CLIMATE CHANGE ADAPTATION TECHNOLOGY NEEDS ASSESSMENT in ENERGY, AGRICULTURE, WATER, FORESTRY, TRANSPORT, HEALTH sectors of the REPUBLIC of MOLDOVA

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FOREWORD

The Republic of Moldova stands at a critical juncture in its development, where climate change adaptation is essential for safeguarding its economic, social, and environmental future. The country has aligned with the UNFCCC Parties in recognizing the significance of technology, following Article 10 of the Paris Agreement's Technology Framework, which emphasizes innovation, implementation, capacity building, enabling environments, collaboration, and stakeholder support.

As global weather patterns grow more erratic, Moldova adopted a strategic approach to climate adaptation, backed by technological innovation and coordinated policy efforts. Recognizing the technological needs for climate adaptation as a cornerstone of effective action, Moldova conducted a Technology Needs Assessment (TNA) in six priority sectors—Agriculture, Energy, Water, Forestry, Health, and Transport—during 2021-2023y.y. In-depth sectoral assessments took an inclusive approach, guided by Sectoral Work Groups focused on enhancing resilience and promoting sustainable development in each area. The TNA was carried out as part of the second iteration of the National Adaptation Plan, funded by the Green Climate Fund and supported by UNDP and FAO UN Agencies.

The TNA process laid a robust foundation for integrating climate adaptation into sectoral planning, addressing existing adaptation gaps, and fostering systemic resilience in response to climate impacts. The identified and prioritised technological solutions aligned with Moldova's broader national and sectoral adaptation strategies, such as the *National Programme for Adaptation* (2023-2030), *Moldova 2030 Sustainable Development Strategy*, *Low Emission Development Programme* 2030 and *Nationally Determined Contribution 2.0 and 3.0* (under consultation). The outcomes of the TNA emphasised transformative adaptation, aiming to meet Moldova's adaptation needs by establishing resilient systems capable of responding to identified climate impacts, vulnerabilities, and risks in a timely manner, matching the anticipated pace of climate change.

The TNA process in Moldova followed a structured, three-stage approach to ensure a comprehensive understanding and prioritisation of adaptation technologies: Identification and *Prioritization of Adaptation Technologies; Barrier Analysis and Enabling Environment; Development of Technology Action Plans (TAPs)* followed by the identification of *Project Ideas* (Energy, Water, Forestry, Transport, Health and investment Concept Note (Agriculture). Sectoral TNA Reports offer a thorough exploration of the technological pathways that can facilitate effective climate adaptation across the prioritized sectors.

Climate adaptation TNA assessments form a vital component of Moldova's contributions to global adaptation efforts under the Paris Agreement, underscoring the country's commitment to strengthening resilience against climate-induced impacts.

Aliona Rusnac
State Secretary
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CLIMATE CHANGE ADAPTATION TECHNOLOGY NEEDS ASSESSMENT

TRANSPORT SECTOR

Integrated Report (TNA, BAEF and TAP)

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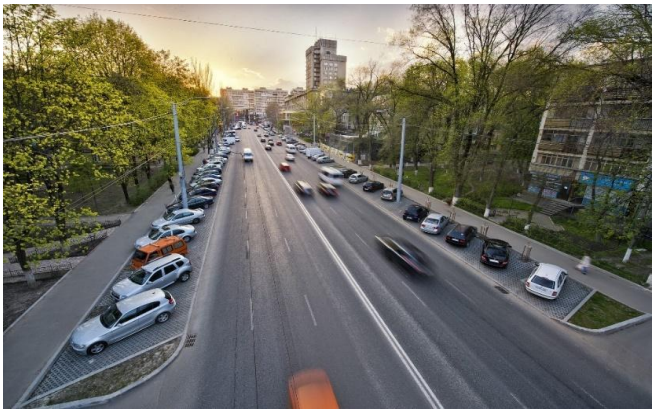

Chisinau 2021-2023

TECHNOLOGY PRIORITISATION REPORT (TNA 1)

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CCA TECHNOLOGY NEED ASSESSMENT Executive Summary

Moldova's transport and road infrastructure sector includes road, rail, naval, and air transport. This sector plays a significant role in the Republic of Moldova's national economy; its current contribution to the gross domestic product is about 6.6%. The sector provides jobs for 74,125 people, or 18.7% of the average annual number of employees, and consists of the following segments: road transport, rail transport, air transport, and naval transport.

Moldova ranks 116th on the World Bank Group's Logistics Performance Index of 2018. At less than 5%, transport makes a small contribution to the country's GDP, yet the transport sector is responsible for 22% of the country's GHG emissions.

The transport sector, which includes road, rail, naval, and air transport, is vulnerable to the increase in the frequencies and intensity of storms (wind, rain, snow), which could bring additional costs in infrastructure construction, maintenance, and operation. Given the fact that the Republic of Moldova is a small country, from a geographical point of view, and has no direct access to the sea, the roads are the basic infrastructure that plays an essential role in the economy, and the negative impact of climate change affects the social-economic development of the country.

In the country's Energy Balance, the Transport Sector is the second energy consumer and registered an increase from 24,887 TJ in 2010 to 32,192 TJ in 2019. The structure of consumption by types of energy remained unchanged from 2010 to 2019. The primary energy products consumed by this sector are Petroleum products (31,199TJ, or 96.91%), Natural gas (830 TJ, or 2.57%), and Electricity (163 TJ, or 0.52%).

Climate change already has, and it is expected to have a wide range of impacts on all sectors of the Republic of Moldova. For example, the Transport Sector is vulnerable to the increase in frequency and intensity of storms (wind, rain, snow), which could raise costs related to the construction, maintenance, and operations of transportation infrastructure and vehicles.

One of the main characteristics of the transport sector is that, because of the different stakeholders in the industry, the specific challenges for adaptation are focused on other targets and activities. Therefore, the responsibility for implementing adaptation action in the transport sector must often be clarified. Some adaptation actions occur spontaneously by the main transport stakeholders; depending on their funding, they can be implemented through synchronization and cooperation.

To promote efficient transport, the primary activities of Strategies and Action Plans focus on developing an infrastructure resistant to climate risks, ensuring adequate infrastructure, and providing quality and safe transport services.

The analysis of the central sectoral Legal Framework concluded that the Transport Sector is included in the main Strategies and Action Plans, and specific targets and objectives relating to reducing this sector's environmental impact are fixed. Therefore, the main actions are focused on reducing GHG emissions by introducing new technologies in this sector's infrastructure and operationality.

One of the main characteristics of the transport sector is that, because of the different stakeholders in industry, the specific challenges for climate change are focused on other targets and activities. In an intense consultation with the TNA, the main stakeholders of this sector, as well as the Working Group, were placed. While determining the representative people from the Working Group, the TNA Team consulted the main stakeholders; they provided the necessary support and information to identify an adequate representative. The gender aspects were considered during all TNA processes.

The analysis of the current technologies used in the transport sector confirmed again that the country's obsolete and poor condition of the transport infrastructure calls for urgent actions to modernize the transport sector and increase its resilience to climate change. As the transportation sector of Moldova is in poor condition, the vehicle fleet is obsolete; the industry is highly vulnerable to the main climate events that damage the infrastructure, increase the number of transport delays, and impact the national economy by raising the costs of public and private stakeholders. The four major conceptual factors to consider regarding climate concerns, exposure to climate stressors, vulnerability, resilience, and adaptation, give a view on the correct intervention in this sector.

INTRODUCTION

1. About the TNA Project

The Technology Roadmap for Key Sectors (Transport, Energy, Water, Forestry, and Health) represents a strategic framework designed to advance Moldova's climate change adaptation efforts by addressing sector-specific vulnerabilities and opportunities for innovation. Developed under the project Advancing Moldova's National Climate Change Adaptation Planning (Phase 2), the roadmap builds upon comprehensive Technology Needs Assessments (TNAs) to identify, prioritize, and implement technologies that enhance resilience and sustainability in each sector.

The roadmap provides a detailed analysis of technological adoption, gaps, and needs in critical areas impacted by climate change. For the transport sector, it emphasizes transitioning to low-emission technologies and strengthening infrastructure resilience. In the energy sector, it identifies pathways for integrating renewable energy solutions and improving energy efficiency to support a sustainable energy transition. The water sector roadmap focuses on advanced water resource management technologies, including systems for monitoring, conservation, and efficient distribution under changing climate conditions. The forestry sector addresses ecosystem-based adaptation, emphasizing technologies for forest management, restoration, and biodiversity protection. For the health sector, the roadmap prioritizes innovations to monitor and mitigate climate-induced health risks, enhance emergency response systems, and promote public health resilience.

The roadmap outlines actionable strategies, timelines, and budgetary requirements to guide the adoption and scaling of these technologies. Aligning with Moldova's National Adaptation Planning process ensures coherence with the country's broader climate and development goals, including its Nationally Determined Contributions (NDCs). This initiative is a cornerstone for strengthening Moldova's adaptive capacity, fostering sectoral collaboration, and securing funding for climate-resilient investments through mechanisms like the Green Climate Fund.

1.1Existing national policies related to technological innovation, adaptation to climate change, and development priorities.

The Republic of Moldova, a country highly vulnerable to climate change and the socio-economic costs of climate change-related hazards, is working to establish a solid foundation for low-emission and climate-resilient growth. It was one of the first countries in the world to develop a Long-Term Low-Emissions Development Strategy (LEDS) and the fourth country to submit to UNFCCC a Second NDC.

National legislation and strategic documents on environmental policy and climate change have been developed to address the challenge. Law No. 78 of 04.05.2017 on the ratification of the Paris Agreement, which regulars the implementation of the Agreement at the national level, focused on the country's objectives of reducing GHG emissions and supporting the implementation of environmentally oriented activities.

Climate change is streamlined into the country's main strategic planning documents. One of the specific objectives of the National Development Strategy "Moldova 2030," approved by Law no. 377 of 10.06.2020, is to "Ensure resilience to climate change by reducing risks related to climate change and by facilitating adaptation in six priority sectors: agriculture, water resources, health, forestry sector, energy, and transport."

The Energy Strategy of the Republic of Moldova, approved by Government Decision No. 102 of 05.02.2013, outlines the sector's climate change mitigation until 2030.

In 2014, by the Government Decision No. 1009 of 10.12.2014, the Government approved the Climate Change Adaptation Strategy. This first national strategic framework aims to advance the resilience of the country's social and economic development processes. In the same year, 2014, Government Decision no.301 of 24.04.2014 approved the Environmental Strategy for 2014-2023 and the Action Plan for its implementation. The Strategy sets the sectoral targets for reducing greenhouse gas emissions compared to the baseline scenario: by 25% in the energy sector; 20% in the housing and industrial sectors; 15% in the transport and waste sectors; by 25% of carbon sequestration in the land-use sector, land-use change, and forestry.

In 2020 the Ministry of Agriculture, Regional Development and Environment presented to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) the second Nationally Determined Contribution (NDC2) of the Republic of Moldova. The country’s new economy-wide unconditional target is to reduce its GHG emissions by 70% below its 1990 level in 2030, instead of 64-67% as committed in the First NDC, which could be further decreased to 88% if international low-cost financial resources, technology transfer, and technical cooperation are ensured. The adaptation measures of NDC focus on the sectors of health, agriculture, water resources, forestry, energy, and transport. The co-benefits of the adaptation actions in the transport sector are expected to lead to a resilient urban infrastructure that reduces exposure to climate risks and increases the climate resilience of transport infrastructure (roads, bridges, viaducts, and tracks).

The Republic of Moldova's Low Emission Development Strategy, approved by Government Decision No. 1470 of 30.12.2016, is a strategic document to assist the country in shifting its development path to a low-carbon economy. The Strategy contains a concrete set of measures leading to GHG emission reduction, the quantity of the corresponding emission reduction for each measure, and the financial requirements to implement them.

The central Legal Framework related to the development of the transport sector, innovation, and the environment is focused on the following Laws and Government Decisions:

The Laws in order of their approbation:

Table 1. *The primary Laws related to the development of the transport sector, innovation, and the environment.*

Nr.	Title	Description
1	Law **no.1515 of 16.06.1993** on environmental protection	This law constitutes the basic legal framework for elaborating unique normative acts and instructions on particular issues in the field of environmental protection to ensure all citizens of the Republic of Moldova have a healthy environment and safety of soil, water, and air. The law establishes the main factors that constitute the basic legal framework, the responsibilities of public institutions, and their field of intervention.
2	Law **no.1540 of 25.02.1998** regarding the payment for environmental pollution	This law aims to create a system of economic activity in which there is unprofitable environmental damage. The law stimulates the construction and operation of systems for capturing and neutralizing pollutants, collecting, recycling, and utilizing waste, and implementing non-polluting technologies. These other measures would reduce the volume of emissions (discharges) of pollutants.

Source: Developed by the author

The Government Decisions in order of their approbation:

Table 1. *The main Government Decisions related to the development of the transport sector, innovation, and the environment.*

Nr.	Title	Description
1	Government Decision no.**827 of 28.10.2013** on the approval of the Transport and Logistics Strategy for the years 2013-2022	The general objective of implementing this Strategy is to create an efficient transport and logistics system that supports citizens' needs for mobility, facilitates trade on national and international markets, and enhances the Republic of Moldova's role as a liaison between EU and CIS member countries. This Strategy is based on the concept that infrastructure projects must comply with the legal provisions in force in the environmental field and balance environmental protection and economic development.
2	Government Decision no.**301 of 24.04.2014** on the approval of the Environmental Strategy for the years 2014-2023 and of the Action Plan for its implementation	The Strategy seeks to establish concrete objectives in environmental protection, whose implementation will lead to the country's sustainable development. The strategy's general objective is to create an efficient environmental management system, which would improve the quality of ecological factors and guarantee the population's right to a clean, healthy, and sustainable environment.
3	Government Decision no.**1009 of 10.12.2014** on approving the Republic of Moldova's Climate Change Adaptation Strategy by 2020 and the Action Plan for its implementation.	The goal of the Strategy is to ensure that the Republic of Moldova's social and economic development is less vulnerable to climate change impacts by becoming more resilient. Therefore, the general objective of the Strategy is oriented towards "Increasing the capacity of the Republic of Moldova to adapt and respond to actual or potential climate change effects."

4	Government Decision no.**1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation	This strategic document will allow the country to adjust its development path toward a low-carbon economy and achieve green, sustainable development based on the government's socioeconomic and development priorities. This Strategy contains a set of measures developed to reduce greenhouse gas emissions. It quantifies the corresponding emission reductions for each action and the financial requirements for their implementation.
5	Government Decision no.**160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for 2018-2020 and the Action Plan for its implementation.	This program aims to promote implementing the principles of the "green" economy in the Republic of Moldova in harmony with economic development and social welfare. The program addresses the increased impact of transport emissions on the environment and public health. It sets specific objectives for each sector and proposes concrete actions to reduce the environmental impact of the main sectors.

Source: Developed by the author.

The analysis of the central sectoral Legal Framework concluded that the Transport Sector is included in the main Strategies and Action Plans, and specific targets and objectives relating to reducing the environmental impact of this sector are fixed. The main actions are focused on GHG emission reduction by introducing new technologies in the infrastructure and operationality of this sector. The removal of greenhouse gas emissions by 15% from the transport sector using motor vehicles based on compressed natural gas and liquefied gases and the use of hybrid electric vehicles through the production of biodiesel and bioethanol is planned in the Environmental Strategy for 2014-2023. Furthermore, the Climate Change Adaptation Strategy by 2020 proposes that research in the field of transport and road infrastructure will focus on examining the impacts of climate change on that sector and analyzing options for adapting to these impacts. Also, the Specific Objective 2 of the Low Emission Development Strategy of the Republic of Moldova until 2030 is the unconditional reduction, by 2030, of greenhouse gas emissions from the transport sector by 30% and the reduction of conditioned greenhouse gasses up to 40%, compared to 1990.

One weakness of the Strategies and Action Plans analyzed is that they need to establish concrete actions for specific technologies. The lack of concrete steps and technological support mechanisms makes implementing the Action Plans challenging.

Also, considering that the main strategies, such as the Environmental Strategy, Moldova's Climate Change Adaptation Strategy, and the Low Emission Development Strategy, were developed from 2014 to 2016, the reference data used in these documents is already not actual and representative of the country's current climate situation. New strategies require up-to-date environmental, weather, and climate data to be considered.

1.2. Vulnerability assessments in the country

Moldova's economy already bears high costs from climate extremes and foregoes potential benefits. Due to poor conditions, the transport sector is one of the most vulnerable to leading climate change events.

The Vulnerability and Adaptation Assessment of the Transport Sector was carried out in the National Communication of the Republic of Moldova under the UN Framework Convention on Climate Change. In addition, a detailed assessment was included in the 3rd and 4th National Communications. Although the previous reviews have some common characteristics, they all concluded that projected climate changes would likely significantly impact transportation infrastructure.

The sector is vulnerable to summer heat, which can result in overheating equipment (e.g., engine ventilation, acclimatization), reduced life of asphalt road surfaces, damage to the bridge structure material, and injury and failure of the old vehicles. The intense and frequent heat waves can deteriorate or disrupt the asphalt pavement. This phenomenon was confirmed in 2003, 2007, and 2012, when more extended periods of high temperatures were registered. The most severe damage was caused to the Chisinau-Balti highway. Even on the recently rebuilt Chisinau-Leuseni national highway, long stretches of road have been deformed. The roads in Rîbniţa and Rezina were practically entirely disrupted by the trucks transporting the cement from local factories. Also, the rising daily temperatures could affect air flights, and the runways should be longer.

Extreme precipitation/floods will damage the infrastructure (e.g., pavements, road washout), flood the road infrastructure, and increase the instability of embankments. The increased humidity and the problems caused by it bring a deterioration of the asphalt, a reduction in the operation period of the roads, the necessity for repairs due to the damage of the asphalt, and, respectively, a decrease in road safety. The heavy summer rains stopped vehicle traffic in Chisinau in 2005, 2008, and 2009, causing additional damage to municipal streets. Also, bridges and viaducts have severe problems because water affects a structure's resistance, causing the metal reinforcements' rapid rusting. In this case, the optimal solution is to replace asphalt pavement with a waterproof layer completely. However, this solution is costly, and to implement it in practice, the traffic on bridges or viaducts must be reduced or completely stopped for a long time.

A severe problem in the Republic of Moldova is the state of the roads after the winter season. Such variations in regions where the temperature fluctuates significantly destroy the asphalt pavement. This is because the water accumulated in the cracks of the asphalt surface freezes (expands) and thaws (contracts) repeatedly. Repeating this cycle during the winter season reduces the elastic properties and disrupts the asphalt pavement.

***Table 3**. The risks of climate change on the transport and road infrastructure sector.*

Nr.	Sector	Climatic event	Risks
1	**Rail**	Summer heat	• Rail buckling • Increased instability of embankments • Overheating of equipment (e.g., engine ventilation, acclimatization) • An increase in wildfires can damage infrastructure
		Winter cold/ice	• Ice on trains and catenary
		Extreme precipitation	• Damage to the infrastructure due to flooding and landslides
		Extreme storms	• Damage to the infrastructure, such as signals, power cables, etc. (e.g., due to falling trees, fall of pillars, etc.)
2	**Road**	Summer heat	• Pavement deterioration • Reduced life of asphalt road surfaces • Expansion/buckling of bridges
		Extreme precipitation/floods	• Damage to the infrastructure (e.g., pavements, road washout) • Underpass flooding • Overstrained drainage systems • Instability of embankments
		Extreme storm events	• Damage to infrastructure (e.g., roadside trees/vegetation can block roads)
3	**Aviation**	Summer heat	• Degradation of runways and runway foundations • Higher-density altitudes cause reduced engine combustion efficiency
		Heavy precipitation events	• Flood damage to runways
4	**Maritime**	High river flow (e.g., extreme precipitation, snow melt)	• Problems with the passage of bridges • Speed limitations because of dike instability • Some restrictions on the height of vessels
		Low river flow (e.g., drought)	• Restrictions on the loading capacity. • Navigation problems, speed reduction

5	**Transport**	Temperature increases, and heat waves	• Increased asphalt rutting due to material constraints • Thermal expansion on bridge expansion joints and paved surfaces • Damage to bridge structure material • Damages and failure of the old vehicles
		Heavy precipitation	• Damage to infrastructure due to flooding • Risk of inundation of road infrastructure • Damage to the energy networks
		Extreme storms, strong winds	• Increased the maintenance costs

Source: Developed by the author.

In the case of significantly changed temperatures and heat waves, the adaptation measures should focus on developing new, heat-resistant paving materials, proper design/construction, milling out ruts, and designing the infrastructure for higher maximum temperatures.

Given the increased intense precipitation events, the measures should focus on developing new, climate-resistant road-building materials. These would use the most efficient technologies to ensure sealing and asphalt renewal, improve flood protection, and increase the standard for drainage capacity for new transportation infrastructure and major rehabilitation projects.

With increased and frequent extreme winds, the actions will shift road alignments beyond at-risk areas, modernize the lighting and signaling system, and introduce the traffic management system.

1.3. Transport Sector

Moldova ranks 116th on the World Bank Group's Logistics Performance Index of 2018. At less than 5%, transport makes a small contribution to the country's GDP, yet the transport sector is responsible for 22% of the country's GHG emissions.

The **Public Road Network** in the Republic of Moldova constitutes 10,586 km, including 5,904 km of national roads and 3,394 km of local roads, respectively. The local roads (of district interest) were transferred to the management of the Local Public Authorities according to point 3 of Government Decision No. 1468/2016. The 9,386 km of the road network are covered by permanent and semi-permanent road pavement (asphalt, cement, bitumen mixtures), comprising 62.7%, 92.5% of national roads, and 46.1% of local roads. Currently, 54% of national roads are in excellent or medium condition, and 46% of local roads - are in terrible condition.

Rail Transport has an important place in the country's economy. Based on the provisions of the Transport and Logistics Strategy for 2013-2022, for the railway sector, the priority is to provide quality services in rail passenger transport at an acceptable cost to society and to support domestic and international trade operations over medium and long distances. The primary reform intended to implement the restructuring and reorganization of the State Enterprise "Calea Ferată din Moldova" (CFM). With the support of International Financial Institutions, the implementation of the reorganization of the State Enterprise "Calea Ferată din Moldova" (CFM) was launched in 2017 and involves the creation of a competitive and efficient railway transport system with European quality and safety standards, by renovating the rolling stock and rehabilitating infrastructure.

The **Maritime Transport** of Moldova is organized by access to the Black Sea through the maritime segment of the Danube River (km 132.7-133.4), where the Giurgiulesti Port Complex was built and developed over the last two decades. The development of international shipping and the international legislation governing this kind of transport requires creating and providing an effective institutional mechanism. Thus, the Naval Agency of the Republic of Moldova was created on July 11, 2018, by Government Decision No. 706. The Naval Agency of Moldova became operational in January 2019. Its mission is to ensure the implementation of state policies in waterborne transport and to monitor compliance by natural and legal people with the normative framework in this field. This ensures the safety of internal waterways and port navigation, waterborne transport services' quality and inoffensiveness, and general shipping.

Being dominated by private companies, **Road Transportation** is relatively competitive and is considered a safe and efficient sector. About 2251 companies operate on the road transport market, providing road services for transporting goods and people nationally and internationally. However, the industry faces the problem of an old and obsolete fleet, which needs to meet safety and ecological standards.

The **Air Transport** sector of Moldova is small and limited. However, in December 1996, the Republic of Moldova became an ICAO Member State, and since 1 January 2008, the Republic of Moldova has become a full member of JAA (Joint Aviation Authority). In 2009, because of the JAA reorganization, the Republic of Moldova signed the Working Arrangements with the European Aviation Safety Agency (EASA), the JAA successor. Ten companies hold the

Air Operator Certificate; three have on-air operator authorization for air operations execution. During 2019, a total of 27,570 tons of goods and 10,107 tons of mail were shipped. Within the same period, national and foreign air companies carried a capacity of 2,995,530 passengers.

Measures to adapt the transport sector to the impact of climate change are focused on modernization that would allow operators in this field to function well. New transport infrastructure and means of transport are planned and geared towards reducing the effects of climate change.

On the analysis of the activities and investment project included in the Medium-Term Budget Framework for the period of 2020-2022 on the Transport and Road Infrastructure sector, the following tasks relating to climate change adaptation were identified:

Table 4. *Analysis of the main sector investment projects.*

Nr.	Sector	Project title	Cost (thousand MDL)	Financing	Implementation period
1	Railway transport	Locomotive procurement and railway infrastructure restructuring project	45 652,4	Credit/Grant: EBRD, EIB	2020 - 2022
2	Air transport	Additional support for the work of the Civil Aviation Authority by increasing budgetary allocations for aeronautical inspections	6 000,0	National budget	2020 - 2022
3	Road transport	Implementation of the Integrated Road Transport Management System	150 290,0	National budget	2020 - 2022
4	Road transport	Development of the automated information system "e-Transport Authorization" to streamline and re-engineer the public services provided through it	1 970,0	National budget	2020 - 2022

5	Road transport	Acquisition of the laboratory for the verification of the technical parameters necessary for the transport of perishable and easily alterable goods and the certification of motor vehicles	100 000,0	National budget	2020 - 2022
6	Air transport	Elaboration of the feasibility study regarding the construction of a new cargo terminal in the northern region of the Republic of Moldova, Balti Airport	2 000,0	National budget	2020 – 2022
7	Road transport	Road Rehabilitation Project with the support of the Republic of China	264 619,5	Credit: Gov China	2020 - 2022
8	Naval transport	Development of the waterways of the Republic of Moldova of international importance and ensuring access to naval infrastructure	3 528,0	National budget	2020 - 2022
9	Road transport	Implementation of the road traffic monitoring and control system	1 000 000	National budget	2020 - 2022

10	Railway transport	Implementation of the energy efficiency system in railway transport	-under evaluation	Credit/Grant: EBRD, EIB	2020 - 2025

Source: Developed by the author.

Climate change threatens to compromise the country's transport infrastructure. Gradual climate change will seriously challenge the transport sector. As such, the effects of climate change usually extend beyond the transport system by hindering the ability to deliver reliable services and jeopardizing the free movement of people and goods.

Despite the crucial role of transport, such as the number of companies and people using the transport and transportation services, its role in the national economy, and the vast challenges posed by climate change, attention to adaptation still needs to be paid to the country.

It is essential to anticipate the impact of climate change on the transport system and prepare for this in time by improvements in transport infrastructure, operations, and services based on long-term visions and focused adaptation solutions.

1.3.1. An Overview of Expected Climate Change and its Impacts in Sectors Vulnerable to Climate Change

The Republic of Moldova is in the temperate-continental zone, characterized by mild winters and long, hot summers with low humidity. The Black Sea influences the continental climate. Precipitation decreases from northwest to southeast, from 620 to 490 mm. Average wind speeds during the year range from 2.5 to 4.5m/s. The probability of winds at speeds above 10m/s is 6-10%. Winters in the country are cold, with average temperatures of -4 °C and -6 °C. Summers are warm, with average temperatures of 25-27 °C in June and 29-32 °C in July and August.

In the last two decades, the climate in the Republic of Moldova has become warmer, with an average annual temperature increase of more than 1.0 °C and rainfall of only 54.7 mm. According to the weather data during the last two decades, the temperature increase in the Republic of Moldova is evident, especially during the summer, when the average increases by 0.9-1.0 °C/decade. Temperature is a significant factor affecting the performance and lifespan of asphalt. During heat waves lasting a few days with values above 40 °C, severe deformations occur (waves, pressure deformations), diminishing the pavement's uniformity and consequently affecting traffic safety. This phenomenon had already appeared in 2003 and, 2007, 2012 when more extended periods of high temperatures were recorded and repeated each time during the extreme summer temperature. Severe damage was caused on even renovated national roads; large road sections were deformed due to this climatic hazard.

Climate models predict continuous increases in average temperatures and variations in precipitation, from a slight rise to a significant decrease in precipitation volume. However, even in the scenarios predicting growth of the average precipitation volume, water availability will decrease due to higher temperatures and evapotranspiration rates. Regarding precipitation,

an upward trend of annual average rainfall is observed in the north of the country (44.7 mm/decade) and in the Center (13.2 mm/decade). In the south of the country, there is a slight increase in autumn precipitation (9.2 mm per decade) and a tendency for precipitation to decrease across the remaining seasons. In the country's central region, precipitation tends to decrease only during the summer. However, the wildly uneven time and space distribution of atmospheric precipitation, associated with high air temperature, creates frequent and intense droughts.

Extreme events, such as storms (with strong winds and lightning) and floods, will become more frequent or severe in Moldova in the future and may threaten the functioning of the transport sector.

Thus, on November 25-27 of 1964, north-westerly solid winds covered the territory of the entire republic. Maximum wind speed reached 30–35 m/s, with intensifications of up to 40 m/s. In many localities, this wind causes damage to energy infrastructure and pillars. The roofs of houses were torn off, and transport traffic was stopped for several days in some localities. A similar event happened on October 27-28, 1969. In both cases, these winds were caused by the flows of active cyclones from northwestern to southeastern Europe.
Currently, on the territory of the Republic of Moldova, the number of days with strong wind (15 m/s and more) is, on average, from 5 to 50 days per year. In addition, wind intensification occurs up to 25 m/s, and more takes place on average 1-2 times a year.

***Table** 5. The potential impact on the transport system and the socio-economic impact of the main climate events.*

Nr.	Climate event	Potential impact on transport system	The socio-economic impact
1	Increased Summer Temperatures	- Asphalt rutting, rail track buckling, deterioration of the airport runway, deformation of bridges. - Overheating of the diesel engine.	- Restrictions on the transport of heavy loads, setting speed limits. - Limitation on certain periods of the repair and/or rehabilitation of roads, bridges, and viaducts. - Increasing expenditure and costs of capital investments for operation and maintenance. - Increase indirect costs to users of public and private transport. - Decrease the revenue of the transportation companies. - Decrease the lifespan of the assets and increase capital expenditure and running costs.
2	Increased Winter Temperatures	- Changed construction seasons. - Increase the deterioration of road cover. - Affections on the local roads are covered by thin asphalt pavement. - The reducing the moisture of the cobblestone, especially in spring and winter.	- Increased investment costs for the infrastructure of communication, transport, and electricity systems. - Increased the maintenance of the vehicle's costs. - Reducing constraints on road and rail maintenance.

3	Increased Precipitation and flooding	- Flooding of land transport infrastructures. - Flooding of underground passages. - Frequent landslides and associated risks. - The number of transport delays due to transportation restrictions is increasing. - Increasing damage to the bridges. - Increasing the number of traffic obstructions. - Additional breaks of the construction work. - Additional breaks are needed for infrastructure, maintenance and operations.	- Increased investments for the repair and maintenance of the infrastructure. - Additional expenditure of the transportation companies. - Increased the costs for transportation services.
4	Increased and more frequent extreme winds	- Damage to infrastructure on roads, railways, pipelines, seaports, airports. - Deteriorations of the cable bridges, signs, overhead cables, and railroad signals. - Reduced safety for vehicles.	- Restricting the transport of heavy loads, setting speed limits. - Limitation on certain periods of the transportation services. - Decrease the revenue of the transportation companies.

Source: Developed by the author

1.3.2. Process and Results of the Transport Sector

The transport sector plays a significant role in the RM's national economy; its contribution to the GDP was about 6.6% in 2019. The transport sector provides jobs for 44 thousand people. However, several indicators reveal a deficient development standard and poor road quality.

The Transport Sector is the second energy consumer in the country's Energy Balance, increasing from 24,887TJ in 2010 to 32,192TJ in 2019. The structure of consumption by types of energy remained unchanged from 2010-2019. The primary energy products consumed by this sector are Petroleum products 31,199TJ or 96.91%, Natural gas 830TJ or 2.57%, and Electricity 163TJ or 0.52% of total consumption. During the mentioned period, Natural Gas registered an increase in final energy consumption from 319TJ in 2010 to 830TJ in 2019, Petroleum products from 24,397TJ in 2010 to 31,199TJ in 2019, and Electricity registered a slight decrease from 166TJ in 2010 to 163TJ in 2019.
Regarding the modernization of road infrastructure, according to the annual reports of the State Road Administration, in 2018, 916.36 km were repaired, including 293.36 km of asphalt concrete road pavement and 623 km of gravel road pavement. In 2019, 642.62 km of roads were restored, of which 267.51 km were asphalt concrete road pavement. With gravel road pavement, this amounted to 375.11 km.

Key characteristics of passenger transport in the period 1999 - 2019 are an outsized share belonging to road passenger transport, followed by air and rail transport. During the reference period, there was a change of structure in demand for road passenger transport. In 1999, Trolleybus transportation predominated by 83.55%, followed by Bus transportation at 16.36%, and Taxis by only 0.08%. Whereas in 2019, Trolleybus transportation decreased to 59.98%, bus transport increased to 36.58%, and taxi transport to 3.4%.

From 1999 to 2019, road freight transport had the largest share compared to other modes of transportation and has seen an upward trend since 2008. In 2019, there was a total flow of goods of 6508,4 mil-km, of which 6506,8 mil-km was by road. There is a significant decrease in freight transported by railway and an increase in road transport. The share of rail freight transport decreased from 52.50% in 1999 to 14.44% in 2019, while road transport rose from 47.37% in 1999 to 85.52% in 2019.

A comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles and diesel in 29%, then in 2018, Gasoline was used in 49% of cars, Diesel in 42%, Liquefied Petroleum Gas in 5%, and Hybrid Electric vehicles in 1%.

According to the Statistics of the State Register of Vehicles, in 2018, registered a total of 872,172 vehicles, of which 721,005 vehicles were over ten years old, i.e., a share of 82.66% of the total number of cars. The trend of growing the average of the years of exploitation of vehicles is increasing in all categories of cars.

The Transport Sector's emissions of polluting substances in the atmospheric air increased from 157.4 million tons in 2009 to 163.8 million tons in 2019. This continues to grow due to the increased number of old and obsolete vehicles used by private and public drivers.

2. Institutional arrangement for the TNA and stakeholder involvement

2.1. National TNA team

The main structure of the national institutional setup for the project are described in the table format of Tables 6.a; 6.b; 6.c.

Table 6.a. ***The composition of the National Steering Committee****.*

Nr	SubSector	Category	Title	Person
1	All	Multilateral Organization	UNDP Moldova	Andrea CUZYOVA
2	All	Government Institutions / Ministries	Ministry of Agriculture	Dorin ANDROS
3	All	Government Institutions / Ministries	Ministry of Economy, and Infrastructure of the Republic of Moldova	Calin NEGURA
4	All	Government Institutions / Ministries	Ministry of Finance of the Republic of Moldova	Eugeniu VERLAN
5	All	NGO	Women's Association for Environmental Protection and Sustainable Development	Ioana BOBINA

Table 6.b. TNA Team. National Experts

Nr	SubSector	Category	Title	Person
1	All	Multilateral Organization	UNDP Moldova	Pavel GAVRILIȚĂ
2	All	Multilateral Organization	UNDP Moldova	Ala DRUȚĂ
3	All	Multilateral Organization	UNDP Moldova	Maria NICOLAEV
4	All	Multilateral Organization	UNDP Moldova	Gherman BEJENARU
5	All	Multilateral Organization	UNDP Moldova	Mihail PÎSLA
6	All	Multilateral Organization	UNDP Moldova	Mihai LUPU
7	All	Multilateral Organization	UNDP Moldova	Nicolae SOLOVIOV
8	All	Multilateral Organization	UNDP Moldova	Ion TALMACI

Table 6.c. The sectoral working group. Transport Sector.

Nr	SubSector	Category	Title	Person
1	All	Government Institutions / Ministries	The Ministry of Economy and Infrastructure	Mr. Serghei MUNTEANU
2	All	Government Institutions / Ministries	The Energy Efficiency Agency	Mr. Valerian COLUN
3	All	Government Institutions / Ministries	The National Agency for Energy Regulation	Mr. George MARTÎNIUC
4	All	Government Institutions / Ministries	The Public Services Agency	Mr. Alexandru CERNOLEV
5	All	Government Institutions / Ministries	The General Police Inspectorate (GPI)	Mr. Vladimir CAZACOV
6	All	Government Institutions / Ministries	The National Transport Agency	Ms. Natalia PORUBAEV
7	All	Government Institutions / Ministries	National Agency for Research and Development	Mr. Sveatoslav POSTORONCĂ
8	Road Transport	Sectoral Company	The State Enterprise "Posta Moldovei"	Mr. Ion TURCANU
9	Road Transport	Professional associations	Asociația Internațională a Transportatorilor Auto din Moldova (AITA)	Mr. Petru MITITIUC
10	All	Research/Education Entities	The Institute of Power Engineering	Mr. Sergiu ROBU
11	All	Research/Education Entities	The Center of Excellence in Construction	Ms. Elena NICOLAEV
12	Air Transport	Government Institutions / Ministries	The Civil Aviation Authority	Ms. Veronica ONEȘCIUC

Source: Developed by the author.

2.2. Stakeholders Engagement Process followed in the TNA – Overall assessment

Project activities were implemented in consultation with the main stakeholders, representatives from the Ministries, Public and Private Companies, and research entities. The stakeholders delegated representatives in the Working Group. In the project's first phase, stakeholder involvement was limited to collecting primary information from the Transport Sector and introducing it to its main activities.

Table 7. *The sectoral Stakeholders. Transport Sector.*

Nr.	SubSector	Category	Title	Description
1	All	Government Institutions / Ministries	The Ministry of Economy and Infrastructure	The Ministry of Economy and Infrastructure operates based on Government Decision No. 690 of 30.08.2017 on the organization and functioning of the Ministry of Economy and Infrastructure. The Ministry has the mission to analyze the situation, elaborate efficient public policies in the administered fields, and propose justified state interventions that offer efficient solutions in the areas of activity. The Republic of Moldova's vision in the transport field is presented in Government Decision No. 827 of 28.10.2013 on approving the Transport and Logistics Strategy for 2013-2022, elaborated by the Ministry of Economy and Infrastructure.
2	All	Government Institutions / Ministries	The Energy Efficiency Agency	The Agency operates based on Government Decision No. 45 of 30.01.2019 on the organization and functioning of the Energy Efficiency Agency. It is an administrative authority subordinated to the Ministry of Economy and Infrastructure. Its mission is to implement state policy in the fields of energy efficiency, building energy

				performance, and renewable energy sources.
3	All	Government Institutions / Ministries	The National Agency for Energy Regulation	The Agency, founded in 1997, is based on Government Decision No. 767 of 11.08.97. It implements state policy on regulation in energy sectors. It ensures regulation and monitoring of the efficient operation of the energy market and activities in energy sectors under accessibility, availability, reliability, continuity, competitiveness, and transparency, in compliance with quality, safety, and environmental protection standards.
4	All	Government Institutions / Ministries	The Public Services Agency	The Agency's mission is to coordinate and organize activities to ensure the implementation of public policies in competence areas. The agency's competence areas are informational technologies, state record-keeping, state information resources, the creation and maintenance of the population register, transport means, and drivers.
5	All	Government Institutions / Ministries	The General Police Inspectorate (GPI)	The Inspectorate is the administrative authority subordinated to the Ministry of Internal Affairs, which ensures, by law, the implementation of state policies in the field of maintaining, insuring, and restoring public order and security, protecting the rights and legitimate interests of the individual and the community, investigation, and discovery of crimes and contraventions, administration of justice, and assisting the population and local public administration

				authorities. GPI ensures the accomplishment of the functions established by its Regulation in the following fields of activity: maintaining, ensuring, and restoring public order and security and protecting the rights and legitimate interests of the individual and the community.
6	All	Government Institutions / Ministries	The National Transport Agency	The Agency is the authority that ensures the implementation of public policy documents and national development strategies in road transport and controls and supervises compliance with national and international legislation in the field by road transport operators, and companies engaged in road transport activities.
7	All	Government Institutions / Ministries	National Agency for Research and Development	The National Agency for Research and Development (NARD) is a central administrative authority under the Government of the Republic of Moldova. It was founded by Government Decision no.196 of 28.02.2018. The Agency is responsible for implementing the research, innovation, and development of national policy, the EU Framework Programme for Research and Innovation Horizon 2020, and other European Programmes and coordinating the Moldovan Office for Science and Technology in Brussels (MOST). NARD's mission is to ensure excellence and performance in achieving national research, innovation, and development priorities.

8	Road Transport	Sectoral Company	The State Enterprise "Posta Moldovei"	The State Enterprise "Posta Moldovei" was founded on 1 April 1993 due to the division of the postal communications sector from that of telecommunications. It is the national operator in postal services, represented by the Ministry of Information Technology and Communications. The company is the largest operator of this kind in Moldova and offers a wide range of postal and financial services throughout the country, having a territorial network of more than 1,300 offices and postal agencies, 37 branches, and providing postal services in 1,527 localities of the country. The company's fleet is about 400 cars, of which around 60% is old, inefficient, and needs modernization.
9	Road Transport	Professional associations	Asociația Internațională a Transportatorilor Auto din Moldova (AITA)	AITA is the largest non-governmental, noncommercial professional organization that meets businesses and organizations trucks from Moldova undertaking international cargo and passenger road transport. AITA is a member of the International Union of Road Hauliers (IRU) in Geneva and the International Federation of Forwarders Association (FIATA) based in Zurich. AITA is a guarantor association of the Customs TIR Convention in Moldova. More than 200 enterprises and organizations benefit from services provided by the Association.

10	All	Research/Education Entities	The Institute of Power Engineering	The Mission of the Institute is scientific support for increasing energy security, development, and efficient operation of the energy complex of the Republic of Moldova in terms of liberalizing the energy market and increasing the share of use of renewable energy resources, contributing to the process of regional and European integration of the national energy system.
11	All	Research/Education Entities	The Center of Excellence in Construction	By Government Decision no.444 of 20.07.2015 regarding reorganizing some technical vocational education institutions, the Construction College was reorganized into the Center of Excellence in Construction. The center has the following specialties: • Specialty N73220 "Civil engineering and operation of buildings and edifices" (CECE) • Specialty N73230 “Construction and operation of roads” • Specialty N73230 "Heat and gas supply systems, ventilation" (SACGV), and others.

12	Air Transport	Government Institutions / Ministries	The Civil Aviation Authority	The Civil Aviation Authority is an administrative authority for certification, supervision, and control of civil aviation and is subordinated to the Ministry of Economy and Infrastructure. The Authority's mission is to implement policies in civil aviation and monitor individuals' and legal entities' compliance with legislation in this area to ensure flight safety, aviation security, consumer protection, and occupational safety.

Source: Developed by the author.

2.3. Consideration of Gender Aspects in the TNA Process

Women and men have different experiences and perceive and identify risks related to health, activity, and life in the context of climate change. For this, gender is a significant consideration in project design and implementation in the Republic of Moldova. Statistical data confirm the existence of gender disparities in the use of transport services, which affect the decisions and behavior of women and men at risk, including those related to climate change.

Thus, the inclusion of the gender equality dimension in the TNA project's carrying out adaptation activities, financial allocations, monitoring, and evaluation of climate change is a significant precondition of the project's carrying out adaptation activities, financial allocations, monitoring, and evaluation of climate change, which is also a significant precondition of effective adaptation to climate change.

In the TNA project implemented in Moldova, 2 (40%) of the five members of the National Steering Committee are women. The TNA team comprises one man and two women (67%). In the sectoral Working Group of the Transport Sector, 3 (25%) of the 12 members are women.

3. TECHNOLOGY PRIORITIZATION FOR THE TRANSPORT SECTOR

3.1. Key Climate Change Vulnerabilities in the Transport Sector

Climate change will significantly impact on the transport infrastructure, as the transport system was designed and put into operation according to the typical weather conditions of the period. Therefore, the impact of climate change should have been considered at the design stages. Due to its technical conditions, vehicles over ten years old represented 82.7% of the total number of used vehicles in 2018, so all types of transport in Moldova are vulnerable to climate change. The impacts on the infrastructure will vary depending on the region, type, and condition.

Considering current climate change scenarios, the vulnerability of the transport sector of Moldova, from the structural strength and integrity of critical facilities and the resulting potential for damage to transportation services, the principal vulnerabilities could be summarized as follows:

***Table 8**. The vulnerability of the Infrastructure and Operationality of the Transport Sector.*

Nr	Climate Event	Vulnerability of the Infrastructure	Vulnerability of operationality
1	Increased Summer Temperatures	Damage infrastructure/equipment/cargo. Reduction of infrastructure asset lifetime.	Increase energy consumption for cooling cargo. Increasing number of transport delays due to transportation restrictions. Overheating of diesel engines.
2	Increased Winter Temperatures	Increase in the deterioration of road cover. A thin asphalt pavement covers damage to the local roads.	Increase in the number of accidents.
3	Increased Precipitation and flooding	Cause flooding of the airports. Cause land infrastructure inundation and damages to cargo/equipment. The number of traffic obstructions is increasing.	Increase in the number of traffic obstructions and delays in delivery.

4	Increased and more frequent extreme winds	Damage to infrastructure on roads, railways, pipelines, seaports, and airports. Reduction in the safety of vehicles in traffic.	Reduction of the safety of vehicles in traffic.

Source: Developed by the author.

Two essential points relating to the vulnerability of the Transport Sector are:

a) Transport infrastructure is more sensitive to extreme events, such as floods, extreme winds, and.
b) Transport operationality is more sensitive to increased temperatures than transport infrastructure.

Some adaptation measures to increase the resilience of the transportation sector to climate change in Moldova could be as follows:

Table 9*. Key Adaptation Opportunities for Infrastructure and Operationality of the Transport Sector.*

Nr	Climate event	Adaptation measures in the infrastructure	Adaptation measures in the operationality
1	Increased Summer Temperatures	Use heat-resistant asphalt and adjust maintenance. Adjustments to the maintenance of rail infrastructure. Adaptation of rail infrastructure to heat and temperature change. Retrofitting air-conditioning systems in trains for increased temperatures. Retrofitting airports against heat. Creation of the charging infrastructure for hybrid and electric vehicles.	Assessment of the adaptation capacity of the transport infrastructure. Researching the design and development of materials and technologies to increase infrastructure resistance. Adjusting rail operations. Shifting construction schedules to more appropriate parts of the day. Introduce vehicles with a new propulsion-type engine. Introduce new public transport adapted to increased temperatures.
2	Increased Winter Temperatures		Introduction of the traffic management system.

3	Increased precipitation and flooding	Modernization of the weather forecasting system. Retrofitting existing road infrastructure concerning increased precipitation. Retrofitting airports against higher precipitation. Increase in the standard for drainage capacity. Improve flood protection. Upgrading of road drainage systems.	Adjustment of urban and land-use planning to flood. Implementation of flood-risk management. Training decision-makers are managing the construction of transport infrastructure on climate risk conditions.
4	Increased and more frequent extreme winds	Shifting of road alignments beyond areas is at risk—modernization of the lighting and signaling system.	Shifting of road alignments beyond areas is at risk. Introduction of the traffic management system. Opening the passenger management system.

Source: Developed by the author.

3.2. Decision context

To promote efficient transport, the Strategies and Action Plan's basic activities focus on developing infrastructure resistant to climate risks and ensuring adequate infrastructure, quality, and safe transport services.

The initial actions to adapt the transport system take place at the governance level, with the development of the legal framework relating to adaptation to climate change and national adaptation actions.

In Government Decision no. 1009 of 10.12.2014 on the approval of the Strategy of the Republic of Moldova for adaptation to climate change until 2020 and of the Action Plan for its implementation, Direction Nr. 6 includes three main Activities relating to ensuring the design of road infrastructure considering the need to adapt to climate change, providing the planning of the urban transport system to create the infrastructure required to promote alternative transport, such as cycling and ensuring the sustainability of the transport infrastructure by using materials resistant to temperature fluctuations, floods.

Also, eight priorities have been established in the Sectoral Strategy of the Medium-Term Budgetary Framework (CBTM 2020-2022) for the Transport and Road Infrastructure sector to develop and maintain public road infrastructure. The objectives are to reduce the number of road accidents by 10% by 2022 compared to 2019 and rehabilitate roads of the priority network.

In the Updated Nationally Determined Contribution of the Republic of Moldova, the Sector-Specific Climate Change Adaptation Priorities in the Transportation Sector are focused on improving understanding of climate change-related risks, supporting planning capacities for climate-resilient infrastructure in the transport sector, improving access to climate-resilient and safe public transport, and creating sustainable transport infrastructure.

Analysis of the primary strategic documents shows that the local government understands the importance of climate change and its impact on the Transport Sector. Therefore, the sectoral action plans include some actions relating to climate adaptation in the transport sector.

3.3. Overview of Existing Technologies in the Transport Sector

Due to a decrease in industrial output following the dissolution of the Soviet Union, Moldova's economy could not produce technological products. As a result, the service sector has grown to dominate Moldova's economy, and most of the equipment needed for the main sectors is imported from abroad. The transportation sector is in a situation where 100% of vehicles and 100% of the components of asphalt mixtures are imported.

The major challenges facing transport infrastructure projects are high pre-operational capital costs, unsatisfactory urban planning, and inadequate institutional mechanisms for managing transport demand in urban areas.

The significant challenges facing the transport sector and the road infrastructure of Moldova are:

- Insufficient road development sub-program funding compared to road degradation's evolution.
- The level of the advanced degradation of equipment, machinery, and techniques necessary for maintaining, repairing, and reconstructing public roads.
- A flawed national road infrastructure monitoring system.
- Completing a road maintenance system reform is impossible because the financial resources allocated annually in the medium and long term cannot be planned.
- The insufficiency of equipment, machinery, and financial resources necessary for maintaining the transport sector and the road infrastructure.

The existing situation within applied technologies in the Infrastructure of the Transportation Sector

- **Asphalt mixtures:** The asphalt mixtures are prepared by the normative SM EN 13108-1:2010/C91:2016 and SM SR EN 13108-1:2010/AC:2010. According to the *"CP A.02.13: 2019 Construction management. Procedure for evaluating and verifying the quality of construction products"* and "*NCM D.02.04: 2018 Roads and bridges. Normative for the maintenance of national roads on performance criteria*",

currently, the method which evaluates the performance of the asphalt on the roads in Moldova considers a single season, whose average annual temperature is 20 °C.

- **Public lighting and signaling system:** In 2018, the length of the illuminated streets was 2.8 thousand km, increasing by 117.9 km compared to 2017. Only 77.0% of the country's roads are connected to public street lighting. In 2018, 81.1 thousand lamps, or 3.0 thousand more lamps than the previous year, were installed on roads in the country. Most of the lamps were installed on the streets of Ocnita (318 units), Calarasi (299 units), Straseni (284 units), and Causeni (252 units) districts.

The existing situation within applied technologies in the Operationality of the Transportation Sector

- **Equipment used for the maintenance of the roads:** For the care and cleaning of the streets during the winter period, 54 vehicles were used for spreading sand and skid material, seven snow loaders, and six snowplows with rotors. To maintain cleanliness in the localities, 109 tractors were equipped with cleaning mechanisms, 13 were self-propelled, and 40 were self-crushing. During 2018, an area of 37.9 million m2 was cleaned in the country, or 6% more compared to the previous year. About 94 percent of the surface of the localities is cleaned with mechanized mode.

- **Vehicle fleet used for the transportation of passengers and goods:** Currently, on the transportation operation approximately 2251 companies provide services for the transportation of passengers and goods in national and international areas, of which 587 companies offer services of passenger transportation (about 6472 transport units); 214 companies offer services by taxi (about 4252 transport units); 1450 companies provide services for transportation of goods (about 12771 transport units, of which: 4111 meet the requirements Euro 0; 3 - Euro 1; 1932 - Euro 2; 2363 - Euro III; 419 - Euro IV; 3621 - Euro V, 322 - Euro VI).

- **Public transport:** In 2020, 144 buses were registered on the balance of the Urban Bus Park, with an average age of 14 years and an average distance of 831.3 thousand km. Of these, 74 buses were over 15 years old. In 2020, the company Î.M. Regia Transport Electric Chisinau (RTEC) included three trolleybus parks, totaling 389 trolleybuses. Out of the total number of trolleybuses, 122 units were purchased until 2011, 102 were purchased in 2011, and another 165 units were assembled from 2012 to 2019. Out of 389 trolleybuses, 35 are self-propelled for a range of up to 30 km of autonomy.

- **Introduction to the passenger management system:** At present, to combat the phenomenon of illicit transportation of passengers, to liquidate clandestine Bus Stations, and to improve the situation in road transportation, the joint control activities with the National Patrol Inspectorate, State Fiscal Service, Customs Service, and other state institutions are being organized regularly on national roads. Implementing the Integrated Management System, administered by the National Auto Transport Agency, an electronic management system for road transport by the established technical requirements, will ensure remote control by accessing data from the registers is planned to be implemented.

3.4. Adaptation Technology Options for Transport Sector and Their Main Adaptation benefits

It is projected that climate change will have a significant impact on the transport infrastructure, as the transport system was designed and put into operation according to the typical weather conditions of the past period, and the impact of climate change was not considered at the design stages. The impacts on the infrastructure will vary depending on the region, type, and condition.

Having into account the current climate change scenarios, the vulnerability of the transport sector of Moldova, could be at the following climate events:

1. **Climate impact 1:** Increased and more frequent extreme winds.

- **Effect of the Climate impact**

  1.1: Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

  1.2: Increasing the number of traffic obstructions and delays of the delivery.

2. **Climate impact 2:** Increased summer temperatures and heat waves frequencies.

- **Effect of the Climate impact**
- **2.1:** Damages of the infrastructure / equipment / cargo. Reduction of infrastructure asset lifetime.

2.2: Overheating and failure of the diesel engines. Increasing the energy consumption for a transport unit.

The proposed adaptation solutions and technologies are focused to adapt the transport sector to be more resilient to climate change and be more operational on the period of climate hazards. Below is presented a short description of the technologies and technological solutions proposed for the consultation to the Working Group. The detailed technological characteristics of each technology are given the "Technology Fact Sheet" are in Annex no. 1.

The preparatory phase of technology prioritization involved reviewing possible technologies and technology options. The technologies have been grouped according to the climate impacts for which they adapt the transport sector.

1. **Climate impact 1:** Increased and more frequent extreme winds.

Effect of the Climate impact 1.1: Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

- **Technology: Intelligent traffic signal control system.** The technological solution for real-time traffic signal control, combining research from artificial intelligence and traffic theory using various parameters like performance, efficiency, flexibility, and sustainability increases the circulation of the traffic in the cities. It optimizes traffic, improving the flow, resulting in shorter wait times, less congestion, shorter journeys, and less pollution.
- **Technology: Autonomous Street lighting system based on solar energy.** The autonomous street lighting system is based on solar energy as the primary source, batteries as a secondary source, and light-emitting diodes (LEDs) as a lighting source. This system is presented as an alternative for remote localities, like roads, crossroads, and tourist places. The electricity consumed by the lamps can be changed to the minimum brightness level required by outdoor lighting standards and the traffic on the

roads. Also, this can be programmed to different lighting regimes depending on the period of the day, seasons, or weather conditions.

- **Technology: Street Lighting Remote Control Management System.** The system utilizes wireless technology and employs RF/GSM technology to program, monitoring, and control geographically distributed remote streetlights. The system is equipped with controllers and has communication and monitoring modules that provide regular streetlight status updates to the Master Control Station (MCS). The management system provides different control modes for controlling the LEDs that can be remotely programmed from a web application.
- **Technology: Autonomous Road Surveillance System (ARSS).** The system can automatically detect changes in the traffic flow, such as the ones due to construction works or accidents. In those cases, the system switches to the learning mode without the necessity of human intervention. In the system, the maps and GPS are used to localize the car, the traffic signals and vehicle turning in roundabouts are determined using a group of sensor data that can be generally classified into two subgroups, namely, traveling distance and direction sensors. The sensor fusion model can be used to predict the 3D dimensions of surrounding environments during autonomous car driving.

Effect of the Climate impact 1.2: Increasing the number of traffic obstructions and delays of the delivery.

- **Technology: Incident detection and management system.** The system uses an algorithm to detect incidents on a signalized technique, managed by a traffic adaptive control system that includes different modules: normality inference module; incident location inference module; incident severity assessment module; and incident termination inference module.
- **Technology: Traffic management systems (TMS).** Sometimes known as a transportation management solution or transportation management software, a TMS provides visibility into day-to-day transportation operations, trade compliance information, and documentation, and ensures the timely delivery of the goods. Transportation management systems also streamline the shipping process and make it easier for businesses to manage and optimize their transportation operations, whether they are by land, air, or sea.

2. **Climate impact 2:** Increased summer temperatures and heat waves frequencies.

Effect of the Climate impact 2.1: Damages of the infrastructure / equipment / cargo.
Reduction of infrastructure asset lifetime.

- **Technology: Hot rolled asphalt (HRA).** Hot Rolled Asphalt (HRA) is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108. There is a high proportion of sand in the mix resulting in a low percentage of air voids when it is compacted. The mortar of bitumen, sand & filler gives it strength. On public roads, high PSV chippings are added to provide a skid-resistant surface. Hot Rolled Asphalt results in an incredibly durable surface with enhanced longevity, has a high skid resistance and is near impervious to water – resulting in reduced damage. Hot Rolled Asphalt (HRA) is produced in accordance with: IS EN 13108-4 Hot Rolled Asphalt.
- **Technology: High modulus asphalt concrete (HMAC).** High modulus asphalt concrete (HMAC) mixtures are produced using hard-grade binders or modified bitumen and are known to have exceptional resistance towards rutting and fatigue. Due to the similarity between hard binder and aged reclaimed asphalt (RA) binder, HMAC mixtures have great potential to incorporate higher percentages of RA material. Due to

its high dynamic modulus, HMAC pavements can reduce the thickness of the entire road structure by 30–35% and the thickness of the base layer by around 25%.

- **Technology: Thin Surfacing Course System (TSCS).** Thin Surface Courses (TSCs) are high stone content materials for Surface Course applications. They are durable, deformation-resistant, reduce noise and spray and offer excellent ride quality when compared with Hot Rolled Asphalt. The faster application can result in lower costs for traffic management and reduced costs of delay to the traveling public. Being thinner and faster to lay, TSCS can be significantly lower in cost than other materials such as HRA.
- **Technology: Road transport management system (RTMS).** Road transport management system (RTMS) is an industry-led, government-supported, voluntary, self-regulation scheme that encourages consignees, consignors & road transport operators to implement a management system (a set of standards) that demonstrates compliance with the Road Traffic Regulations and contributes to preserving road infrastructure, improving road safety & increasing productivity. Even though RTMS, was initially mooted as an overload control mechanism (then known as at Load Accreditation Programme), it has evolved to be currently recognized as a holistic system of managing a road transport operation.

Effect of the Climate impact 2.2: Overheating and failure of the diesel engines. Increasing energy consumption for a transport unit.

- **Technology: Charging infrastructure for the plug-in electric vehicles.** A charging station, also called electric vehicle charging station, electric recharging point, charging point, charge point, electronic charging station (ECS), and electric vehicle supply equipment (EVSE), is a machine that supplies electric energy to charge plug-in electric vehicles—including cars, neighborhood electric vehicles, trucks, buses, and others.
- **Technology: Electro-diesel hybrid locomotives.** An electro-diesel locomotive (also referred to as a dual-mode, bi-mode, or hybrid locomotive) is a type of locomotive that can be powered either from an electricity supply (like an electric locomotive) or by using the onboard diesel engine (like a diesel-electric locomotive). For the most part, these locomotives are built to serve regional, niche markets with a very specific purpose. Electro-diesel locomotives are used to provide continuous journeys along routes that are only partly electrified without a change of locomotive, avoid extensive running of diesel under the wires (using a diesel locomotive where electrified lines are available), and give solutions where diesel engines are banned.
- **Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it.** Using the charging stations, the hydrogen fuel can be supplied regularly through delivery vehicles that we use for carrying gasoline or diesel. In addition, hydrogen charging infrastructures can be easily established by using the current CNG charging stations. The Hydrogen-powered Buses are expected to be more effective in the country when run in the interurban routes, at the same time, Hydrogen Fuel Cell Heavy trucks offer an attractive value proposition, particularly where user requirements favor long-range, heavy payloads and fast refueling.
- **Technology: The automatic temperature control system in public transport.** The system includes Heating, Ventilation, and Air Conditioning (HVAC) Solutions. The system automatically regulates cabin temperature. When outside temperatures are low, a slightly higher temperature is generated in the cabin without the driver's intervention to ensure that the driver's cabin heats up quickly, and the windscreen is de-iced (melting) rapidly. The HVAC is designed for different bus types including hybrid and

electric driven buses. The modular system design with one control unit and up to eight substations enable universal use and fast adaptation to different bus variants.

- **Technology: Integrated public transport fare payment system.** The integrated payment system will permit passengers to use different modes of public transport with the same electronic ticket, either a contactless card or a card with a magnetic stripe. The new system will not only make payment easier and offer a discount to season ticket holders but will also allow the city to monitor passenger flows. This information will help to better organize the public transport network according to users' needs.
- **Technology: Hybrid electric vehicle.** A hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). There is a variety of HEV types and the degree to which each function as an electric vehicle (EV) also varies. Modern HEVs make use of efficiency-improving technologies such as regenerative brakes which convert the vehicle's kinetic energy to electric energy, which is stored in a battery or supercapacitor.
- **Technology: Plug-in electric vehicles.** A plug-in electric vehicle (PEV) is a vehicle that can be recharged from an external source of electricity, such as wall sockets, and the electricity stored in the rechargeable battery packs drives or contributes to driving the wheels. PEV is a subset of electric vehicles that includes all-electric, or battery electric vehicles (BEVs).
- **Technology: Self-driving shuttle for passenger transportation.** Capable of transporting up to 15 people, a Self-driving shuttle combines several advantages. Autonomic fleets make it possible for operators to improve productivity on private sites, and ease road congestion in urban centers. The Self-driving shuttle is explicitly designed to meet the needs of an autonomous, driverless vehicle while also optimizing navigation and safety features.
- **Technology: Autonomous battery trolleybuses.** A battery-assisted trolleybus is a vehicle that uses an electric engine. Electricity is primarily obtained from overhead contact wires installed above the road. However, compared to the conventional trolleybus, it has the advantage of the possibility to pass through sections of the route without many overhead contact wires.
- **Technology: Electric bikes and mopeds.** An electric bicycle, also known as an e-bike or e-bike, is a bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedal-power (i.e. pedelecs) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedaled by the cyclist and are therefore not electric motorcycles.
- **Technology: Electric Three Wheelers.** Three-wheelers can have either one wheel at the back and two at the front, or one wheel at the front and two at the back. Due to better safety when breaking, an increasingly popular form is the front-steering "tadpole" or "reverse trike" sometimes with front-drive but usually with rear-drive. As a result of their light construction and potential better streamlining, three-wheeled cars are usually less expensive to operate.
- **Technology: Transport demand management system.** Transportation demand management, traffic demand management, or travel demand management (TDM) is the application of strategies and policies to reduce travel demand or to redistribute this demand in space or in time. Transport demand management is understood as a much broader concept. Implicit in the use of the term is the assumption that it is accompanied by the implementation of sustainable mobility, the introduction of full-cost pricing, and

organizational or structural measures to ensure a broad range of complementary interventions work effectively together to realize the benefits of sustainable transport.

The proposed technologies will be imported from outside of the country, this will impact on the investment costs also will need financing of some additional activities, such as capacity building, operation and maintenance.

According to the procedures, in close collaboration with the Sectoral Working Group (SWG) it worked on identifying priority technologies for climate adaptation based on the following steps:

- Providing an overview of possible adaptation technology options which respond to sectoral needs and emphasize their adaptation potential based on identified sectoral vulnerabilities and currently (baseline) applied technologies referring to climate change.
- Preparation of the Technology Fact Sheets.
- Proposing, discussing, and approving by Work Group (WG) the criteria of technology prioritization.
- Through a participatory process, using MCA tools carrying out sector-level technology prioritization exercise and formulate the results of technological prioritization.

The detailed list of contacts of the representatives of the Working Group is in Annex nr. 2

3.5. Criteria and process of technology prioritisation

3.5.1. Prioritization of adaptation technologies.

The selection of technologies took place in two stages. At the first stage of identifying and prioritizing technologies, the most appropriate technologies for reducing climate vulnerability in the transport sector were identified and grouped. At this stage, in close collaboration with the members of sectoral, the Working Group received the description of 25 technologies identified as most responsive to the impacts of climate change, which was associated with the development of Technology Fact Sheets. At the meeting of the Working Group on 05.08.2021, each member had the opportunity to express his opinion on prioritization of technologies and assigning scores, which resulted in the Short List of Technologies. In this phase, 9 of 25 technologies were selected and formed the Short List of prioritized technologies.

Table 10. The result of the selection to the Sort List

Title of the Technology	Total score
Technology: Autonomous Street lighting system based on solar energy	96
Technology: Hot rolled asphalt (HRA)	78
Technology: Charging infrastructure for plug-in electric vehicle	103
Technology: Plug-in electric vehicles	87
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	88
Technology: Electric bikes and mopeds	88
Technology: Street Lighting Remote Control Management System	96
Technology: Autonomous Road Surveillance System (ARSS)	90
Technology: Integrated public transport fare payment system	95

Source: Developed by the author.

The meeting was attended by 11 members of the Working Group of which, 7 men and 4 women. 45.5% of members of the Working Group have master's degrees. 72.7% of members of the Working Group have experience of working in the Transport Sector for more than 5 years and 54.5% of members of the Working Group work in the Governmental sector.

At this stage, the members of the Working Group made a general assessment of the technologies. The evaluation of the technologies was made based on the information provided in the TFS and was done on a scale from 0 to 10 (scoring), where "0" means the least preferred option and "10" means the most preferred option.

3.5.2. Criteria on evaluation of the adaptation technologies

The identification of criteria against which technologies were ranked was based on a clear and transparent process. The sectoral Working Group members involved in MCA had the opportunity to propose their criteria.

According to MCA tool, for the evaluation criteria for which there were no measurement units, or are qualitative, they are converted to numerical form on a scale from 0 to 100 where "0" means the least preferred option and "100" means the most preferred option.
For the prioritization of technologies ere used the next criteria:

a) Evaluation criteria: Costs

- Investments, US$ - The main investment costs per main components as: the costs per unit, costs of the installation work, additional equipment, etc.
- O&M costs, US$/year - The main costs of O&M (Operation and Maintenance) during the period of functioning of the one unit.

b) Evaluation criteria: Economic benefits

- Innovation – Evaluation of the main innovative components of the technology. The impact of innovation on the economic benefits of technology.
- Financing – Evaluation of the potential of financing of the technology. Availability of financing technology from financial entities at local and international levels.
- Public and private expenditures – Evaluation of the main source of the expenditures for investment or for maintenance. Description of how the expenditure affects the budget of the public or private entities.

c) Evaluation criteria: Social benefits

- Gender equality – Evaluation of the impact of the technology on the Gender equality. Evaluation of the potential to address gender inequalities. The expected magnitude of the impact on gender equality.
- Direct Employment – Evaluation of the impact of the technology on Job Creation. The potential stimulation of the labor market and the intersectoral potential of the creation of new jobs.
- Skill & Capacity Development – Evaluation of the needs of the Capacity Building programs for new specializations or new jobs.

d) Evaluation criteria: Development impacts, indirect benefits

- Positive Local Environmental Impacts – Evaluation of the expected positive impact on the environment, the main areas of the impact, the modalities of the impact.
- Contribution to the reduction of climate vulnerability – Evaluation of the impact of the technology to contribute to the reduction of climate vulnerability of the sector.

I. Allocation of scores

- **From 0 to 25:** Extremely weak performance; strongly unfavorable.
- **From 26 to 50:** Poor performance, major improvement needed.

- **From 51 to 75:** At an acceptable or above level.
- **From 76 to 100:** Very favorable performance.

One of the important actions in this phase was the assigning of the weights to each of the criteria. This action was undertaken based on the consensus of the Working Group, where every member proposed his weights based on the argumentations.

3.5.3. The evaluation processes.

The Multicriteria Analysis (MCA) was used in the final phase of the selection of the technologies.
The WG received in advance the detailed description of the technologies and an explanation of the Criteria for evaluation of the adaptation technologies. Based on this information, the WG members filled in the primary forms for the performance matrix.
As result, was completed the first Performance Matrix.

Table 11. The result of the Performance Matrix.

Title of the Technology	**Total score**
Technology: Autonomous Street lighting system based on solar energy	9300
Technology: Hot rolled asphalt (HRA)	882807
Technology: Charging infrastructure for plug-in electric vehicle	11367
Technology: Plug-in electric vehicles	32446
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	370565
Technology: Electric bikes and mopeds	7863
Technology: Street Lighting Remote Control Management System	10971
Technology: Autonomous Road Surveillance System (ARSS)	32726
Technology: Integrated public transport fare payment system	22090

Source: Developed by the author.

In the next step, the outcome and performance of each technology were evaluated against each of the criteria. The scoring scale from 0 to 100 was applied, using 0 as the least important criteria and 100 as the most important criteria, and each technology is evaluated against each criterion. To reach a score for each of the criteria and technologies, discussions took place with the representatives of the working group and were voted for the criteria and their weight. Basically, the group discussed the importance of the criterion and then reached a consensus on the weight against this criterion.

Table 12. The result of the Multicriteria Analysis (MCA).

Title of the Technology	**Total score**
Technology: Autonomous Street lighting system based on solar energy	4793.33
Technology: **Hot rolled asphalt (HRA)**	879156.33
Technology: Charging infrastructure for plug-in electric vehicle	6836.33
Technology: Plug-in electric vehicles	28049.56
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	365973.89

Technology: Electric bikes and mopeds	3584.78
Technology: Street Lighting Remote Control Management System	7174.56
Technology: Autonomous Road Surveillance System (ARSS)	28969.56
Technology: Integrated public transport fare payment system	18098.89

Source: Developed by the author.

The results of the technology prioritisation were validated by the Sectoral Work Group.
The next step was the sensitive analysis against the climate impacts. In the first scenario, the technologies were evaluated based on the common impact of climate events: Climate impact 1: Increased and more frequent extreme winds; Climate impact 2: Increased summer temperatures and heat waves frequencies. As the result of this evaluation, the prioritized technology was Hot rolled asphalt (HRA).

Table 13. Prioritizing Technologies for all Climate Impacts.

Title of the Technology	**Score**	**Prioritization**
Technology: Autonomous Street lighting system based on solar energy	28.1	8
Technology: Hot rolled asphalt (HRA)	**83.6**	**1**
Technology: Charging infrastructure for plug-in electric vehicle	36.2	5
Technology: Plug-in electric vehicles	43.9	3
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	45.4	2
Technology: Electric bikes and mopeds	37.6	4
Technology: Street Lighting Remote Control Management System	35.8	6
Technology: Autonomous Road Surveillance System (ARSS)	35.2	7
Technology: Integrated public transport fare payment system	21.5	9

Source: Developed by the author.

The next evaluation was against the climate impacts: Climate impact 1: Increased and more frequent extreme winds. As the result of this evaluation, the prioritized technology was Autonomous Road Surveillance System (ARSS).

Table no. 14. Prioritizing Technologies for all Climate Impact: Increased and more frequent extreme winds.

Title of the Technology	**Score**	**Prioritization**
Technology: Autonomous street lighting system based on solar energy	25.8	4
Technology: Street Lighting Remote Control Management System	53.7	2
Technology: Autonomous Road Surveillance System (ARSS)	**56.9**	**1**
Technology: Integrated public transport fare payment system	33.0	3

Source: Developed by the author.

The next step was the sensitive analysis against the climate impacts: Increased summer temperatures and heat waves frequencies. As the result of this evaluation, the prioritized technology was Hot rolled asphalt (HRA).

Table no. 15. Prioritizing Technologies for all Climate Impact: Increased summer temperatures and heat waves frequencies.

Title of the Technology	Score	Prioritization
Technology: Hot rolled asphalt (HRA)	**70.0**	**1**
Technology: Charging infrastructure for plug-in electric vehicle	29.1	4
Technology: 8 Plug-in electric vehicles	40.6	2
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	35.4	3
Technology: Electric bikes and mopeds	25.0	5

Source: Developed by the author.

3.5.4. The Sensitivity Analysis

The Sensitivity analysis is an integral part of the TNA and is used when the technologies are tested in different scenarios of the evolution of the climate's impacts. In the case of the Transport sector was simulated 2 scenarios.
1)In the first scenario, the Climate Impact: "Increased and more frequent extreme winds" had the weight of 60%, and the Climate Impact: "Increased summer temperatures and heat waves frequencies" had the weight of 40%.
As a result of this analysis, the Technology: *Autonomous Road Surveillance System* (ARSS) was prioritized.

Table no. 16. The result of the first Sensitivity Analysis

Title of the Technology	Score	Prioritization
Technology: Autonomous Street lighting system based on solar energy	11	9
Technology: Hot rolled asphalt (HRA)	25	4
Technology: Charging infrastructure for plug-in electric vehicle	14	7
Technology: Plug-in electric vehicles	18	5
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	16	6
Technology: Electric bikes and mopeds	14	8
Technology: Street Lighting Remote Control Management System	31	2
Technology: Autonomous Road Surveillance System (ARSS)	**38**	**1**
Technology: Integrated public transport fare payment system	26	3

Source: Developed by the author.

2)In the second scenario, the Climate Impact: "Increased summer temperatures and heat waves frequencies" had the weight of 60%, and the Climate Impact: "Increased and more frequent extreme winds" had the weight of 40%.

As a result of this analysis, the Technology: *Hot rolled asphalt (HRA) was prioritized.*

Table no. 17. The result of the second Sensitivity Analysis

Title of the Technology	Score	Prioritization
Technology: Autonomous Street lighting system based on solar energy	7	9
Technology: Hot rolled asphalt (HRA)	**38**	**1**
Technology: Charging infrastructure for plug-in electric vehicle	21	5
Technology: Plug-in electric vehicles	28	2
Technology: Transport powered by hydrogen fuel cells and charging infrastructure for it	25	4
Technology: Electric bikes and mopeds	21	6
Technology: Street Lighting Remote Control Management System	21	7
Technology: Autonomous Road Surveillance System (ARSS)	25	3
Technology: Integrated public transport fare payment system	18	8

Source: Developed by the author.

3.6. Results of technology prioritisation

The process undertaken in the final phase results in a list of ranked technologies prioritized according to their score according to the criteria and weights given to each criterion.
The technology with the highest relatively weighted total score is ranked as the most preferred technology, while the one with the lowest relative score is ranked as the least preferred option.

According to all phases of the evaluation of the technologies and considering the projections of the climate impacts on the transport sector in different scenarios, the next technologies were selected:

- **Climate impact 1:** Increased and more frequent extreme winds.
- **Effect of the Climate impact 1.1:** Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.
- **Technology:** Autonomous Road Surveillance System (ARSS)

The system can automatically detect changes in the traffic flow, such as the ones due to construction works or accidents. In those cases, the system switches to the learning mode without the necessity of human intervention. In the system, the maps and GPS are used to localize the car, the traffic signals and vehicle turning in roundabouts are determined using a group of sensor data that can be generally classified into two subgroups, namely, traveling distance and direction sensors. The sensor fusion model can be used to predict the 3D dimensions of surrounding environments during autonomous car driving.

- **Climate impact 2:** Increased summer temperatures and heat waves frequencies.
- **Effect of the Climate impact 2.1:** Damages of the infrastructure / equipment / cargo. Reduction of infrastructure asset lifetime.
- **Technology:** Hot rolled asphalt (HRA).

Hot Rolled Asphalt (HRA) is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108. There is a high proportion of sand in the mix resulting in a low

percentage of air voids when it is compacted. The mortar of bitumen, sand & filler gives it strength. On public roads, high PSV chippings are added to provide a skid-resistant surface. Hot Rolled Asphalt results in an incredibly durable surface with enhanced longevity, has a high skid resistance and is near impervious to water – resulting in reduced damage. Hot Rolled Asphalt (HRA) is produced in accordance with: IS EN 13108-4 Hot Rolled Asphalt.

- **Climate impact 2:** Increased summer temperatures and heat waves frequencies.
- **Effect of the Climate impact 2.2:** Overheating and failure of the diesel engines. Increasing energy consumption for a transport unit.
- **Technology:** Transport powered by hydrogen fuel cells and charging infrastructure for it.

Using the charging stations, the hydrogen fuel can be supplied regularly through delivery vehicles that we use for carrying gasoline or diesel. In addition, hydrogen charging infrastructures can be easily established by using the current CNG charging stations. The Hydrogen-powered Buses are expected to be more effective in the country when run in the interurban routes, at the same time, Hydrogen Fuel Cell Heavy trucks offer an attractive value proposition, particularly where user requirements favor long-range, heavy payloads and fast refueling.

As result, the selected technologies will adapt the transport sector to the infrastructure and operationality. Also, the technologies offer opportunities for synchronization with the technologies from the long list. This opportunity will be used to introduce more efficient and new technologies on the market, that will play a crucial role in the adaptation of the transport sector to climate change.
Special attention will be focused on hydrogen-related technologies. As decarbonization of the global energy system is needed, transportation is one of the most challenging sectors to decarbonize and adapt to climate changes. Hydrogen can play an important role in reducing CO2 emissions in the transport sector, among others. Hydrogen fuel cell electric vehicles are expected to play an increased role in the transportation sector soon. The TNA will pay special attention to the identification of the adequate solution for the implementation of this technology in the future in the country.

BARRIER ANALYSIS and ENABLING ENVIRONMENT REPORT (2)/BAEF

BARRIER ANALYS Executive Summary

This report analyzes the main barriers to further disseminating and deploying the three technologies prioritized in the Technology Needs Assessment and proposes solutions. The identification and prioritization of the technologies were based on several criteria oriented towards technology's potential to reduce vulnerability to climate change and its social, economic, and environmental benefits. The process was participatory and ensured the involvement of stakeholders from the Sectoral Work Group. As a result, the top three technologies respond to the stringent need to adapt to climate change in the transport sector referring to the main areas: for infrastructure-Hot rolled asphalt (HRA), transport management- Autonomous Road Surveillance System (ARSS), and for the fleet of vehicles-Transport powered by hydrogen fuel cells and charging infrastructure. Each technology has been prioritized, given its potential for adaptation to climate change in the transport sector.

Hot-rolled asphalt (HRA), the top prioritized technology, will give the transport infrastructure better coverage of the asphalt strip. As a result, it will be more durable and functional for a longer period. The Autonomous Road Surveillance System (ARSS) will allow efficient traffic management in crowded cities, especially during rush hours. Technology will support one of the main priorities of the country's strategic development, the adoption of intelligent technological solutions to increase road safety. Introducing this technology will lead to more efficient use of the vehicle fleet. In addition, it will lead to more efficient fuel consumption, which will reduce CO2 emissions from public transport.

Transport powered by hydrogen fuel cells and charging infrastructure is a technological solution that will modernize public transport. The targets for this technology are set according to the main objectives of the Transport and Logistics Strategy for 2013-2022, the Environmental Strategies for 2014-2023, and the Low Emission Development Strategy of the Republic of Moldova until 2030. The fleet will adapt to ambitious standards by introducing hydrogen fuel cell-powered transport. As a result, it will reduce greenhouse gas emissions and climate change's impact on the transport sector.
The first step in identifying barriers has been identifying and analyzing the obstacles hindering the adoption of technological priorities to adapt the transport sector to climate change. Next, their details have been described to understand the reasons preventing the transfer and diffusion of priority technologies.

To understand the fundamental problems in technology transfer, the Logical Problem Analysis has been applied, precisely the cause-effect relations based on the Problem tree, having the main problem put as the starter problem, causes at the bottom of the tree, and their effects in the upper part of the diagram. The Problem trees were used to understand the causal relations of barriers and their linkages. The Objective Trees have been built to identify measures for overcoming obstacles.

The sectoral working group members participated in prioritizing the barriers using their knowledge and experience. The working group's feedback was analyzed, and comments and objections were addressed and incorporated into the Report, which led to a hierarchic classification of barriers.

The identified barriers and overcoming measures are summarized in Table 1 .

Table 1. *Identified barriers and measures to overcome technology transfer and dissemination*

Nr	Barriers	Measures	Barriers	Measures	Barriers	Measures
	Hot rolled asphalt (HRA)		**Autonomous Road Surveillance System (ARSS)**		**Transport powered by hydrogen fuel cells and charging infrastructure for it**	
1	High up-front costs	Create a mechanism for adequate up-front cost evaluation			High up-front costs	Reducing costs by introducing fiscal measures the import by reducing taxes
2	Inadequate maintenance services	Develop efficient maintenance services				
3	Ineffective/poor cost management	Introducing a cost management process				
4	Excessive operating costs	Introducing expense management process	Excessive operating costs	The new management mechanism of the Implementation Unit covers the operating costs.	Excessive operating costs	Reducing operating costs by creating and introducing supporting services on the whole value chain

5	An incomplete regulatory framework	Develop an adequate regulatory framework	An incomplete regulatory framework	Development and implementation of the regulatory framework	An incomplete regulatory framework	Develop a regulatory framework to respond to the needs of the introduction of modern technology in the market
6	Focus on old technologies to meet old standards	Acts based on newly developed and adapted quality standards			Focus on old technologies to meet old standards.	Supporting moving toward innovative technologies to respond to the new needs of the sector
7	Lack of adequate public financing mechanism for infrastructure projects	Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects			Lack of adequate public financing mechanism	Develop a public financing mechanism that corresponds to the need to modernize the transport sector.
8	Inefficient implementation of investment projects	Develop a Handbook for the preparation and implementation of investment projects				
9	Lack of experience in cooperating with stakeholders	Improve collaboration between different stakeholders	Lack of experience in cooperating with stakeholders	Improve collaboration between different stakeholders	Lack of experience in cooperating with stakeholders	Creating a platform for cooperation between different stakeholders

10	Insufficient research in this field	Support research in infrastructure projects			Insufficient research in this field	Creating a mechanism for supporting research in the transport sector
11	Lack of quality management system in the infrastructure projects	Introducing quality management systems for infrastructure/construction projects				
12	Limited knowledge of the technological process	Support technology transfer for infrastructure/construction projects	Limited knowledge of the technological process	Implement capacity-building programs for the main stakeholders	Limited knowledge of the technological process	Develop a technology transfer mechanism
13	Limited technical and business management skills of all stakeholders of the value chain	Develop technical and business management skills for all stakeholders of the value chain.			Limited technical and business management skills of all stakeholders of the value chain	Capacity building of all stakeholders of the value chain
14	Lack of information regarding the technology	Promoting technology at public events			Lack of information regarding the technology	Promote technology at public events.
15	Lack of pilot and demonstration projects	Implement pilot and demonstration projects on the local market	Lack of pilot and demonstration projects	Implementation of the small pilot and demonstration projects	Lack of pilot and demonstration projects	Launch of a mechanism for financing and implementing pilot and demonstration

						projects on the local market
16	Low awareness regarding the efficiency of new technologies in the sector	Raise awareness regarding the efficiency of the technology			Low awareness regarding the efficiency of new technologies in the sector	Increase awareness regarding the efficiency of technology by the organization of public events
17			Lack of implementation model	Create a PPP to implement the ARSS in Moldova.		
18			Lack of awareness programs covering the main media resources across the country	Lack of information regarding the technology		
19					Lack of maintenance services	Creating the maintenance services for all products and equipment of the value chain

1. The Transport Sector of the Republic of Moldova

To ensure the Republic of Moldova's sustainable economic development, it is essential to develop an efficient road transport system and a climate-resilient structure that can meet citizens' needs and facilitate trade in both domestic and international markets.

The Republic of Moldova's road infrastructure is old and weak, which is why it needs urgent action to modernize the sector and increase its resilience to climate change by implementing new technologies.

Under the Transport sector's Technology Needs Assessment report (Report I), three priority technologies have been prioritized, with contributions oriented towards adaptation of the sector to climate change. They are:

- Hot rolled asphalt (HRA), Technology 1.
- Autonomous Road Surveillance System (ARSS), Technology 2.
- Transport powered by hydrogen fuel cells and charging infrastructure, Technology 3.

Considering that the prioritized technologies are intended to adapt the transport sector to overcome the significant climatic impacts, the table below reflects an aggregated ranking of barriers hindering the implementation of the new technologies in the transport sector.

Table 2. *The list of all barriers to the implementation of technologies in the local market in the transport sector.*

Nr	Barriers	Barrier category	Barrier importance
1	Lack of quality management system in the infrastructure projects	Technical barriers	Important
2	Limited technical and business management skills of all stakeholders of the value chain	Institutional and organizational capacity	Important
3	Limited direct contact with factories and distribution companies	Network Failures	Important
4	Lack of experience in international cooperation	Network Failures	Important
5	Limited technical skills in managing new technologies	Institutional and organizational capacity	Important
6	Limited capacities of the companies to manage innovative infrastructure projects	Institutional and organizational capacity	Important
7	Capital projects poorly planned and executed	Economics and Financial	Less important

8	Difficulty in survey and design	Policy, legal, and regulatory	Less important
9	Government funding is too low	Economics and Financial	Less important
10	Government lack of borrowing capacity	Economics and Financial	Less important
11	Insufficient funding	Economics and Financial	Less important
12	Insufficient sharing and communication of technical experience	Network Failures	Less important
13	Insufficient transparency in the implementation of transport projects	Policy, legal, and regulatory	Less important
14	Lack of innovative application	Technical barriers	Less important
15	Lack of standardization/codes	Technical barriers	Less important
16	Poor financial environment	Economics and Financial	Less important
17	Poor long-term planning of upstream national documents	Policy, legal, and regulatory	Less important
18	Lack of experience in international cooperation	Network Failures	Less important
19	The old transport regulation	Technical barriers	Less important
20	The poor balance between supply and demand	Economics and Financial	Less important

1.1. Preliminary targets for technology transfer and diffusion

According to the Global Industry Classification Standard (GICS), transportation is technically a subgroup of the industrial sector. It comprises several industries: air freight and logistics, airlines, marine, road and rail, and transportation infrastructure.

The Republic of Moldova's transportation infrastructure (network of public roads) is about 9.4 thousand km long. The road network is developed, the density of public roads is about 322km per 1000km², and in the last years, large-scale repair and restoration works have been conducted on the national road network. As a result, about 26% of national roads are in good to fair condition, 54% in poor condition, and about 20% in bad shape. At the same time, once the Land Transport Infrastructure Strategy for 2008-2017 was approved, the situation improved. Between 2008 and 2012, over 250 km of road was rehabilitated, including 60 km of a local road in a perfect state.

According to the official statistics, in 2018, 872172 vehicles were registered, of which 721005 vehicles were over ten years old, i.e., a share of 82.66% of the total number of cars. The trend of growing the average of the years of exploitation of vehicles is increasing in all categories of cars. As a result, the transport sector is highly vulnerable to climate events because the vehicle fleet and infrastructure are obsolete and in poor condition.

The government of Moldova's main legislative activities are focused on ensuring an efficient transport system that can meet citizens' needs for mobility and facilitate trade on domestic and international markets. A range of sectoral strategies were adopted for this.

The common purpose of these documents is to create an efficient and adapted-to-climate-change transport and logistics system that supports citizens' mobility needs and facilitates trade on national and international markets.

Primary targets for technology transfer and diffusion are developed and adapted to the objectives of the transport sector's leading national strategies.

***Table 3**. Targets for technology transfer and diffusion.*

Nr.	The technology	The main target
1	Hot rolled asphalt (HRA)	At least 300 km of national roads have been made more resilient to climate change by being rehabilitated using hot-rolled asphalt (HRA).
2	Autonomous Road Surveillance System (ARSS)	Improving public traffic in difficult weather conditions and reducing road accidents by 10% by installing the Autonomous Road Surveillance System (ARSS) on the most critical public roads.
3	Transport powered by hydrogen fuel cells and charging infrastructure for it	Introduce hydrogen-powered vehicles and develop charging infrastructure to increase the resilience of the transport fleet and modernize at least 5% of public transport.

The target for Hot-rolled asphalt (HRA) has been set according to the main objectives of the Transport and Logistics Strategy for 2013-2022. As the local government plans to modernize the infrastructure and repair the local and international roads, the solution for the material used in the works will be Hot-rolled asphalt (HRA), which will increase the strength of asphalt pavement.

The target for the Autonomous Road Surveillance System (ARSS) is set according to the main objectives of the Transport and Logistics Strategy for 2013-2022. The technology will help to reduce road accidents by creating an efficient traffic control system that detects and counts vehicles at various times and locations. The target for Transport powered by hydrogen fuel cells and charging infrastructure for it is set according to the main objectives of the Transport and Logistics Strategy for 2013-2022, the Environmental Strategies for the years 2014-2023,

and the Low Emission Development Strategy of the Republic of Moldova until 2030. The fleet will adapt to the ambitious standards by introducing hydrogen fuel cells powered transport. As a result, it will reduce greenhouse gas emissions and the impact of climate change on the transport sector.

2. Barrier analysis and possible enabling measures for Technology 1 of the Transport Sector: Hot rolled asphalt (HRA)

2.1. General Description of Technology 1 of the Transport Sector: Hot rolled asphalt (HRA)

Hot Rolled Asphalt (HRA)[1] is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108—a high proportion of sand in the mix results in a low percentage of air voids when compacted. The mortar of bitumen, sand & filler gives it strength. High PSV chippings are added on public roads to provide a skid-resistant surface.

The material is designed for heavy-duty industrial applications such as stocking bays and loading areas. It is particularly suitable where forklift trucks operate, or heavy trucks/buses regularly corner tightly.

This is the standard specification for surfacing roads and is used with high PSV Pre-Coated Chips to provide an exceptionally durable, anti-skid surface.

Hot-rolled asphalt results in an incredibly durable surface with enhanced longevity, high skid resistance, and near imperviousness to water—resulting in reduced damage. Due to their high characteristics, pavements can reduce the thickness of the entire road structure by 30–35% and the thickness of the base layer by around 25%.

Table 4. Characteristics of Hot Rolled Asphalt technology

Category	Details
Standards	- IS EN 13108-4 Hot Rolled Asphalt - NSA I's Standard Recommendation (SR) 28 - IS EN 13108-20: Type Testing - IS EN 13108-21: Factory Production Control
Main Components	- Binder: Petroleum bitumen - 30% coarse aggregate (max size: 14mm) - Additives: Fibers, pigments, adhesion agents (suitability demonstrated by IS EN 13108-4)
Main Characteristics	- Hot bituminous material: Black granular, temperature up to 200°C, density ~1.6 - Thickness: 30–40 mm - Paving Grade of Bitumen: 40/60, 70/100, or 100/150 - BS EN 13108-4/PD 6691 Reference: HRA 30/10 F surf
Major Benefits	- Increased point loading resistance - Increased fuel resistance - Superior rut resistance - High stone content (no pre-coat chippings required)

According to laboratory tests, stability/strength is twice that of a standard 30/14 asphalt design mix.

Hot Rolled Asphalt (HRA), as a dense mixture of mineral aggregate, sand, filler, and bitumen, will change the old system of asphalt pavements. Introducing this technology to the local market will shift the asphalt structure and composition, the paving model, and the periodic maintenance process, considering that being more durable, maintenance will be needed less often. Also, by introducing Hot Rolled Asphalt (HRA), the transport infrastructure became more resistant, stable, and strengthened. Maintenance services will also be changed, considering the new needs and criteria.

According to the technology categories' classification and market characteristics, hot-rolled asphalt (HRA) is a "non-market good" characterized by investments to be decided at the government level and heavy dependence on existing infrastructure and national policies.

[1] https://www.researchgate.net/publication/288823869_Development_of_Long_Life_Deformation_Resistant_Hot _Rolled_Asphalt_Surfacing

[2] Hot Rolled Asphalt and Coated Chippings – Checks and Key Points. CC-PAV-04011. January 2019

2.2. Identification of barriers for Hot rolled asphalt (HRA) adoption

2.2.1. Economic and Financial Barriers

a) High up-front costs
High up-front costs are significant barriers to implementing this technology in the Moldavian market. The investment costs start at USD 870.000/km. This cost includes materials, transportation of goods to the destination, installation work, etc.

Also, the costs of operation and maintenance are about 1% for the first five years of operation; after this, the costs can be increased by around 0.5% every three years. Compared to traditional technologies based on the old standards, the rehabilitation of the road costs around 200.000 USD/km, and the construction of new roads costs around 600.000 USD/km.

b) Inadequate maintenance services
Road maintenance is essential to preserving the road in its originally constructed condition, and long-term cost savings are one of the characteristics and benefits of hot-rolled asphalt (HRA).

The primary stakeholder groups in road maintenance in Moldova include government agencies responsible for planning, executing, and financing these activities, as well as contractors and others involved in the work. This creates a situation of complex coordination for all of them. In addition, the Ministry of Finance plays a significant role in sourcing funding and allocation. Because of the problematic coordination of all stakeholders, in the Republic of Moldova, the infrastructure assets are often under-maintained, either because maintenance is poorly planned or because planned maintenance is deferred or needs to be financed adequately.

c) Ineffective/poor cost management
Initial decision-making depends on stakeholders at different levels, from governmental entities responsible for budgeting to architects and engineers responsible for technical documentation. Finally, the entity responsible for acquiring goods and services dramatically differs in the range.

d) Excessive operating costs
As the up-front costs of technology are higher than the usual costs in the local market, the operating costs associated with maintenance and administration are too high under some circumstances.

The costs of operation and maintenance are about 1%/km for the first five years of exploitation; after this, they can increase by around 0.5% every three years.

3 https://journal.uii.ac.id/teknisia/article/view/8290

2.2.2. Policy, legal and regulatory barriers

a) Incomplete regulatory framework

The main regulatory and policy barrier is ***the need for more technical norms and standards to implement international requirements on the quality of infrastructure projects***. For example, in 2020, the elaboration of the following normative documents (Practical Codes in Constructions): CP D.02.29, CP D.02.30, CP D.02.31, CP D.02.36, CP D.02.39, but both the old Practical Codes in constructions as well the new ones do not consider resilience needs of the transport infrastructure of the Republic of Moldova to the new climate change reality.

b) Focus on old technologies to meet old standards

Since implementing the infrastructure investment projects requires many bars to select the right equipment, the acquisition entities focus on old technologies that meet old standards and are already available on the local market.

c) Lack of regulatory framework to finance the infrastructure projects by the public budget

Public financing is the dominant channel in Moldova's transport infrastructure projects. However, due to increased budgetary constraints, financing has increasingly become financing from external sources. This mechanism has become the solution to attract international financial institutions' funding. However, given that the different donors have different criteria and objectives, this has led to a difference in technical standards compared to other projects implemented in other localities of the country. Also, because of the few practice projects, some governmental agencies still need to gain experience in how to blend financing sources.

d) Inefficient implementation of investment projects

Involving many stakeholders, specific conditions of international financial institutions, and synchronization between the local standards and technical of the donors, consume a lot of the time to develop tendering documentation.

Also, in the implementation process, some specific monitoring and evaluation procedures require more time to execute the infrastructure works. This usually leads to delays in the execution process.

2.2.2. Network Failures

a) Lack of experience in cooperating with stakeholders

Cooperation and coordination are essential in implementing investment projects in the transport sector. However, considering the numerous stakeholders in the industry, it is difficult to bring all together to discuss and resolve sector-specific issues.

Moreover, given the precise specialization of some technicians and engineers, identifying partners for cooperation is expensive, and the specialized agencies need to have focused actions for this.

2.2.3. Technical barriers

a) Insufficient research in this field

There is a moderate number of studies on the transport sector. Usually, the studies are financed or performed by international financing institutions and are focused on specific research topics to solve or identify solutions to particular projects. The lack of budgets of national research entities leads to research being carried out very rarely in the transport sector. As a result, more studies are needed to identify the real needs and propose solutions to improve the quality of investments in this sector.

b) Lack of quality management system in the infrastructure projects

Poor quality control leads to higher operating costs. Due to the lack of a quality management system, it is not easy to respect and maintain some standards for the quality of infrastructure projects. These standards must be improved to evaluate the performance of execution works companies, including third-party contractors and the supply chain.

c) Limited knowledge of the technological process

Lack of knowledge remains the most significant barrier to adopting technology. Currently, companies in Moldova operate based on only part of the asphalt production cycle. This means that the production process is unknown to local producers, and they need to gain the necessary experience to ensure the production of asphalt throughout the process.

2.2.4. Institutional and Organizational Capacity Barriers

a) Limited technical and business management skills of all stakeholders of the value chain

Because no companies operate based on an entire cycle of asphalt production in Moldova, there are no experts with technical and business management skills in the whole value chain. Therefore, many essential skills that need to be developed are procurement and commercial management, supply chains, quality and standards control, construction, engineering, etc.

2.2.5. Social, Information, and Awareness Barriers

a) Lack of information regarding technology

New technologies in the Moldovan infrastructure sector cannot be implemented due to insufficient financing and need to be studied and promoted.

The pessimistic attitude of the technology promoters in this field is accentuated when the implementation perspectives in practice are weak.

The main stakeholders prefer to focus on old and verified technologies over the years. The information on innovative technologies in the transport field remains only in specialized literature for engineers and architects.

b) Lack of pilot and demonstration projects

No pilot and demonstration projects were implemented in Moldova in the infrastructure field using a new asphalt solution.

Considering that the main objectives of these projects are to create learning externalities and support technology diffusion in the local market, while infrastructure projects need public infrastructure and essential financing, it is not easy to implement them.

c) Low awareness regarding the efficiency of new technologies in the sector
More information regarding technology, demonstrations, and pilot projects is needed. As a result, awareness regarding the efficiency of this technology could be much higher. The primary beneficiaries have yet to learn preliminary information about technology, one of the main barriers to its promotion.

Table 5. *Prioritization of barriers hindering the implementation of Technology 1: Hot rolled asphalt (HRA)*

Nr	Barriers	Barrier importance
1	High up-front costs	Crucial
2	Inadequate maintenance services	Important
3	Ineffective/poor cost management	Crucial
4	Excessive operating costs	Crucial
5	An incomplete regulatory framework	Crucial
6	Focus on old technologies to meet old standards	Crucial
7	Lack of adequate public financing mechanism for infrastructure projects	Crucial
8	Inefficient implementation of investment projects	Important
9	Lack of experience in cooperating with stakeholders	Crucial
10	Insufficient research in this field	Crucial
11	Lack of quality management system in the infrastructure projects	Important
12	Limited knowledge of the technological process	Crucial
13	Limited technical and business management skills of all stakeholders of the value chain	Important
14	Lack of information regarding the technology	Important
15	Lack of pilot and demonstration projects	Crucial
16	Low awareness regarding the efficiency of new technologies in the sector	Crucial

The problem tree for hindering climate change adaptation technology developed based on consultations with the sectoral working group is attached in Figure 1

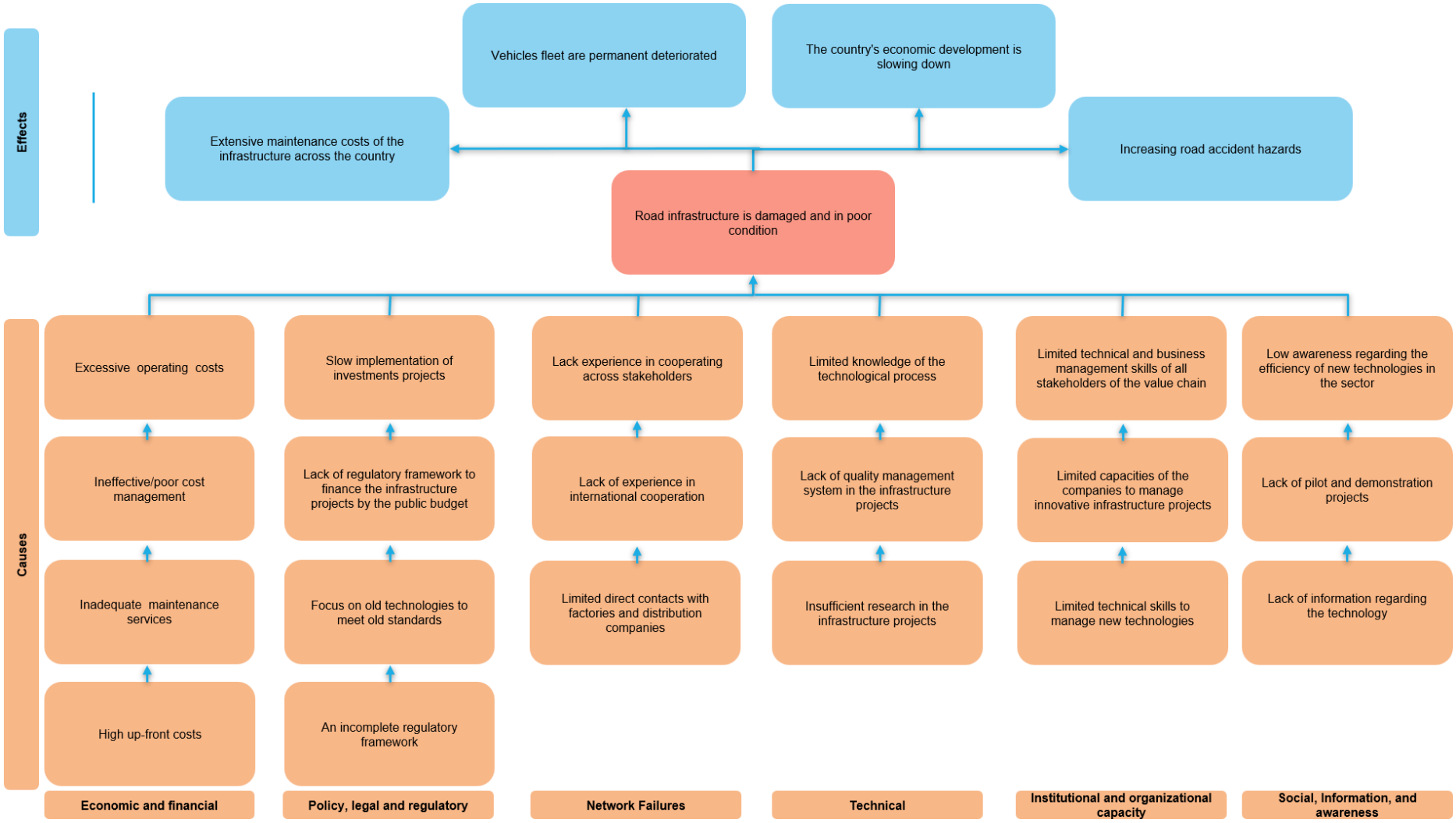

Figure 1. Logical Problem Analysis of Technology1: Hot rolled asphalt (HRA).

3. Identified Measures

3.1. Economic and Financial Measures

a) Create a mechanism for adequate up-front cost evaluation
To decrease the upfront costs, a mechanism should be created to evaluate the up-front fees adequately. This mechanism should include the cost analysis of the entire value chain of implementing infrastructure investment projects, including pricing forms, payment models, and intermediary groups (agents, wholesalers, distributors, and retailers).

b) Develop efficient maintenance services
Introducing the ISO standards in the maintenance planning and execution of the services according to the requirements for civil engineering infrastructure.

c) Introduce a cost management process
The cost management process allows predicting future expenses to reduce the chances of budget overruns. Projected costs are calculated during the project's planning phase and must be approved before work begins.
The cost management process in an infrastructure investment project includes resource planning, cost estimation, cost budgeting, cost control, etc.

d) Introduce expense management process
Expense management can be considered any organized methodology for processing expense reports and approvals and reimbursable expenses by employees, administrative and supply services, etc.

3.2. Policy, legal and regulatory measures

a) Develop an adequate regulatory framework
Developing technical norms and standards according to the new climate change reality, especially in infrastructure projects. The Practical Codes in Construction should be adapted to the infrastructure projects' unique needs and respond to the new weather conditions.

b) Acts based on newly developed and adapted quality standards
Infrastructure projects should be strictly implemented following the new climate change situation. In particular, after a probation of the latest Practical Codes in Constructions, a mechanism monitors the concordance of the execution of the works of the investment projects according to them.

c) Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects
As public financing is the dominant channel in infrastructure projects in Moldova, a mechanism that can respond to the main rules and conditions of financing by international donors and channel investment flow should be developed.

d) Develop a Handbook for the preparation and implementation of investment projects

Public investment refers to government (central or local) spending on public infrastructure, so it is crucial to have a project management Handbook that describes the modus operandi. The Handbook can also be used by organizations actively involved in the planning, formulation, budget request, contracting, monitoring, and completion of infrastructure investment projects.

The Handbook will help organizations in all phases of projects, including project identification, preparation, implementation, completion/evaluation, and post-completion follow-up.

3.3. Network Failures measures

a) Improve collaboration between different stakeholders

As different stakeholders have different objectives and goals, it is essential to create preconditions for joint meetings (forums, exhibitions, workshops).

Public events should be organized to meet all stakeholders, discuss common problems, and propose solutions that can support their activities.

Also, one practical mechanism for improving stakeholder collaboration is implementing multilateral projects in which different organizations contribute their input and work together toward a common objective.

3.4. Technical measures

a) Support research in infrastructure projects

Develop a financing mechanism to support research in infrastructure projects, especially to analyze the technical characteristics of new technologies and to identify the best way to implement them in practice.

Also, strengthening the research capacity at the national level by providing support for the research ecosystem and strengthening the R&D bases of the country's universities is essential.

b) Introduce quality management systems for infrastructure/construction projects

The Quality Management System (QMS) used in infrastructure/construction projects refers to quality planning, assurance, and control. The QMS helps achieve the projects' objectives by assisting in comprehensive quality implementation and enables a quality process for better risk management, assured compliance, and meeting all regulatory requirements.

c) Support technology transfer for the infrastructure/construction projects

Technology transfer projects are essential in introducing new products to a new market. Collaboration between institutions from different countries, sectors, and areas of activity can create a solid base for identifying the right solutions to the climate change needs of infrastructure projects.

3.5. Institutional and Organizational Capacity Measures

a) Develop technical and business management skills for all value chain stakeholders

Create learning platforms for online and offline programs to support the development of technical and business management skills.
Management skills can be developed through learning and practical experience as a project manager.
For infrastructure projects, technical skills involve operating machines and software, production tools and equipment, and the skills needed to design different maintenance services.

3.6. Social, Information, and Awareness Measures

a) Promote technology at public events

Organizing public events such as B2B and B2G forums, exhibitions, and workshops is one of the best ways to promote new technologies in infrastructure projects.
In the B2B and B2G forums, the participants can meet to discuss the main obstacles and solutions to the projects' implementation.
The exhibitions can exhibit the projects' new technologies, equipment, and presentations.
In the workshops, the main stakeholders can learn about new research results, identify new solutions to implement the projects, discuss the situation in the sector, etc.

b) Implement pilot and demonstration projects on the local market

Pilot and demonstration (P&D) projects are commonly deployed to catalyze early technology adoption but need to be better understood regarding mechanism and impact.
One of the solutions to create a mechanism to implement pilot and demonstration (P&D) projects is to synchronize the available financing from the research infrastructure projects of international donors and local funds.

c) Raise awareness regarding the efficiency of technology

To raise awareness of infrastructure projects, it is essential to mobilize and involve citizens by promoting actions for the responsible use of the resources.
It can be focused on disseminating goals and achievements in the efficient use of new solutions and the results of the activity.

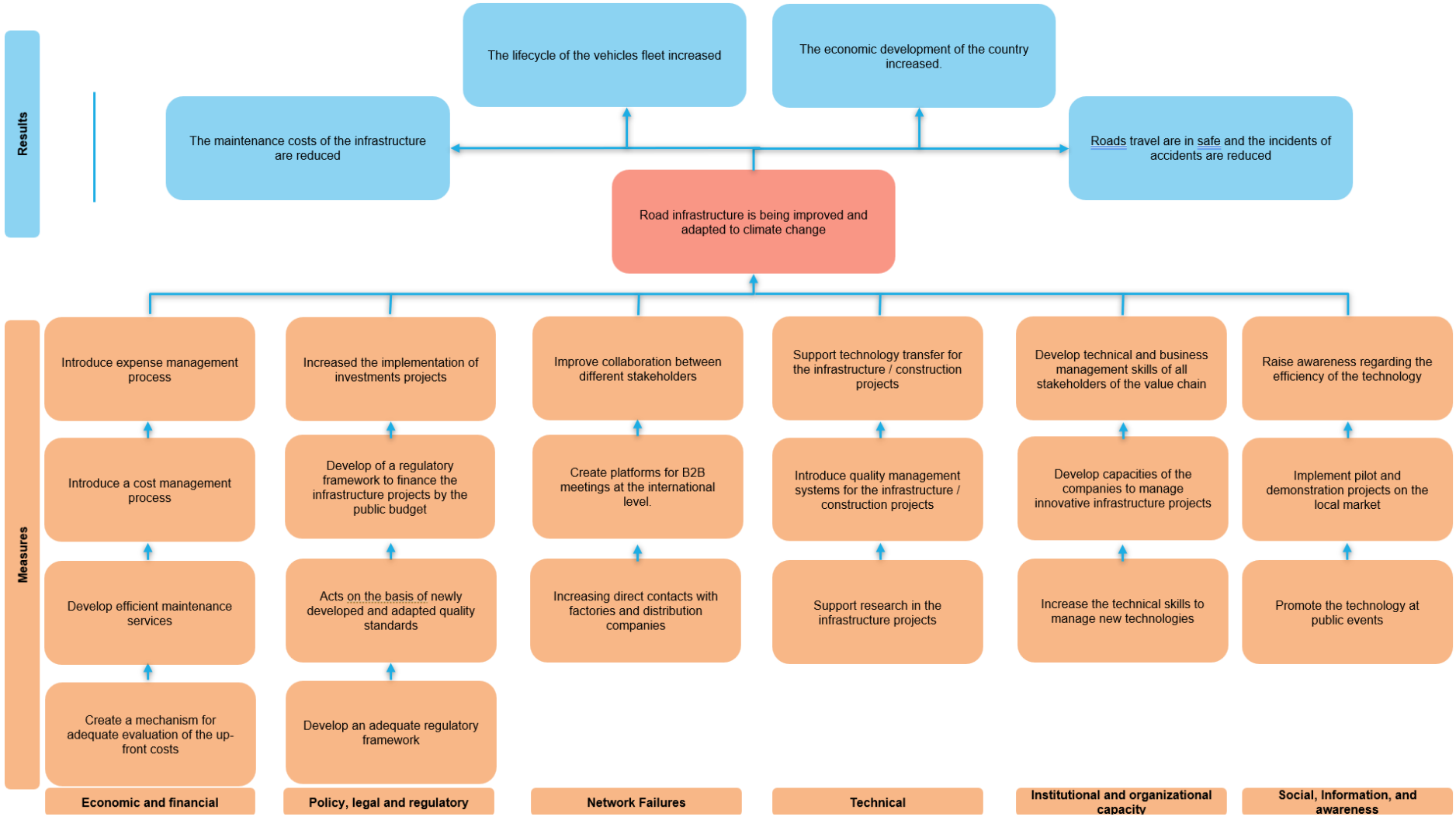

Figure 2. The Objective Tree of the Technology 1: Hot rolled asphalt (HRA).

4. Barrier analysis and possible enabling measures for Technology 2: Autonomous Road Surveillance System (ARSS)

4.1 General description of technology 2 of the Transport Sector: Autonomous Road Surveillance System (ARSS)

The Autonomous Road Surveillance System (ARSS) is an efficient traffic control system that detects and counts vehicle numbers at various times and locations. The solution is designed to solve one of the biggest problems in the country's main cities, the traffic jams during office hours and office break hours. Sometimes, the traffic signal green light is still ON even though no vehicle is on the road. Similarly, it is also observed that long queues of cars are waiting even though the road is empty due to an inefficient traffic control system. This is due to the malfunction of the signaling system, which did not properly investigate vehicle flow. This can be handled by adjusting ARSS.

The ARSS configuration includes the following components: a camera, image storage device, object detection algorithm, background subtraction to remove the background object, shadow removal algorithm, segmentation and merging technique, object classification algorithm, etc. Some barriers and factors slow down the large-scale introduction of ARSS. Some result from the legal use and storage of the data, and the significant barrier is implementing the technology in practice.

4.2. Identification of Barriers to Autonomous Road Surveillance System (ARSS) adoption

4.2.1. Economic and Financial Barriers

a) Excessive operating costs

Experts from different areas of activity, especially from the IT sector, must be involved in operating the implementation unit. This condition means that operating expenses are substantial when the implementation unit does not generate economic profit to cover costs.

4.2.2. Policy, legal and regulatory barriers

a) An incomplete regulatory framework

Public policy is not regulated, as reflected in laws and regulations relating to collecting, using, and analyzing personal data.

4.2.3. Network Failures

a) Lack of experience in cooperating with stakeholders

One of this technology's primary functions is data collection and analysis. In this regard, the responsible entity for each activity should be defined.

4.2.4. Technical barriers

a) Limited knowledge of the technological process

The technological process is new and has never been implemented by a single entity. So far, in the Republic of Moldova, the General Police Inspectorate is responsible for traffic management, and the municipal enterprise "Lumteh" is accountable for the semaphores management.
All of the entities need the necessary knowledge to manage the whole process.

4.2.5. Institutional and Organizational Capacity Barriers

a) Lack of implementation model
In the Republic of Moldova, the General Inspectorate of Police is responsible for traffic management. However, as a public entity with specific fields of activity, the institution needs the competencies to manage activities related to ARSS. On the other hand, the municipal enterprise Lumteh manages semaphores (signaling infrastructure) in Chisinau.

4.2.6. Social, Information, and Awareness Barriers

a) Lack of awareness programs covering the primary media resources across the country.
Because technology is new, it is essential to explain its benefits and involve the people in the primary processes relating to its use. This can be done by specific programs targeted at different groups divided by region. Considering that the traffic is heavier in cities and less in the villages, it is crucial to identify the right audience for the program and respond to their needs.

b) Lack of pilot and demonstration projects
Implementing pilot projects is essential when introducing new technologies. However, in the case of ARSS, as only two public entities, can be involved in activities related to these technologies, it took them much work to implement pilot projects.

Figure 3 includes the problem tree for hindering climate change adaptation technology developed based on consultations with the sectoral working group.

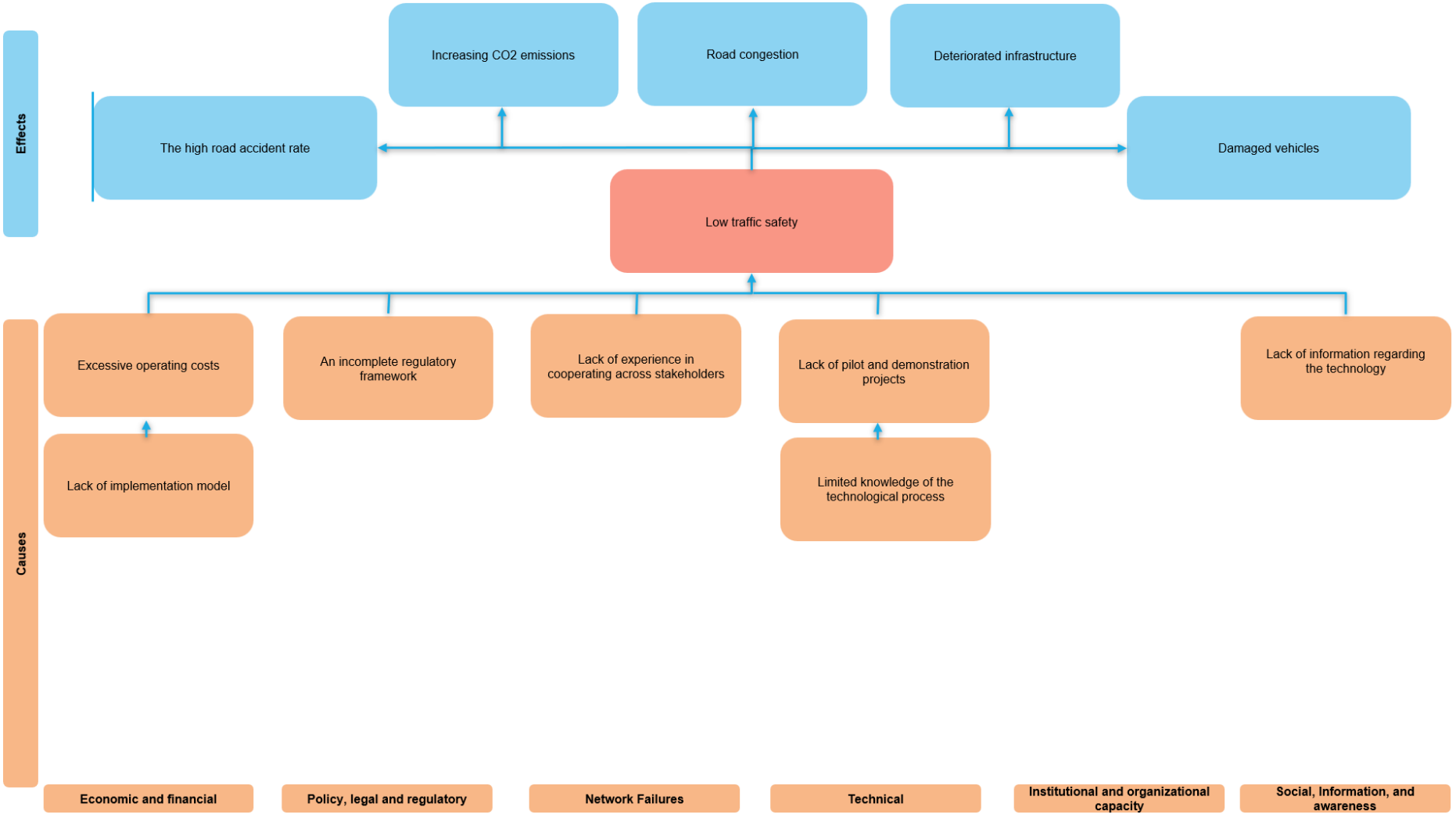

Figure 3. Logical Problem Analysis of the Technology 2: Autonomous Road Surveillance System (ARSS)

5. Identified measures

5.1 Economic and Financial Measures

a) The new management mechanism of the Implementation Unit covers the operating costs. Implementing a PPP can create an operating mechanism for the deployment unit that will allow it to generate revenue and cover operational costs.

5.2. Policy, legal and regulatory measures

a) Development and implementation of the regulatory framework
It is recommended that the regulatory framework be developed and adapted to allow public entities to create PPPs and be involved in their management.

5.3. Network Failures measures

a) Improve collaboration between different stakeholders
At a minimum, two different entities should be involved in implementing this technology in the country, and a mechanism of interaction should be created between the main stakeholders. Public events should be organized to meet all stakeholders, discuss common problems, and propose solutions to support activities for all of them.
Also, a platform of cooperation should be created between equipment distributors, maintenance companies, cloud, and collection data companies, etc.
Also, it is crucial to identify the main responsible entities for the vulnerable data.

5.4. Technical measures

a) Implement capacity-building programs for the main stakeholders
Implement capacity-building programs, including practical exercises. The programs should contain the main modules to cover the training needed to manage ARSS applications and store, analyze, and use the data.

5.5. Institutional and Organizational Capacity Measures

a) Create a PPP to implement the ARSS in Moldova
Because in the Republic of Moldova, the functioning of the ARSS system is the responsibility of 2 different public entities, the best solution, in this case, is to develop a PPP.
The PPP will solve the managerial and operational problems relating to implementing the ARSS in the country.

5.6. Social, Information, and Awareness Measures

a) Lack of information regarding technology

The technology is new, and because the current traffic management system covers the essential functions needed, the institutions responsible still need to take action to modify and implement new technologies.

Likewise, action has yet to be taken to promote new technological solutions that efficiently manage traffic and add value to this process.

b) Implementation of the small pilot and demonstration projects.

Implementing the pilot and demonstration (P&D) projects can solve the main problem relating to the promotion of new technology.

Small pilot and demonstration projects, especially in villages, can create a baseline for scaling up the projects in big cities, where traffic is more intensive, and the result can have a more significant impact.

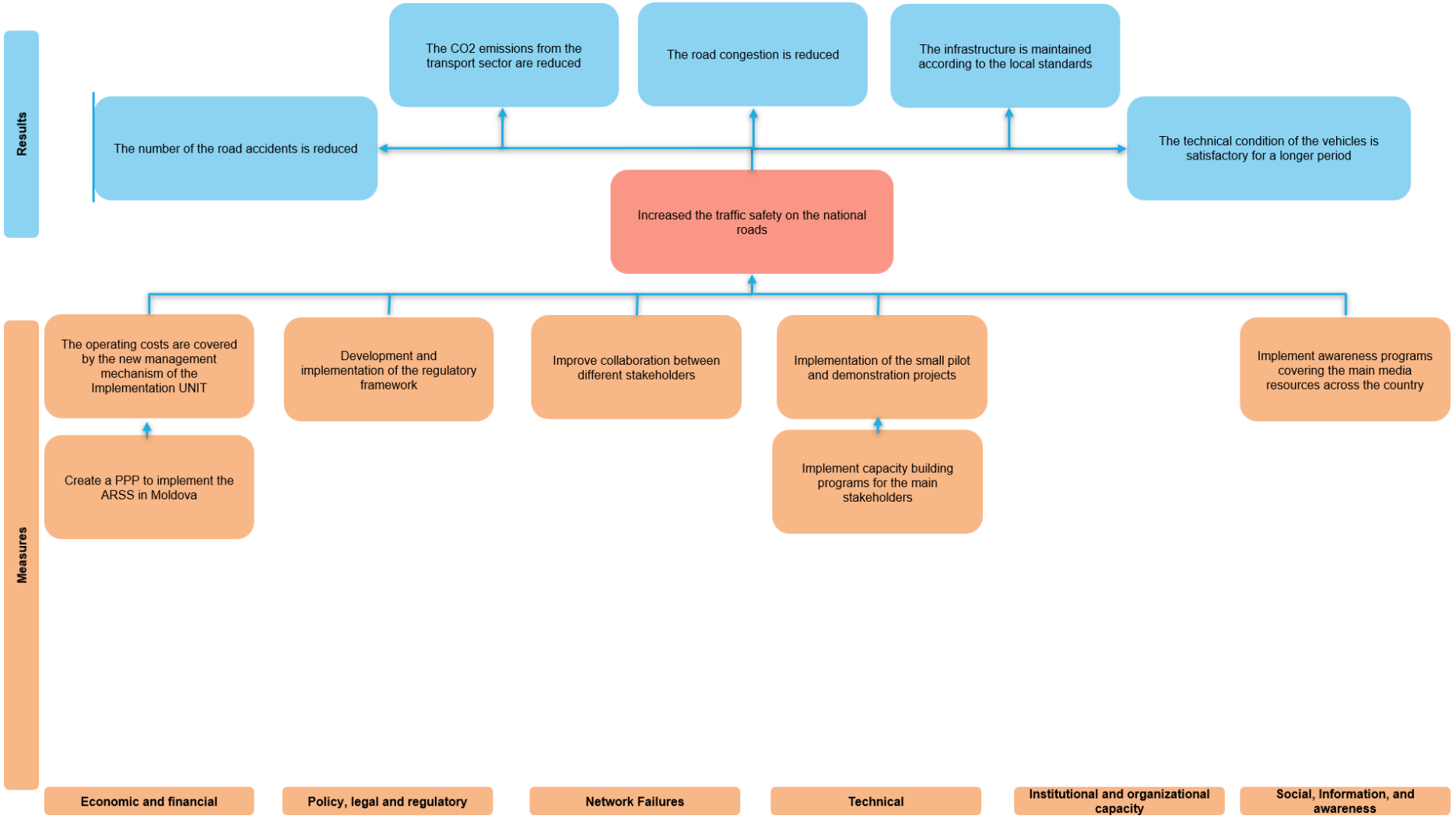

Figure 4. The Objective Tree of the Technology 2: Autonomous Road Surveillance System (ARSS)

6. Barrier analysis and possible enabling measures for Technology 3 of the Transport Sector: Transport powered by hydrogen fuel cells and charging infrastructure for it

6.1. General Description of Technology

A fuel cell electric vehicle is a car that includes both a hydrogen fuel cell and batteries/capacitors. In this hybrid architecture, the fuel unit provides all the energy for vehicle movement, while the batteries/capacitors can give maximum power to the engines to cope with rapid acceleration.

The fuel cell module generates electricity through an electrochemical reaction, leaving only water and heat as by-products, so no pollutant emissions are emitted into the atmosphere. Electricity is used to provide direct electric traction and to keep the batteries charged. The heat from the by-product is stored in the brake resistors and is used to maintain the passenger's heating comfort and increase the vehicle's energy efficiency. The batteries also provide storage for regenerative braking energy. The hydrogen stored onboard provides all the energy the bus needs to run.

Hydrogen offers a higher energy density than electrical storage systems such as batteries, which allows for a more extended range than systems where batteries are used as energy storage.

The technology, vehicles, and charging infrastructure are produced outside the local market and should be imported from outside.

Hydrogen as an energy product (Cod TARIC 280410), in the period 2017 – 2021, was imported to Moldova from Romania and Ukraine for a total of 8758 USD. In the mentioned period, 927 cubic meters were imported, and the average price was $8.59 per cubic meter.

According to the World Trade Organization data, in the Republic of Moldova, in 2021, the tariff rate charged as a percentage of the price (Ad Valorem AV) for hydrogen as an energy product is 5.5%.

6.2. Identification of barriers for Transport powered by hydrogen fuel cells and charging infrastructure for it

6.2.1. Economic and Financial Barriers

a) High up-front costs

High up-front costs are one of the significant barriers to implementing transport powered by hydrogen fuel cells in the Moldavian market. The costs for charging infrastructure and maintenance components are expensive, and the cost for one unit starts from 180.000 USD. Therefore, the price per bus varies from 750.000 USD to 950.000 USD for wholesale prices.

Also, the costs of operation and maintenance are about 1% for the first five years of operation; after this, they can increase by around 0.5% every three years.

b) Lack of maintenance services

The need for maintenance infrastructure is a critical barrier to introducing expensive technology in the local market. Implementing this technology requires additional costs for maintenance services, equipment, and parts.

c) Excessive operating costs

As the technology is costly and the maintenance services require additional investment, the operating costs increase. Also, training the particular technical staff will require additional financing.

The maintenance costs of equipment and transport units are about 1% for the first five years of exploitation; after this, they can increase by around 0.5% every three years.

6.2.2. Policy, legal and regulatory barriers

a) Incomplete regulatory framework

The current legal framework does not regulate the Value-Added Tax (VAT) on transport powered by hydrogen fuel cells, which is payable at the point of importation into the Republic of Moldova.

A lack of this regulation leads to an increase in the price of hydrogen-powered vehicles.

b) Focus on old technologies to meet old standards

As vehicles powered by petrol and diesel are more accessible and cheaper, public and private users prefer to continue to focus on the old technologies, even if they are more polluting.

c) Lack of adequate public financing mechanism

Public entities are the dominant client in the acquisition of new transport units. In this case, the general acquisition procedures are focused, particularly on the lower prices rather than on efficiency or the promotion of new clean technologies.

6.2.3. Network Failures

a) Lack of experience in cooperating with stakeholders
Considering the numerous stakeholders in the sector and the value chain, it is easier to bring all together to discuss and resolve sector-specific issues.

b) Limited technical and business management skills of all value chain stakeholders
The value chain in the transportation sector is very fragmented, and because the main stakeholders are usually small companies, they need to pay more attention to developing management skills.
The management capacities of the main stakeholders are usually common-oriented and do not specifically focus on the transport sector.

6.2.4. Technical barriers

a) Need for more research in this field
No studies relate to implementing this technology in the local market. Moreover, the lack of budgets for national research entities means that studies are carried out very rarely in the transport sector.

b) Limited knowledge of the technological process
Lack of knowledge remains the most significant barrier to adopting this technology. Currently, no companies in Moldova operate hydrogen-powered vehicles, meaning the local beneficiaries and users need to be made aware of the technology's benefits.

6.2.5. Social, Information, and Awareness Barriers

a) Lack of information regarding technology
Due to financial insufficiency, new technologies in the Republic of Moldova's transport sector cannot be implemented, and more study and promotion are needed.
More information is needed regarding the efficiency and benefits of the technology due to the limited market and areas where new vehicles can be introduced.
Also, due to the limited budget for promotional activities, the technology owners prefer to organize short promotional campaigns that finally reduce their impact.

b) Lack of pilot and demonstration projects
There are no pilot and demonstration projects implemented in Moldova using hydrogen-powered vehicles.
The two main obstacles are the high cost of technology and the final beneficiary (public entities). In this case, pilot projects can be implemented only by grant programs, a scarce opportunity in this field.

c) Low awareness regarding the efficiency of new technologies in the sector
As no pilot projects exist to use this technology, awareness regarding its benefits and efficiency could be much higher. Unfortunately, due to a limited budget, potential beneficiaries cannot promote the technology and focus on its efficiency and benefits.

***Table 7**. Prioritization of barriers hindering the implementation of technology*

Nr	Barriers	Barrier importance
1	High up-front costs	Crucial
2	Excessive operating costs	Crucial
3	An incomplete regulatory framework	Crucial
4	Focus on old technologies to meet old standards	Crucial
5	Lack of adequate public financing mechanism	Crucial
6	Lack of experience in cooperating with stakeholders	Crucial
7	Insufficient research in this field	Crucial
8	Limited knowledge of the technological process	Crucial
9	Limited technical and business management skills of all stakeholders of the value chain	Important
10	Lack of information regarding the technology	Important
11	Lack of pilot and demonstration projects	Crucial
12	Low awareness regarding the efficiency of new technologies in the sector	Crucial

Figure 5 contains the problem tree for hindering climate change adaptation technology, which was developed based on consultations with the sectoral working group.

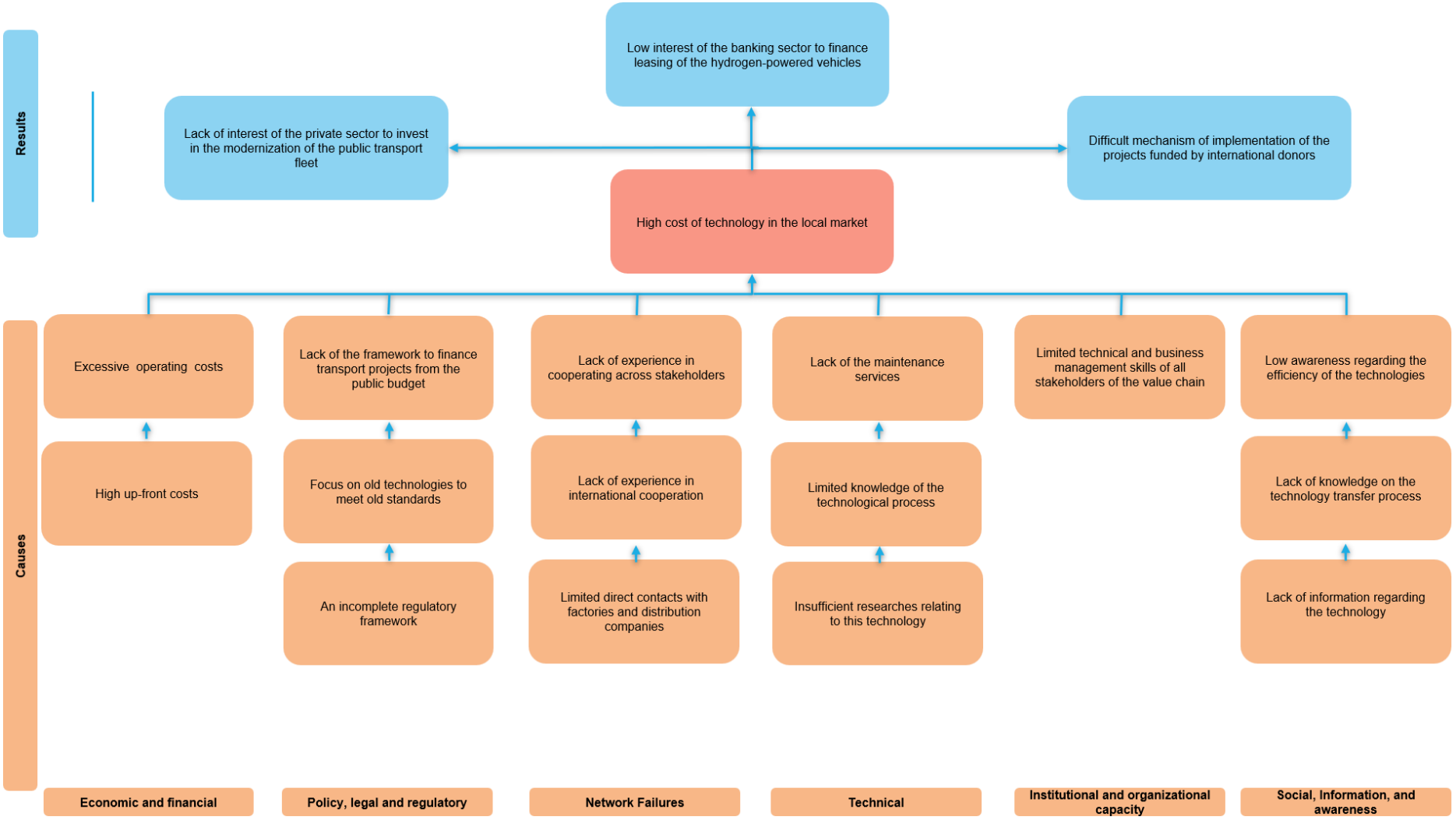

Figure 5. Logical Problem Analysis of Technology 3 of the Transport Sector: Transport powered by hydrogen fuel cells and charging infrastructure.

7. Identified measures

7.1. Economic and Financial Measures

a) Reduce costs by introducing fiscal measures and imports by reducing taxes.
Reducing costs for this technology can be done by introducing fiscal measures to import by lowering taxes. Significantly can be raised special taxes on importing for:

- Hydrogen as the energy carrier
- Equipment for the changing infrastructure
- Hydrogen-powered vehicles

b) Create maintenance services for all products and equipment of the value chain
By creating maintenance services for all products and equipment in the value chain, preconditions can be designed to support the large-scale use of vehicles.

c) Reduce operating costs by creating and introducing support services throughout the value chain
Creating a network of supporting/maintenance services on the whole value chain can reduce transportation services companies' operating costs.

7.2. Policy, legal and regulatory measures

a) Develop a regulatory framework to respond to the needs of introducing modern technology in the market
Developing a new regulatory framework to support the introduction of hydrogen-powered vehicles will respond to the current situation's primary needs and facilitate the technology's entry into the local market.
The regulatory framework should be focused on fiscal areas, such as reducing the tax on the import of technology.

b) Support a move toward innovative technologies to respond to the new needs of the sector
The introduction of hydrogen-powered vehicles in the leading Sectoral Action Plans will stimulate the local market to use them in the mass market. The specific targets of these Plans will create preconditions for increasing their use in the country.

c) Develop a public financing mechanism corresponding to modernizing the transport sector
As one of the final leading public transport operators is the public entities, one of the top solutions, in this case, can be the creation of a Fund that can finance the investment in public transport by acquiring hydrogen-powered vehicles.

7.3. Network Failures measures

a) Create a platform for cooperation between different stakeholders
A cooperation platform that can contact stakeholders of the hydrogen-powered vehicle value chain will solve the main problem of the need for more cooperation.

Through periodic public events, the cooperation platform will discuss stakeholders' main problems and create conditions for identifying the right solutions.

b) Capacity building of all stakeholders of the value chain

As the Moldovan transportation sector is very fragmented and because the main stakeholders are usually small companies, one of the existing solutions that can solve capacity-building programs to support the development of management skills.

7.4. Technical measures

a) Create a mechanism for supporting research in the transport sector

An adequate solution to the situation relating to the lack of sectoral studies in the transport sector can be the development of programs for financing the calls for proposals by specific agencies responsible for research in this sector, especially the National Agency for Research and Development.

b) Develop a technology transfer mechanism

Developing a technology transfer mechanism can support the introduction of innovative technology in the local market. The National Agency for Research and Development can undertake this activity in the Republic of Moldova. The Agency has already implemented similar programs in different sectors by supporting technology transfer in the principal areas of activity.

7.5. Social, Information, and Awareness Measures

a) Promote technology at public events

New technologies in the Republic of Moldova transport sector can be efficiently promoted by organizing public events such as B2B and B2G forums, exhibitions, workshops, etc. During these forums, the participants can meet to discuss the main obstacles and solutions to implementing the projects.

The exhibitions can exhibit innovative technologies, equipment, and presentations of the pilot or investment projects.

b) Launch a mechanism for financing and implementing pilot and demonstration projects on the local market

Implementing pilot and demonstration (P&D) projects is one efficient way to introduce innovative technology to the local market.

In the Republic of Moldova, the National Agency for Research and Development has the experience, budget, and capacity to undertake this activity.

c) Increase awareness regarding the efficiency of technology by organizing public events.

A specific general program should be developed to increase public awareness regarding the efficiency and benefits of hydrogen-powered vehicles, having as a target concrete stakeholder group.

Each group should identify a specific objective and activities. The material should also be disseminated across the groups.

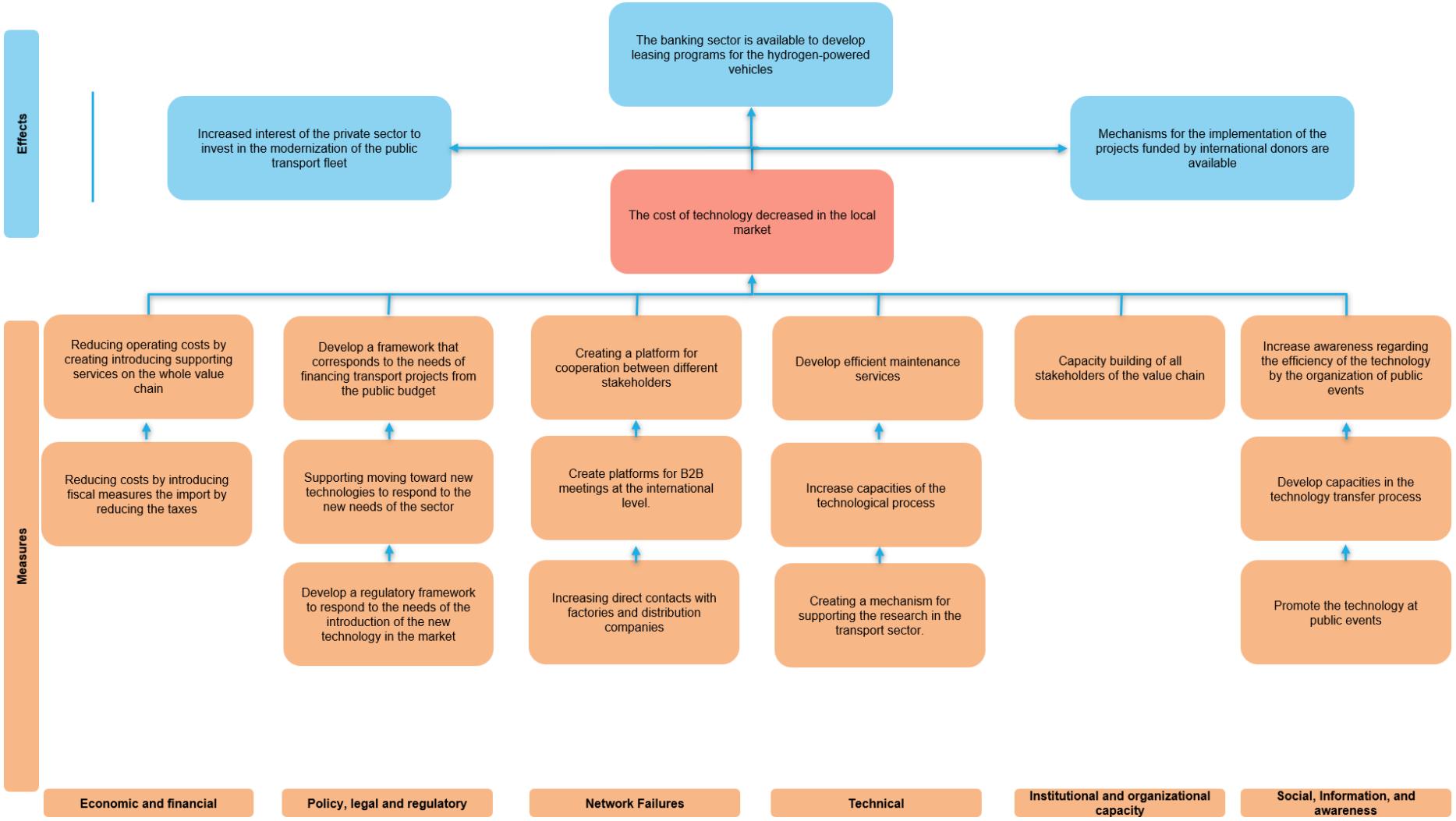

Figure 6. The Objective Tree of the Technology 3 of the Transport Sector: Transport powered by hydrogen fuel cells and charging infrastructure for it.

8. Linkages of the Barriers Identified

The analysis of the barriers identified for the transport sector shows that most are in the "Economic and financial" category and refer to "Excessive operating costs." This is large because 100% of the new technologies are imported from abroad, which adds value to the final product on the local market.

From the category "Policy, legal, and regulatory," the main barrier for the three technologies is the "Incomplete regulatory framework." Given that the prioritized technologies are new and have yet to be introduced to the local market, more preconditions have been created for the normative and regulatory framework to be adapted for the actions necessary to implement these technologies.

The category "Network Failures" is one of the most important in the case of the Republic of Moldova, considering that all technologies should be imported from outside the country and the value chain should involve many intermediaries. In this category, the main barrier is "Lack of experience in cooperating across stakeholders." Therefore, it is essential to create cooperation platforms between public administrations, distributors of equipment, maintenance companies, execution companies, etc., and to create opportunities to bring all stakeholders together to discuss and resolve sector-specific issues.

In the category "Technical," the main barrier is "Limited knowledge of the technological process," which is that the technological process for all prioritized technologies is new and has never been implemented in the country.

In addition, the main barrier in the "Social, Information, and Awareness" category is the "Lack of pilot and demonstration projects." Implementing these projects is exceedingly difficult, given that their main objectives are creating learning externalities and supporting technological diffusion in the local market. At the same time, infrastructure projects need public infrastructure and essential financing from the general budget.

The common barriers of three technologies in the transport sector are presented in the table below.

Table 8. *Common barriers to technologies of the transport sector.*

Nr	Barrier category	Barriers
1.	Economics and financial	Excessive operating costs
2.	Policy, legal, and regulatory	Incomplete regulatory framework
3.	Network Failures	Lack of experience in cooperating with stakeholders
4.	Technical	Limited knowledge of the technological process
5.	Social, Information, and awareness	Lack of pilot and demonstration projects

9. Enabling framework for overcoming the barriers in the Transport Sector

The enabling framework for overcoming barriers in the transport sector should respond to the main obstacles and create preconditions for implementing measures to overcome the barriers. In the economic and financial framework, it is essential to focus on cost reduction by developing and introducing fiscal measures to reduce the costs of raising the technologies in the Moldovan market. Also, as the technologies are new, the cost and expenditure management processes will play a vital role in implementing investment projects.

The Policy, legal, and regulatory framework should be developed in line with the new reality of climate change, anticipate upcoming mid- and long-term impacts, and respond to the actual needs of the transport sector.

It is essential to stimulate cooperation among leading technology actors, creating preconditions for joint meetings (forums, exhibitions, workshops) between stakeholders to share the opinions, expertise, and lessons learned from applied technologies.

Developing the technology transfer mechanism for the technical framework to support the adoption of prioritized technologies in the local market is also essential.

In addition, for the Social, Information, and Awareness framework, it is essential to implement more pilot and demonstration (P&D) projects to catalyze the early adoption of technologies.

The enabling framework for the prioritized technologies of the transport sector is presented below.

Table 9. *Enabling a framework for the prioritized technologies of the transport sector.*

Nr	Enabling framework	Comments
1	Economics and Financial	This framework should focus on cost reduction through the development and introduction of fiscal measures, cost and expenditure management processes, and the development of new financing instruments. The fiscal framework must reduce taxes to stimulate the import of new equipment. Financial areas should focus on soft loans, and cost and expense management processes should focus on proper management. Initial cost assessment, complete value chain cost analysis, initial investment assessment, etc.

2	Policy, legal, and regulatory	Developing a legal framework and technical standards in line with the new reality of climate change, especially in infrastructure projects, is mandatory for the transport sector's adaptation process. Construction codes should be adapted to the unique needs of infrastructure projects and to meet new weather conditions. It is also recommended that the regulatory framework be developed and adjusted to allow public entities to create PPPs in infrastructure projects and be involved in their management.
3	Network Failures	Creating preconditions for meetings (forums, exhibitions, workshops) between different stakeholders is crucial. Also, it is helpful to develop practical mechanisms for improving collaboration in implementing multilateral projects, where various organizations contribute their input and work together toward the common objective of technology deployment.
4	Technical	Developing a technology transfer mechanism can support introducing prioritized technologies in the local market. Therefore, technology transfer projects are an essential process for introducing new technologies, and in the case of the Republic of Moldova, they can play a crucial role. Also, it is necessary to strengthen the technology transfer capacity at the national level by providing support for research on the ecosystem and strengthening the R&D base of the universities in the country.
5	Social, Information, and awareness	Pilot and demonstration (P&D) projects are deployed to catalyze the early adoption of technology and will play an essential role in raising awareness regarding the efficiency of prioritized technologies. Also, tiny pilot and demonstration projects, especially in villages, can create a baseline for scale-up projects in big cities, which can have a more significant impact.

TECHNOLOGY ACTION PLANS and PROJECT IDEAS REPORT (3) / TAP

TECHNOLOGY ACTION PLAN Executive Summary

The Technology Action Plan (TAP) is the third and final report of the Republic of Moldova's activities under the Technology Needs Assessment (TNA) under the NAP-2 Project.

TAP Report's objective is to outline the steps that must be taken in response to the findings of a thorough and drawn-out evaluation of the barriers and constraints impeding the widespread dissemination and application of climate change technologies in the nation. It is based on the Barrier Analysis and Enabling Framework (BA&EF).

Three technologies selected in the BAEF Report are included in this TAP for the Transport Sector:

1. Hot Rolled Asphalt (HRA).
2. Autonomous Road Surveillance System (ARSS).
3. Transport powered by hydrogen fuel cells and charging infrastructure for it.

Considering that the main barriers to implementing hot-rolled asphalt (HRA) were grouped depending on their importance, the actions and activities to overcome the obstacles are grouped according to a similar structure. The main activities in this TAP aim to ensure the implementation of the technology at the national level. Creating a mechanism for adequate up-front cost evaluation in the first phase will create a base for implementing this technology in the country. The next step will be to develop efficient maintenance services by introducing ISO standards and the introduction of the cost management process. The policy, legal, and regulatory actions focus on developing technical norms and standards according to the reality of climate change, especially in infrastructure projects. To support the introduction of technology, a handbook will be set up for the preparation and implementation of investment projects that will be used by organizations actively involved in the planning, contracting, monitoring, and implementing of infrastructure investment projects. Special attention is focused on institutional and organizational capacity actions that will develop technical and business management skills of all stakeholders of the value chain of this technology.

Raised awareness actions regarding the benefits of this technology will be focused on disseminating its efficient use.

The ambition for this technology is that at least 300 km of the national roads are more resilient to climate change by being rehabilitated using Hot Rolled Asphalt (HRA) by the end of 2030

The Autonomous Road Surveillance System (ARSS) is an efficient traffic control system that detects and counts vehicles at different times and locations. The solution is designed to solve one of the biggest problems in the country's main cities: traffic jams during office hours and office break hours.

The TAP's activities for this technology start with developing and implementing the regulatory framework, which will solve the managerial and operational problems relating to implementing the ARSS in the country.

An interaction mechanism between the main stakeholders will be created to improve collaboration. Public events will be organized to meet all stakeholders, discuss common problems, and propose solutions to support activities for all of them. As the technology is new in the country, the capacity-building programs will play a unique role in deploying the technology and will contain the main modules to cover the training needs to manage ARSS applications and store, analyze, and use the data.

This technology aims to improve public traffic in difficult weather conditions and reduce road accidents by 10% by installing the Autonomous Road Surveillance System (ARSS) on the most critical public roads.

To implement the third selected technology, i.e., “Transport powered by hydrogen fuel cells and charging infrastructure for it,” at the national level, the TAP contains detailed activities needed to undertake for the introduction of new technologies from "zero.” The activities will start with the policy, legal, and regulatory measures focused on developing a regulatory framework to respond to the needs of the market's introduction of modern technology. Also, creating a public financing mechanism corresponding to the need to modernize the transport sector will stimulate investment in public transport by acquiring hydrogen-powered vehicles.

The technical measures of this TAP are focused on creating a mechanism for supporting research in the transport sector and developing a technology transfer mechanism that will help introduce innovative technology into the country’s transport sector.

The ambition for this technology is to increase the resilience of the transport fleet and modernize at least 5% of public transport by introducing hydrogen-powered vehicles and developing charging infrastructure.

1. Technology Action Plan and Project Ideas for the Transport Sector

1.1. Sector Overview

The transport sector of Moldova includes road, rail, naval, and air transport, which plays a significant role in the national economy of the Republic of Moldova. Although the current contribution to the gross domestic product is about 6.6%, the transport sector is responsible for 22% of the country's GHG emissions.

According to the country's Energy Balance, the Transport Sector is the second energy consumer and registered an increase from 24,887 TJ in 2010 to 32,192 TJ in 2019. The structure of consumption by types of energy remained unchanged from 2010-2019. The primary energy products consumed by the transport sector are Petroleum products with 31,199TJ or 96.91%, Natural gas with 830 TJ or 2.57%, and Electricity with 163TJ or 0.52% of total consumption.

Climate change already has, and it is expected to have a wide range of impacts on all sectors of the Republic of Moldova. For example, the transport Sector is vulnerable to the increase in frequency and intensity of storms (wind, rain, snow, extreme heat), which could raise costs related to the construction, maintenance, and operations of transportation infrastructure and vehicles.

One of the main characteristics of the transport sector is that, because of the different stakeholders in the industry, the specific challenges for adaptation are focused on other targets and activities. Therefore, the responsibility for implementing adaptation action in the transport sector is often unclear and is not seen as a priority. Depending on their funding, some adaptation actions occur spontaneously by the main transport stakeholders; they can be implemented through synchronization, cooperation, and an integrated approach.

The legal framework analysis concluded that the Transport Sector is included in the main Strategies and Action Plans, and some established objectives relate to reducing this sector's environmental impact. However, the main actions are focused on reducing GHG emissions by introducing new technologies in this sector's infrastructure and operationality.

Climate change is streamlined into the country's main strategic planning document. One of the specific objectives of the National Development Strategy "Moldova 2030," approved by Government Decision no. 377 of 10.06.2020, is to "Ensure resilience to climate change by reducing risks related to climate change and by facilitating adaptation in six priority sectors: agriculture, water resources, health, forestry sector, energy, and transport. The Energy Strategy of the Republic of Moldova, approved by Government Decision No. 102 of 05.02.2013, outlines the climate change mitigation in the sector until 2030. In 2014, by the Government Decision No. 1009 of 10.12.2014, the Government approved the Climate Change Adaptation Strategy. This first national strategic framework aims to advance the resilience of the country's social and economic development processes. In the same year, 2014, the Government Decision No. 301 of 24.04.2014 approved the Environmental Strategy for 2014-2023 and the Action Plan for its implementation. The Strategy sets the sectoral targets for reducing greenhouse gas emissions compared to the baseline scenario: by 25% in the energy sector, 20% in the housing

and industrial sectors, 15% in the transport and waste sectors, and 25% in carbon sequestration in the land-use sector, land-use change, and forestry.

The Republic of Moldova's Low Emission Development Strategy, approved by Government Decision No. 1470 of 30.12.2016, is a strategic document to assist the country in shifting its development path to a low-carbon economy. The Strategy contains a concrete set of measures leading to GHG emission reduction, the quantity of the corresponding emission reduction for each action, and the financial requirements to implement them.

***Table 1**. The main Legal Framework related to the development of the transport sector, innovation, and relevant targets for deploying selected technologies.*

Nr	Legal framework	Relevant targets
1	Government Decision **no.827 of 28.10.2013** on the approval of the Transport and Logistics Strategy for 2013-2022 and its Implementation Action Plan	● Ensure the proper repair and maintenance of local roads (6,008 km) by 2022. ● Rehabilitate approximately 310 km of national roads annually and complete the rehabilitation of other national highways by 2022. ● 1920 million Moldovan lei (120 million euros) of foreign investment attracted annually for road rehabilitation. ● Adapt the fleet of vehicles and passenger transport operators to the established standards in 2018. ● Reduce road accidents, resulting in fatalities and the total number of road accidents by 50%.
2	Government Decision **no.301 of 24.04.2014** on the approval of the Environmental Strategy for the years 2014-2023 and of the Action Plan for its implementation	● Reduce greenhouse gas emissions and climate change impact mitigation of the transport sector by 15% (through broader use of motor vehicles on compressed natural gas and liquefied petroleum gas; use of hybrid electric vehicles, through biodiesel productions and bioethanol).
3	Government Decision **no.1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation	● Specific objective 2. Unconditional GHG emissions will be reduced by 30% by 2030, and conditional GHG emissions will be reduced by up to 40% relative to 1990.

The Transport Sector is one of the most critical sectors in the country's main Strategies and Action Plans. Specific development objectives are related to reducing its environmental impact. The main actions are focused on GHG emission reduction by introducing new technologies in the infrastructure and operationality of this sector. The removal of greenhouse gas emissions by 15% from the transport sector using motor vehicles based on compressed natural gas and liquefied well gases and the use of hybrid electric vehicles through the production of biodiesel and bioethanol is planned in the Environmental Strategy for 2014-2023. Furthermore, the Climate Change Adaptation Strategy by 2020 proposes that research

in the field of transport and road infrastructure will be focused on examining the impacts of climate change on that sector and analyzing options for adapting to these impacts. Also, Specific Objective 2 of the Low Emission Development Strategy of the Republic of Moldova until 2030 is the unconditional reduction 2030 of greenhouse gas emissions from the transport sector by 30% and the reduction of conditioned greenhouse gasses by up to 40% compared to 1990.

The selected technologies will contribute to achieving the objectives set in the sectoral strategies. Using **hot-rolled asphalt (HRA)** on public roads will reduce environmental pollution through efficient transport circulation. This technological solution will lead to more efficient use of car tires. Likewise, improved infrastructure will lead to more efficient fuel consumption, reducing CO2 emissions from public transport. However, the technology is not used in the Republic of Moldova infrastructure projects. Using the **Autonomous Road Surveillance System (ARSS)** will support one of the country's strategic development priorities: adopting intelligent technological solutions to enhance road safety. All the surveillance systems that are currently used are managed remotely, which requires additional expenses for the salaries of the technical staff. This technological solution on public roads will reduce the environmental population through efficient transport circulation. Also, road safety will increase the traffic and commercialization of merchandise and private investment in public goods and services. At the same time, **hydrogen-powered transport and charging infrastructure** is a suitable long-term alternative to reduce the environmental impacts of goods and services, considering supply chain activities and passenger public transportation. Hydrogen, as an energy source, is not used to power the transport units in the country. Hydrogen imported to Moldova is used only for welding machines.

1.2. Action Plan for Technology 1 of the Transport Sector: Hot Rolled Asphalt (HRA)

1.2.1. Introduction

Hot-rolled asphalt (HRA)4 is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108. A high proportion of sand in the mix results in a low percentage of air voids when compacted. The mortar of bitumen, sand, and filler gives it strength. High PSV chippings are added on public roads to provide a skid-resistant surface.

The material is designed for heavy-duty industrial applications such as stocking bays and loading areas. It is particularly suitable where forklift trucks operate or heavy trucks/buses regularly corner tightly.

This is the standard specification for surfacing roads and is used with high PSV Pre-Coated Chips to provide an exceptionally durable, anti-skid surface.

Hot-rolled asphalt results in an incredibly durable surface with enhanced longevity, high skid resistance, and near imperviousness to water—resulting in reduced damage. Due to their high characteristics, pavements can reduce the thickness of the entire road structure by 30–35% and the thickness of the base layer by around 25%.

Hot Rolled Asphalt (HRA) is produced by:

- IS EN 13108-4 Hot Rolled Asphalt
- NSA I's Standard Recommendation (SR) 28
- IS EN 13108-20: Type Testing and IS EN13108-21: Factory Production Control

The main components of technology:

- The binder shall be petroleum bitumen
- Contain 30% coarse aggregate with a maximum aggregate size of 14mm
- Additives may include fibers, pigments, and adhesion agents
- The suitability of such additives shall be demonstrated following IS EN 13108-4

Main characteristics:

- Hot bituminous material is a black granular material with a temperature of up to 200 Celsius and a density of up to about 1.6
- Thickness (mm): 30 – 40
- Paving Grade of Bitumen: 40/60, 70/100, or 100/150
- BS EN 13108-4/PD 6691 Reference: HRA 30/10 F surf

Major benefits include:

- Increased point loading resistance above standard asphalt materials
- Increased fuel resistance
- Superior rust resistance
- High stone content, so no application of pre-coat chippings is required

The main benefit of technology against climate change in the country is an increase in resilience to major climate disasters. In addition, this technology will adapt the road

infrastructure to extreme heat. The characteristics of this technology allow the road infrastructure to be functional in intense summer heat. The mixture of the components of the structure of this technology does not allow water to enter the system, increasing the resistance during flush floods. Also, the mix of different parts increases flexibility, allowing the structure to resist temperature fluctuations.

Introducing this technology to the local market will change the asphalt structure and composition, the paving model, and the periodic maintenance process. As it is more durable, maintenance will be needed less often. Also, by introducing Hot-Rolled Asphalt (HRA), the transport infrastructure became more resistant, stable, and strengthened. Also, maintenance services will be changed, considering the new needs and criteria.

According to the technology categories' classification and market characteristics, hot-rolled asphalt (HRA) is a "non-market good" characterized by investments to be decided at the government level and heavy dependence on existing infrastructure and national policies.

[4] https://www.researchgate.net/publication/288823869_Development_of_Long_Life_Deformation_Resistant_Hot_Rolled_Asphalt_Surfacing

[5] Hot Rolled Asphalt and Coated Chippings – Checks and Key Points. CC-PAV-04011. January 2019

1.2.2. Ambition for the TAP

The target for Hot-Rolled Asphalt (HRA) has been set according to the main objectives of the Transport and Logistics Strategy for 2013-2022. As the local government plans to modernize the infrastructure and repair the local and international roads, the solution for the material used in the works will be hot-rooted asphalt (HRA), increasing the strength of asphalt pavement. The ambition is to build at least 300 km of national roads more resilient to climate change by rehabilitating hot-rolled asphalt (HRA) by the end of 2030.

1.2.3. Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers
The main barriers that this technology faces are grouped into several vital categories: a) Policy, legal, and regulatory; b) Economic and Financial; c) Network Failures; d) Social Information and awareness; e) Technical barriers; f) Institutional and organizational capacity. The main **regulatory and policy barrier is the need for more technical norms and standards to implement international requirements for** the quality of infrastructure projects. Also, the focus is on old technologies to meet old standards because implementing the infrastructure investment projects requires following many measures. Therefore, to select the right equipment, the acquisition entities focus on old technologies that meet old standards and are already available in the local market.

From the **Economic and Financial** category, the high up-front costs are one of the significant barriers to implementing this technology in the Moldavian market.

One of the main barriers to the Network Failures category is the lack of experience in cooperating with stakeholders. Considering the numerous stakeholders in the sector, it is difficult to bring all of them together to discuss and resolve sector-specific issues.

More research is needed in this field; the lack of quality management systems in infrastructure projects and limited knowledge of the technological process remain the most significant technical barriers to adopting this technology.

Limited technical and business management skills of all value chain stakeholders are a main institutional and organizational capacity barrier.

At the same time, the need for more information about this technology, the lack of pilot and demonstration projects, and low awareness regarding its efficiency in the sector are the primary **social, information, and awareness barriers**.

[6] https://journal.uii.ac.id/teknisia/article/view/8290

The main measures to overcome barriers focus on responding directly to the need to implement the technology nationally.

The main economic and financial measures focus on creating a mechanism for adequate upfront cost evaluation needed to implement the technology. Also, introducing cost and expense management processes should support the economic feasibility of investment projects in the country.

Introducing the ISO standards in the maintenance planning and execution of the services according to the requirements for civil engineering infrastructure will create preconditions for increasing the feasibility of infrastructure projects.

Actions selected for inclusion in the TAP

The main actions included in TAP aim to implement the measures, overcome the barriers, and achieve the ambition of implementing technology.

Creating a mechanism for adequate upfront cost evaluation is expected to decrease upfront costs and provide a good assessment of the upfront fees for projects nationwide.

Developing efficient maintenance services by introducing the ISO standards in the planning and executing of the services according to the requirements for civil engineering infrastructure.

Introducing the cost management process will allow for the prediction of future expenses, reducing the chances of budget overruns. The cost management process in an infrastructure investment project will also include resource planning, cost estimation, cost budgeting, and cost control, which will increase its efficiency.

The introduction of the expense management process will help to process expense reports and approvals, as well as reimbursable expenses by employees, administrative and supply services, etc.

Policy, legal, and regulatory actions focus on developing technical norms and standards according to the new climate change reality, especially in infrastructure projects. The Practical Codes in Construction will be adapted to the needs of infrastructure projects to respond to current weather conditions.

It also develops a handbook for preparing and implementing investment projects that will be used by organizations actively involved in planning, contracting, monitoring, and implementing infrastructure investment projects. The Handbook should help the organizations in all project phases, such as project identification, preparation, implementation, completion/evaluation, and post-completion follow-up.

The actions that should solve the barriers related to the network failures aim to improve collaboration between different stakeholders by organizing public events to meet all stakeholders, discuss common problems, and propose solutions that can support activities for all of them.

Technical actions will support research in infrastructure projects by developing a financing mechanism to support research and technology transfer projects in infrastructure, especially to analyze technical characteristics of new technologies and to identify the way of implementation in practice.

Introducing the Quality Management System (QMS) will help achieve the projects' objectives by assisting in comprehensive quality implementation and enabling a quality process for better risk management, assured compliance, and meeting all regulatory requirements.

The institutional and organizational capacity actions will develop all value chain stakeholders' technical and business management skills.

The social, information, and awareness actions will promote technology at public events such as B2B and B2G forums, exhibitions, and workshops. Pilot and demonstration projects will also be implemented in the local market to catalyze the early adoption of technology.

Raised awareness actions regarding the efficiency of the technology will focus on disseminating the goals and achievements in the efficient use of new solutions and the result of this activity.

Activities identified for implementation of selected actions
Action 1: Create a mechanism for adequate up-front cost evaluation.
Activity 1.1. Creating a database for the products and services needed for infrastructure investment projects. Systematic collection and monitoring of the data.
Activity 1.2 Analysis and systematization of the fiscal framework and assessment of import taxes for infrastructure investment projects.

A mechanism should be created to adequately evaluate the upfront fees and decrease infrastructure investment projects' upfront costs. Implementing this action will create a database for the products and services needed for infrastructure investment projects and a guide on using the fiscal framework and tax data for infrastructure investment projects. These activities will help better estimate the upfront costs and increase the economic feasibility of the investment projects.

Action 2: Develop efficient maintenance services.
Activity 2.1 Develop quality-control criteria for subcontractors and vendors.
Activity 2.2 Introducing the information system for recording trouble calls and repairs.
Activity 2.3 Generating reports to monitor the quality of the infrastructure.

Introducing ISO standards in the maintenance planning and execution of services according to the requirements for civil engineering infrastructure is expected to increase the lifetime of the infrastructure. Furthermore, the activities of this action will identify the quality-control criteria for subcontractors and vendors. Also, an information system recording trouble calls and repairs will be developed and operational in 2024.

Reports will be generated every year to monitor the quality of the infrastructure, which will help improve monitoring.

Action 3: Introduce a cost management process.
Activity 3.1 Identify and introduce parameters for the costs and expenses estimation model.
Activity 3.2 Developing cost and expense estimating guidelines.
Activity 3.3 Translating cost and expenses management principles into practice.

The cost management process allows for the prediction of future expenses to reduce the chances of budget overrun. This action will focus on introducing a cost management process, especially parameters for the cost and expenses estimation model. In the second phase, guidelines for cost estimating will be developed, and the cost management principles will be translated into practice.

Action 4: Develop an adequate regulatory framework.
Activity 4.1 Assess the policy, regulatory, and institutional requirements.
Activity 4.2 Propose optimal solutions for modifying the legal framework or developing a new one.
Activity 4.3 Pursuing the necessary procedures for the adoption of the legal framework.

Developing technical norms and standards according to the new climate change reality, especially in infrastructure projects, will be conducted in a new, more resilient infrastructure. These activities will start by assessing policy, regulatory, and institutional requirements. As a result, this activity will prepare a list of optimal solutions for modifying the legal framework or for developing a new framework, depending on which has a better chance of success. At the final phase, a regulatory framework will be adopted and put in place.

Action 5: Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects.
Activity 5.1 Identification of funding sources.
Activity 5.2 Development of the operational manual.
Activity 5.3 Capacity building and institutional strengthening of the entities involved.

As public financing is the dominant channel in infrastructure projects in Moldova, a financing mechanism will be developed that can respond to the primary needs and conditions of financing by the national and international donors in the country. The implementation of this action will start with activities to identify funding sources. In the next step, an operation manual will be developed to regulate the main activities of the future financing mechanism and its primary function. In the next phase, the main stakeholders will be trained to have the capacity to implement a public financing mechanism that corresponds to the needs of infrastructure investment projects.

Action 6: Develop a Handbook for preparing and implementing investment projects.
Activity 6.1 Assessment of the needs of the main stakeholders involved in implementing the investment projects.
Activity 6.2 Formulation of a concept for the implementation of investment projects.
Activity 6.3 Designing and implementing capacity development projects.

As public investment refers to government (central or local) spending on public infrastructure, a project management handbook must be used to describe the modus operandi. The main activities for implementing this action will start with assessing the needs of the main stakeholders involved in implementing investment projects. Then, based on the review, a

concept for implementing investment projects will be prepared. Also, capacity development projects at the national level will be implemented, aiming to increase the capacities of the key stakeholders in implementing investment projects.

Action 7: Improve collaboration between different stakeholders.
Activity 7.1 Identify the main stakeholders at the national and international levels.
Activity 7.2 Develop a schedule and attend public events at the national and international levels.
Activity 7.3 Support the creation of effective partnerships by signing cooperation agreements.

As different stakeholders have different objectives and goals in the process of investments in the infrastructure project, it is essential to create preconditions for joint meetings (forums, exhibitions, workshops). This action will start with activities on conducting a stakeholder analysis to identify the main stakeholders at the national and international levels. In the second phase, the key stakeholders will attend public events to establish contacts and negotiate and sign cooperation agreements.

Action 8: Support research and technology transfer projects in infrastructure.
Activity 8.1 Identify the budget for developing a financing mechanism for the research and technology transfer in infrastructure.
Activity 8.2 Develop the financing mechanism operation manual.
Activity 8.3 Launch call for proposal and finance of the research in the infrastructure projects.

To promote new technologies, it is essential to develop a financing mechanism to support research and technology transfer in infrastructure projects, especially in analyzing the technical characteristics of new technologies and identifying the implementation method in practice. The activities for this action will start by establishing a fund to finance the research for the infrastructure projects. Then, an operation manual will be developed and ready for use. Finally, at the base of the operation manual, at least ten infrastructure research projects will be identified and financed.

Action 9: Introduce quality management systems for the infrastructure/construction projects.
Activity 9.1 Establish new quality procedures and standards.
Activity 9.2 Introduce quality management systems for developing the new quality management forms and documentation.
Activity 9.3 Capacity building and institutional strengthening of the entities involved.
Activity 9.4 Identify responsible staff in each institution and delimit tasks for each.

A Quality Management System (QMS) that refers to quality planning, quality assurance, and quality control helps achieve the projects' objectives by assisting in the comprehensive quality implementation. This action will be developed and adapted to the new quality procedures and standards at the national level. In addition, new quality management forms and documentation will be created and ready to use to support this. Also, in the implementation phase, capacity-building programs will be implemented for key stakeholders to implement quality management systems for the infrastructure/construction projects.

Action 10: Develop technical and business management skills for all stakeholders.
Activity 10.1 Identification of the main stakeholders and their needs for technical and business management skills.

Activity 10.2 Develop the training curricula.
Activity 10.3 Implementation of the training program at the national level.

Technical and business management skills are crucial for all implementation phases in the implementation of infrastructure projects. As this action is for the development of technical and business management skills, the main activities will start by conducting an assessment to identify the primary needs of the critical stakeholders. Then, based on the assessment results, training curricula will be developed, and training programs will be implemented at the national level in the final phase.

Action 11: Promote technology at public events.
Activity 11.1 Develop a schedule, organize, and attend public events at the national and international levels.
Activity 11.2 Identify the main stakeholders at the national and international levels.
Activity 11.3 Establishing cooperation at the national and international levels.

Organizing public events such as B2B and B2G forums, exhibitions, and workshops is one of the best ways to promote new technologies in infrastructure projects. Therefore, this action's main activities will be focused on promoting technology through participation in public events. Furthermore, these participations will stimulate cooperation between the main stakeholders by signing cooperation agreements.

Action 12: Implement pilot and demonstration projects on the local market.
Activity 12.1 Identify the budget for creating a fund to finance the pilot and demonstration projects on the local market.
Activity 12.2 Development of the operation manual.
Activity 12.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market.

Pilot and demonstration (P&D) projects are commonly deployed to catalyze the early adoption of technologies. To implement pilot and demonstration projects in the local market, a fund will be established to finance the technology transfer projects in infrastructure/construction. The fund will develop an operational manual, and at least ten projects will be identified and funded.

Action 13: Raise awareness regarding the efficiency of the technology.
Activity 13.1 Developing awareness-raising and outreach strategy.
Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately.
Activity 13.3 Implementing the awareness-raising strategy using the most effective methods to achieve the target audience.

Raising awareness of introducing new technologies in infrastructure projects is essential to share complete, helpful information with the maximum audience. Therefore, to raise awareness regarding the efficiency of the technology, a strategy will be developed, the target audience will be identified, and audio-visual materials, a web page, and official pages on social media will be developed and promoted.

Actions to be implemented as Project Ideas

All actions were grouped into three primary groups to identify the steps for implementing the selected projects. Each project idea combined several measures, allowing each project idea to achieve the maximum objectives necessary for introducing new technologies in the transport sector. The project idea groups were identified according to the grouping of the barrier as follows: a) Economic and financial; b) Policy, legal, and regulatory; c) Network Failures; d) Technical barriers; e) Institutional and organizational capacity; f) Social, Information, and awareness.

Table 2. *Systematization of Measures by Categories and Importance.*

Nr	Measures	Category	Importance
1	Create a mechanism for adequate up-front costs evaluation	Economics and Financial	Crucial
2	Develop efficient maintenance services	Economics and Financial	Important
3	Introducing a cost management process	Economics and Financial	Crucial
4	Introducing the expense management process	Economics and Financial	Crucial
5	Develop an adequate regulatory framework	Policy, legal, and regulatory	Crucial
6	Acts based on newly developed and adapted quality standards	Policy, legal, and regulatory	Crucial
7	Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects.	Policy, legal, and regulatory	Crucial
8	Develop a Handbook for the preparation and implementation of investment projects.	Policy, legal, and regulatory	Important
9	Improve collaboration between different stakeholders	Network Failures	Crucial
10	Support research in infrastructure projects	Technical barriers	Crucial
11	Introducing quality management systems for the infrastructure/construction projects	Technical barriers	Important
12	Support technology transfer for infrastructure / construction projects	Technical barriers	Crucial
13	Develop technical and business management skills for all stakeholders of the value chain.	Institutional and organizational capacity	Important
14	Promote technology at public events	Social, Information, and awareness	Important

15	Implement pilot and demonstration projects on the local market	Social, Information, and awareness	Crucial
16	Raise awareness regarding the efficiency of the technology	Social, Information, and awareness	Crucial

Also, the actions that can solve the most critical barriers and combine or synchronize some activities were selected.

In the final list of the project ideas were selected the following:

Project Idea. ***Develop a public financing mechanism corresponding to the infrastructure investment projects' climate change adaptation needs*** (Policy, legal, and regulatory).

This project idea will include the Activities of following Actions:

- **Action 1:** Create a mechanism for adequate up-front costs evaluation.
- **Action 2:** Develop efficient maintenance services.
- **Action 5:** Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects.
- **Action 8:** Support research and technology transfer projects in infrastructure.
- **Action 9:** Introduce quality management systems for the infrastructure/construction projects.
- **Action 11:** Promote technology at public events.
- **Action 12:** Implement pilot and demonstration projects on the local market.
- **Action 13:** Raise awareness regarding the efficiency of technology.

1.2.4. Stakeholders and Timeline for implementation of TA

The main stakeholders involved in the performance of the project idea are:

1. **The Ministry of Infrastructure and Regional Development** is the central specialized body that promotes state policy in the field of infrastructure and regional development and operates following the Constitution and Laws of the Republic of Moldova, Parliamentary Decisions, Acts of the President of the Republic of Moldova, Government Decisions and Orders, as well as other normative acts.

2. **The Ministry of Finance** is the central specialized body of public administration, which develops and promotes the unique policy of training and managing public finances, applying financial levers in line with the requirements of the market economy. The Ministry of Finance elaborates on the necessary normative acts regulating the budgetary process. The taxation and accounting system develops medium and long-term forecasts regarding financial resources, finds solutions for public finance reform, and ensures receipts and payments to the state budget. The ministry also elaborates and promotes the draft annual budget law and, if necessary, draft laws for amending and supplementing the yearly state budget law.

3. **State-owned enterprise State Road Administration of Moldova** is responsible for maintaining, repairing, rehabilitating, developing, upgrading, and administrating national public roads in Moldova and for corresponding road infrastructure. Also, the company is responsible for implementing the unitary development programs of the public roads network following the Transport and Logistics Strategy and with the requirements of the national economy. In addition, the company is responsible for efficiently managing the financial resources allocated from the Road Fund and external sources for the development, modernization, and maintenance of the national public roads network of the Republic of Moldova.

4. **The Road Fund's particular purpose is** to finance the maintenance, repair, and reconstruction of national and local public roads, road design, construction materials production, and procuring techniques and equipment for road maintenance. The fund distribution for national and regional public roads is presented by the Government and approved annually by the Parliament, considering that at least 50 percent of the funds will be used to finance national roads.

1.2.5. Scheduling and sequencing of specific activities

The specific activities of the actions are planned for the next period and timeline:

Action 1: Create a mechanism for adequate up-front cost evaluation.
Activity 1.1 Creating a database for the products and services needed for infrastructure investment projects. Year: 1
Activity 1.2 Analysis and systematization of the fiscal framework and assessment of import taxes for infrastructure investment projects. Year: 1

Action 2: Develop efficient maintenance services.
Activity 2.1 Develop quality-control criteria for subcontractors and vendors. Year: 1
Activity 2.2 Introducing the information system for recording trouble calls and repairs. Year: 1
Activity 2.3 Generating reports to monitor the quality of the infrastructure. Year: 1

Action 3: Introduce the costs and expense management process.
Activity 3.1 Identify and introduce parameters for the cost estimation model. Year: 1
Activity 3.2 Developing cost estimating guidelines. Year: 1
Activity 3.3 Translating cost management principles into practice. Year: 1

Action 4: Develop an adequate regulatory framework.
Activity 4.1 Assess the policy, regulatory, and institutional requirements. Year: 1
Activity 4.2 Propose optimal solutions for modifying the legal framework or developing a new one. Year: 1
Activity 4.3 Pursuing the necessary procedures for the adoption of the legal framework. Year: 1

Action 5: Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects.

Activity 5.1 Identification of funding sources. Year: 2
Activity 5.2 Development of the operational manual. Year: 2
Activity 5.3 Capacity building and institutional strengthening of the entities involved. Year: 2
Action 6: Develop a Handbook for preparing and implementing investment projects.
Activity 6.1 Assessment of the needs of the main stakeholders involved in implementing the investment projects. Year: 1
Activity 6.2 Formulation of a concept for the implementation of investment projects. Year: 1
Activity 6.3 Designing and implementing capacity development projects. Year: 1

Action 7: Improve collaboration between different stakeholders.
Activity 7.1 Identify the main stakeholders at the national and international levels. Year: 1
Activity 7.2 Develop a schedule and attend public events at the national and international levels. Year: 1
Activity 7.3 Support the creation of effective partnerships by signing cooperation agreements. Year: 1

Action 8: Support research and technology transfer projects in infrastructure.
Activity 8.1 Identify the budget for creating a fund to finance the infrastructure research and technology transfer projects. Year: 3
Activity 8.2 Development of the operation manual of the financing mechanism. Year: 3
Activity 8.3 Launch call for proposal and finance of the infrastructure research and technology transfer projects. Year: 3

Action 9: Introduce quality management systems for the infrastructure/construction projects.
Activity 9.1 Establishing new quality procedures and standards. Year: 3
Activity 9.2 Development of unique quality management forms and documentation. Year: 3
Activity 9.3 Capacity building and institutional strengthening of the entities involved. Year: 3

Action 10: Develop all value chain stakeholders' technical and business management skills.
Activity 10.1 Identification of the main stakeholders and their needs for technical and business management skills. Year: 3
Activity 10.2 Develop the training curricula. Year: 3
Activity 10.3 Implementation of the training program at the national level. Year: 3

Action 11: Promote technology at public events.
Activity 11.1 Develop a schedule and attend public events at the national and international levels. Year: 3
Activity 11.2 Identify the main stakeholders at the national and international levels. Year: 3
Activity 11.3 Establishing cooperation at the national and international levels. Year: 3

Action 12: Implement pilot and demonstration projects on the local market.
Activity 12.1 Identify the budget for creating a fund to finance the pilot and demonstration projects on the local market. Year: 3
Activity 12.2 Development of the operation manual. Year: 3
Activity 12.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market. Year: 3

Action 13: Raise awareness regarding the efficiency of technology.
Activity 13.1 Developing the awareness-raising strategy. Year: 3
Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately. Year: 3
Activity 13.3 Implementing the awareness-raising strategy using the most effective methods to reach the target audience. Year: 3

1.2.6. Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs
Capacity-building programs for key stakeholders will play an essential role in the implementation phase of project ideas. Furthermore, developing capacities will help achieve the objectives necessary for introducing new technology in the transport sector.

Since public financing is the dominant channel in infrastructure projects in Moldova, capacity-building activities for financing actions will focus on managing funds according to the needs of public projects funded by international donors. The key stakeholders will be trained to handle the financing procedures for investment projects.

Likewise, considering that the quality management system (QMS) will be developed and introduced to the planning, assurance, and quality control of investment projects, key stakeholders will implement capacity-building programs to implement quality management systems in the infrastructure investment projects.

Estimations of costs of actions and activities
The exact costs of all actions and activities are in the TAP overview table. The summarizing of all charges in USD is listed below:

- **Action 1:** Create a mechanism for adequate up-front costs evaluation - 100.000,00
- **Action 2:** Develop efficient maintenance services: 100,000,00
- **Action 3:** Introduce a cost and expenses management process: 150.000,00
- **Action 4:** Develop an adequate regulatory framework: 150,000,00
- **Action 5:** Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects: 10.400.000,00
- **Action 6:** Develop a Handbook for the preparation and implementation of investment projects: 250.000,00
- **Action 7:** Improve collaboration between different stakeholders: 250.000,00
- **Action 8:** Support research in the infrastructure projects: 15.200.000,00
- **Action 9:** Introduce quality management systems for the infrastructure/construction projects: 300.000,00
- **Action 19:** Develop technical and business management skills of all stakeholders of the value chain: 400.000,00
- **Action 11:** Promote the technology at public events: 400.000,00
- **Action 12:** Implement pilot and demonstration projects on the local market: 10.200.000,00
- **Action 13:** Raise awareness regarding the efficiency of the technology: 700.000,00

The estimated costs of the project ideas are listed below:

- **Project Idea 1.** Develop a public financing mechanism to finance the introduction of Hot Rolled Asphalt (HRA) in infrastructure investment projects: 36.000.000 USD

1.2.7. Management Planning

Risks and Contingency Planning
The main risks related to the implementation of the project idea are:

1. High inflation rates:

Moldova's inflation rate reached a record 33.5 percent on August 10, the highest in Europe, hurting the living standards of an already impoverished population.

Under the revised Inflation Outlook published on August 10, the National Bank of Moldova (BNM) forecasts the annual inflation rate to peak at 34.7% y/y in Q3 and ease afterward. Compared to its previous scenario, BNM revised the inflation forecast for the coming three quarters (until Q1 2023) and downwards afterward. As a result, annual inflation is expected at 6.5% y/y in Q2 2024.

This risk will be difficult to manage, and it is expected to decrease in 2024/25. However, this risk will probably affect the mobilization of financing for the principal investment activities for the period mentioned. In this case, it is recommended to focus on the main activities of the project ideas in the first years of implementation, such as developing the technical documentation.

2. Low interest of the main stakeholders:

The key stakeholders are expected to pay more attention to social problems because of the economic crisis, and the public budget will be focused on social needs. Therefore, public investments in the infrastructure project are expected to decrease over the next 2-3 years. However, the interest of the stakeholders will likely return in 2024-25. Therefore, it is recommended that until this period, maintain the stakeholder's interest in the project ideas, work on developing the project's technical documentation, and organize public events and public consultations.

3. High-interest rates:

Policymakers at the National Bank of Moldova voted unanimously on August 4 to increase the primary interest rate by three percentage points, taking it to 21.5% – a record high. Consumer price index (CPI) inflation reached 31.8% in June, and prices, especially gas, are still rising. The high interest rates directly affect the investment process. In the next period of 2-3 years, it is expected that the interest rates will still be at high indicators. In this situation, the investment projects could be implemented only with the support of multilateral and bilateral organizations. Although, as usual, the budget of these organizations is minimal for the republic of Moldova, it is recommended that activity be focused on synchronizing the available budgets and financing opportunities.

Next Steps
To identify immediate and critical requirements, one must remember two important things about implementing infrastructure investment projects: the public budget will be minimal, and the key stakeholders will prefer general funding for the social projects.

a) Immediate requirements:

- Proceed with developing technical documentation for all activities.
- Identify financing from multilateral and bilateral organizations.
- Thirdly, adapt the budget of the project ideas to the new economic reality.
- Finally, identify a better way to demonstrate the positive social impact of technology.

b) Critical steps to succeed:

- Maintain continuous contact with key stakeholders, primarily governmental entities and donors' organizations.
- Organize public events, such as workshops, to present information about technology and public consultations.
- Continuously monitoring the market's prices and the leading economic indicators and actualizing the budget to the new prices.

Table 3. *TAP Overview of* Hot Rolled Asphalt (HRA)

TAP overview table								
Sector	Transport							
Sub-sector	Infrastructure							
Technology	Hot rolled asphalt (HRA)							
Ambition: At least 300 km of the national roads are more resilient to climate change by being rehabilitated using Hot rolled asphalt (HRA) by the end of 2030								
Benefits	Increased resilience of the road infrastructure to the new climate change disasters.							
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time**	**Risks**	**Success criteria**	**Indicators for Monitoring of Implementation**	**Budget per activity USD**
Action 1: Create a mechanism for adequate up- front costs evaluation	Activity 1.1 Creation of a database for the products and services needed for infrastructure investment projects. Systematic collection and monitoring of the data.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration	2023	Limited access to the import/export database. Little information about the products	Creation of the database on time and established bugged	A database for the products and services needed for infrastructure investment projects will be created and functional at the end of 2023	**50.000,00**
	Activity 1.2 Analysis and systematization of the fiscal framework and assessment of import taxes for infrastructure	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration	2023	Limited capacities and low knowledge of using and systematization of the data	All data are systematized and analyzed.	A guide on using the fiscal framework and taxes for infrastructure investment projects is published at the end of 2023.	**50.000,00**

	investment projects.							
Action 2: Develop efficient maintenance services	Activi ty 2.1 Develop quality control criteria for subcontractors and vendors.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2024	Different criteria for different products and services	The quality-control criteria for subcontractors and vendors are developed.	Quality-control criteria for subcontractors and vendors are developed and adopted.	**40.000,00**
	Activity 2.2 Introducing the information system for recording trouble calls and repairs.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2024	Insufficient capacity to collect data about the whole infrastructure	The system for introducing the data works efficiently	An information system for recording trouble calls and repairs will be developed and operational at the end of 2024.	**40.000,00**
	Activity 2.3 Generating reports to monitor the quality of the infrastructure.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2024	Limited capacities to collect and systematize the data to generate reports to monitor the quality of the infrastructur e.	The information for the report is collected without any barriers.	The reports are generated every year.	**20.000,00**

Action 3: Introduce a cost and expenses management process	Activi ty 3.1 Identify and introduce parameters for the costs and expense estimation model	The Public Budget	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	High inflation rates	The information about the cost and expense parameters is available and easy to process.	The parameters for the costs and expenses estimation model are identified and introduced	**50.000,00**
	Activity 3.2 Developing costs and expenses estimating guideline	The Public Budget	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	High inflation rates	The data is available and easy to process.	The costs and expenses estimating guideline is developed	**50.000,00**
	Activity 3.3 Translating costs and expenses management principles into practice	The Public Budget	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	High inflation rates	The process of translating costs is easy to put into practice.	The costs and expenses management principles are translating into practice	**50.000,00**
Action 4: Develop an adequate regulatory framework	Activity 4.1 Assess the policy, regulatory, and institutional requirements	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	Low interest of the main stakehold ers	The policy, regulatory, and institutional requirements are available for assessment	An assessment of policy, regulatory, and institutional requirements is carried out.	**50.000,00**

	Activity 4.2 Proposing optimal solutions for modifying the legal framework or for developing a new one	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	Low interest of the main stakeholders	The optimal solutions for modifying the legal framework are easy to implement	A list of options on optimal solutions for modifying the legal framework or for developing a new one is developed	**50.000,00**
	Activity 4.3 Pursuing the necessary procedures for the adoption of the legal framework	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	Low interest of the main stakeholders	The procedures for the adoption of the legal framework are easy to manage and implement	A regulatory framework is adopted and put in place.	**50.000,00**
Action 5: Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects	Activity 5.1 Identification of funding sources	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	High inflation rates, High interest rates	Availability of the financing programs/projects	The source of funding is identified	**10.000.000,00**
	Activity 5.2 Development of the operational manual	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	High inflation rates, High interest rates	Availability of human resources to develop the operational manual	An operation manual is developed	**200.000,00**

	Activity 5.3 Capacity building and institutional strengthening of the involved entities	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	High inflation rates, High interest rates	High interest from the main stakeholders	The main stakeholders have capacities to implement a public financing mechanism that corresponds to the needs of infrastructure investment projects	**200.000,00**
Action 6: Develop a Handbook for the preparation and implementation of investment projects	Activity 6.1 Assessment of the needs of the main stakeholders involved in the implementation of the investment projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	Difficult access to the data because of the low feedback from the main stakehol der	Information to be analyzed and cooperation with the main stakeholders	An assessment of the needs of the main stakeholders involved in implementing investment projects is carried out.	**100.000,00**
	Activity 6.2 Formulation of a concept for the implementation of investment projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	It is a limited concept because of the limiting of the local market	Accepting the concept by the main stakeholders	A concept for the implementation of investment projects is ready at the final of the year	**50.000,00**

	Activity 6.3 Designing and implementing the capacity-building development projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2024	Low interest of the main stakeholders		Implementation of capacity-building development projects at the national level	**100.000,00**
Action 7: Improve collaboration between different stakeholders	Activity 7.1 Identify the main stakeholders at the national and international level	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2025	Low interest of the main stakeholders	Data about the needs of the main stakeholders	A stakeholder analysis is conducted	**50.000,00**
	Activity 7.2 Develop a schedule and attend public events at the national and international levels.	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2025	Limited budget for organization and attending public events at the national and international levels	Availability to attend the events	Key stakeholders attend at least 12 public events per year	**100.000,00**
	Activity 7.3 Support the creation of effective partnerships by signing cooperation agreements	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2025	Low interest of the main stakeholders	High interest in cooperation from the main stakeholder s	Ten cooperation agreements are signed between key stakeholders	**100.000,00**

Action 8: Support research in the infrastructure projects	Activity 8.1 Identifying the budget for developing a financing mechanism for research and technology transfer in infrastructure.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	High inflation rates, High interest rates	Availability of the financing programs/projects	A fund for financing the research in the infrastructure projects is established	**10.000.000,00**
	Activity 8.2 Development of the operation manual of the financing mechanism.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed and ready for use	**200.000,00**
	Activity 8.3 Launch call for proposal and finance of the research in the infrastructure projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	High inflation rates, High interest rates, Low interest of the main stakeholders	High interest in the implementation of investment projects from the main stakeholders	At least ten research projects in infrastructure projects are identified and financed	**5.000.000,00**

Action 9: Introduce quality management systems for the infrastructure/ construction projects	Activity 9.1 Establishing new quality procedures and standards	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	The actual Legal framework is not adapted for introducing the new quality procedures and standards	The procedure of establishing the new quality procedures and standards has no barriers to introduction	New quality procedures and standards are developed and adapted at the national level	**100.000,00**
	Activity 9.2 Development of the new quality management forms and documentation	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	The actual Legal framework is not adapted for introducing the new quality procedures and standard s	The procedure of adaptation is easy	The new quality management forms and documentation are developed and ready to use	**100.000,00**
	Activity 9.3 Capacity building and institutional strengthening of the involved entities	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	The interest of the stakeholders in the capacity-building courses	The main stakeholders have the capacity to quality management systems for the infrastructure/construction projects	**100.000,00**

	Activity 9.4 Identify responsible staff in each institution and limit tasks for each.	The Public Budget	State Road Administration, Ministry of Infrastructure and Regional Development		Low interest of the main stakeholders		The key staff is identified and works based on newly developed and adapted quality standards	**100.000,00**
Action 10: Develop technical and business management skills of all stakeholders of the value chain	Activity 10.1 Identify the main stakeholders and their technical and business management skills needs.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Lack of local capacities	Active feedback from the stakeholders to share information	An assessment is conducted	**100.000,00**
	Activity 10.2 Develop the training curricula.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Lack of the local capacities to develop the training curricula.		A training curriculum is developed and ready to use in the training program.	**100.000,00**
	Activity 10.3 Implementation of the training program at the national level.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	Access to the main training materials	At least 100 representatives of the main stakeholders are trained	**200.000,00**

Action 11: Dissemination of technology	Activity 11.1 Develop a schedule, organize and attend public events at the national and international level	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	High inflation rates, Lack of financing	Availability of the stakeholders to attend of public events	Participation in at least 50 public events	**100.000,00**
	Activity 11.2 Identify the main stakeholders at the national and international level	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	Access to the database to identify the main stakeholders	At least 100 representatives of the main stakeholders (public and private entities) and their technologies and services are identified	**100.000,00**
	Activity 11.3 Establishing cooperation at the national and international level	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	Low interest of the main stakeholders	Availability and interest of the main stakeholders to sign cooperation agreements	As at least 50 collaboration agreements are signed	**200.000,00**
Action 12: Implement pilot and demonstration projects on the local market	Activity 12.1 Identification of the budget for the creation of a fund for financing the pilot and demonstration projects on the local market	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2027	High inflation rates, High interest rates	Availability of the financing programs/projects	A fund for financing the technology transfer projects in infrastructure/construction is established	**5.000.000,00**

	Activity 12.2 Development of the operation manual	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed and ready for use	**200.000,00**
	Activity 12.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market	The Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2027	High inflation rates, High interest rates, Low interest of the main stakeholders	The interest of the companies in applying to the call for applications	At least 10 projects are identified and financed	**5.000.000,00**
Action 13: Raise awareness regarding the efficiency of the technology	Activity 13.1 Developing awareness-raising and outreach strategy.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	High inflation rates, High interest rates, Lack of financing		An awareness-raising strategy is developed	**100.000,00**
	Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of financing	Access to the data about the audience	The target audience for the awareness-raising strategy is identified.	**100.000,00**

	Activity 13.3 Implementing the awareness-raising strategy using the most effective methods to achieve the target audience	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	High inflation rates, Low interest of the main stakeholders	Access to the data about the audience	One audiovisual material, such as a television, video, or documentary film, is developed and promoted, and one web page is developed and promoted. Official pages in social media are developed and promoted;	**500.000,00**

1.3. Action Plan for Technology 2: Autonomous Road Surveillance System (ARSS)

1.3.1. Introduction

The Autonomous Road Surveillance System (ARSS) is an efficient traffic control system that detects and counts vehicle numbers at various times and locations. The solution is designed to solve one of the biggest problems in the country's main cities: traffic jams during office hours and office break hours. It is sometimes seen to be the case that traffic signal green lights are still ON, even though there are no vehicles on the road. Similarly, long waiting car queues are also observed even though roads are empty, due to an inefficient traffic control system. The functioning of this system requires proper investigation into vehicle flow. This can be handled by adjusting ARSS.

ARSS configuration includes the following components: a camera, image storage device, object detection algorithm, background subtraction to remove the background object, shadow removal algorithm, segmentation and merging technique, object classification algorithm, etc. Considering the problematic situation of transport infrastructure, providing access to safe, affordable, accessible, and sustainable transport systems for all, as well as improving road safety, notably by expanding public transport, the technology will support one of the main priorities of the strategic development of the country, by adopting intelligent technological solutions to enhance the level of road safety.

At the community level, safety will increase cohesion between people, public administration, and the business environment, creating preconditions for satisfying everyone's needs.

1.3.2. Ambition for the TAP

The target for the Autonomous Road Surveillance System (ARSS) is set according to the main objectives of the Transport and Logistics Strategy for 2013-2022. The technology will help reduce road accidents by creating an efficient traffic control system that detects and counts vehicles at various times and locations.

The ambition is to improve public traffic in difficult weather conditions and reduce it by 10% of road accidents by installing the Autonomous Road Surveillance System (ARSS) on the most critical public roads.

1.3.3. Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome the obstacles.

The main barriers that prevent the implementation of this technology in the country were grouped into common categories: a) Economic and financial, b) Policy, legal, and regulatory, c) Network Failures, d) Technical, and e) Social, Information, and awareness barriers.

The main **economic and financial barriers are related to the high operating costs. As experts from different areas of activity, especially from the IT sector, must be involved in operating** the implementation unit, the operating expenses will be substantial.

Relating to the **Policy, legal, and regulatory** barriers, the incomplete regulatory framework will play a vital role in implementing this technology. As public policy is reflected in laws and regulations relating to the collection, use, and analysis of personal data that are not regulated, it needs to solve this matter by adopting new rules.

In the Network failures category, the lack of experience in cooperation among stakeholders is the main barrier to collecting and analyzing the data surrounding the system's functioning.

In particular, the collection of feedback relating to the results of functioning in practice in different cities.

The **technical barriers are focused on the implementation entities' limited knowledge of the technological process.** As the technological revolution is new and has never been implemented before, the primary entity responsible for traffic management, the General Police Inspectorate, and the municipal enterprise **"Lumteh,"** responsible for semaphores management, should cooperate in implementing technology and managing the standard process.

The same situation applies to institutional **and organizational** capacities; here, the need for an implementation model is the main problem. As in the country, the General Inspectorate of Police is responsible for traffic management. However, as a public entity with specific objectives of the activity, the entity has no competencies to manage activities related to ARSS.

The barriers to Social, Information, and Awareness are due to the technology's newness. This means the primary beneficiaries and entities responsible for implementing the technology need more information about its benefits and impact on the economy and environment.

Actions selected for inclusion in the TAP

The main actions included in TAP for this technology aim to implement measures, overcome barriers, and achieve the ambition of implementing the technology in the country. Through the development and implementation of the regulatory framework, existing regulations will be adapted to allow public entities to create and manage PPPs.

A mechanism of interaction will be created between the main stakeholders to improve collaboration. Public events will also be organized to meet all stakeholders, discuss common problems, and propose solutions that can support activities for all of them.

The technical actions will focus on implementing capacity-building programs, including practical exercises for the main stakeholders. The capacity-building programs will contain the main modules to cover the training needed to manage ARSS applications and store, analyze, and use the data.

Creating a PPP to implement ARSS will solve the managerial and operational problems related to its implementation in the country.

The social, information, and awareness barriers will be removed by taking action to promote new technological solutions that manage traffic more efficiently and add value to this process. Also, by implementing the pilot and demonstration (P&D) projects, the main problem relating to the promotion of the technology can be solved and demonstrated in practice its efficiency. Furthermore, it is expected that the small pilot and demonstration projects, particularly in the villages, can create a baseline for the scale-up of the projects in the big cities, where the traffic is more intensive, and the result can have a more significant impact.

Activities identified for implementation of selected actions:
Action 1: Development and implementation of the regulatory framework
Activity 1.1 Assess the policy, regulatory, and institutional requirements
Activity 1.2 Proposing optimal solutions for modifying the legal framework or for developing a new one
Activity 1.3 Pursuing the necessary procedures for the adoption of the legal framework

A precondition for introducing the technology in the country will be developing and implementing the regulatory framework, which will allow public entities to create PPPs and be involved in project management.

In the first phase, policy, regulatory, and institutional requirements will be assessed. A list of optimal solutions for modifying or developing the legal framework will also be generated. This will prepare the process for adopting and implementing it.

Action 2: Improve collaboration between different stakeholders.
Activity 2.1 Identify the main stakeholders at the national and international levels.
Activity 2.2 Develop a schedule and attend public events at the national and international levels.
Activity 2.3 Support in creating effective partnerships by signing the cooperation agreements.

Considering that at least two different entities should be involved in implementing this technology in the country, a mechanism of interaction between the main stakeholders should be created. For this, a stakeholder analysis will be conducted, which will identify the main potential partners. Also, stakeholders' participation in public events such as exhibitions, B2B forums, and conferences will be stimulated. Furthermore, general activities will create a base for cooperation by signing cooperation agreements between key stakeholders.

Action 3: Implement capacity-building programs for the main stakeholders.
Activity 3.1 Identification of the main stakeholders and their needs for capacity-building.
Activity 3.2 Develop the training curricula.
Activity 3.3 Implementation of the capacity-building program at the national level.

Through the implementation of capacity-building programs, the capacities of the main stakeholders will be developed to introduce the new technology in the country. The capacity-

building programs should contain the main modules to cover the training needs to manage ARSS applications and store, analyze, and use the data.

In the preparatory phase of this action, an assessment will be conducted to identify the needs of the main stakeholders. Then, the base of the requirements will be developed as a training curriculum, and the representatives of the main stakeholders will be trained.

Action 4: Create a PPP to implement the ARSS in Moldova.
Activity 4.1 Assess the policy, regulatory, and institutional requirements for PPP creation.
Activity 4.2 Development of the operational manual and templates for the dossier of a PPP.
Activity 4.3 Designing and implementing a PPP.

To create a PPP that will implement ARSS in Moldova and solve the managerial and operational problems relating to the implementation of the technology in the country will be assessed the policy, regulatory, and institutional requirements for the creation of the PPP. Based on the evaluation, an operational manual and templates for the dossier of a PPP will be developed. After preparing all documents, we will start activities on designing and implementing a PPP.

Action 5: Implementation of the small pilot and demonstration projects.
Activity 5.1 Identify the budget for creating a fund to finance the pilot and demonstration projects on the local market.
Activity 5.2 Development of the operation manual.
Activity 5.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market.

As technology is new in the local market, implementing pilot and demonstration projects is crucial in demonstrating the technology's efficiency and benefits. Therefore, the first activity will be identifying the budget for creating a fund to finance the pilot and demonstration projects on the local market. When the budget is determined, the operation manual will be developed, considering the financing entities' conditions. A call for applications to finance the pilot and demonstration projects on the local market will be announced when all is prepared.

1.3.4. Actions to be implemented as Project Ideas

To identify the actions necessary to implement the selected projects, they have been grouped into three primary groups based on their importance. Each project idea combined several steps, allowing each project idea to reach the maximum objectives necessary for introducing technology in the transport sector. The project idea was identified due to the grouping of the importance of the measures needed to implement the technology in the local market.

Table 3. *Systematization of Measures by Categories and Importance.*

Nr	Measures	Category	Importance
1	Creating an Implementation Unit based on a new management mechanism	Economics and Financial	Crucial
2	Development and implementation of the regulatory framework	Policy, legal, and regulatory	Crucial
3	Improve collaboration between different stakeholders	Network Failures	Crucial
4	Implement capacity-building programs for the main stakeholders	Technical	Crucial
5	Create a PPP to implement ARSS in Moldova	Institutional and organizational capacity	Important
6	Implementation of awareness programs by covering the main media across the country	Social, Information, and awareness	Important
7	Implementation of the small pilot and demonstration projects	Social, Information, and awareness	Important

Actions that can solve the most critical barriers and combine or synchronize some activities were also selected.

The actions aimed at identifying the most critical measures that would significantly impact introducing the technology to the local market have been prioritized.

The next actions on the final list were ***to create a PPP to implement ARSS in Moldova*** and solve the managerial and operational problems related to implementing the technology in the country.

This Project Idea will include the following actions:
Action 1: Development and implementation of the regulatory framework.
Action 2: Improve collaboration between different stakeholders.
Action 3: Implement capacity-building programs for the main stakeholders.
Action 4: Create a PPP to implement the ARSS in Moldova.

1.3.5. Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the performance of TAP

The main stakeholders involved in the version of both project ideas are:

1. **The Ministry of Infrastructure and Regional Development** is the central specialized body that promotes state policy in the field of infrastructure and regional development and operates following the Constitution and Laws of the Republic of Moldova, Parliamentary

Decisions, Acts of the President of the Republic of Moldova, Government Decisions and Orders, as well as other normative acts.

2. The **Ministry of Finance** is the central specialized body of public administration, which develops and promotes the unique policy of training and managing public finances, applying financial levers in line with the requirements of the market economy. The Ministry of Finance elaborates on the necessary normative acts regulating the budgetary process. The taxation and accounting system develops medium and long-term forecasts regarding financial resources, finds solutions for public finance reform, and ensures receipts and payments to the state budget. The ministry also elaborates and promotes the draft annual budget law and, if necessary, draft laws for amending and supplementing the yearly state budget law.

3. **State-owned enterprise State Road Administration of Moldova** is responsible for maintaining, repairing, rehabilitating, developing, upgrading, and administrating national public roads in Moldova and for corresponding road infrastructure. Also, the company is responsible for implementing the unitary development programs of the public roads network following the Transport and Logistics Strategy and with the requirements of the national economy. In addition, the company has as its responsibilities the efficient management of the financial resources allocated from the Road Fund and external sources for the development, modernization, and maintenance of the national public roads network of the Republic of Moldova.

4. The **Road Fund's particular purpose is** to finance the maintenance, repair, and reconstruction of national and local public roads, road design, construction materials production, and procuring techniques and equipment for road maintenance. The fund distribution for federal and regional public roads is presented by the Government and approved annually by the Parliament, considering that at least 50 percent of the funds will be used to finance national roads.

5. The **General Police Inspectorate**. As a law enforcement body of state power, the police of the Republic of Moldova is divided into state and municipal. State police perform their duties throughout the republic and municipal areas in the territory of the corresponding administrative unit. State and municipal police carry out their tasks in close cooperation. The state police provide the municipal police with methodological and advisory assistance and assist in implementing the duties assigned to them by their forces and means. The municipal police assist the state police in carrying out operational investigative measures and promptly inform them of the persons and facts of interest to them.

1.3.6. Scheduling and sequencing of specific activities

The specific activities of the actions are planned for the next period and timeline:
Action 1: Development and implementation of the regulatory framework
Activity 1.1 Assess the policy, regulatory, and institutional requirements: Year: 1
Activity 1.2 Proposing optimal solutions for modifying the legal framework or for developing a new one: Year 1. 2024
Activity 1.3 Pursuing the necessary procedures for the adoption of the legal framework: Year: 2

Action 2: Improve collaboration between different stakeholders
Activity 2.1 Identify the main stakeholders at the national and international level: Year: 2
Activity 2.2 Develop a schedule and attend public events at the national and international level: Year:2
Activity 2.3 Support in the creation of effective partnerships by signing the cooperation agreements: Year: 3

Action 3: Implement capacity-building programs for the main stakeholders
Activity 3.1 Identification of the main stakeholders and their needs for capacity-building: Year: 2
Activity 3.2 Develop the training curricula: Year: 2
Activity 3.3 Implementation of the capacity-building program at the national level: Year: 3

Action 4: Create a PPP to implement the ARSS in Moldova
Activity 4.1 Assess the policy, regulatory, and institutional requirements for the creation of a PPP: Year: 2
Activity 4.2 Development of the operational manual and templates for the dossier of a PPP: Year: 2
Activity 4.3 Designing and implementing a PPP: Year: 3

1.3.7. Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity-building programs will develop the capacities of the main stakeholders to introduce new technology in the country. Therefore, they will play an essential role in introducing this technology nationally.

This activity will focus on capacities to support the development and implementation of the regulatory framework, improve collaboration between different stakeholders, and develop and implement PPP using ARSS in Moldova.

Estimations of costs of actions and activities

The specific activities of the steps that are planned and their costs:
Action 1: Development and implementation of the regulatory framework.
Activity 1.1 Assess the policy, regulatory, and institutional requirements: 50,000 USD.
Activity 1.2 Proposing optimal solutions for modifying the legal framework or for developing a new one: 50,000 USD.
Activity 1.3 Pursuing the necessary procedures for the adoption of the legal framework: 50,000 USD.

Action 2: Improve collaboration between different stakeholders.
Activity 2.1 Identify the main stakeholders at the national and international level: 50,000 USD.
Activity 2.2 Develop a schedule and attend public events at the national and international level: 50,000 USD.

Activity 2.3 Support in creating effective partnerships by signing the cooperation agreements: 100,000 USD.

Action 3: Implement capacity-building programs for the main stakeholders.
Activity 3.1 Identify the main stakeholders and their needs for capacity-building: 100,000 USD.
Activity 3.2 Develop the training curricula: 100,000 USD.
Activity 3.3 Implementation of the capacity-building program at the national level: 100,000 USD.

Action 4: Create a PPP to implement ARSS in Moldova.
Activity 4.1 Assess the policy, regulatory, and institutional requirements for creating the PPP: 100,000 USD.
Activity 4.2 Development of the operational manual and templates for the dossier of a PPP: 100,000 USD.
Activity 4.3 Designing and implementing a PPP: 100,000 USD.

1.3.8. Management Planning

Risks and Contingency Planning

The main risks related to the implementation of the project ideas are associated with the economic situation of the country are:

High inflation rates:

High inflation rates stopped the economic activities of most companies, especially companies that operate on the international market and can import new equipment. Moldova's inflation rate reached a record 33.5 percent on August 10. The National Bank of Moldova (BNM) forecasts the annual inflation rate to peak at 34.7% y/y in Q3 and ease afterward; import-export companies stopped activities relating to the import of new equipment

Taking into account this risk, it is recommended that the period at the start of the project focuses on the main activities to capacity building activities and the import of equipment to plan for the project's final phase. Also, activities relating to legal framework development can be implemented in the first phases.

Low interest of the main stakeholders:

The economic crisis in the country created preconditions for the key stakeholders to pay more attention to social problems. As a result, public investments in the infrastructure project are expected to decrease over the next 2-3 years. Lack of financing for social issues will focus the stakeholders' main activities on prioritization to reduce investments and management costs. Therefore, it is recommended that until this period, maintain the stakeholder's interest in the project ideas, work on developing the project's technical documentation, and organize public events and public consultations. Also, the involvement of the stakeholders' representatives in the project's activities can stimulate interest in implementing the project.

Next Steps

The current economic crisis will be essential in implementing the project's main activities. Considering the economic outlook shows a slow development of the county, it is critical to monitor the economic indicators and adapt the project's activities depending on the new economic reality. In identifying the immediate and essential requirements for implementing the project's actions, it is crucial to consider that the activity of the public authorities will be focused on social needs.

a) the immediate requirements to proceed:

- identify financing from multilateral and bilateral organizations.
- Adopt the budget for the project ideas to the new economic reality.
- identify a better way to demonstrate the positive social impact of technology.

b) the critical steps to succeed:

- continuous monitoring of the leading economic indicators.
- maintain contact with key stakeholders, primarily governmental entities and donor organizations.
- the project costs will be adjusted depending on the inflation indicators.

Table 4. *TAP overview of Autonomous Road Surveillance System (ARSS) technology*

TAP overview table								
Sector	Transport							
Sub-sector	Infrastructure							
Technology	Autonomous Road Surveillance System (ARSS)							
Ambition	Improving public traffic in difficult weather conditions and reducing road accidents by 10% by installing the Autonomous Road Surveillance System (ARSS) on the most important public roads.							
Benefits								
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time frame**	**Risks**	**Success criteria**	**Indicators for Monitoring of Implementation**	**Budget per activity**
Action 1: Development and implementation of the regulatory framework	Activity 1.1 Assess the policy, regulatory and institutional requirements	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	Low interest of the main stakeholders	Access to the legal framework in force	An assessment of policy, regulatory, and institutional requirements is carried out.	**50.000,00**
	Activity 1.2 Proposing optimal solutions for modifying the legal framework or developing a new one	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2024	Low interest of the main stakeholders	Availability of the main stakeholders to cooperate in the area of the legal framework	A list of options on optimal solutions for modifying the legal framework or developing a new one is developed	**50.000,00**
	Activity 1.3 Pursuing the necessary procedures for the adoption of the legal framework	Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development. Ministry of Finance	2025	Low interest of the main stakeholders	Availability of the main stakeholders to cooperate within the bounds of the legal framework	A regulatory framework is adopted and put in place.	**50.000,00**

Action 2: Improve collaboration between different stakeholders	Activity 2.1 Identify the main stakeholders at the national and international level	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2025	Low interest of the main stakeholders	Access to the data about the sectoral stakeholders	A stakeholder analysis is conducted	**50.000,00**
	Activity 2.2 Develop a schedule and attend public events at the national and international levels.	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2025	Limited budget for organization and attending public events at the national and international level	Availability to attend the events	Key stakeholders attend at least six public events per year	**100.000,00**
	Activity 2.3 Support the creation of effective partnerships by signing the cooperation agreements.	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	High interest in cooperation from the main stakeholders	Six cooperation agreements are signed between key stakeholders	**100.000,00**
Action 3: Implement capacity-building programs for	Activity 3.1 Identification of the main stakeholders and their needs for capacity-building	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Lack of local capacities	Access to the data about the sectoral stakeholders	An assessment is conducted	**100.000,00**

the main stakeholders	Activity 3.2 Develop the training curricula	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Lack of local capacities to develop the training curricula		A training curriculum is developed and ready to use in the training program	**100.000,00**
	Activity 3.3 Implementation of the capacity-building program at the national level	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders	The interest of the stakeholders in the capacity-building courses	At least 100 representatives of the main stakeholders are trained	**100.000,00**
Action 4: Create a PPP to implement the ARSS in Moldova	Activity 4.1 Assess the policy, regulatory, and institutional requirements for the creation of the PPP	The Public Budget, Multilateral Organizations, Bilateral Organizations, Private companies	State Road Administration, Ministry of Infrastructure and Regional Development, General Police Inspectorate, Private companies	2027	Low interest of the main stakeholders	Access to the policy, regulatory, and institutional requirements database	An assessment is conducted	**100.000,00**
	Activity 4.2 Development of the operational manual and templates for the dossier of a PPP	The Public Budget, Multilateral Organizations, Bilateral Organizations, Private companies	State Road Administration, Ministry of Infrastructure and Regional Development, General Police Inspectorate, private companies	2028	Low interest of the main stakeholders, Lack of financing	Availability of the data and information about the activity of PPP in the country	A set of the documents is developed	**100.000,00**
	Activity 4.3	The Public Budget,	State Road Administration,	2029	Low interest of the main	Availability of the data and	A PPP is created and is functional	**100.000,00**

	Designing and implementing a PPP	Multilateral Organizations, Bilateral Organizations, Private companies	Ministry of Infrastructure and Regional Development, General Police Inspectorate, private companies		stakeholders, High inflation rates, High-interest rates, Lack of financing	information about the activity PPP in the country		
Action 5: Implementation of the small pilot and demonstration projects	Activity 5.1 Identification of the budget for the creation of a fund for financing the pilot and demonstration projects on the local market	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, National Agency for Research and Development		High inflation rates, High interest rates, Lack of financing	Availability of the financing programs/projects	A budget for financing the small pilot and demonstration projects is identified.	**100.000,00**
	Activity 5.2 Development of the operation manual	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, National Agency for Research and Development		Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual developed and ready for use	**100.000,00**
	Activity 5.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, National		High inflation rates, High interest rates, and Low interest	The interest of the companies in applying to the call for applications	At least three projects are identified and financed in the main cities of Moldova	**1.000.000,00**

			Agency for Research and Development		of the main stakeholders		(Chisinau, Balti, Cahul)	

1.4. Action Plan for Technology 3 of the Transport Sector: Transport powered by hydrogen fuel cells and charging infrastructure for it

Introduction

A fuel cell electric vehicle is a car that includes both a hydrogen fuel cell and batteries/capacitors. In this hybrid architecture, the fuel unit provides all the energy for vehicle movement, wh. In contrast, batteries/capacitors can give maximum power to the engines to cope with rapid acceleration.

The fuel cell module generates electricity through an electrochemical reaction, leaving only water and heat as by-products, so no pollutant emissions are emitted into the atmosphere. Electricity is used to provide direct electric traction and to keep the batteries charged. The heat from the by-product is stored in the brake resistors and is used to maintain the passenger's heating comfort and increase the vehicle's energy efficiency. The batteries also provide storage for regenerated braking energy. The hydrogen stored onboard provides all the energy the bus needs to run.
Hydrogen offers a higher energy density than electrical storage systems such as batteries, which allows for a more extended range than systems where batteries are used as energy storage.
The technology, vehicles, and charging infrastructure are produced outside the local market and should be imported from outside.
Hydrogen as an energy product (Cod TARIC 280410), in the period 2017 – 2021, was imported to Moldova from Romania and Ukraine for a total of 8758 USD. In the mentioned period, 927 cubic meters were imported, and the average price was $8.59 per cubic meter.
According to the World Trade Organization data, in the Republic of Moldova, in 2021, the tariff rate charged as a percentage of the price (Ad Valorem AV) for hydrogen as an energy product is 5.5%.

1.4.1. Ambition for the TAP

The target for Transport powered by hydrogen fuel cells and charging infrastructure for it is set according to the main objectives of the Transport and Logistics Strategy for 2013-2022, the Environmental Strategies for the years 2014-2023, and the Low Emission Development Strategy of the Republic of Moldova until 2030. The fleet will adapt to the ambitious standards by introducing hydrogen fuel cells powered transport. As a result, greenhouse gas emissions and climate change impact on the transport sector will be reduced.

The ambition is to increase the resilience of the transport fleet and modernize at least 5% of public transport by introducing hydrogen-powered vehicles and developing charging infrastructure.

1.4.2. Actions and Activities selected for inclusion in the TAP

Summary of barriers and measures to overcome barriers

The main barriers to the implementation of this technology in the country were grouped into the following categories: a) Economic and Financial; b) Policy, legal, and regulatory; c) Network Failures; d) Social Information and awareness; e) Technical barriers, f) Institutional and organizational capacity. High up-front costs are a significant Economic and financial barrier to implementing transport powered by hydrogen fuel cells in the Moldavian transport sector. Furthermore, the lack of maintenance infrastructure is also a critical barrier to introducing this technology because its implementation requires additional costs for maintenance services, equipment, and pieces. Furthermore, as the technology is new and should be imported 100%, its costs are prohibitive, and maintenance services require additional investment; finally, operating costs increase.

The incomplete regulatory framework is the main barrier to the **Policy, legal, and regulatory categories. For example, the current legal framework does not regulate the Value-Added Tax (VAT) of transport powered by hydrogen fuel cells, leading** to an increase in the price of hydrogen-powered vehicles.

This category's next significant barrier is focusing on old technologies to meet old standards. Also, a significant barrier is the need for an adequate public financing mechanism. Public entities are the dominant clients in the acquisition of new transport units, and in this case, the general acquisition procedures established on public procurement laws are focused on lower prices rather than efficiency or the promotion of new clean technologies. As a result, new technologies in the transport sector are difficult to introduce.

The lack of experience in cooperating with stakeholders plays an essential role in the Network Failures category. Considering the numerous stakeholders responsible for different value chain phases, it is difficult to bring all together to discuss and solve sector-specific issues.

Also, the limited technical and business management skills of all value chain stakeholders resulted in the reduction of the import-export procedures, which affected the finalization of the investment project.

More research in this field is a significant technical barrier. No studies are related to implementing this technology in the local market, leading to limited knowledge of the technological process. Currently, there are no companies in Moldova that operate using hydrogen-powered vehicles. As a result, the local beneficiaries and users need to be made aware of the benefits of this technology.

The lack of pilot and demonstration projects led to limited knowledge about the technology and is a critical barrier to the **Social, Information, and awareness categories**. As there are no pilot projects in place to use this technology, awareness regarding its benefits and efficiency could be much higher. As a result, potential beneficiaries have yet to be able to promote the technology and focus on its efficiency and benefits.

Actions selected for inclusion in the TAP

A detailed structure grouped the proposed measures to implement the technology nationally. The Economic and financial measures focus on reducing costs by introducing fiscal incentives and reducing import taxes. Also, creating maintenance services for all products and equipment of the value chain will be the precondition to support the use of the vehicles on a large scale. Finally, creating a network of supporting/maintenance services on the whole value chain can reduce the operating costs of the transportation services companies.

The policy, legal, and regulatory measures are focused on developing a regulatory framework to respond to the needs of the market's introduction of modern technology. Another activity is the introduction of hydrogen-powered vehicles in the leading sectoral action plans that will stimulate the local market to use them in mass markets. Specific targets of these Plans will create preconditions to increase their use of it in the country. Also, developing a public financing mechanism corresponding to the need to modernize the transport sector will stimulate investment in public transport by acquiring hydrogen-powered vehicles.

The Network failure barriers will be overcome by creating a platform for cooperation between stakeholders of the value chain of hydrogen-powered vehicles.

Technical measures focus on creating a mechanism to support research in the transport sector and developing a technology transfer mechanism to support introducing innovative technology in the local market.

The social, information, and awareness measures will focus on promoting technology at public events such as B2B and B2G forums, exhibitions, workshops, etc. In addition, a specific general program should be developed to increase public awareness regarding the efficiency and benefits of hydrogen-powered vehicles. Each group will be identified as a target concrete stakeholder group with a particular objective and activities.

Activities identified for implementation of selected actions

Action 1: Reducing costs by introducing fiscal measures to the import by reducing taxes.

Activity 1.1: Elaborate on the list of products necessary for implementing the technology in the country.

Activity 1.2 Drafting of the changes in the fiscal framework regarding tax reduction and proposal for approval by the government.

The main activities of this action will be focused on reducing costs by introducing fiscal measures on the import procedures, creating the maintenance services for all products and equipment of the value chain, and reducing operating costs by developing and introducing supporting services on the whole value chain, it is expected that the final investment costs will decrease essentially.

As a result of these activities, a list of products that need to be included in the tax reduction procedure will be developed, and a document will be prepared following the process for approving the reduction of taxes on the import of the equipment.

Action 2: Creating maintenance services for all products and equipment in the value chain.

Activity 2.1 Identifying the value chain products and equipment required to operate the technology.

Activity 2.2 Elaboration of repair & maintenance manuals.
Activity 2.3 Developing the capacities of companies providing maintenance services.

The objective of this action is to create maintenance services for all value chain products and equipment by identifying the value chain products and equipment required for the operation of the technology, developing repair and maintenance manuals, and developing companies' capacities to provide maintenance services.

As a result of these activities, a list of the equipment required to operate and repair the technology, as well as maintenance manuals, is expected to be developed. At least ten companies are expected to attend the training course on providing maintenance services for this technology.

Action 3: Reducing operating costs by creating and introducing supporting services on the whole value chain.
Activity 3.1 Systematization of supporting services on the whole value chain.
Activity 3.2 Develop a Manual for supporting services on the whole value chain.
Activity 3.3 Create a Center for Coordination and Support of the supportive services.

These activities will focus on reducing operating costs by systematizing supportive services, developing a manual for supportive services, and creating a center for coordination and support.

All these activities will contribute to developing a list of the supporting services on the whole value chain and will prepare all actions to reduce the technology’s operating costs.

Action 4: Develop a regulatory framework to respond to the need to introduce modern technology in the market.
Activity 4.1 Assessment of the existing regulatory framework and identify the needs for modifications.
Activity 4.2 Develop a new regulatory framework or introduction of modifications to the existing one.
Activity 4.3 Implement an awareness campaign to inform all stakeholders about the modifications.

The main activities in developing the regulatory framework to respond to the need for introducing transport powered by hydrogen fuel cells and charging infrastructure for it in the market will be assessing the actual regulatory framework and developing the new one. In addition, implementing an awareness campaign to inform all stakeholders about the modifications made will play an important role. This activity will explain the recent changes and benefits of using the new technologies in detail.

As a result of these activities, an assessment of the existing regulatory framework will be conducted to identify the need for modifications. Based on this, a new regulatory framework will be developed.

The awareness campaign to inform all stakeholders about the operated modifications will be implemented as soon as possible at the national level to involve more companies and potential beneficiaries.

Action 5: Supporting moving toward innovative technologies to respond to the new needs of the sector.
Activity 5.1 Identify the gap and obstacles to introducing hydrogen-powered transport in the transport sector.
Activity 5.2 Identify the technologies that can respond to the need for innovation by introducing hydrogen-powered transport.
Activity 5.3 Develop a National Action Plan for the introduction of hydrogen-powered transport.

The first activity of this action will focus on identifying the gap and the obstacles to introducing hydrogen-powered transport in the country's transport sector. Also, introducing this technology will locate tetralogies that can respond to the need for innovation. Finally, a National Action Plan will be developed to introduce hydrogen-powered transport.

As a result of these activities, a gap analysis will be conducted. A list of technologies that can respond to the need for innovation by introducing hydrogen-powered transport will be prepared.

Action 6: Develop a public financing mechanism for modernizing the transport sector.
Activity 6.1 Identification of funding sources.
Activity 6.2 Development of the operational manual.
Activity 6.3 Launch call for proposal and finance of the hydrogen-powered transport projects.

This action's activities will focus on developing a public financing mechanism corresponding to the need to modernize the transport sector. They will start by identifying funding sources, which will be the basis for the following activities. This is because the donors' conditions will be considered priorities.

First, the operational manual will be developed based on the donor conditions and financing requirements at the national level. Then, based on the operation manual, a call for proposals will be launched, and the projects will be financed.

As a result of this activity, at least ten research projects will be identified and financed based on the identified funding source and the developed operation manual.

Action 7: Creating a platform for cooperation between different stakeholders.
Activity 7.1 Identify the main stakeholders at the national and international levels.
Activity 7.2 Develop a schedule and attend public events at the national and international levels.
Activity 7.3 Support the creation of effective partnerships by signing cooperation agreements.

Creating a platform for cooperation between different stakeholders will start with activities to identify the main stakeholders at the national and international levels who can be interested in implementing the projects in the country. Next, a schedule will be developed to attend public

events. Also, signing cooperation agreements between stakeholders will stimulate the creation of effective partnerships.

As a result of these activities, key stakeholders will attend at least 12 public events per year and sign at least ten cooperation agreements.

Action 8: Capacity building of all stakeholders of the value chain.
Activity 8.1 Identification of the main stakeholders and their capacity-building needs.
Activity 8.2 Develop training curricula.
Activity 8.3 Implementation of the training program at the national level.

The actions relating to capacity building of all stakeholders in the hydrogen-powered transport projects' value chain will start with the identification of the stakeholders' primary capacity-building needs. Then, based on the markets, they will develop the training curricula and implement a training program at the national level.

As a result of this activity, at least 100 representatives of the main stakeholders will be trained in implementing the hydrogen-powered transport projects.

Action 9: Creating a mechanism for supporting research in the transport sector.
Activity 9.1 Identify the budget for developing a financing mechanism for research in the transport sector.
Activity 9.2 Development of the operation manual of the financing mechanism.
Activity 9.3 Launch call for proposal and finance of the research in the infrastructure projects.

The implementation of the action on creating a mechanism for supporting research in the transport sector will start with identifying the budget for the financing mechanism. Then, the operation manual will be developed in the following steps, which will consider the requirements of the donors and financing entities. Finally, when all technical documentation is ready, the call for proposals and project financing will be launched.

As a result of this activity, at least ten research projects in the transport sector that promote hydrogen-powered transport are expected to be identified and financed.

Action 10: Develop a technology transfer mechanism.
Activity 10.1 Identification of the budget for the technology transfer mechanism.
Activity 10.2 Development of the operation manual for the technology transfer mechanism.
Activity 10.3 Launch call for proposal for technology transfer projects.

Developing a technology transfer mechanism will start with identifying the budget for financing it. Then, as per the previous action, the operation manual and a call for proposals for technology transfer projects will need to be developed.
The budgeted sum is expected to finance at least ten research technology transfer projects, which will demonstrate in practice the benefits of this technology on the transport sector and local market.

Action 11: Promote technology at public events.

Activity 11.1 Develop a schedule, organize, and attend public events at the national and international levels.
Activity 11.2 Identify the main stakeholders at the national and international levels.
Activity 11.3 Establishing cooperation at the national and international levels.

To promote technology at public events, a schedule will be developed to organize and attend public affairs at the national and international levels. In the second phase, the main stakeholders at the national and international levels who will be interested in promoting the technology will be identified. In the final step, the activities will focus on establishing national and international cooperation.

As a result of the activities of this action, at least 100 representatives of the main stakeholders will attend at least 12 public events per year. In addition, they will be signed for around 50 collaboration agreements.

Action 12: Launch a mechanism for financing and implementing pilot and demonstration projects on the local market.
Activity 12.1 Identification of the budget for a mechanism for financing the pilot and demonstration projects on the local market.
Activity 12.2 Development of the operation manual.
Activity 12.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market.

The activities relating to the launch of a mechanism for financing and implementing pilot and demonstration projects on the local market, as the previous activities, which have the objective of the funding, will start with training on the identification of the budget for that mechanism. Then, the following steps will be to develop the technical documentation needed for operation and to launch a call for proposals and finance of the pilot and demonstration projects on the local market.

Based on the identified budget, at least ten projects are expected to be financed.

Action 13: Increase awareness regarding the efficiency of technology by organizing public events.
Activity 13.1 Developing the awareness-raising and outreach strategy.
Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately.
Activity 13.3 Implementing the awareness-raising strategy using the most effective methods to achieve the target audience.

Increasing awareness regarding the efficiency of technology by organizing public events will start with activities on developing awareness-raising and outreach strategies. After identifying the target audience and tailoring the awareness-raising initiative, activities will be implemented using the most effective methods to achieve the target audience. As a result, it is expected that will be developed and promoted audio-visual materials such as television, video, or documentary film will be promoted on mass media. In addition, the generated web page will be announced online, especially on social media.

Actions to be implemented as Project Ideas

The importance of all the actions the TAP needs to implement for this technology was analyzed.

Finally, the project idea combines several actions to reach the maximum objectives for introducing technology in the transport sector.

Table 5. *Systematization of Measures by Categories and Importance.*

Nr	Measures	Category	Importance
1	Reducing costs by introducing fiscal measures the import by reducing taxes	Economics and Financial	Crucial
2	Creating the maintenance services for all products and equipment of the value chain	Economics and Financial	Crucial
3	Reducing operating costs by creating and introducing supporting services on the whole value chain	Economics and Financial	Crucial
4	Develop a regulatory framework to respond to the need to introduce modern technology.	Policy, legal, and regulatory	Crucial
5	Supporting moving toward innovative technologies to respond to the new needs of the sector	Policy, legal, and regulatory	Important
6	Develop a public financing mechanism that will modernize the transport sector.	Policy, legal, and regulatory	Crucial
7	Creating a platform for cooperation between different stakeholders	Network Failures	Important
8	Capacity building of all stakeholders of the value chain	Network Failures	Crucial
9	Creating a mechanism for supporting research in the transport sector	Technical	Crucial
10	Develop a technology transfer mechanism	Technical	Crucial
11	Promote technology at public events	Social, Information, and awareness	Important
12	Launch of a mechanism for financing and implementing pilot and demonstration projects on the local market	Social, Information, and awareness	Important
13	Increase awareness regarding the efficiency of technology by organizing public events.	Social, Information, and awareness	Important

Analyzing the measures according to their importance and necessity for implementing the technology in the country, the crucially necessary ones were selected.

The project idea for this technology will include the following actions:

Action 1: Reducing costs by introducing fiscal measures and imports by reducing taxes.
Action 2: Creating maintenance services for all products and equipment in the value chain.
Action 3: Reducing operating costs by creating and introducing supporting services on the whole value chain.
Action 4: Develop a regulatory framework to respond to the need to introduce modern technology in the market.
Action 6: Develop a public financing mechanism for modernizing the transport sector.
Action 8: Capacity building of all stakeholders of the value chain
Action 9: Creating a mechanism for supporting research in the transport sector.
Action 10: Develop a technology transfer mechanism.

1.4.3. Stakeholders and Timeline for Implementation of TAP

Overview of Stakeholders for the implementation of the TAP

The main stakeholders involved in the performance of both project ideas are:

1. **The Ministry of Infrastructure and Regional Development** is the central specialized body that promotes state policy in the field of infrastructure and regional development and operates following the Constitution and Laws of the Republic of Moldova, Parliamentary Decisions, Acts of the President of the Republic of Moldova, Government Decisions and Orders, as well as other normative acts.

2. The **Ministry of Finance** is the central specialized body of public administration, which develops and promotes the unique policy of training and managing public finances, applying financial levels in line with the requirements of the market economy. The Ministry of Finance elaborates on the necessary normative acts regulating the budgetary process. The taxation and accounting system develops medium and long-term forecasts regarding financial resources, finds solutions for public finance reform, and ensures receipts and payments to the state budget. The ministry also elaborates and promotes the draft annual budget law and, if necessary, draft laws for amending and supplementing the yearly state budget law.

3. **State-owned enterprise State Road Administration of Moldova** is responsible for maintaining, repairing, rehabilitating, developing, upgrading, and administrating national public roads in Moldova and for corresponding road infrastructure. Also, the company is responsible for implementing the unitary development programs of the public roads network following the Transport and Logistics Strategy and with the requirements of the national economy. In addition, the company is responsible for efficiently managing the financial resources allocated from the Road Fund and external sources for the development, modernization, and maintenance of the national public roads network of the Republic of Moldova.

4. The **Road Fund** has a particular destination to finance the maintenance, repair, and reconstruction of national and local public roads, road design, construction materials production, and procuring techniques and equipment for road maintenance. The fund distribution for federal and regional public roads is presented by the Government and approved annually by the Parliament, considering that at least 50 percent of the funds will be used to finance national roads.

5. The **National Agency for Research and Development** (NARD) is an important development in the institutional setting for innovation. NARD is the successor of three previously existing bodies that have implemented state policy in science, innovation, and technology transfer. Among its responsibilities, the Agency manages national funds for creation, increases public knowledge of R&D and scientific resources, and develops the innovation infrastructure's activity.

Scheduling and sequencing of specific activities

Action 1: Reducing costs by introducing fiscal measures and imports by reducing taxes.
Activity 1.1 Elaboration of the list of products necessary for the implementation of technology in the country: Year: 1
Activity 1.2 Drafting of the changes in the fiscal framework regarding tax reduction and proposal for approval by the government: Year: 1

Action 2: Creating maintenance services for all products and equipment in the value chain.
Activity 2.1 Identifying the value chain products and equipment required for the operation of the technology: Year: 1
Activity 2.2 Elaboration of repair & maintenance manuals: Year: 1
Activity 2.3 Developing the capacities of companies providing maintenance services: Year: 1

Action 3: Reducing operating costs by creating and introducing supporting services on the whole value chain.
Activity 3.1 Systematization of the supporting services on the whole value chain: Year: 2
Activity 3.2 Develop a Manual for supporting services on the whole value chain: Year: 2
Activity 3.3 Create a Center for Coordination and Support of the supporting services: Year: 2

Action 4: Develop a regulatory framework to respond to the need to introduce modern technology in the market.
Activity 4.1 Assessment of the actual regulatory framework and identify the needs for modifications: Year: 2
Activity 4.2 Develop a new regulatory framework or introduction of modifications to the existing one: Year: 2
Activity 4.3 Implement an awareness campaign to inform all stakeholders about the modifications operated: Year: 2

Action 6: Develop a public financing mechanism for modernizing the transport sector.
Activity 6.1 Identification of funding sources: Year: 1
Activity 6.2 Development of the operational manual: Year: 1
Activity 6.3 Launch call for proposal and finance of the hydrogen-powered transport projects: Year: 2

Action 8: Capacity building of all stakeholders of the value chain.
Activity 8.1 Identification of the main stakeholders and their capacity-building needs: Year: 2
Activity 8.2 Develop the training curricula: Year: 2
Activity 8.3 Implementation of the training program at the national level: Year: 2

Action 9: Creating a mechanism for supporting research in the transport sector.

Activity 9.1 Identification of the budget for the development of a financing mechanism for research in the transport sector: Year: 2
Activity 9.2 Development of the operation manual of the financing mechanism: Year: 2
Activity 9.3 Launch call for proposal and finance of the research in the infrastructure projects: Year: 3

Action 10: Develop a technology transfer mechanism.
Activity 10.1 Identification of the budget for the technology transfer mechanism: Year: 3
Activity 10.2 Development of the operation manual for the technology transfer mechanism: Year: 3
Activity 10.3 Launch call for proposal for technology transfer projects: Year: 3

1.4.4. Estimation of Resources Needed for Action and Activities

Estimation of capacity building needs

Capacity building is needed. Actions and Activities were identified based on the need to introduce this technology nationally.

One of the main areas of these activities will focus on developing the capacities of all stakeholders in the value chain, especially those of the companies providing maintenance services. As the technology is new in the country, the companies will need special training programs focused on maintaining its functioning.

Estimations of costs of actions and activities (USD)

Action 1: Reducing costs by introducing fiscal measures and imports by reducing taxes.
Activity 1.1 Elaboration of the list of products necessary for the implementation of the technology in the country: 50.000,00
Activity 1.2 Drafting of the changes in the fiscal framework regarding tax reduction and proposal for approval by the government: 50.000,00

Action 2: Creating maintenance services for all products and equipment in the value chain.
Activity 2.1 Identifying the value chain products and equipment required for the operation of the technology: 50.000,00
Activity 2.2 Elaboration of repair & maintenance manuals: 50.000,00
Activity 2.3 Developing the capacities of companies providing maintenance services: 50.000,00

Action 3: Reducing operating costs by creating and introducing supporting services on the whole value chain.
Activity 3.1 Systematization of the supporting services on the whole value chain: 50.000,00
Activity 3.2 Develop a Manual for supporting services on the whole value chain: 50.000,00
Activity 3.3 Create a Center for Coordination and Support of the supporting services: 150.000,00

Action 4: Develop a regulatory framework to respond to the need to introduce modern technology in the market.
Activity 4.1 Assessment of the actual regulatory framework and identify the needs for modifications: 50.000,00

Activity 4.2 Develop a new regulatory framework or introduction of modifications to the existing one: 150.000,00
Activity 4.3 Implement an awareness campaign to inform all stakeholders about the operated modifications: 150.000,00
Action 6: Develop a public financing mechanism for modernizing the transport sector.
Activity 6.1 Identification of funding sources: 10.000.000,00
Activity 6.2 Development of the operational manual: 200.000,00
Activity 6.3 Launch call for proposal and finance of the hydrogen-powered transport projects: 100.000,00

Action 8: Capacity building of all stakeholders of the value chain.
Activity 8.1 Identification of the main stakeholders and their capacity-building needs: 100.000,00
Activity 8.2 Develop the training curricula: 100.000,00
Activity 8.3 Implementation of the training program at the national level: 200.000,00

Action 9: Creating a mechanism for supporting research in the transport sector.
Activity 9.1 Identification of the budget for the development of a financing mechanism for research in the transport sector: 1.000.000,00
Activity 9.2 Development of the operation manual of the financing mechanism: 200.000,00
Activity 9.3 Launch call for proposal and finance of the research in the infrastructure projects: 200.000,00

Action 10: Develop a technology transfer mechanism.
Activity 10.1 Identification of the budget for the technology transfer mechanism: 1.000.000,00
Activity 10.2 Development of the operation manual for the technology transfer mechanism: 200.000,00
Activity 10.3 Launch call for proposal for technology transfer projects: 200.000,00

1.4.5. Management Planning

Risks and Contingency Planning

It will be essential to adapt instruments that reduce risk by addressing the underlying barriers that are the root causes of implementing technology in the country. In addition, it will be essential to use mechanisms that transfer risk, shift risk from the private sector to the public sector, and compensate for risk, providing a financial incentive. These actions will help better implement projects in the country when the main stakeholders are representatives of 3 main groups: the private sector, governmental entities, and municipalities.

The main risks related to the implementation of the project idea for this technology are:

High inflation rates:
Moldova's inflation rate reached a record 33.5 percent on August 10, the highest in Europe, hurting the living standards of an already impoverished population. The Inflation Outlook

published by the National Bank of Moldova (BNM) forecasts the annual inflation rate to peak at 34.7% y/y in Q3 and ease afterward.

This risk will probably affect the mobilization and financing of the leading investment activities for the mentioned period.

Low interest of the main stakeholders:
Because of the economic crisis, key stakeholders are expected to pay more attention to social problems, and the public budget will be focused on social needs. Also, as the prices of energy resources increase, the costs of entrepreneurial activities for private companies will likely reduce investment activities. Instead, they will use the money to cover the correct costs.

High-interest rates:
Policymakers at the National Bank of Moldova voted unanimously on August 4 to increase the primary interest rate by three percentage points, taking it to 21.5% – a record high. The high- interest rates directly affect the investment process of the leading companies in the country. In the next period of 2-3 years, it is expected that the interest rates will still be at high indicators. Although, in this situation, the investment projects could be implemented only with the support of multilateral and bilateral organizations, it is recommended that activity be focused on synchronizing the available budgets and financing opportunities.

Next Steps

The current social and economic crisis is expected to create additional barriers to implementing new technologies in the country. To be prepared for the new ones, it will be critical to focus on the following:

a) immediate requirements to proceed:
   - develop technical documentation for all activities.
   - identify financing from multilateral and bilateral organizations.
   - Adopt the budget for the project ideas to the new economic reality.
   - identify a better way to demonstrate the positive social impact of technology.

b) critical steps to succeed:
- maintain contact with key stakeholders, especially governmental entities and donor organizations.
- organize public events, such as workshops to present information about technology and public consultations.
- Continuously monitor the market's prices and the leading economic indicators and actualize the budget for the new prices.

Table 6. *TAP overview of Transport powered by hydrogen fuel cells and charging infrastructure for it*

TAP overview table								
Sector	Transport							
Sub-sector	Transportation and vehicle fleet							
Technology	Transport powered by hydrogen fuel cells and charging infrastructure for it							
Ambition increases the resilience of the transport fleet and modernizes at least 5% of public transport by introducing hydrogen-powered vehicles and developing charging infrastructure for it.								
Benefits								
Action	**Activities to be implemented**	**Sources of funding**	**Responsible body and focal point**	**Time fra me**	**Risks**	**Success criteria**	**Indicators for Monitoring of Implementation**	**Budget per activity**
Action 1: Costs can be reduced by introducing fiscal measures, and imports can be reduced by reducing taxes.	Activity 1.1 Elaborate on the list of products necessary for implementing the technology in the country.	The Public Budget	Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	Limited access or restriction to the database and lists of products	Access to the database and lists of products	A list of products that need to be included in the tax reduction procedure is developed	**50.000,00**
	Activity 1.2 Drafting of the changes in the fiscal framework regarding tax reduction and proposal for approval by the government.	The Public Budget	Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	High inflation rates	Access to the fiscal framework regarding tax reduction	A document prepared by the procedure for approving the reduction of taxes on the import of the equipment	**50.000,00**
Action 2: Create the maintenance services for all products and equipment of	Activity 2.1 Identifying the value chain products and equipment required for the operation of the technology.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Access to the database and lists of products	A list of the equipment required for the operation of the technology is developed.	**50.000,00**

the value chain	Activity 2.2 Elaboration of repair & maintenance manuals	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Access to the existing repair & maintenance requirements manuals	Repair & maintenance manuals are developed	**50.000,00**
	Activity 2.3 Developing the capacities of companies providing maintenance services	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Availability and interest of the companies to attend the training course	At least ten companies attended a training course on providing maintenance services	**50.000,00**
Action 3: Reducing operating costs by creating and introducing supporting services on the whole value chain	Activity 3.1 Systematization of the supporting services on the whole value chain	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of local capacities	Access to the list of supporting services on the whole value chain	A list of supporting services on the whole value chain is developed	**50.000,00**
	Activity 3.2 Develop a Manual for supporting services on the whole value chain	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of local capacities	Availability of data and information about the supporting services	A Manual for supporting services on the whole value chain is developed	**50.000,00**
	Activity 3.3 Create a Center for Coordination and Support of the supporting services	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of local capacities	The interest of the main stakeholders and availability to cooperate	A Center for Coordination and Support of supporting services is operational.	**150.000,00**

Action 4: Develop a regulatory framework to respond to the need for the introduction of modern technology in the market	Activity 4.1 Assessment of the actual regulatory framework and identify the needs for modifications.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Lack of local capacities	Access to the actual regulatory framework	The actual regulatory framework is assessed to identify the need for modifications.	**50.000,00**
	Activity 4.2 Develop a new regulatory framework or introduction of modifications to the existing one.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of local capacities	Access to the actual regulatory framework	A new regulatory framework is developed	**150.000,00**
	Activity 4.3 Implement an awareness campaign to inform all stakeholders about the operation modifications.	Public Budget, Multilateral Organizations, Bilateral Organizations	Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of local capacities	Active involvement of the main stakeholders in the awareness campaign	An awareness campaign has been implemented at the national level to inform all stakeholders about the modifications that have been implemented.	**150.000,00**
Action 5: Supporting moving toward innovative technologies to respond to the new needs of the sector	Activity 5.1 Identify the gap and the obstacles to the introduction of hydrogen-powered transport in the transport sector	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Access to the data relating to the use of technology in the country	A gap analysis is conducted	**100.000,00**
	Activity 5.2 Identify the technologies that can respond to the need for innovation by introducing hydrogen-powered transport	The Public Budget, Multilateral Organizations Bilateral Organizations,	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Access to the data relating to the use of technology in the country	A list of the technologies that can respond to the need for innovation by introducing hydrogen-powered	**100.000,00**

							transport is developed	
	Activity 5.3 Develop a National Action Plan for the introduction of hydrogen-powered transport	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders, Lack of local capacities	Access to the data, information, regulations, and legal framework relating to the use of technology in the country	National Action Plan is developed	**100.000,00**
Action 6: Develop a public financing the mechanism that corresponds to the need for modernization of the transport sector	Activity 6.1 Identification of funding sources	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	High inflation rates, High interest rates	Availability of the financing programs/projects in the country	The source of funding is identified	**10.000.000,00**
	Activity 6.2 Development of the operational manual	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed	**200.000,00**
	Activity 6.3 Launch call for proposal and finance of the hydrogen-powered transport projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders	The interest of the companies in applying to the call for applications	At least ten research projects are identified and financed	**100.000,00**

Action 7: Creating a platform for cooperation between different stakeholders	Activity 7.1 Identify the main stakeholders at the national and international level	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	Access to the database and list of companies	A stakeholder analysis is conducted	**50.000,00**
	Activity 7.2 Develop a schedule and attend public events at the national and international levels.	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Limited budget for organization and attending public events at the national and international level	Availability of the stakeholders to attend public events	Key stakeholders attend at least 12 public events per year	**100.000,00**
	Activity 7.3 Support the creation of effective partnerships by signing cooperation agreements	Public Budget, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2026	Low interest of the main stakeholders	Availability and interest of the main stakeholders to sign cooperation agreements	Ten cooperation agreements are signed between key stakeholders	**100.000,00**
Action 8: Capacity building of all stakeholders of the value chain	Activity 8.1 Identification of the main stakeholders and their capacity-building needs.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders	Access to the database and list of companies	An assessment is conducted	**100.000,00**
	Activity 8.2 Develop the training curricula.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Lack of local capacities		A training curriculum is developed and ready to use in the training program.	**100.000,00**

	Activity 8.3 Implementation of the training program at the national level.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders	Access to the main training materials	At least 100 representatives of the main stakeholders are trained	**200.000,00**
Action 9: Creating a mechanism for supporting research in the transport sector.	Activity 9.1 Identification of the budget for the development of a financing mechanism for research in the transport sector	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2028	High inflation rates, High interest rates	Availability of the financing programs/projects in the country	A fund for financing the research in transport projects is established	**1.000.000,00**
	Activity 9.2 Development of the operation manual of the financing mechanism.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2028	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed and ready for use	**200.000,00**
	Activity 9.3 Launch call for proposal and finance of the research in the infrastructure projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional	2028	High inflation rates, High interest	The interest of the companies in applying to the call for applications	At least ten research in transport sector projects are identified and financed	**200.000,00**

			Development, Ministry of Finance, National Agency for Research and Development		rates, Low interest of the main stakeholders			
Action 10: Develop a technology transfer mechanism	Activity 10.1 Identification of the budget for the technology transfer mechanism	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2028	High inflation rates, High interest rates	Availability of the financing programs/projects in the country	A budget for the technology transfer mechanism is identified	**1.000.000,00**
	Activity 10.2 Development of the operation manual for the technology transfer mechanism	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2028	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed and ready for use	**200.000,00**

	Activity 10.3 Launch call for proposals for technology transfer projects	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2028	Low interest of the main stakeholders	The interest of the companies in applying to the call for applications	At least ten research technology transfer projects are identified and financed	**200.000,00**
Action 11: Promote technology at public events	Activity 11.1 Develop a schedule, organize, and attend public events at the national and international level	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2028	Lack of financing, Low interest of the main stakeholders	Availability of the stakeholders to attend of public events	Participation in at least 12 public events per year	**50.000,00**
	Activity 11.2 Identify the main stakeholders at the national and international level	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2028	Lack of financing, Low interest of the main stakeholders	Access to the database and list of the companies	At least 100 representatives of the main stakeholders (public and private entities) and their technologies and services are identified	**200.000,00**
	Activity 11.3 Establishing cooperation at the national and international level	The Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance	2026	Low interest of the main stakeholders	Availability and interest of the main stakeholders to sign cooperation agreements	As at least 50 collaboration agreements are signed	**200.000,00**

Action 12: Launch of a mechanism for financing and implementing pilot and demonstration projects on the local market	Activity 12.1 Identification of the budget for a mechanism for financing the pilot and demonstration projects on the local market	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2027	High inflation rates, High interest rates	Availability of the financing programs/project in the country	A budget for financing the pilot and demonstration projects on the local market is identified	**5.000.000,00**
	Activity 12.2 Development of the operation manual	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, National Agency for Research and Development	2027	Lack of local capacities for the development of the operation manual	Availability of the data and information about the activity of the financing entities	An operation manual is developed and ready for use	**200.000,00**
	Activity 12.3 Launch call for proposal and finance of the pilot and demonstration projects on the local market	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development, Ministry of Finance, National Agency for Research and Development	2027	High inflation rates, High interest rates, Low interest of the main stakeholders	The interest of the companies in applying to the call for applications	At least ten projects are identified and financed	**200.000,00**

Action 13: Increase awareness regarding the efficiency of technology by the organization of public events	Activity 13.1 Developing awareness-raising and outreach strategy.	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of financing	Access to media resources and promotion materials	An awareness-raising strategy is developed	**100.000,00**
	Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders, Lack of financing	Access to the database relating to the target audience	The target audience for the awareness-raising strategy is identified.	**100.000,00**
	Activity 13.3 Implementing the awareness-raising strategy using the most effective methods to achieve the target audience	Public Budget, Multilateral Organizations, Bilateral Organizations	State Road Administration, Ministry of Infrastructure and Regional Development	2027	Low interest of the main stakeholders	Access to the database relating to the target audience	One audio-visual material such as television, video, or documentary film is developed and promoted. One web page is developed and promoted. Official pages in social media are developed and promoted;	**500.000,00**

2. PROJECT IDEAS FOR THE TRANSPORT SECTOR

2.1. Brief Summary of the Project Ideas for the Transport Sector

The actions selected for TAP for each technology were set and grouped depending on the necessity of introducing the technologies to the local market.

The selected actions play a crucial role and are essential for the identified technologies. Considering the current situation of the national economy and the economic risks, international financial institutions are expected to finance most project ideas.

Each project idea from the selected ones is focused on covering the needs of introducing technology in the local market. The chosen actions cover the financial, legislative, organizational, and administrative requirements.

In the process of identifying technologies for the transport sector, three technologies have been prioritized with a potentially significant impact on adaptation of climate change. They are:

- Hot rolled asphalt (HRA), Technology 1.
- Autonomous Road Surveillance System (ARSS), Technology 2.
- Transport powered by hydrogen fuel cells and charging infrastructure for it, Technology 3.

2.2. Specific Project Idea: Develop a public financing mechanism to finance the introduction of hot-rooted asphalt (HRA) in infrastructure investment projects.

Item	Description
Introduction/Background	The next stage of the TAP is the development of project ideas. In the first stage, the TFSs were designed for each technology. Subsequently, they consulted with the main stakeholders of the transport sector. Stakeholders conducted extensive evaluations and discussions to select the most viable technology identified. In the second phase, the barriers were analyzed, and measures were identified. First, for each technology, the obstacles that prevent its introduction at the national level were grouped and analyzed. Subsequently, measures to overcome the given barriers were identified. The measures and actions identified are the basis of project ideas. They will contribute to the objectives of transfer diffusion and implementation of technologies for adapting the transport sector to climate change.,

The **objective** of the project	This project aims to make at least 300 km of national roads more resilient to climate change by rehabilitating them using hot-rolled asphalt (HRA) by the end of 2030.
The **outputs** of the project	**Action 1:** Create a mechanism for adequate up-front cost evaluation. **Output 1.1:** By the end of 2023, a database listing the products and services needed for infrastructure investment projects will be created and functional. **Output 1.2:** A guide on using the fiscal framework and taxes for infrastructure investment projects will be published at the end of 2023. **Action 2:** Develop efficient maintenance services. **Output 2.1:** Quality-control criteria for subcontractors and vendors are developed and adopted. **Output 2.2:** An information system for recording trouble calls and repairs will be developed and operational at the end of 2024. **Output 2.3:** The reports on monitoring the infrastructure quality are generated annually. **Action 3:** Introduce a cost and expense management process. **Output 3.1:** The cost and expense estimation model parameters are identified and introduced. **Output 3.2:** The costs and expenses estimating guidelines are developed. **Output 3.3:** Cost and expense management principles are translated into practice. **Action 4:** Develop an adequate regulatory framework. **Output 4.1:** An assessment of policy, regulatory, and institutional requirements is carried out. **Output 4.2:** A list of optimal solutions for modifying the legal framework or developing a new one is created. **Output 4.3:** A regulatory framework is adopted and put in place. **Action 5:** Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects. **Output 5.1:** The source of funding is identified. Output 5.2: An operation manual is developed. **Output 5.3:** The main stakeholders have the capacity to implement a public financing mechanism that corresponds to the needs of infrastructure investment projects. **Action 6:** Develop a Handbook for preparing and implementing investment projects. **Output 6.1:** The needs of the main stakeholders involved in implementing investment projects are assessed.

	Output 6.2: A concept for implementing investment projects is ready at the end of the year. **Output 6.3:** Capacity-building development projects are implemented at the national level. **Action 7:** Improve collaboration between different stakeholders. **Output 7.1:** A stakeholder analysis is conducted. **Output 7.2:** At least 12 public events per year are attended by key stakeholders. **Output 7.3:** 10 cooperation agreements are signed between key stakeholders. **Action 8:** Support research in infrastructure projects. **Output 8.1:** A fund for financing research in infrastructure projects is established. **Output 8.2:** An operation manual is developed and ready for use. **Output 8.3:** At least ten infrastructure research projects have been identified and financed. **Action 9:** Introduce quality management systems for the infrastructure/construction projects. **Output 9.1:** New quality procedures and standards are developed and adapted nationally. **Output 9.2:** The new quality management forms and documentation are developed and ready to use. **Output 9.3:** The main stakeholders have capacities to quality management systems for the infrastructure/construction projects. **Output 9.4:** The critical staff is identified and works based on newly developed and adapted quality standards. **Action 10:** Develop technical and business management skills for all stakeholders. **Output 10.1:** An assessment is conducted to identify the main stakeholders and their needs. **Output 10.2:** A training curriculum is developed and ready to use in the training program. **Output 10.3:** At least 100 representatives of the main stakeholders are trained. **Action 11:** Dissemination of technology. **Output 11.1:** Participation of the main stakeholders in at least 50 public events at the national and international levels. **Output 11.2:** At least 100 representatives of the main stakeholders (public and private entities) and their technologies and services are identified.

	Output 11.3: At least 50 collaboration agreements are signed between the main stakeholders at the national and international levels. **Action 12:** Implement pilot and demonstration projects on the local market. **Output 12.1:** A fund for financing the technology transfer projects in infrastructure/construction is established. **Output 12.2:** An operation manual is developed and ready for use. **Output 12.3:** At least ten technology transfer projects are identified and financed. **Action 13:** Raise awareness regarding the efficiency of the technology. **Output 13.1:** An awareness-raising strategy is developed. **Output 13.2:** The target audience for the awareness-raising strategy is identified. **Output 13.3:** One audio-visual material such as television, video, or documentary film is developed and promoted.
Description of the technology	Permanent road pavement (asphalt concrete, cement concrete, and bituminous mixtures executed in situ). The government's strategy focuses on rehabilitating covered roads and expanding the infrastructure. Hot-rolled asphalt (HRA) is a dense mixture of mineral aggregate, sand, filler, and bitumen that will change the old system of asphalt pavements. First, it will change the asphalt structure and composition, the paving model, and the periodic maintenance process, considering that being more durable, maintenance will be needed less often. Introducing Hot-Rolled Asphalt (HRA) will make the transport infrastructure more resistant, stable, and strengthened. Also, the maintenance services will be changed, considering the new needs and criteria.
Project activities	**Action 1:** Create a mechanism for adequate up-front cost evaluation. **Activity 1.1** Creating a database for the products and services needed for infrastructure investment projects. Year: 1 **Activity 1.2** Analysis and systematization of the fiscal framework and assessment of import taxes for infrastructure investment projects. Year: 1 **Action 2:** Develop efficient maintenance services.

	Activity 2.1 Develop quality-control criteria for subcontractors and vendors. Year: 1 **Activity 2.2** Introducing the information system for recording trouble calls and repairs. Year: 1 **Activity 2.3** Generating reports to monitor the quality of the infrastructure. Year: 1 **Action 3:** Introduce the costs and expense management process. **Activity 3.1** Identify and introduce parameters for the cost estimation model. Year: 1 **Activity 3.2** Developing cost estimating guidelines. Year: 1 **Activity 3.3** Translating cost management principles into practice. Year: 1 **Action 4:** Develop an adequate regulatory framework. **Activity 4.1** Assess the policy, regulatory, and institutional requirements. Year: 1 **Activity 4.2** Proposing optimal solutions for modifying the legal framework or developing a new one. Year: 1 **Activity 4.3** Pursuing the necessary procedures for the adoption of the legal framework. Year: 1 **Action 5:** Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects. **Activity 5.1** Identification of funding sources. Year: 2 **Activity 5.2** Development of the operational manual. Year: 2 **Activity 5.3** Capacity building and institutional strengthening of the entities involved. Year: 2 **Action 6:** Develop a Handbook for preparing and implementing investment projects. **Activity 6.1** Assessment of the needs of the main stakeholders involved in implementing the investment projects. Year: 1 **Activity 6.2** Formulation of a concept for the implementation of investment projects. Year: 1 **Activity 6.3** Designing and implementing capacity development projects. Year: 1 **Action 7:** Improve collaboration between different stakeholders. **Activity 7.1** Identify the main stakeholders at the national and international levels. Year: 1 **Activity 7.2** Develop a schedule and attend public events at the national and international levels. Year: 1 **Activity 7.3** Support the creation of effective partnerships by signing cooperation agreements. Year: 1

	Action 8: Support research and technology transfer projects in infrastructure. **Activity 8.1** Identify the budget for creating a fund to finance the infrastructure research and technology transfer projects. Year: 3 **Activity 8.2** Development of the operation manual of the financing mechanism. Year: 3 **Activity 8.3** Launch call for proposal and finance of the infrastructure research and technology transfer projects. Year: 3 **Action 9:** Introduce quality management systems for the infrastructure/construction projects. **Activity 9.1** Establishing new quality procedures and standards. Year: 3 **Activity 9.2** Development of the unique quality management forms and documentation. Year: 3 **Activity 9.3** Capacity building and institutional strengthening of the entities involved. Year: 3 **Action 10:** Develop all value chain stakeholders' technical and business management skills. **Activity 10.1** Identification of the main stakeholders and their needs for technical and business management skills. Year: 3 **Activity 10.2** Develop the training curricula. Year: 3 **Activity 10.3** Implementation of the training program at the national level. Year: 3 **Action 11:** Promote technology at public events. **Activity 11.1** Develop a schedule and attend public events at the national and international levels. Year: 3 **Activity 11.2** Identify the main stakeholders at the national and international levels. Year: 3 **Activity 11.3** Establishing cooperation at the national and international levels. Year: 3 **Action 12:** Implement pilot and demonstration projects on the local market. **Activity 12.1** Identify the budget for creating a fund to finance the pilot and demonstration projects on the local market. Year: 3 **Activity 12.2** Development of the operation manual. Year: 3 **Activity 12.3** Launch call for proposal and finance of the pilot and demonstration projects on the local market. Year: 3 **Action 13:** Raise awareness regarding the efficiency of the technology. **Activity 13.1** Developing the awareness-raising strategy. Year: 3

	Activity 13.2 Identifying the target audience and tailoring the awareness-raising initiative appropriately. Year: 3 **Activity 13.3** Implementing the awareness-raising strategy using the most effective methods to achieve the target audience. Year: 3
Budget/Resource requirements	The estimated costs of the project idea are 36.000.000 USD; the estimated prices are listed below: **Action 1:** Create a mechanism for adequate up-front costs evaluation: 100.000,00 **Action 2:** Develop efficient maintenance services: 100.000,00 **Action 3:** Introduce a cost and expenses management process: 150.000,00 **Action 4:** Develop an adequate regulatory framework: 150.000,00 **Action 5:** Develop a public financing mechanism that corresponds to the needs of infrastructure investment projects: 10.400.000,00 **Action 6:** Develop a Handbook for the preparation and implementation of investment projects: 250.000,00 **Action 7:** Improve collaboration between different stakeholders: 250.000,00 **Action 8:** Support research in the infrastructure projects: 15.200.000,00 **Action 9:** Introduce quality management systems for the infrastructure/construction projects: 300.000,00 **Action 10:** Develop technical and business management skills of all stakeholders of the value chain: 400.000,00 **Action 11:** Promote the technology at public events: 400.000,00 **Action 12:** Implement pilot and demonstration projects on the local market: 10.200.000,00 **Action 13:** Raise awareness regarding the efficiency of the technology: 700.000,00 The high-interest rates and inflation rates registered in the last year directly affect the country's investment process. In the next period of 2-3 years, it is expected that the interest rates will still be at high indicators. In this situation, the investment projects could be implemented only with the support of multilateral and bilateral organizations. Although, as usual, the budget of these organizations is minimal for the republic of Moldova, it is recommended to focus activity on synchronizing the available budgets and financing opportunities.
Engaging consultants, partnerships, etc.	The key stakeholder groups in road maintenance in Moldova are the government organizations in charge of organizing, carrying out, and funding these operations; contractors; and other parties involved in carrying out the works, which makes

	it challenging for all of them to coordinate. In addition, the Ministry of Finance also contributes significantly to the distribution and source of financing. The leading consultative group should be part of or represent the interest of the critical stakeholders, especially the Ministry of Infrastructure and Finance.
Measurement/Evaluation.	The public sector accounts for much of the country's economic activity and public investment. Public investments are often recognized as powerful catalysts for economic recovery. Fixing the measures to be monitored is essential for implementing long-term policies. In this project, each action has an indicator for monitoring, as mentioned in Table nr. 3. TAP Overview.
Possible complications/challenges.	The possible complications/challenges are related to the risks of the project's implementation, especially the high inflation rates, which reached a record 33.5 percent in August of 2022, the highest in Europe. They are hurting the living standards of an already impoverished population. Also, because of the economic crisis in the country, it is expected that the key stakeholders will pay more attention to social problems, and the public budget will focus on social needs. One of the challenges for this project is that high interest rates directly affect the investment process. In the next 2-3 years, it is expected that interest rates will still be high. In this situation, investment projects could be implemented only with the support of multilateral and bilateral organizations.
Responsibilities and coordination	The project's main actions and activities are planned to be executed by three main entities: the State Road Administration, the Ministry of Infrastructure and Regional Development, and the Ministry of Finance. The Ministry of Infrastructure and Regional Development will be responsible for the technical and legal components of the project. The Ministry of Finance will coordinate activities related to financing and budgeting. The State Road Administration will be responsible for executing the investment projects.

2.3. Specific Project Idea: Installing the autonomous road surveillance system (ARSS) will improve public traffic in difficult weather conditions and reduce road accidents.

Item	Description
Introduction/Background	The TAP's first phase involves developing the project idea. In this phase, the TFSs for each technology were created, and then they were discussed with the transport sector's critical stakeholders. Stakeholders undertook in-depth analyses and discussions to determine which technology is the most viable for implementation in the Republic of Moldova. The second phase completed the assessment of the barriers and the selection of remedial actions. The hurdles that limit the implementation of each technology at the national level were categorized and examined, and the steps necessary to remove them were determined. Project ideas are built on defined measures and actions. They will support the goals of transferring, disseminating, and implementing technology to adapt the transport sector to climate change.
The **objective** of the project	The project aims to improve public traffic in difficult weather conditions and reduce road accidents by 10% by 2030 by installing the Autonomous Road Surveillance System (ARSS) on the most critical public roads.
The **outputs** of the project	**Action 1:** Development and implementation of the regulatory framework. **Output 1.1:** An assessment of policy, regulatory, and institutional requirements is carried out. **Output 1.2:** A list of optimal solutions for modifying the legal framework or developing a new one is created. **Output 1.3:** A regulatory framework is adopted and put in place. **Action 2:** Improve collaboration between different stakeholders. **Output 2.1:** A stakeholder analysis is conducted. **Output 2.2:** At least six public events per year are attended by key stakeholders. **Output 2.3:** 6 cooperation agreements are signed between key stakeholders. **Action 3:** Implement capacity-building programs for the main stakeholders.

	Output 3.1: An assessment of the identification of the main stakeholders and their needs for capacity-building is conducted. **Output 3.2:** A training curriculum is developed and ready to use in the training program. **Output 3.3:** At least 100 representatives of the main stakeholders are trained. **Action 4:** Create a PPP to implement the ARSS in Moldova. **Output 4.1:** The policy, regulatory and institutional requirements for creating the PPP is assessed. **Output 4.2:** A set of documents as operational manuals and templates for the dossier of a PPP is developed. **Output 4.3:** A PPP is created and is functional. **Action 5:** Implementation of the small pilot and demonstration projects. **Output 5.1:** A budget for financing the small pilot and demonstration projects is identified. **Output 5.2:** An operation manual is developed and ready for use. **Output 5.3:** At least three projects are identified and financed in the main cities of Moldova (Chisinau, Balti, and Cahul).
Relationship to the country's sustainable development priorities	Access to safe road infrastructure directly marks the country's quality of life and economic development. In addition, safety on the road increases the traffic and commercialization of merchandise and will increase private investment in public goods and services. Government Decision **no. 827 of 28.10.2013** approved the Transport and Logistics Strategy for 2013-2022. Implementing the strategy's investment program will determine the optimization of accessibility and capacity to increase freight volumes and the number of passengers carried. Furthermore, the technology proposed by this project will help reduce road accidents by creating an efficient traffic control system that detects and counts vehicles at various times and locations. Government Decision **no. 1470 of 30.12.2016** approved the Low Emission Development Strategy of the Republic of Moldova until 2030 and the Action Plan for its implementation. Technological solutions on public roads will reduce the environmental population through efficient transport circulation.

	Technology will lead to more efficient car use. Likewise, improved infrastructure will lead to more efficient fuel consumption, reducing CO2 emissions from public transport.
Project deliverables	A surveillance road system that will reduce by 10% road accidents in 2030 by installing the Autonomous Road Surveillance System (ARSS) on the most critical public roads.
Project scope and possible implementation.	Considering the problem of transport infrastructure, providing access to safe, affordable, accessible, and sustainable transport systems for all and improving road safety, notably by expanding public transport. Technology will support one of the country's strategic development priorities: adopting intelligent technological solutions to enhance road safety. Technology will change the paradigm of monitoring and surveillance of public traffic and roads. The system will introduce new concepts on machine vision, pattern recognition, human detection, object detection, tracking, and video surveillance based on a pre-processing algorithm that determines the contour of an object depending on the application. As the system is fully autonomous, sustainability will be ensured by reducing the costs for the technical personnel. Also, the system will contribute to the sustainability of the entire transport sector by increasing traffic efficiency. At the community level, safety will increase cohesion between people, public administration, and the business environment, creating preconditions for satisfying everyone's needs.
Project activities	All activities of the project are planned to be implemented for six years. **Action 1:** Development and implementation of the regulatory framework **Activity 1.1** Assess the policy, regulatory, and institutional requirements: Year: 1 **Activity 1.2** Proposing optimal solutions for modifying the legal framework or for developing a new one: Year 1. 2024 **Activity 1.3** Pursuing the necessary procedures for the adoption of the legal framework: Year: 2 **Action 2:** Improve collaboration between different stakeholders **Activity 2.1** Identify the main stakeholders at the national and international level: Year: 2

	Activity 2.2 Develop a schedule and attend public events at the national and international level: Year: 2 **Activity 2.3** Support in the creation of effective partnerships by signing the cooperation agreements: Year: 3 **Action 3:** Implement capacity-building programs for the main stakeholders. **Activity 3.1** Identification of the main stakeholders and their needs for capacity-building: Year: 3 **Activity 3.2** Develop the training curricula: Year: 3 **Activity 3.3** Implementation of the capacity-building program at the national level: Year: 3 **Action 4:** Create a PPP to implement the ARSS in Moldova. **Activity 4.1** Assess the policy, regulatory, and institutional requirements for the creation of the PPP: Year: 3 **Activity 4.2** Development of the operational manual and templates for the dossier of a PPP: Year: 3 **Activity 4.3** Designing and implementing a PPP: Year: 6
Budget/Resource requirements	The estimated costs of the project idea are 950.000 USD; the estimated prices are listed below: **Action 1:** Development and implementation of the regulatory framework: 150,000 USD. **Action 2:** Improve collaboration between different stakeholders: 200,000 USD. **Action 3:** Implement capacity-building programs for the main stakeholders: 300,000 USD. **Action 4:** Create a PPP to implement the ARSS in Moldova: 300,000 USD. The country's investment process has been strongly impacted by recent years' high interest rates and high inflation rates. Moreover, interest rates will remain high over the next two to three years. The only way investment projects can be carried out in this circumstance is with the assistance of bilateral and international organizations. Therefore, the best solution is to concentrate efforts on the synchronization of the available public budgets and financing options of the bilateral organizations.
Engaging consultants, partnerships, etc.	The key stakeholders in road surveillance in Moldova are the government organizations responsible for organizing, carrying out, and funding these operations. The main counterparts in this project are the General Police Inspectorate, the Ministry of Infrastructure and Regional Development, and the State-owned enterprise State Road

	Administration of Moldova. Therefore, the leading consultative group should be part of or represent the interests of the critical stakeholders, especially the Ministry of Infrastructure and Finance.
Measurement/Evaluation	The public sector accounts for much of the country's economic activity and public investment. Public investments are often recognized as powerful catalysts for economic recovery, and for implementing long-term policies, it is essential to fix the measures to be monitored. In this project, each action has an indicator for monitoring, as mentioned in Table No. 4. TAP Overview.
Possible complications/challenges	The possible complications/challenges for this project are the high inflation rates, which hit a record high of 33.5 percent in August 2022 and are tied to the potential problems and obstacles to implementation. Additionally, it is anticipated that the key stakeholders will focus on social issues and that the public budget will concentrate on addressing social needs because of the country's economic crisis. One issue for this project is the high interest rates, which directly impact on the country's investing process. Interest rates will remain high over the next two to three years. In this circumstance, the only way the investment projects would be implemented would be with the assistance of bilateral and international organizations.
Responsibilities and coordination	The General Police Inspectorate, the Ministry of Infrastructure and Regional Development, and the State-owned enterprise State Road Administration of Moldova are the three major organizations responsible for the project's primary operations and activities. The General Police Inspectorate and the Ministry of Infrastructure and Regional Development will handle the project's technical and legal aspects. The Ministry of Finance will coordinate the financing and budgeting of the activities. Additionally, the General Police Inspectorate will carry out the investment projects and manage the PPPs.

2.4. Specific Project Idea: Increase the resilience of the transport fleet by introducing hydrogen-powered vehicles and developing charging infrastructure for it.

Item	Description
Introduction/Background	The final phase of the TAP is the development of project ideas. The TFS for this technology, developed in the first phase and discussed with the critical stakeholders of the transport sector, was analyzed, considering its importance and innovative solutions for implementation. In addition, stakeholders undertook in-depth analyses and discussions to determine its advantages. The second phase completed the analysis of the obstacles and the identification of the measures. The hurdles that limit the implementation of each technology at the national level were categorized and examined, and the measures necessary to remove them were determined. The project idea is developed based on defined actions and activities. They will support the goals of transferring, diffusing, and implementing technology for adapting the transport sector to climate change.
The **objective** of the project	This project aims to increase the resilience of at least 5% of public transport by introducing hydrogen-powered vehicles and developing charging infrastructure by 2030.
The **outputs** of the project	**Action 1:** Reducing costs by introducing fiscal measures and imports by reducing taxes. **Output 1.1:** A list of products that must be included in the tax reduction procedure is developed. **Output 1.2:** A document prepared following the procedure for approving the reduction of taxes on equipment import. **Action 2:** Creating the maintenance services for all products and equipment of the value chain. **Output 2.1:** A list of the equipment required to operate the technology is developed. **Output 2.2:** A repair & maintenance manual is developed. **Output 2.3:** At least ten companies attended a training course on providing maintenance services. **Action 3:** Reducing operating costs by creating and introducing supporting services on the whole value chain. **Output 3.1:** A list of the supporting services on the whole value chain is developed.

	Output 3.2: A Manual for supporting services on the whole value chain is developed. **Output 3.3:** A Center for Coordination and Support of the supportive services is operational. **Action 4:** Develop a regulatory framework to respond to the need to introduce modern technology in the market. **Output 4.1:** An assessment of the existing regulatory framework to identify the need for modifications is conducted. **Output 4.2:** A new regulatory framework is developed. **Output 4.3:** An awareness campaign to inform all stakeholders about the operating modifications is implemented nationally. **Action 6:** Develop a public financing mechanism for modernizing the transport sector. **Output 6.1:** The funding source for creating the financing mechanism is identified. **Output 6.2:** An operation manual of the financing mechanism is developed. **Output 6.3:** At least ten research projects are identified and financed. **Action 8:** Capacity building of all stakeholders of the value chain. **Output 8.1:** An assessment of the identification of the main stakeholders and their capacity-building needs is conducted. **Output 8.2:** A training curriculum is developed and ready to use in the training program. **Output 8.3:** At least 100 representatives of the main stakeholders attended the training program at the national level. **Action 9:** Creating a mechanism for supporting research in the transport sector. **Output 9.1:** A fund for financing the research in the transport projects is established. **Output 9.2:** An operation manual of the financing mechanism is developed and ready for use. **Output 9.3:** At least ten research in transport sector projects are identified and financed. **Action 10:** Develop a technology transfer mechanism. **Output 10.1:** A budget for the technology transfer mechanism is identified. **Output 10.2:** An operation manual for the technology transfer mechanism is developed and ready for use.

	Output 10.3: Ten research technology transfer projects are identified and financed.
Relationship to the country's sustainable development priorities	Until 2022, hydrogen was avoided in the primary sector strategies. Only 2022 is included in the Energy Strategy for 2030 and 2050. For the period after 2030, the possibility of sectoral coupling and the inclusion of hydrogen and small-scale nuclear energy in the energy mix will be evaluated. Domestic production of biofuels from waste, residues, biomass, and green hydrogen will be encouraged. In the long term, the country should assess the possibility of sectoral coupling and include hydrogen and small-scale nuclear power in the energy mix. The enabling actions will focus on introducing technical conditions for large-scale electricity storage facilities or adapting gas infrastructure for hydrogen transport. Considering Ukraine's strategy to play an essential role as a regional center and a vital partner in the EU hydrogen and biomethane market, the Republic of Moldova will analyze the possibility of using blended or dedicated hydrogen.
Project deliverables	By the end of 2030, introducing hydrogen-powered vehicles and developing charging infrastructure will make at least 5% of public transport more resilient.
Project scope and possible implementation	The scope for the transport powered by hydrogen fuel cells and charging infrastructure for it is set according to the main objectives of the Transport and Logistics Strategy for 2013-2022, the Environmental Strategies for 2014-2023, and the Low Emission Development Strategy of the Republic of Moldova until 2030. By introducing transportation powered by hydrogen fuel cells, the fleet will be updated to meet high standards, and the impact of the transportation industry on climate change will be lessened.

Project activities	**Action 1:** Reducing costs by introducing fiscal measures and imports by reducing taxes. **Activity 1.1** Elaboration of the list of products necessary for the implementation of technology in the country: Year: 1 **Activity 1.2** Drafting of the changes in the fiscal framework regarding tax reduction and proposal for approval by the government: Year: 1 **Action 2:** Creating maintenance services for all products and equipment in the value chain. **Activity 2.1** Identifying the value chain products and equipment required for the operation of the technology: Year: 1 **Activity 2.2** Elaboration of repair & maintenance manuals: Year: 1 **Activity 2.3** Developing the capacities of companies providing maintenance services: Year: 1 **Action 3:** Reducing operating costs by creating and introducing supporting services on the whole value chain. **Activity 3.1** Systematization of the supporting services on the whole value chain: Year: 2 **Activity 3.2** Develop a Manual for supporting services on the whole value chain: Year: 2 **Activity 3.3** Create a Center for Coordination and Support of the supporting services: Year: 2 **Action 4:** Develop a regulatory framework to respond to the need to introduce modern technology in the market. **Activity 4.1** Assessment of the actual regulatory framework and identify the needs for modifications: Year: 2 **Activity 4.2** Develop a new regulatory framework or introduction of modifications to the existing one: Year: 2 **Activity 4.3** Implement an awareness campaign to inform all stakeholders about the modifications operated: Year: 2 **Action 6:** Develop a public financing mechanism for modernizing the transport sector. **Activity 6.1** Identification of funding sources: Year: 1 **Activity 6.2** Development of the operational manual: Year: 2 **Activity 6.3** Launch call for proposal and finance of the hydrogen-powered transport projects: Year: 2 **Action 8:** Capacity building of all stakeholders of the value chain. **Activity 8.1** Identification of the main stakeholders and their capacity-building needs: Year: 2 **Activity 8.2** Develop the training curricula: Year: 2

	Activity 8.3 Implementation of the training program at the national level: Year: 2 **Action 9:** Creating a mechanism for supporting research in the transport sector. **Activity 9.1** Identification of the budget for the development of a financing mechanism for the research in the transport sector: Year: 3 **Activity 9.2** Development of the operation manual of the financing mechanism: Year: 3 **Activity 9.3** Launch call for proposal and finance of the research in the infrastructure projects: Year: 3 **Action 10:** Develop a technology transfer mechanism. **Activity 10.1** Identification of the budget for the technology transfer mechanism: Year: 3 **Activity 10.2** Development of the operation manual for the technology transfer mechanism: Year: 3 **Activity 10.3** Launch call for proposal for technology transfer projects: Year: 3
Budget/Resource requirements	The estimated costs of the project idea are 14.350.000 USD; the estimated prices are listed below: **Action 1:** Reducing costs by introducing fiscal measures and imports by reducing taxes. 100.000 USD **Action 2:** Creating maintenance services for all products and equipment in the value chain. 150.000 USD **Action 3:** Reducing operating costs by creating and introducing supporting services on the whole value chain. 250.000 USD **Action 4:** Develop a regulatory framework to respond to the need to introduce modern technology in the market. 350.000 USD **Action 6:** Develop a public financing mechanism for modernizing the transport sector. 10.300.000 USD **Action 8:** Capacity building of all stakeholders of the value chain. 400.000 USD **Action 9:** Creating a mechanism for supporting research in the transport sector. 1.400.000 USD **Action 10:** Develop a technology transfer mechanism. 1.400.000 USD The country's investment process has been highly affected by recent years' high interest rates and high inflation rates. Interest rates are expected to remain at high levels over the next two to three years. The only way investment projects can be carried out is through financing from bilateral and

	international organizations. Therefore, it is advised that efforts be concentrated on synchronizing the multilateral organizations' available budgets and financing options.
Possible complications/challenges	The possible complications/challenges are related to the high inflation rates that hit a record high of 33.5 percent in August 2022. Additionally, it is anticipated that significant stakeholders will pay attention to social issues and that the public budget will be focused on addressing social needs due to the local economic crisis. One issue for this project is the high interest rates directly impacting the investment process. Interest rates will remain high over the next two to three years. In this circumstance, the only way the investment projects could be carried out is through cooperation with bilateral and international organizations.
Responsibilities and coordination	Two public entities, the State Road Administration and the Ministry of Infrastructure and Regional Development, plan to execute the project's main actions and activities. The Ministry of Infrastructure and Regional Development will be responsible for the technical and legal components of the project relating to the development of the red charging infrastructure, and the State Road Administration will be responsible for executing the investment projects. The Ministry of Finance will coordinate public budgeting activities to acquire municipal entities' transport fleets.

ANNEX 1. The composition of the sectoral Working Group, Transport Sector.

Nr.	SubSector	Category	Title	Person	Contacts
2	All	Government Institutions / Ministries	The Energy Efficiency Agency	Ms. Irina Țerigradean	Chișinău, str. Alecu Russo 1, bloc A1, Etajul 10, MD-2068 Tel: (+373) 22 311 001 email: office@aee.md, info@aee.md; irina.terigradean@aee.md
3	All	Government Institutions / Ministries	The National Agency for Energy Regulation	Mr. George MARTÎNIUC	A. Pușkin str.,no 52/A, MD-2005 Chișinău, Republica Moldova Tel: 022 823 951 Email: gmartiniuc@anre.md
5	All	Government Institutions / Ministries	The General Police Inspectorate (GPI)	Mr. Vladimir CAZACOV	MD-2001, mun.Chişinău, str. Tiraspol, nr. 11/1 tel: +373 (22) 868-018 fax: +373 (22) 868-114 vladimir.cazacov@igp.gov.md ion.gurdis@igp.gov.md
6	All	Government Institutions / Ministries	The National Transport Agency	Ms. Natalia PORUBAEV	MD-2001, Chişinău, str. Aleea Gării 6 Tel.: (+373 22) 22 06 57 Fax: (+373 22) 444 003 e-mail: anta@anta.gov.md
7	All	Government Institutions / Ministries	National Agency for Research and Development	Ms. Olga DAVIDENCO	MD-2004, mun. Chișinău, bd. Ștefan cel Mare și Sfânt, 180 Tel: 022-272-791 Fax: 022-296-271 Email: olga.davidenco@ancd.gov.md Igor Chiosa 022 29 48 61 igor.chiosa@ancd.gov.md

8	Road Transport	Sectoral Company	The State Enterprise "Posta Moldovei"	Mr. Ion TURCANU	bd. Ștefan cel Mare și Sfânt, 134, MD-2012, mun. Chișinău, Tel.: +373 22 270 044 Email: anticamera@posta.md, ion.turcan@posta.md
9	Road Transport	Professional associations	Asociația Internațională a Transportatorilor Auto din Moldova (AITA)	Mr. Petru MITITIUC	bd. Dimitrie Cantemir, nr. 3/1, mun. Chisinau, MD-2001, Republica Moldova Tel: 069711833, 022-57 25 00 Fax: (+373 22) 27-88-37, 27-88-38 E-mail: mititiuc@aita.md
10	All	Research/Education Entities	The Institute of Power Engineering	Mr. Sergiu ROBU	str. Academiei 5, mun. Chisinau, MD-2028 Tel: (+373 22) 72 70 40 Fax: (+373 22) 73 53 82, 73 53 86 Email: tirsu.mihai@gmail.com, energplan.srl@gmail.com
11	All	Research/Education Entities	The Center of Excellence in Construction	Ms. Elena NICOLAEV	Str. Asachi 71, mun. Chișinău, MD-2028 Tel: 022 721 234, Email: catedra.acgv@gmail.com
12	Air Transport	Government Institutions / Ministries	The Civil Aviation Authority	Ms. Veronica ONEȘCIUC	mun. Chisinau, bd. Dacia 80/2, MD-2026 Tel: + 373 22 823 593; +373 79526879 E-mail: info@caa.gov.md, veronica.onesciuc@caa.gov.md

ANNEX 2. TECHNOLOGY FACT SHEETs TRANSPORT SECTOR, short format .

Domain	Infrastructure
The Technology (technological solution) Nr. 1	Intelligent traffic signal control system[1]
The Legal Framework	- Law no. 1422 of 17.12.1997 on the protection of atmospheric air - Law no. 1540 of 25.02.1998 regarding the payment for environmental pollution. - Government Decision no. 827 of 28.10.2013 on approving the Transport and Logistics Strategy for 2013-2022. - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation.
Brief description of the technology	The technological solution for real-time traffic signal control combines research from artificial intelligence and traffic theory using various parameters like performance, efficiency, flexibility, and sustainability, increasing traffic circulation in cities. It optimizes signal performance for on-road traffic, improving traffic flow and resulting in shorter wait times, less congestion, shorter journeys, and less pollution. As a result of the implementation of the technology, millions of cars, trucks, busses, and other motorized two-wheelers on busy roads will reduce the population and will be more efficient on the road.
Investment cost and profitability	The main components (per unit): - Traffic detection sensors - Video surveillance equipment - Computer Workstation - Server - Software - The cost of a system for monitoring at least 10 interjections costs 480.000 USD - The cost of the project: 3,840,000 USD
Market potential	The system can be implemented in the major cities / municipalities of Moldova as: - Chisinau and Balti municipality - Cities : Anenii Noi, Briceni, Cahul, Ialoveni, Orhei, Ungheni
Impact and benefits of adaptation	- Further improvements of the operations and services of the transport infrastructure. - Increasing operations in the new conditions created by climate change.

[1] https://www.atlantis-press.com/journals/ijcis/125941268/view

Domain	Infrastructure
The Technology (technologically solution) Nr. 2	Autonomous street lighting system based on solar energy
The Legal Framework	- Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021
Brief description of the technology	- The autonomous street lighting system based on solar energy as the primary source, batteries as a secondary source, and light-emitting diodes (LEDs) as a lighting source. This system is presented as an alternative for remote localities, like roads, crossroads, and tourist places. The energy consumed by public lighting is for lighting by lamps. The consumption of the lamps can be changed to the minimum brightness level required by outdoor lighting standards and the traffic on the roads. Also, this can be programmed to different lighting regimes depends on the period of the day, seasons, or weather conditions. The solar PV panel produces sufficient energy to charge the battery and to guarantee autonomous functioning. The integrated solar-powered system provides a convenient and cost-effective way to light streets, gardens, courtyards, residences, paths, branch roads, parks, etc.[2]
Investment cost and profitability	The main components (per unit): - Solar panel - Pillar - Battery - LED - Sensors (motion, weather, etc.) - The cost for one unit starts from 2.200 USD - The cost of the project: 44,000,000 USD
Market potential	- In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0% and requires urgent interventions[3].
Impact and benefits of adaptation	- Creation of an adaptive and autonomous infrastructure - Money savings from efficient use of electricity produced by solar PV - Reduction of the CO2 Emission on the electricity production process.

[2] https://www.academia.edu/27065481/Smart_Autonomous_Street_Light_Control_System

[3] https://statistica.gov.md/newsview.php?l=ro&idc=168&id=6354

Domain	Infrastructure
The Technology (technologically solution) Nr. 3	Street Lighting Remote Control Management System
The Legal Framework	- Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021
Brief description of the technology	- The system utilizes wireless technology and employs RF/GSM technology to program, monitoring, and control geographically distributed remote streetlights. The system is equipped with controllers that contain communication and monitoring modules that provide regular streetlight status updates to the Master Control Station (MCS). The control system provides different control modes for controlling the light bulbs that can be remotely programmed from web-based software. Lamps can be remotely controlled based on user configurable ON and OFF schedules that can be programmed on a daily/monthly/yearly basis or can be controlled locally based on a clock that accurately calculates sunset and sunrise times using location and time zone data throughout the year. Thus the streetlights continue to be operated even when the communication link fails.
Investment cost and profitability	The main components (per unit): - LED lamp - Controllers that contain communication and monitoring modules - Sensors (motion, weather, etc.) - Master Control Station (MCS) - The cost for one unit starts from 570 USD - The cost of the project: 11,400,000 USD
Market potential	- In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. - In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0% and requires urgent interventions[4].
Impact and benefits of adaptation	- Increasing integration of the local transport sector within the international network. - Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services.

[4] https://statistica.gov.md/newsview.php?l=ro&idc=168&id=6354

Domain	Infrastructure
The Technology (technologically solution) Nr. 3	Street Lighting Remote Control Management System
The Legal Framework	- Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021
Brief description of the technology	- The system utilizes wireless technology and employs RF/GSM technology to program, monitoring, and control geographically distributed remote streetlights. The system is equipped with controllers that contain communication and monitoring modules that provide regular streetlight status updates to the Master Control Station (MCS). The control system provides different control modes for controlling the light bulbs that can be remotely programmed from web-based software. Lamps can be remotely controlled based on user configurable ON and OFF schedules that can be programmed on a daily/monthly/yearly basis or can be controlled locally based on a clock that accurately calculates sunset and sunrise times using location and time zone data throughout the year. Thus the streetlights continue to be operated even when the communication link fails.
Investment cost and profitability	The main components (per unit): - LED lamp - Controllers that contain communication and monitoring modules - Sensors (motion, weather, etc.) - Master Control Station (MCS) - The cost for one unit starts from 570 USD - The cost of the project: 11,400,000 USD
Market potential	- In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. - In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0% and requires urgent interventions[5].
Impact and benefits of adaptation	- Increasing integration of the local transport sector within the international network. - Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services.

[5] https://statistica.gov.md/newsview.php?l=ro&idc=168&id=6354

Domain	Infrastructure
The Technology (technologically solution) Nr. 4	Autonomous Road Surveillance System (ARSS)[6]
The Legal Framework	- Government Decision no. 40 of 17.01.2012 on the approval of the Concept of the Automated Road Traffic Monitoring System "Traffic Control" - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation -
Brief description of the technology	- Image processing has a wide range of applications. Based on this, machine vision, pattern recognition, human detection, object detection and tracking, video surveillance system, etc. are developed. The pre-processing algorithm determines the contour of an object depending on the application. Once the object is detected and located, its boundary can be found by using edge detection and boundary following algorithms. For object detection and recognition in video surveillance, various approaches are proposed. The system works in multi-threaded mode can automatically detect changes in the traffic flow, such as the ones due to construction works or accidents. In those cases, the system switches back to the learning mode without the necessity of human intervention. In the system, the maps and GPS are used to localize the car in the roundabout setting; however, the traffic signals and vehicle turning in roundabouts are determined using a group of sensor data that can be generally classified into two subgroups, namely, traveling distance and direction sensors. The sensor fusion model can be used to predict the 3D dimensions of surrounding environments during autonomous car driving.
Investment cost and profitability	The main components (per unit): - Hardware - Model System Design - Sensors (motion, weather, etc.) - Video surveillance system - The cost for one unit starts from 28000 USD - The cost of the project: 1,680,000 USD
Market potential	The system can be implemented in the major cities / municipalities of Moldova as: - Chisinau and Balti municipality - Cities: Anenii Noi, Briceni, Cahul, Ialoveni, Orhei, Ungheni
Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services. - Relieving congestion problems in specific parts of the cities.

[6] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934239/

Domain	Infrastructure
The Technology (technologically solution) Nr. 5	Incident detection and management system[7]
The Legal Framework	- Government Decision no. 40 of 17.01.2012 on the approval of the Concept of the Automated Road Traffic Monitoring System "Traffic Control" - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation
Brief description of the technology	- The consequences of traffic accidents caused by driver error or imperfect infrastructure and technology may be severe and end in death if medical help is not provided quickly enough. According to the principle of the "Golden Hour," the lives of 20–40% of seriously injured victims can be saved if they receive hospital treatment within 60 minutes of the accident. The probability of survival is greater if first aid is provided at the scene before the victim is taken to the hospital. The best solution, in this case, is an Incident detection and management system, to detect as many incidents as possible, automatic detection must be used. The system uses an algorithm to detect incidents on a signalized mechanism, controlled by a traffic adaptive control system that includes different modules: normality inference module; incident location inference module; incident severity assessment module; and incident termination inference module.
Investment cost and profitability	The main components (per unit): - Hardware - Model System Design - Sensors (motion, weather, etc.) - Video surveillance system - The cost for one unit starts from 15000 USD - The cost of the project: 300,000 USD
Market potential	The system can be implemented in the major cities / municipalities of Moldova as: - Chisinau and Balti municipality - Cities : Anenii Noi, Briceni, Cahul, Ialoveni, Orhei, Ungheni
Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services.

7 https://www.researchgate.net/publication/304530126_Automatic_Incident_Detection_at_Intersections_with_Use_of_Telematics

Domain	Infrastructure
The Technology (technologically solution) Nr. 6	Hot rolled asphalt (HRA)[8]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 -
Brief description of the technology	- Hot Rolled Asphalt (HRA) is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108. There is a high proportion of sand in the mix resulting in a low percentage of air voids when it is compacted. The mortar of bitumen, sand & filler gives it strength. On public roads, high PSV chippings are added to provide a skid-resistant surface. The material is designed for heavy-duty industrial applications such as stocking bays and loading areas. It is particularly suitable where forklift trucks operate, or heavy trucks/buses are cornering tightly on a regular basis. This is the traditional specification for surfacing roads and is used in conjunction with high PSV Pre-Coated Chips to provide an exceptionally durable, anti-skid surface. Hot Rolled Asphalt results in an incredibly durable surface with enhanced longevity, has a high skid resistance, and is near impervious to water – resulting in reduced damage. Hot Rolled Asphalt (HRA) is produced in accordance with: - IS EN 13108-4 Hot Rolled Asphalt - NSAI's Standard Recommendation (SR) 28 - IS EN 13108-20: Type Testing and IS EN13108-21: Factory Production Control
Investment cost and profitability	- The cost for one unit starts from 800.000 USD / km - The cost of the project: 80,000,000 USD
Market potential	- According to the latest data, 92.5% of the national roads and 46.1% of the local roads are covered by permanent and semi-permanent road pavement (asphalt concrete, cement concrete, bituminous mixtures executed in situ). - The Government strategy is focused on rehabilitation of the existing covered roads and expand the infrastructure.
Impact and benefits of adaptation	- Increased point loading resistance above standard asphalt materials - Further improvements of the operations and services of the transport infrastructure. - Increasing operations in the new conditions created by climate change.

8 https://www.researchgate.net/publication/288823869_Development_of_Long_Life_Deformation_Resistant_Hot_Rolled_Asphalt_Surfacing

Domain	Infrastructure
The Technology (technologically solution) Nr. 7	High modulus asphalt concrete (HMAC)[9]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 -
Brief description of the technology	- High modulus asphalt concrete (HMAC) mixtures are produced using hard-grade binders or modified bitumen and are known to have exceptional resistance towards rutting and fatigue. Due to the similarity between hard binder and aged reclaimed asphalt (RA) binder, HMAC mixtures have great potential to incorporate higher percentages of RA material. Due to its high dynamic modulus, HMAC pavements can reduce the thickness of the entire road structure by 30–35% and the thickness of the base layer by around 25%. The binders used in HMAC have stiffness similar to that of aged binder in reclaimed asphalt (RA) material. For this reason, the HMAC mixtures are expected to incorporate higher percentages of RA material. Inclusion of RA material into AC (asphalt concrete) type mixtures has often been reported to increase the resistance to rutting, because of the aged binder present in the RA material. This benefit might not be present for HMAC mixtures as it already offers better resistance towards rutting failure and thus RA bitumen might not necessarily increase the viscosity of the final binder blend.
Investment cost and profitability	- The cost for one unit starts from 870.000 USD / km - The cost of the project: 87,000,000 USD The estimative costs were calculated based on the data of the State Road Administration
Market potential	- According to the latest data, 92.5% of the national roads and 46.1% of the local roads are covered by permanent and semi-permanent road pavement (asphalt concrete, cement concrete, bituminous mixtures executed in situ). - The Government strategy is focused on rehabilitation of the existing covered roads and expand the infrastructure.
Impact and benefits of adaptation	- Increased fuel resistance - Further improvements of the operations and services of the transport infrastructure. - Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services.

9 https://www.researchgate.net/publication/326450190_Production_of_high_modulus_asphalt_concrete_with_high_rutting_resistanc

Domain	Infrastructure
The Technology (technologically solution) Nr. 8	Thin Surfacing Course System (TSCS)
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022
Brief description of the technology	- Thin Surface Courses (TSCs) are high stone content materials for Surface Course applications. They are durable, deformation-resistant, reduce noise and spray and offer excellent ride quality when compared with traditional Hot Rolled Asphalt. TSCS offers a very fast means of surfacing roads. The faster application can result in lower costs for traffic management and reduced costs of delay to the traveling public. Being thinner and faster to lay, TSCS can be significantly lower in cost than other materials such as HRA. Due to their skeleton structure formed by the coarse aggregate particles, TSCS generally have a high resistance to wheel track rutting. A high degree of compaction necessary for thin wearing course systems is achieved by the paver, compaction being completed by the roller tight up behind the paving machine. In this respect, and because the application of chippings is unnecessary, the installation of thin wearing course systems in less than perfect weather conditions might appear straightforward.
Investment cost and profitability	- The cost for one unit starts from 870.000 USD / km - The cost of the project: 87,000,000 USD The estimative costs were calculated based on the data of the State Road Administration
Market potential	- According to the latest data, 92.5% of the national roads and 46.1% of the local roads are covered by permanent and semi-permanent road pavement (asphalt concrete, cement concrete, bituminous mixtures executed in situ). - The Government strategy is focused on rehabilitation of the existing covered roads and expand the infrastructure.
Impact and benefits of adaptation	- Increased point loading resistance above standard asphalt materials - Lower costs for traffic management - Significantly lower in cost than other materials such as HRA - High resistance to wheel track

Domain	Infrastructure
The Technology (technologically solution) Nr. 9	Traffic management systems (TMS)[10]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022
Brief description of the technology	- A transportation management system (TMS) is a logistics platform that uses technology to help businesses plan, execute, and optimize the physical movement of goods, both incoming and outgoing and making sure the shipment is compliant, proper documentation is available. This kind of system is often part of a larger supply chain management (SCM) system. Sometimes known as a transportation management solution or transportation management software, a TMS provides visibility into day-to-day transportation operations, trade compliance information, and documentation, and ensuring the timely delivery of freight and goods. Transportation management systems also streamline the shipping process and make it easier for businesses to manage and optimize their transportation operations, whether they are by land, air, or sea. Transportation management systems play a central role in supply chains, affecting every part of the process—from planning and procurement to logistics and lifecycle management. The broad and deep visibility afforded by a powerful system leads to more efficient transportation planning and execution, which results in higher customer satisfaction. That, in turn, leads to more sales, helping businesses grow. With such a dynamic global trade environment that we live and transact in, it is important to have a system that will allow you to successfully navigate complicated processes around trade policies and compliance.
Investment cost and profitability	The main components (per unit): - Hardware, Servers, GPS System, - Cost from 10,000 to 250,000 USD / license - The cost of the project: 2,500,000 USD
Market potential	- Transportation management systems are primarily used by businesses that need to ship, move, and receive goods on a regular basis, including: - Manufacturers - Distributors - Ecommerce companies - Retail businesses - Companies that provide logistics services, such as third-party and fourth-party logistics (3PL and 4PL) companies and logistics service providers (LSPs)
Impact and benefits of adaptation	- Increasing integration of the local transport sector within the international network. - Increasing capacities of the transportation services.

[10] https://journals.sagepub.com/doi/full/10.1177/1550147716683612

	- Increasing transport stakeholders' capacities to develop and implement their adaptation actions.
Domain	**Infrastructure**
The Technology (technologically solution) Nr. 10	Charging infrastructure for plug-in electric vehicle[11]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- A charging station, also called electric vehicle charging station, electric recharging point, charging point, charge point, electronic charging station (ECS), and electric vehicle supply equipment (EVSE), is a machine that supplies electric energy to charge plug-in electric vehicles—including cars, neighborhood electric vehicles, trucks, buses, and others. Some electric vehicles have onboard converters that plug into a standard electrical outlet or a higher voltage outlet. Others use custom charging stations. Charging stations provide connectors that conform to a variety of standards. For common direct current rapid charging, chargers are equipped with multiple adaptors such as Combined Charging System (CCS), CHAdeMO, and AC fast charging. Multiple standards have been established for charging technology to enable interoperability across vendors. Standards are available for nomenclature, power, and connectors. Notably, Tesla has developed proprietary technology in these areas.
Investment cost and profitability	The main components (per unit): - Charging station - Infrastructure to connection to the grid - Software Cost from 600 to 5,700 USD The cost of the project: 570,000 USD
Market potential	- The number of conventional cars increased constantly, from 404,290 in 2010 to 648,780 in 2019. - The comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles, Diesel in 29% then in 2018, Gasoline was used in 49% of vehicles, Diesel in 42%, Liquefied Petroleum Gas in 5% and appear 1% of Hybrid Electric vehicles. - It expected that Electric vehicles will continue to grow on the market at that same share.

[11] https://www.sciencedirect.com/science/article/abs/pii/S1361920919305309

Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services. - Reducing the delays and incidents on the transport services.
Domain	**Infrastructure**
The Technology (technologically solution) Nr. 11	Charging infrastructure for hydrogen fuel cell electric buses[12]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- The efficiency of the fuel cell buses can be guaranteed when charging stations are built in the terminal stations. Regarding regular city bus routes, it allows buses to run for a whole day just with one or two recharging. The hydrogen fuel can be supplied regularly through delivery vehicles that we use for carrying gasoline or diesel. In addition, hydrogen charging infrastructures can be easily established by using the current CNG charging stations. The hydrogen-powered buses are expected to be more effective when running in small cities where building charging stations is relatively hard, and for long-distance travel. A fuel cell electric bus does not require any additional city infrastructure work or permits other than a centralized hydrogen refueling station (HRS) at the bus depot.
Investment cost and profitability	The main components (per unit): - Charging infrastructure - Hydrogen fuel cells The cost for one unit starts from 180.000 USD The cost of the project: 1.800.000 USD
Market potential	- The number of autobuses is continuously growing, from 20968 units in 2016 to 21087 units in 2019. It is expected that the Fuel Cell Buses can be implemented in the municipalities where the passenger flux is high and constant. - Chisinau and Balti municipality
Impact and benefits of adaptation	- Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

[12] https://www.sciencedirect.com/topics/engineering/hydrogen-station

Domain	Transport
The Technology (technologically solution) Nr. 12	The automatic temperature control system in public transport
The Legal Framework	- Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- The system includes Heating, Ventilation, and Air Conditioning (HVAC) Solutions. The system automatically regulates cabin temperature. When outside temperatures are low, a slightly higher temperature is generated in the cabin without the driver's intervention to ensure that the driver's cabin heats up quickly and the windscreen is de-iced rapidly. The HVAC is designed for different bus types including hybrid and electrical driven buses. The modular system design with one control unit and up to eight substations enabling universal use and fast adaptation to different bus variants. Connections between the control unit and substation. All characteristics and parameters can be stored in the control unit. Substations can be exchanged without the need to set parameters in advance. Front panels can be customized. The HVAC aims the system to choose a setting then always creating a pleasant indoor climate. Therefore, several sensors measure the inside and outside temperatures, the angle of the sun, and even the air humidity at the windscreen, to prevent misted-up windows before they can disturb the driver.
Investment cost and profitability	The main components (per unit): - Hardware - Model System Design - Sensors (motion, weather, etc.) - Video monitoring system The cost for one unit starts from 1.200 USD The cost of the project: 120.000 USD
Market potential	- The number of autobuses is continuously growing, from 20968 units in 2016 to 21087 units in 2019. It is expected that the Fuel Cell Buses can be implemented in the municipalities where the passenger flux is high and constant. - Chisinau and Balti municipality - Bus operators on interurban and international rutes
Impact and benefits of adaptation	- Increased comfort for passengers - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

Domain	Transport
The Technology (technologically solution) Nr. 13	Integrated public transport fare payment system[13]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- The integrated payment system will permit passengers to use different modes of public transport with the same electronic ticket, either a contactless card or a card with a magnetic stripe. The new system will not only make payment easier and offer a discount to season ticket holders but will also allow the city to monitor passenger flows. This information will help to better organize the public transport network according to users' needs. By making the long-distance journeys on public transport more affordable and accessible, the city could reduce the amount of traffic entering the city center. Linked with the introduction of quasi-public bus management, the distance-based fare system also can help improve the quality of bus service by offering correct incentives for bus drivers. Relieved of the pressure to cram in as many people as possible, bus operators could focus on providing convenient and safe journeys.
Investment cost and profitability	The main components (per unit): - Hardware - Software - Video monitoring system - Payment terminal The cost for one unit starts from 1.700 USD The cost of the project: 170.000 USD
Market potential	- The number of autobuses is continuously growing, from 20968 units in 2016 to 21087 units in 2019. It is expected that the Fuel Cell Buses can be implemented in the municipalities where the passenger flux is high and constant. - Chisinau and Balti municipality - Bus operators on interurban and international routes
Impact and benefits of adaptation	- Increased operating services. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

[13] https://www.sciencedirect.com/science/article/pii/S1877705817300991

Domain	Transport
The Technology (technologically solution) Nr. 14	Hybrid electric vehicle[14]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- A hybrid electric vehicle (HEV) is a type of hybrid vehicle that combines a conventional internal combustion engine (ICE) system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance. There is a variety of HEV types and the degree to which each function as an electric vehicle (EV) also varies. Modern HEVs make use of efficiency-improving technologies such as regenerative brakes which convert the vehicle's kinetic energy to electric energy, which is stored in a battery or supercapacitor. Some varieties of HEV use an internal combustion engine to turn an electrical generator, which either recharges the vehicle's batteries or directly powers its electric drive motors; this combination is known as a motor-generator. Many HEVs reduce idle emissions by shutting down the engine at idle and restarting it when needed; this is known as a start-stop system. A hybrid-electric produces fewer tailpipe emissions than a comparably sized gasoline car since the hybrid's gasoline engine is usually smaller than that of a gasoline-powered vehicle. If the engine is not used to drive the car directly, it can be geared to run at maximum efficiency, further improving fuel economy.
Investment cost and profitability	- Cost pe unit it starts from around 24.300 for a new car
Market potential	- The comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles, Diesel in 29% then in 2018, Gasoline was used in 49% of vehicles, Diesel in 42%, Liquefied Petroleum Gas in 5% and appear 1% of Hybrid Electric vehicles. - It expected that Hybrid Electric vehicles will continue to grow on the market at that same share.
Impact and benefits of adaptation	- Increased operating services. - Adapting the transportation fleet to the new climate change conditions.

[14] https://en.wikipedia.org/wiki/Hybrid_electric_vehicle

	- Improving the functioning of the transportation services.

Domain	**Transport**
The Technology (technologically solution) Nr. 15	Plug-in electric vehicles[15]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- A plug-in electric vehicle (PEV) is any road vehicle that can be recharged from an external source of electricity, such as wall sockets, and the electricity stored in the rechargeable battery packs drives or contributes to drive the wheels. PEV is a subset of electric vehicles that includes all-electric, or battery electric vehicles (BEVs). - PEV is a subcategory of electric vehicles that includes battery electric vehicles (BEVs), plug-in hybrid vehicles, (PHEVs), and electric vehicle conversions of hybrid electric vehicles and conventional internal combustion engine vehicles. Even though conventional hybrid electric vehicles (HEVs) have a battery that is continually recharged with power from the internal combustion engine and regenerative braking, they cannot be recharged from an off-vehicle electric energy source, and therefore, they do not belong to the category of plug-in electric vehicles. - Plug-in electric vehicles operating in all-electric mode do not emit greenhouse gases from the onboard source of power, but from the point of view of a well-to-wheel assessment, the extent of the benefit also depends on the fuel and technology used for electricity generation. This fact has been referred to as the long tailpipe of plug-in electric vehicles.
Investment cost and profitability	- Cost pe unit it starts from around 26.900 for a new car
Market potential	- The comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles, Diesel in 29% then in 2018, Gasoline was used in 49% of vehicles, Diesel in 42%, Liquefied Petroleum Gas in 5% and appear 1% of Hybrid Electric vehicles. - It expected that Electric vehicles will continue to grow on the market at that same share.
Impact and benefits of adaptation	- Increased operating services. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

[15] https://en.wikipedia.org/wiki/Plug-in_electric_vehicle

Domain	Transport
The Technology (technologically solution) Nr. 16	Self-driving shuttle for passenger transportation[16]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- Capable of transporting up to 15 people, a Self-driving shuttle [17]combines a number of advantages. Autonomic fleets make it possible for operators to improve productivity on private sites, and ease road congestion in urban centers. Passengers also enjoy a pleasant trip while making the most of their travel time. The Self-driving shuttle is explicitly designed to meet the needs of an autonomous, driverless vehicle while also optimizing navigation and safety features. With neither a steering wheel nor pedals, the Shuttle uses effective guidance and detection systems that combine various advanced technology types. Data from Lidar sensors, cameras, GPS RTK, IMU, and odometry is merged and interpreted by deep learning programs. The Self-driving shuttle moves about efficiently and makes proficient decisions, without any driver. - Areas of use: a) Urban zones: pedestrianized town centers, narrow roads. b) Airports: internal or external passenger transfers, movement of staff. c) Hospitals: transporting patients and their loved ones from a public transport station or car park to the hospital site; movement of staff on the site. d) University campuses: transporting students between a distant public transport station and the university; movement within the campus. e) Industrial sites: transporting personnel between the various points of interest (place of work, canteen, etc.) f) Shopping centers: transporting clients from a shopping center to a public transport station, and vice versa.
Investment cost and profitability	- Cost pe unit it starts from around 120.000 for a new car

16 https://www.researchgate.net/publication/348179754_Autonomous_buses_Intentions_to_use_passenger_experiences_and_suggestions_for_improvement

17 https://www.sciencedirect.com/science/article/pii/S1369847820305921

Market potential	- Urban zones in municipalities, Airport, University campuses, Industrial parks and free economic zones.
Impact and benefits of adaptation	- Increased operating services. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.
Domain	Transport
The Technology (technologically solution) Nr. 17	Battery Powered trolleybuses [18]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	A battery-assisted trolleybus is a vehicle that uses an electric engine. Electricity is primarily obtained from overhead contact wires installed above the road. However, compared to the conventional trolleybus, it has the advantage of the possibility to pass through sections of the route without many overhead contact wires. This is achieved by adding an additional energy source. There are two possible approaches to the additional energy source. One is the addition of a diesel engine that serves as an electric generator for the main electric traction motor and is only switched-on during parts of the route with no overhead contact wires. The more interesting and more environmentally friendly way is to add a battery that can be recharged on electrified sections, possibly also by recuperation. The batteries used in vehicles can be smaller, they serve only as an auxiliary power source. This approach also produces less environmentally hazardous waste when traction battery is replaced. The traction battery also has a significantly lower capacity than traction batteries in conventional electric buses, but it can provide enough power to overcome some distance without overhead contact wires. The main benefits are also that vehicles never need to stop recharging their batteries. Their performance is the same under overhead wires and with batteries. There is also significant energy-saving potential of the battery-assisted trolleybus.
Investment cost and profitability	Cost pe unit it starts from around 280.000 for a new trolleybus
Market potential	Chisinau and Balti municipality
Impact and benefits of adaptation	- Reducing CO2 emissions - Reducing noise from engine fractionation - Reducing maintenance and operational costs

18 https://www.researchgate.net/publication/286365095_Trolleybus_with_traction_batteries_for_autonomous_running

Domain	**Transport**
The Technology (technologically solution) Nr. 18	Electric bikes and mopeds[19]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- An electric bicycle, also known as an e-bike or e-bike, is a bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedal-power (i.e. pedelecs) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedaled by the rider and are therefore not electric motorcycles. E-bikes use rechargeable batteries and typically travel up to 25 to 32 km/h. High-powered varieties can often travel more than 45 km/h. In some markets, they are gaining in popularity and taking some market share away from conventional bicycles, while in others, they are replacing fossil fuel-powered mopeds and small motorcycles. E-bikes are classed according to the power that their electric motor can deliver and the control system, i.e., when, and how the power from the motor is applied. Also, the classification of e-bikes is complicated as much of the definition is due to legal reasons of what constitutes a bicycle and what constitutes a moped or motorcycle. As such, the classification of these e-bikes varies greatly across countries and local jurisdictions.
Investment cost and profitability	- Cost pe unit it starts from around 700 EUR for a new bike
Market potential	- To be estimated
Impact and benefits of adaptation	- Adapting the transportation fleet to the new climate change conditions. - Increasing operations in the new conditions created by climate change. -

[19] https://en.wikipedia.org/wiki/Electric_bicycle

Domain	Transport
The Technology (technologically solution) Nr. 19	Electric Three Wheelers[20]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- Many three-wheelers which exist in the form of motorcycle-based machines are often called trikes and often have the front single wheel and mechanics like that of a motorcycle and the rear axle like that of a car. Often such vehicles are owner-constructed using a portion of a rear-engine, rear-drive Volkswagen Beetle in combination with a motorcycle front end. Other trikes include ATVs that are specially constructed for off-road use. Three-wheelers can have either one wheel at the back and two at the front, or one wheel at the front and two at the back. Due to better safety when braking, an increasingly popular form is the front-steering "tadpole" or "reverse trike" sometimes with front-drive but usually with rear-drive. Three-wheelers, including some cyclecars, bubble cars, and microcars, are built for economic and legal reasons. As a result of their light construction and potential better streamlining, three-wheeled cars are usually less expensive to operate. Experts agree that two and three-wheelers are the priority in moving to electric mobility. Scenario calculations using the UN Environment eMob calculator show that assuming a steep and global shift to 90% battery-electric motorcycles sales by 2030 could result in CO2 emissions reductions of about 11 billion tons between now and 2050. Given the rapid growth of two and three-wheeler fleets in developing and transitional countries, UN Environment is supporting countries to develop national programs for the introduction of electric two and three-wheelers.
Investment cost and profitability	- Cost pe unit it starts from around 8800 EUR for a new vehicle
Market potential	- The main market potential for this type of vehicles in Republic of Moldova will be focused on the delivery services. As this kind of services is constantly growing, and because of the pandemic situation,

[20] https://en.wikipedia.org/wiki/Three-wheeler

	the people prefer to use delivery services, it expects that this market will continue grown for around 5-7% annually.
Impact and benefits of adaptation	- Reducing CO2 emissions - Reducing noise from engine fractionation - Reducing maintenance and operational costs
Domain	**Transport**
The Technology (technologically solution) Nr. 20	Transport demand management system[21]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- Crucial to the delivery of a sustainable urban transport system is integrating the TDM philosophy into urban transport planning, as well as the daily management and operation of transport services and infrastructure. Transportation demand management, traffic demand management, or travel demand management (TDM) is the application of strategies and policies to reduce travel demand or to redistribute this demand in space or in time. In transport, as in any network, managing demand can be a cost-effective alternative to increasing capacity. A demand management approach to transport also has the potential to deliver better environmental outcomes, improved public health, stronger communities, and more prosperous cities. TDM techniques link with and support community movements for sustainable transport. Transport demand management is understood as a much broader concept. Implicit in the use of the term is the assumption that it is accompanied by the implementation of sustainable mobility, the introduction of full-cost pricing, and organizational or structural measures to ensure a broad range of complementary interventions work effectively together to realize the benefits of sustainable transport. It is the unifying philosophy of TDM, not specific measures associated with it, that underpin the policy objective of a more sustainable system of transport. This philosophy of managing demand accepts that meeting unfettered demand for travel is impractical and that therefore the system needs to be managed.
Investment cost and profitability	- Cost pe system including the main components start from 1.200.000 USD
Market potential	- The system is developed to be implemented in the whole country.
Impact and benefits of adaptation	- Improving the functioning of the transportation services. - Increasing capacities of the transportation services.

[21] https://en.wikipedia.org/wiki/Transportation_demand_management

	- Increasing integration of the local transport sector within the international network.

Domain	**Transport**
The Technology (technologically solution) Nr. 21	Ethanol-powered buses[22]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- The usage of ethanol in buses is a reality in cities from Sweden, such as Stockholm. The technology of diesel buses adapted to operate with ethanol has been used in that country since 1985, with great success, mainly from the environmental point of view. With the intent of encouraging ethanol usage in urban public transportation aiming, among other goals, at the reduction of atmospheric pollution in the big urban centers. The ethanol fuel is considered a low-pollutant fuel, however, the high compression rate involved in the Diesel cycle engine powered by additive ethanol, which is 28:1, has as its consequence high pressures and high combustion temperatures in the interior of the cylinders, thus favoring the formation of NOx in unacceptable quantity, in case a management system is not used to reduce the emission of NOx to the emission level accepted by the Euro5 standard. The engine powered by additives ethanol uses a new-generation EGR system.
Investment cost and profitability	- Cost pe unit it starts from around 220.000 USD for a new bus
Market potential	- Chisinau and Balti municipality - Bus operators on interurban and international routes
Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

[22] https://en.wikipedia.org/wiki/BioEthanol_for_Sustainable_Transport#Ethanol-powered_buses

Domain	Transport
The Technology (technologically solution) Nr. 22	Production of transport biofuels and bioethanol[23]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- Biofuels for transport are part of important strategies to improve fuel security, mitigate climate change and support rural development. In 2010 some 84 million tons of conventional biofuels based on crops containing starch, sugar, or vegetable oil were delivered, which represents some 104 billion liters of fuels that address 2.7% of the global demand for transportation fuels. Conventional biofuel production not only delivers ethanol and biodiesel but also protein feed, with the quantities of these both being produced on a similar scale. In 2010, the protein production associated with conventional biofuels based on corn, cereals, canola, and soybeans delivered 79 million tons of protein feed corresponding to the protein production of 29 million ha soybeans, that is more than a quarter of the global demand for soybean cake. Hence, conventional biofuel production chains are a vital part of both global fuel and protein supplies. Advanced biofuels based on cellulosic feedstocks, various waste streams, and algae have a large potential in the future. However, some of these are in the early commercial phase in the market at present but most of these new technologies remain in a pre-commercial phase. Investors need reliable long-term framework conditions to be created by governments to offset the huge capital expenditures required to start large-scale production and to offset the initially high production cost of these new fuels.
Investment cost and profitability	- Cost pe unit it starts from around 1.600.000 USD for a new installation for production of bioethanol.
Market potential	- Chisinau and Balti municipality - Bus operators on interurban and international routes
Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Adapting the transportation fleet to the new climate change conditions.

[23] https://en.wikipedia.org/wiki/Ethanol_fuel

	- Improving the functioning of the transportation services.

Domain	**Transport**
The Technology (technologically solution) Nr. 23	Road transport management system (RTMS)[24]
The Legal Framework	- Government Decision No. 827 of 28.10.2013 regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision no. 1470 of 30.12.2016 on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. 160 of 21.02.2018 approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.
Brief description of the technology	- Road transport management system (RTMS) is an industry-led, government-supported, voluntary, self-regulation scheme that encourages consignees, consignors & road transport operators to implement a management system (a set of standards) that demonstrates compliance with the Road Traffic Regulations and contributes to preserving road infrastructure, improving road safety & increasing productivity. Even though RTMS, was initially mooted as an overload control mechanism (then known as at Load Accreditation Programme), it has evolved to be currently recognized as a holistic system of managing a road transport operation. The systems require the transport operators that shall establish, implement, and maintain a process to ensure that the vehicles do not exceed the permissible mass and dimensions applicable to each vehicle configuration. The transport operators shall define the method(s) used to assess the vehicle mass (including axle mass) and dimensions before each laden trip, including backup methods where practicably possible. There shall also be a process of load verification which should provide objective evidence of the reliability and accuracy of the load assessment method(s).
Investment cost and profitability	- Cost pe unit it starts from around 2.400.000 USD to be implemented across the country and to involve private companies.
Market potential	- The system is developed to be implemented in the whole country.
Impact and benefits of adaptation	- Increasing operations in the new conditions created by climate change. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.

24 https://www.researchgate.net/publication/318681602_PERCEPTIONS_OF_THE_ROAD_TRANSPORT_MANAGEMENT_SYSTEM_RTMS_PROMOTING_VOLUNTARY_CERTIFICATION

	- Increasing transport stakeholders' capacities to develop and implement their adaptation actions.

ANNEX 3. TECHNOLOGY FACT SHEETs TRANSPORT SECTOR, elaborated format

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.

Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.
Adaptation measures	Introduce transportation units with a new propulsion-type engine. Introduce new transport adapted to increased temperatures.
Technology Name	Electro-diesel hybrid locomotives[25]
Short description of the technology option	An electro-diesel locomotive (also referred to as a dual-mode, bi-mode, or hybrid locomotive) is a type of locomotive that can be powered either from an electricity supply (like an electric locomotive) or by using the onboard diesel engine (like a diesel-electric locomotive). For the most part, these locomotives are built to serve regional, niche markets with a very specific purpose. Electro-diesel locomotives are used to provide continuous journeys along routes that are only partly electrified without a change of locomotive, avoid extensive running of diesel under the wires (using a diesel locomotive where electrified lines are available), and give solutions where diesel engines are banned. They may be designed or adapted mainly for electric use, mainly for diesel use, or to work well as either electric or diesel. The powertrain of standard diesel-electric multiple units consists of an internal combustion engine (ICE) directly connected to an AC electric generator (G), which is further connected via the rectifier and inverter to an AC electric motor (EM) located on the driveshaft. In the case of braking, the EM acts as the generator. The ICE supplies the mechanical auxiliaries (e.g., hydraulic pump), while the electrical auxiliaries are connected to the existing DC link via a DC/AC inverter. The braking energy is, in this case, dissipated through the resistor, which is connected to the DC link via a DC/DC converter. Hybridization of the diesel-electric unit can be achieved by adding the appropriate energy storage system on the DC link.[26] Compared to road transport, or even to railway freight transport, railway passenger transport is characterized by fixed routes with predetermined stops and timetables, which also enable forecasts of typical driving behavior, speed profiles, and duty cycles. This is a very important aspect, allowing creating an adequate charging infrastructure for the electro-diesel hybrid locomotives. The locomotive is designed to tow passenger and freight railway vehicles on non-electrified single and multiple traction portions, as well as heavy maneuvers.[27]
Country social development priorities	The country's social development priorities are focused on harnessing the economic potential of care activities to increase the employment rate of women. Public expenditure for care services creates jobs, while simultaneously approaching the needs of potentially vulnerable groups of the population.

[25] https://en.wikipedia.org/wiki/Electro-diesel_locomotive

[26] https://www.sciencedirect.com/science/article/pii/S0306261921004840

[27] https://www.researchgate.net/publication/329291427_Determining_the_probability_of_failure_for_a_diesel_electric_locomotive_060-DA_using_fault_tree_analysis

	Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, economic activity must evolve in harmony with the environment, produce green economic growth, and stop the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[28] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan supports an enabling legal and institutional environment and enhances women's capacities to engage in decision-making proactively; empowers women and achieves de facto equality between men and women in Moldova; fights against stereotypes in society and promotes non-violent communication; and promotes gender-responsive budgeting. The technology will contribute to achieving the main goal of the strategies focused on improving the rural population's access to neighboring towns/localities, especially by developing local road infrastructure and public transport, considering the accessibility of persons with disabilities, universal design, and reasonable accommodation.
Country economic development priorities	The country's strategic vision is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the “green” economy in the Republic of Moldova for the years 2018-2020 and the Action Plan for its implementation. Considering the difficult situation of transport infrastructure, the government's vision is focused on providing access to safe, affordable, accessible, and sustainable transport systems for all and improving road safety, notably by expanding public transport. The passengers will have access to new transportation services that will stimulate mobility and economic growth. The technology will also

[28] https://www.legis.md/

	strengthen national and regional development by supporting positive economic, social, and environmental links between urban, peri-urban, and rural areas.
Country environmental development priorities	The vision relating to the environment is focused on integrating green economy measures and principles into the production process in different branches of the national economy, which can contribute to improving environmental quality and the living standards of the Republic of Moldova's population. The principle of a green economy will be implemented, which will contribute to the efficient use of resources and energy, the application of clean technologies in the economy reduced CO2 emissions and pollution, and the minimization of environmental risks. The main strategic documents relating to environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The introduction of Electro-diesel hybrid locomotives will replace the old and obsolete diesel locomotives with new, cleaner, and more sustainable technologies. The technology will reduce CO2 emissions, and it is expected that it will cover the country's environmental priorities in this sector.
Market potential	Because of its inefficiency, the transportation of goods and passengers by rail registered a continuous decrease. The introduction of new technologies is expected to allow the modernization of transport and increase transportation services.
● **Country specific applicability**	
Institutional Capacity	In Moldova, only one local company is responsible for the import of the locomotives: the State Enterprise "Railway of Moldova." The companies responsible for the maintenance services have the capacity to implement the technology at the local level. They have sufficient experience and capacity. The main entities involved in the promotion of the technology by category: - Governmental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) State Enterprise "Railway of Moldova" - Private sector: a) engineering companies b) transportation companies c) leasing companies d) import - export and distribution companies - NGO: a) environmental promotion organizations

	b) technology promotion organizations c) professional associations of auto and transportation, etc
Status of technology in-country	The technology is new to the country. It has not been tested before in the country.
Acceptability to locals	The technology is being developed for use by train passengers and companies transporting goods by rail. It is expected that the technology will cover the needs of the majority of passengers, particularly on interurban and international routes.
Paradigm shift potential	Hybridization of diesel multiple-unit railway vehicles is an effective approach to reducing fuel consumption and related emissions in regional non-electrified networks. This co-optimization method addresses the main aspects of the powertrain design, which affects the sizing of the system components, and the control of such systems, which affects the system's performance, leading to a trade-off between performance and system sizing.
Efficiency and effectiveness	Despite the high initial costs, investing in a hybrid drive can bring many benefits, not only economic but also operational and ecological. This solution allows the recovery of a significant amount of energy that was previously lost in the form of heat. This reduces the unit fuel consumption and, consequently, limits the emission of harmful substances into the atmosphere.[29]
Sustainable development potential	Electro-diesel hybrid locomotives normally operate under pure electric traction where possible and use diesel engines to extend the journeys along non-electrified sections, which would not be cost-effective to electrify. They may also be used on long cross-country routes to take advantage of shorter sections of electrified main lines. The solution will ensure the functioning of the railways on all territories of the country and increase the sector's sustainability.[30]
● **Evaluation criteria: Costs**	
Investments, US$	- Cost per unit starts from around 5.85–11.83 million USD including maintenance of the diesel engine and electric motor. Total: 11.830.000 USD
O&M costs, US$/year	The cost of maintenance: - Periodically testing of functionality (every 3 years) – 0.5% on average per unit. - Replacement of the main components (every 3 years) - 1% on average per unit. It is expected that the costs of maintenance will be around 118.300 USD / per unit for every 3 years. Total: 118.300 USD[31]
● **Evaluation criteria: Economic benefits**	

29 https://www.researchgate.net/publication/337683178_Application_of_hybrid_drives_in_diesel_locomotives

30 https://en.wikipedia.org/wiki/Electro-diesel_locomotive

31 https://www.nature.com/articles/s41560-021-00915-5

Innovation	Hybridizing a diesel locomotive, where energy is recovered during braking, effectively decreases fuel consumption. Real-time optimization algorithms provide a means to minimize fuel consumption more effectively and, as a result, reduction of CO2 emissions.[32] An important element of this system is the use of a converter/inverter, which is responsible for converting the value of intensity and current voltage to the rated voltage of the traction engines. Traction engines will only be modernized by sealing them and replacing the used subassemblies. The microprocessor controller supervises the optimal use of energy stored in the entire hybrid drive system.[33]
Financing	Usually, the main investors in rail in the country are multilateral agencies and governmental agencies. It is expected that the main modernization programs of rail infrastructure will support the technology.
Public and private expenditures	The State Enterprise "Railway of Moldova" will pay for the implementation of this technology.
● Evaluation criteria: Social benefits	
Gender equality	Having into account the results of the international studies that demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport, it is expected that the main train's passengers in the case of the electro-diesel hybrid locomotives will be women.
Direct Employment	The introduction of this technology will create the potential for the introduction of new professionals in the market, in special for engineers, technicians, and electricians. Also, the technicians responsible for locomotive maintenance would be new experts who would consider the technology's characteristics and its needs for better functioning.
Skill & Capacity Development	The implementation of the technology will need workshops for drivers in special on the optimal energy management strategy that will aim to minimize the total fuel consumption (and related CO2 emissions) of the internal combustion engine by adjusting the power flows at the DC link. Also, the development of capacities for the maintenance team should be organized in special for the engineers, technicians, and electricians.[34]
● Evaluation criteria: Development impacts, indirect benefits	
Positive Local Environmental Impacts	Electro-diesel hybrid locomotives normally operate under pure electric traction where possible. This is an effective method for decreasing fuel consumption and as result, reduction of CO2 emissions.

[32] https://www.researchgate.net/publication/301301919_JRC2016-5777_POWER_MANAGEMENT_CONTROL_OPTIMIZATION_OF_A_HYBRID_ELECTRIC-_DIESEL_LOCOMOTIVE

[33] https://www.researchgate.net/publication/337683178_Application_of_hybrid_drives_in_diesel_locomotives

[34] https://en-academic.com/dic.nsf/enwiki/972636

Contribution to the reduction of climate vulnerability	- Adapting the transport fleet of the public transport services to the new conditions of climate change. - Improving the functioning of transport services. - Noise reduction from engine fractionation. - Reducing maintenance and operating costs.
Other, if any	

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.
Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hydrogen engine transportation units.
Technology Name	Hydrogen Fuel Cell Electric Bus (FCEB)

Short description of the technology option	A fuel cell bus is a bus that uses a hydrogen fuel cell as its power source for electrically driven wheels, sometimes augmented in a hybrid fashion with batteries or a supercapacitor[35]. The fuel cell power module onboard the bus generates electric energy through an electrochemical reaction leaving only water and heat as by-products, thus there are no local emissions. The electric energy is used to provide direct electric traction and keep the batteries charged. The by-product heat is stored on the brake resistors and is used to maintain heating passenger comfort and considerably increase energy efficiency. The batteries also provide storage for regenerated braking energy. All the energy required for the bus to operate is provided by hydrogen stored onboard. Hydrogen offers higher energy density compared to electrical storage systems such as batteries, this enables a longer range compared to systems where the batteries are used as stores of energy[36]. The hydrogen-powered buses are expected to be more effective when running in small cities where building charging stations is relatively hard, and for long-distance travel. A fuel cell electric bus does not require any additional city infrastructure work or permits other than a centralized hydrogen refueling station (HRS) at the bus depot.
Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[37] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting.

[35] https://en.wikipedia.org/wiki/Fuel_cell_bus

[36] https://fuelcellbuses.eu/wiki/fuel-cell-electric-buses-fuel-cell-electric-buses/about-fuel-cell-electric-buses

[37] https://www.legis.md/

	The technology will contribute to achieving the main goal of the strategies focused on improving the access of the rural population to neighboring towns/localities, especially by developing local road infrastructure and public transport, considering the accessibility of persons with disabilities, universal design, and reasonable accommodation. In this specific case, by the connection of the suburban areas with the center of municipalities.
Country economic development priorities	The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation. Considering the difficult situation of transport infrastructure, the vision of the Government is focused on providing access to safe, affordable, accessible, and sustainable transport systems for all, as well as improving road safety, notably by expanding public transport. The technology will support achieving the main goals by introducing new solutions for public transport. The technology will generate new production of energy in the energy sector as well as new activities in the transportation sector. The passengers will have access to new transportation services that will stimulate mobility and economic growth. The technology will support positive economic, social, and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning.
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are:

	- Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The introduction of FCEBs will replace the internal combustion autobuses with new technologies cleaner and more sustainable. FCEBs will reduce CO2 emissions, and it is expected that the technology will cover the environmental priorities of the country in this sector.
Market potential	Since the first fuel cell electric buses began operation in Beijing in 2006, transit agencies in countries around the world have adopted zero-emission FCEBs to decarbonize their fleets. FCEBs are currently operating in service in China, Japan, Germany, the United States, the United Kingdom, and other locations with over 15 years on the road and millions of kilometers in passenger service in a range of hot and cold climates. In Moldova, the number of autobuses is continuously growing, from 20968 units in 2016 to 21087 units in 2019. It is expected that the Fuel Cell Buses can be implemented in the municipalities where the passenger flux is high and constant. The main potential market can be focused on the main municipalities as Chisinau and Balti
● **Country specific applicability**	
Institutional Capacity	The local companies responsible for the import of the FCEBs and the companies responsible for the maintenance services have the capacity to implement the technology at the local level. The local authorities and public agencies responsible for public transport have sufficient experience and capacities. The main entities involved in the promotion of the technology by category: - Governmental: d) Ministry of Infrastructure. e) National Agency for Research and Development. f) National Car Transport Agency g) RTEC Chisinau - Private sector: e) engineering companies f) transportation companies g) leasing companies h) import - export and distribution companies - NGO: d) environmental promotion organizations e) technology promotion organizations f) professional associations of auto and transportations, etc

Status of technology in-country	The technology has not been tested in the country. The technology is expected to be implemented in Chisinau and Balti.
Acceptability to locals	The technology is developed to be used by local passengers. As public transport is very popular and used by locals, the technology will cover the needs of the main number of passengers, in particular from suburban areas.
Paradigm shift potential	FCEBs offer conventional full vehicle performance in terms of highway speed, fueling times, and range for all types of transit routes. The fuel economy (which is already 1.7 to 1.9 times higher than conventional buses) is expected to increase with efficiency improvements in the coming years.[38] FCEBs provide adequate service on shorter, less demanding routes. Their range is approximately 250km at best, and less when the route includes steep hills. They are the choice for longer routes, and routes with hills and heavy loads.[39] Hydrogen is ideal for the centralized fueling of transit fleets. Quick refueling means buses have less downtime and higher utilization. In many cases, agencies can install hydrogen refueling infrastructure with a similar footprint to CNG refueling. Today several companies provide turnkey hydrogen infrastructure solutions and are developing methods to produce green hydrogen from renewable energy.[40]
Efficiency and effectiveness	Technological advantages of Fuel Cell Electric Buses offer a one-to-one replacement for diesel and CNG buses, with no compromise in service. Key attributes of fuel cell electric buses: - Zero-emission at the tailpipe - Consistent power delivery during the duty cycle, in heat and cold - Range of up to 300 miles or 450 km between refueling - Compact depot gas refueling, eliminating the need for roadside charging infrastructure - Can be refueled in less than 10 minutes - Proven durability, with a fuel cell lifetime of more than 30,000 hours[41]
Sustainable development potential	Hydrogen as a road fuel yields significant potential for carbon neutrality on a well-to-wheel basis along the entire hydrogen value chain, including production and means of delivery. Hydrogen can be produced with electricity from 100% renewable energy sources. Hence, operating FCEBs can be achieved with zero CO2 emissions along the entire hydrogen value chain. By using hydrogen produced from renewable energy sources only, one standard FCEB would save approximately 800 tons of CO2 in its lifetime of 12 years compared to a conventional diesel bus.[42]

[38] http://www.chfca.ca/fuel-cell-electric-buses-fcebs/

[39] https://cafcp.org/blog/zero-emission-bus-rollouts-4-factors-ensure-success-you-scale

[40] https://www.ballard.com/markets/transit-bus

[41] https://www.ballard.com/markets/transit-bus

[42] https://www.fch.europa.eu/publications/fuel-cell-electric-buses-%E2%80%93-potential-sustainable-public-transport-europe

● **Evaluation criteria: Costs**	
Investments, US$	The purchase price of FCEBs has come down considerably by about 75% since the introduction of first prototypes in the 1990s. However, to enable sustainable market-based commercialization all stakeholders need to push for better and cheaper FCEBs, larger-scale projects as well as an environment conducive FCEBs. - Cost per unit starts from around 450.000 USD for a new FCEBs Total: 450.000 USD
O&M costs, US$/year	The cost of maintenance: - Periodically testing of functionality (every 3 years) – 0.5% on average per unit. - Replacement of the main components (every 3 years) - 1% on average per unit. It is expected that the costs of maintenance will be around 4.500 USD / per unit for every 3 years. Total: 4.500 USD
● **Evaluation criteria: Economic benefits**	
Innovation	FCEBs offers the performance benefits of long-range, fast refueling, and full route flexibility, consistent with the internal combustion engine vehicle experience. FCEBs operate over 250 km during an 18-hour shift on the road with a single 10-minute re-filling at night. This is in contrast to the limitations of BEBs that are range-constrained, require long recharge times or roadside recharging infrastructure, and may be limited to certain routes while the outside temperature may affect bus performance. The innovative solution offers a variety of advantages: Ecology: low emissions, low noise; Energy: it is not a fossil fuel; Innovation high-tech development; Economy: new industry; Autonomy: less dependent on oil cartel countries
Financing	Usually, the main investor in public transport is the local public authority. NEoT Capital is an investment company supporting its customers to make their transition to zero mobility and low-carbon energy. NEoT offers tailor-made financing and ser-vice solutions for zero-emission buses and refueling infra-structure[43]. The investment would require a different financial structure. The environmental advantages of this technology could be used to access climate finance with partial grant and partial concessional funding. This would result in a low-cost financial structure and lower operational costs for the city.
Public and private expenditures	Both public and private initiatives are needed and given that FCEBs are expected to deploy faster in urban and suburban zones, such intervention would, at least in the first stage, focus on such areas.

[43] https://www.neotcapital.com/en/mobilite/

	Public-private collaborative strategies at different levels (supranational, national, and local) are needed to address different types of barriers.
● **Evaluation criteria: Social benefits**	
Gender equality	The international studies demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport and walking, although existing conditions do not always take the specific needs and constraints of women into account. Travel patterns in daily life differ greatly between women and men, and differences in socialization substantially impact travel mode choice. It is expected that electric vehicles will be utilized by men and women in equal access.
Direct Employment	The introduction of the technology will create the potential for replacing fossil fuels because of the benefits they offer in terms of increased energy efficiency and reduction in local pollution. By the introduction of this kind of vehicle, a large specter of new companies will be created, starting from the distribution, in areas of batteries solutions and pieces for the maintenance, until the energy companies that will produce more electricity in special from renewable sources. Direct employment is expected to be on the operator's activity, will increase the number of drivers of the FCEBs. Also, technical experts in maintenance services will need it.
Skill & Capacity Development	The implementation of the FCEBs will need workshops and special training courses for drivers, also, the development of capacities for the maintenance team should be organized in special for the engineers, technicians, and electricians.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	The sustainability of hydrogen depends on the manner in which it is produced. At present, hydrogen is produced using natural gas. Sustainable production of hydrogen is by the process of electrolysis using wind or solar energy. Hydrogen is: - is the lightest element in the periodic table - fourteen times lighter than air; 1 Nm3 (normal cubic meter) of hydrogen gas weighs 90 grams; - is colorless, odorless, and non-toxic; - is not an energy source, but an energy carrier; - can be produced of a wide variety of resources; - has an enormous capacity for energy storage, even in small quantities; - can be stored. Fuel-cell electric vehicles are zero-emission vehicles. When a hydrogen fuel-cell electric bus operates, it emits only water.
Contribution to the reduction of climate vulnerability	- Adapting the transport fleet of the public transport services to the new conditions of climate change. - Improving the functioning of transport services. - Noise reduction from engine fractionation. - Reducing maintenance and operating costs.
Other, if any	

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.
Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hydrogen engine transportation units.
Technology Name	Hydrogen Fuel Cell Heavy trucks

Short description of the technology option	Hydrogen fuel cells offer great promise for heavy-duty trucks in applications requiring a higher density of energy, fast refueling, and additional range[44]. Fuel cell technology is particularly well-suited to commercial shipping and logistics due to long ranges and short refueling times. The dual-mounted fuel cell system provides enough energy to drive the heavy-duty trucks up and down the mountainous terrain in the region. Hydrogen fuel cells generate electricity through an electrochemical reaction between hydrogen and oxygen, which combine to generate electricity, heat, and water. One fuel cell can generate about 300 watts of power[45]. Operating with higher efficiency than combustion engines, fuel cells demonstrate an electrical energy conversion efficiency of 60% or more, with lower emissions. Water is the only product of the power generation process in hydrogen fuel cells, and thus there are no carbon dioxide emissions or air pollutants that create smog and cause health problems during operation[46].
Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[47] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The technology will contribute to achieving the main goal of the strategies focused on improving the access of the more efficient and

[44] https://www.internationaltrucks.com/alternate-fuel/hydrogen-fuel-cell
[45] https://www.ornl.gov/news/heavy-duty-vehicles-ideal-entry-hydrogen-fuel-cell-use
[46] https://www.sciencedirect.com/science/article/pii/S2352484721006053
[47] https://www.legis.md/

	transport services, also a better interconnection of the international trade will stimulate the economic development of the country.
Country economic development priorities	The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation. Considering the difficult situation of transport infrastructure, the vision of the Government is focused on providing access to safe, affordable, accessible, and sustainable transport systems for all, as well as improving road safety, notably by expanding public transport. The technology will support achieving the main goals by introducing new solutions for transport services and in special in the international trade. The technology will generate new production of energy in the energy sector as well as new activities in the transportation sector. The technology will support positive economic, social, and environmental links between the transport services and international trade of the goods.
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation

	- Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The introduction of Hydrogen Fuel Cell Heavy trucks will replace the old and internal combustion trucks with new technologies cleaner and more sustainable.
Market potential	Hydrogen Fuel Cell Heavy trucks offer an attractive value proposition, particularly where user requirements favor long-range, heavy payloads and fast refueling. As the external trade increased in the last years, the export from 1,541,486.60 thousand USD in 2010 to 2,467,106.08 thousand USD in 2020 and the import from 3,855,288.60 thousand USD in 2010 to 5,415,988.30 thousand USD in 2020, the Hydrogen Fuel Cell Heavy trucks is a good solution to support the continuously increased of this activity. According to the Energy Transition Outlook Report it is anticipated that 5-13% of heavy good vehicles will be powered by hydrogen fuel cells by 2050.[48] Also, the fuel cell heavy-duty trucks could be used for sanitation (sweepers, sprinklers, garbage & dust suppression trucks) or urban construction (muck & mixer trucks), usually with fixed routes, slow speed, and short daily operating mileages. In most cases, these vehicles are manufactured by OEMs specialized in sanitation or machinery vehicles and sold to government agencies or state-owned enterprises. Its use in the public sector lowers the promotion difficulty and makes it an ideal application scenario for HDT to begin with.
● **Country specific applicability**	
Institutional Capacity	The local companies responsible for the import of the Hydrogen Fuel Cell Heavy trucks and the companies responsible for the maintenance services have the capacity to implement the technology at the local level. The main entities involved in the promotion of the technology by category: - Governmental: h) Ministry of Infrastructure; i) National Agency for Research and Development; j) National Car Transport Agency - Private sector: i) engineering companies j) transportation companies k) leasing companies l) import - export and distribution companies - NGO: g) environmental promotion organizations h) technology promotion organizations i) professional associations of auto and transportations, etc

[48] https://www.howden.com/en-gb/articles/hydrogen-fuel-cells-heavy-duty-transport

Status of technology in-country	The technology is new in the country. A fundamental driver for hydrogen technology and fuel cell vehicle adoption will be the government and energy departments consolidated and streamlined push to provide a favorable environment for fuel cell truck operation.
Acceptability to locals	As the technology is new and eco-friendly, it is expected to be acceptable by locals.
Paradigm shift potential	Hydrogen is ideal for centralized fueling of heavy-duty commercial trucks. Quick refueling means commercial trucks have less downtime and higher utilization. Today several companies provide turnkey hydrogen infrastructure solutions and are developing methods to produce green hydrogen from renewable energy[49]. Transitioning to hydrogen fuel cell heavy-duty vehicles would have a significant impact on reducing greenhouse gas emissions of the transport sector. Heavy-duty trucks play an important role in the transportation industry. The technology will change the transportation sector and service industry by change the charging infrastructure and time for charging. Also, by introducing of the new more and efficient engine, the capacities of the trucks will increase that will impact the revenue of the transportation companies.
Efficiency and effectiveness	Hydrogen derived from fossil fuels may contribute to future energy systems due to its stable energy supply and economic efficiency. The power supplied by geothermal, wind, and solar power generation impacts the efficiency of hydrogen production from fossil fuels. If the low-carbon power supply increases, the environmental and energy efficiencies of fossil fuel-derived hydrogen are further improved, and it can be effectively used from the economic and stability perspectives. An important advantage of hydrogen is the energy density. Diesel has an energy density of 45.5 megajoules per kilogram (MJ/kg), slightly lower than gasoline, which has an energy density of 45.8 MJ/kg. By contrast, hydrogen has an energy density of approximately 120 MJ/kg, almost three times more than diesel or gasoline. In electrical terms, the energy density of hydrogen is equal to 33.6 kWh of usable energy per kg, versus diesel which only holds about 12–14 kWh per kg. What this really means is that 1 kg of hydrogen, used in a fuel cell to power an electric motor, contains approximately the same energy as a gallon of diesel.[50]
Sustainable development potential	Fossil fuel-derived hydrogen production, which provides a stable and economical energy supply, can contribute to improved environmental and energy efficiencies, making it a viable low-carbon power source option for the near future.[51]
• Evaluation criteria: Costs	
Investments, US$	The scale will reduce equipment costs significantly across the hydrogen value chain. Hydrogen technologies currently have niche status, and there is significant potential for both achieving economies of scale in the manufacturing process and improving the technology further. In

[49] https://www.ballard.com/markets/truck
[50] https://energypost.eu/hydrogen-fuel-cell-trucks-can-decarbonise-heavy-transport/
[51] https://www.sciencedirect.com/science/article/pii/S0360319921033784

	solar and wind power, for example, each doubling of cumulative production in the past led to cost reductions of 19 to 35 percent[52]. Since 2010, the cost of electrolysis has fallen by 60 percent, from 10-15 USD/kg of hydrogen to 4-6 today. The sectoral studies show that the prices will continue to fall: offshore wind-based electrolysis shows another 60 percent cost reduction from now until 2030. - Cost per unit starts from around 320.000 USD for a new unit Total: 320.000 USD
O&M costs, US$/year	The cost of maintenance: - Periodically testing of functionality (every 3 years) – 0.5% on average per unit. - Replacement of the main components (every 3 years) - 1% on average per unit. It is expected that the costs of maintenance will be around 3.200 USD / per unit for every 3 years. Total: 3.200 USD The portion of the life cycle was calculated from the value-added. The maintenance and insurance premiums during driving vary were not considered.[53]
● **Evaluation criteria: Economic benefits**	
Innovation	Since trucks are responsible for the transportation of large amounts of goods, fuel-cell technology is currently being seen as the answer to this long-existing problem. Hydrogen is considered to be a more compact fuel due to which vehicles have considerably larger travel ranges. A hydrogen fuel cell propulsion system includes a fuel cell stack, which is layered with many individual fuel cells. Hydrogen from an onboard fuel source and oxygen from the air are fed into the anode (negative) and cathode (positive), respectively. At the anode, the hydrogen molecules release electrons, which travel to the cathode via an external circuit, creating an electrical current that powers the electric motor(s) and other system electronics. In an FCEV, the power generated by the fuel cell stack is used to drive the FCEV‘s electric motor(s), with additional power supplied when needed from a rechargeable battery. This battery is also used to store additional short-term energy generated in FCEVs equipped with regenerative braking. The main characteristics of the Hydrogen fuel cell trucks are: - Low-temperature starts: Can be stored and operated in temperatures as low as -40°C degrees without fear of damage or failure. - Fully integrated system: One compact fuel cell system for easy, seamless integration, without the need for additional components. - Water-free operation: Fuel cells do not require water for humidification. With no residual water, there’s no risk of freezing or moisture issues.

[52] https://www.h2haul.eu/reports/

[53] https://www.sciencedirect.com/science/article/pii/S0360319921033784#appsec4

Financing	It is expected that the main financing entities related to this technology will be the local banks by the leasing programs. Also, additional financing can be mobilized by the governmental programs focused on the international trade and promotion of the export of agricultural products.
Public and private expenditures	The main expenditures will be on the purchases of the vehicles and promotion. In particular, the expenditures will be on the private companies. No public expenditures from public entities are expected.
● **Evaluation criteria: Social benefits**	
Gender equality	The transport sector is still acknowledged as being a male-dominated industry with more male employees than females. This situation can be improved by the involvement of transport companies, educational establishments, and policymaking organizations implementing the additional measures required to ensure equal access to employment and transport use for both men and women are considered. The additional measures are based on sharing family care duties and providing equal opportunities for the development of women and their careers.
Direct Employment	The introduction of the technology will create the potential for replacing fossil fuels because of the benefits they offer in terms of increased energy efficiency and reduction in local pollution. One of the important aspects can be focused on electricity production at the national level, in particular, by the electricity production from renewable sources. By the introduction of this kind of vehicle, a large specter of new companies will be created, starting from the distribution and pieces for the maintenance, until the energy companies that will produce more electricity in special from renewable sources. Direct employment is expected to be on the operator's activity, in particular will increase the number of drivers and technical experts in maintenance services.
Skill & Capacity Development	The implementation of the technology will need workshops and special training courses for drivers of the charging installations. The training should be focused on the adequate use of the battery. Also, the development of capacities for the maintenance team should be organized in special for the engineers, technicians, and drivers.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	The results of the comparative analysis of the energy consumption and GHG emissions of fossil fuel-derived hydrogen and gasoline energy systems over their entire life cycle demonstrate that for similar vehicle weights, the hydrogen energy system consumes 1.8 MJ/km less energy and emits 0.15 kg-CO 2 eq./km fewer GHG emissions than those of the gasoline energy system. Hydrogen derived from fossil fuels may contribute to future energy systems due to its stable energy supply and economic efficiency. Lowering the power source carbon content also improved the

	environmental and energy efficiencies of hydrogen energy derived from fossil fuels.[54]
Contribution to the reduction of climate vulnerability	- Adapting the transport fleet of the public transport services to the new conditions of climate change. - Improving the functioning of transport services. - Noise reduction from engine fractionation. - Reducing maintenance and operating costs.
Other, if any	

Climate event: Increased and more frequent extreme winds.
Climate impact: Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

● **General information**	
Sector	Transport
Category	Infrastructure
Climate event	Increased and more frequent extreme winds.
Impact	Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.
Adaptation measures	Modernization of the lighting and signaling system
Technology Name	Autonomous street lighting system based on solar energy[55]

[54] https://www.sciencedirect.com/science/article/pii/S0360319921033784
[55] https://patents.google.com/patent/US20100029268

	The autonomous street lighting system is based on solar energy as the primary source, batteries as a secondary source, and light-emitting diodes (LEDs) as a lighting source. This system is presented as an alternative for remote localities, like roads, crossroads, and tourist places. The energy consumed by public lighting is for lighting by lamps. The consumption of the lamps can be changed to the minimum brightness level required by outdoor lighting standards and the traffic on the roads. Also, this can be programmed to different lighting regimes depends on the period of the day, seasons, or weather conditions[56]. The solar PV panel produces sufficient energy to charge the battery and to guarantee autonomous functioning. The integrated solar-powered system provides a convenient and cost-effective way to light streets, gardens, courtyards, residences, paths, branch roads, parks, etc.[57]
Short description of the technology option	The main components of the technology: - 1 solar panel capable of providing 1.5A charging current at 12V with 10W minimum. - 1 Storage system including a battery from 5Ah to 20Ah. - 1 Pillar from 3.8m. - 1 LED Lamps of 30-50W. Its Ra(CRI)>70 and available in 4000K. - 1 Charge controller. Main characteristics: - Energy management consumption designed to optimize the life of the battery. - Service life > 20 years - High efficiency solar panel. - Service life of the PV panel > 25 years at 80 % of initial power - LED luminaire manufactured for public lighting standards. - Service life of the LED Lamp > 100 000 h at 80% of initial power. - System adapted to extreme temperatures: -20 °C /+ 65 °C - 2 days of autonomy with full charge in case of low light
Country social development priorities	The social development priorities of the country are focused on harness the economic potential of care activities as an opportunity to increase the employment rate, of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population[58]. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources.

[56] https://www.ijert.org/autonomous-distributed-controlled-light-system
[57] https://www.academia.edu/27065481/Smart_Autonomous_Street_Light_Control_System
[58] https://go.sunna-design.com/blog/solar-lighting-positive-change-social-community-environnement

	One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[59] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The technology will contribute to supporting the implementation of the social development priorities of the country in order to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. Sustainable lighting will contribute to increasing activities during the evening, especially studying, and attending overtime in educational institutions. It will also stimulate the economic activity of women during the dark period.
Country economic development priorities	Enhancing the efficiency of economic processes by strengthening the capacities of companies to innovate and implement innovations is one of the focuses of main development strategies of Moldova. The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 290 of 13.05.2020**[60] on the approval of the National Action Plan for 2020 for the implementation of the National Employment Strategy for 2017-2021. The Action Plan is focused on Increasing formal employment based on economic competitiveness, skills, and appropriate qualifications, in a sustainable and inclusive development environment. - Law **no. 239 of 13.10.2016** for the approval of the National Strategy for regional development for the years 2016-2020. Balanced and sustainable development in all regions of Moldova. The technology will stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the

[59] https://www.legis.md/
[60] https://www.legis.md/cautare/getResults?doc_id=121513&lang=ro

	environment, produces green economic growth, and stops the depletion of natural resources.
Country environmental development priorities	The government of Moldova understands that a good environment, as well as the availability of natural resources, are necessary for life existence and is a precondition for the population's health. The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The production of clean energy and use of it individually in the night creates sustainable individual units. An autonomous lighting system based on the solar photovoltaic system and LEDs[61] transform the lighting industry by deploying environmentally sustainable lighting technologies. The transformative outlook toward the incorporation of environmentally sustainable lighting technologies is leaving an influential impact on the environment by[62]: ● **Durability:** LED lights have a great and extended lifespan and can last up to 15 years with the same brightness. ● **Energy efficient/Lesser lights needed:** LEDs have a better quality of light distribution as the light is focused on a single direction. This makes the LED lights even more economical, efficient, and thus lesser lights are required to achieve the same level of brightness in comparison with fluorescents and incandescent lights. ● **No toxic element (Mercury or UV emission):** LED lights do not contain mercury, and therefore it has a very low environmental impact than incandescent bulbs. Since LED lights have no mercury at all, it is safe for the environment and can be easily recycled. LEDs maintain a cold temperature and do not emit ultraviolet radiation like other lights. Unlike those old fluorescent lamps, LEDs do not heat up. The excessive heat

[61] https://en.wikipedia.org/wiki/Light-emitting_diode
[62] https://link.springer.com/article/10.1007/s12652-021-02970-y

	and ultraviolet radiation present in other lights can be a hazard to people and materials. ● **Rapid cycling:** LEDs are made of recyclable material and do not contain any dangerous chemicals, thus recycling the LED does not harm the environment. Hence, you can safely recycle your LED lights.
Market potential	In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0%, and requires urgent interventions.
● **Country specific applicability**	
Institutional Capacity	The capability of the institutions involved in the entire process of the use of the technology in the specific investment process is confirmed by previous execution works of using the separate components of the technology: LEDs, solar photovoltaic panels, storage systems, etc. Also, for the financing of the investment projects, the ESCO companies are available on the local market. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) Energy Efficiency Agency; c) National Agency for Research and Development; - Private sector: a) engineering companies b) electricity companies c) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of engineers, electricians, etc
Status of technology in-country	The technology is available in the country and can be used in investment projects, there is no restriction on the implementation. The Energy Efficiency Agency of Moldova implemented a pilot project in Tohatin village[63]. The Pilot Project has 2 pillars with an autonomous street lighting system based on solar energy. Currently, the project is installed at one of the main streets of the village and ensures the safety of cars in traffic as well as pedestrians crossing the street. Relating to the procedures of the use of the technology in specific projects, there are companies that can cover all needs as: - for the import of the equipment, the local distribution companies are in contact with the main producers and factories. - for the energy auditing services, in the country the procedure of accreditation of the auditors, also, a list of auditors is in free access.

[63] https://aee.md/index.php/ru/news/sistem-autonom-de-iluminat-instalat-in-comuna-tohatin-mun-chi-inau-cu-suportul-aee

	- for the execution of the installation and maintenance work, the energy companies have enough technical capacities for the execution of the works. The statistical data of World Trade Organization by the Customs Tariff Number Position 8539 which refer to "Electric filament or discharge lamps, incl. sealed beam lamp units and ultraviolet or infra-red lamps; arc lamps; light-emitting diode "LED" lamps; parts thereof" shows that the import of this equipment in the Republic of Moldova increased in the period when the Government of Moldova started the Energy Efficiency Programs and projects around the country. The total amount of imported equipment in the last 10 years is $38,451,249. In 2019 the main commercial partner, as the source of the import of the equipment is China 33,95%, followed by Germany 14.6% and Poland 13.29%,
Acceptability to locals	The previous small pilot project implemented in Tohatin village received positive feedback as well from authorities and from locals. Some financing entities already implemented energy efficiency projects using similar technology. Currently, the local banks implement financing credit lines to facilitate importing and use of the new technologies in the main sectors.
Paradigm shift potential	The Autonomous Street lighting system based on solar energy not only involves lamps, but also the sensors which collect and transfer the information. The technological shift toward LEDs creates a new concept of management of public street lighting that is acting as a basic factor for the new concept of the management of the transport infrastructure. The production of clean energy and its use for one's own consumption at night creates sustainable individual units. As the autonomous lighting system based on the solar photovoltaic system and LEDs transforms the lighting industry by deploying environmentally sustainable lighting technologies[64], a new mechanism of efficient management of the transport infrastructure. Also, the transformative outlook toward the incorporation of environmentally sustainable lighting technologies is leaving an influential impact of the transport sector on the environment.
Efficiency and effectiveness	New LEDs can last between 50,000 and 100,000 hours or more. The typical lifespan for an incandescent bulb, by comparison, is about 1,200 hours. LEDs are extremely energy efficient compared to any other available lighting technology. The technology will encourage investment in promoting renewable energy production and efficient lighting due to the higher performance of the technological solution. The main characteristics of the efficiency:

[64] Luminol: A contribution to solar street lighting in developing countries. Rita Hogan Teves de Almeida

	- reducing the electricity bills to zero. - generates additional savings through dimming functionality, motion sensors and proactive remote maintenance. - 365 days of autonomy. - does not require trenching and cabling significantly reducing installation costs compared to traditional lights.
Sustainable development potential	Usually, the system produces more energy during the day that can be consumed during the night. This contributes to the energy system having additional clean energy. The technology will contribute to development of the concept of energy autonomy at the local level and to support development by increasing savings of the Local Authorities. The main characteristics of the efficiency: - decreases maintenance costs up to 80 %. - improves maintenance, 70% of issues are managed remotely. - offers automatic lighting schedules and predictive weather analysis to optimize performance. - provides 24/7 automatic monitoring with system alerts and alarms. - enables battery optimization through monitoring for a longer life cycle, cutting maintenance costs by 40%.
Expandability, replicability, and applicability	In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0%, and requires urgent interventions[65].
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Women and men benefit from well-functioning street lighting in equal measure. Installing efficient lighting technology in the right places makes sure everyone's needs are met, especially those of the non-motorized road users, i.e. mostly women, children, youth, and elderly people. Gender-equitable public lighting means moving away from simply lighting traffic lanes towards fully illuminating footpaths and pavements as well.
● **Evaluation criteria: Costs**	
Investments, US$	The main components (per unit): - The cost for one unit starts from 2.200 USD per unit - Installation works: 180 USD per unit
O&M costs, US$/year	The cost of maintenance: - Periodically testing of functionality (every 3 years) - 10 USD on average per unit.

[65] https://statistica.gov.md/newsview.php?l=ro&idc=168&id=6354

	- Replacement of the main components (every 3 years) - 50 USD on average per unit.
● **Evaluation criteria: Economic benefits**	
Employment	New jobs will be created for engineers and electricians. Likewise, the appearance of a new product will stimulate the labor market with the appearance of new sellers.
Investment	Some financing entities already implemented energy efficiency projects using similar technology. Currently, the local banks implement financing credit lines to facilitate importing and use of the new technologies in the main sectors.
Public and private expenditures	The main public expenditures will be on maintenance services. The specific costs should be calculated individually for each project. The benefits of the public entities will be on the efficiency of the management of the public budget.
● **Evaluation criteria: Social benefits**	
Direct Employment	In terms of job creation, the employment of the technicians will contribute to developing the labor market, maintaining certain levels of payment for people in particular in rural areas. Also, employment and new jobs will contribute to poverty reduction.
Skill & Capacity Development	The capacity building will be focused on the development of the capacities of the engineers and electricians. The efficiency of the technology can be included as good practice solution in the lists of technologies for the engineers, technicians, and electricians.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	- Creation of an adaptive and autonomous infrastructure - Money savings from efficient use of electricity produced by solar PV - Reduction of the CO2 Emission on the electricity production process[66].
Benefits of adapting to climate change	As public street lighting as part of the infrastructure is vulnerable to High temperatures, heatwaves, and wind, and storms, the autonomous country-specific and infrastructure links. The solar panel will allow the generation of electricity for autonomous use. The LED lighting will allow the efficient use of electricity. The technology will contribute to developing a resilient infrastructure to reduce exposure to climate risks. Will be increased the access of the rural population to a climate-resilient infrastructure system that considers social and gender issues. - Adaptation of the lighting infrastructure to working in extreme conditions. - Creating an adaptive and autonomous infrastructure. - Creation of an adaptive working of the autonomous renewable energy system.

66 https://www.researchgate.net/publication/280716558_Energy_Consumptions_Operating_Costs_and_CO2_Emission_of_LED_Lighting_in_Offices_Buildings

Other, if any	

Climate event: Increased Summer Temperatures.
Climate impact: Damages of the infrastructure / equipment / cargo. Reduction of infrastructure asset lifetime.

● **General information**	
Sector	Transport
Category	Infrastructure
Climate event	Increased Summer Temperatures.
Impact	Damages of the infrastructure / equipment / cargo. Reduction of infrastructure asset lifetime.
Adaptation measures	Use heat-resistant asphalt and adjustment of maintenance.
Technology Name	Hot rolled asphalt (HRA)
Short description of the technology option	Hot Rolled Asphalt (HRA)[67] is a dense mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108. There is a high proportion of sand in the mix resulting in a low percentage of air voids

67 https://www.researchgate.net/publication/288823869_Development_of_Long_Life_Deformation_Resistant_Hot_Rolled_Asphalt_Surfacing

	when it is compacted. The mortar of bitumen, sand & filler gives it strength. On public roads, high PSV chippings are added to provide a skid-resistant surface. The material is designed for heavy-duty industrial applications such as stocking bays and loading areas. It is particularly suitable where forklift trucks operate, or heavy trucks/buses are cornering tightly on a regular basis. This is the traditional specification for surfacing roads and is used in conjunction with high PSV Pre-Coated Chips to provide an exceptionally durable, anti-skid surface. Hot Rolled Asphalt results in an incredibly durable surface with enhanced longevity, has a high skid resistance and is near impervious to water – resulting in reduced damage. Due to its high characteristics, pavements can reduce the thickness of the entire road structure by 30–35% and the thickness of the base layer by around 25%. Hot Rolled Asphalt (HRA) is produced in accordance with[68]: - IS EN 13108-4 Hot Rolled Asphalt - NSAI's Standard Recommendation (SR) 28 - IS EN 13108-20: Type Testing and IS EN13108-21: Factory Production Control The main components of the technology: - The binder shall be petroleum bitumen. - Contain 30% coarse aggregate with a maximum aggregate size of 14mm, - Additives may include for example: fibres, pigments and adhesion agents. The suitability of such additives shall be demonstrated in accordance with IS EN 13108-4. Main characteristics: - Hot bituminous material is a black granular material with a temperature up to 200 Celcius and a density up to about 1.6. - Thickness (mm): 30 – 40 - Paving Grade of Bitumen: 40/60, 70/100 or 100/150 - BS EN 13108-4/PD 6691 Reference: HRA 30/10 F surf Major benefits include: - Increased point loading resistance above standard asphalt materials - Increased fuel resistance - Superior rut resistance - High stone content, so no application of pre-coat chippings is required - Stability/strength twice that of normal 30/14 asphalt design mix, according to laboratory tests

[68] Hot Rolled Asphalt and Coated Chippings – Checks and Key Points. CC-PAV-04011. January 2019

Country social development priorities	The country's social development priorities are focused on harnessing the economic potential of care activities to increase the employment rate of women. Public expenditure for care services creates jobs, while simultaneously approaching the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[69] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan supports an enabling legal and institutional environment and enhances women's capacities to engage in decision-making proactively; empowers women and achieves de facto equality between men and women in Moldova; fights against stereotypes in society and promotes non-violent communication; and promotes gender-responsive budgeting. As the technology will contribute to reducing the construction and maintenance costs of public infrastructure, it will have a positive impact on the country's social development priorities, particularly by stimulating entrepreneurial activities in transportation services. Public transport will be more resilient and more attractive for socially vulnerable people this will contribute to regional development. The social services will be more accessible for people around the country[70].
Country economic development priorities	The Government of Moldova plans to develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. One of the main documents in this regard is Government Decision **No. 827 of 28.10.2013** on the approval of the Transport and Logistics Strategy for the years 2013-2022. The general objective of implementing this Strategy is to create an efficient transport and logistics system that supports citizens' needs for mobility, facilitates trade on national and international markets, and enhances the Republic of Moldova's role as a liaison between EU and CIS member countries. This Strategy is based on the concept that infrastructure projects must comply with the legal provisions in force in the field of environment, and there must be a balance between environmental protection and economic development.

[69] https://www.legis.md/

[70] Use of Wehner Schulze to predict skid resistance of Irish surfacing materials. Shaun Friel, Malal Kane, David Woodward. Submitted on 14 Aug 2013

	Adaptive public roads will contribute to the sustainable development of transportation services, which will increase entrepreneurship activities in the area of transportation services for goods and passengers. The technological solution simulates the investments in infrastructure and will create access of people to public utilities[71].
Country environmental development priorities	The government of Moldova understands that a good environment, as well as the availability of natural resources, are necessary for life existence and is a precondition for the population's health. The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The use of technological solutions on public roads will reduce the environmental population through the efficient circulation of transport. The use of technology will lead to more efficient use of car tires. Likewise, improved infrastructure will lead to more efficient fuel consumption, which will lead to reduced CO2 emissions from public transport[72].
Market potential	- According to the latest data, 92.5% of the national roads and 46.1% of the local roads are covered by permanent and semi-permanent road pavement (asphalt concrete, cement concrete, bituminous mixtures executed in situ). - The Government strategy is focused on rehabilitation of the existing covered roads and expanding the infrastructure.
● **Country specific applicability**	

[71] https://hal.archives-ouvertes.fr/hal-00851551

[72] https://www.researchgate.net/publication/288823869_Development_of_Long_Life_Deformation_Resistant_Hot_Rolled_Asphalt_Surfacing

Institutional Capacity	The local authorities and public agencies responsible for infrastructure investment have sufficient experience and capacities to explore new asphalt mixtures. The local companies responsible for the import of the goods for mixtures and the execution companies have capacities to develop the entire process of import of the goods and execute the construction works. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) State Road Administration - Private sector: a) engineering companies b) transportation companies c) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of engineers, transportations, etc
Status of technology in-country	Currently, the mixture of mineral aggregate, sand, filler, and bitumen that complies with EN 13108 is not used. To modernize, the infrastructure uses the old mixture that does not correspond to the actual weather conditions.
Acceptability to locals	The technology will improve the quality of the transport infrastructure, it is very well accepted by the locals. In general, infrastructure improvements are positively appreciated by locals. From the practice of the previous projects that modernized the transport infrastructure, it was demonstrated that the localities where the given improvements took place were positively appreciated.
Paradigm shift potential	Hot Rolled Asphalt (HRA) as a dense mixture of mineral aggregate, sand, filler, and bitumen will change the old system of asphalt pavements. First, it will change the asphalt structure and composition, it will change the paving model and it will change the periodic maintenance process, considering that being more durable, maintenance will be needed less often[73] By introducing the Hot Rolled Asphalt (HRA) the transport infrastructure became more resistant, stable and strengthened. Also, the maintenance services will be changed taking into account the new needs and criterias.
Efficiency and effectiveness	Hot Rolled Asphalt (HRA) will increase the efficiency of the transport infrastructure as well, the efficiency of the end-users (transportations). As a more resistant technology, it will increase the period of exploitation and will reduce the costs for maintenance.

[73] https://journal.uii.ac.id/teknisia/article/view/8290

	The transportations will be more efficient because it will have safer tires and will save fuel when providing services.
Sustainable development potential	Hot Rolled Asphalt (HRA) will increase the main physical characteristics of the asphalt pavement. An adequate infrastructure prepared for climate change, more resistance to the climate hazard, and having a bigger period of exploitation will contribute to the sustainable development of the entire sector[74]. Increased life cycle of the asphalt mixture will be used by governments and city administrators as one of arguments of the decision-making process toward creating a more sustainable society. The savings from the maintenance services will be redirected to cover other local needs.
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The significant differences between the travel patterns of women and men are in Moldova. Also, women are more likely than men to combine several purposes into one trip; women tend to use cheaper forms of public transport; and women and men of all ages use roads as pedestrians. The new quality of infrastructure will satisfy the needs of both groups as the modernized asphalt pavement will increase and improve personal transportations as well as public transport.
● **Evaluation criteria: Costs**	
Investments, US$	- The cost for one unit starts from 870.000 USD / km This cost includes costs of material, costs of transportation of goods to the destination, costs of installation work, etc.
O&M costs, US$/year	- The costs of operation and maintenance are about 1% for the first 5 years of exploitation, after this, the costs can be increased by around 0.5% for every 3 years. - The estimated cost is about 8700 USD / km for the first 5 years of exploitation
● **Evaluation criteria: Economic benefits**	
Employment	Subcontract implementation of public works to private enterprises, especially small rural contractors will develop local capacities and public-private partnerships that will create more local employment and enhance the use of local resources, thus stimulating the local economy.
Investment	The modernization of the infrastructure will stimulate investments in regional development. As the local companies will be contracted for the execution works, will increase the investments in regional

74 https://www.researchgate.net/publication/265623308_THE_PERFORMANCE_EVALUATION_OF_HOT_ROLLED_ASPHALT_MIXED_WITH_SAWDUST_ASH_AS_A_FILLER_1

	development in special investments in construction works and commerce[75].
Public and private expenditures	The main public expenditure will be on maintenance services. As taxes cover the maintenance services of the public infrastructure, there is no need to plan an additional budget from public authorities. There is no expenditure for maintenance from the private sector.
● **Evaluation criteria: Social benefits**	
Direct Employment	The direct employment resulting from this activity's construction, supervision, and project management will be based on local needs. Also, new jobs will be created for operation and maintenance. Indirect employment will be significantly higher. This could be explained by the large number of workers employed by the suppliers, who generate induced employment through local consumption.
Skill & Capacity Development	Small rural contractors can be trained to develop their managerial and technical skills for implementing labor-intensive public works.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	Two environmental indicators, non-renewable cumulative energy demand (nr-CED) and global warming potential (GWP), are used to estimate the impact of this technology. he technology will positively impact the environment in two main ways: - The new asphalt pavement will increase the exploitation of safer tires. This will reduce the number of used tires. - A good infrastructure reduces transportation fuel consumption, which will reduce CO2 emissions.
Benefits of adapting to climate change	- Increased point loading resistance above standard asphalt materials - Further improvements of the operations and services of the transport infrastructure. - Increasing operations in the new conditions created by climate change.
Other, if any	

75 https://www.researchgate.net/publication/221997647_Design_and_Construction_of_A_Road_Pavement_Using_Fly-Ash_in_Hot_Rolled_Asphalt

Climate event: Increased Summer Temperatures.
Climate impact: Overheating of the diesel engine. Increasing the energy consumption for cooling cargo. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Infrastructure
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling cargo. Increasing the number of transport delays due to transportation restrictions.
Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hybrid and electric vehicles.
Technology Name	Charging infrastructure for plug-in electric vehicle

Short description of the technology option	A charging station, also called electric vehicle charging station, electric recharging point, charging point, charge point, electronic charging station (ECS), and electric vehicle supply equipment (EVSE), is a machine that supplies electric energy to charge plug-in electric vehicles—including cars, neighborhood electric vehicles, trucks, buses, and others[76]. Some electric vehicles have onboard converters that plug into a standard electrical outlet or a higher voltage outlet. Others use custom charging stations. Charging stations provide connectors that conform to a variety of standards. For common direct current rapid charging, chargers are equipped with multiple adaptors such as Combined Charging System (CCS), CHAdeMO, and AC fast charging[77]. Multiple standards have been established for charging technology to enable interoperability across vendors. Standards are available for nomenclature, power, and connectors. Notably, Tesla has developed proprietary technology in these areas[78]. The main components of the technology:[79] - Charging station - Charging outlet - Charging plug - Charging port - Charger - EVSE (Electric Vehicle Supply Equipment) Main characteristics: - Standard 5 inch HMI user-friendly, modern and stylish appearance design - IEC 62196-2, Type 2 plug - RFID card reader for user authentication - Support Ethernet, Wifi, 4G/5G, OCPP 1.6 - Intelligent operation and cost saving - Input voltage: 1 AC 230V±10% - Output voltage: 1 AC 230V±10% - Charging interface type: IEC 62196-2016 AC Type2 - Communication: Ethernet/WIFI/4G/OCPP 1.6
Country social development priorities	The country's social development priorities are focused on harnessing the economic potential of care activities to increase the employment rate of women. Public expenditure for care services creates jobs, while simultaneously approaching the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity by sustainable development goals, especially those related to the environment, so the economic

[76] https://new.abb.com/ev-charging/ev-selector-demo
[77] https://www.epa.gov/greenvehicles/plug-electric-vehicle-charging
[78] https://afdc.energy.gov/fuels/electricity_infrastructure.html
[79] https://chargehub.com/en/electric-car-charging-guide.html

	activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[80] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan supports an enabling legal and institutional environment and enhances women's capacities to engage in decision-making proactively; empowers women and achieves de facto equality between men and women in Moldova; fights against stereotypes in society and promotes non-violent communication; and promotes gender-responsive budgeting. Considering the difficult situation of transportation, providing access to safe, affordable, accessible, and sustainable transport systems for all and improving road safety, notably by expanding public transport, is one of the priorities of the government of Moldova. The technology will contribute to the country's social development priorities, which are focused on harnessing the economic potential of groups by creating jobs and covering the needs of all social groups of the population.
Country economic development priorities	Enhancing the efficiency of economic processes by strengthening the capacities of companies to innovate and implement innovations is one of the focuses of the main development strategies of Moldova. The country's strategic vision is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, focusing on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation. Developing the charging infrastructure for electric vehicles will create opportunities for two main areas of services in this field. First, it is expected to increase the number of electric vehicles on the local market. This will also increase the need for maintenance services and periodic repair. At the same time, it will increase the market for additional pieces for the replacement of used or deformed pieces of the vehicles.

[80] https://www.legis.md/

	It is expected that will increase the number and employment as well for big dealers' companies, as for small maintenance companies for both, for electric vehicles and for charging installations[81]. This will cover the country's main priorities for developing quality, reliable, sustainable, and resilient infrastructure.
Country environmental development priorities	The government of Moldova understands that a good environment, as well as the availability of natural resources, are necessary for life existence and is a precondition for the population's health. The vision relating to the environment is focused on integrating green economy measures and principles into the production process in different branches of the national economy, which can contribute to improving environmental quality and the living standards of the Republic of Moldova's population. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 As the charging infrastructure for plug-in electric vehicles will increase the number of electric vehicles on the local market, increase their utilization, reduce the use of fossil fuels, and reduce CO2 emissions, the technology is expected to cover the country's environmental priorities in this sector.[82]
Market potential	The number of conventional cars increased constantly, from 404,290 in 2010 to 648,780 in 2019. The comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles, Diesel in 29% then in 2018, Gasoline was used in 49% of vehicles, Diesel in 42%, Liquefied Petroleum Gas in 5% and appear 1% of Hybrid Electric vehicles. It is expected that Electric vehicles will continue to grow on the market at that same share.
● **Country specific applicability**	
Institutional Capacity	The main entities involved in the creation of the charging infrastructure for plug-in electric vehicles are engineering companies, dealers' companies, electrician companies, and local public authorities in the cases when the installations will need the approbation from them. All the involved stakeholders have the capacities, knowledge, and experience needed for the installation of this kind of installation.

[81] https://www.sciencedirect.com/science/article/abs/pii/S1361920919305309
[82] https://op.europa.eu/webpub/eca/special-reports/electrical-recharging-5-2021/en/

	The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) Energy Efficiency Agency; c) National Agency for Research and Development; - Private sector: a) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations
Status of technology in-country	Some pilot projects of installation and use of the charging infrastructure for electric vehicles already were implemented as well by private companies and multilateral agencies as UNDP Moldova and the Energy Efficiency Agency. The technology was adopted by end-users and is very popular in the main municipalities.
Acceptability to locals	The technology is very popular in the main municipalities. As few charging stations are available on the public access, the management of its needs additional technical resources. In particular, it is solved by software management solutions. The technology is intuitive and easy to use, this creates maximum comfort for end-users.
Paradigm shift potential	The electric mobility paradigm shift looks at the need for a transition toward electric mobility to reduce GHG emissions, air pollution, and dependence on oil imports. The paradigm shift, in this case, will impact a lot of activities, in particular the charging concept of the vehicles. As the charging stations for electric vehicles don't need services technical personal, so will be changed an entire business model of delivery services of the charging. Also, the use of electricity as energy for electric vehicles will change the role of the vehicles and their impact on the environment[83].
Efficiency and effectiveness	Charging infrastructure for plug-in electric vehicles is an efficient technology used for charging vehicles. The electricity provided for the cars is very efficiently accounted for, also, the option of the management of the electricity for a network can be developed.
Sustainable development potential	With increasingly serious environmental pollution, EVs have become an important way to develop sustainable transportation because of their advantages of zero-emission. Electric vehicles (EVs) have great potential to increase energy efficiency, reduce greenhouse gas emissions, and diversify energy resources for more sustainable transport[84].

[83] https://www.americanprogress.org/issues/green/reports/2018/07/30/454084/investing-charging-infrastructure-plug-electric-vehicles/

[84] https://www.researchgate.net/publication/340842926_Electric_Vehicle_Charging_Station_Location_towards_Sustainable_Cities

	The charging stations will create a sustainable business model for the operating companies. For the first, it will be created a model that will support clean vehicle development in the country, and for the second, the continuous increase of electric vehicles will ensure the continuous clients that will the basis for sustainability[85]. Public charging infrastructure increases the value of PEVs to their owners and potential purchasers by increasing the distance that can be traveled powered by electricity.[86]
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The international studies demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport and walking, although existing conditions do not always take the specific needs and constraints of women into account. Travel patterns in daily life differ greatly between women and men, and differences in socialization substantially impact travel mode choice. It is expected that the charging infrastructure for electric vehicles will be utilized by men and women in equal access. As the infrastructure has no restrictions, the only limitation will be on the ownership of electric vehicles.
● **Evaluation criteria: Costs**	
Investments, US$	- The cost per unit is about 5.700 USD. This cost includes costs of material, costs of transportation of goods to the destination, costs of installation work, etc.[87]
O&M costs, US$/year	- The cost for maintenance is about 500 USD every 3 years.
● **Evaluation criteria: Economic benefits**	
Employment	It is expected the introduction of the technology in the market will create new jobs in special on maintenance services. New jobs will be created for engineers and electricians. Also, the new product will stimulate the labor market with the appearance of new sellers. The implementation of the installation works by the private companies, especially engineer companies will develop local capacities and public-private partnerships.
Investment	The charging infrastructure for plug-in electric vehicles will generate investments from the distribution companies. Also, the companies focused on the development of the facilities for the customers will invest in the development of this kind of infrastructure[88].

[85] https://en.wikipedia.org/wiki/Charging_station#Renewable_energy

[86] https://www.sciencedirect.com/science/article/abs/pii/S1361920919305309

[87] https://www.researchgate.net/publication/338230005_Public_Charging_Infrastructure_for_Plug-in_Electric_Vehicles_What_is_it_worth

[88] https://www.americanprogress.org/issues/green/reports/2018/07/30/454084/investing-charging-infrastructure-plug-electric-vehicles/

Public and private expenditures	The main expenditures will be on the purchases of the equipment and the installation works. In particular, the expenditures will be on the private companies. No public expenditures from public entities are expected, just, only in case if public authorities will develop their own project relating to the charging infrastructure for plug-in electric vehicles[89].
● **Evaluation criteria: Social benefits**	
Direct Employment	Direct employment is expected to be the two main activities. The first, on the sale areas and the second on the maintenance services.
Skill & Capacity Development	Training for the technical personnel of the sale areas and the maintenance services need it.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	Charging infrastructure for plug-in electric vehicles will increase the number of electric vehicles on the local market. As a result, the utilization of electric vehicles will decrease the use of fossil fuels in the transport sector, will reduce CO2 emissions.
Benefits of adapting to climate change	- Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services. - Reducing the delays and incidents on the transport services.
Other, if any	

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling cargo. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling cargo. Increasing the number of transport delays due to transportation restrictions.
Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hybrid and electric vehicles.
Technology Name	Plug-in electric vehicles

[89] https://www.sciencedirect.com/science/article/abs/pii/S1361920919305309

Short description of the technology option	A plug-in electric vehicle (PEV) is any road vehicle that can be recharged from an external source of electricity, such as wall sockets, and the electricity stored in the rechargeable battery packs drives or contributes to drive the wheels. PEV is a subset of electric vehicles that includes all-electric, or battery electric vehicles (BEVs)[90]. PEV is a subcategory of electric vehicles that includes battery electric vehicles (BEVs), plug-in hybrid vehicles, (PHEVs), and electric vehicle conversions of hybrid electric vehicles and conventional internal combustion engine vehicles. Even though conventional hybrid electric vehicles (HEVs) have a battery that is continually recharged with power from the internal combustion engine and regenerative braking, they cannot be recharged from an off-vehicle electric energy source, and therefore, they do not belong to the category of plug-in electric vehicles[91]. Plug-in electric vehicles operating in all-electric mode do not emit greenhouse gases from the onboard source of power, but from the point of view of a well-to-wheel assessment, the extent of the benefit also depends on the fuel and technology used for electricity generation. This fact has been referred to as the long tailpipe of plug-in electric vehicles. The main components of the technology: - Battery (auxiliary): In an electric drive vehicle, the low-voltage auxiliary battery provides electricity to start the car before the traction battery is engaged; it also powers vehicle accessories. - Charge port: The charge port allows the vehicle to connect to an external power supply. - DC/DC converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power. - Electric generator: Generates electricity from the rotating wheels while braking, transferring that energy back to the traction battery pack. - Electric traction motor: Using power from the traction battery pack, this motor drives the vehicle's wheels. - Onboard charger: Takes the incoming AC electricity supplied via the charge port and converts it to DC power for charging the traction battery. - Power electronics controller: This unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces. - Traction battery pack: Stores electricity for use by the electric traction motor. - Transmission: The transmission transfers mechanical power from the engine and/or electric traction motor to drive the wheels.[92]

[90] https://en.wikipedia.org/wiki/Plug-in_electric_vehicle
[91] https://afdc.energy.gov/vehicles/how-do-plug-in-hybrid-electric-cars-work
[92] https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[93] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The social dimension of sustainability of transport is at the core of the main reason for the transport system to exist - to provide access to: resources, services, and markets (central components for the generation of welfare). The implementation of plug-in electric vehicles will have a positive impact on the social development priorities of the country in particular to stimulate entrepreneurial activities on the transportation services.
Country economic development priorities	The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.

[93] https://www.legis.md/

	Alternative electricity generation or renewable power generation technology may need to be considered for the future to meet the extra energy demand arising from electric vehicles. This will generate new developments in the energy sector, an increase in investments, and the creation of new jobs. Plug-in electric vehicles will stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources in the two main sectors, in transportation and in the energy sectors[94].
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The introduction of plug-in electric vehicles will replace the internal combustion vehicles with new technologies cleaner and more sustainable. Electric vehicles will reduce CO2 emissions, and it is expected that the technology will cover the environmental priorities of the country in this sector.[95]
Market potential	The comparative analysis of the share of fuel used in road transport demonstrates that if in 2008, Gasoline was used in 64% of vehicles, Diesel in 29% then in 2018, Gasoline was used in 49% of vehicles, Diesel in 42%, Liquefied Petroleum Gas in 5% and appear 1% of Hybrid Electric vehicles. It is expected that Electric vehicles will continue to grow on the market at that same share.
● **Country specific applicability**	
Institutional Capacity	The local companies (car dealers) responsible for the import of the cars have the capacities, infrastructure, and knowledge to import the vehicles.

[94] https://phev.ucdavis.edu/about/faq-phev/
[95] https://www.fueleconomy.gov/feg/phevtech.shtml

	The central, local authorities and public agencies responsible for the promotion of new technologies, especially in the transport sector, have sufficient experience and capacities. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) National Car Transport Agency - Private sector: a) engineering companies b) transportation companies c) leasing companies d) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of auto and transportations, etc
Status of technology in-country	The statistics show that electric vehicles are used more and more in the country. The legal framework is prepared to import these cars, also, the Custom's services and procedures are prepared and well-functioning. Relating to the electric vehicles, the products were divided into two main categories, the vehicles for work and the vehicles for passengers. The vehicles for works included in the group 8709 "Works trucks, self-propelled, not fitted with lifting or handling equipment, of the type used in factories, warehouses, dock areas or airports for short-distance transport of goods; tractors of the type used on railway station platforms; parts of the foregoing vehicles, n.e.s." The total amount of these vehicles imported to Moldova for the period of 2010 - 2019 is $738,552. The main commercial partner of this product in 2019 is the Popular Republic of China.
Acceptability to locals	The new electric vehicles are very attractive to the locals. In particular, statistics show that cars are preferred by young people, in particular by women, because women are more responsible for the environment.
Paradigm shift potential	The electric mobility paradigm shift looks at the need for a transition toward electric mobility to reduce GHG emissions, air pollution, and dependence on oil imports. The paradigm shift, in this case, will impact a lot of activities, in particular the charging concept of the vehicles. As the charging stations for electric vehicles don't need services technical personal, so will be changed an entire business model of delivery services of the charging. Also, the use of electricity as energy for electric vehicles will change the role of the vehicles and their impact on the environment[96].
Efficiency and effectiveness	Electric vehicles are very efficient in that they have a lot of efficient technologies to monitor energy charging and consumption. Also, the technology using for monitoring energy consumption is implemented in the transmission system[97].

[96] https://www.epa.gov/greenvehicles/explaining-electric-plug-hybrid-electric-vehicles
[97] https://afdc.energy.gov/vehicles/electric_basics_phev.html

	Comparing the costs of electricity and fuel, consumption, and population, electric vehicles are more efficient and effective than internal combustion cars.
Sustainable development potential	With increasingly serious environmental pollution, EVs have become an important way to develop sustainable transportation because of their advantages of zero-emission. Electric vehicles (EVs) have great potential to increase energy efficiency, reduce greenhouse gas emissions, and diversify energy resources for more sustainable transport[98]. An important feature of BEV that can contribute to a sustainable transportation system is the lower noise emission compared to conventionally driven cars. Electric cars, which do not use cyclic explosions of the fuel-air mix for propulsion emit virtually no noise. Noise resulting from the movement of an electric car reaches 40 dB, which is like that of a refrigerator. The sustainability of electric vehicles is considered by examining the sustainability of the transport system itself, in view of its positive and negative external effects on the environment, public health, safety and security, land use, economic growth, and social inclusion.[99]
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The international studies demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport and walking, although existing conditions do not always take the specific needs and constraints of women into account. Travel patterns in daily life differ greatly between women and men, and differences in socialization substantially impact travel mode choice. It is expected that electric vehicles will be utilized by men and women in equal access.
● **Evaluation criteria: Costs**	
Investments, US$	- Cost per unit starts from around 26.900 USD for a new car
O&M costs, US$/year	- the maintenance costs of the cars start from 600 USD per year[100]
● **Evaluation criteria: Economic benefits**	
Employment	The introduction of electric vehicles creates the potential for replacing fossil fuels because of the benefits they offer in terms of increased energy efficiency and reduction in local pollution. One of the important aspects of the provisioning of electric vehicles can be focused on electricity production at the national level, in particular, by the electricity production from renewable sources.

98 https://www.researchgate.net/publication/340842926_Electric_Vehicle_Charging_Station_Location_towards_Sustainable_Cities

99 https://driveclean.ca.gov/plug-in-hybrid

100 https://www.eesi.org/papers/view/fact-sheet-plug-in-electric-vehicles-2017

	By the introduction of this kind of vehicle, a large specter of new companies will be created, starting from the car dealers and pieces for the maintenance, until the energy companies that will produce electricity to supply the cars.
Investment	The main investments will be done by car dealers' companies. In particular, the investments will be focused on the increase of the stock of cars and promotion activities.[101]
Public and private expenditures	Both public and private initiatives are needed and given that electric cars are expected to deploy faster in urban and suburban zones, such intervention would, at least in the first stage, focus on such areas. Public-private collaborative strategies at different levels (supranational, national, and local) are needed to address different types of barriers.
● **Evaluation criteria: Social benefits**	
Direct Employment	Direct employment is expected to be the two main activities. The first, on the sale areas and the second on the maintenance services.
Skill & Capacity Development	Training for the technical personnel of the sale areas and the maintenance services need it.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	Electrification of road transport in the urban environment has the potential to significantly reduce the CO2 emissions (and other pollutants) in the roads of our cities as well as our nearly complete reliance on fossil fuels. This is based on the much higher efficiency of electric motors compared to ICEs as well as the potential to de-carbonize the energy chain used in transportation and in particular in the well to tank pathway. [102]
Benefits of adapting to climate change	- Increased operating services of the transportation companies. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.
Other, if any	

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. The number of transport delays due to transportation restrictions is increasing.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

[101] https://www.eesi.org/papers/view/fact-sheet-plug-in-electric-vehicles-2017
[102] https://www.carsdirect.com/green-cars/plug-in-hybrid-advantages-and-disadvantages

Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hybrid and electric vehicles.
Technology Name	Battery Powered trolleybuses
Short description of the technology option	A battery-powered trolleybus is a vehicle that uses an electric engine. Electricity is primarily obtained from overhead contact wires installed above the road. However, compared to the conventional trolleybus, it has the advantage of the possibility to pass through sections of the route without many overhead contact wires. This is achieved by adding an additional energy source[103]. There are two possible approaches to the additional energy source. One is the addition of a diesel engine that serves as an electric generator for the main electric traction motor and is only switched-on during parts of the route with no overhead contact wires. The more interesting and more environmentally friendly way is to add a battery that can be recharged on electrified sections, possibly also by recuperation. The batteries used in vehicles can be smaller, they serve only as an auxiliary power source. This approach also produces less environmentally hazardous waste when the traction battery is replaced. The traction battery also has a significantly lower capacity than traction batteries in conventional electric buses, but it can provide enough power to overcome some distance without overhead contact wires. The main benefits are also that vehicles never need to stop recharging their batteries. Their performance is the same under overhead wires and with batteries. There is also significant energy-saving potential of the battery-assisted trolleybus. The main components of the technology: The storage system comprises 220 lithium cells connected in series in 2 parallel sections containing 110 cells each. The parameters are as follows: - Total voltage: 407 V, - Capacity: 40 Ah, 16.3 kWh - Weight: 390 kg. Main characteristics: - Average battery consumption 1.5 kWh/km - Charging time of 1% of battery capacity 40s - Battery capacity 20 kWh - Average energy recovered by recuperation 0.5 kWh/km - Additional energy needed to overcome 1% rising slope 1 kWh/km - Energy that can be saved at 1% downgrade slope 20% - Minimum allowed battery level 20% - Maximum allowed battery level 80% - Initial battery SOC 50%

103 https://www.researchgate.net/publication/286365095_Trolleybus_with_traction_batteries_for_autonomous_running

Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[104] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The technology will contribute to achieving the main goal of the strategies focused on improving the access of the rural population to neighboring towns/localities, especially by developing local road infrastructure and public transport, considering the accessibility of persons with disabilities, universal design, and reasonable accommodation. In this specific case, by the connection of the suburban areas with the center of municipalities.
Country economic development priorities	The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the “green” economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation.

[104] https://www.legis.md/

	Considering the difficult situation of transport infrastructure, the vision of the Government is focused on providing access to safe, affordable, accessible, and sustainable transport systems for all, as well as improving road safety, notably by expanding public transport. The technology will support achieving the main goals by introducing new solutions for public transport[105]. The technology will generate new production of energy in the energy sector as well as new activities in the transportation sector. The passengers will have access to new transportation services that will stimulate mobility and economic growth. The technology will support positive economic, social, and environmental links between urban, peri-urban, and rural areas by strengthening national and regional development planning.
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The introduction of battery-powered trolleybuses will replace the internal combustion autobuses with new technologies cleaner and more sustainable. Battery-powered trolleybuses will reduce CO2 emissions, and it is expected that the technology will cover the environmental priorities of the country in this sector[106].
Market potential	The market for this technology is Chisinau municipality and Balti municipality and their suburban areas. In Chisinau at present 312 trolleybuses operate on 31 lines, of which in the case of 8 are used trolleybuses with autonomous propulsion.

[105] Case Study: Ebus Hybrid Electric Buses and Trolleys R. Barnitt. Prepared under Task No. FC06.3000. National Renewable Energy Laboratory

[106] https://www.urban-transport-magazine.com/en/bus-electrification-a-comparison-of-capital-costs/

● **Country specific applicability**	
Institutional Capacity	The local companies responsible for the import of the trolleybuses and the companies responsible for the maintenance services have the capacity to implement the technology at the local level. The local authorities and public agencies responsible for public transport have sufficient experience and capacities. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) National Car Transport Agency d) RTEC Chisinau - Private sector: a) engineering companies b) transportation companies c) leasing companies d) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of auto and transportations, etc
Status of technology in-country	The technology was tested in the country, in particular in Chisinau Municipality, and received positive feedback from the operator company, local public authority, and passengers.
Acceptability to locals	The technology is developed to be used by local passengers. As public transport is very popular and used by locals, the technology will cover the needs of the main number of passengers, in particular from suburban areas.
Paradigm shift potential	As electric vehicles, the battery-powered trolleybuses will change the paradigm of the consumption of fuels by the transport sector. The paradigm shift, in this case, will impact a lot of activities, in particular the charging concept of the vehicles. The technology will change the way passenger services are provided in areas without electricity infrastructure. Also, the use of electricity as the energy source for electric vehicles will change the role of vehicles and their impact on the environment.[107] The technology will change the
Efficiency and effectiveness	With efficient use of the trolleybuses with onboard batteries can cover longer routes and connections. The technology permits to reduce or increase the capacity of the onboard batteries and thus the weight of the vehicle and increase the number of passenger seats. Optimal adjustment of the battery capacity to the length of the section which the trolleybus must cover makes this solution economically sound and efficient[108].

[107] https://ieeexplore.ieee.org/document/8892862

[108] Analysis of limiting factors of battery assisted trolleybuses. Dobroslav Grygara, Michal Kohánia, Rastislav Štefúnb*, Peter Drgoňa. 2019 The Authors. Published by Elsevier B.V

Sustainable development potential	Sustainable and efficient use of the overhead lines is a key challenge for trolleybus network operators. Installing alternative power sources on board trolleybus increases the sustainability of the functioning of the public transport.[109] Assuming that the trolleybus life cycle is around 20 years and with the currently available battery solutions, it can be inferred that the onboard batteries, if used reasonably, will have a similar life cycle. Special technical solutions are employed to automate the connection of pantographs of trolleybuses with onboard batteries. Those solutions make the connection process quick and efficient; it does not require an extended stay at the stop and thus does not affect the trolleybus schedule.
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The international studies demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport and walking, although existing conditions do not always take the specific needs and constraints of women into account. Travel patterns in daily life differ greatly between women and men, and differences in socialization substantially impact travel mode choice. It is expected that electric vehicles will be utilized by men and women in equal access.
● **Evaluation criteria: Costs**	
Investments, US$	Cost per unit starts from around 360.000 USD for a new trolleybus
O&M costs, US$/year	The cost of maintenance: - Periodically testing of functionality (every 3 years) – 0.5% on average per unit. - Replacement of the main components (every 3 years) - 1% on average per unit. It is expected that the costs of maintenance will be around 5.400 USD / per unit for every 3 years.
● **Evaluation criteria: Economic benefits**	
Employment	The introduction of the technology will create the potential for replacing fossil fuels because of the benefits they offer in terms of increased energy efficiency and reduction in local pollution. One of the important aspects of the provisioning of electric vehicles can be focused on electricity production at the national level, in particular, by the electricity production from renewable sources. By the introduction of this kind of vehicle, a large specter of new companies will be created, starting from the distribution, in speciality of batteries solutions and pieces for the maintenance, until the energy companies that will produce more electricity in special from renewable sources.

109 https://www.researchgate.net/publication/286365095_Trolleybus_with_traction_batteries_for_autonomous_running

Investment	Usually, the main investor in public transport is the local public authority. The battery-powered trolleybuses have a higher investment cost and might require the replacement of costly batteries during their lifespan. However, battery costs are decreasing by less than 10% per annum while battery quality is improving in terms of degradation rates and power storage. These factors reduce the difference in capital expenditure between electric vehicles and fossil fuels[110]. The investment would require a different financial structure. The environmental advantages of this technology could be used to access climate finance with partial grant and partial concessional funding. This would result in a low-cost financial structure and lower operational costs for the city.
Public and private expenditures	Both public and private initiatives are needed and given that battery-powered trolleybuses are expected to deploy faster in urban and suburban zones, such intervention would, at least in the first stage, focus on such areas. Public-private collaborative strategies at different levels (supranational, national, and local) are needed to address different types of barriers.
● **Evaluation criteria: Social benefits**	
Direct Employment	Direct employment is expected to be on the operator's activity, in particular will increase the number of drivers of the trolleybuses. Also, technical experts in maintenance services will need it.
Skill & Capacity Development	The implementation of the battery-powered trolleybuses will need workshops and special training courses for drivers of the trolleybuses. The training should be focused on the adequate use of the battery. Also, the development of capacities for the maintenance team should be organized in special for the engineers, technicians, and electricians.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	Battery Powered trolleybuses result in the reduction of significant emissions of CO2. Replacing diesel buses with trolleybuses results in GHG emission savings as well as reduces noise pollution. This creates a good opportunity for attracting climate finance.
Benefits of adapting to climate change	- Adapting the transport fleet of the public transport services to the new conditions of climate change. - Improving the functioning of transport services. - Noise reduction from engine fractionation. - Reducing maintenance and operating costs.
Other, if any	

[110] https://www.researchgate.net/publication/332182096_Fast-Charging_Station_Deployment_for_Battery_Electric_Bus_Systems_Considering_Electricity_Demand_Charges

Climate event: Increased Summer Temperatures.
Climate Impact: Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

● **General information**	
Sector	Transport
Category	Transport fleet
Climate event	Increased Summer Temperatures.
Impact	Overheating of the diesel engine. Increasing the energy consumption for cooling public transport. Increasing the number of transport delays due to transportation restrictions.

Adaptation measures	Introduce vehicles with a new propulsion-type engine. Introduce new transport adapted to increased temperatures. Creation of the charging infrastructure for hybrid and electric vehicles.
Technology Name	Electric bikes and mopeds
Short description of the technology option	An electric bicycle, also known as an e-bike or e-bike, is a bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedal-power (i.e. pedelecs) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedaled by the rider and are therefore not electric motorcycles.[111] E-bikes use rechargeable batteries and typically travel up to 25 to 32 km/h. High-powered varieties can often travel more than 45 km/h. In some markets, they are gaining in popularity and taking some market share away from conventional bicycles, while in others, they are replacing fossil fuel-powered mopeds and small motorcycles[112]. The main components of the technology: - Suspension Travel: (Front / Rear) 70 / 65mm - Rim: 24 ”aluminum - Pedal assistance: King-Meter FH - Front lighting: AXA Blueline 30 LED - Battery: Lithium 360 Wh Main characteristics: - Certification: EN15194 - Length: 1.500 - 1.800 cm - Width: 500 - 800 cm - Wheelbase: 1.000 - 1.200 cm - Speed 15 - 25 km h - Loudness: <50 dB - Maximum load (on the e-bike): 120 kg - Suggested Height Range: 150 - 200cm - Charging time: 4 h (from 0 to 100% capacity) E-bikes are classed according to the power that their electric motor can deliver and the control system, i.e., when, and how the power from the motor is applied. Also, the classification of e-bikes is complicated as much of the definition is due to legal reasons of what constitutes a bicycle and what constitutes a moped or motorcycle. As such, the classification of these e-bikes varies greatly across countries and local jurisdictions.[113]
Country social development priorities	The social development priorities of the country are focused on harness the economic potential of care activities as an opportunity to increase the employment rate, of women, so public expenditure for care services

[111] https://optibike.com/electric-bikes-vs-mopeds/
[112] https://www1.nyc.gov/html/dot/html/bicyclists/ebikes.shtml
[113] https://dmv.ny.gov/registration/electric-scooters-and-bicycles-and-other-unregistered-vehicles

	creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population[114]. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[115] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The technology will contribute to increasing the mobility of the people in rural and urban areas. The implementation of this technology will have a positive impact on the social development priorities of the country in special to stimulate entrepreneurial activities in rural and urban areas. The increased mobility will impact economic growth and regional development.
Country economic development priorities	The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 827 of 28.10.2013** regarding the approval of the Transport and Logistics Strategy for the years 2013-2022 - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision **no. 160 of 21.02.2018** approving the Program for the promotion of the "green" economy in the Republic of Moldova for the years 2018-2020 and of the Action Plan for its implementation. The technology will stimulate entrepreneurial activity in accordance with the sustainable development goals of the country, especially in

[114] https://en.wikipedia.org/wiki/Electric_bicycle#Health_effects
[115] https://www.legis.md/cautare/getResults?doc_id=102127&lang=ro

	rural areas. Small commerce, farmers, and entrepreneurs will have a new option for economic mobility.
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks[116]. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The technology will reduce the number of fuel-based motorcycles. This will decrease the CO2 emissions of the transport sector. Also, the electric bikes and mopeds will stimulate people to mobility in the fresh air which will be beneficial to health.
Market potential	As this technology doesn't need special infrastructure or requirements for charging, the electric bikes and mopeds can be charged at home using standard access to electricity, it is expected that the technology can be deployed around the country without any barriers.
● **Country specific applicability**	
Institutional Capacity	No special capacities are needed from the public or private sector regarding the implementation of this technology around the country. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) National Car Transport Agency - Private sector: a) engineering companies b) transportation companies c) leasing companies d) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of auto and transportations, etc

[116] https://en.wikipedia.org/wiki/Electric_bicycle

Status of technology in-country	The technology is already imported into the country. The technology is rapidly gaining use across the country. It is easy to use and is especially acceptable to young people.
Acceptability to locals	The technology is easy to use and is especially acceptable to young people. No restriction on the use of this technology in the country.
Paradigm shift potential	The paradigm shift of the small capacity electric mobility units is focused on the decarbonization of the motorcycle's units. Also, one of the main aspects of the paradigm is that, the Cycling will be more accessible for longer distances. The moto will be based on the more efficient and clean units.[117]
Efficiency and effectiveness	The small capacity electric mobility units are more efficient and effective due to their technology of the management of the charging and use of the electricity.[118]
Sustainable development potential	This technology will create employment for youth as they will work as assistants or sellers. It will improve the physical health of users through fit cycling. In addition, it will reduce emissions from cars, encourage use of renewable technologies such as solar and reduce poor families' transport burden to work. As the technology can be charged by the electricity generated from renewable sources, the sustainability concept is highly integrated into the concept of this kind of vehicle.[119]
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Women are more inclined than men to use low-carbon transport modes such as public transport and walking. Also, the statistical data demonstrate that women prefer to use small capacity mobility units. As the technology has no restriction for men or women, it is expected that it will be used in equal access.
● **Evaluation criteria: Costs**	
Investments, US$	The cost per unit starts from around 700 USD for a new bike and 3.000 USD for a new moped.
O&M costs, US$/year	The cost of maintenance is about 1% for the first 5 years of exploitation, after this, the costs can be increased by around 0.5% for every 3 years. The average of the costs for maintenance starts from 15 USD per unit.
● **Evaluation criteria: Economic benefits**	
Employment	It is expected the introduction of the technology in the market will create new jobs in special on maintenance services. New jobs will be created for engineers and electricians.

[117] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7503491/
[118] https://www.amfam.com/resources/articles/on-the-road/electronic-bikes-vs-mopeds
[119] https://www.sciencedirect.com/science/article/pii/S2352146516302733

	Also, the new product will stimulate the labor market with the appearance of new sellers.
Investment	Implementation and promotion of this technology in the country will generate investments from the distribution companies.
Public and private expenditures	The main expenditures will be on the purchases of the equipment and promotion. In particular, the expenditures will be on the private companies. No public expenditures from public entities are expected
● **Evaluation criteria: Social benefits**	
Direct Employment	Direct employment is expected to be the two main activities. The first, on the sale areas and the second on the maintenance services.
Skill & Capacity Development	Training for the technical personnel of the sale areas and the maintenance services need it.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	As a result, the utilization of electric bikes and mopeds will decrease the use of fossil fuels in the transport sector, and will reduce CO2 emissions.[120]
Benefits of adapting to climate change	- Adapting the transportation fleet to the new climate change conditions. - Increasing operations in the new conditions created by climate change. - Increase the mobility of people in the new climate conditions.
Other, if any	

Climate event: Increased and more frequent extreme winds.
Climate Impact: Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

● **General information**	
Sector	Transport
Category	Software and management. Digitalization
Climate event	Increased and more frequent extreme winds.
Impact	Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

[120] https://en.wikipedia.org/wiki/Electric_bicycle#Environmental_effects

Adaptation measures	Modernization of the lighting and signaling system
Technology Name	Street Lighting Remote Control Management System
Short description of the technology option	The system utilizes wireless technology and employs RF/GSM technology to program, monitoring, and control geographically distributed remote streetlights[121]. The system is equipped with controllers that contain communication and monitoring modules that provide regular streetlight status updates to the Master Control Station (MCS).[122] The control system provides different control modes for controlling the light bulbs that can be remotely programmed from web-based software. Lamps can be remotely controlled based on user configurable ON and OFF schedules that can be programmed on a daily/monthly/yearly basis or can be controlled locally based on a clock that accurately calculates sunset and sunrise times using location and time zone data throughout the year. Thus, the streetlights continue to be operated even when the communication link fails[123]. The main components of the technology: - LED light - Communication port - Sensors - Cloud hosting - Current voltage metering & datalog - Operator Workstation (OWS) - Central Server (CS) Main characteristics: - Operation range: Temperature range: -30... +75 ºC. Voltage range: 110-277V 50-60Hz - Control mode: Remote, wireless, end-to-end, con gurable, programmable (GSM, FM) - Adressing: IPv6 - 6LowPAN - Accessibility: Worldwide accessible. 365/7/24 - System requirements: Optimized for / Optimizado para Android 2.3, Google Chrome 23, Internet Explorer 9, iOS 5, Mozilla Firefox 17, Opera 12 The system utilizes the latest developments in wireless technology and employs RF/GSM technology to program; monitor and control geographically distributed remote streetlights. The ON/OFF switching of the streetlights can be remotely programmed and re-programmed as per requirement so as to save valuable power. Intelligent interface devices can optimize the energy requirements by recording the changes in nightfall in different seasons. The system utilizes wireless mode of

[121] High Efficient Automatic Solar Tracking Street Lighting System With Base Station Monitoring. Naresh Manda, Pedda Krishna Samineni and Shaik Mahaboob Subani
[122] https://en.wikipedia.org/wiki/Lighting_control_system#Automated_control
[123] https://en.wikipedia.org/wiki/Lighting_control_system

	data communication and saves the cost and labor of cable lying throughout the busy roads. This improves the scalability of the system to a new height. Any number of new streetlights can be added to the existing network with simple and easy modifications.
Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017** on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. The technology will contribute to supporting the implementation of the social development priorities of the country in order to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. Sustainable lighting will contribute to increasing activities during the evening, especially studying, and attending overtime in educational institutions. It will also stimulate the economic activity of women during the dark period[124].
Country economic development priorities	Enhancing the efficiency of economic processes by strengthening the capacities of companies to innovate and implement innovations is one of the focuses of main development strategies of Moldova. The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are:

[124] https://patents.google.com/patent/US5479159

	- Government Decision **no. 290 of 13.05.2020** on the approval of the National Action Plan for 2020 for the implementation of the National Employment Strategy for 2017-2021. The Action Plan is focused on Increasing formal employment based on economic competitiveness, skills, and appropriate qualifications, in a sustainable and inclusive development environment. - Law **no. 239 of 13.10.2016** for the approval of the National Strategy for regional development for the years 2016-2020. Balanced and sustainable development in all regions of Moldova. The technology will stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. it will increase the efficiency of the lighting system and will contribute to the efficient use of public money and investments[125].
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The production efficient use of energy in special for the public use is one of the pillars of sustainable development of the country. The Street Lighting Remote Control Management System will transform the lighting industry by deploying environmentally

[125] https://www.researchgate.net/publication/260494832_Remote-Control_System_of_High_Efficiency_and_Intelligent_Street_Lighting_Using_a_ZigBee_Network_of_Devices_and_Sensors

	sustainable lighting technologies[126]. The transformative outlook toward the incorporation of environmentally sustainable lighting technologies is leaving an influential impact on the environment.
Market potential	- In 2018, the length of the illuminated streets was 2.8 thousand km, increasing compared to 2017 by 117.9 km. The degree of the country's coverage of the streets with lighting is 77.0%. - In some cities, street lighting is provided in a proportion of only 25%, for example in Glodeni is 20.2%, in Floresti - 22.0%, and requires urgent interventions.
● **Country specific applicability**	
Institutional Capacity	The capability of the institutions involved in the entire process of the use of the technology in the specific investment process is confirmed by previous execution works of the installation management systems for the lighting system. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) Energy Efficiency Agency; c) National Agency for Research and Development; - Private sector: a) engineering companies b) electricity companies c) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of engineers, electricians, etc
Status of technology in-country	The old version of this technology is available in the country. Relating to the procedures of the use of the technology in specific projects, there are companies that can cover all needs as: - for the import of the equipment, the local distribution companies are in contact with the main producers and factories. - for the energy auditing services, in the country the procedure of accreditation of the auditors, also, a list of auditors is in free access. - for the execution of the installation and maintenance work, the energy companies have enough technical capacities for the execution of the works.
Acceptability to locals	The previous small pilot projects received positive feedback as well from authorities and from locals. The Energy Efficiency Agency of Moldova implemented a pilot project in Tohatin village[127]. The Pilot Project has 2 pillars with an autonomous street lighting system based on solar energy. Currently, the

[126] https://www.semanticscholar.org/paper/Streetlight-Control-System-Based-on-Wireless-over-Outeiri%C3%B1o-Quiles-Latorre/009e650ce69f01a446d02a6b5a5ca7128bc5295b

[127] https://aee.md/index.php/ru/news/sistem-autonom-de-iluminat-instalat-in-comuna-tohatin-mun-chi-inau-cu-suportul-aee

	project is installed at one of the main streets of the village and ensures the safety of cars in traffic as well as pedestrians crossing the street. Some financing entities already implemented energy efficiency projects using similar technology. Currently, the local banks implement financing credit lines to facilitate importing and use of the new technologies in the main sectors.
Paradigm shift potential	The Street Lighting Remote Control Management System not only involves lamps, but also the sensors which collect and transfer the information, also motion sensors which detect moving objects (pedestrians or cars). The technological concept of management of public street lighting purposes is acting as a deterrent for the growth of this market[128]. The technological concept of management of public street lighting purposes is acting as a factor for the growth of this market. The technology transforms the lighting industry by deploying environmentally sustainable lighting technologies. As currently, the public street lighting management process is manual, the introduction of the Street Lighting Remote Control Management System will introduce a new concept of management and will change the paradigm of this[129].
Efficiency and effectiveness	The system addresses the specific needs and budgets of different agencies. These products range from extremely low cost controllers that can replace digital timers on individual poles to complete streetlight systems that control power to a large group of streetlights. As a centralized streetlight management solution that is powerful yet economical, provides a ROI based on the following: - Reduce energy costs - Reduce maintenance costs - Low-cost wireless control - Energy Monitoring - Increased lamp lifes - Sun-set/Sun-rise based ON/OFF schedule - Powerful web-based software with GPS mapping - Powerful Asset Management with complete and accurate streetlight inventory - Extensive reporting on the performance and energy savings and more The Street Lighting Remote Control Management System will increase the efficiency of the public street lighting from 50% to 80%. [130]
Sustainable development potential	The technology will increase the efficiency of the lighting system and will generate additional income for the public authorities.

[128] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3690067/

[129] https://www.researchgate.net/publication/260494832_Remote-Control_System_of_High_Efficiency_and_Intelligent_Street_Lighting_Using_a_ZigBee_Network_of_Devices_and_Sensors

[130] https://intelilight.eu/intelilight-streetlight-control-software/

	The efficient consumption of electricity will create the precondition for economic and sustainable development[131]. Also, lower energy consumption reduces CO2 emissions drastically.
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Women and men benefit from well-functioning street lighting in equal measure. Installing efficient lighting technology in the right places makes sure everyone's needs are met, especially those of the non-motorized road users, i.e. mostly women, children, youth, and elderly people. Gender-equitable public lighting means moving away from simply lighting traffic lanes towards fully illuminating footpaths and pavements as well.
● **Evaluation criteria: Costs**	
Investments, US$	The main components (per unit): - LED lamp - Controllers that contain communication and monitoring modules - Sensors (motion, weather, etc.) - Master Control Station (MCS) The cost for one unit starts from 5.700 USD
O&M costs, US$/year	The costs of operation and maintenance are about 1% for the first 5 years of exploitation, after this, the costs can be increased by around 0.5% for every 3 years.[132] It is expected that the cost will start from 600 USD per unit for the first 5 years, after this, for every 3 year it will be around 1000 USD per unit.
● **Evaluation criteria: Economic benefits**	
Employment	New jobs will be created for engineers and electricians. Likewise, the appearance of a new product will stimulate the labor market with the appearance of new sellers.
Investment	Some financing entities already implemented energy efficiency projects using similar technology. Currently, the local banks implement financing credit lines to facilitate importing and use of the new technologies in the main sectors.
Public and private expenditures	The main public expenditures will be on maintenance services. The specific costs should be calculated individually for each project[133].
● **Evaluation criteria: Social benefits**	
Direct Employment	In terms of job creation, the employment of the technicians will contribute to developing the labor market, maintaining certain levels of payment for people in particular in rural areas. Also, employment and new jobs will contribute to poverty reduction.

[131] https://www.elt.es/en/stelaria-remote-wireless-street-lighting-cms

[132] https://www.ijsr.net/get_abstract.php?paper_id=23071402

[133] Adaptive street lighting predictive control. Francesco Marinoa*, Fabio Leccesea, Stefano Pizzuti

Skill & Capacity Development	The capacity building will be focused on the development of the capacities of the engineers and electricians. The efficiency of the technology can be included as a good practice solution in the lists of technologies for the engineers, technicians, and electricians.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	- Creation of an adaptive and autonomous infrastructure - Money savings from efficient use of electricity[134]
Benefits of adapting to climate change	The technology will contribute to developing a resilient infrastructure to reduce exposure to climate risks. Will be increased the access of the rural population to a climate-resilient infrastructure system that considers social and gender issues. - Increasing integration of the local transport sector within the international network. - Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services.
Other, if any	

Technology Fact Sheet Template
Climate event: Increased and more frequent extreme winds.
Climate impact: Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.

● **General information**	
Sector	Transport
Category	Software and management. Digitalization
Climate event	Increased and more frequent extreme winds.
Impact	Damage to the lighting and signaling infrastructure on roads. Reducing the safety of vehicles in traffic and pedestrians on the road.
Adaptation measures	Introduction the traffic management system Introduction the passenger management system
Technology Name	Autonomous Road Surveillance System (ARSS)
Short description of the technology option	Image processing has a wide range of applications. Based on this, machine vision, pattern recognition, human detection, object detection and tracking, video surveillance systems, etc. are developed. The pre-processing algorithm determines the contour of an object depending on the application. Once the object is detected and located, its boundary can be found by using edge detection and boundary following algorithms. For object detection and recognition in video surveillance, various approaches are proposed[135]. The system works in multi-threaded mode and can automatically detect changes in the traffic flow, such as the ones due to construction works or accidents. In those cases, the system switches back to the learning mode without the necessity of human intervention.

[134] https://ieeexplore.ieee.org/document/6389795
[135] https://www.sciencedirect.com/science/article/pii/S1877050913007424

	The main components of the technology: - Video cameras - Communication port - Sensors - Cloud hosting - Operator Workstation (OWS) - Central Server (CS) - Hardware and software In the system, the maps and GPS are used to localize the car in the roundabout setting; however, the traffic signals and vehicle turning in roundabouts are determined using a group of sensor data that can be generally classified into two subgroups, namely, traveling distance and direction sensors[136]. The sensor fusion model can be used to predict the 3D dimensions of surrounding environments during autonomous car driving.[137]
Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[138] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. Public safety and the quality of the environment are equally important to everyone. Considering the difficult situation of transport infrastructure, provide access to safe, affordable, accessible, and sustainable transport systems for all, as well as improving road safety, notably by expanding public transport.

[136] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934239/

[137] https://www.researchgate.net/publication/275541426_Autonomous_Road_Surveillance_System_A_Proposed_Model_for_Vehicle_Detection_and_Traffic_Signal_Control

[138] https://www.legis.md/

	The technology will support one of the main priorities of the strategic development of the country, to adopt intelligent technological solutions to enhance the level of road safety. At the community level, safety will increase cohesion between people, public administration, and the business environment, creating thus, preconditions to satisfy the needs of everyone.
Country economic development priorities	Enhancing the efficiency of economic processes by strengthening the capacities of companies to innovate and implement innovations is one of the focuses of main development strategies of Moldova. The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 290 of 13.05.2020** on the approval of the National Action Plan for 2020 for the implementation of the National Employment Strategy for 2017-2021. The Action Plan is focused on Increasing formal employment based on economic competitiveness, skills, and appropriate qualifications, in a sustainable and inclusive development environment. - Law **no. 239 of 13.10.2016** for the approval of the National Strategy for regional development for the years 2016-2020. Balanced and sustainable development in all regions of Moldova. Access to safe road infrastructure marks directly the quality of life and economic development of the country. Safety on the road will increase the traffic and commercialization of the merchandise and will increase the private investment in public goods and services.[139]
Country environmental development priorities	The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation

[139] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934239/

	- Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 The use of technological solutions on public roads will reduce the environmental population through the efficient circulation of transport. The use of technology will lead to more efficient use of cars. Likewise, improved infrastructure will lead to more efficient fuel consumption, which will lead to reduced CO2 emissions from public transport.
Market potential	The system can be implemented in the biggest cities/municipalities of Moldova as: - Chisinau and Balti municipality - Cities: Anenii Noi, Briceni, Cahul, Ialoveni, Orhei, Ungheni
● **Country specific applicability**	
Institutional Capacity	The local authorities and public agencies responsible for infrastructure investment and monitoring the safety of the roads have sufficient experience and capacities to introduce road surveillance systems. The local companies responsible for the import of the goods and the agencies responsible for the safety of the roads have experience in the import, installation, and management of equipment for traffic management.
Status of technology in-country	In the country was implemented before some technologies relating to surveillance the traffic control. The implemented technologies were focused only on speed car traffic monitoring.
Acceptability to locals	The technology is acceptable to the locals. Due to that, the traffic control ensures the safety of the transport and pedestrians, the technology is acceptable by the locals.
Paradigm shift potential	The technology will change the paradigm of monitoring and surveillance of public traffic and roads. The system will introduce new concepts on machine vision, pattern recognition, human detection, object detection, tracking, and video surveillance based on a preprocessing algorithm that determines the contour of an object depending on the application.
Efficiency and effectiveness	The main advantages of this system is that integrates many important features of surveillance applications such as: - Real-time object detection - Real-time object classification - Real-time object tracking - ARSS core mode to analyze the data in details - Event based video search in ARSS The technology will increase the efficiency of public traffic. This will lead to the more efficient transportation of goods and merchandise. As the technology is autonomous, it will increase the efficiency of the surveillance systems. [140]

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https://www.researchgate.net/publication/275541426_Autonomous_Road_Surveillance_System_A_Proposed_Model_for_Vehicle_Detection_and_Traffic_Signal_Control

Sustainable development potential	As the system is fully autonomous, sustainability will be ensured by the reduction of the costs for the technical personnel. Also, the system will contribute to the sustainability of the entire transport sector by increasing the efficiency of the transport in the traffic.
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	Women and men benefit equally from the well-functioning of the Road Surveillance System. As women prefer to choose public transport and pedestrian movements (walks), the management of the roads will increase safety.
● **Evaluation criteria: Costs**	
Investments, US$	The main components (per unit): - Hardware - Model System Design - Sensors (motion, weather, etc.) - Video surveillance system The cost for one unit starts from 28.000 USD
O&M costs, US$/year	The costs of operation and maintenance are about 1% for the first 5 years of exploitation, after this, the costs can be increased by around 0.5% for every 3 years. The maintenance costs are expected to be around US $ 300 per unit for the first 5 years of operation. Subsequently, the amount is likely to increase to $ 350 per unit.
● **Evaluation criteria: Economic benefits**	
Employment	New jobs will be created for engineers, installers, and software specialists.
Investment	It is expected that the main investments will be public entities. In particular, the investments will be focused on the purchase of equipment and software. It is expected that the main investment benefit will be reflected in the economic growth of companies in the field of providing freight and passenger transport services.
Public and private expenditures	The main public expenditures will be on maintenance services. The economic growth of transport companies will generate additional jobs. Public budgets will benefit from the creation of jobs and taxes collected.
● **Evaluation criteria: Social benefits**	
Direct Employment	The direct employment will be focused on the management unit. Directly employed technicians, software developers, and electricians.
Skill & Capacity Development	The skill & capacity development will be focused on the development capacities of technicians, software developers, and electricians.

● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	As the use of technological solutions on public roads will reduce the environmental population through the efficient circulation of transport it is expected that will lead to more efficient fuel consumption, which will lead to reduced CO2 emissions from public transport.
Benefits of adapting to climate change	- Increasing operations in the new conditions created by climate change. - Increasing capacities of the transportation services. - Relieving congestion problems in specific parts of the cities.
Other, if any	

Climate event: Increased and more frequent extreme winds.
Climate impact: Increasing the number of traffic obstructions and delay of the delivery

● **General information**	
Sector	Transport
Category	Software and management. Digitalization
Climate event	Increased and more frequent extreme winds
Impact	Increasing the number of traffic obstructions and delay of the delivery

Adaptation measures	Introduction the traffic management system Introduction the passenger management system
Technology Name	Integrated public transport fare payment system[141]
Short description of the technology option	The integrated payment system will permit passengers to use different modes of public transport with the same electronic ticket, either a contactless card or a card with a magnetic stripe. The new system will not only make payment easier and offer a discount to season ticket holders but will also allow the city to monitor passenger flows. This information will help to better organize the public transport network according to users' needs. By making the long-distance journeys on public transport more affordable and accessible, the city could reduce the amount of traffic entering the city center[142]. Linked with the introduction of quasi-public bus management, the distance-based fare system also can help improve the quality of bus service by offering correct incentives for bus drivers[143]. Relieving the pressure to cram in as many people as possible, bus operators could focus on providing convenient and safe journeys. The main components of technology: - Operations Monitoring System - Customer Information System - Fare Collection System - Signal Control System - Fleet Management System - Surveillance System Main characteristics: - In stations, the IT system informs passengers of upcoming departure times and destinations; - On buses, electronic displays indicate the destination; - In buses, the IT system informs passengers of upcoming stop names and transfer opportunities; - Emergency notifications; - Records sales, payment collection, and system usage; - Provides opportunities to integrate fare payment mechanism across multiple transport modes;
Country social development priorities	The social development priorities of the country are focused on harnessing the economic potential of care activities as an opportunity to increase the employment rate of women, so public expenditure for care services creates jobs, approaching at the same time the needs of potentially vulnerable groups of the population. Also, to stimulate entrepreneurial activity in accordance with sustainable development goals, especially those related to the

[141] https://en.wikipedia.org/wiki/Integrated_ticketing

[142] https://www.researchgate.net/publication/343558405_PUBLIC_TRANSPORT_INTEGRATION_A_PROPOSAL_FOR_A_SINGLE_FARE_IN_RIO_JANEIRO_CITY

[143] https://development.asia/explainer/smart-way-introduce-integrated-fare-system

	environment, so the economic activity evolves in harmony with the environment, produces green economic growth, and stops the depletion of natural resources. One of the main strategic documents relating to the social development priorities is: - Government Decision **no. 259 of 28.04.2017**[144] on the approval of the Strategy for ensuring equality between women and men in the Republic of Moldova for the years 2017-2021 and the Action Plan on its implementation. The Action Plan is Supporting an enabling legal and institutional environment and enhancing the capacities of women to engage in decision-making proactively; empowering women and achieving de facto equality between men and women in Moldova; fighting against stereotypes in society and promoting non-violent communication; gender-responsive budgeting. As the integrated payment system will permit passengers to use different modes of public transport with the same electronic ticket, this will improve the access of the rural population to neighboring towns/localities, considering the accessibility of persons with disabilities, and reasonable accommodation. This activity will fit with the strategic priorities of the country to ensure road safety, especially by extending the public transport network as well as providing access to safe, affordable, accessible, and sustainable transport systems for all and improving road safety.
Country economic development priorities	Enhancing the efficiency of economic processes by strengthening the capacities of companies to innovate and implement innovations is one of the focuses of main development strategies of Moldova. The strategic vision of the country is to develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all. The main strategic documents relating to the technology of TNA and the country's economic development priorities are: - Government Decision **no. 290 of 13.05.2020** on the approval of the National Action Plan for 2020 for the implementation of the National Employment Strategy for 2017-2021. The Action Plan is focused on Increasing formal employment based on economic competitiveness, skills, and appropriate qualifications, in a sustainable and inclusive development environment. - Law **no. 239 of 13.10.2016** for the approval of the National Strategy for regional development for the years 2016-2020. Balanced and sustainable development in all regions of Moldova. The integrated electronic fare payment system can charge by distance or time, regardless of the number of transfers passengers make. It also allows different public transport operators to divide their revenues equally according to the distance traveled in a particular transport type.

[144] https://www.legis.md/

	These aspects of the technology will support the economic development priorities of the country, in particular by the development of public transportation services.[145]
Country environmental development priorities	The government of Moldova understands that a good environment, as well as the availability of natural resources, are necessary for life existence and is a precondition for the population's health. The vision relating to the environment is focused on the integration of green economy measures and principles in the production process in different branches of the national economy that can contribute to the improvement of environmental quality and the living standards of the population of the Republic of Moldova. The principle of a green economy will be implemented, which will contribute to efficient use of resources and energy, application of clean technologies in the economy, with a reduced level of CO2 emissions and reduced pollution, and minimization of environmental risks. The main strategic documents relating to the environmental development priorities are: - Law **no. 10 of 26.02.2016** on the promotion of energy utilization from renewable sources - Government Decision **no. 1470 of 30.12.2016** on the approval of the Low Emission Development Strategy of the Republic of Moldova until 2030 and of the Action Plan for its implementation - Government Decision no. **698 of 27.12.2019** on the approval of the National Energy Efficiency Action Plan 2019-2021 Technology will propose an environmentally friendly means of transportation that generates fewer social costs around issues, such as traffic congestion, atmospheric contamination, and traffic accidents, compared to private transportation means that will fit the environmental priorities of the country.
Market potential	The number of autobuses is continuously growing, from 20968 units in 2016 to 21087 units in 2019. It is expected that the Fuel Cell Buses can be implemented in the municipalities where the passenger flux is high and constant. - Chisinau and Balti municipality - Bus operators on interurban and international routes
● **Country specific applicability**	
Institutional Capacity	The local companies responsible for the import of the equipment have the capacity to implement the technology at the local level. The local authorities and public agencies responsible for public transport have sufficient experience and capacities. The main entities involved in the promotion of the technology by category: - Governamental: a) Ministry of Infrastructure; b) National Agency for Research and Development; c) National Car Transport Agency d) RTEC Chisinau

[145] https://www.sciencedirect.com/science/article/pii/S1877705817300991

	- Private sector: a) engineering companies b) transportation companies c) leasing companies d) import - export and distribution companies - NGO: a) environmental promotion organizations b) technology promotion organizations c) professional associations of auto and transportations, etc
Status of technology in-country	The technology of payment was tested in the country, in particular in Chisinau Municipality, and received positive feedback from the operator company, local public authority, and passengers.
Acceptability to locals	The technology is developed to be used by local passengers. As public transport is very popular and used by locals, the technology will cover the needs of the main number of passengers, in particular from suburban areas.
Paradigm shift potential	According to the general principle of the integration of transportation, the integrated fare is one of the aspects of integrating public transportation. In the Republic of Moldova, this concept can integrate into suburban and urban transport. Will be changed the paradigm of existing payment for transportation services for different routes and kinds of transports[146].
Efficiency and effectiveness	Public transportation fare integration, specifically, the entire payment system for payment, collection, and distribution, can be digitized, which allows the collection of real-time bus operation data, one of the most important sub-effects. This can result in the accurate and uniform recording of data related to bus usage patterns[147]. With the use of accurate and detailed data on transportation usage behavior, the accurate demand for each route, region, and time can be more fully understood, and information on the traffic flow at each period can be registered, in order for bus operating companies to form demand-focused scheduling in response to the demands. Furthermore, the efficiency of route operation can be increased in order to enhance profitability.[148]
Sustainable development potential	The main characteristics of sustainable development can be summarized as having achieved the following five effects[149]: - Reduced public transportation costs for users

[146] https://www.worldbank.org/en/news/press-release/2015/04/07/integrated-public-transport-systems-make-travel-easier-and-more-affordable

[147] AFFORDABLE FARES, SUSTAINABLE PUBLIC TRANSPORT. The Fare Review Mechanism. Committee Report 2013

[148] https://www.pwc.in/consulting/financial-services/fintech/dp/the-changing-face-of-transit.html

[149] https://www.seoulsolution.kr/en/content/one-card-fits-all-integrated-public-transport-fare-system

	- Increased efficiency in operation due to reduced times in the payment of bus fares - Enhanced connectivity between public transportation means - Increased number of public transportation users - Increased user satisfaction of public transportation services Combination and integration gives the opportunity to use the entire public transport system across a local or regional area independently of transport modes, tariffs, fares, schedules, or ticket systems.
Impact on gender. Does this technology have the potential to address gender inequalities? How can it contribute to achieving gender equality? What is the expected magnitude of the impact?	The international studies demonstrated that women are more inclined than men to use low-carbon transport modes such as public transport and walking, although existing conditions do not always take the specific needs and constraints of women into account. Travel patterns in daily life differ greatly between women and men, and differences in socialization substantially impact travel mode choice.
● **Evaluation criteria: Costs**	
Investments, US$	The main components (per unit): - Hardware - Software - Video monitoring system - Payment terminal The cost for one unit starts from 17.000 USD
O&M costs, US$/year	The costs of operation and maintenance are about 1% for the first 5 years of exploitation, after this, the costs can be increased by around 0.5% for every 3 years. The maintenance costs are expected to be around US $ 200 per unit for the first 5 years of operation. Subsequently, the amount is likely to increase to $ 300 per unit.
● **Evaluation criteria: Economic benefits**	
Employment	It is expected the introduction of the technology in the market will create new jobs in maintenance and IT services. New jobs will be created for engineers.
Investment	It is expected that the main investments will be operated by bus operation entities. In particular, the investments will be focused on the purchase of equipment and software. The main investment benefits[150]: - Increasing the passenger satisfaction - Increases in revenue - Reductions in the transaction and administrative costs - Reductions in fraud

[150] The Benefits of Simplified and Integrated Ticketing in Public Transport. Passenger Transport Executive Group United Kingdom, October 2009

	- Acquisition of accurate data on passenger behavior enabling better capacity and network planning
Public and private expenditures	The main expenditures will be on the purchases of the equipment and promotion. In particular, the expenditures will be on the operation (municipal) companies. No public expenditures from the public budget are expected. The benefits of the public and private expenditures will be on[151]: - Standardization of the fare rates charged by different modes; and - Establishment of a series of price levels in accordance with the public companies attached to the public transportation services.
● **Evaluation criteria: Social benefits**	
Direct Employment	The direct employment will be focused on the management unit. Directly employed technicians, software developers, and electricians.
Skill & Capacity Development	The skill & capacity development will be focused on the development capacities of technicians, software developers, and electricians.
● **Evaluation criteria: Development impacts, indirect benefits**	
Positive Local Environmental Impacts	As the use of technological solutions in public transport will facilitate the decrease of use of private transport, it is expected that it will reduce the environmental population through the efficient circulation of transport. It is expected that will lead to more efficient fuel consumption, which will lead to reduced CO2 emissions from public transport.
Benefits of adapting to climate change	- Increasing operations in the new conditions created by climate change. - Adapting the transportation fleet to the new climate change conditions. - Improving the functioning of the transportation services.
Other, if any	

[151] Evaluating Public Transit Benefits and Costs Best Practices. Guidebook. 31 August 2021. Todd Litman Victoria. Transport Policy Institute