Prizren Municipality GHG Inventory – Methodology Report and Results

February 2023

Executive Summary

Greenhouse gas emissions inventories play a crucial role in policy development as they provide an important evidence base for understanding the sources and magnitudes of greenhouse gas emissions within a particular region. By quantifying and tracking greenhouse gas emissions over time, inventories enable policymakers to identify key emission sources and trends, as well as evaluate the effectiveness of existing policies and programmes aimed at reducing emissions. This report provides a summary of the results and underlying methodology used to estimate emissions from the municipality of Prizren from 2016 to 2019. A previous inventory had been undertaken for Prizren city for the year 2014, but no municipality-level inventory has been reported before for Prizren. Standard methodologies were applied, aligning with international best practice on community-scale greenhouse gas inventories, and data was sourced either locally or from Kosovo statistical agencies, that enabled the estimation of emissions from the energy, industry, agriculture and waste sectors. The methodology used quantifies the emissions on a 'end-user' basis: namely that emissions are attributed to the consumers of energy. This means, for example, that emissions estimates for electricity consumption in residential settings incorporates the emissions that result from the generation of the electricity at power stations.

The largest emission sector across the 2016 to 2019 time series in Prizren was the energy sector, with residential consumption of electricity and road transportation. In Kosovo, as the dominant fuel used to generate electricity is lignite, the emissions associated with electricity generation, and subsequent consumption, are high. High levels of transmission and distribution losses also contribute to the high grid emission factor used in these calculations. This aligns with the results of the Kosovo inventory, where the emissions from energy generation form a significant part of the overall greenhouse gas emissions.

Source	Emissions (kt CO_2e)			
	2016	2017	2018	2019
Agriculture	66.3	67.0	68.2	70.3
Energy	573	542	533	535
Waste	26.1	28.3	30.4	32.7
Total	**665**	**637**	**632**	**638**

In many cases, data sources used have been Kosovo level statistics which have been scaled on the basis of municipality-level proxies such as population, numbers of households, or employment rates. The report includes recommendations on a sectoral basis which would address data gaps for Prizren and ensure future inventory cycles are more accurate and reflective of the local context. An update to the inventory is recommended at least every two to three years. Efforts in the meantime should focus on ensuring completeness of the inventory is possible in future iterations, whilst improving data sources for the priority sectors identified in this report, including electricity consumption in the residential and commercial sectors, and road transportation.

Contents

Glossary

AFOLU	Agriculture, forestry and other land use
ASK	Agency of Statistics Kosovo
CH_4	Methane
CO_2	Carbon dioxide
EEA	European Environment Agency
EU	European Union
GHG	Greenhouse gas
GPC	Greenhouse Gas Protocol for Cities
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
KEDS	Kosovo Electricity Distribution Services
KEPA	Kosovo Environmental Protection Agency
N_2O	Nitrous oxide
NDC	Nationally Determined Contribution
T&D	Transmission and distribution
UNDP	United Nations Development Programme

1 Introduction

1.1 Background

In response to rising global temperatures due to greenhouse gases (GHG) emissions the Intergovernmental Panel on Climate Change (IPCC) released the Special Report on Global Warming of 1.5°C. In this, it is made clear that ensuring global temperatures stay well-below 2°C pre-industrial levels is crucial to reduce large risks to human and natural systems, and efforts should be made to pursue warming of only 1.5°C to prevent the largest risks. Following this, global accords such as the Paris Agreement were signed, requiring signatories to report GHG emission and determined contributions to reducing emissions of GHGs. Whilst Kosovo is not a signatory to the UNFCCC and does not have a determined contribution under the 2015 Paris Agreement, and therefore is not legally required to set emissions reduction targets or regularly report greenhouse gas (GHG) emissions, Kosovo[1] has initiated setting its "Nationally Determined Contribution" (NDC) and related targets on a voluntary basis. In support of this, Kosovo re-established its Climate Change Council, a body responsible for monitoring the implementation of strategic documents and action plans for climate change. The Council consists of a number of Ministers while it is chaired by the Ministry of Environment, Spatial Planning and Infrastructure.

The Kosovo Environmental Protection Agency (KEPA) is responsible for the collection of environmental data and have compiled a GHG inventory for the years 2008 to 2019 and is responsible for reporting this to the European Environment Agency (EEA). However, legislation defining Kosovo GHG inventory system and the systems for monitoring and reporting of policies, measures and projections is missing. That said, Kosovo has begun building a series of climate and energy strategies, policies, and laws. For example, the future Climate Law should transpose Regulation (EU) 525/2013 and 1999/2019 as parts of the EU climate acquis, which will establish the foundation for Kosovo climate action monitoring and reporting. Kosovo has also developed the Strategy and Action Plan on Climate Change for 2019-2028, and has invested in the development of a Kosovo Energy and Climate Plan, whilst the Kosovo Energy Strategy 2022-2031 has recently undergone public review and is expected to receive final approval from the Assembly.

It is not only on a central scale that progress has been made to progressing climate and energy action: the city of Prizren has previously developed a city-level GHG emissions inventory, whilst the UNDP's project 'Support for Sustainable Prizren – Initiating Urban NAMAs' has begun to guide local climate change actions. Prizren has implemented pilot urban NAMAs initiatives in the transport and energy sectors and the aforementioned UNDP project provided capacity building for the Prizren Working Group and the establishment of an MRV system for NAMAs, methodology for measuring and verifying GHG emissions data, and emissions data management systems, methodologies and tools. Conversely, other regions intend to develop climate

[1] References s to Kosovo shall be understood to be in the context of United Nations Security Council resolution 1244 (1999).

and energy measures but are yet to build GHG emissions inventories, such as Suharekë / Suva Reka.

Key to addressing and monitoring climate change is a good quality GHG inventory and a well-designed and functioning MRV system. This allows detailed understanding of the sectoral sources and sinks of GHG emissions, their trends over time and the calculation of projected emission reductions under different scenarios. A broad range of sectoral mitigation actions are possible, and it is very important to be able to track their progress and contributions to GHG emission reduction. The Monitoring Verification Platform (MVP) has been defined in the Law on EE (adopted in 2018) as an official tool for calculation, verification, and reporting on achieved energy savings to be used by municipalities, as well as in current draft of Energy Strategy 2022-2031 (Strategic Objective 2: Decarbonization and promotion of renewal energy) as key tool in setting a carbon pricing.

Under this scheme of work, the SLCA project advanced the understanding of existing GHG emissions and relevant policies in the municipalities of Prizren and Suharekë, more specifically by:

- Reviewing, upgrading and extending the Prizren municipality GHG inventory
- Developing a GHG inventory for the Suharekë municipality (reported separately to this document)
- Designing and developing an MRV system for the GHG emission inventory and monitoring mitigation actions for the two municipalities.
- Providing capacity building and training for municipal sectoral officials, relevant private businesses and university students, to build their knowledge and skills to enable them to prepare future GHG inventories and use the MRV system independently.

This report is the summary and methodology report for Prizren's GHG inventory for 2016 to 2019.

A GHG inventory is a dataset which presents estimates of emissions of various greenhouse gases from a wide range of activities in an organisation, country or other geographical area. The main greenhouse gases are: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The global warming potentials of CH_4 and N_2O are used to calculate the equivalent warming to CO_2, to allow the estimation of total GHG effects on the atmosphere in one unit, CO_2-equivalent, or CO_2e.

The standard approach to estimate GHG emissions is by multiplying activity data by an emission factor associated with the activity being measured (**Equation 1**).

Equation 1: Emission factor approach for calculating GHG emissions.

GHG emissions = activity data * emission factor

Emission Factor - This is the emissions per unit of activity, which usually comes from scientific literature. It is typically derived from measurement.

Activity data - This is a measure or estimate of the activity which is taking place, such as number of cows or tonnes of fuel. This data typically comes from Kosovo statistical datasets or from the organisation in question.

For example, estimating CO_2 emissions from the use of electricity involves multiplying data on kilowatt-hours (kWh) of electricity used by the emission factor ($kgCO_2/kWh$) for electricity, which will depend on the technology and type of fuel used to generate the electricity. Emission factors are usually obtained from scientific literature and are typically derived from measurement.

1.2 Emission inventory scope

1.2.1 Operational scope

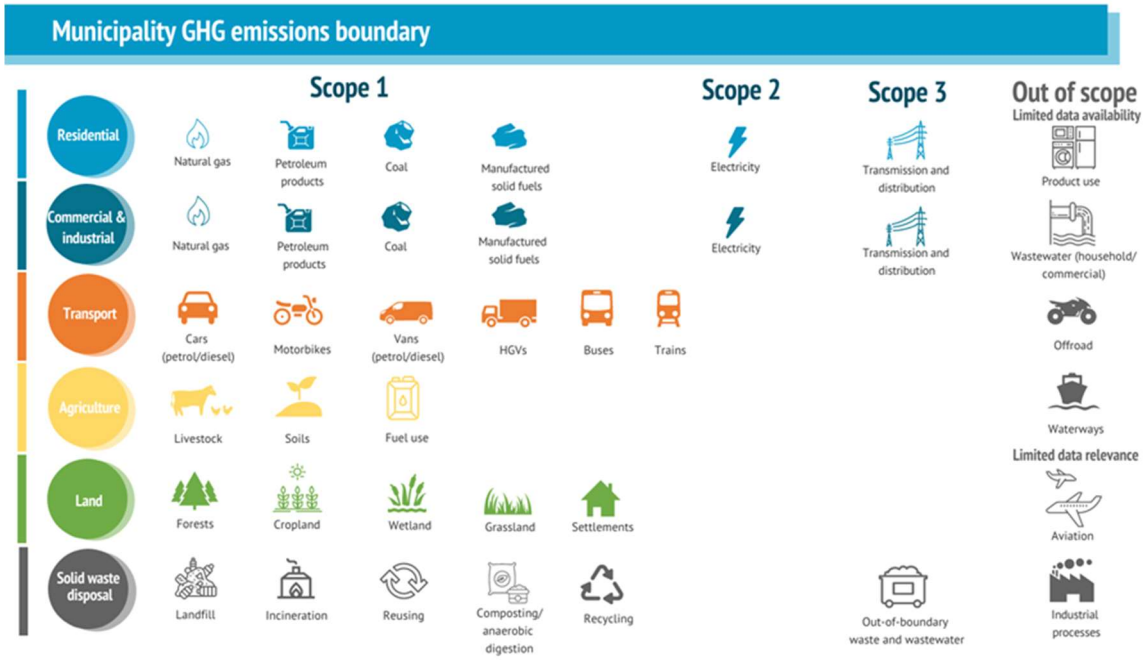
The most widely used set of standards for local or regional carbon accounting are those produced under the Greenhouse Gas Protocol. Of particular relevance to this project is the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories[2], otherwise known as the GHG Protocol (GPC). This standard describes the emission sources and "scopes" which should be considered as part of a municipality-wide carbon accounting process; the definition of the three scopes are as follows:

- **Scope 1**: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the municipality.
- **Scope 2**: All other GHG emissions that occur outside the borough boundary as a result of activities taking place within the municipality.
- **Scope 3**: GHG emissions from sources located within the municipality boundary.

The emission sources included within each scope are shown in **Figure 1**.

Figure 1 Sources and boundaries of city GHG emissions

[2] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities



The GHG Protocol also sets out a series of principles, which are consistent with other standards under the GHG Protocol series, and which are intended to guide GHG accounting towards a fair and accurate account of GHG emissions. These are:

- **Relevance**: The reported GHG emissions shall appropriately reflect emissions occurring as a result of activities and consumption patterns of the municipality. The inventory will also serve the decision-making needs of the municipality, taking into consideration relevant municipality and Kosovo regulations. The principle of relevance applies when selecting data sources and determining and prioritising data collection improvements.
- **Completeness:** cities shall account for all required emissions sources within the inventory boundary. Any exclusion of emission sources shall be justified and clearly explained.
- **Consistency:** emissions calculations shall be consistent in approach, boundary, and methodology. Using consistent methodologies for calculating GHG emissions enables meaningful documentation of emission changes over time, trend analysis, and comparisons between cities.
- **Transparency:** activity data, emission sources, emission factors, and accounting methodologies require adequate documentation and disclosure to enable verification. The information should be sufficient to allow individuals outside of the inventory process to use the same source data and derive the same results. All exclusions shall be clearly identified, disclosed and justified.
- **Accuracy:** The calculation of GHG emissions shall not systematically overstate or understate actual GHG emissions. Accuracy should be sufficient enough to give decision makers and the public reasonable assurance of the integrity of the reported information. Uncertainties in the quantification process shall be reduced to the extent that it is possible and practical.

Complying with these principles will provide a very high standard of GHG accounting. It also sets a very high bar in terms of the level of resource required simply to collect and verify data, resource which could be diverted towards planning and

implementation of carbon reduction actions. The GHG Protocol acknowledges this, stating that a municipality will need to make important decisions in terms of setting the inventory boundary, choosing calculation methods, deciding whether to include additional Scope 3 sources, etc. Trade-offs between the five principles above may be required based on the objectives or needs of the municipality. Nor do the principles fully take into account the complexities of accounting for a region, in this case a municipality. Some further guidance towards the application of the GHG Protocol scopes within this project, are shown in **Table 1** below.

Table 1 Further principles for data inclusion and exclusion for the municipality inventory

Reasons for including data within the GHG boundary	Reasons for excluding data from the GHG boundary
The emission source occurs within the administrative boundary of Prizren	The emission source has no available dataset and estimation methods will not benefit the decision-making
The quantity of activity data for the emission source is controlled by an organisation/individual within the administrative boundary of Prizren	The emission source clearly belongs to a different geographical region, and they are better placed to account for it
An organisation/individual within the geographical region has a significant level of control over the emission source even though it occurs outside the administrative boundary of Prizren	The emission source makes up a very small proportion of overall emissions AND it is very time consuming or difficult to collect activity data

This will in effect create three types of sources and their associated data:

- Sources which are clearly "in scope", are important, and for which a reasonable level of data are available. This will include total electricity consumption and fossil fuel use within Prizren;
- Sources which are clearly out of scope, either because they are sources which are not of significance in Prizren, such as electricity generation or industrial process emissions, or are minor and are best considered as sources outside the municipality;
- Sources which are important but for which data are either unavailable or so uncertain that it becomes virtually impossible to show progress, and thus are not useful for making decisions or the development of actions. Such sources need to be acknowledged and discussed. However, they may not be included in the GHG inventory. This could include activities such as the goods purchased by residents and businesses within the municipality, or the transport generated by activities outside the municipality (e.g. flights taken by Prizren residents).

Based on the principles outlined above the following datasets have been excluded from the project boundary for modelling purposes:

Excluded due to lack of data, lack of activity, and insignificance

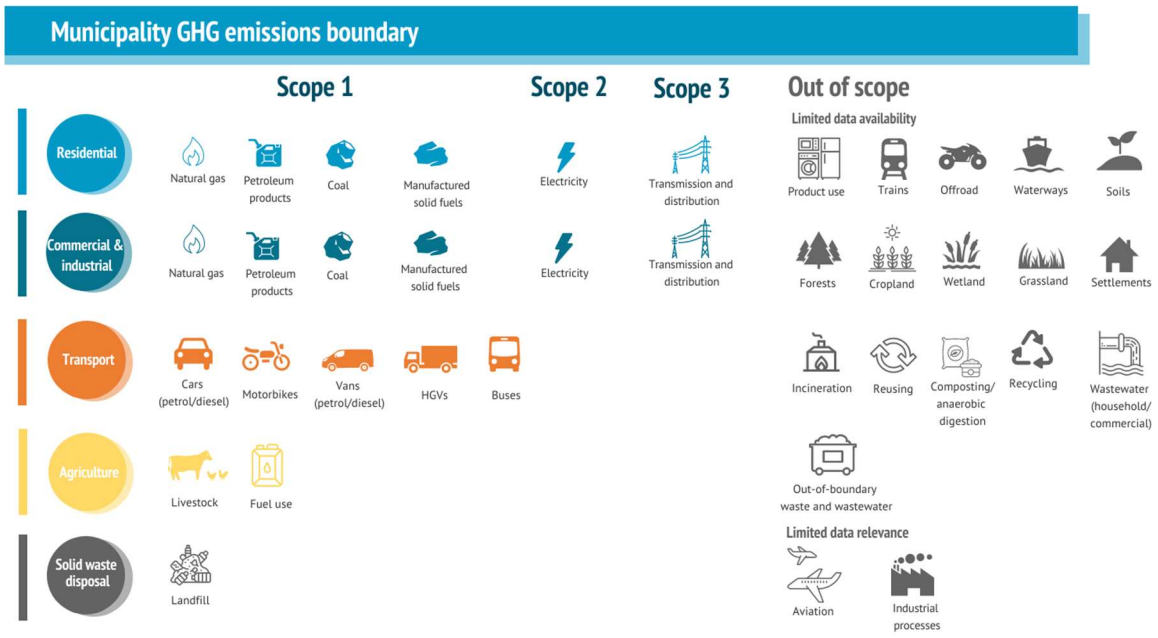
- **Aviation:** emissions from aviation are typically assigned to the location of the departure/arrival airport. With no commercial airports in Prizren this is not a significant source of emissions. Travel to airports from Prizren could be considered under Prizren's climate action plan but reliable data do not exist to enable it to be fully modelled (the part of journeys to airports that occur within Prizren are already included under the road transportation calculations).
- **Industrial and Chemical Product Use**: Emissions of concern in this sector are fluoro-carbons used in electronics production, refrigerants in cooling systems and lubricants/paraffin waxes for non-energy products, none of which are likely to be a significant source in Prizren and data are scarce and uncertain.
- **Off-road vehicles** Non-road mobile machinery and transport data is unavailable but is not expected to be significant, given that in many other regional and local inventories of this type, the off-road vehicles sector forms a very small contribution to total GHG emissions. There is no reason to suspect Prizren is any different in this regard.
- **Non-landfill waste sources:** it is believed the only major route to dispose of waste is to landfills, primarily Landovicë/a landfill site. Illegal dumps are not estimated due to a lack of data on the local or central scale. Some minor incineration emissions are expected at the hospitals but after engagement with stakeholders it is understood that total incineration is not undertaken. Instead, clinical waste is partially burned to sanitise and disposed of at solid waste sites. Wastewater treatment is also unavailable in Prizren across the considered time series. The opening of a new wastewater treatment facility in Prizren will advance water quality, but this only began operation in 2021 and so falls beyond the scope of the inventory presented here.

Excluded due to lack of data

- **Land use, land use change and forestry:** There is no municipality-level information available which enables the estimation of emissions from land use, land use change, and forestry. Recommendations are presented in this report to highlight data source requirements to enable the quantification of this on a municipality-level in future iterations of the GHG inventory, however. It is expected that given the urban expansion of areas in Prizren over the past decade, the emissions from this sector would be a net source rather than a sink to offset emissions from elsewhere in the municipality.

A summary of the emissions included in the emissions boundary in presented in **Figure 2**.

Figure 2 Scope of emission sources included in Prizren's GHG inventory



1.2.2 Emissions scope

Prizren's GHG emission inventory was compiled for 2016-2019 for the following pollutants:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

Emissions were reported as a mass of CO_2 equivalent, CO_2e. Whilst less abundant than CO_2, other GHGs such as CH_4 and N_2O have a greater warming effect than CO_2. A Global Warming Potential (GWP) factor were applied to these GHGs to convert to CO_2e.

The GPC provides a reporting framework for the reporting of emissions sources. Emission sources were categorised as follows:

- Stationary energy (GPC code I)
- Transportation (GPC code II)
- Waste (GPC code III)
- Agriculture, forestry and other land use (AFOLU; GPC code V)

Each sector is then split into individual categories (for example II.1 on-road transportation) and sub-categories (for example II.1.1 Emissions from fuel combustion on-road transportation occurring within the city boundary).

Where emissions data are not provided for any GPC code, a notation key is used to explain why. These have been standardised across air quality and greenhouse gas emissions reporting and are provided below. This approach has been used in this project and has been used in subsequent chapters to indicate the reasons for any gaps in the data.

NO: Not Occurring. The activity does not occur within Kosovo / Regional inventory being reported.

NE: Not estimated. The reason for this, should be provided in the accompanying report to provide transparency.

IE: Included elsewhere. This is used where emissions are included elsewhere in the inventory. For example, it is sometimes not possible for emissions arising from mobile machinery to be separated from stationary machinery within the industrial sector.

2 Methodology

2.1 Compilation process

The GHG inventories for Prizren were compiled by international inventory experts from Aether, with extensive experience in compiling central, regional and local GHG inventories. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) was followed throughout, abiding by the methodologies and QA/QC practices where data was available.

2.1.1 Data Handling

The data and information required for compiling GHG emissions inventories includes data provided directly by the municipality authorities, local level agencies (such as the Prizren Vehicle Registry Centre), and regional stakeholders at major emission sites (such as Landovicë/a landfill site). Other parameters and assumptions were made using expert judgement after discussion with local experts.

Throughout the inventory compilation process, sector experts applied good practice guidance outlined in the GPC guidelines to review and incorporate data gathered in a consistent and accurate manner. All datasets and information used have been transparently documented in the Excel-based compilation tools and in the methodology statements included in Section 2.1.2 below. As far as possible, local datasets have been used and prioritised in the inventory. However, there have been some instances where local datasets are not available. Where data was unavailable for a particular source, proxy activity data was sourced from the Kosovo inventory and scaled using parameters including numbers of households or distribution of energy consumption by type and business type. This is an approach that aligns with GPC recommendations should municipality-level datasets be unavailable.

For the land use sector, no applicable data was identified on a local level and so emission estimates have not been possible. Recommendations on the data requirements and potential sources is included in this report to provide material for future compilers and data collectors to use to enable a robust calculation of emissions from the sector. It is expected that the main source of emissions from the land use sector is the conversion of land to settlement area, due to the expansion of urban areas in Prizren and Suharekë/Suva Reka over the past decade.

Throughout the data collection process, the sector experts have been conscious of the prioritisation of categories. These are sectors which are likely to have a more significant contribution to total emissions and therefore deemed a higher priority.

Given the Kosovo emissions inventory is dominated by emissions from the energy sector, particularly from energy generation and from road transportation, particular effort has been made to identify sources of data on electricity and energy consumption and road transport.

2.1.2 Compilation spreadsheets

The GHG inventories were compiled in Excel spreadsheets on a sector-specific basis. In general, there is a spreadsheet for each sector and within this file each tab contains the calculations for one or more than one category, depending on the complexity of the calculation and method used.

Figure 3 below shows the tabs present within the compilation spreadsheets. At the beginning of the file there are metadata sheets:

- **QA sheet** - containing metadata for the identification of the file, data sources and processing, checks and colour coding
- **Notes** - containing instruction to inventory compilers for the update of the calculations in the file
- **Check Library** - where QA/QC checks and status are recorded

The sectoral files also contain a 'parameters' tab used in different parts of the calculations. This includes constants, conversion factors and emission factors. This approach ensures consistency within the sector compilation as calculations for each sub-category are linked to this tab.

To bring all the data together there is a summary tab which is linked to all category tabs in the spreadsheet. The summary tab for each sector contains the output from all categories in that sector spreadsheet in both tabular and graph format.

There are then separate summary files which contain data covering all sectors.

Throughout the compilation spreadsheets, standardised colour-coding is used to improve the transparency of the data and corresponding calculations. For example, all cells that contain formulae are colour-coded yellow. Within each spreadsheet, the data are presented in a logical and consistent format that includes clear headings, general notes and distinct sections for activity data tables, emission factors and emission calculations. **Figure 4** provides a summary of the structure of the compilation sheets.

Figure 3 Summary of the tabs within the compilation spreadsheets

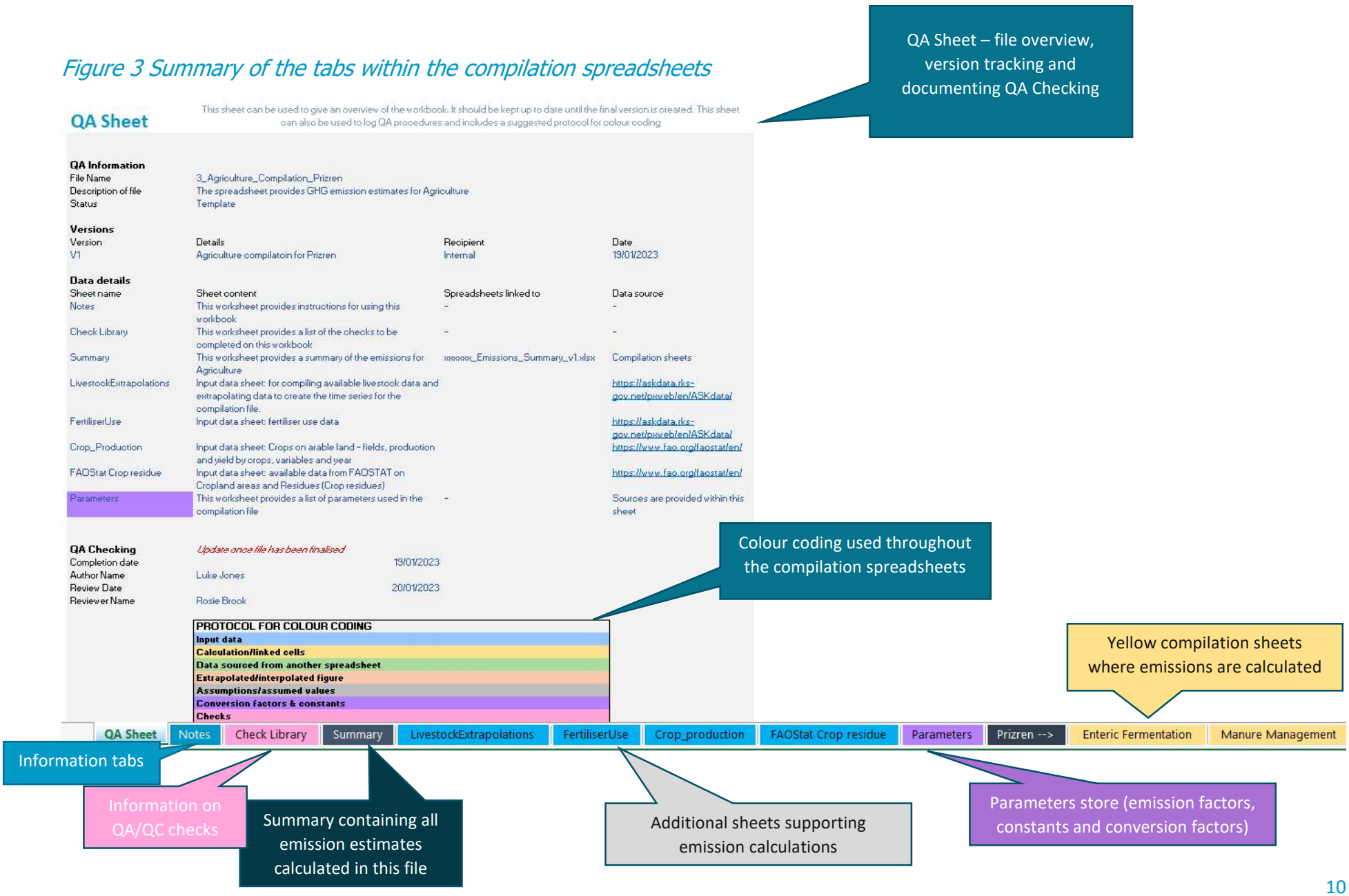
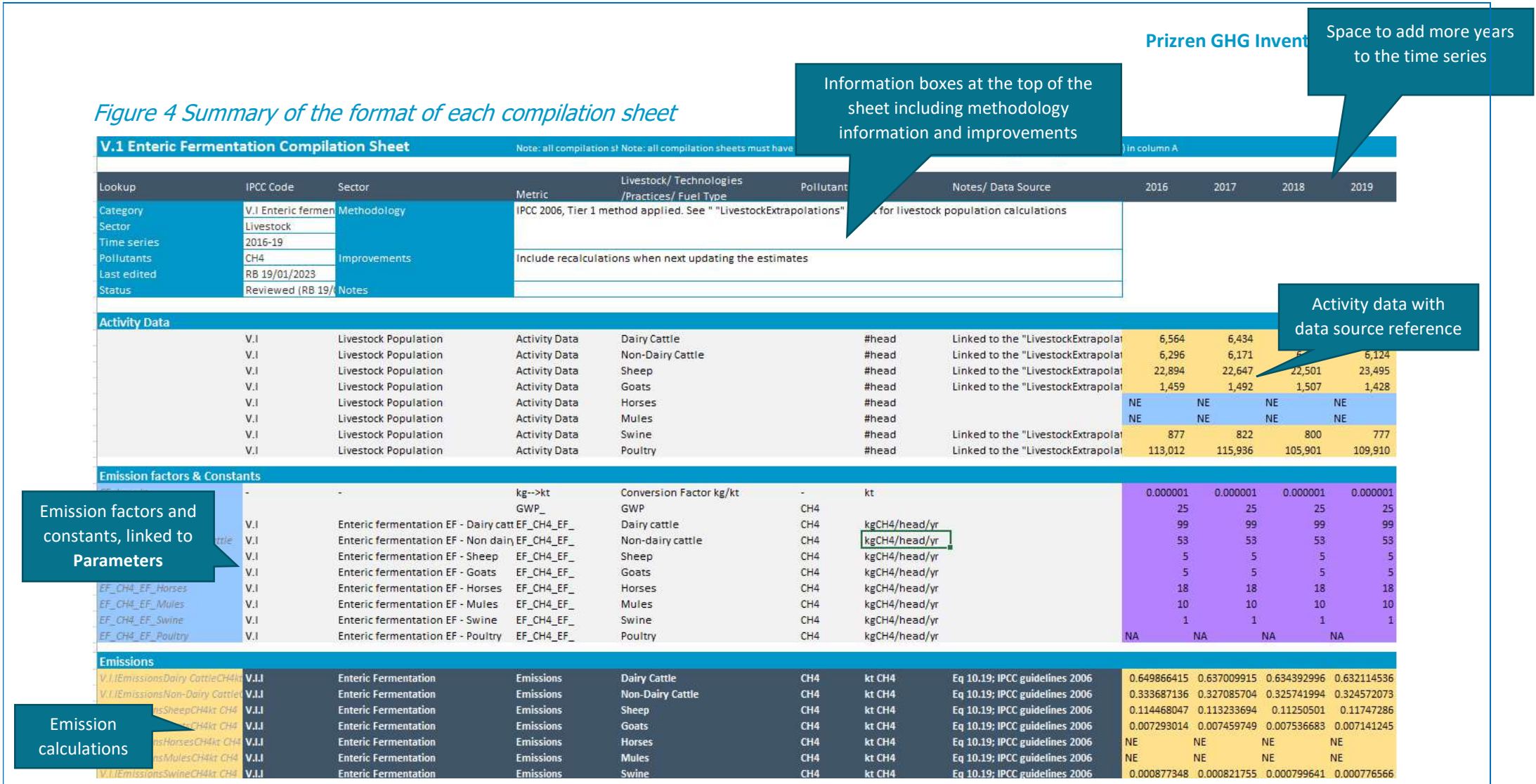


Figure 4 Summary of the format of each compilation sheet



V.1 Enteric Fermentation Compilation Sheet

Note: all compilation sh Note: all compilation sheets must have) in column A

Lookup	IPCC Code	Sector	Metric	Livestock/ Technologies /Practices/ Fuel Type	Pollutant		Notes/ Data Source	2016	2017	2018	2019
Category	V.I Enteric fermen	Methodology	IPCC 2006, Tier 1 method applied. See " "LivestockExtrapolations"				for livestock population calculations				
Sector	Livestock										
Time series	2016-19										
Pollutants	CH4	Improvements	Include recalculations when next updating the estimates								
Last edited	RB 19/01/2023										
Status	Reviewed (RB 19/	Notes									
Activity Data											
	V.I	Livestock Population	Activity Data	Dairy Cattle		#head	Linked to the "LivestockExtrapolat	6,564	6,434		
	V.I	Livestock Population	Activity Data	Non-Dairy Cattle		#head	Linked to the "LivestockExtrapolat	6,296	6,171		6,124
	V.I	Livestock Population	Activity Data	Sheep		#head	Linked to the "LivestockExtrapolat	22,894	22,647	22,501	23,495
	V.I	Livestock Population	Activity Data	Goats		#head	Linked to the "LivestockExtrapolat	1,459	1,492	1,507	1,428
	V.I	Livestock Population	Activity Data	Horses		#head		NE	NE	NE	NE
	V.I	Livestock Population	Activity Data	Mules		#head		NE	NE	NE	NE
	V.I	Livestock Population	Activity Data	Swine		#head	Linked to the "LivestockExtrapolat	877	822	800	777
	V.I	Livestock Population	Activity Data	Poultry		#head	Linked to the "LivestockExtrapolat	113,012	115,936	105,901	109,910
Emission factors & Constants											
	-	-	kg-->kt	Conversion Factor kg/kt	-	kt		0.000001	0.000001	0.000001	0.000001
			GWP_	GWP	CH4			25	25	25	25
	V.I	Enteric fermentation EF - Dairy catt	EF_CH4_EF_	Dairy cattle	CH4	kgCH4/head/yr		99	99	99	99
	V.I	Enteric fermentation EF - Non dair	EF_CH4_EF_	Non-dairy cattle	CH4	kgCH4/head/yr		53	53	53	53
	V.I	Enteric fermentation EF - Sheep	EF_CH4_EF_	Sheep	CH4	kgCH4/head/yr		5	5	5	5
	V.I	Enteric fermentation EF - Goats	EF_CH4_EF_	Goats	CH4	kgCH4/head/yr		5	5	5	5
EF_CH4_EF_Horses	V.I	Enteric fermentation EF - Horses	EF_CH4_EF_	Horses	CH4	kgCH4/head/yr		18	18	18	18
EF_CH4_EF_Mules	V.I	Enteric fermentation EF - Mules	EF_CH4_EF_	Mules	CH4	kgCH4/head/yr		10	10	10	10
EF_CH4_EF_Swine	V.I	Enteric fermentation EF - Swine	EF_CH4_EF_	Swine	CH4	kgCH4/head/yr		1	1	1	1
EF_CH4_EF_Poultry	V.I	Enteric fermentation EF - Poultry	EF_CH4_EF_	Poultry	CH4	kgCH4/head/yr		NA	NA	NA	NA
Emissions											
V.I.IEmissionsDairy CattleCH4kt	V.I.I	Enteric Fermentation	Emissions	Dairy Cattle	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	0.649866415	0.637009915	0.634392996	0.632114536
V.I.IEmissionsNon-Dairy CattleC	V.I.I	Enteric Fermentation	Emissions	Non-Dairy Cattle	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	0.333687136	0.327085704	0.325741994	0.324572073
nsSheepCH4kt CH4	V.I.I	Enteric Fermentation	Emissions	Sheep	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	0.114468047	0.113233694	0.11250501	0.11747286
CH4kt CH4	V.I.I	Enteric Fermentation	Emissions	Goats	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	0.007293014	0.007459749	0.007536683	0.007141245
nsHorsesCH4kt CH4	V.I.I	Enteric Fermentation	Emissions	Horses	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	NE	NE	NE	NE
nsMulesCH4kt CH4	V.I.I	Enteric Fermentation	Emissions	Mules	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	NE	NE	NE	NE
V.I.IEmissionsSwineCH4kt CH4	V.I.I	Enteric Fermentation	Emissions	Swine	CH4	kt CH4	Eq 10.19; IPCC guidelines 2006	0.000877348	0.000821755	0.000799641	0.000776566

2.2 Methodology Summary and Completeness Assessment

The inventory has been compiled in line with GPC, using local and central data as far as possible. The estimates have been calculated using the highest Tier of methodology possible considering the data available, in line with the 2006 IPCC Guidelines[3]. The IPCC Guidelines form the basis of the methodologies of the GPC for all sources. Tier 1 indicates that the simplest methodology has been used; Tier 2 indicates that sufficient information is available to apply a more complex methodology; Tier 3 indicates that highly complex models are available to calculate estimates.

Whilst improving the accuracy of the inventory by moving from Tier 1 to Tier 2 or Tier 2 to Tier 3 is a useful improvement activity, it is more important to ensure that the current inventory is complete. **Table 2** provides a list of the categories that have not been estimated ('Not Estimated', NE) in the current inventory, but that the inventory compilation team believe are present in Prizren. **It is recommended in future inventories that emissions are estimated for these sectors where possible.**

Those categories that are thought not to occur ('Not Occurring', NO) in Prizren are provided below. **It is recommended that these 'Not Occurring' categories are reviewed to confirm that the activities continue to not take place in Prizren.** For example, the wastewater treatment plant in Prizren began processing wastewater in 2021 and would therefore have emissions associated with the activity that would need to be included from that year onwards. These would also be priority sources to include in future inventories.

Those categories which have been included under another category ('Included Elsewhere', IE). **It is recommended that these 'Included Elsewhere' categories are reviewed to confirm that emissions are reported in the correct category at the most appropriate level of aggregation.**

Table 2 Summary of the completeness of the Prizren GHG inventory and availability of local and municipality-level data to inform calculations

NFR code and description	Local data available?	Estimates made?
I STATIONARY ENERGY		
I.1 Residential		
I.1.1 Emissions from fuel combustion within the municipality boundary	No	Y
I.1.2 Emissions from grid-supplied energy consumed within the municipality boundary	Regional only	Y
I.1.3 Emissions from transmission and distribution losses from grid-supplied energy consumption	No	Y
I.2a Commercial		

[3] https://www.ipcc-nggip.iges.or.jp/public/2006gl/

NFR code and description	Local data available?	Estimates made?
I.2a.1 Emissions from fuel combustion within the municipality boundary	No	Y
I.2a.2 Emissions from grid-supplied energy consumed within the municipality boundary	Regional only	Y
I.2a.3 Emissions from transmission and distribution losses from grid-supplied energy consumption	No	Y
I.2b Institutional		
I.2b.1 Emissions from fuel combustion within the municipality boundary	No	Y
I.2b.2 Emissions from grid-supplied energy consumed within the municipality boundary	Yes	Y
I.2b.3 Emissions from transmission and distribution losses from grid-supplied energy consumption	No	Y
I.3 Manufacturing industries and construction		
I.3.1 Emissions from fuel combustion within the municipality boundary	No	Y
I.3.2 Emissions from grid-supplied energy consumed within the municipality boundary	Regional only	Y
I.3.3 Emissions from transmission and distribution losses from grid-supplied energy consumption	No	Y
I.4 Energy industries		
I.4.1 Emissions from energy used in power plant auxiliary operations		NO
I.4.2 Emissions from grid-supplied energy consumed in power plant auxiliary operations within the municipality boundary		NO
I.4.3 Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations		NO
I.4.4 Emissions from energy generation supplied to the grid		NO
I.5 Agriculture, forestry, and fishing activites		
I.5.1 Emissions from fuel combustion within the municipality boundary	No	Y
I.5.2 Emissions from grid-supplied energy consumed within the municipality boundary	Regional only	Y
I.5.3 Emissions from transmission and distribution losses from grid-supplied energy consumption	No	Y
I.6 Non-specified sources		

NFR code and description	Local data available?	Estimates made?
I.6.1 Emissions from fuel combustion within the municipality boundary		NE
I.6.2 Emissions from grid-supplied energy consumed within the municipality boundary		NE
I.6.3 Emissions from transmission and distribution losses from grid-supplied energy consumption		NE
I.7 Fugitive emissions from mining, processing, storage, and transportation of coal		
I.7.1 Fugitive emissions within the municipality boundary		NO
I.8 Fugitive emissions oil and natural gas systems		
I.8.1 Emissions from fugitive emissions within the municipality boundary		NO
II TRANSPORT		
II.1 On-road transportation		
II.1.1 Emissions from fuel combustion on-road transportation occurring within the municipality boundary	Fleet composition statistics only	Y
II.1.2 Emissions from grid-supplied energy consumed within the municipality boundary for on-road transportation	No	IE – included in electricity consumption statistics provided by KEDS for residential
II.1.3 Emissions from portion of transboundary journeys occurring outside the municipality boundary, and transmissions and distribution losses	No	IE – transmission and distribution (T&D) losses in KEDS statistics. Transboundary transport unable to be determined

NFR code and description	Local data available?	Estimates made?
		so included in II.1.1
II.2 Railways		
II.2.1 Emissions from fuel combustion for railway transportation occurring within the municipality boundary	No	NE
II.2.2 Emissions from grid-supplied energy consumed within the municipality boundary for railways		NO
II.2.3 Emissions from portion of transboundary journeys occurring outside the municipality boundary, and transmission and distribution losses from grid-supplied energy consumption	No	NE
II.3 Waterborne navigation		
II.3.1 Emissions from fuel combustion for waterborne navigation occurring within the municipality boundary		NO
II.3.2 Emissions from grid-supplied energy consumed within the municipality boundary for waterborne navigation		NO
II.3.3 Emissions from portion of transboundary journeys occurring outside the municipality boundary, and transmission and distribution losses from grid-supplied energy consumption		NO
II.4 Aviation		
II.4.1 Emissions from fuel combustion for aviation occurring within the municipality boundary		NO
II.4.2 Emissions from grid-supplied energy consumed within the municipality boundary for aviation		NO
II.4.3 Emissions from portion of transboundary journeys occurring outside the municipality boundary, and transmission and distribution losses from grid-supplied energy consumption		NO
II.5 Off-road transportation		
II.5.1 Emissions from fuel combustion for off-road transportation occurring within the municipality boundary	No	IE
II.5.2 Emissions from grid-supplied energy consumed within the municipality boundary for off-road transportation	No	IE
III WASTE		
III.1 Solid waste disposal		
III.1.1 Emissions from solid waste generated within the municipality boundary and disposed in landfills or open dumps within the municipality boundary	Yes	Y
III.1.2 Emissions from solid waste generated within the municipality boundary but disposed in landfills or open dumps outside the municipality boundary		NO

NFR code and description	Local data available?	Estimates made?
III.1.3 Emissions from waste generated outside the municipality boundary and disposed in landfills or open dumps within the municipality boundary	Yes	Y
III.2 Biological treatment of waste		
Emissions from solid waste generated within the municipality boundary that is treated biologically within the municipality boundary		NO
Emissions from solid waste generated within the municipality boundary but treated biologically outside of the municipality boundary		NO
Emissions from waste generated outside the municipality boundary but treated biologically within the municipality boundary		NO
III.3 Incineration and open burning		
Emissions from solid waste generated and treated within the municipality boundary	Data from hospital available but incineration not common practice anymore. Waste is sterilised and disposed in landfill	NO
Emissions from solid waste generated within the municipality boundary but treated outside of the municipality boundary		NO
Emissions from waste generated outside the municipality boundary but treated within the municipality boundary		NO
III.4 Wastewater treatment and discharge		
Emissions from wastewater generated and treated within the municipality boundary		NO
Emissions from wastewater generated within the municipality boundary but treated outside of the municipality boundary		NO
Emissions from wastewater generated outside the municipality boundary but treated within the municipality boundary		NO
IV Industrial processes and product use		

NFR code and description	Local data available?	Estimates made?
Emissions from industrial processes occurring within the municipality boundary		NO
Emissions from product use occurring within the municipality boundary	No	NE
V Agriculture, Forestry and Other Land Use (AFOLU)		
Emissions from livestock within the municipality boundary	Yes (from 2014 census)	Y
Emissions from land within the municipality boundary	Only 2014 – 20-year time series required	NO
Emissions from aggregate sources and non-CO_2 emission sources on land within the municipality boundary		Y
VI Other Scope 3		
Other Scope 3		NE

3 Summary of results

3.1 Emission estimates

Prizren's GHG emissions were estimated to have been 665 $ktCO_2e$ in 2016, decreasing to 638 $ktCO_2e$ in 2019. Emissions by sector and subsector are presented in **Figure 5** and **Table 2**. The most significant emissions source is the energy sector, comprising 80.4% of total emissions in 2019. The agriculture sector represented 10.6% of emissions and waste represented 4.9% of emissions in 2019.

Figure 5 Timeseries of emissions for Prizren by sector, 2016 – 2019

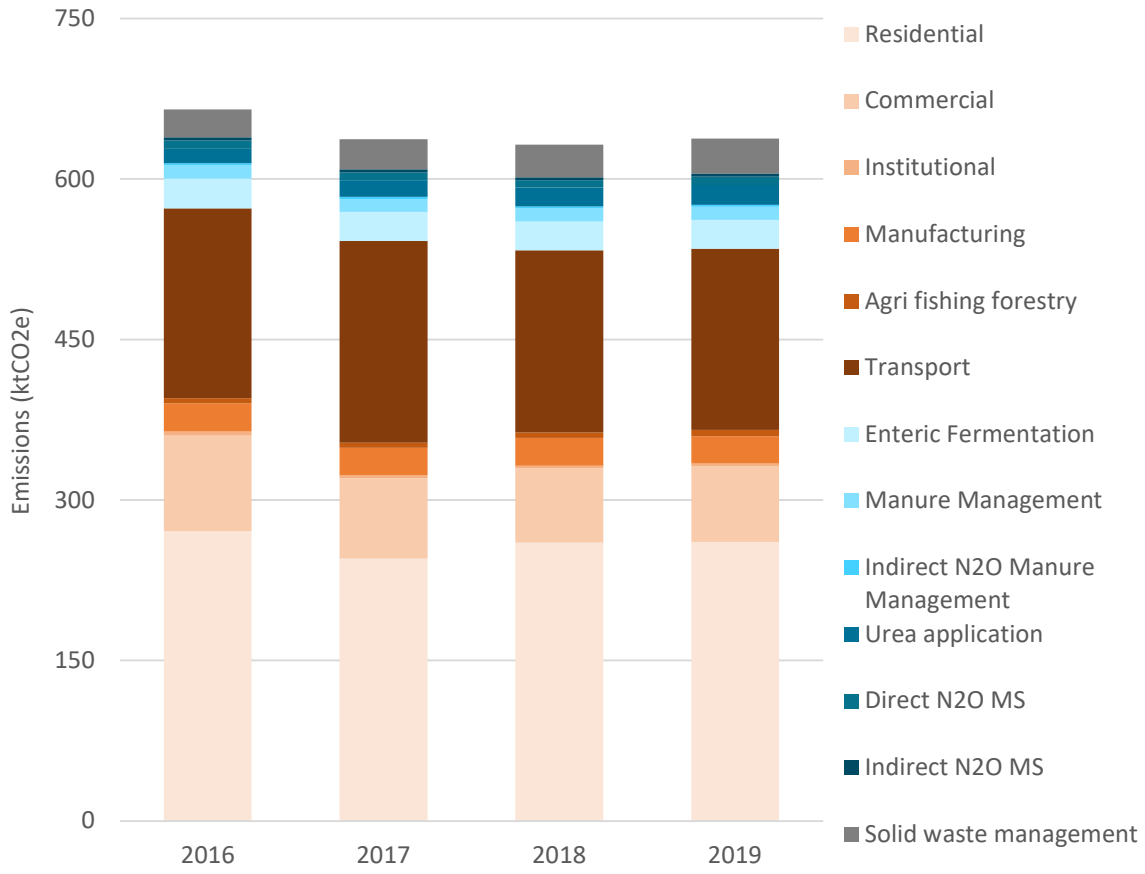


Table 2 Timeseries of emissions for Prizren by sector and subsector, 2016 – 2019

Source	Emissions (kt CO_2e)			
	2016	2017	2018	2019
Agriculture	**66.3**	**67.0**	**68.2**	**70.3**
Direct N_2O MS	7.72	7.29	6.94	7.69
Enteric Fermentation	27.7	27.1	27.0	27.1
Indirect N_2O Manure Management	1.93	1.93	1.93	1.93
Indirect N_2O MS	2.98	2.83	2.71	2.96
Manure Management	12.3	12.1	12.0	12.0
Urea application	13.7	15.7	17.6	18.7
Energy	**573**	**542**	**533**	**535**
Agri fishing forestry	4.67	4.79	5.06	6.07
Commercial	89.2	75.1	69.7	70.5
Institutional	0.0	0.0	0.0	0.0
Manufacturing	3.89	3.02	2.13	2.68
Residential	26.3	25.2	26.1	25.4
Transport	271	245	260	261

Source	Emissions (kt CO_2e)			
	2016	2017	2018	2019
Waste	26.1	28.3	30.4	32.7
Solid waste disposal	26.1	28.3	30.4	32.7
Total	665	637	632	638

Emissions from the sources included in the inventory changed throughout the timeseries. There was an estimated decrease in emissions of 6.6% and 6.1% for energy and agriculture sectors, respectively, whilst emissions from waste increased by 26.8% as a result of increases in municipal solid waste generation over the time series which is all assumed to be disposed of at Landovica landfill site.

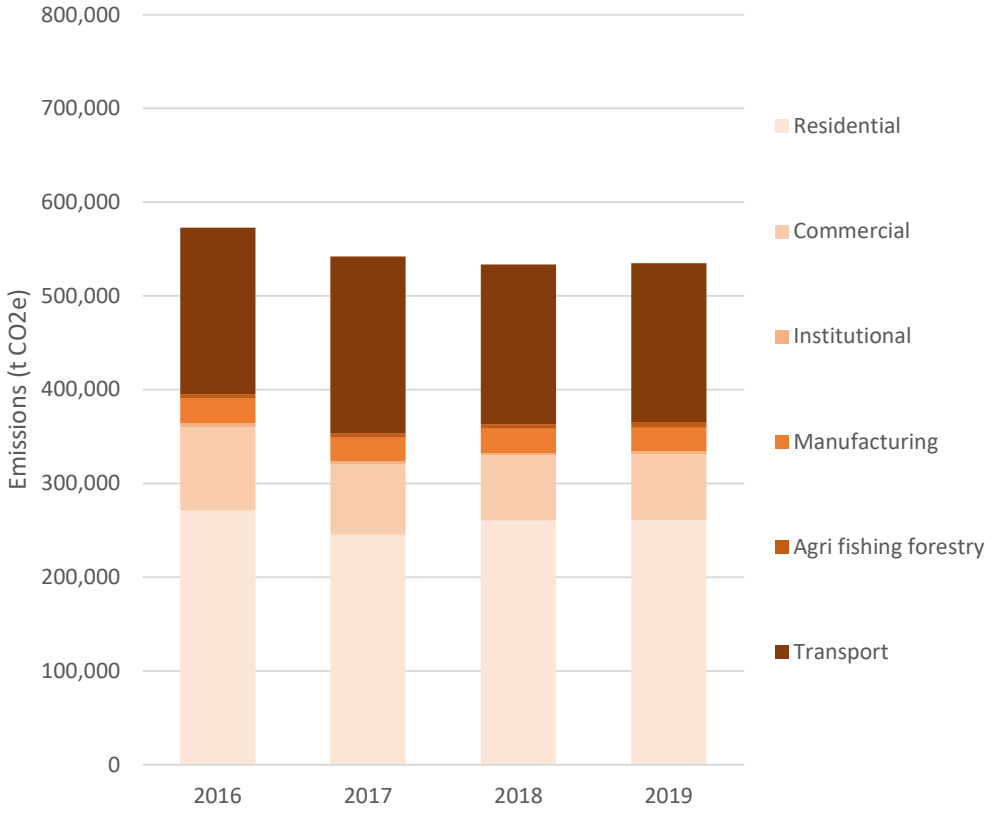
4 Energy

4.1 Overview of emissions

This sector includes emissions from combustion of fuel for energy from I. Stationary energy and II. Transportation sources. Stationary combustion comprises burning of fuels to provide energy in industrial sites, and residential, commercial, and institutional buildings. This sector also includes transportation sources, primarily road transport. These activities result in emissions of all the pollutants considered within the scope of this inventory and include some of the most significant sources of some of the GHG pollutants covered in the inventory.

The change in energy emissions from 2016 to 2019 is shown in **Figure 6**.

Figure 6 Prizren estimated emissions from the energy sector 2016 - 2019



Emissions by pollutant are presented in **Table 3** and by scope in **Table 4**.

Table 3 Prizren emission estimates for the energy sector by pollutant, 2016 – 2019

Sector and pollutant	Emissions (t CO_2e)			
	2016	2017	2018	2019
Agri fishing forestry	4,667	4,792	5,056	6,071
CH_4	82.8	82.6	84.1	86.4
CO_2	4,559	4,684	4,946	5,952

Sector and pollutant	Emissions (t CO_2e)			
	2016	2017	2018	2019
N_2O	26.2	25.5	26.4	32.7
Commercial	89,179	75,063	69,716	70,465
CH_4	408.8	377.8	345.3	342.7
CO_2	88,362	74,340	69,048	69,611
N_2O	408.7	345.9	323.1	511.2
Institutional	3,895	3,024	2,131	2,678
CH_4	37.4	37.1	39.9	54.1
CO_2	3,839	2,972	2,080	2,608
N_2O	18.7	14.9	11.3	15.5
Manufacturing	26,309	25,220	26,064	25,431
CH_4	519.3	516.9	523.8	516.3
CO_2	25,615	24,536	25,368	24,694
N_2O	174.3	167.5	172.1	220.9
Residential	271,007	245,310	260,260	260,880
CH_4	10,933	10,791	10,784	10,589
CO_2	257,265	231,837	246,705	246,757
N_2O	2,809	2,682	2,771	3,533
Transport	177,622	188,600	170,134	169,312
CH_4	279.4	297.1	297.1	296.0
CO_2	176,152	187,036	168,681	167,863
N_2O	1,191	1,266	1,156	1,153
Total	**572,679**	**542,009**	**533,361**	**534,836**

Table 4 Prizren emission estimates for the energy sector by scope and sector, 2016 – 2019

Sector and scope	Emissions (t CO_2e)			
	2016	2017	2018	2019
Agri fishing forestry	4,667	4,792	5,056	6,071
Scope 1	3,275	3,537	3,741	4,803
Scope 2	993.3	946.5	1,009	1,006
Scope 3	399.6	307.8	306.8	261.3
Commercial	89,179	75,063	69,716	70,465
Scope 1	37,320	26,846	15,018	13,883
Scope 2	36,982	36,384	41,942	44,916

Sector and scope	Emissions (t CO_2e)			
	2016	2017	2018	2019
Scope 3	14,878	11,833	12,756	11,666
Institutional	3,895	3,024	2,131	2,678
Scope 1	3,513	2,721	1,803	2,391
Scope 2	272.1	229.3	252.1	227.5
Scope 3	109.5	74.6	76.7	59.1
Manufacturing	26,309	25,220	26,064	25,431
Scope 1	8,387	9,081	9,139	9,127
Scope 2	12,780	12,179	12,978	12,943
Scope 3	5,141	3,961	3,947	3,362
Residential	271,007	245,310	260,260	260,880
Scope 1	19,819	18,918	16,826	16,268
Scope 2	179,127	170,832	186,662	194,179
Scope 3	72,061	55,560	56,771	50,433
Transport	177,622	188,600	170,134	169,312
Scope 1	177,622	188,600	170,134	169,312
Scope 2	IE	IE	IE	IE
Scope 3	IE	IE	IE	IE
Total	**572,679**	**542,009**	**533,361**	**534,836**

4.2 Stationary energy - methodology overview

4.2.1 Emissions from electricity consumption

In Kosovo, as the fuel used to generate the electricity is itself primarily lignite, the emissions of GHGs from its production and consumption are significant. In fact, after transmission and distribution losses are accounted for, using lignite directly as a primary fuel rather than consuming electricity actually produces less GHG emissions on a per energy unit basis. Expanding the electricity network and reducing the reliance on fossil fuels for energy generation, however, should be seen as an opportunity to manage contributions to climate change in Prizren. If decarbonisation strategies are developed to introduce more renewable and low-carbon energy sources that produce electricity, then emissions from the stationary energy sector in Prizren would drastically decline.

To estimate greenhouse gas emissions on a per unit electricity basis, emissions data was sourced from the latest Kosovo inventory (KEPA, 2022) and from the datasets published on the Agency of Statistics Kosovo (ASK) data portal. This enables the calculation of a year-specific emission factor as per Table 5 below.

Table 5 Electricity grid emission factor derivation for Kosovo as used in the Prizren energy modelling

		Unit	2016	2017	2018	2019
1A1a Electricity Generation emissions (KEPA, 2022)						
Emissions of CO_2	CO_2	kt CO2e	6,732.5	5,650.1	6,023.4	6,296.0
Emissions of CH_4	CH_4	kt CO2e	0.07	0.06	0.06	0.13
Emissions of N_2O	N_2O	kt CO2e	0.10	0.08	0.09	0.16
Electricity consumption (ASK database)						
Production		GWh	6,483	5,906	5,912	6,369
Consumption		ktoe	333	343	354	405
		GWh	3,875	3,985	4,114	4,715
Implied emission factor						
Grid emission factor (excluding T&D losses)		kg CO_2e / kWh	1.04	0.96	1.02	0.99
Transmission and distribution losses		%	40%	33%	30%	26%

A value of ~1kg CO_2e/kWh for emissions for electricity consumption is high. By comparison, grid factors for 2021 in other European states typically ranges from 0.2-0.8kg CO_2e/kWh[4], as shown in Error! Reference source not found. indicative of the relative reliance on high-carbon fuels for energy production. Transmission and distribution loss rates, which are calculated as the proportion of energy that is lost between production and consumption are also significant although trends across the 2016 – 2019 time series show marked improvements. As such, major reductions in emissions from Scope 3 of the stationary energy sector is a dominant trend in emissions from the sector. Reported T&D losses are typically in the range of ~10%[4].

4.2.2 I.1: Residential

The majority of emissions from the residential sector are from the consumption of electricity through the grid. Whilst there are some emissions from primary fuel consumption, a significant proportion the non-electricity energy demand is met through the use of firewood as a fuel, the CO_2 emissions from which are considered biogenic and excluded from emissions totals. As such, the trends in the residential sector are dictated primarily by the grid emission factor, transmission and distribution losses and actual amounts of energy consumption. Between 2016 and 2019 there was

[4] https://www.carbonfootprint.com/docs/2022_03_emissions_factors_sources_for_2021_electricity_v11.pdf

no significant change in the primary fuel used to generate electricity in Kosovo and so the main contributors to trends are the reduction in T&D losses, as shown in Table 5.

Electricity consumption data was provided on request to the compilation team by KEDS (Kosovo Electricity Distribution Services) split by consumer type and year. Received data was applicable to Prizren region (i.e., Dragash/Dragaš, Malishevë/Mališevo, Mamushë/Mamuša, Prizren, and Suharekë/Suva Reka) and so needed to be further cleaned before use in the calculation tool. To estimate the relative proportions of consumption in each of the municipalities in Prizren region, data on the number of households as published by ASK after the 2011 census was used. By assuming that the relative consumption of electricity per household is similar in each municipality, it is possible to estimate the residential consumption for each municipality separately. **It is recommended that KEDS collect and provide more detailed data for future updates as data from the 2011 census is unlikely to be representative of the distribution of energy consumption in later years. If this data is unavailable, updating to the results of the next census (from 2021) will represent an improvement to this methodology also.**

Figure 7 Estimated annual electricity consumption by municipality using data provided by KEDS

Municipality	2011 Census – number of households	Estimated electricity consumption (MWh)			
		2016	2017	2018	2019
Kosovo	296,535				
Prizren	29,588	171,694,269	171,694	177,742	182,360
Suharekë/Suva Reka	9,138	53,026,302	53,026	54,894	56,320
Malishevë/Mališevo	6,878	39,911,896	39,912	41,318	42,391
Dragash/Dragaš	6,208	36,023,997	36,024	37,293	38,262
Mamushë/Mamuša	566	3,284,404	3,284	3,400	3,488

No data is available on the consumption of primary fuels in residential settings. Indeed, this is not an issue unique to Prizren: many local and central inventories struggle to identify robust data sources that closely monitor the consumption of primary fuels, particularly when they are used in systems that are not connected by a grid, such as natural gas. Kosovo wide level data is available to the GHG inventory of Kosovo and was provided for this study, providing information on the emissions and activity data associated with emissions from the residential sector. Kosovo wide level data was then scaled to the municipality level on the same basis as electricity: the relative proportion of households in each region as found in the ASK 2011 Census.

Table 6 Estimated annual primary fuel consumption by fuel type in Prizren after scaling Kosovo level inventory data

Municipality	Unit	Energy consumption from primary fuels in residential settings in Prizren			
		2016	2017	2018	2019

Lignite	ktoe	0.87	0.74	0.25	0.25
Petrol	ktoe	0.14	0.09	0.09	0.09
Diesel	ktoe	0.31	0.34	0.36	0.37
LPG	ktoe	0.84	0.77	0.74	0.64
Wood	ktoe	33.72	33.42	33.87	33.04

Table 6 clearly illustrates that the most commonly used primary fuel is firewood. As discussed above, the CO_2 emissions from the combustion of firewood are not included in an emissions inventory: they are removed from totals to prevent the double counting of emissions from elsewhere, as the carbon emissions from wood production would be accounted for the land use change sector. CH_4 and N_2O emissions that result from its combustion, however, are included but form a very small proportion of the warming effect of using firewood.

Emission factors for primary fuel combustion used are Tier 1 default emission factors from the 2006 IPCC Guidelines.

4.2.3 I.2: Commercial and Institutional

The institutional sector (I.2b) includes emissions from energy usage of public buildings and street lighting. It is often reported separately to commercial emissions (I.2a) despite being reported under the same GPC code (I.2) as data availability tends to be greater.

Data was available made available to the inventory compilation team by the municipality of Prizren on the electricity consumed across its buildings and street lights. The estimates of emissions for Scope 2 and Scope 3 emissions from the institutional sector are therefore considered to have high levels of certainty in comparison to other elements of the inventory. This data was used directly in the inventory calculations, along with the grid emission factor and transmission and distribution loss estimates discussed in **Section 4.2.1**. Data was also received from KEDS on the electricity consumption by commercial and institutional sites for Prizren region. Employment statistics on a municipality level were then used to scale regional electricity consumption to municipality-level consumption statistics in a similar manner to proxies for the residential sector. In particular, employment from the following census categories were included in this proxy analysis:

- Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods
- Hotels and restaurants
- Transport, storage and communication
- Financial intermediation
- Real estate, renting and business activities
- Public administration and defence; compulsory social security – *considered to be institutional employment only*
- Education – *considered to be institutional employment only*
- Health and social work – *considered to be institutional employment only*

- Other community, social and personal service activities
- Activities of households
- Extra-territorial organizations and bodies

It is assumed that the electricity consumption reported by the municipalities is included in the data provided by KEDS and is removed from the totals in KEDS to prevent double counting of the associated emissions.

The use of primary fuels is not directly reported for either commercial or institutional buildings. Kosovo wide level data on the primary fuel consumption for the services sector (assumed to include both the commercial and institutional sectors) is available from the ASK data portal. As with the residential sector, a scaling proxy was used to estimate the relative contribution of Prizren's commercial and institutional sectors to the domestic consumption of energy. For this, data from the 2011 census was again identified with levels of employment in commercial sectors and public administrations used to estimate the primary energy consumption across both sectors for each year. The modelling approach then assumes the energy consumption per employee remains similar. By considering the electricity consumption reported by the municipality and for the data provided by KEDS, energy consumption by fuel is then scaled to satisfy total energy demands for the commercial and institutional sectors. **Simplification of the approach can be achieved by clarifying the primary fuel demands for the institutional sector in each year of the inventory and future compilers are recommended to take this step.**

The use of lignite in the services sector as reported by ASK is much larger than for the residential sector, and as such, the relative contribution of emissions from primary fuel combustion (Scope 1) to the category wide emission totals is larger.

Emission factors for primary fuel combustion used are Tier 1 default emission factors from the 2006 IPCC Guidelines.

4.2.4 I.3: Manufacturing industries and construction

It is understood that no major industrial activities occur in the municipality of Prizren and as such the emissions calculations required for this category are limited. However, emissions from the use of small-scale machinery, generators, and construction needs to be included under I.3. Therefore, emissions from the sector are expected, albeit they are not anticipated to be significant.

Industrial and construction electricity consumption was provided for Prizren region by KEDS. To scale region-wide electricity consumption to Prizren municipality only, as with commercial services, employment statistics from the 2011 Census were used. In particular, the number of employees in each municipality according to the following census categories:

- Mining and quarrying
- Manufacturing
- Electricity, gas, and water supply
- Construction

Electricity consumption from the agriculture sector (I.5) was assumed to be included in the consumption estimates for industry provided by KEDS and removed from the total electricity consumption for this category.

Energy consumption from the combustion of primary fuels was also estimated. No local data was found to be available and so fuel use reported in by ASK for the industrial sector was used and scaled using the same employment proxy derived above. Fuels reported in the Kosovo dataset that are more typically used in major industries, such as hard coal, coke, semi-coke, and petroleum coke, however are excluded from Prizren's inventory under the assumption that they are unlikely to be used, given they are often used as fuels within the iron and steel sector. Emissions from the sector are dominated by diesel combustion and from electricity consumption, reflective of the smaller nature of industry in Prizren, where small diesel generators and diesel-powered mobile machinery at construction sites and supporting electricity infrastructure are likely to be common.

Emission factors for primary fuel combustion used are Tier 1 default emission factors from the 2006 IPCC Guidelines.

4.2.5 I.4: Energy industries

As no power plant or energy production facilities operate in Prizren, emissions from the sector are considered 'Not Occurring'.

4.2.6 I.5: Agriculture, forestry, and fishing energy consumption

As with the manufacturing sector (I.3), it is expected that a small contributor to emissions from the energy sector in Prizren will be from the combustion of fuels in agricultural and forestry processes.

Electricity consumption from the agriculture sector was assumed to be included in the consumption estimates for industry (I.3) provided by KEDS, the relative proportion of which was determined through the relative size of the agriculture, hunting, and forestry sector as reported in the 2011 census.

Primary fuel consumption from the agriculture sector is reported in the ASK data portal on a Kosovo wide level basis, and using the same employment proxy (i.e., 2011 Census data) can be scaled to estimate the municipality-level fuel consumption. Note the ASK database includes data for the agricultural sector only. **An improvement item for future inventory compilation can be to clarify the scope of ASK's collected data to understand whether this data includes fuel consumption from the fishing and forestry sectors**

4.2.7 I.6: Non-specific sources

No sources that could not be categorised in any of the previous energy consumption categories was identified in the data collection and stakeholder engagement stages of this work and, as such, emissions are reported as 'Not Estimated'.

4.2.8 I.7: Fugitive emissions from mining, processing, storage, and transportation of coal

Fugitive emissions associated with mining processes are not applicable to Prizren as there is no existing coal mine in the municipality that needs to be accounted for. Therefore, emissions are reported as 'Not Occurring'.

4.2.9 I.8: Fugitive emissions oil and natural gas systems

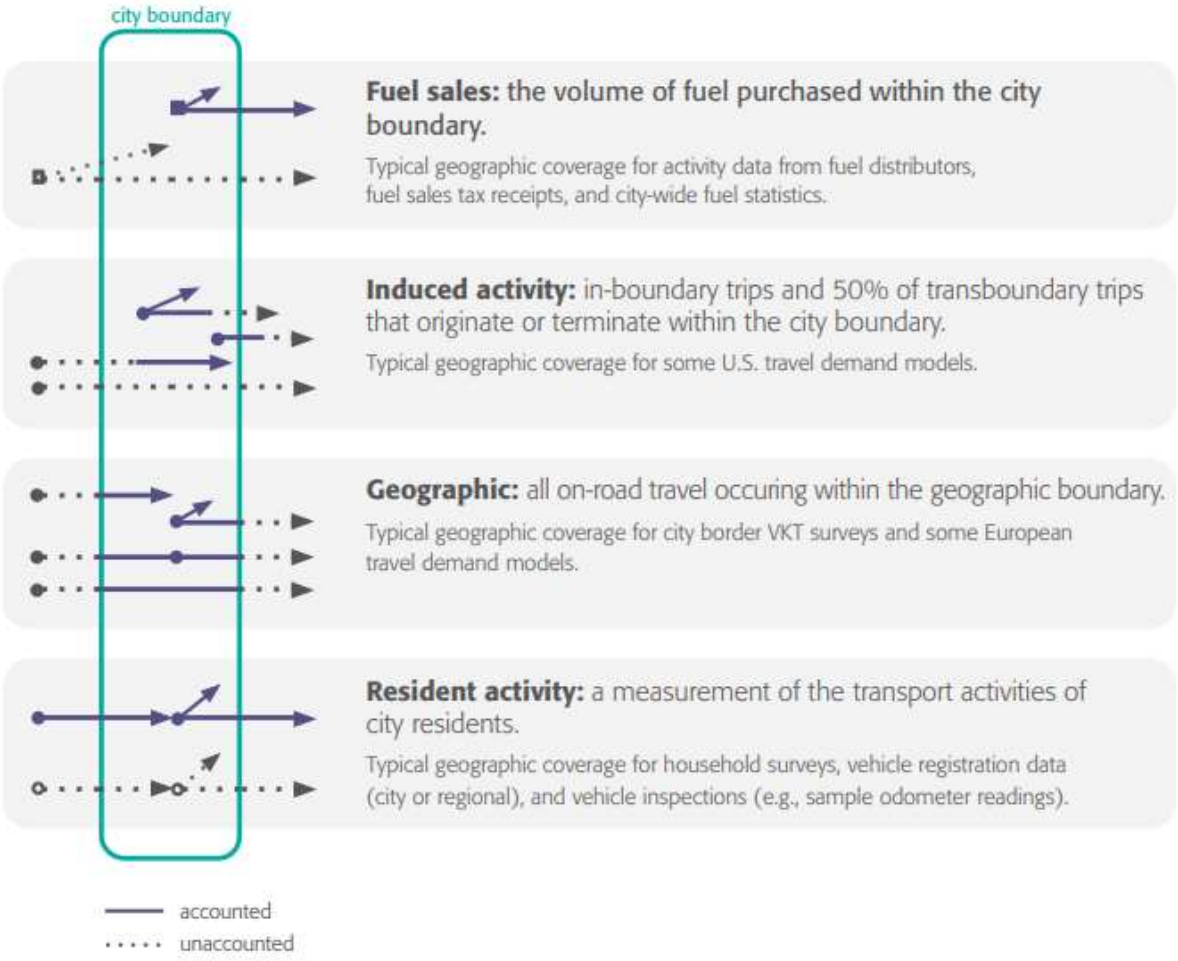
There are no existing major oil and natural gas systems in Kosovo which form a major blocker to the decarbonisation of the energy sector.. Emissions are reported as 'Not Occurring'.

4.3 Transportation - methodology overview

In Prizren, the dominant transport mode is on-road transportation. It is understood that minor rail services are provided but after consultation with stakeholders in the municipality, it is expected that the emissions from the rail network would be very small. There was no data identified for fuel consumption from the rail network and so only on-road transportation emissions are included in category II. There is no aviation or inland waterway transport to account for.

Depending on the availability of data, the GPC offers several methods to quantify and allocate transportation emissions. The methods most commonly used for transportation modelling and planning vary in terms of their "system boundaries," or how the resulting data can be attributable to a municipality's geographic boundary. The GPC does not require a specific calculation method for road transport, but as with stationary energy, emissions allocated to Scope 1 or 3 should only reflect emissions from combustion of fuel only. Scope 2 emissions are derived from the consumption of electricity in on-road vehicles used for transportation. Four main methodological themes can be used to derive transport emissions estimates, as shown below.

Figure 8 Illustration of emissions methods from GPC Guidelines for road transportation



After discussion with stakeholders, it was found that the most likely source of information for the road transportation sector would be statistics on vehicle registrations at each municipality Vehicle Registry Centre. Another approach could be to survey fuel suppliers on the volume of fuel purchased but the large number of independent fuel suppliers in the region would mean an intensive data collection campaign which would be difficult to assess for completeness.

Only limited data is available on the fleet composition, however. In Prizren, this is limited to statistics on the number of vehicle registrations by manufacturer and year of production. This is insufficient to undertake a complete assessment of road transport emissions. Instead, assumptions were made on the representativeness of other data to Prizren. Vehicle registry data recorded in Suharekë/Suva Reka, for example, provided numbers of vehicles per year that were registered by fuel type and EURO standard.

A full fleet composition requires at least:

- **Vehicle type** (i.e. car, HGV, bus etc)
- **Size** (small, medium, large car; <7t rigid HGV, >34t artic HGV etc)
- **Fuel type**

- **EURO standard of engine**

It is recommended that the vehicle registry centre in Prizren is asked to record at least this information upon vehicle registration in future, to enable a more accurate calculation of road transportation emissions

It has therefore been found that no municipality level data exists that can fully satisfy the calculation requirements of road transport emissions methodologies on its own. Additional data sources were utilised to fill gaps. A recent European Commission study[5] published in 2022 provides EU-wide mobility patterns in urban and non-urban contexts, undertaking a survey that aligns with the Eurostat Passenger Mobility Guidelines. It measured the number of trips and activity in passenger-kilometres by mode of transport, whilst also providing country-wide statistics on fleet composition and vehicle stock, and average vehicle mileage per year. Using the data reported in this study for Albania, it is assumed that the overall vehicle mileage is applicable to Prizren. Data from Suharekë/Suva Reka was used to approximate the fleet composition of Prizren, with vehicle type and size information incorporated by assuming that the distribution of vehicle types and sizes in Albania on a fuel type and EURO standard specific basis are representative. The number of vehicles was the extrapolated to Prizren on the basis of numbers of households in Prizren and Suharekë/Suva Reka as available in the ASK data portal from the 2011 census. This enables the development of a dataset of fleet composition and vehicle mileage per year, in line with the data requirements for a **resident activity** method. These datasets are only available to be used in combination in 2017 and 2018. For 2016 and 2019, extrapolations are based on emissions trends in the Kosovo GHG inventory for the transport sector.

Whilst the output dataset is at the resolution required to apply Tier 2 emission factors, the uncertainty in the underlying data sources and the representativeness of Albania's fleet mean that it was considered to be of too high uncertainty to fully adopt a Tier 2 method as this would imply a level of accuracy of the calculations that is inappropriate. Instead, Tier 1 emission factors for CO_2 and N_2O were based on Tier 1 methods outlined in the EMEP/EEA Guidelines[6] (2019) whilst CH_4 emissions factors were based on Tier 1 defaults from the IPCC Guidelines (2006).

It is also not possible without further information to disaggregate between Scope 1 and Scope 3 emissions. **It is recommended that surveys are used in future by municipalities to determine the amount of transboundary activity, looking particularly at the kilometres driven in and outside the municipality by vehicles registered in Prizren.**

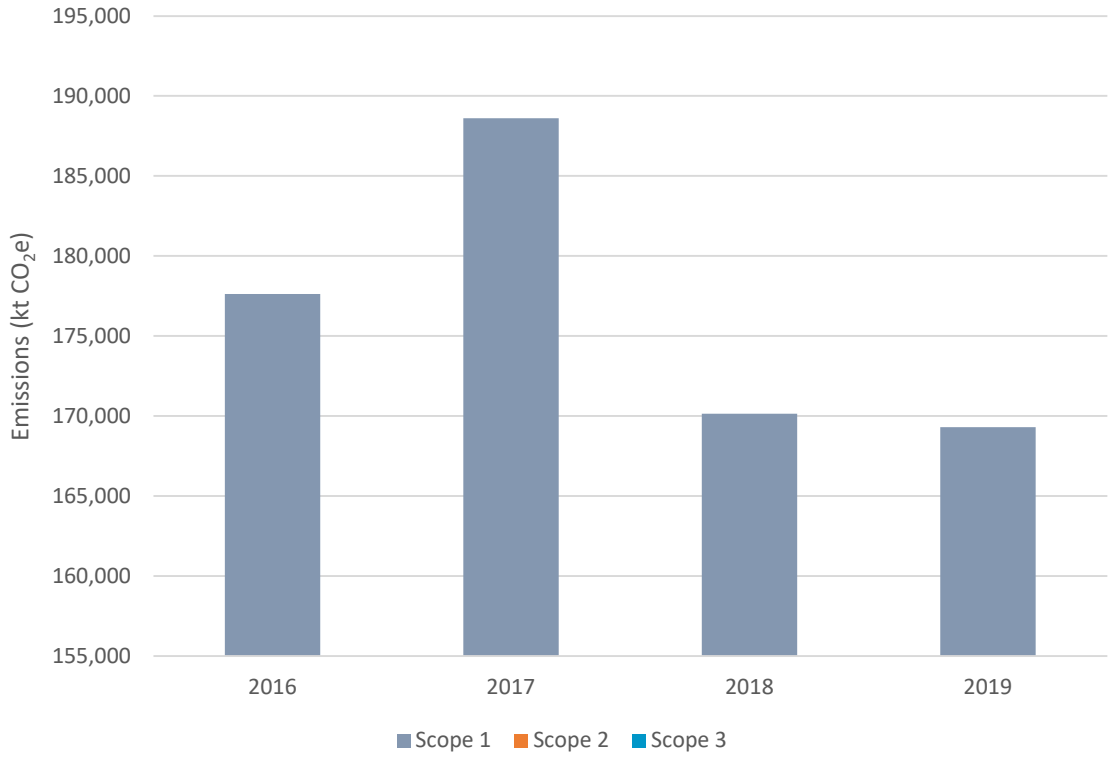
Scope 2 emissions calculations are not possible either: there is no disaggregation the electricity consumed in data provided by KEDS for amounts used to charge electric or hybrid vehicles. It is instead assumed to be included elsewhere in the inventory already. **Greater resolution of electricity data or surveys on the explicit**

[5] https://transport.ec.europa.eu/news/new-mobility-patterns-study-insights-passenger-mobility-and-urban-logistics-2022-12-20_en#:~:text=The%20EU%2Dwide%20survey%20on,almost%20half%20of%20all%20trips

[6] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

mileage of electric vehicles within the city would enable Scope 2 emissions to be calculated separately, and it is recommended that this takes place to improve the accuracy of the allocation of emissions.

Figure 9 - Emissions trends from the road transportation sector from 2016-19 in t CO_2e



Emissions drop significantly between 2017 and 2018 is due to artefacts of the assumptions made. European Commission data for Albania shows significant reductions in the number of Euro V buses and HGVs between 2017 and 2018 as Euro VI buses are introduced into the fleet. This is reflected in the outputs here, where between 2017 and 2018, activity of buses is modelled to decrease in line with that change, but registration data doesn't show a likewise shift towards Euro VI heavy duty vehicles. This demonstrates the importance of developing a robust dataset for Prizren municipality rather than using alternative proxies.

4.4 Recommendations

A summary of the main recommendations on future activity data collection is included in the table below. These recommendations should be prioritised in terms of the importance of the sector for which they are relevant (i.e., actions to improve the accuracy of the residential and road transport sectors is of highest priority for Prizren).

Table 7 Priority recommendation items for Prizren for the energy sector

ID	Improvement Issue	Sector	Effort required to carry out task
1	Disaggregating electricity data further to enable allocation more accurately to Prizren municipality only, and also by business type and industry type.	Residential, Commercial, Manufacturing	Medium
2	Undertaking periodic surveys of residents and businesses of primary fuel combustion to enable a municipality-specific estimate of fuel used and type per year and to capture trends	Residential	High
3	Logging industry types that exist in Prizren more closely to enable the reduction of the assumptions reliant on employment statistics from the most recent census and periodically survey to understand consumption of primary fuels (e.g., diesel, lignite)	Commercial	High
4	Develop a more robust road transport database of fleet composition to include, at a minimum, vehicle type, size, fuel type, and EURO standard	Road transport	Medium
5	Add odometer readings to database to enable fleet-wide mileage estimates to be derived on a vehicle type basis	Road transport	Medium
6	Distribute a survey to road users or find automated ways of tracking transport activity, particular transboundary activity and in-boundary activity	Road transport	Medium

5 Agriculture, Forestry, and Land Use (AFOLU)

5.1 Overview of emissions

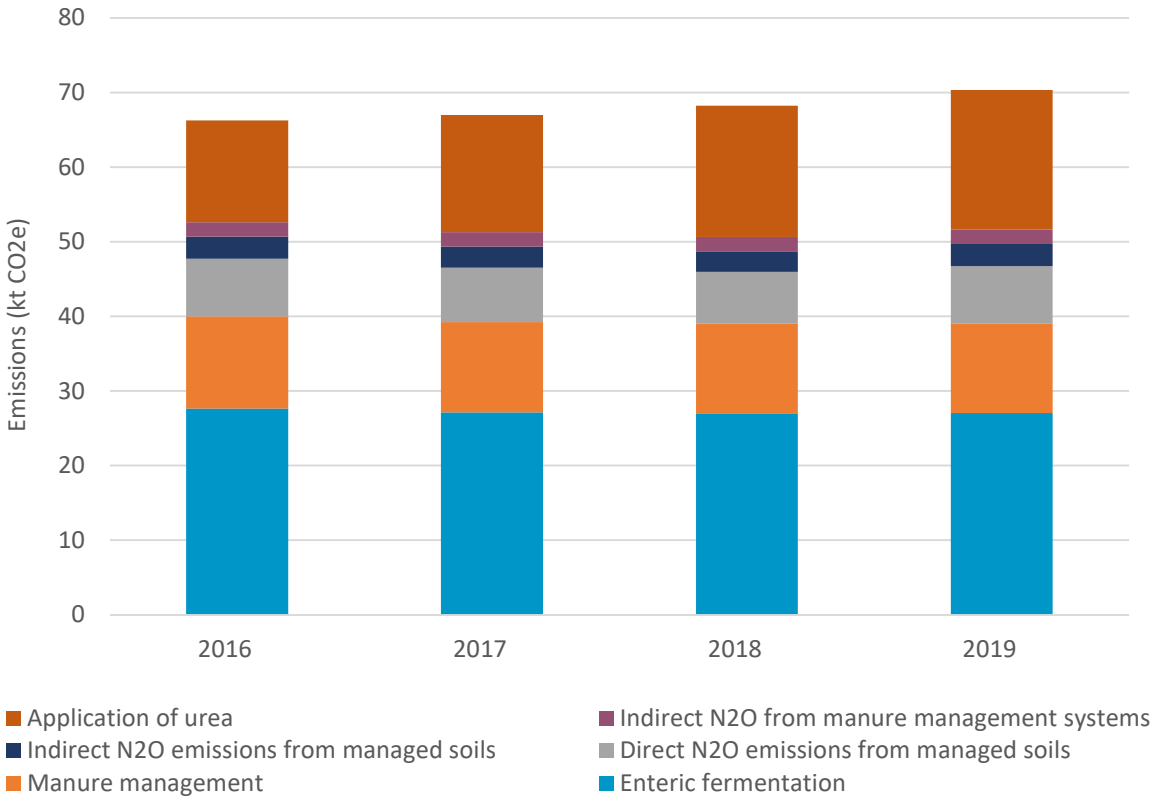
The agriculture, forestry, and land use (AFOLU) sector are important considerations for GHG inventories. Agricultural processes typically produce emissions of CH_4 and N_2O, which are much more potent GHGs than CO_2, which dominates the energy sector emissions. Therefore, smaller quantities of emissions can quickly become important considerations on the climate warming impact of activity in Prizren. At the same time, changes to land use imply changes to the capability of land to sequester CO_2. The methods for land use change require 20 years of data of hectares of land that fall under the different emissions categories such as cropland, forestland, and settlements. However, data is not available for Prizren region alone across this time period. It is understood that ASK have access to Kosovo wide satellite images from 2004 onwards on a periodic basis, but analysis of this dataset on a municipality level has not taken place regularly, with the only substantial land use dataset for Prizren from the 2014 Agriculture Census. As a result, no emissions from land use change have been possible. Instead, this report will provide recommendations on the data requirements that are needed to build a land use change inventory for future compiler reference.

Emissions from the agriculture sector can be divided into several sources, aligning with the IPCC Guidelines:

- Enteric fermentation
- Manure management
- Direct N_2O emissions from managed soils
- Indirect N_2O emissions from managed soils
- Indirect N_2O from manure management systems
- Application of urea

The relative size of these sectors is illustrated in the figure below.

Figure 10 Prizren estimated emissions from the agriculture sector 2016 - 2019



Emissions from V.1 Livestock (i.e., enteric fermentation and manure management) dominate the source of emissions from the agriculture sector, with enteric fermentation and manure management alone accounting for ~80% of emissions across the time series. There is no significant trend in emissions, with emissions reducing by 2% between 2016 and 2019. The introduction of more locally relevant data would perhaps generate more significant trends as calculations are based on Kosovo livestock data primarily, which would be expected to be less sensitive to local variations.

5.2 Methodology overview

5.2.1 V.1 Livestock

Enteric fermentation

A Tier 1 method is applied to calculate emissions of methane from enteric fermentation in Prizren. In Kosovo, there is good level of data on livestock populations, split by type of livestock and by age of livestock. However, this data is not available on a municipality only level and so, as with the methods used in energy, proxies are used to estimate livestock populations within Prizren by scaling down Kosovo-wide statistics. The 2014 Agricultural Census does, however, provide municipality level data and an assumption common across the agriculture inventory is that the relative contributions of Prizren to Kosovo-wide livestock numbers, fertiliser application, and crop production remains the same across the time series calculated here. For example, in 2014, 5%

of domestic dairy cow stock was in Prizren and so it assumed that for 2016 to 2019 this 5% proxy still applies. No information on horse or mule livestock numbers were included in any source dataset and as a result no emissions estimate is possible. These are categorised as 'Not Estimated' as small farms with horses and mules are likely to exist.

Table 8 Assumed livestock numbers for Prizren municipality in the agriculture calculations

Livestock	2016	2017	2018	2019
Dairy Cattle	6,564	6,434	6,408	6,385
Non-Dairy Cattle	6,296	6,171	6,146	6,124
Sheep	22,894	22,647	22,501	23,495
Goats	1,459	1,492	1,507	1,428
Horses	NE	NE	NE	NE
Mules	NE	NE	NE	NE
Swine	877	822	800	777
Poultry	113,012	115,936	105,901	109,910

Emission factors are Tier 1 defaults from the IPCC Guidelines for developing countries was used, which provide methane emissions per livestock head per animal type. For cattle, regional emission factors were used, with factors applicable to Eastern Europe used.

To improve emissions estimates from enteric fermentation (and other livestock source categories) it is recommended that agricultural surveys on livestock numbers are undertaken more regularly at a municipality level. This would improve certainty in estimates and account for local variations in livestock numbers and associated emissions.

Manure management

Emissions of methane from manure management follow the same principles that of methane from enteric fermentation: the use of Tier 1 IPCC default emission factors and livestock extrapolations for Prizren were used. Methane emission factors in manure management are also dependent on the mean temperature. Temperatures in Kosovo have significant seasonal variations, but with an average temperature of 9^{o}C has been selected[7] and therefore qualifies as a cool, Eastern Europe climate.

Table 8 shows the livestock activity data used for the methane calculations.

Calculations for N_2O emissions, however, are more complex and require information on the manure management systems in place (**Table 9- Table 10**). Data is only available on a central basis for different types of livestock from the 2014 agricultural

[7] https://en.wikipedia.org/wiki/Climate_of_Kosovo

census and it is assumed that the data from this census remains applicable and representative to Prizren livestock manure management across the time series.

Table 9 Manure management system distribution for cattle assumed in the inventory

Type of manure management system for cattle	Number of agricultural holdings	Categorisation to align with IPCC Guidelines
Loose housing stable (where the manure is removed mechanically)	7,575	Solid storage
Loose housing stable (where the solid dung and liquid manure drop down below the floor, into a channel/pit)	4,658	Pit storage
Stanchion-tied stable (where the manure is removed mechanically)	47,782	Solid storage
Stanchion-tied stable (where the solid dung and liquid manure drop down below the floor, into a channel/pit)	5,084	Pit storage
Other stables for cattle (not mentioned in the categories above)	2,602	Solid storage

Table 10 Manure management systems for broilers and laying hens assumed in the inventory

Type of manure management system for broilers and laying hens	Number of places – Owned	Categorisation to align with IPCC Guidelines
Hutch on straw	1,587,349	Dry lot
Cage with manure belt	828,059	Solid storage
Battery cage with deep pit	137,975	Pit storage
Battery cage in stilt house	2,108,469	Pit storage
Other cages (not mentioned in the categories above)	660,973	Solid storage

No information is available on the manure management systems used for swines, sheep, or goats and so default manure management system proportions from the IPCC Guidelines for Eastern Europe are assumed. **To improve emissions estimates from manure management, it is recommended that agricultural surveys on manure management systems used in Prizren are undertaken on a per livestock type basis. This would remove the need for assuming the distribution of manure management systems nationwide as reported in the 2014 agricultural census is applicable to Prizren across the time series and thereby improve the accuracy of emissions calculations.**

A Tier 1 approach is then used to estimate emissions of N_2O, following the formulae:

Direct N_2O emissions:

$$N_2O = \sum_s (\sum_T N_T * Nex_T * MS_{S,T}) * EF_S) * 44/28$$

where N_T is a number of livestock per species *T*; Nex_T is the average annual nitrogen excretion per head per species *T*, $MSS_{,T}$ is the fraction of nitrogen excreted that is managed by manure management system *S* per species *T*, and EF is the default emission factor for each manure management system in the IPCC Guidelines.

Indirect N_2O emissions

$$N_2O = \sum_s (\sum_T N_T * Nex_T * MS_{S,T} * \frac{Frac_{GasMT}}{100}_{S,T}) * EF_S) * 44/28$$

where $Frac_{Ga}S_{MT}$ is the fraction of manure managed nitrogen that volatilises as NH_3 or NO_X in the manure management system *S* as a % which are available as default factors from the IPCC Guidelines (2006).

5.2.2 V.2 Land

The IPCC divides land use into six categories:

- Forest land
- Cropland
- Grassland
- Wetlands
- Settlements
- Other land

Emissions and removals of CO_2 are based on changes in carbon stocks and should be estimated for each category. Of importance is the change in the area and carbon stocks of each as this implies changes in the levels of carbon sequestration. Estimating changes in carbon depends on the data and model availability. The methods for land use change require 20 years of data of hectares of land that fall under the different emissions categories such as cropland, forestland, and settlements. However, data is not available for Prizren region alone across this time period. It is understood that ASK have access to Kosovo wide satellite images from 2004 onwards on a periodic basis, but analysis of this dataset on a municipality level has not taken place regularly, with the only substantial land use dataset for Prizren from the 2014 Agriculture Census. As a result, no emissions from land use change have been possible.

Land use categorisation data, providing areas of land in each category in hectares, is needed for these calculations. **It is recommended that analysis of existing satellite images to determine land use in the municipality of Prizren alone is undertaken.** For years between satellite images, linear interpolation is an acceptable approach, as long as the total area of land remains the total area of Prizren municipality. For land that can meet multiple of the six categories above, a prioritisation is used to assign: Settlements > Cropland > Forest land > Grassland > Wetlands > Other land from highest to lowest priority. If land is unchanged in the last

20 years, it is classified as "remaining". However, land that is changes is considered "converted" under the convention of the IPCC. Emissions are calculated for remaining and converted land: the former is the result of the overturn of existing land, with the loss of biomass and the growth of biomass balanced, whilst the latter considers the implications of conversion on carbon sequestration rates.

5.2.3 V.3 Emissions from aggregate sources and non-CO_2 emissions sources on land

Biomass burning

No information on biomass burning is available on a municipality level. It is likely that some biomass burning occurs in some regions of Kosovo, and Prizren is no different. As a result, emissions estimates are given the code 'Not Estimated'.

Liming

Liming is the process of treating soil with lime to reduce acidity and to improve the fertility of soils. Through discussion with stakeholders in the Department of Economic Analysis and Agriculture Statistics it was established that liming is not a significant process in Kosovo, and so emissions estimates are given the code 'Not Occurring'.

Urea application

The use of urea as fertiliser leads to emissions of CO_2 that were fixed during the production of the material. Kosovo wide level estimates of urea application are available for 2016 – 2019 from the ASK data portal. This dataset is disaggregated by crop type also. However, no municipality level information on crop types is available. Instead, a proxy derived from the 2014 agricultural census is used, estimating the Prizren's croplands are 4.9% of Kosovo utilised agricultural land area. This therefore provides a value of quantity of urea applied to croplands. Emission factors are Tier 1 defaults for CO_2 emissions per kg of urea applied. Emissions of CH_4 and N_2O are not occurring from this process.

Direct N_2O emissions from managed soils

This emissions category includes emissions of N_2O that result from nitrogen that is added and released through the volatilisation, biomass burning, leaching, and runoff of nitrogen from managed soils. Activity data required for this emissions source include crop production split by type of crop and the application of different types of fertilisers to cropland. Neither of these activity datasets are available on the municipality level. Instead, there are domestic statistics published annually on crop production and fertiliser use and, as with the approach of other sectors, proxies are applied based on the last municipality-level study of agriculture, the Agriculture Census of 2014.

Crop production

To disaggregate domestic level crop production to Prizren only statistics, it is assumed that the area of utilised farmland is a suitable proxy. This implies that 4.9% of all of Kosovo's crops are produced in Prizren municipality. This approach does not account,

however, for regional variability of the types of crops grown and as a result it is recommended that agricultural surveys on crop production are more regularly undertaken on a municipality level.

Table 11 Assumed tonnes of crop production by crop type across time series

Crop type	2016	2017	2018	2019
Wheat	2,172	1,740	1,984	1,997
Grains	2,972	2,374	2,148	2,334
Barley	18	28	27	28
Rye	9	7	12	12
Oats	12	10	6	9
Beans & pulses	155	150	122	125
Potato	52	63	37	39
Alfalfa	138	147	161	183
Grass-clover mixtures	124	132	151	159
Root crops, other	76	127	110	124
N-fixing forages	53	89	107	127

The type of crops produced is an important factor in the calculations of direct N_2O emissions from managed soils as they define the amount of nitrogen that is left behind as crop residue, often a key metric in the nitrogen balance of the soils.

Fertiliser application

As with crop production, fertiliser quantities are available on a Kosovo level for NPK, NAG and other synthetic fertilisers. However, assumptions are needed on the nitrogen content of these fertilisers which can vary substantially. This data is not available for Kosovo at any level, and so it is assumed that the average nitrogen content of fertilisers used on cropland is similar to that of Albania. FAO data suggests that the nitrogen content of fertilisers used in Albania is between 15% and 20% across the time series. The use of manure as a fertiliser is also included and is calculated during the calculations for manure management emissions for Prizren. Following the IPCC Guideline Tier 1 methodology and applying Tier 1 emission factors and parameters through enables a calculation of emissions from the application of fertilisers to land, as presented in the table below.

Table 12 Emissions from fertiliser applied to agricultural soils

Fertiliser application	Units	2016	2017	2018	2019
Lime application	kt CO_2e	NE	NE	NE	NE
Urea application	kt CO_2e	13.7	15.7	17.6	18.7
Synthetic fertilisers	kt CO_2e	2.32	1.99	1.70	2.39

Organic fertilisers – Manure spreading	kt CO_2e	5.03	4.95	4.91	4.94
Organic fertilisers – Urine and Dung	kt CO_2e	NE	NE	NE	NE
Crop residues	kt CO_2e	0.37	0.34	0.34	0.35
Mineralisation	kt CO_2e	NE	NE	NE	NE
Histosols	kt CO_2e	NE	NE	NE	NE

As **Table 12** illustrates, there are some categories for which emissions estimates were not possible, namely the fertilisation of soils through urine and dung, and the nitrogen released from mineralisation and histosols. These are not expected to be significant emissions sources in Prizren. To estimate their emissions, **more detailed information on the crop management and living conditions of livestock is needed and it is recommended that this is collected at through a periodic agricultural survey of farms in Prizren**

5.3 Recommendations

A summary of the main recommendations on future activity data collection is included in the table below. These recommendations should be prioritised in terms of the importance of the sector for which they are relevant.

Table 13 Priority recommendation items for Prizren for the agriculture sector

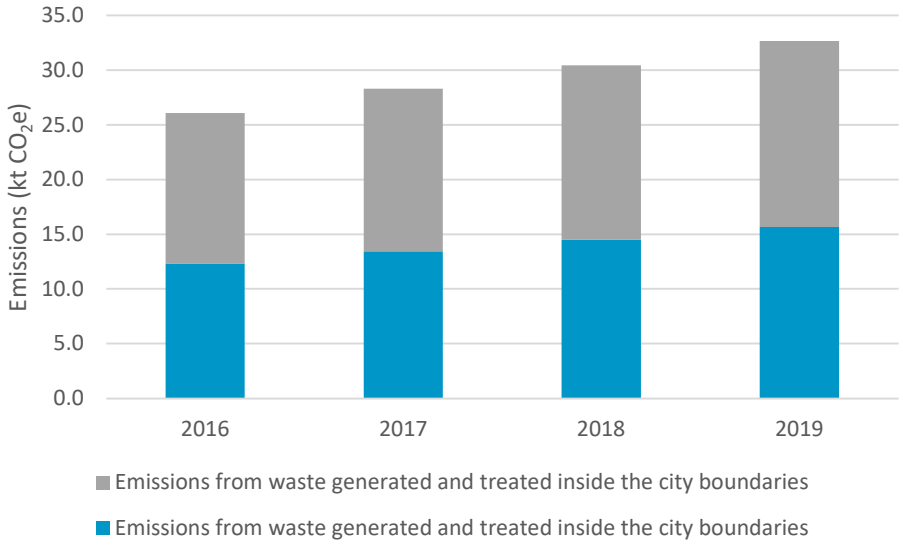
ID	Improvement Issue	Sector	Effort required to carry out task
7	Conduct regular agricultural surveys on livestock numbers at a municipality level	Livestock: enteric fermentation	High
8	Conduct regular agricultural surveys on manure management systems at a municipality level	Livestock: manure management	High
9	Analyse existing satellite image to determine land use in the municipality of Prizren	Land	Medium
10	Conduct periodic agriculture surveys of farms in Prizren to obtain to more detailed information on crop management and living conditions of livestock	Aggregate and non-CO_2 emissions: fertiliser application	High

6 Waste

6.1 Overview of emissions

The only source of emissions in the waste sector in Prizren is from solid waste disposal emissions. Methane emissions from solid waste landfills are increasing with growing population size. Although this is not reflected in the reported emissions due to lack of data, the per capita waste generation is increasing so methane emissions from solid waste landfills can be expected to increase further. Before the year 2000, most of the solid waste in urban areas in Kosovo were placed in unmanaged landfills and waste dump sites[8]. The change to sanitary managed landfills is reflected in the inventory from 2006 with the introduction of Landovica sanitary landfill. This landfill collects waste from the Prizren region. However, most of the observed increases in methane emissions as observed in **Figure 11** are due to increases in waste production resulting from an increased population.

Figure 11 CO_2e emissions from methane produced during solid waste disposal in Prizren municipality between 2016 and 2019



Biological treatment of waste, incineration and open burning, and wastewater treatment and discharge do not occur within Prizren municipality so are reported as 'Not Occurring'. Solid waste disposal sites account for all of the observed CO_2e emissions in Prizren as shown in **Table 14**. Although incineration used to occur, it is not a common practice so is reported as 'Not Occurring'.

In comparison to other sectors, the CO_2e emissions from solid waste disposal sites in the waste sector are minor, accounting for only 2.2% of overall emissions in 2019.

[8] Berisha, Veselaj, and Sallaku, 2018, 'Estimation of Methane Emission from Solid Waste Landfill in Prizren'.

Table 14 Estimated emissions for Solid waste disposal in Prizren from 2016 to 2019

Sector and pollutant	Emissions (tCO_2e)			
	2016	2017	2018	2019
Solid waste disposal	26.1	28.3	30.4	32.7
Emissions from waste generated and treated inside the municipality boundaries	12.3	13.4	14.5	15.6
Emissions from waste generated within but treated outside of the municipality	NO	NO	NO	NO
Emissions from waste generated and treated inside the municipality boundaries	13.7	14.9	16.0	17.0

As the Landovicë/a waste disposal site includes waste generated from other municipalities (Suharekë/Suva Reka, Gjakovë/Djakovica, Malishevë/Mališevo, Rahovec/Orahovac, and Mamushë/Mamuša), a significant proportion of emissions from the landfill site are from waste generated outside of the municipality boundaries. Therefore, emissions are reported as a scope 3 source.

6.2 Methodology overview

The quantification of GHG emissions from solid waste disposal and treatment is determined by two main factors: the mass of waste disposed and the amount of degradable organic carbon within the waste. For the calculations, default IPCC Tier 1 emission parameters are utilised throughout, except for specific distribution of waste and specific waste composition studies that are relevant for the municipality. Kosovo-wide disposal statistics for different management types are assumed to apply to Prizren from 2006. Before the opening of the Landovicë/a landfill in 2006, it is assumed that unmanaged open dumping was the main form of waste disposal. CH_4 emissions from the continued decay of this waste are included in the calculations. From 2006, the landfill is assumed to be managed well, semi-aerobic.

Population data

Until 2006 in the time series, the total municipal solid waste is calculated from population estimates and waste generated per capita per year. Population data for Prizren municipality were taken from the ASK census population for intervals between 1948 and 2011 and interpolated in between census years. It is assumed that before the opening of Landovicë/a landfill in 2006, all waste disposal in Prizren municipality comes from within the municipality, after which it is assumed that waste from other municipalities (Suharekë/Suva Reka, Gjakovë/Djakovica, Malishevë/Mališevo, Rahovec/Orahovac, and Mamushë/Mamuša) are transported into the municipality. To estimate the emission to be allocated under Scope 1 and Scope 3, population

estimates as presented by the ASK data portal where used, assuming a constant waste generation per capita across the municipalities that send waste to Landovica.

Waste generation data

The waste generated per capita per year was taken from the "Report On Municipal Waste Management In Kosovo" for Prizren municipality for 2020, and assumed to apply to all the years in the time series. From 2006, the total municipal solid waste for Landovicë/a is obtained from "Estimation of methane emission from solid waste landfill in Prizren" until 2014. Total municipal solid waste data for Landovicë/a for 2015 to 2020 were obtained from the "Report On Municipal Waste Management In Kosovo", as well as validating data provided by landfill operators for the purposes of this study. Using the total municipal solid waste includes all the waste arriving at Landovicë/a, including from other municipalities.

Waste composition data

A recent study into the composition of waste data has taken place in Suharekë/Suva Reka. The results of this were provided and enabled a more municipality-specific approach. It is assumed, in the absence of other data, that the waste composition between Suharekë/Suva Reka and Prizren is similar from 2006 onwards. Before 2006, default IPCC waste composition values are used for Southern Europe, assuming unmanaged landfill sites would have been used for waste disposal.

6.3 Recommendations

Data availability for waste sector calculations are largely good in Prizren. Transparent information on waste quantities is available and information on the management techniques at Landovicë/a is readily available. For wastewater treatment, a source that will emerge in Prizren, information on the quantity of wastewater treated, preferably split between domestic and industrial wastewater is needed, and the proportion of wastewater that is treated through this pathway. Information on the mechanism of wastewater treatment (i.e., anaerobic reactors, septic systems, latrine systems) is needed to identify the appropriate methane correction factors to apply IPCC default methodologies.

7 Conclusions

The report outlines the data sources, methodologies, and results of a GHG inventory for the municipality of Prizren from 2016-2019. In the process of developing the inventories for these municipalities, the methodologies developed were designed to be transferable to other municipalities. Standard methodologies were applied, aligning with international best practice on community-scale greenhouse gas inventories, and data was sourced either locally or from Kosovo statistical agencies, that enabled the estimation of emissions from the energy, industry, agriculture and waste sectors.

The process of collecting activity data was focussed on building up local datasets and knowledge of the processes and source profiles for each municipality. Municipality-level data, however, is not widely available across sectors for all years. For example, data from the last agricultural census in 2014 was of high quality and split by municipality for many of the datasets used to quantify emissions, but there is no similar data that exists for 2016 onwards. Additionally, in some cases, the lack of local data precludes the development of an inventory of any accuracy: for example, a lack of spatial data on the area of different types of land mean that deriving a land use change emissions method is not possible for now. Recommendations are provided in this report which outline steps that can be taken to produce locally-specific data in future and we would encourage work to prioritise these for the most polluting sectors and the sectors without sufficient data to allow an emissions calculation first.

The calculations show, as expected, that the energy sector is the most emitting. In the residential sector, which is the largest individual sector in the inventory, emissions are dominated by the implied emissions from electricity consumption. This is because of Kosovo's high carbon fuel mix for electricity generation, being nearly totally reliant on lignite as a primary fuel. High levels of transmission and distribution losses contribute to the high grid emission factor used in these calculations. This aligns with the results of the Kosovo inventory, where the emissions from energy generation form a significant part of the overall GHG emissions. Additionally, road transport forms the second largest sector in the inventory. Data sources used to derive the road transport sector need improving in order to more accurately ascertain the relative contribution of road transport to the emissions in the municipality. Other road transport methods, outlined in this report, can also be utilised to validate the calculations or to scale the total emissions to known quantities of fuel use.

An update to the inventory is recommended at least every two to three years. Efforts in the meantime should focus on ensuring completeness of the inventory is possible in future iterations, whilst future compilation cycles should utilise the same methodologies as presented here, or recalculate the entire time series if alternative data allows a more advanced methodology to be used. Significant improvements to the accuracy of the inventory can be achieved through the build up of local data sources and emission factors that reflect local practices and technologies. Indeed, building datasets in a way that enables the evaluation of the emissions (and spatial distribution) of air pollutants mean that cross-interventions which improve air quality whilst reducing greenhouse gas emissions can be more readily identified and prioritised for implementation.