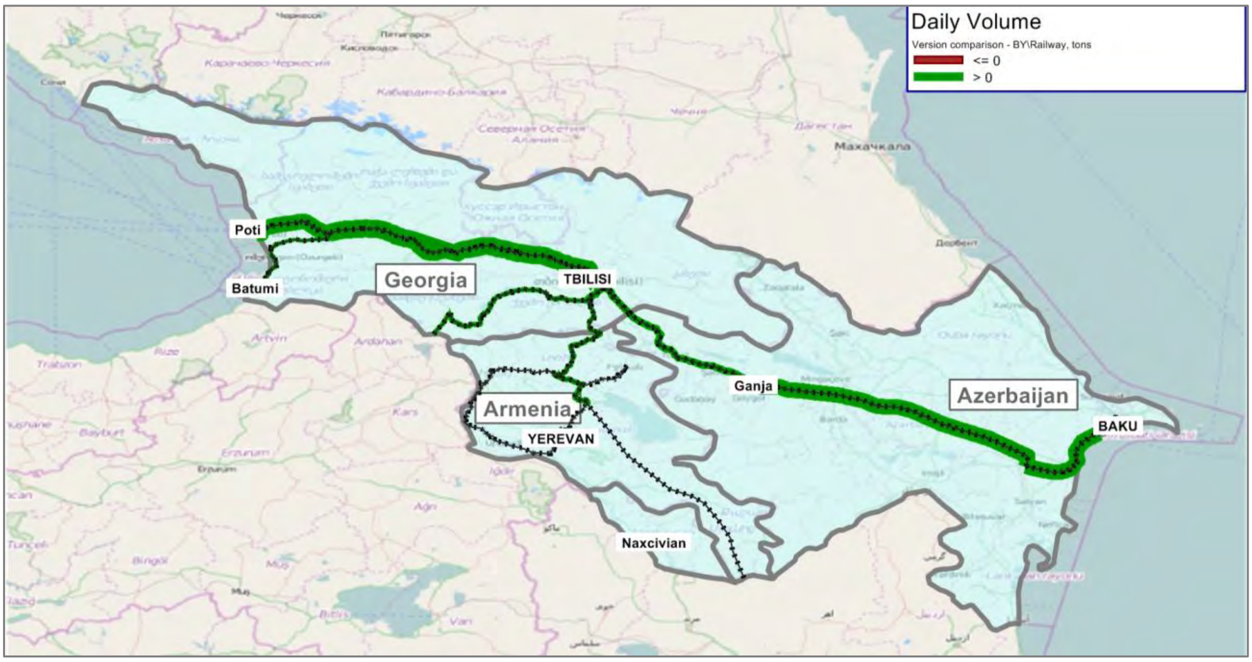


Figure 39 – Comparison between Base Year and Baseline 2030 scenarios road freight flow patterns, Georgia, Armenia, Azerbaijan

The comparison of the passenger flow patterns between Baseline 2030 and Base Year scenarios doesn't show any remarkable variation given the very small demographic change in the EaP countries.

4.4.2 IMPACT ON EAP NETWORK LEVEL OF SERVICE

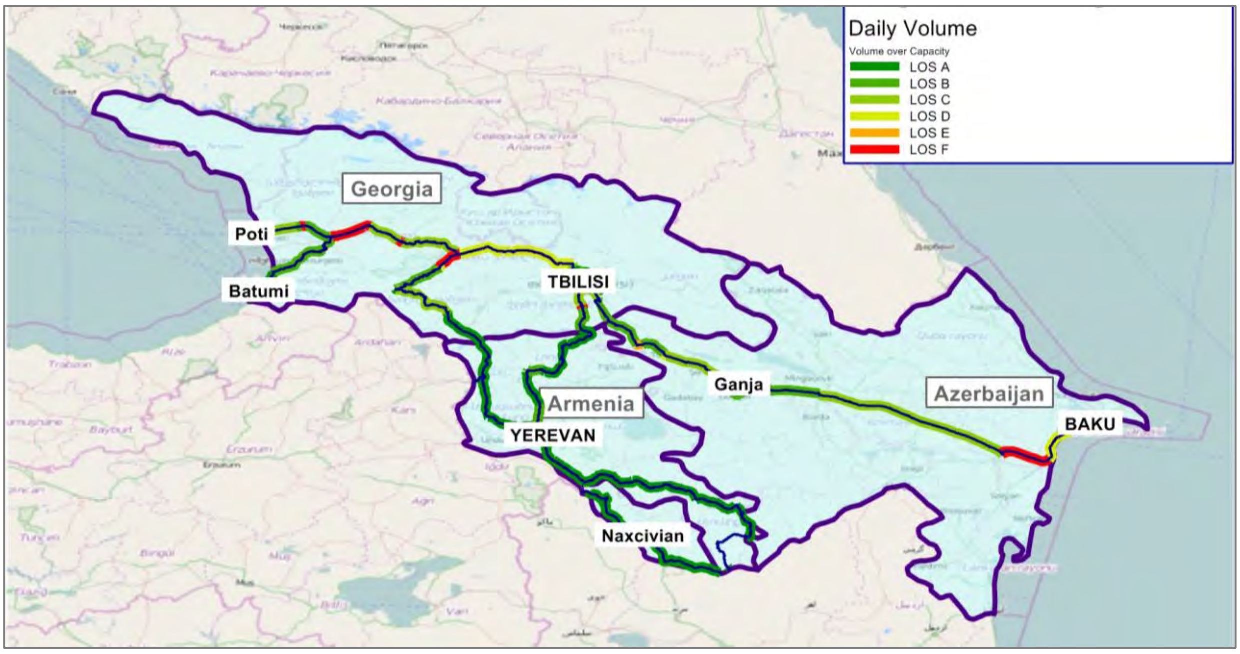
The change in the Level of Service in the EaP network is visible in Georgia where considerable increase of the volume turns the LOS towards level F. In fact, most roads around major cities gets close to level E / F, but this has to be considered with care due to the model uncertainties close to large urban areas.

In Belarus, Ukraine and Moldova the LoS remains almost unchanged with an exception of Ukraine along the route Uman-Odessa and in Belarus between Minsk and Vitsyebsk.

Also in the Baseline scenario the comparison of volume/capacity ratios with the information on current road conditions shows that higher ratios do not apply on roads currently presenting poor or poor-to-medium road conditions.

Figure 40 – Baseline scenario 2030 - Level of services in Belarus, Ukraine and Moldova

Figure 41 – Baseline scenario 2030 - Level of services in Georgia, Armenia, Azerbaijan



4.4.3 COMPARISON BETWEEN INTEGRATION AND STAGNATION SCENARIOS AT THE YEAR 2030

Figure 42 to Figure 45 provide a comparison of road and freight flow patterns between Integration and Baseline 2030 scenarios for the EaP countries. As expected the increase of exchanges between the EU and EaP, as well as between EaP countries, determines a general increase of freight volumes on both road and rail networks.

In particular it can be observed an increase of the road traffic on the EaP directions Kovel-Kiev (44%), Kiev-Odessa (13%), Brest-Minsk (18%), Lithuania Border-Minsk (26%), Gomel-Kiev (17%).

For rail, the main routes showing traffic significant increase are Brest – Minsk – Russian border and Poland Border–L'viv–Rivne–Zhytomyra-Cherkasy-Dnipropetrovsk-Donetsk (40%) with the bifurcation Rivne-Kovel (40%) and the two rail sections from L'viv to Hungary and Romania border (respectively 40% and 100%).

Figure 42 – Comparison between Integration and Baseline 2030 scenarios rail freight flow patterns, Belarus, Ukraine and Moldova

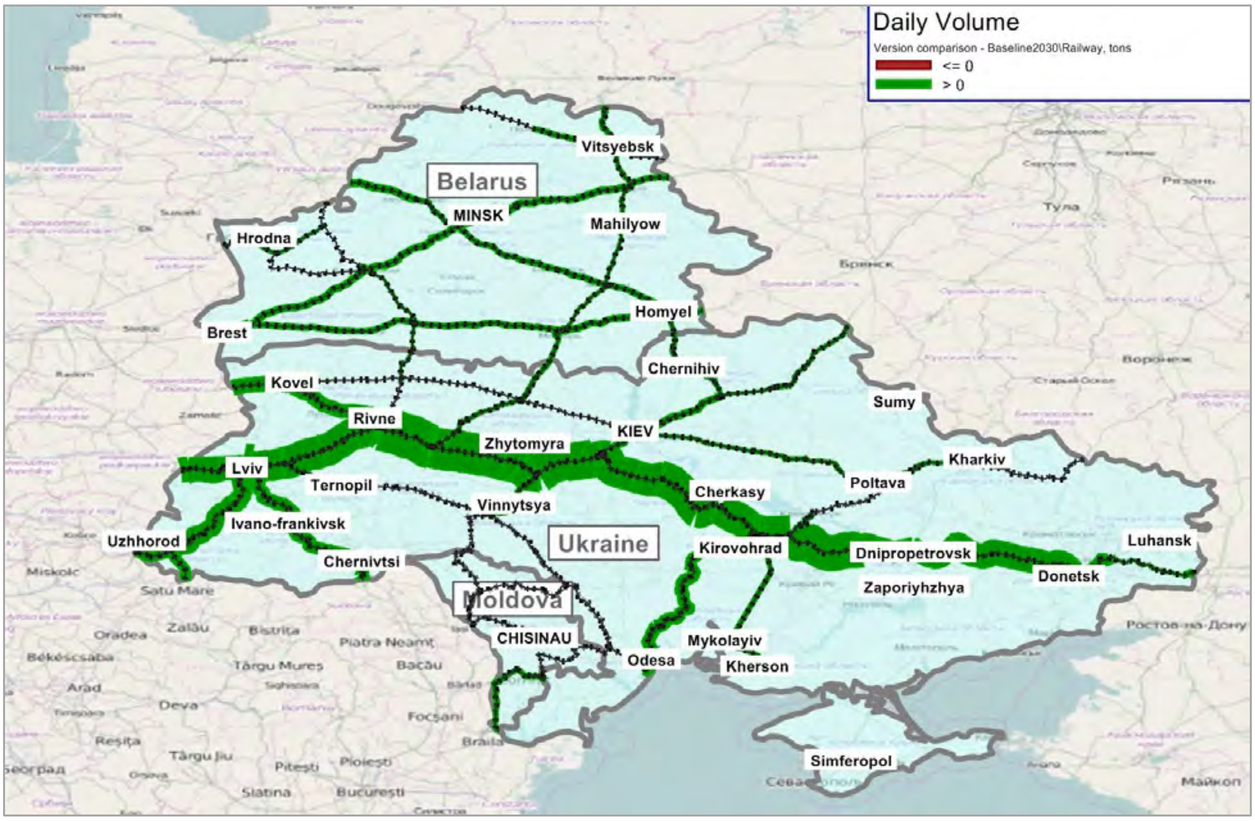


Figure 43 – Comparison between Integration and Baseline 2030 scenarios road freight flow patterns, Belarus, Ukraine and Moldova

Figure 44 – Comparison between Integration and Baseline 2030 scenarios rail freight flow patterns, Georgia, Armenia, Azerbaijan

Figure 45 – Comparison between Integration and Baseline 2030 scenarios road freight flow patterns, Georgia, Armenia, Azerbaijan

Figure 46 to Figure 49 show a comparison of road and freight flow patterns between Stagnation and Baseline 2030 scenarios for the EaP countries. As expected the reduction of exchanges between the EU and EaP, as well as between EaP countries, determines a general decrease of freight volumes in comparison of Baseline 2030 on both road and rail networks on the same directions that presented an increase of traffic volumes in the integration scenario.

In Figure 46 more visible reduction can be observed on the EaP rail directions L'viv–Rivne–Zhytomyra-Cherkasy-Dnipropetrovsk-Donetsk (which decrease on average about 22%), on the direction Mykolayiv–Kirovograd–Dnipropetrovsk–Kharkiv (22% reduction) and from Ternopil to Odessa (25% reduction).

When focusing on road, traffic flows are expected to decrease more on the EaP direction Ternopil–Vinnitsa–Uman–Odessa (20% reduction), L'viv-Rivne-Kiev (20% reduction) Kiev-Odessa (26% reduction)

In Figure 48 it can be noted that the EaP rail connection from Baku to Poti is expected to decrease on average of about 17% from Baku to Georgian border and of about 25% from Georgian border to Poti and Batumi ports. For road transport, it can be observed that a decrease is expected on the same route, with a more visible one in Georgia. In particular the direction Samtredia - Tibilisi is expected to decrease on average about 20%, while from Baku to the Georgian border the reduction is of about 18%.

Figure 46 – Comparison between Stagnation and Baseline 2030 scenarios rail freight flow patterns, Belarus, Ukraine and Moldova

Figure 47 – Comparison between Stagnation and Baseline 2030 scenarios road freight flow patterns, Belarus, Ukraine and Moldova

Figure 48 – Comparison between Stagnation and Baseline 2030 scenarios rail freight flow patterns, Georgia, Armenia, Azerbaijan

Figure 49 – Comparison between Stagnation and Baseline 2030 scenarios road freight flow patterns, Georgia, Armenia, Azerbaijan

The passenger flow patterns do not change between the future scenarios (Baseline, Integration and Stagnation) as they all assume the same demographic change in the EaP countries.

Figure 50 to Figure 53 show a comparison of road and rail freight flow patterns between Stagnation and Integration 2030 scenarios for the EaP countries. As expected the reduction of exchanges between the EU and EaP in Stagnation scenario and the increase in Integration scenario, as well as between EaP countries, determines a general increase of freight volumes in Integration scenario in comparison of Stagnation 2030 on both road and rail networks on the same directions that presented an increase of traffic volumes in the Integration scenario compared to Baseline 2030. The main increase for rail is along the route L'viv-Rivne-Cherkasy-Dnipropetrovsk (80%) while for road is along the route Kiev Odessa (45%)

Figure 50 – Comparison between Integration and Stagnation 2030 scenarios rail freight flow patterns, Belarus, Ukraine and Moldova

Figure 51 – Comparison between Integration and Stagnation 2030 scenarios road freight flow patterns, Belarus, Ukraine and Moldova

Figure 52 – Comparison between Integration and Stagnation 2030 scenarios rail freight flow patterns, Georgia, Armenia, Azerbaijan

Figure 53 – Comparison between Integration and Stagnation 2030 scenarios road freight flow patterns, Georgia, Armenia, Azerbaijan

4.4.4 IMPACTS ON EAP NETWORK LEVEL OF SERVICE

Figure 54 and Figure 55 below show the level of service of EaP roads in Integration 2030 scenario. It can be noted that the level of service on roads in Georgia (Samtredia-Kutaisi and Kashuri -Tblisi) and in Azerbaijan (Baku – Haciqabul) is expected to shift to level E and F due to the increase of road traffic. In Ukraine and Belarus, the increase of traffic causes the reduction of LoS on some roads, but the overall level of service on the EaP network is still high.

Figure 56 and Figure 57 show the level of service on EaP roads in the Stagnation scenario 2030. It can be observed that the level of service in Belarus, Ukraine and Moldova is generally high with only some punctual problems close to urban settlements, while in Georgia and Azerbaijan some sections (already presenting low level of service in the Base Year) benefit only to a limited extent from the reduction of traffic volumes and thus persisting in a critical status. Also in this case higher volume/capacity ratios do not occur on roads currently presenting poor or poor to medium road conditions.

Figure 54 – Integration scenario 2030 - Level of services in Belarus, Ukraine and Moldova

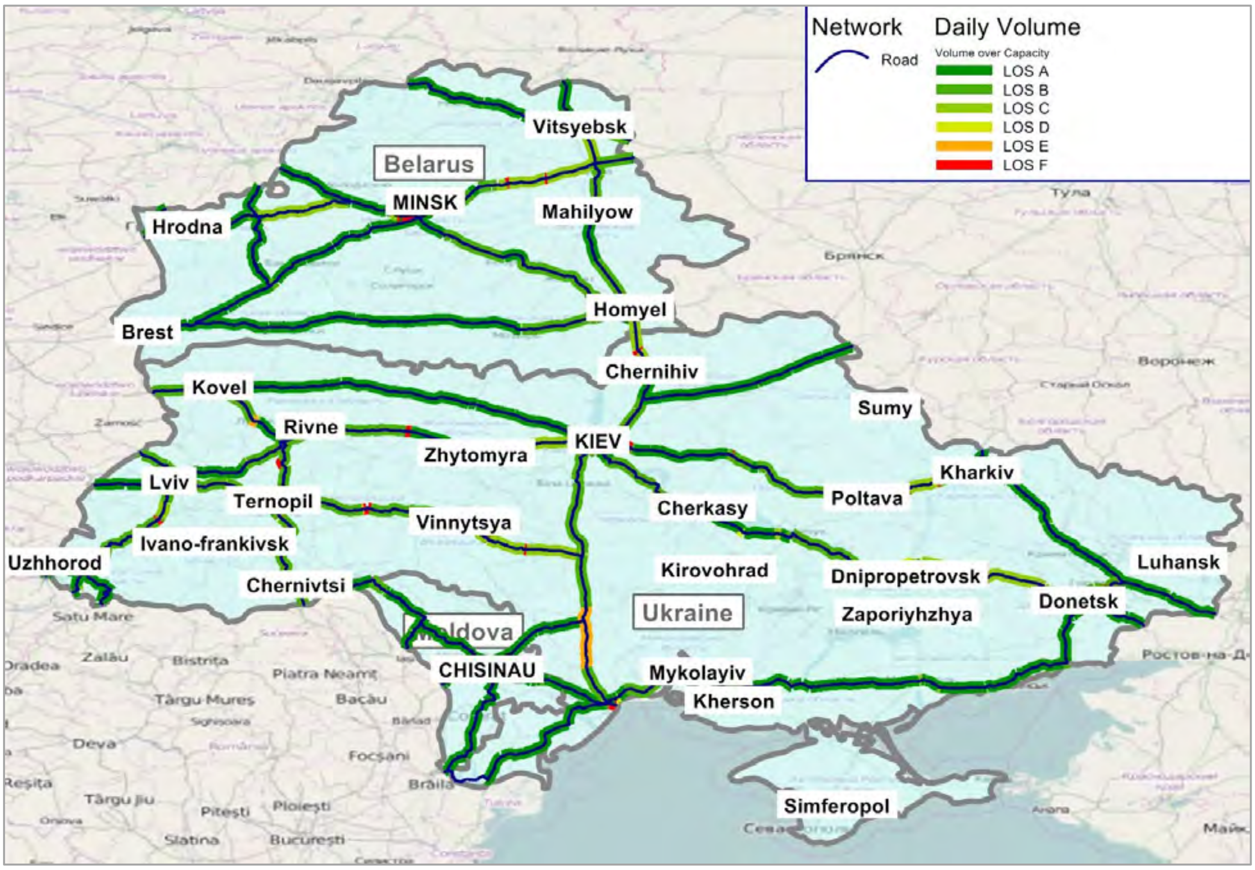


Figure 55 – Integration scenario 2030 - Level of services in Georgia, Armenia, Azerbaijan

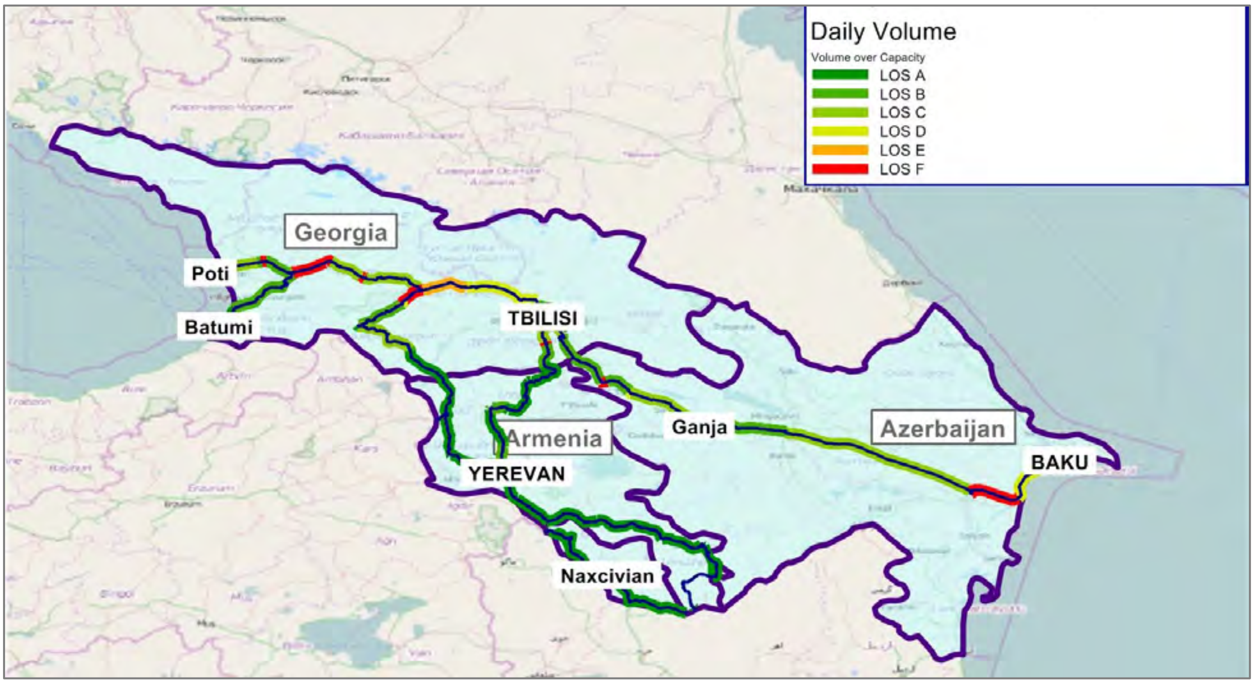
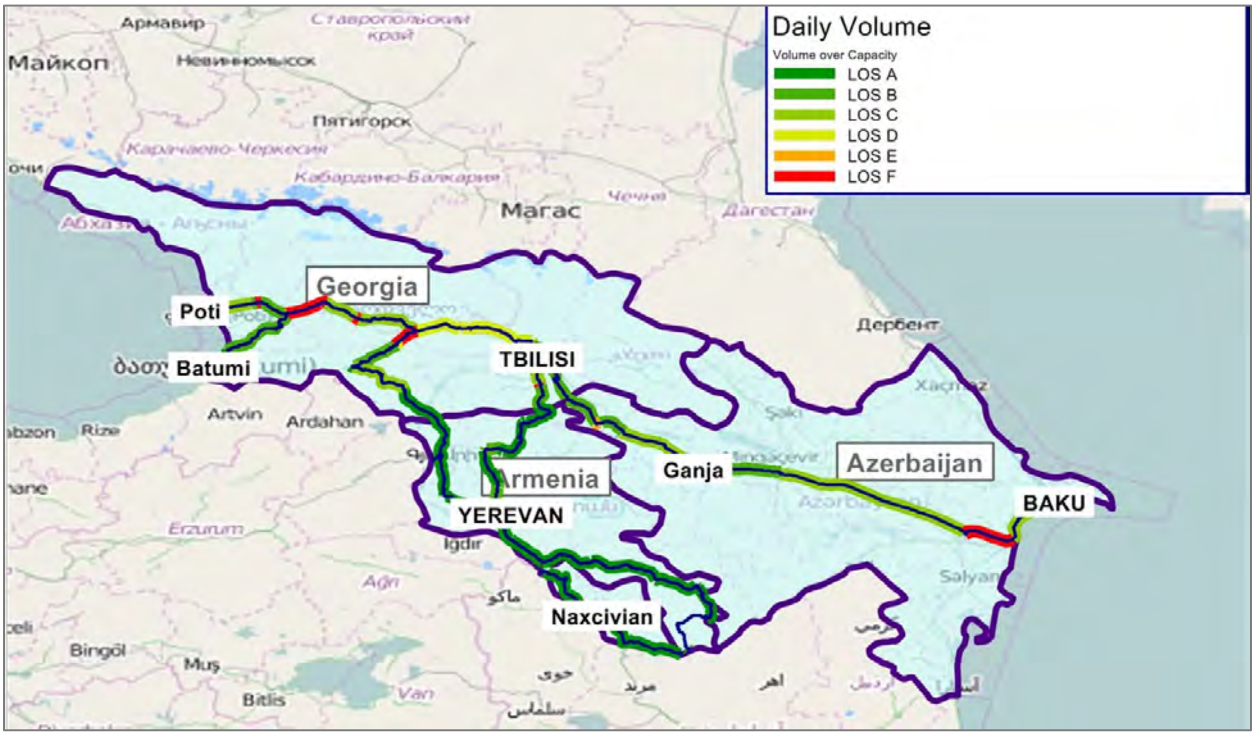


Figure 56 – Stagnation scenario 2030 - Level of services in Belarus, Ukraine and Moldova

Figure 57 – Stagnation scenario 2030 - Level of services in Georgia, Armenia, Azerbaijan



4.5 ASSESSMENT OF POSSIBLE BOTTLENECKS AND MISSING LINKS

The analysis of the EaP strategic network shows that:

- The EaP road network is dominantly composed of single carriageway roads with one lane per direction and a speed of 90 Km/h. This speed limit mostly complies with national regulations. It reflects infrastructure characteristics that generally might appear not adequate for a strategic transnational network.
- In addition 27% of the road network (about 3,180 km) presents poor or poor-to-medium surface conditions. Road conditions vary considerably among countries like Georgia and Azerbaijan on one side, where generally good road conditions prevail, and Armenia, showing considerable criticalities on road quality.
- The level of service, i.e. the ratio between long distance traffic flows and road capacity, along the road network is good in most of the EaP countries, with the exception of some stretches in Georgia and Azerbaijan, although here is important to mention that the analysis doesn't take into consideration the specific urban nodes, where local congestion may occur.
- The EaP rail network is equally composed by single track lines (5,680 km) and double tracks lines (about 6,160 km). Also in this case the presence of a high share of single track railways on the total network highlights infrastructure characteristics that generally appear not adequate for a strategic transnational network.
- The level of electrification of the rail network is different among countries. For example, railways in Armenia, Azerbaijan and Georgia are all electrified, while rail lines in Moldova are entirely in diesel operation and Belarus and Ukraine present mixed traction systems. At some border crossing the coexistences of different traction systems (diesel and electrified) might pose problems of interoperability and increase delays.
- The definition of some parts of the road network needs to be further verified since some of the sections cannot be identified without ambiguity. It is the case of the road link from Mukacheve (Ukraine) to Romania Border which is not clear whether it is a planned infrastructure or it is envisaged to be a path encompassing sections of H09, M23 and M26 roads. Similar perplexities arise in relation to the existence of a railway link connecting Balti (Moldova) to Vapnyarka (Ukraine).
- The 2030 baseline scenario shows general increase of both road and rail freight flows on the overall network. Further assessment is needed for railway growth between 45% and 75% at some corridor. Road freight transport shows a growth rate at some corridor in the integration scenario ranging around 70% - 84%.
- The comparison for passenger flows does not reflect any significant variation due to the small demographic change in the EaP countries and considering that the Scenarios do not include any change in the motorization rates.
- In 2030 the EaP road network in Ukraine, Belarus, Moldova and Armenia shows a balanced picture of volume to capacity ratio, with only limited sections presenting low level of service. In Georgia and Azerbaijan low level of service is expected on some road sections, especially in case of integration scenario.