GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

CENTAR ZA ODRŽIVI RAZVOJ

CRNA GORA
MINISTARSTVO ODRŽIVOG RAZVOJA I TURIZMA

UNDP

2015 GHG EMISSIONS FROM TOURISM IN MONTENEGRO

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0.1. From Factor CO_2:

- Asier Sopelana
- Juan Carlos Gómez

0.2. From EQO:

- Lluís Vilardell
- Predrag Novosel

0.3. From UNDP

- Aleksandra Kikovic
- Viktor Subotic

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Acronyms

CH_4	Methane
CO_2e	CO_2-equivalents
CO_2	Carbon dioxide
DEFRA	UK Department for Environment, Food & Rural Affairs
HFC	Hydrofluorocarbon
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse effect gas
GWP	Global warming potential
IPCC	Intergovernmental Panel on Climate Change
MSW	Municipal solid waste
NIR	National Inventory Report
N_2O	Nitrous oxide
TCNTM	Towards a Carbon Neutral Tourism in Montenegro
UNDP	United Nations Development Programme
UNWTO	United Nations World Tourism Organization

1. PRESENTATION

In recent years, Montenegro's tourism sector has experienced a rapid development with an increase in the number of visitors and investments, becoming the main and most dynamic economic sector. As a major contributor to the country's gross domestic product (GDP), is one of the strategic drivers of economic growth. However, in the business-as-usual scenario, tourism sector's greenhouse effect gases (GHGs) emissions will rise by 40% in 2020 above 1990 baseline. As a result of this state of affairs, Montenegro's government has decided to curb the sector's emissions and seek its low carbon development.

In this context, Montenegro's Ministry of Sustainable Development and Tourism and the United Nations Development Programme (UNDP) launched the "Towards Carbon Neutral Tourism in Montenegro" (TCNTM) project, with the immediate target of maintaining tourism sector related GHG emissions at the 2013 level. In order to assess the effectiveness of the measures implemented under the project TCNTM's scope of action, the 2013 baseline emissions of GHGs from the tourism sector of Montenegro was calculated.

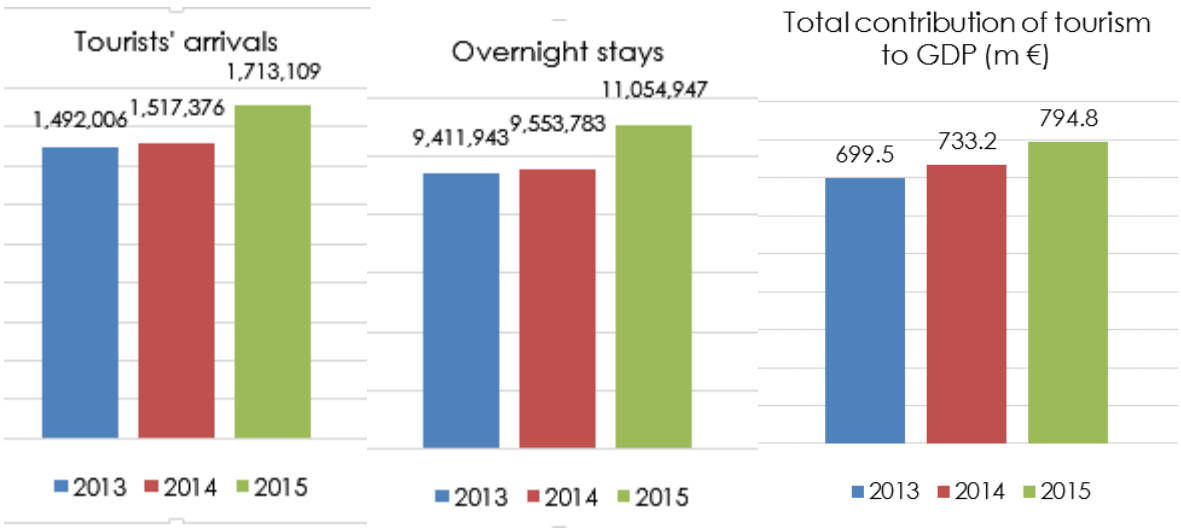
The main goal of this Report is to present the emissions of greenhouse effect gases (GHGs) from tourism in Montenegro during the year 2015.

2. 2015 TOURISM IN MONTENEGRO

Montenegro registered 1,713,109 tourists' arrivals during 2015, representing an increase of 12.9 % in relation of previous year. The total overnight stays of tourists accounted for 11,054,947 nights, 15.7 % more than in 2015 (MONSTAT, 2016).

The total contribution of tourism to the national GDP was estimated in 794.8 million € (22 % of total GDP), 8.4 % more than in 2014 (World Travel & Tourism Council, 2016).

Figure 1: Main tourism figures for 2015.
Source: Own elaboration.

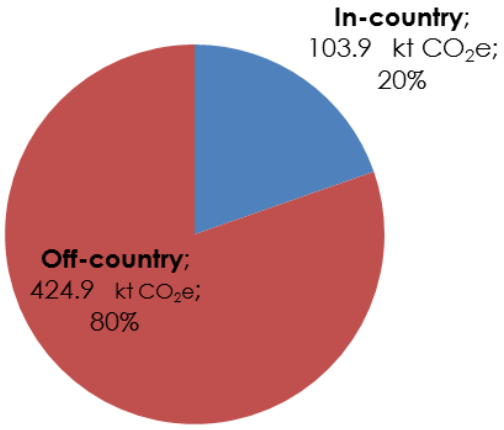


3. GHG EMISSIONS FROM TOURISM

3.1. Global emissions

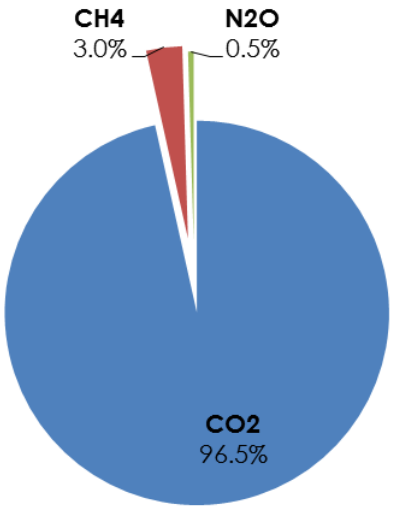
The total emissions from tourism in Montenegro in year 2015 were **528.84 kt CO_2e**. The majority of these emissions (429.94 kt CO_2e; 80 % of the total) took place out of the country, in the transportation of foreign tourists from their countries of origin to Montenegro. The rest (103.89 kt CO_2e; 20 % of the total) was country-based and had its source in the touristic activities, transportation and waste management within Montenegro.

Figure 2: Total emissions by geographical distribution.
Source: Own elaboration.



In terms of type of GHG, 2015 emissions were 510.34 kt CO_2, 639.7 t CH_4 (15.99 kt CO_2e) and 8.4 t N_2O (2.50 kt CO_2e). Considering each GHG global warming potential (GWP), CO_2 emissions were 96.5 % of the total emissions, while CH_4 and N_2O had a 3.0 % and 0.5 % share of the total, respectively.

Figure 3: Total emissions by type of GHG.
Source: Own elaboration.



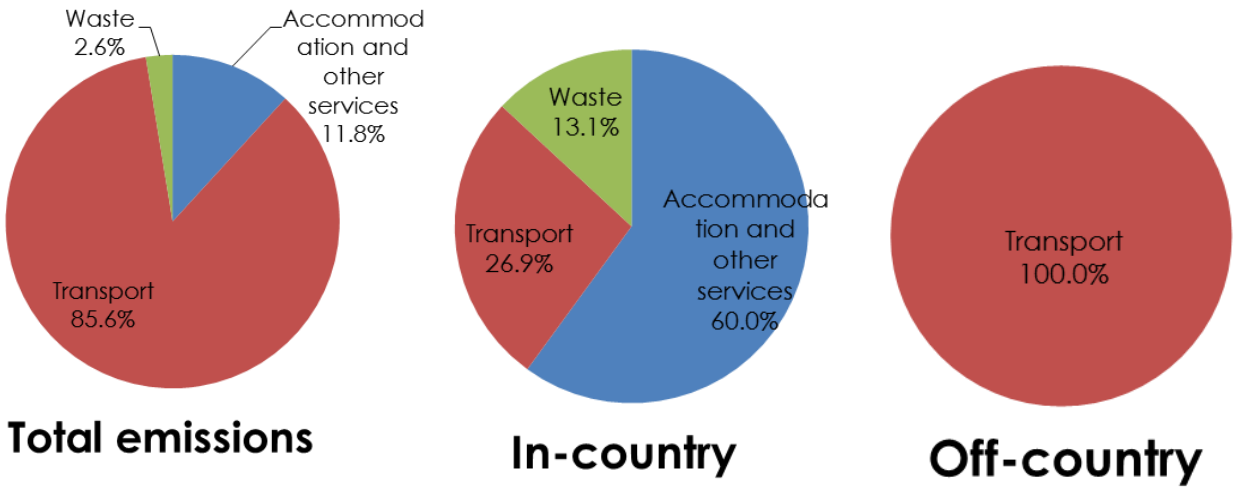
The tourist emissions by sector were as follows:

Table 1. 2015 emissions by sector.
Source: Own elaboration.

Sector	t CO_2	t CH_4	t N_2O	kt CO_2e
Accommodation and other services	59,897.6	76.9	1.8	62.4
Transport	450,447.0	43.9	4.4	452.9
Waste	-	518.9	2.1	13.6
Total	**510,344.6**	**639.7**	**8.4**	**528.8**

Of the total emissions, emissions from transport contributed to 85.6 % of the total, while accommodation and other services to 11.8 % and waste to 2.6 % respectively.

Figure 4: Emissions by sector.
Source: Own elaboration.



In the case of in-country emissions, accommodation and other services contributed to 60.0 %, in-country transport to 26.9 %, and waste to 13.1 % of the total. All off-country emissions were sourced from transport.

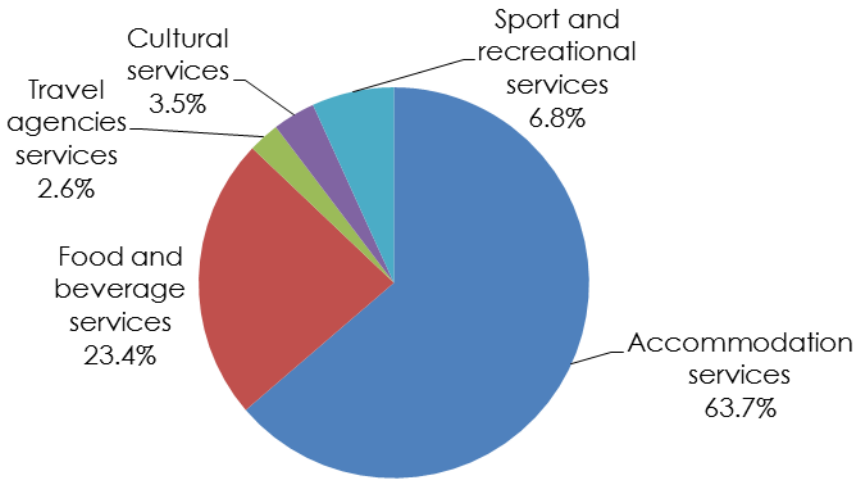
3.2. Accommodation and other services

The emissions from accommodation and other services for tourists in the year 2015 were as shown in following table:

Table 2. Emissions from Accommodation and other services.
Source: Own elaboration.

Emissions summary (t)	CO_2	CH_4	N_2O	CO_2e
Accommodation services	37,555.2	70.1	1.4	**39,737**
Food and beverage services	14,388.2	4.4	0.2	**14,571**
Travel agencies services	1,591.9	0.5	0.0	**1,612**
Cultural services	2,173.1	0.7	0.0	**2,201**
Sport and recreational services	4,189.2	1.3	0.1	**4,242**
Total	**59,897.6**	**76.9**	**1.8**	**62,363**

Figure 5: Source of emissions from accommodation and other services.
Source: Own elaboration.



All emissions from accommodation and other services took place in-country and were originated directly by the consumption of fuels or indirectly by the consumption of electricity.

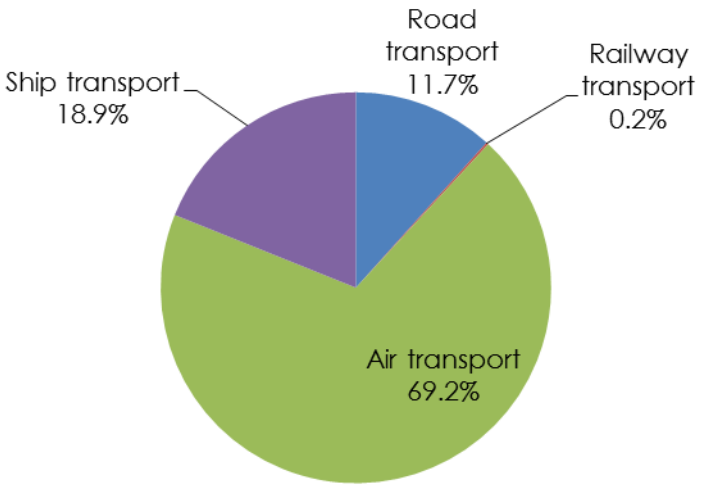
3.3. Transport

Emissions from transport of tourists were as follows:

Table 3. Emissions from Transport.
Source: Own elaboration.

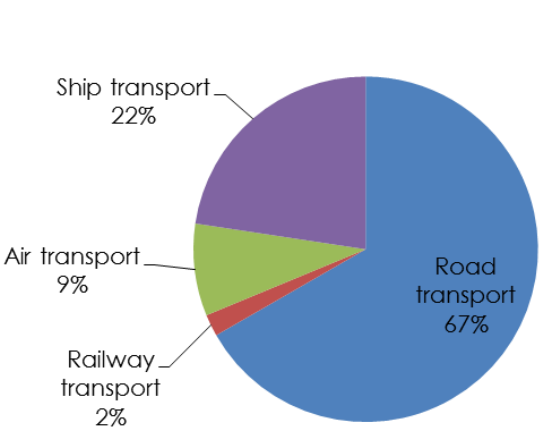
Emissions summary (t)	CO_2	CH_4	N_2O	CO_2e
In-country road transport	*18,513.9*	*2.7*	*0.2*	*18,629.9*
In-country railway transport	*569.9*	*0.1*	*0.0*	*573.7*
Air transport (airports)	*2,390.5*	*0.2*	*0.0*	*2,407.2*
Ship transport	*6,267.0*	*1.2*	*0.1*	*6,315.5*
Cruises at berth	5,838.0	0.9	0.1	5,874.5
Inland navigation	429.0	0.4	0.0	441.0
Total	***27,741.3***	***4.3***	***0.3***	***27,926.3***
Memo items				
Off-country road transport	34,026.2	5.0	0.3	34,238.7
Off-country rail transport	87.4	0.1	0.6	259.2
Air transport (international flights)	309,701.7	23.2	2.6	311,063.2
Maritime navigation	78,890.4	11.5	0.7	79,383.5
Total (including memo items)	**450,447.0**	**43.9**	**4.4**	**452,870.8**

Figure 6: Source of emissions from transport.
Source: Own elaboration.

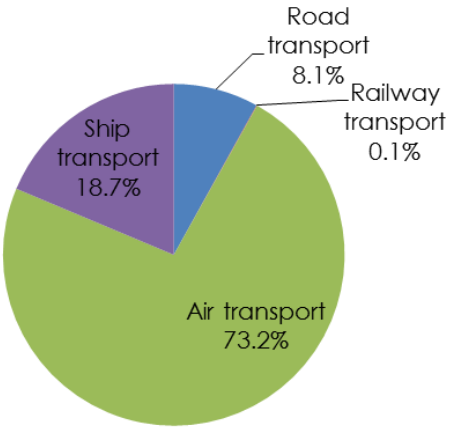


The majority of transport emissions were originated by air transport, followed by ship, road and railway transport. If in- and off-country emissions are analysed separately, the contribution of each type of transport was as follows:

Figure 7: Source of emissions from transport by geographical distribution.
Source: Own elaboration.



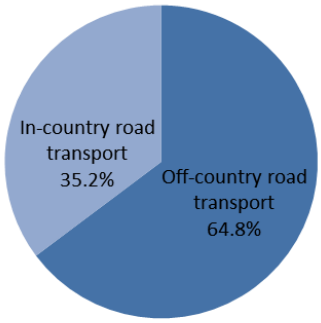
In-country transport emissions



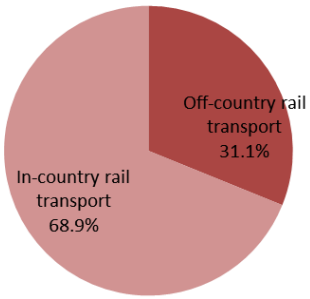
Off-country transport emissions (memo items)

The emissions analysed by type of transport were:

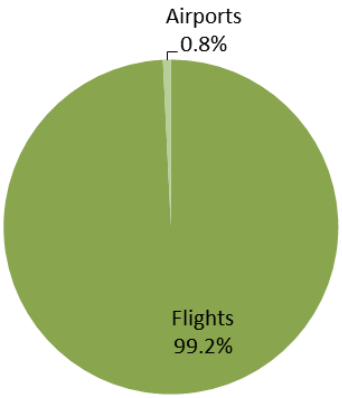
Figure 8: Emissions by transport type.
Source: Own elaboration.



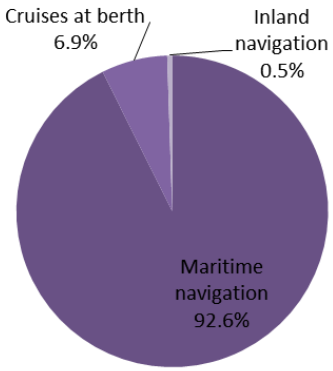
Emissions from Road transport



Emissions from Railway transport



Emissions from Air transport



Emissions from Ship transport

These emissions were originated by the consumption of fuels by vehicles, planes and ships, as well as electricity in the case of trains. Additionally, emissions originated by other activities related to transport are taken into account: fuel and electricity consumed by land activities and airports facilities and fuel consumed by cruises at berth in ports.

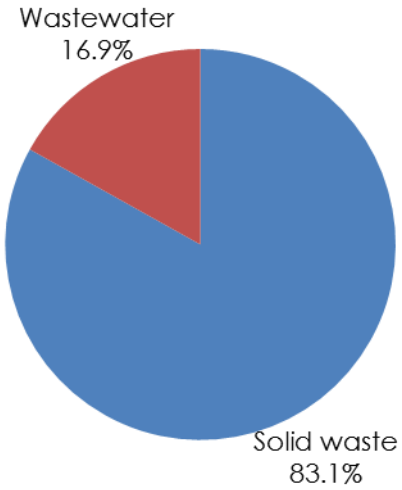
3.4. Waste

The emissions from the management of waste generated by tourists in the year 2015 were as shown in following table:

Table 4. Emissions from Waste.
Source: Own elaboration.

Emissions summary (t)	CO_2	CH_4	N_2O	CO_2e
Solid waste	-	452.1	-	11,301.5
Wastewater	-	66.9	2.1	2,300.9
Total	**-**	**518.9**	**2.1**	**13,602.4**

Figure 9: Source of emissions from waste.
Source: Own elaboration.



All emissions from waste took place in-country and were originated by the decomposition of the waste (solid or liquid) generated by tourists.

3.5. Main indicators

In the following table, the most relevant indicators of 2015 emissions from tourism in Montenegro are shown:

Table 5. Main indicators of tourism GHG emissions.
Source: Own elaboration.

Indicator	Unit	Value
Total average emission per tourist arrival (including memo items)	kg CO_2e/tourist arrival	308.7
Total average emission per tourist arrival (excluding memo items)	kg CO_2e/tourist arrival	60.6
Total average emission per overnight stay (including memo items)	kg CO_2e/overnight stay	47.8
Total average emission per overnight stay (excluding memo items)	kg CO_2e/overnight stay	9.4
Average emission per overnight stay (excluding in- and off-country transport)	kg CO_2e/overnight stay	6.9
Accommodation and other services emissions per overnight stay	kg CO_2e/overnight stay	5.6
Accommodation emissions per overnight stay (excluding other services)	kg CO_2e/overnight stay	3.6
Accommodation and other services emissions per tourist arrival	kg CO_2e/tourist arrival	36.4
Off-country transport emissions per foreign tourist arrival	kg CO_2e/foreign tourist arrival	272.4
In-country transport emissions per tourist	kg CO_2e/tourist arrival	16.3
Waste emissions per tourist arrival	kg CO_2e/tourist arrival	7.9

4. EVOLUTION OF EMISSIONS

The following table shows the comparison of 2015 GHG emissions from tourism with the baseline emissions, corresponding to the year 2013[1].

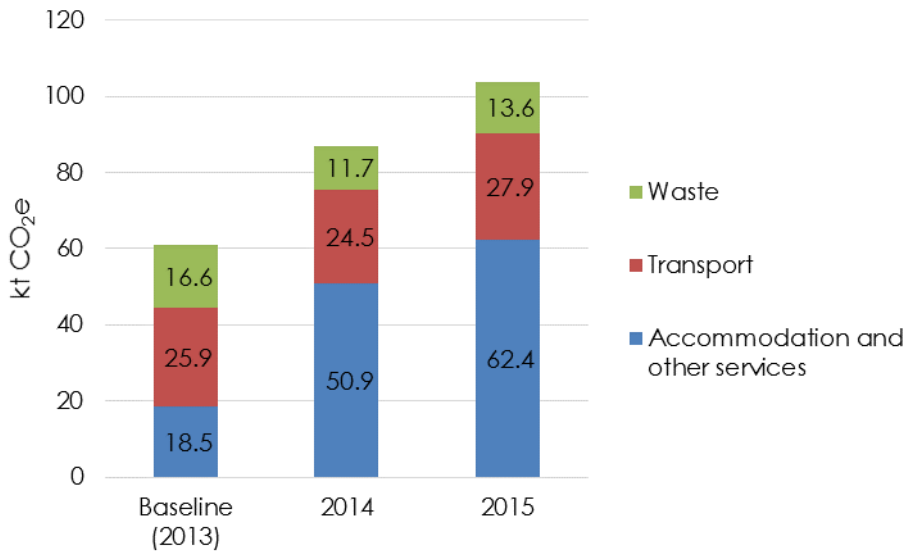
Table 6. Comparison of emissions with baseline year.
Source: Own elaboration.

Emissions (t CO_2e)	Baseline (2013)	2015	Variation (%)
Accommodation and other services	**18,461.2**	**62,363.3**	**238%**
Transport	**25,871.7**	**27,926.3**	**8%**
Road transport	***17,873.2***	***18,629.9***	**4%**
In-country road transport	17,873.2	18,629.9	4%
Railway transport	***624.6***	***573.7***	**-8%**
In-country rail transport	624.6	573.7	-8%
Air transport	***1,484.4***	***2,407.2***	**62%**
Airports	1,484.4	2,407.2	62%
Ship transport	***5,889.5***	***6,315.5***	**7%**
Cruises at berth	5,032.1	5,874.5	17%
Inland navigation	857.4	441.0	-49%
Waste	***16,571.5***	***13,602.4***	**-18%**
Solid waste	14,612.6	11,301.5	-23%
Wastewater	1,958.9	2,300.9	17%
Total	**60,904.4**	**103,892.0**	**71%**
Memo items			
Off-country road transport	21,613.7	34,238.7	58%
Off-country rail transport	116.0	259.2	123%
Flights	325,515.5	311,063.2	-4%
Maritime navigation	56,783.7	79,383.5	40%
Total (including memo items)	**464,933.3**	**528,836.6**	**14%**

[1] Comparisons with the baseline have to take into account that the emissions of Accommodation and other services in year 2013 are abnormally low due to the fact that the values of final energy consumption for the category *Other sectors* included in the energy balance of Montenegro for that year are remarkably low. It is expected that the energy balances are going to be redone, allowing to achieve a more coherent value for Accommodation and other services emissions in 2013.

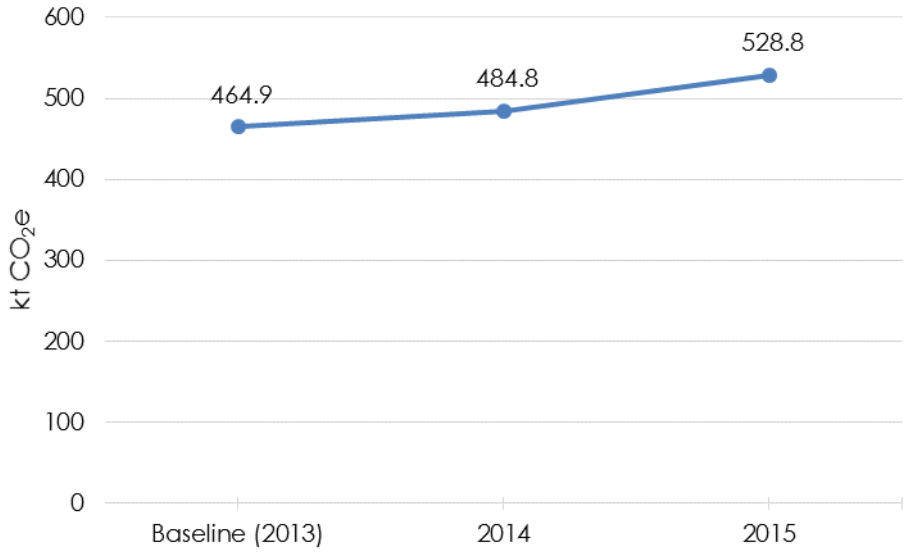
The following figure shows the evolution of in-country emissions.

Figure 10: Evolution of in-country emissions.
Source: Own elaboration.



Next figures presents the evolution of total emissions, including memo items (i.e. off-country emissions).

Figure 11: Evolution of total emissions (including memo items).
Source: Own elaboration.



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ANNEX I: CALCULATION METHODOLOGY

➢ Scope

The scope of the calculation methodology is the emissions generated by the tourism sector of Montenegro. The accounted emissions are those generated by tourist, either foreign or domestic, within Montenegro and those originated by means of transport to reach the country, in a year of inventory. The scope is restricted to those emissions generated directly by the combustion of fuel, indirectly by the consumption of electricity (i.e. direct emissions from fuel combustion for the production of the consumed electricity) and the direct emissions from waste; due to tourist activities.

The methodology does not account for all other life-cycle emissions of fuels or products, nor emission sinks and removals.

The definition of tourism considered for the calculations is the one provided by the United Nations World Tourism Organization: "Tourism is defined by the activities of persons identified as visitors. A visitor is someone who is making a visit to a main destination outside his/her usual environment for less than a year for any main purpose [including] holidays, leisure and recreation, business, health, education or other purposes" (UNWTO. Department of Economic an Social Affairs, 2010).

The detailed sources of GHG emissions considered are the following:

Table 7. Sources of GHG within scope.
Source: Own elaboration.

Geographical distribution	Sector	Source
IN-COUNTRY EMISSIONS	Accommodation and other services	Fuel consumption by tourists in: • Accommodation services. • Food and beverage services. • Travel agencies services. • Cultural services. • Sport and recreational services. • Other services.
	Road transport	Fuel consumption of vehicles used for tourists transportation within Montenegro.
	Railway transport	Fuel and electricity consumption due to tourists using the railway system within the Montenegro.
	Air transport	Fuel and electricity consumption in land activities and airport facilities due to tourists visiting Montenegro.
	Ship transport	Fuel and electricity consumption due to: • Inland navigation for tourists transportation. • Cruises at berth.
	Waste	Degradation of waste generated by tourists during their stay in Montenegro: • Solid waste • Wastewater
MEMO ITEMS		
OFF-COUNTRY EMISSIONS	Road transport	Fuel consumption of vehicles used for foreign tourists transportation from origin country to Montenegro and back.
	Railway transport	Fuel and electricity consumption due to foreign tourists using the railway system from origin country to Montenegro and back.
	Air transport	Fuel consumption of planes due to foreign tourists transportation from city of origin to Montenegro and back.
	Ship transport	Fuel consumption of ships used for foreign tourists transportation from origin country to Montenegro and back.

The GHGs within the scope of the methodology are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O). The three of them are converted into CO_2 equivalents (CO_2e) using the global warming potential (GWP) established by the IPCC for a time horizon of 100 years in the 4th Assessment Report:

Table 8. Global warming potential of GHG within scope.
Source: Own elaboration based on IPCC.

	CO_2	CH_4	N_2O
GWP 100-yr	1	25	298

➢ Methodology completeness and key categories identification

The present methodology allows the calculation of the emissions **originated from tourism activities exclusively**. The methodological approach to calculate the GHG emissions is a hybrid approach, combining both top-down and bottom-up approaches. The first one correlates economic data with emissions, through energy consumption of the economic sectors. The bottom-up utilizes activity data related to the sector in study and translates them into GHG emissions through emission factors. Which approach to use varies depending on the sector, as well as on the data availability.

Table 9. Methodological approach per sector.
Source: Own elaboration.

Sector	Subsector	Methodological approach	
		Applicable	Optimal
Accommodation and other services	Accommodation services.	Hybrid	Bottom-up
	Food and beverage services	Top-down	Bottom-up
	Travel agencies services.		
	Cultural services.		
	Sport and recreational services.		
Road transport	In-country	Top-down	Bottom-up
Railway transport	In-country	Top-down	Bottom-up
Air transport	Airports	Bottom-up	Bottom-up
Ship transport	Inland navigation	Top-down	Bottom-up
	Cruises at berth	Bottom-up	Bottom-up
Waste	Solid waste	Bottom-up	Bottom-up
	Wastewater		
Memo items			
Road transport	Off-country	Bottom-up	Bottom-up
Railway transport	Off-country	Bottom-up	Bottom-up
Air transport	Flights	Bottom-up	Bottom-up
Ship transport	Maritime navigation	Bottom-up	Bottom-up

The following table shows the correlation between the categories as described in the inventory and the categories of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories:

Table 10. Correlation among the accounting methodology and the 2006 IPCC Guidelines categories.
Source: Own elaboration.

Accounting methodology			
	Sector	Source	2006 IPCC Category
IN-COUNTRY EMISSIONS	Accommodation and other services	Fuel and electricity consumption by tourists in: • Accommodation services. • Food and beverage services. • Travel agencies services. • Cultural services. • Sport and recreational services. • Other services.	1.A.1.a Electricity and Heat Production (from electricity consumption) 1.A.4.a Commercial/Institutional (Collective accommodation & other services) 1.A.4.b Residential (private accommodation)
	Road transport	Fuel consumption of vehicles used for tourists transportation within Montenegro.	1.A.3.b Road Transportation
	Railway transport	Fuel and electricity consumption due to tourists using the railway system within the Montenegro.	1.A.1.a Electricity and Heat Production (from electricity consumption) 1.A.3.c Railways
	Air transport	Fuel and electricity consumption in land activities and airport facilities due to tourists visiting Montenegro.	1.A.1.a Electricity and Heat Production (from electricity consumption) 1.A.3.e Other Transportation
	Ship transport	Fuel and electricity consumption due to: • Inland navigation for tourists transportation. • Cruises at berth.	1.A.1.a Electricity and Heat Production (from electricity consumption) 1.A.3.d.ii Domestic water-borne Navigation
	Waste	Degradation of waste generated by tourists during their stay in Montenegro: • Solid waste • Wastewater	4.A.1 Managed Waste Disposal Sites 4.D.1 Domestic Wastewater Treatment and Discharge
MEMO ITEMS			
OFF-COUNTRY EMISSIONS	Road transport	Fuel consumption of vehicles used for foreign tourists transportation from origin country to Montenegro and back.	Not categorised in 2006 IPCC Guidelines.
	Railway transport	Fuel and electricity consumption due to foreign tourists using the railway system from origin country to Montenegro and back.	Not categorised in 2006 IPCC Guidelines.
	Air transport	Fuel consumption of planes due to foreign tourists transportation from city of origin to Montenegro and back.	1.A.3.a.i International Aviation (International Bunkers)
	Ship transport	Fuel consumption of ships used for foreign tourists transportation from origin country to Montenegro and back.	1.A.3.d.i International waterborne navigation (International Bunkers)

Certain sources/sinks of emissions have not been included into the accounting methodology, either because those emissions don't take place directly due the tourism activity (i.e. **not occurring, NO**) or because not enough data is available for their estimation (i.e. **not estimated, NE**). CO_2 emissions from biomass combustion for energy use are not estimated, since are considered as life-cycle emission that are out of the scope. Likewise, no emissions/absorptions from the AFOLU sector are estimated, since it is considered as out of the scope. The following table shows the exclusion from the methodology, following 2006 IPCC Guidelines categorisation.

Table 11. Categories of GHG sources and sinks excluded from the accounting methodology.
(NO: not occurring in tourism sector; NE: not estimated)
Source: Own elaboration.

Sector/Source category by 2006 IPCC	Type of exclusion
1. ENERGY	
1.A.1.b Petroleum Refining	NO
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries	NO
1.A.2 Manufacturing Industries and Construction	NO
1.A.4.c Agriculture / Forestry / Fishing / Fish farms	NO
1.B. Fugitive emissions from fuels	NO
2. INDUSTRIAL PROCESSES AND PRODUCT USE	
2A Mineral Industry	NO
2B Chemical Industry	NO
2C Metal Industry	NO
2D Non-Energy Products from Fuels and Solvent Use	NE
2E Electronics Industry	NO
2F Product Uses as Substitutes for Ozone Depleting Substances	NE
2G Other Product Manufacture and Use	NO
2H Other	NO
3. AGRICULTURE, FORESTRY AND OTHER LAND USE	**NO**
4. WASTE	
4A2 Unmanaged Waste Disposal Sites	NE
4A3 Uncategorised Waste Disposal Sites	NE
4B Biological Treatment of Solid Waste	NO
4C1 Waste Incineration	NO
4C2 Open Burning of Waste	NE
4D2 Industrial Wastewater Treatment and Discharge	NO
4E Other	NE
5 OTHER	**NE**
NON - 2006 IPCC Category	
Emissions from informal tourism sector	**NE**

Regarding the type of GHG and GHG precursors, only carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) emissions are considered in the methodology for their accounting. The rest of the gases are excluded due to no occurrence or insufficient available data for estimation.

Table 12. GHG not controlled by the Montreal Protocol and GHG precursors excluded from the accounting methodology.
(NO: not occurring in tourism sector; NE: not estimated)
Source: Own elaboration.

Greenhouse gas	Type of exclusion
CO_2 removals	NO
CO	NE
NOx	NE
$NMVOC_s$	NE
SO_x	NE
HFC_s	NE
PFC_s	NE
SF_6	NO

For the **identification of the key emission sources,** the methodological approach used is **Level Assessment (Approach 1)**, as presented in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1 General Guidance and Reporting*. The assessment only includes in-country emissions, since off-country emissions are considered as memo items.

Table 13. Key GHG sources analysis.
(Key sources in bold).
Source: Own elaboration.

Emission sources	CO_2e emissions estimate (t)	Level assessment	Cumulative total
Accommodation and other services	***62,363.3***	***0.60***	***0.60***
In-country road transport	***18,629.9***	***0.18***	***0.78***
Waste	***13,602.4***	***0.13***	***0.91***
Ship transport	***6,315.5***	***0.06***	***0.97***
Air transport (airports)	2,407.2	0.02	0.99
In-country rail transport	573.7	0.01	1.00
Total	103,892.0	1.00	-

➢ Emission factors

The emission factors used for the calculations are those derived from the National Inventory Report (NIR) of Montenegro. In case of lack of specific emission factors, default emission factors from other sources are used (e.g. 2006 IPCC Guidelines or the UK Department for Environment, Food & Rural Affairs, DEFRA). For the detailed list and values of emission factors, see Annex II.

➢ General equation

The general equation of the GHG emissions generated by the tourism sector in Montenegro for an inventory year is:

Equation 1. General equation of GHG emissions from tourism sector.
Source: Own elaboration.

$$Total\ emissions_{CO_2e} = \sum [(Accom\&other_{GHG} + Road_{GHG} + Rail_{GHG} + Air_{GHG} + Ship_{GHG} + Waste_{GHG}) \cdot GWP_{GHG}]$$

Where:

Total emissions$_{CO2e}$ = total CO_2e emissions from Montenegro's tourism sector (t CO_2e)

Accom&other$_{GHG}$= total emission of given GHG from tourist accommodation and other services (t GHG).

Road$_{GHG}$= total emission of given GHG from tourists road transportation (t GHG).

Rail$_{GHG}$= total emission of given GHG from tourists railway transportation (t GHG).

Air$_{GHG}$ = total emission of given GHG from tourists air transportation (t GHG).

Ship$_{GHG}$ = total emission of given GHG from tourists ship transportation (t GHG).

Waste$_{GHG}$ = total emission of given GHG from tourists' waste treatment (t GHG).

GWP = global warming potential of given GHG.

- **In-country emissions**
  - **Accommodation and other services**

The calculation of the GHG emissions from accommodation and other services for tourists include the calculation of emissions from:

- Accommodation:
  - Collective accommodation establishments: hotels, boarding houses, motels, tourist resorts, etc.).
  - Private accommodation establishments: rooms, apartments, houses.
- Other services:
  - Beverage and food services.
  - Travel agencies services.
  - Cultural services.
  - Sport and recreational services.

The calculation is performed using a hybrid approach. For the accommodation in collective facilities and the other services a top-down approach is used, while for accommodation in private facilities (apartments, rooms, etc.) a bottom-up approach is used.

The general equations to calculate the GHG emissions from collective accommodation and other services are:

Equation 2. GHG emissions from fuel combustion in accommodation and other services.
Source: Own elaboration.

$$Emissions_{GHG,fuel} = \sum Fuel\ consumption_{fuel\ i} \cdot Emission\ factor_{GHG,fuel\ i}$$

Where:

Emissions$_{GHG,fuel}$ = emission of given GHG from fuel combustion in accommodation and other services (t GHG).

Fuel consumption$_{fuel\ i}$ = amount of fuel type i consumed in collective accommodation and other services (TJ).

Emission factor$_{GHG,fuel i}$ = emission factor of a given GHG for fuel type i (t GHG/TJ).

Equation 3. GHG emissions from electricity consumption in accommodation and other services.
Source: Own elaboration.

$$Emissions_{GHG,electricity} = Electricity\ consumption \cdot Emission\ factor_{GHG,electricity}$$

Where:

Emissions$_{GHG,electricity}$ = emission of given GHG from electricity consumption in collective accommodation and other services (t GHG).

Electricity consumption = electricity consumed in accommodation and other services (GWh).

Emission factor$_{GHG,electricity}$ = emission factor of a given GHG for the electricity generation mix (t GHG/GWh).

Collective accommodation and other services

The energy consumption of services and other sectors is correlated with the gross output of all the services activities in Montenegro, obtaining the energy intensity of services. These data are used with a calculation of the mean expenditure of tourists in each service to obtain the final energy consumption of each of them.

Equation 4. Energy intensity of services (fuel).
Source: Own elaboration.

$$Energy\ intensity_{services;fuel\ i} = \frac{Consumption\ fuel\ i_{services}}{Gross\ output}$$

Where:

Energy intensity$_{services;\ fuel\ i}$ = energy intensity of services for fuel type i (TJ/mill €).

Consumption fuel $i_{services}$ = consumption of fuel type i for the category "Other sectors" in the energy balances (TJ).

Gross output$_{services}$ = total gross output of services activities (categories F, G and from I to R) for the year of inventory (mill €).

Equation 5. Energy intensity of services (electricity).
Source: Own elaboration.

$$Energy\ intensity_{services;electricity} = \frac{Consumption\ \ electricity_{services}}{Gross\ output_{services}}$$

Where:

Energy intensity$_{services;\ electricity}$= energy intensity of services for electricity (GWh/mill €).

Consumption electricity$_{services}$ = consumption of electricity for the category "Other sectors" in the energy balances (GWh).

Gross output$_{services}$ = total gross output of services activities (categories F, G and from I to R) for the year of inventory (mill €).

The calculation of the tourist's expenditure in each of the sector is performed using the "GDP: Total contribution" figure of tourism sector in Montenegro provided by the World Travel & Tourism Council (WTTC). In order to disaggregate the figure for each type of service, the share of the contribution of each services in the Pilot Tourist Satellite Accounts (TSA) of 2009 is used as an approximation. The categories, contribution and share to use are shown in the following table:

Table 14. Tourism services contribution to GDP.
Source: Own elaboration based on Pilot TSA 2009.

Category of service	Internal tourism consumption (€)	Share (fraction)
Accommodation services	248,978,383	0.44
Food and beverage services	110,488,266	0.19
Local passenger transport services	39,139,859	0.07
Air passenger transport services	32,508,049	0.06
Travel agencies services	12,224,189	0.02
Cultural services	16,687,406	0.03
Sport and recreational services	32,169,190	0.06
Other consumption products	76,792,995	0.13
TOTAL	**568,988,337**	**1**

The share is used to calculate the expenditure in **Food and beverage services; Travel agencies services, Cultural services and Sport and recreational services**[2], with the following equation:

Equation 6. Expenditure in other services.
Source: Own elaboration.

$$Expenditure_{service\ j} = Total\ contribution\ GDP \cdot Share_{service\ j\ 2009}$$

Where:

Expenditure$_{service\ j}$ = expenditure of tourists in service j in the inventory year (mill €).

Total contribution GDP = total contribution of the tourism sector to the GDP in the inventory year (mill €).

Share$_{service\ j\ 2009}$ = share of service j to the total contribution to GDP of tourism in 2009 (fraction).

For the calculation of the expenditure in **collective accommodation services**, the following equation is used:

[2] The shares of Local passenger transport services, Air passenger transport services and Other consumption products are not used for these calculations.

Equation 7. Expenditure in collective accommodation services.
Source: Own elaboration.

$$Expenditure_{collective\ accomodation} = Total\ contribution\ GDP \cdot Share_{accomodation\ 2009} \cdot \frac{Overnight\ stays_{collective}}{Overnight\ stays_{total}}$$

Where:

Expenditure$_{collective\ accommodation}$ = expenditure of tourists in collective accommodation services in the inventory year (mill €).

Total contribution GDP = total contribution of the tourism sector to the GDP in the inventory year (mill €).

Share$_{accommodation\ 2009}$ = 0.44; share of accommodation services to the total contribution to GDP of tourism in 2009 (fraction).

Overnight stays$_{collective}$ = overnight stays of tourists in collective accommodation facilities in the year of inventory.

Overnight stays$_{total}$ = total overnight stays of tourists in accommodation facilities (collective and private) in the year of inventory.

The fuel and electricity consumption of collective accommodation and other services is calculated according the following equation:

Equation 8. Fuel consumption in collective accommodation and other services.
Source: Own elaboration.

$$Fuel\ consumption_{service\ j,fuel\ i} = Energy\ intensity_{services;fuel\ i} \cdot Expenditure_{service\ j}$$

Where:

Fuel consumption$_{service\ j,\ fuel\ i}$ = amount of fuel type i consumed in service j (TJ).

Energy intensity$_{services;\ fuel\ i}$ = energy intensity of services for fuel type i (TJ/mill).

Expenditure$_{service\ j}$ = expenditure of tourists in service j in the inventory year (mill €).

Equation 9. Electricity consumption in collective accommodation and other services.
Source: Own elaboration.

$$Electricity\ consumption_{service\ j} = Energy\ intensity_{services;electricity} \cdot Expenditure_{service\ j}$$

Where:

Electricity consumption$_{service\ j}$ = amount of electricity consumed in service j (GWh).

Energy intensity$_{services;\ electricity}$ = energy intensity of services for electricity (GWh/mill).

Expenditure$_{service\ j}$ = expenditure of tourists in service j in the inventory year (mill €).

Private accommodation services

In the case of the emissions from private accommodation (apartments, private rooms, etc.), a bottom-up approach is used. Through the fuel consumption of households, an activity factor of average fuel consumption per overnight stay is calculated and crossed with the total tourist overnight stays in private accommodation in the inventory year.

Equation 10. Fuel consumption in private accommodation.
Source: Own elaboration.

$$Fuel\ consumption_{private,fuel\ i} = Consumption\ fuel\ i_{households} \cdot \frac{Overnight\ stays_{foreign,private}}{Total\ population \cdot 365 + Overnight\ stays_{foreign,private}}$$

Where:

Fuel consumption$_{private,\ fuel\ i}$ = amount of fuel type i consumed in private accommodation (TJ).

Consumption fuel i$_{households}$ = consumption of fuel type i for the category "Households" in the energy balances (TJ).

Overnight stays$_{foreign,\ private}$ = overnight stays of foreign tourists in private accommodation facilities in the year of inventory.

Total population = total population of Montenegro in the year of inventory.

For the electricity consumption, a similar approximation is done, using the households' electricity consumption of the eight most visited cities of Montenegro, in terms of foreign tourists' overnight stays.

Equation 11. Electricity consumption in private accommodation.
Source: Own elaboration.

$$Electricity\ consumption_{private} = \left(\sum_{m=1}^{8} Consumption\ \ electricty_{hhls,city\ m}\right) \cdot \frac{Overnight\ stays_{foreign,private}}{\sum_{m=1}^{8} Population_{city\ m} \cdot 365 + Overnight\ stays_{foreign,private}}$$

Where:

Electricity consumption$_{private}$ = amount of electricity consumed in private accommodation (GWh).

Consumption electricity$_{hhls,\ city\ m}$ = consumption of electricity in the households of city m.

Overnight stays$_{foreign,\ private}$ = overnight stays of foreign tourists in private accommodation facilities in the year of inventory.

Population$_{city\ m}$ = total population of city m in the year of inventory.

- **In-country transport**

The GHG emissions of tourist transport within Montenegro is calculated using a hybrid approach. The emissions of road transport, railway transport and inland navigation are calculated using a top-down approach. The in-country emissions from air transport (airports) and maritime navigation (cruises at berth) are calculated using a bottom-up approach.

- **In-country road transport, railway transport and inland navigation**

The GHG emissions from in-country road transport, in-country railway transport and inland navigation are calculated using a top-down approach similar to the one used for the emissions of collective accommodation and other services.

The general equations to calculate the GHG emissions is the following:

Equation 12. GHG emissions from fuel combustion in in-country road transport, railway transport and inland navigation.
Source: Own elaboration.

$$Emissions_{GHG,fuel,transport\ j} = \sum Fuel\ consumption_{fuel\ i,transport\ j} \cdot Emission\ factor_{GHG,fuel\ i}$$

Where:

Emissions$_{GHG,fue,\ transport\ j}$ = emission of given GHG from fuel combustion in transport j (road, railway, navigation) (t GHG).

Fuel consumption$_{fuel\ i,\ transport\ j}$ = amount of fuel type i consumed in transport j (TJ).

Emission factor$_{GHG,fueli}$ = emission factor of a given GHG for fuel type i (t GHG/TJ).

Equation 13. GHG emissions from electricity consumption in in-country railway transport and inland navigation.
Source: Own elaboration.

$$Emissions_{GHG,electricity,transport\ j} = Electricity\ consumption_{transport\ j} \cdot Emission\ factor_{GHG,electricity}$$

Where:

Emissions$_{GHG,electricity,transport}$ j = emission of given GHG from electricity consumption in transport j (t GHG).

Electricity consumption$_{transport\ j}$ = electricity consumed in transport j (GWh).

Emission factor$_{GHG,electricity}$ = emission factor of a given GHG for the electricity generation mix (t GHG/GWh).

The energy consumption of all the sectors is correlated with the total gross output of Montenegro in the year of inventory, obtaining the energy intensity of the economy.

These data are crossed with the mean expenditure of tourists in transport services, which calculated using ***Equation 6 Expenditure in other services*** and the share of Local passenger transport services in ***Table 14. Tourism services contribution to GDP.***

Equation 14. Energy intensity of the economy.
Source: Own elaboration.

$$Energy\ intensity_{economy} = \frac{\sum Final\ energy\ consumption_{source\ i}}{Gross\ output}$$

Where:

Energy intensity$_{economy}$ = energy intensity of the economy (TJ/mill €).

Final energy consumption$_{source\ i}$ = final energy consumption of energy source i (TJ).

Gross output = total gross output of the economy for the year of inventory (mill €).

The expenditure in Local passenger transport services is used to estimate the energy consumption of tourist transportation within Montenegro with the following equation:

Equation 15. Total Energy consumption in in-country tourist transportation (road, railway, inland navigation).
Source: Own elaboration.

$$Energy\ consumption_{tourists,in-transport} = Energy\ intesity_{economy} \cdot Expenditure_{transport}$$

Where:

Energy consumption$_{tourists,\ in\text{-}transport}$ = total energy consumption of tourists in local transport services (TJ).

Energy intensity$_{economy}$ = energy intensity of the economy (TJ/mill €).

Expenditure$_{transport}$ = expenditure of tourists in Local passenger services in the inventory year (mill €).

The energy consumption per type of transport is estimated considering the contribution of each type of transport (road, railway and inland navigation) in the energy balances of the inventory year.

Equation 16. Energy consumption of tourists in-country transportation per type of transport.
Source: Own elaboration.

$$Energy\ consumption_{tourist,transport\ j} = Energy\ consumption_{tourists,in-transport} \cdot \frac{T.e.consumption_{transport\ j}}{(T.e.consumption_{road} + T.e.consumption_{railways} + T.e.consumption_{inland\ nav}}$$

Where:

Energy consumption$_{tourist,transport\ j}$ = total energy consumption of the use in-country of transport j (road, railway or inland navigation) by tourists (TJ).

Energy consumption$_{tourists,\ in\text{-}transport}$ = total energy consumption of tourists in local transport services (TJ).

T.e.consumption$_{transport\ j}$ = total energy consumption of transport j (road, railway or inland navigation) (TJ).

T.e.consumption$_{road}$ = total energy consumption of road transport in the energy balances of the inventory year (TJ).

T.e.consumption$_{railway}$ = total energy consumption of railway transport in the energy balances of the inventory year (TJ).

T.e.consumption$_{inland\ nav}$ = total energy consumption of inland navigation in the energy balances of the inventory year (TJ).

The disaggregation into types of fuel and electricity is done using the proportions of fuels consumption per type of transport in the energy balances of the inventory year.

Equation 17. Disaggregation into fuel types of energy consumption of tourists in-country transportation per type of transport.
Source: Own elaboration.

$$Fuel\ consumption_{fuel\ i,transport\ j} = Energy\ consumption_{tourist,transport\ j} \cdot \frac{Consumption_{fuel\ i,transport\ j}}{T.e.consumption_{transport\ j}}$$

Where:

Energy consumption$_{tourist,transport\ j}$ = total energy consumption of the use in-country of transport j (road, railway or inland navigation) by tourists (TJ).

Energy consumption$_{tourists,\ in\text{-}transport}$ = total energy consumption of tourists in local transport services (TJ).

Consumption$_{fuel\ i,\ transport\ j}$ = consumption of fuel type i in the transport j category of the energy balance in the inventory year (TJ).

- **In-country air transport (airports)**

The in-country air transport GHG emissions are those sourced in the energy consumption due to land activities in airports and the consumption of airport facilities themselves. The calculation uses a bottom-up approach, in which the contribution of tourists to energy consumption is differentiated from the total energy consumption.

Equation 18. GHG emissions from tourist in-country air transport (airports).
Source: Own elaboration.

$$Emissions_{GHG,airport} = (Electricity\ consumption_{airport} \cdot EF_{GHG,electricity} + \sum Fuel\ consumption_{airport,fuel\ i} \cdot EF_{GHG,fuel\ i}) \cdot \frac{Torusit\ arrivals}{Total\ arrivals}$$

Where:

Emissions$_{GHG,airport}$ = emission of given GHG from airport facilities (ground activities, t GHG).

Electricity consumption$_{airport}$ = total electricity consumed by Podgorica and Tivat airports (GWh).

$EF_{GHG,electricity}$ = emission factor of a given GHG for the electricity generation mix (t GHG/GWh).

Fuel consumption$_{airport,fuel\ i}$ = total amount of fuel type i consumed by Podgorica and Tivat airports (ground activities; TJ).

$EF_{GHG,fuel\ i}$ = emission factor of a given GHG for fuel type I (t GHG/TJ).

Tourist arrivals = total number of foreign passenger arrivals (passengers).

Total arrivals = total number of arrivals to airport (Tivat and Podgorica) in the year of inventory (passengers).

- **In-country maritime transport (cruises at berth)**

The emissions caused by cruises staying at port are calculated through a bottom-up approach. The number of cruises arriving at port, along with specific information provided by Kotor's Port Authority is used in the following equitation:

Equation 19. GHG emissions from tourist in-country maritime transport (cruises at berth).
Source: Own elaboration.

$$Cruise_{sGHG} = (\sum Cruise_i tonnage) \cdot Avg\ time\ at\ berth \cdot \frac{Fuel\ consumption_{h,t}}{1{,}000{,}000} \cdot Emission\ factor_{GHG,fuel\ oil}$$

Where:

Cruise$_{GHG}$ = total emission of given GHG from cruises at berth (t GHG).

Cruise$_i$ tonnage = cruise i gross tonnage (t).

Avg time at berth = average time of ships at berth (hr).

Fuel consumption$_{h,t}$ = 9.2 kg of fuel oil/hr/1,000 tonnage; hourly fuel consumption of cruise at berth[3].

Emission factor$_{GHG,fuel}$ oil = emission factor of a given GHG for fuel oil (t GHG/t fuel oil).

- **Waste**

The calculation of GHG emissions from the waste generated by tourists (either solid waste or wastewater) is done based in the methodology of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Waste.

- **Solid waste**

The calculation of emissions from solid waste generated by tourists is performed through a bottom-up approach method based on the First Order Decay (FOD) method contained in IPCC's 2006 Guidelines. The equation is:

Equation 20. CH_4 emissions from tourists' SWD.
Source: Own elaboration based on IPCC.

$$CH_4\ Emissions_{SWDS,tourists} = \left[\sum CH_4 generated\right] \cdot (1 - R) \cdot (1 - OX_T)$$

Where:

CH$_4$Emissions$_{SWDS,tourists}$ = *CH$_4$* emissions from tourist's solid waste managed in landfills in the year of inventory (t CH_4).

CH$_4$generated = CH_4 generated from the solid waste of tourists managed in landfills (t).

R = recovered CH_4 (fraction).

OX= 0, oxidation factor (IPCC default) (fraction).

The recovered CH_4 is calculated in base of the figure of CH_4 burned in landfills provided by EPA and the total CH_4 generated from SWD provided by the National Inventory Report.

[3] Figure provided by Ecofys in its document *Potential for Shore Side Electricity in Europe* (http://www.ecofys.com/files/files/ecofys-2014-potential-for-shore-side-electricity-in-europe.pdf).

Equation 21.Recovered CH_4 from tourists' SWD.
Source: Own elaboration based on IPCC.

$$R = \frac{CH_4\ burned}{CH_4 generated_{Montenegro}}$$

Where:

R = recovered CH_4 (fraction).

CH_4 burned = CH_4 burned in landfills' torches (t).

CH_4 generated$_{Montenegro}$ = total CH_4 generated in landfills of Montenegro according to the NIR (t).

The CH_4 generated by tourists' solid waste is calculated considering a period of 30 years from the moment of disposal. The equation to use is the following:

Equation 22. CH_4 generated from tourists' SWD.
Source: Own elaboration based on IPCC.

$$CH_4 generated_t = L_0 \cdot W_{tourist} \cdot k \cdot (\frac{1 - e^{-k}}{k}) \cdot \sum_{i=0}^{30} e^{-k \cdot i}$$

Where:

CH_4generated = CH_4 generated from the solid waste of tourists managed in landfills (t).

L_0 = CH_4 generation potential (fraction).

$W_{tourists}$ = solid waste generated by tourists and managed in landfills in the inventory year (t).

k = 0.05 reaction constant (IPCC default).

Equation 23. CH_4 generation potential from tourists' SWD (L_0).
Source: Own elaboration based on IPCC.

$$L_0 = DDOCm \cdot F \cdot 16/12$$

Where:

L_0 = CH_4 generation potential (fraction).

$DDOC_m$ = decomposable fraction of degradable organic carbon deposited (fraction).

F = 0.5; fraction of CH_4 in generated landfill gas (IPCC default) (fraction).

16/12 = molecular weight ratio CH_4/C (ratio).

Equation 24. Decomposable fraction of degradable organic carbon deposited (*DDOCm*).
Source: Own elaboration based on IPCC.

$$DDOCm = DOC \cdot DOC_f \cdot MCF$$

Where:

DDOC$_m$ = decomposable fraction of degradable organic carbon deposited (fraction).

DOC = 0.131; degradable organic carbon in tourists' waste deposited in the year of inventory (fraction).

DOC$_f$ = 0.5; fraction of DOC that can decompose (IPCC default) (fraction).

MCF = 1; CH_4 correction factor for aerobic decomposition in the year of deposition (IPCC default) (fraction).

The degradable organic carbon in tourists' waste is calculated in base of the 2006 IPCC guidelines, using the municipal solid waste characterization of the *National Waste Management Plan*. For more detail of its calculation, see Annex II.

The amount of solid waste generated by tourists in a year is calculated in base of the global amount of municipal solid waste (MSW) generated in Montenegro. The equation to use is the following:

Equation 25. Solid waste generated by tourists (*W$_{tourist}$*).
Source: Own elaboration based on IPCC.

$$W_{tourist} = MSW_{total} \cdot \frac{Overnight\ stays_{foreign}}{Overnight\ stays_{foreign} + Total\ population \cdot 365}$$

Where:

W$_{tourists}$ = solid waste generated by tourists and managed in landfills in the inventory year (t).

MSW$_{total}$ = total municipal solid waste collected in Montenegro in the year of inventory (t).

Overnight stays$_{foreign}$ = total overnight stays of foreign tourists in the year of inventory.

Total population = total population of Montenegro in the year of inventory.

- **Waste water**

In a similar way to emissions from solid waste, GHG emission from tourists' wastewater are calculated using a bottom-up approach based on the 2006 IPCC Guidelines. The equations to use are:

Equation 26. CH_4 emissions from tourists' wastewater treatment.
Source: Own elaboration based on IPCC.

$$CH_4\ Emissions_{WW,tourists} = \frac{T \cdot B_0 \cdot MCF \cdot TOW_{tourists} \cdot (1-S) \cdot (1-R)}{1{,}000}$$

Where:

CH_4 Emissions$_{WW,tourists}$ = *CH_4* emissions from tourists' wastewater treatment (t CH_4).

T= degree of utilisation of septic tanks by tourists (fraction).

B_0 = maximum CH_4 producing capacity (kg CH4/kg BOD).

MCF = 0.5; methane correction factor of septic tanks (IPCC default) (fraction).

$TOW_{torusits}$ = total organics from tourists in wastewater (kg BOD).

S = 0; organic component fraction removed as sludge (IPCC default) (fraction).

R = 0; fraction of CH_4 recovered (IPCC default) (fraction).

Equation 27. Organics from tourists in waste water.
Source: Own elaboration based on IPCC.

$$TOW_{tourists} = Overnight\ stays \cdot BOD \cdot 0.001 \cdot I$$

Where:

$TOW_{torusits}$ = total organics from tourists in wastewater (kg BOD).

Overnight stays = total overnight stays of tourists (day·tourist).

BOD = per capita BOD (g/person/day).

0.001 = conversion from grams BOD to kg BOD.

I = 1; correction factor for additional industrial BOD discharged into sewers (IPCC default value) (fraction).

To calculate the nitrous oxide emissions from wastewater, the following equations are used:

Equation 28. N_2O emissions from tourists' wastewater treatment.
Source: Own elaboration based on IPCC.

$$N_2O\ Emissions_{WW,tourists} = \frac{N_{effluent} \cdot EF_{effluent} \cdot 44/28}{1{,}000}$$

Where:

$N_2O\ Emissions_{ww,tourists}$= N_2O emissions from the wastewater generated by tourists (t N_2O).

$N_{effluent}$ = total amount of nitrogen from tourists in the wastewater effluent (kg N).

$EF_{effluent}$= 0.005 emission factor for N_2O from nitrogen discharged to wastewater (IPCC default) (kg N_2O-N/kg N).

44/28 = conversion factor from kg N_2O-N to N_2O.

Equation 29. **Nitrogen from tourists in the wastewater effluent ($N_{effluent}$).**
Source: Own elaboration based on IPCC.

$$N_{effluent} = (Overnight\ stays \cdot Protein \cdot F_{NPR} \cdot F_{NON-CON} \cdot F_{IND-COM}) - N_{sludge}$$

Where:

$N_{effluent}$ = total amount of nitrogen from tourists in the wastewater effluent (kg N).

Overnight stays = total number of tourists' overnight stays (person-day).

Protein = daily per capita protein consumption (kg/person-day).

F_{NPR} = 0.16; fraction of nitrogen in protein (kg N/kg protein).

$F_{NON-CON}$ = 1.10, factor for non-consumed protein added to the wastewater (IPCC default).

$F_{IND-COM}$ = 1.25; factor for industrial and commercial co-discharged protein into the sewer system (IPCC default).

N_{SLUDGE} = 0; nitrogen removed with sludge (IPCC default) (kg N).

- **Memo items: Off-country transport emissions**

All the off-country GHG emissions accounted are those generated by off-country transport and are to be reported as memo items, separately from the in-country emissions. Off-county transport emissions are those generated by roundtrips made by foreign tourists between their countries of origin and Montenegro. All the off-country transport calculations use a bottom-up approach.

- **Estimation of foreign tourists' transport mode**

The first step of the calculation requires the estimation of the transport modes used by foreign tourist to travel for and back from Montenegro. The starting point is the figure of **foreign arrivals** provided by MONSTAT every year. The general equation of transport modes is:

Equation 30. General equation of transport modes.
Source: Own elaboration.

$$F.arrrivals_{total} = F.arrrivals_{road} + F.arrrivals_{train} + F.arrrivals_{plane} + F.arrrivals_{ship}$$

Where:

F.arrivals$_{total}$ = total arrivals of foreign tourists in the year of inventory (passengers). Figure provided by MONSTAT.

F.arrivals$_{road}$ = arrivals of foreign tourist by road (passengers). To estimate.

F.arrivals$_{train}$ = arrivals of foreign tourist by train (passengers). To estimate.

F.arrivals$_{plane}$ = arrivals of foreign tourist by plane (passengers). Figure provided by Police authority in the Passenger activity of the year of inventory.

F.arrivals$_{ship}$ = arrivals of foreign tourist by ship (passengers). Result of adding foreign arrivals of tourists by vessel and arrivals by cruise. Both figures are provided by MONSTAT.

The estimation of the arrivals by road and by train is done using the data of Passenger activity in the year of inventory provided by Police authority.

Equation 31. Foreign arrivals by road.
Source: Own elaboration.

$$F.arrrivals_{road} = \frac{\left(F.arrrivals_{total} - F.arrrivals_{plane} - F.arrrivals_{ship}\right) \cdot Cross_{road}}{Cross_{road} + Cross_{train}}$$

Where:

F.arrivals$_{road}$ = arrivals of foreign tourist by road (passengers).

F.arrivals$_{total}$ = total arrivals of foreign tourists in the year of inventory (passengers). Figure provided by MONSTAT.

F.arrivals$_{plane}$ = arrivals of foreign tourist by plane (passengers). Figure provided by Police authority in the Passenger activity of the year of inventory.

F.arrivals$_{ship}$ = arrivals of foreign tourist by ship (passengers). Result of adding foreign arrivals of tourists by vessel and arrivals by cruise. Both figures are provided by MONSTAT.

Cross$_{road}$ = Border crosses of foreigners (in or out, choose minimum value) by road in the year of inventory (passengers). Figure provided by Police authority.

Cross$_{train}$ = Border crosses of foreigners (in or out, choose minimum value) by train in the year of inventory (passengers). Figure provided by Police authority.

Equation 32. Foreign arrivals by train.
Source: Own elaboration.

$$F.arrrivals_{train} = \frac{\left(F.arrrivals_{total} - F.arrrivals_{plane} - F.arrrivals_{ship}\right) \cdot Cross_{train}}{Cross_{road} + Cross_{train}}$$

Where:

F.arrivals$_{train}$ = arrivals of foreign tourist by train (passengers).

F.arrivals$_{total}$ = total arrivals of foreign tourists in the year of inventory (passengers). Figure provided by MONSTAT.

F.arrivals$_{plane}$ = arrivals of foreign tourist by plane (passengers). Figure provided by Police authority in the Passenger activity of the year of inventory.

F.arrivals$_{ship}$ = arrivals of foreign tourist by ship (passengers). Result of adding foreign arrivals of tourists by vessel and arrivals by cruise. Both figures are provided by MONSTAT.

Cross$_{train}$ = Border crosses of foreigners (in or out, choose minimum value) by train in the year of inventory (passengers). Figure provided by Police authority.

Cross$_{road}$ = Border crosses of foreigners (in or out, choose minimum value) by road in the year of inventory (passengers). Figure provided by Police authority.

- **Off-country road transport**

The general equation of off-country road transport is the following:

Equation 33. GHG emissions from off-country tourist road transportation.
Source: Own elaboration.

$$Emissions_{GHG,off-road} = \frac{Distance\ travelled_{road} \cdot Emission\ factor_{GHG,road}}{1{,}000}$$

Where:

Emissions$_{GHG,\ off\text{-}road}$ = emission of given GHG from the use of cars off-country (t GHG).

Distance travelled$_{road}$ = car distance travelled off-country by tourist (km·car).

Emission factor$_{GHG,road}$ = emission factor of a given GHG per kilometre travelled with cars (kg GHG/km·car).

The distance travelled is calculated in based of the distance from the tourist's home country to Montenegro. To do so, the procedure is to create a table containing all the countries of origin of foreign tourist in the inventory year (provided by MONSTAT). The distance from these countries is calculated considering roundtrips from the capital cities of the home-country to Podgorica and **subtracting 100 km** (in order to prevent the double accounting of emission within the country). In the case of routes that require the uses of ferries, the distance travelled by ship must be subtracted as well. Countries from which is not feasible to reach Montenegro by road, are not included. Common tools such as Google Maps can be used to determine the trip distances.

Equation 34. Distance travelled by road.
Source: Own elaboration.

$$Distance\ travelled_{road} = \frac{F.arrivals_{road}}{Car\ occupancy} \cdot \sum (Roundtrip_{country\ m} \cdot Share_{road,country\ m})$$

Where:

Distance travelled$_{road}$ = car distance travelled off-country by tourist (km·car).

F.arrivals$_{road}$ = arrivals of foreign tourist by road (passengers).

Car occupancy = 2,23 passengers/car(4).

Roundtrip$_{country\ m}$ = road roundtrip from country of origin m to Montenegro's border (km).

Share$_{road,\ country\ m}$ = share of foreign tourists that come from country m traveling by car (fraction).

[4] Calculated on base of surveys of travel company and travel modes in MTO Guest Survey 2014.

The share of tourists per country is calculated using an exponential distribution in which the closer countries to Montenegro are the countries from which more tourists travel by car. To calculate the share, consider the following proportions:

Table 15. Distribution by roundtrip distance of foreign tourists traveling by road.
Source: Own elaboration.

Roundtrip distance	Proportion of foreign tourists
< 500 km	67%
> 500 km and < 1,000 km	24%
> 1,000 km	9%

These proportions are distributed between the roundtrip distances for each country in inverse proportionality: the closer the country is, the bigger the proportion of total foreign tourists that come from that country.

- **Off-country railway transport**

The GHG emissions of off-country railway transport of tourists are calculated in a very similar way than off-country road transport. The general equation of off-country railway transport is the following:

Equation 35. GHG emissions from off-country tourist railway transportation.
Source: Own elaboration.

$$Emissions_{GHG,off-train} = \frac{Distance\ travelled_{train} \cdot Emission\ factor_{GHG,train}}{1{,}000}$$

Where:

Emissions$_{GHG,off\text{-}train}$ = emission of given GHG from the use of railway systems off-country (t GHG).

Distance travelled$_{train}$ = railway distance travelled off-country by tourist (passenger·km).

Emission factor$_{GHG,train}$ = emission factor of a given GHG per kilometre travelled per passenger by train(kg GHG/ passenger·km).

The distance travelled is calculated in a similar way as for off-country road transport: roundtrip distance from tourists' countries of origin (capital city) to the border of Montenegro (in order to prevent the double accounting of emission within the country). Countries from which is not feasible to reach Montenegro by train, are not included. As

there is no common tool to calculate railway distances the use of Google Maps is recommendable, make the assumption that railway distances are similar to road distances, once routes that include the use of ferries are eliminated.

Equation 36. Distance travelled by train.
Source: Own elaboration.

$$Distance\ travelled_{train} = F.arrivals_{train} \cdot \sum (Roundtrip_{country\ m} \cdot Share_{train,country\ m})$$

Where:

Distance travelled$_{road}$ = railway distance travelled off-country by tourists (passenger·km).

F.arrivals$_{train}$ = arrivals of foreign tourist by train (passengers).

Roundtrip$_{country\ m}$ = road roundtrip from country of origin m to Montenegro's border (km).

Share$_{road,\ country\ m}$ = share of foreign tourists that come from country m traveling by train (fraction).

As in off-country road distance, the share of tourists per country is calculated using an exponential distribution in which the closer countries to Montenegro are the countries from which more tourists travel by train. To calculate the share, consider the following proportions:

Table 16. Distribution by roundtrip distance of foreign tourists traveling by train.
Source: Own elaboration.

Roundtrip distance	Proportion of foreign tourists
< 500 km	67%
> 500 km and < 1,000 km	24%
> 1,000 km	9%

These proportions are distributed between the roundtrip distances for each country in inverse proportionality: the closer the country is, the bigger the proportion of total foreign tourists that come from that country.

- **Off-country air transport**

The off-country air transport emissions are calculated using a bottom-up approach. The activity data to use are the passenger-kilometers to reach Podgorica and Tivat airports. As no other data is available, it is preferred to considered the whole flight emissions as off-country, taking into account that DEFRA emission factors (used in this case) already include emissions from taking-off and landing.

Equation 37. GHG emissions from off-country tourist air transportation.
Source: Own elaboration.

$$Emissions_{GHG,flight} = Distance\ travelled_{flight,tourist} \cdot Emission\ factor_{GHG,flight}$$

Where:

Emissions$_{GHG,flight}$ = emission of given GHG from tourist air transportation (t GHG).

Distance travelled$_{flight,tourist}$ = distance travelled by foreign tourists by plane (passenger·km).

Emission factor$_{GHG,flight}$ = emission factor of a given GHG for tourist air transportation (t GHG/passenger-km).

The distance travelled is calculated on the base of the city of origin/destiny that reach Tivat and Podgorica airports. These data are provided by the airport's authorities. The flight distances can be found in common web tools to calculate flight mileages (e.g. https://www.webflyer.com/travel/mileage_calculator/ or http://www.flightmanager.com/content/timedistanceform.aspx).

Equation 38. Distance travelled by plane.
Source: Own elaboration.

$$Distance\ travelled_{flight,tourist} = F.arrivals_{plane} \cdot (\sum Flight\ distance_{city\ n} \cdot \frac{Arrivals_{city\ n}}{Total\ arrivals})$$

Where:

Distance travelled$_{flight,tourist}$ = distance travelled by foreign tourists by plane (passenger·km).

F.arrivals$_{plane}$ = arrivals of foreign tourist by plane (passengers).

Flight distance$_{city\ n}$ = roundtrip flight distance from city n to airport (Tivat or Podgorica) (km).

Arrivals$_{city\ n}$ = passenger arrivals from city n to airport (Tivat or Podgorica) in the year of inventory (passengers).

Total arrivals = total number of arrivals to airport (Tivat or Podgorica) in the year of inventory (passengers).

- **Maritime navigation**

The emissions from maritime navigation are calculated using a bottom-up approach, in which the distance travelled by tourist is an estimation based on distance of neighbouring ports. The equation is the following:

Equation 39. GHG emissions from tourist maritime navigation.
Source: Own elaboration.

$$Maritime_{GHG} = Distance\ travelled_{maritime,tourist} \cdot Passengers_{maritime,tourist} \cdot Emission\ factor_{GHG,maritime}$$

Where:

Maritime$_{GHG}$ = total emission of given GHG from tourist maritime navigation (t GHG).

Distance travelled$_{maritime,tourist}$ = 1,481.6 km, assumption of distance travelled by tourists by maritime passenger ships (800 nautical miles).

F.arrivals$_{ship}$ = arrivals of foreign tourist by ship (passengers). Result of adding foreign arrivals of tourists by vessel and arrivals by cruise. Both figures are provided by MONSTAT.

Emission factor$_{GHG,maritime}$ = emission factor of a given GHG for tourist maritime navigation (t GHG/passenger·km).

ANNEX II: ACTIVITY DATA

➢ Economic

Gross Output 2015. Source: MONSTAT

	Nace rev 2	Gross output 2015, current prices, in 000 EUR
A	Agriculture. forestry and fishing	483,662
B	Mining and quarrying	70,260
C	Manufacturing	523,043
D	Electricity. gas. steam and air conditioning supply	231,800
E	Water supply; sewerage. waste management and remediation activities	93,012
H	Transportation and storage	538,789
F	Construction	827,671
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	348,112
I	Accommodation and food service activities	534,992
J	Information and communication	287,477
K	Financial and insurance activities	269,300
L	Real estate activities	311,682
M	Professional. scientific and technical activities	250,773
N	Administrative and support service activities	111,311
O	Public administration and defence; compulsory social security	394,241
P	Education	178,707
Q	Human health and social work activities	199,797
R	Arts. entertainment and recreation	108,636
S+T	Other service activities; Activities of households as employers; undifferentiated goods-and services-producing activities of households for own use	45,480
U	Activities of extraterritorial organisations and bodies	-

2015 Tourism's GDP: Total contribution. Source: World Travel & Tourism Council

Tourism's GDP: Total contribution in 2015. Million €.	794.8

➢ Tourism

Arrivals and overnight stays 2015. Source: MONSTAT

	Arrivals in Inventory year	Overnight stays in Inventory year
Foreign	1,559,924	10,307,371
Domestic	153,185	747,576
Collective accommodation	733,850	3,247,820
Individual accommodation	979,259	7,807,127

➢ Energy

Energy balances 2015. Source: MONSTAT

	Energy balance of Montenegro, 2015. Source: MONSTAT													
	Electricity	LPG	Motor gasoline	Kerosene aviation fuel	Transport diesel and residual fuel oil	Waste oil (Mazut)	Other oil products	Lignite	Fuelwood and long-meter roundwood	Wood residue	Wood chips	Wood briquettes	Wood pellets	Charcoal
	GWh	kt							m3		t			
Final energy consumption	1,411.6							1,668.8						
Industry	1,462.0													
Transport	2,679.3	18.0	35.9	18.1	184.2	4.6	34.2	49.9	718,221.0	48,158.0		327.0	6,435.6	818.0
Railways	767.3	7.7	1.1		36.2	3.0	23.7	28.6	42,058.0			63.0	621.0	2.0
Road transport	32.2	8.0	34.0	18.1	136.5	0.8	5.2							
Air transport	19.7						2.0							
Inland navigation		8.0	34.0		134.5		3.2							
Other transport	5.0			18.1										
Households, commerce, pub. auth. etc.	7.5				2.0	0.8								
Households	1,879.8	2.3	0.8		11.5	0.8	5.3	21.3	676,163.0			264.0		816.0
Agriculture	1,242.9	0.9						14.5	657,080.0	48,158.0		125.0	5,814.6	540.0
Other sectors										47,147.0			2,343.0	

Households' electricity consumption in the 8 most touristic cities (cities with most foreign tourist's overnight stays) in 2015. Source: MONSTAT

City	Local population (inhabitants)	Foreign Overnight stays (No.)	Households' electricity consumption (kWh)
Bar	43,688	1,494,031	108,113,844
Budva	20,523	4,527,724	102,304,184
Herceg Novi	30,729	2,018,242	88,554,253
Kolasin	7,678	45,179	11,107,461
Kotor	22,574	354,335	69,943,658
Podgorica	195,524	132,242	455,490,869
Tivat	14,460	654,968	45,304,072
Ulcinj	20,081	1,003,672	48,199,845

Energy consumption in airport facilities and land activities in 2015. Source: Podgorica and Tivat airports.

Energy consumption in airport facilities and land activities. Source: Podgorica and Tivat airports	Electricity (MWh)	Gasoline (t)	Diesel (t)
Podgorica	3,710.0	0.3	41
Tivat	1,387.8	0.8	27

➢ Transport

Border crossings in 2015. Source: Police authority

Border crossings	**Domestic**		**Foreign**	
	In	**Out**	**In**	**Out**
Road	1,187,218	1,279,317	4,822,899	4,418,189
Rail	33,238	34,583	88,987	77,409
Air	124,891	131,379	676,242	689,183

Air

Arrivals and departures from Podgorica and Tivat airports 2015. Source: Podgorica's and Tivat's Airport Authority.

Origin/Destination	Podgorica (No. of Passengers) Arrivals	Departures	Tivat (No. of Passengers) Arrivals	Departures
Baku			1,312	1,265
Bari	3,151	5,970	3,730	1,308
Belgrade	134,853	137,649	111,622	114,447
Brno	2,626	3,252		
Brussel	12,413	12,746	5,782	5,644
Budapest	145	148		
Copenhagen	3,826	3,802	75	2
Dnepropetrovsk			2,340	2,292
Ekaterinburg	3,063	3,062	2,123	2,110
Frankfurt	12,303	13,183		
Graz			376	376
Istanbul	37,325	37,677		
Kharkov			3,369	3,078
Kiev			21,702	21,405
Ljubljana	15,281	16,693		
London	18,069	18,319	6,857	6,898
Lvov			3,952	4,269
Minsk	3,058	3,035	16,124	16,239
Moscow	8,685	10,665	215,160	214,965
Munich			1,079	1,088
Naples	2,576	2,497	1,198	984
Odessa			2,557	2,627
Oslo			2,046	1,976
Ostrava	739	3,399		
Pardubice	2,676	-		
Paris	16,744	16,734	4,230	4,461
Perm	349	-	978	1,153
Prague	5,849	5,213		
Rome	20,136	20,335		
Samara			1,495	1,553
Stockholm			1,136	1,113
St. Petersburg	980	-	29,811	29,983
Tyumen	292	311		
Vienna	35,532	35,402	170	171
Warsaw	2,958	2,992	106	107
Yerevan			321	378
Zagreb	104	124		
Zurich	14,137	16,100		
Other	10,556	11,165	8,399	7,064

Maritime

Number of people arrived by vessels 2015. Source: MONSTAT.

Number of people arrived by vessels, 2015. Source: MONSTAT	
Total	20,859

Cruises of foreign vessels in Montenegro 2015. Source: MONSTAT

Cruises of foreign vessels in Montenegro, 2015. Source: MONSTAT	
Cruises	411
Passengers	441,513

Tonnage of passenger ships arriving at Port of Kotor in 2015. Source: Port Authority

Tonnage (t, average). Source: Port of Kotor	250	750	3.000	7.500	15.000	25.000	35.000	45.000	75.000	125.000
Passenger ships arriving at Kotor	9	7	91	17	33	5	29	30	155	5

Average stay at berth at Port of Kotor in 2015. Source: Port Authority

Cruises at berth	
Average stay in port (hours). Source: Port of Kotor	12 hr 50 min

➢ Waste

Total quantity of collected Municipal solid waste in 2015. Source: MONSTAT

Total annual quantity of collected MSW (tons)	293,842

Total CH_4 emitted from Solid Waste Disposal in Montenegro in 2013. Source: NIR

Total CH_4 emited from SWD (tons)	8,488

Total CH_4 burned or recovered from landfills in 2015. Source: EPA

CH_4 burned (tons)	321

ANNEX III: EMISSION FACTORS

Fuels emission factors (stationary)

	LPG	Motor gasoline	Kerosene aviation fuel	Transport diesel and residual fuel oil	Waste oil (Mazut)	Other oil products	Lignite	Fuelwood and long-meter roundwood	Wood residue	Wood chips	Wood briquettes	Wood pellets	Charcoal
CO_2 Emission factor (t CO_2/TJ). Source: NIR	63.1	68.6	70.8	68.6	76.6	73.3	99.2	-	-	-	-	-	-
CH_4 Emission factor (t CH_4/TJ). Source: IPCC	0.010	0.010	0.010	0.010	0.300	0.010	0.010	0.300	0.300	0.300	0.300	0.300	0.200
N_2O Emission factor (t N_2O /TJ). Source: IPCC	0.001	0.001	0.001	0.001	0.004	0.001	0.002	0.004	0.004	0.004	0.004	0.004	0.001

Electricity emission factor

	Electricity
CO_2 Emission factor (t CO_2/GWh)	530.4
CH_4 Emission factor (t CH_4/GWh)	0.053
N_2O Emission factor (t N_2O /GWh)	0.008

Road transport (IPCC adjusted)

Emission factors Source: DEFRA	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit
Car (car-km)	0.19	0.00003	0.000
Coach (pass-km)	0.03	0.00000	0.000
Motorcycle (mc-km)	0.12	0.00002	0.000
RV (RV-km)	0.27	0.00004	0.000

Railway transport (IPCC adjusted)

Emission factors Source: DEFRA	kg CO_2/pass-km	kg CH_4/pass-km	kg N_2O/pass-km
Rail	0.01	0.00001	0.00008

Air transport (IPCC adjusted)

Emission factor Source: DEFRA	kg CO_2/pass-km	kg CH_4/pass-km	kg N_2O/pass-km
Domestic (average passenger)	0.324811	0.000046	0.000003
Short-haul (average passenger)	0.191452	0.000011	0.000002
Long-haul (average passenger)	0.225351	0.000011	0.000002

Ship transport (IPCC adjusted)

Emission factors Source: DEFRA	kg CO_2/pass-km	kg CH_4/pass-km	kg N_2O/pass-km
Boat	0.12	0.00002	0.000001