GENERAL INFORMATION

Title of NAMA

- REHABILITATION OF ARTERIAL ROADS IN SERBIA

Description

- **Description of the Mitigation Action**

  This NAMA represents rehabilitation of the 19 different arterial road sections throughout the country. Total length of all proposed road sections is 324 km. Project introduce rehabilitation of roads as a way to mitigate the intensity of carbon emissions for transport projects.

  Mitigation target is to improve the efficiency and operation of Serbian roads and reduce CO2 emissions from road vehicles. Decreasing of CO2 emissions will be ensured through improved fuel consumption level (-3.64%) by all vehicles that is achieved by running speed of 60 km/h, or the International Roughness Index (IRI) of the proposed roads are improved up to the value of 2.0 m/km.

  This NAMA will contribute to climate change mitigation as the traffic on rehabilitated roads (highly efficient traffic) emit less GHG than traffic performed on proposed road sections which currently are in very poor condition. According to the studies developed by Asian Development Bank (ADB), periodic road maintenance projects have a major impact on carbon emissions reductions in transport sector. Road maintenance projects also ensure reducing of road user costs, discomfort, pollution and travel time delays.

  In order to ensure full control in project implementation, it is planned to establish a Project Implementation Team (PIT) within the Sector for Investment of Public Enterprise "Roads of Serbia" (PERS). PIT will be incharged for fully implementation of the project.

- **Technologies/ measures**

  Based on following facts:

  - Traffic management and speed optimization can cut CO2 emissions. Reductions in CO2 of about 20% can be obtained by techniques to mitigate congestion, manage excess speeds, and smooth traffic flow. Road maintenance projects can significantly reduce Carbon Dioxide Emission Rates.[1]
  - An uneven road can increase fuel consumption by up to 12% relative to an even road. A rough macrotexture may increase fuel consumption by 7% relative to a very smooth macrotexture. Fuel consumption for a car may be influenced as much as 12% by road surface characteristics within the tested range.[2]

  Optimal maintenance of roads is a tool to reduce fuel consumption and greenhouse gas emission. Reducing the rolling resistance loss can contribute significantly to the overall fuel need: the smoother the road, the lower the fuel consumption![3]

[1] ADB Evaluation Study - Reducing Carbon Emissions from Transport Projects, July 2010

[2] Eurobitume & European Asphalt Pavement Association (EAPA), Industry Report, Study in Sweden, March 2004 (Eurobitume was established as an international association in 1969, to provide a forum for bitumen producers to share and develop technical and scientific information.)

[3] EAPA & EUROBITUME, Environmental Impacts and Fuel Efficiency of Road Pavements, March 2004

PERS decided to candidate rehabilitation of 19 arterial roads in Serbia as an appropriate NAMA from Serbian transport sector. PERS selected roads sections which are very important for everyday transport of humans and goods in their regions, but with serious damages on the road surface (pavement) and very high Roughness Index (IRI). The International Roughness Index (IRI) is the roughness index most commonly obtained from measured longitudinal road profiles. It is calculated using a quarter-car vehicle math model, whose response is accumulated to yield a roughness index with units of slope (in/mi, m/km, etc.).[1] Since its introduction in 1986,[2] IRI has become the road roughness index most commonly used worldwide for evaluating and managing road systems.All proposed arterial road sections could be considered as uneven road. Average of their current IRI is 7.85 m/km. High values of IRI caused higher fuel consumption[4] and higher emissions of CO2[5].

arterial road section	Lenghth [km]	AADT [veh/day]	IRI [m/km]
Pirot - Sukovo	14,627	4.355	6,05
Loznica 5 - Zavlaka 2 (Likodra) (0184-0187)	27,345	4.498	5,70
Zavlaka 2 (Likodra) - Valjevska Kamenica (0188-0191)	27,008	2.319	5,28
Despotovac 2 (Manastir Manasija) - Dvorište	7,063	1.269	7,91
Prijepolje - Sjenica 3 (Medare) (0337-1, 0340)	17,711	2.636	7,74
Sušica - Dojevice (0344,0345)	30,155	3.427	6,56
granica APKiM (Mutivode) - Maćedonce (0348-0349)	20,485	700	7,59
Negosavlje - Krivača	17,897	1.660	6,33
Leskovac 5 (Bratmilovci) - Nomanica (km 2.595 - 5.238)	5,480	4.451	6,73
Vlasotince - Svođe	15,850	3.593	5,33
Svođe - Babušnica (0366,0367)	21,358	1.780	7,45
Babušnica - Donji Striževac	4,405	1.600	6,29
Donji Striževac - Sadikov Bunar (0369,0370)	19,693	1.615	10,71
Valjevo 5 (obilaznica) - Kaona (0464,0465)	28,802	3.377	5,78
Duga Poljana - Karajukića Bunari (0.0-6.3km)	6,319	800	16,77
Duga Poljana - Karajukića Bunari (6.3-22.4km)	16,081	800	16,77
Petrovaradin 6 - Inđija 1 (Novi Karlovci) (05932-0595)	14,780	5.255	6,17
Bukovo 2 - Negotin 1 (0687,0688)	5,077	1.693	7,04
Beloljin - Rudare (0735,0736)	24,088	2.123	6,93

[4] ADB, 2009. Green Transport – Resource Optimization in the Road Sector in the People's Republic of China

[5] National Highway Authority of India project documents and reports from Salem – Namakkai highwa

Project technology comprise routine maintenance of proposed road sections which will ensure desired level of service, smoother roads, increasing of average transport speed to the optimal level (up to 80 km/h) and decreasing of fuel consumption and CO2 emissions.

Location

Proposed road sections are located in different part of Serbia. Most of them belong to the southern-east region. Seven of them are located along arterial M-9S road, connecting Kosovo border, Leskovac and Pirot. Two more road section is located within the same region (Beloljin - Rudare on arterial road M-25S and Pirot – Sukovo on arterial road M-1.12S)

Four road sections are located in southern-west part of Serbia. Two of them are located on M-8S Novi Pazar – Sjenica – Prijepolje arterial road. Remaining two road sections (M-21.1S Duga Poljana – Karajukica Bunari) are excluded from Serbian arterial road network by Government Decree during 2012.

Three road sections are located on western Serbia (M-4S Loznica – Zavlaka, M-4S Zavlaka – Valjevska Kamenica and M-21S Valjevo – Kaona)

Road section M-22.1V Petrovaradin – Indjija is located in northern part of Serbia, Autonomous Province of Vojvodina.

Two remaining road sections are located in eastern Serbia. Road section M-24S Bukovo – Negotin is located close to Romanian Border. Last road section M-4S Despotovac – Dvoriste is also excluded from Serbian arterial road network by Government Decree during 2012.

All proposed road sections, except the ones which are excluded from arterial road network are shown on Picture No. 1 – State Road Network NAMA Program.

Overview of proposed road sections is shown within the following table:

N°	Name	Length (km)	Cost (EUR)	Location
1	M-1.12S (0140) Pirot – Sukovo	14.6	5.032.000,00	Pirot
2	M-4S (0184-0187) Loznica 5 - Zavlaka 2 (Likodra)	27.3	11.812.000,00	Loznica
3	M-4S (0188-0191) Zavlaka 2 (Likodra) – Valjevska Kamenica	27.0	12.973.000,00	Zavlaka
4	M-4S (0236) Despotovac 2 (Manastir Manasija) – Dvoriste	7.1	3.329.000,00	Despotovac
5	M-8S (0337,3-0340) Prijepolje - Sjenica 3 (Medare)	17.7	8.278.000,00	Prijepolje
6	M-8S (0344-0345) Susica - Dojevice	30.2	13.564.000,00	Susica
7	M-9S (0348-0349) granica APKiM (Mutivode) – Macedonce	20.5	11.087.000,00	Macedonce
8	M-9S (0351) Negosavlje – Krivaca	17.9	9.140.000,00	Leskovac
9	M-9S (0361-0363) Leskovac 5 (Bratmilovci) – Nomanica	8.1	3.790.000,00	Leskovac
10	M-9S (0365) Vlasotince – Svodje	15.9	7.244.000,00	Vlasotince
11	M-9S (0366-0367) Svodje – Babusnica	21.4	9.321.000,00	Babusnica
12	M-9S (0368) Babusnica - Donji Strizevac	4.4	1.836.000,00	Babusnica
13	M-9S (0369-0370) Donji Strizevac – Pirot	19.7	8.131.000,00	Pirot
14	M-21S (0464-0465) Valjevo 5 (obilaznica) – Kaona	28.8	14.868.000,00	Valjevo
15	M-21.1S (0490-1) Duga Poljana - Karajukica Bunari	6.3	3.095.000,00	Duga Poljana
16	M-21.1S (0490-2) Duga Poljana - Karajukica Bunari	15.8	12.831.000,00	Duga Poljana
17	M-22.1V (0593,2-0595) Petrovaradin 6 - Indjija 1 (Novi Karlovci)	14.8	7.902.000,00	Novi Sad
18	M-24S (0687-0688) Bukovo 2 - Negotin 1	5.1	2.149.000,00	Negotin
19	M-25S (0735-0736) Beloljin – Rudare	24.1	12.201.000,00	Beloljin
TOTAL:		**297.5**	**139.328.000**	

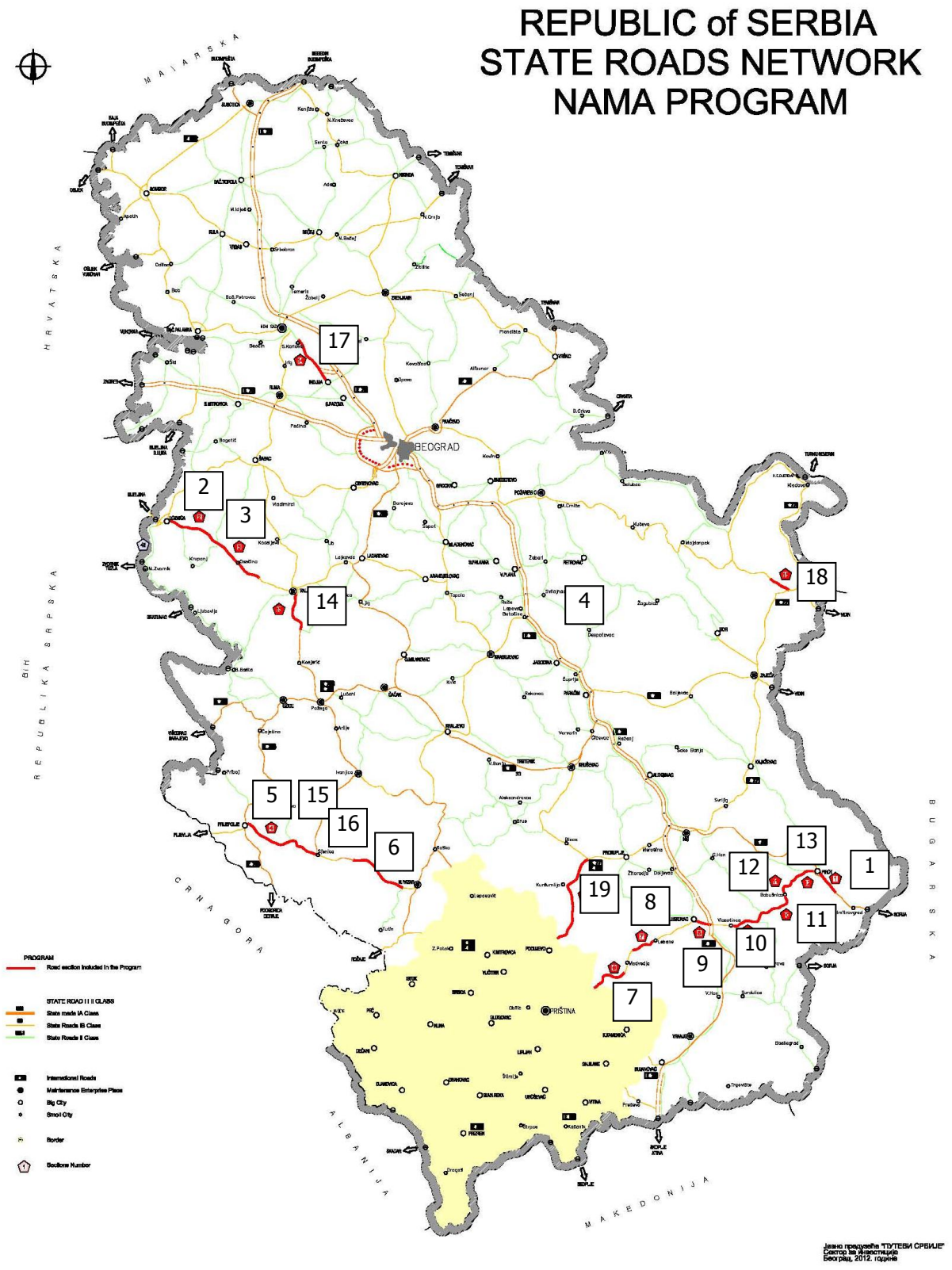


Figure 1: State Road Network - NAMA Program

NAMA Implementing Entity

- PE "Roads of Serbia" - PERS

  Pursuant to the Law on Public Roads (The Official Gazette of the Republic of Serbia, No. 101-05), PERS is established for managing state roads. (see Annex 01 to this document).

  PERS is responsible for maintenance, protection, usage, development and management of state roads of I and II category in the Republic of Serbia. Tasks of primary national importance are set for the PERS in the area of preservation, further construction and improvement of the road network in the Republic of Serbia.

  Financing of construction and reconstruction, maintenance and protection of public roads is provided from:

  - Fee for using state road - toll
  - Financial loans
  - Budget of the Republic of Serbia
  - Other sources pursuant to the Law

Implementing Schedule

Time span	Activity	
2013 – 2015	Preparatory period	19 Main Designs for proposed road rehabilitation projects, including Technical Review, obtaining the necessary approvals from the relevant institutions, preparation of tender documents, bidding and contracting procedures and other necessary activities. Purchasing of necessary equipment for CO2 monitoring and zero monitoring measurement.
2016 – 2020	Implementation	rehabilitation of proposed roads, supervision activities, CO2 monitoring activities, technical acceptance.

Expected starting date of Action

Start date: 2013
End date: 2020

Lifetime

20 years

Current Status

Poor condition of pavement on proposed road sections caused many problems related with traffic safety and congestion. Carbon monitoring program is not established yet, but first monitoring activities will start immediately after signing Contract between PERS and International Financing Institution which will funded (partially or in total) Serbian Arterial Road Rehabilitation Project.

Proposed road sections are planned to be rehabilitated according to routine maintenance plan. Lack of financial means caused serious damaging of existing pavement on proposed road sections. Roughness index

become much higher that is acceptable (8-16) which caused very low level of service on proposed roads. Devastation of proposed road section caused many traffic safety and environmental problems. Low levels of average transport speed increased fuel consumption and CO2 emissions on proposed road sections.

Summarizing above mentioned facts, PERS has undertaken many different activities in order to analyze possible project benefits which can be achieved through the rehabilitation of proposed road sections. Activities already completed are:

- Feasibility Study is completed by using HDM-4 Model. Most important figures (feasibility data, economic analysis, estimated Costs) and conclusions are presented within this Short Description. Road database is already prepared by PERS as a source of relevant data (AADT, vehicle by type, IRI)
- Roughness detection is measured on each road section during 2009 with special vehicle type ARAN
- Data for each section were taken from "Program Analyses of State Road Network", PERS, 2011. Data analyzed by using software HDM-4 and HIMS
- Fuel consumption on proposed road sections estimated by using COPERT 4 Model

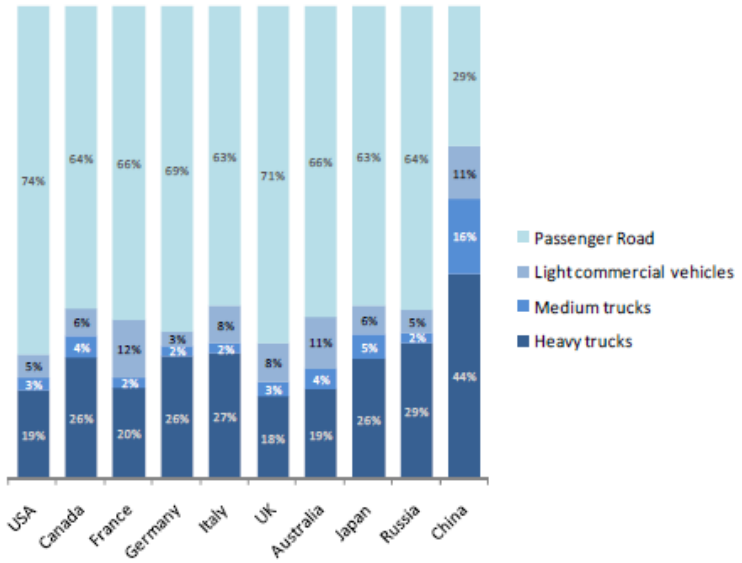
Coverage

- Sector: Transport

Transport-sector CO2 emissions represent 23% (globally) and 30% (OECD) of overall CO2 emissions from Fossil fuel combustion. The sector accounts for approximately 15% of overall greenhouse gas emissions. Automobile transport is the principal CO2 emitter.

Road sector emissions dominate transport emissions with light-duty vehicles accounting for the bulk of emissions globally. In certain ITF member countries for which estimates can be made, road freight accounts for up to 30% to 40% of road sector CO2 emissions.

Figure 1-5: Estimated Breakdown of Freight Versus non-Freight Road CO2 Emissions (Mt CO2) in Selected Countries (2005)



- GHG Gases: CO_2

Global CO2 emissions from transport are expected to continue to grow by approximately 40% from 2007 to 2030 – though this is lower than pre-crisis estimates.

FINANCIAL INFORMATION

Finance and Cost

- Expected cost of **preparation**:

  Feasibility study: NONE (this document is already completed)
  Design: 3.5 mil €

- Expected cost of **implementation**:

  Works: 139.328 mil €
  Supervising: 3.5 mil €

- Expected **incremental cost** of implementation:

  None

- **Financial sources** identified:

  N/A

  Serbian Arterial Road Rehabilitation Project is planned to be primarily financed as a **Grant**. However, it can be financed by **Loan** too, but under specific conditions which should be a subject of potential Negotiations between PERS and Financial Institutions which will consider possibility to finance this Project. PERS is searching financial support from Annex-I countries and international organizations through NAMA scheme. Development Bank of Serbia will be intermediate and it could provide some sort of incentive.

- **Financial analysis**:

  Based on a Serbian road database and executed measurement of the road characteristics, for the benefit of PERS, a Program Analyses of State Road Network and Transport Rehabilitation Project Performance Indicators (World Bank Project, Contract No. WBC/ICS-PA/2010-05) was done. Program Analyses (PA) was done on the network level. Through PA it is confirmed justification of the investment in the respective nominated projects. The data presented in the accompanying tables are presented based on abovementioned PA.

N°	Name	Length (km)	Cost (EUR)	NPV mil €	EIRR %	NPV/ CAP
1	M-1.12S (0140) Pirot – Sukovo	14.6	5.032.000,00	16.42	59.9	4.37
2	M-4S (0184-0187) Loznica 5 - Zavlaka 2 (Likodra)	27.3	11.812.000,00	10.97	27.8	1.25
3	M-4S (0188-0191) Zavlaka 2 (Likodra) – Valjevska Kamenica	27.0	12.973.000,00	.366	10.7	0.04
4	M-4S (0236) Despotovac 2 (Manastir Manasija) – Dvoriste	7.1	3.329.000,00	1.466	20.0	0.59

N°	Name	Length (km)	Cost (EUR)	NPV mil €	EIRR %	NPV/ CAP
5	M-8S (0337,3-0340) Prijepolje - Sjenica 3 (Medare)	17.7	8.278.000,00	7.707	28.8	1.25
6	M-8S (0344-0345) Susica - Dojevice	30.2	13.564.000,00	10.21	24.9	1.01
7	M-9S (0348-0349) granica APKiM (Mutivode) – Macedonce	20.5	11.087.000,00	-2.739	1.5	-0.40
8	M-9S (0351) Negosavlje – Krivaca	17.9	9.140.000,00	0.736	12.0	0.11
9	M-9S (0361-0363) Leskovac 5 (Bratmilovci) – Nomanica	8.1	3.790.000,00	5.613	36.5	1.99
10	M-9S (0365) Vlasotince – Svodje	15.9	7.244.000,00	1.569	14.9	0.29
11	M-9S (0366-0367) Svodje – Babusnica	21.4	9.321.000,00	3.359	17.9	0.48
12	M-9S (0368) Babusnica - Donji Strizevac	4.4	1.836.000,00	1.091	20.9	0.80
13	M-9S (0369-0370) Donji Strizevac – Pirot	19.7	8.131.000,00	9.795	33.6	1.62
14	M-21S (0464-0465) Valjevo 5 (obilaznica) – Kaona	28.8	14.868.000,00	3.744	15.9	0.34
15	M-21.1S (0490-1) Duga Poljana - Karajukica Bunari	6.3	3.095.000,00	0.477	14.4	0.21
16	M-21.1S (0490-2) Duga Poljana - Karajukica Bunari	15.8	12.831.000,00	5.374	17.0	0.60
17	M-22.1V (0593,2-0595) Petrovaradin 6 - Indjija 1 (Novi Karlovci)	14.8	7.902.000,00	9.721	32.9	1.65
18	M-24S (0687-0688) Bukovo 2 - Negotin 1	5.1	2.149.000,00	0.236	12.7	0.15
19	M-25S (0735-0736) Beloljin – Rudare	24.1	12.201.000,00	6.400	21.3	0.70
TOTAL:		**297.5**	**139.328.000**	**136.731**	**23.2**	

INFORMATION ON SUPPORT REQUIRED

Description of Support Required

Type of Support	Support required for preparation	Support required for implementation
Financial	3,500,000 €	139,328,000 €
Technical	establishing of appropriate CO2 monitoring technology and monitoring equipment It must be corresponding to the "Monitoring plan and structure" part of this document; who will purchase monitoring equipment and who will perform monitoring	
Capacity Building	transfer of knowledge (knowledge on relation between GHG emission reduction and road rehabilitation projects, appropriate monitoring tools etc.), study tours (in order to collect information hoe monitoring og GHG emission is working in countries which already established such activities as a consisting part of road management), strengthening of PERS monitoring capacity	

EXPECTED GHG EMISSION REDUCTIONS AND MRV

Expected Mitigation Potential

- **Annual reduction**: 2,138 tCO_{2e}
- **Total reduction**: 46,360 tCO_{2e} (20 years)

Methodologies and Assumptions (including BAU scenario)

- **Methodologies**:

PERS used a **C**omputer **P**rogramme to calculate **E**missions from **R**oad **T**ransport (COPERT) methodology for calculating CO2 emissions from proposed road sections.

COPERT 4 is a software tool used world-wide to calculate air pollutant and greenhouse gas emissions from road transport. The development of COPERT is coordinated by the European Environment Agency (EEA), in the framework of the activities of the European Topic Centre for Air Pollution and Climate Change Mitigation. The European Commission's Joint Research Centre manages the scientific development of the model. COPERT has been developed for official road transport emission inventory preparation in EEA member countries. However, it is applicable to all relevant research, scientific and academic applications.

The COPERT 4 methodology is part of the EMEP/EEA air pollutant emission inventory guidebook for the calculation of air pollutant emissions and is consistent with the 2006 IPCC Guidelines for the calculation of greenhouse gas emissions. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation.

COPERT 4 draws its origins in a methodology developed by a working group which was set up explicitly for this purpose in 1989 (COPERT 85). This was then followed by COPERT 90 (1993), COPERT II (1997) and COPERT III (1999). The current version is a synthesis of results of several large-scale activities and dedicated projects, such as:

- Dedicated projects funded by the Joint Research Centre / Transport and Air Quality Unit
- The annual work-programme of the European Topic Centre for Air Pollution and Climate Change Mitigation (ETC/ACM)
- The European Research Group on Mobile Emission Sources (ERMES) work programme.
- The MEET project (Methodologies to Estimate Emissions from Transport), a European Commission (DG VII) sponsored project within 4th Framework Program (1996-1998)
- The PARTICULATES project (Characterization of Exhaust Particulate Emissions from Road Vehicles), a European Commission (DG Transport) PROJECT within the 5th Framework Program (2000-2003)
- The ARTEMIS project (Assessment and Reliability of Transport Emission Models and Inventory Systems), a European Commission (DG Transport) PROJECT within the 5th Framework Program (2000-2007)
- A joint JRC/CONCAWE/ACEA project on fuel evaporation from gasoline vehicles (2005-2007)
- Emission factor work conducted by the HBEFA group.

Methodology Outline

COPERT 4 estimates emissions of all major air pollutants (CO, NOx, VOC, PM, NH3, SO2, heavy metals) produced by different vehicle categories (passenger cars, light commercial vehicles, heavy duty trucks, busses, motorcycles, and mopeds) as well as greenhouse gas emissions (CO2, N2O, CH4). It also provides speciation for NO/NO2, elemental carbon and organic matter of PM and non-methane VOCs, including PAHs and POPs.

Emissions are produced from two sources: Engine emissions, distinguished into those produced during thermally stabilized engine operation (hot emissions), and emissions occurring during engine start from ambient temperature (cold-start and warming-up effects). Diffuse emissions, i.e. NMVOC emissions due to fuel evaporation and non-exhaust PM emissions from tires and break wear. Total emissions are calculated as a product of activity data provided by the user and speed-dependent emission factors calculated by the software.

The software application of COPERT 4 methodology has been developed for the compilation of national inventories (i.e. NUTS 0) on a yearly basis. However, it has been shown that the methodology can also be used with a sufficient degree of certainty at a higher resolution too, i.e. for the compilation of urban emission inventories with a spatial resolution of 1×1 km2 and a temporal resolution of 1 hour.

In order to estimate exhaust emissions from internal combustion engines used in off-road applications (agriculture, forestry, household, industry, waterways and railways) one must still use the separate module of COPERT III.

Based on the methodology of COPERT Tier 1, 2 and 3, calculation of CO2 emission of baseline was conducted as follows.

$$E_{CO2} = \sum_j \left(\sum_m \left(FC_{j,m} * EF_{j,m} \right) \right)$$

Where;

E_{cO2} -Emission of CO2 [g]

$FC_{j,m}$ -Fuel Consumption [kg] fuel type *m* ; vehicle category *j*

$EF_{j,m}$ -Emission Factor [g/kg] fuel type *m* ; vehicle category *j*

Vehicle categories (*j*) contain five vehicle categories (passenger car, light trucks, heavy trucks, motorcycles and mopeds) and vehicle technology (*k*) includes 7 categories (conventional, Euro 1, Euro 2, Euro 3, Euro 4, Euro 5 and Euro 6). Fuel types (*m*) include 5 categories(petrol, diesel, LPGa, LPGb and NG).

$FC_{j,m}$ [kg] is estimated by the following equation;

$$FC_{j,m} = \sum_m \left[N_{j,k} * M_{j,k} * FC_{j,k} / n \right]$$

Where;

$FC_{j,m}$ Fuel Consumption, [kg],fuel type m; vehicle category j

$N_{j,k}$	Number of vehicle with vehicle technology k, fuel type m, vehicle category j
$M_{j,k}$	Av. annual single vehicle trip, [km/veh], vehicle technol. k, fuel type m, vehicle category j
$FC_{j,k}$	Fuel Consumption Factor, [g/km], vehicle technol. k, fuel type m, vehicle category j
n	Fuel consumption efficiency by IRI

Fuel consumption will be affected by roughness of the road. Fuel consumption efficiency by IRI was reported by Asian Development Bank, based on statistical data of impact on road roughness on fuel consumption. Impact on fuel consumption (fuel efficiency by IRI) is shown in the following Table.

Table A3.4: Impact of Road Roughness on Fuel Consumption

Roughness (m/km)	Impact on Fuel Consumption
2	1.00
3	0.99
4	0.98
5	0.98
6	0.97
7	0.96
8	0.95
9	0.95
10	0.94
11	0.93
12	0.92
13	0.92
14	0.91
15	0.90

km = kilometer, m = meter.
Source: Asian Development Bank and Ministry of Transport, People's Republic of China. 2009. *Green Transport: Resource Optimization in the Road Sector in the People's Republic of China*. Manila. Collaborative project. http://www.adb.org/Documents/Books/Green-Transport/ Green-Transport.pdf

- **BAU scenario:**

Poor condition of pavement on proposed arterial road sections remains the same and fossil fuel consumption will remain large as the vehicles are forced to move slowly. Additional deterioration of proposed road section will cause increased fuel consumption and increased CO2 emissions.

- **Calculation of emission reduction**

Baseline emission

Baseline emission was calculated as follows.

$$BE_{CO2} = \Sigma_j (\Sigma_m (FC_{j,m} * EF_{j,m}))$$
$$= \Sigma_j (\Sigma_m (N_{j,k} * D_{j,k} * FCF_{j,k} / n_B * EF_{j,m}))$$

Where;

BE_{CO2}	Baseline Emission of CO2 [kg]
$FC_{j,m}$	Fuel Consumption, [kg], fuel type m; vehicle category j
$N_{j,k}$	Number of vehicle with vehicle technology k, fuel type m, vehicle category j
$M_{j,k}$	Av. annual single vehicle trip, [km/veh], vehicle technol. k, fuel type m, vehicle category j
$FCF_{j,k}$	Fuel Consumption Factor, [g/km], vehicle technol. k, fuel type m, vehicle category j
n_B	Fuel consumption efficiency by baseline IRI
$EF_{j,m}$	Emission Factor [kg CO2/kg] fuel type m; vehicle category j

Fuel Consumption Factor [g/km] by vehicle category, vehicle technology, engine capacity and speed range is provided by COPERT 4 version 9.1, Tire 3 method. For calculation of Baseline emission, Fuel Consumption Factor in vehicle speed 60km/h was used.

CO_2 Emission Factors ($EF_{j,m}$) by fuel type are shown in following table:

Fuel	kg of CO_2 per kg of fuel
Petrol	3,180
Diesel	3,140
LPG	3,017
NG	2,750

Source: EMEP/EEA emission inventory Guidebook 2009, updated May 2012

Project emission

Project CO_2 emission was calculated as follows.

$$PE_{CO2} = \sum_j (\sum_m (FC_{j,m} * EF_{j,m}))$$
$$= \sum_j (\sum_m (N_{j,k} * D_{j,k} * FCF_{j,k} / n_p * EF_{j,m}))$$

PE_{CO2}	Project Emission of CO2 [kg]
$FC_{j,m}$	Fuel Consumption, [kg],fuel type m; vehicle category j
$N_{j,k}$	Number of vehicle with vehicle technology k, fuel type m, vehicle category j
$M_{j,k}$	Av. annual single vehicle trip, [km/veh], vehicle technol. k, fuel type m, vehicle category j
$FCF_{j,k}$	Fuel Consumption Factor, [g/km], vehicle technol. k, fuel type m, vehicle category j
n_P	Fuel consumption efficiency by Project IRI (IRI=2.0, n_p=1)
$EF_{j,m}$	Emission Factor [kg CO2/kg] fuel type m; vehicle category j

Fuel Consumption Factor [g/km] by vehicle category, vehicle technology, engine capacity and speed range is provided by COPERT 4 version 9.1, Tire 3 method. For calculation of Baseline emission, Fuel Consumption Factor in vehicle speed 60km/h was used.

Data / Parameter	$N_{j,k}$
Unit	vehicle
Description	Number of vehicle with vehicle technology k, fuel type m, vehicle category j
Source of data	Database of Road of Serbia (Annual vehicle number in each road section) National Statistical Data (The ratio of vehicle technology k, vehicle category j in all roads of Serbia)
Value applied	
Comment	Annual vehicle number with vehicle technology k, vehicle category j is not monitored in each road section. The ratio of vehicle technology k, vehicle category j is multiplied to annual vehicle number in each road section.

Data / Parameter	$M_{j,k}$
Unit	km/veh
Description	Average of annual single vehicle trip
Source of data	Database of Road of Serbia
Value applied	
Comment	Average of annual single vehicle trip is same as length of each road section

No.		arterial road sections	length	AADT	IRI (Baseline)	IRI (Project)	**Fuel efficiency (nB)**	Fuel consumption (Baseline)	Fuel consumption (Project)	Fuel consumption Reduction
			[km]	**[veh/day]**	**[m/km]**	**[m/km]**	**-**	**[ton/year]**	**[ton/year]**	**[ton/year]**
1	M017	**Pirot - Sukovo**	15	4,355	6.05	2.00	0.97	1,366	1,323	-44
2	M034	**Loznica 5 - Zavlaka 2 (Likodra) (0184-0187)**	27	4,498	5.70	2.00	0.97	2,631	2,554	-77
3	M035	**Zavlaka 2 (Likodra) - Valjevska Kamenica (0188-0191)**	27	2,319	5.28	2.00	0.97	1,335	1,300	-35
4	M053	**Despotovac 2 (Manastir Manasija) – Dvorište**	7	1,269	7.91	2.00	0.95	195	186	-9
5	M095	**Prijepolje - Sjenica 3 (Medare) (0337-1, 0340)**	18	2,636	7.74	2.00	0.96	1,015	970	-45
6	M098	**Sušica - Dojevice (0344,0345)**	30	3,427	6.56	2.00	0.96	2,225	2,146	-79
7	M100	**granica APKiM (Mutivode) - Maćedonce (0348-0349)**	20	700	7.59	2.00	0.96	311	298	-14
8	M102	**Negosavlje - Krivača**	18	1,660	6.33	2.00	0.97	639	617	-22
9	M104	**Leskovac 5 (Bratmilovci) - Nomanica (km 2.595 - 5.238) (0361-0363)**	5	4,451	6.73	2.00	0.96	526	507	-19
10	M106	**Vlasotince - Svođe**	16	3,593	5.33	2.00	0.97	1,215	1,183	-32
11	M107	**Svođe - Babušnica (0366,0367)**	21	1,780	7.45	2.00	0.96	824	789	-35
12	M108	**Babušnica - Donji Striževac**	4	1,600	6.29	2.00	0.97	151	146	-5
13	M109	**Donji Striževac - Sadikov Bunar (0369,0370)**	20	1,615	10.71	2.00	0.93	708	660	-47
14	M143	**Valjevo 5 (obilaznica) - Kaona (0464,0465)**	29	3,377	5.78	2.00	0.97	2,082	2,020	-62
15	M157	**Duga Poljana - Karajukića Bunari (0.0-6.3km)**	6	800	16.77	2.00	0.89	118	105	-13
16	0	**Duga Poljana - Karajukića Bunari (6.3-22.4km)**	16	800	16.77	2.00	0.89	301	267	-34
17	M176	**Petrovaradin 6 - Inđija 1 (Novi Karlovci) (05932-0595)**	15	5,255	6.17	2.00	0.97	1,668	1,613	-55
18	M210	**Bukovo 2 - Negotin 1 (0687,0688)**	5	1,693	7.04	2.00	0.96	186	178	-7
19	M227	**Beloljin - Rudare (0735,0736)**	24	2,123	6.93	2.00	0.96	1,105	1,062	-43
Total			**324**	-	-		**-**	**18,602**	**17,925**	-677

Emission Reduction

CO_2 emission reduction was calculated as follows.

$ER = \sum_n (BE_n - PE_n)$

ER	Emission Reduction of CO_2 [kg]
BE_n	Baseline emission in road section $_n$
PE_n	Project emission in road section $_n$

Reduction of fuel consumption by fuel type in 19 road sections is shown as follow.

Fuel type	Reduction of fuel consumption (ton/year)	EF (t CO2 / t fuel)	Emission Reduction (tCO2/year)
Petrol	367.7	3.180	1169.4
Diesel	287.9	3.140	904.0
LPG	15.8	3.017	47.7
Hyb	0.0	3.180	0.0
Other	5.3	3.180	16.9
Total	677	-	2,138

Measurement, Reporting, and Verification (MRV)

Monitoring plan

The PERS will conduct quantification and monitoring of greenhouse gas emissions annually in accordance with internationally recognized methodologies. GHG calculation is NOT required by Air Protection Law of Serbia. In addition, the PERS will evaluate technically and financially feasible and cost/effective options to reduce or offset project-related greenhouse gas emissions during project design and operation.

Installing devices which will allow measuring of CO2 emissions (possible link with Road Weather Information System - RWIS stations) is part of this project too. Resultats will be automatically collected and stored (in real time) in PERS Server.

- **Data and parameters to be monitored**:

CO2 emission reduction will be calculated as follows.

$ER = \sum_n (BE_n - PE_n)$

ER Emission Reduction of CO_2 [kg]

BE_n Baseline emission in road section $_n$

PE_n Project emission in road section $_n$

Data / Parameter	Road length
Unit	km
Description	Length of rehabilitated road section n
Source of data	Road of Serbia
Measurement procedures	
Monitoring frequency	Yearly
QA/QC procedures	-
Comment	-

Data / Parameter	$N_{j,k}$
Unit	vehicle
Description	Number of vehicle with vehicle technology k, fuel type m, vehicle category j in road section n
Source of data	Database of Road of Serbia
Measurement procedures	PERS will monitor the number of vehicle with vehicle technology , fuel type, vehicle category in each road section.
Monitoring frequency	Yearly
QA/QC procedures	-
Comment	If PERS can not monitor the number of vehicle by vehicle type, the ratio of vehicle technology k, vehicle category j in all roads of Serbia will be monitored and used.

Data / Parameter	Vehicle speed
Unit	Km/h
Description	Average vehicle speed in each road section
Source of data	Database of Road of Serbia
Measurement procedures	PERS will monitor vehicle speed in each road section.
Monitoring frequency	Yearly
QA/QC procedures	-
Comment	

Data / Parameter	$FCF_{j,k}$
Unit	g/km
Description	Fuel Consumption Factor with vehicle technol. k, fuel type m, vehicle category j, speed range
Source of data	COPERT
Measurement procedures	-

Monitoring frequency	Yearly
QA/QC procedures	-

Data / Parameter	IRI
Unit	[m/km]
Description	International Roughness Index
Source of data	Database of Road of Serbia
Measurement procedures	PERS will monitor IRI in each road section.
Monitoring frequency	Yearly
QA/QC procedures	-

Data / Parameter	$EF_{j,m}$
Unit	kg CO2/kg
	Emission Factor with fuel type m
Source of data	COPERT or IPPC
Measurement procedures	-
Monitoring frequency	Yearly
QA/QC procedures	-

- **Monitoring plan and structure:**

Monitoring activities will be conducted by PERS (or accredited laboratory), based on its ISO 9001:2008 certified quality management system.

PERS will perform monitoring activities and measurement on the site.

- **Domestic MRV arrangements**

Domestic MRV arrangement of Serbia is currently under development.

It is expected that under the Serbian domestic MRV system, a PERS is responsible for the Measurement (M) and Reporting (R) activities, which will go through Verification (V) from third party. It is expected that the MRV of proposed NAMA will be conducted in the following manner:

PERS will conduct the Measurement activity based on the above-mentioned monitoring plan in order to calculate the emission reductions achieved by the NAMA.

PERS will prepare a Report that contains information on 1) the detailed result of the monitoring activities conducted based on the monitoring plan, 2) the result of emission reduction calculation based on the above mentioned methodology, and 3) any support received under NAMA scheme from Annex-I countries or international organization regarding financial support, technical support, or support on capacity building.

OTHER INFORMATION

Contribution to Sustainable Development

Implementation of the NAMA is meeting majority of the Sustainable Development Indicators in accordance with three criterion indicated in appendix of the Serbian DNA Rules of procedure.

- According to the economic criterion, it satisfies following fields:

  1. Social benefits - Economic development of the region – Rehabilitation of proposed road sections will ensure better traffic conditions on Serbian road network. It can significantly contribute to the economic development of those regions.

  2. Employment – Rehabilitation of proposed roads will provide work for many domestic companies.

- According to the social criterion, it satisfies following fields:

  2. Life conditions improvement - Project implementation of such scope, lead up to the employment increase, as well as income increase, on the local and regional level.

  3. Capacity increase - According to the work needs and modern equipment maintenance, strategic partner will provide training for the employees, as well as expertise and tools for local companies engaged on this implementation of the project during its operational life.

- According to the environment and natural resources criterions, it satisfies following fields:

  ➢ Energy resources – rehabilitated road sections will ensure smooth traffic and will reduce fuel consumption.

  ➢ Air - Due to the application of the modern technology and higher energy efficiency of the road, project will result in reduced emission levels of CO_2, SO_x and NO_x, comparing to the existing conditions on proposed road sections.

  ➢ Soil – Rehabilitation of proposed roads will be performed within the road right of way, so it would not be necessary to change the purpose of the land. In addition, waste disposal will be at the area anticipated for this purpose with application of the reclamation measures.

Stakeholder consultation

- PERS will conduct a public stakeholder consultation regarding the NAMA. At the consultation, objective and outcome, expected impacts on local environment, employment opportunities, etc. will be presented to stakeholders, and their comments will be collected and compiled.
- PERS will take necessary due actions to the comments received during the public consultation and report the results.
- Public consultation will be held either through website or through meetings near the project site.

CONTACT INFORMATION

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NAMA Coordinating Entity

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Attachment: Financial Information (available only upon request)

Financial information will be provided only to interested investors.