Informative Inventory Report for Malta 2017

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Glossary of terms

Term	Definition
WM	With Measures
WaM	With additional Measures
SCR	Selective catalytic reduction
AER	Annual Environment Report
TERT	Technical expert review team
HFO	Heavy Fuel Oil
GDO	Gas Diesel Oil
TSP	Total suspended particulates
EF	Emission factors
vkm	Vehicle/kilometres (mileage or activity)
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
NFR-14	Nomenclature for reporting template 2014

Executive Summary

Malta's Informative Inventory Report (IIR) contains information on the emission inventories for air pollutants in the Maltese Islands, covering the time series 2005 to 2017. It also outlines a description of the methodology applied, data sources and trend analysis.

There have been major changes in some of the sectors making up the NFR-14 template from the previous submission. This was due to both a change in sources and a change in the methodology used. The major change observed was in the sector of public electricity and heat production, due to the switch from liquid fuel powered plants to liquefied natural gas. There was also an upgrade in the level of detail of the methodologies applied for the estimation of emissions in the national navigation, aviation, national fishing and manure management sectors. A number of new sources were estimated for the first time under sector 2G, Other product use, and these were emissions from fireworks and cigarettes. Inorganic fertilizers, animal manure applied to soil, farm-level agriculture operations including storage, handling and transport of agriculture products were also estimated for the first time. The sectors, 2H2, Food and beverage industry, was also updated, while sector 1A3b, Road Transport, was updated for the year 2017 only.

1. Introduction

The Environment and Resources Authority (ERA) is entrusted with the role of compiling the national emission inventories and their submission to the European Commission as an obligation under the National Emission Ceilings Directive (NECD) and the Convention on Long-Range Transboundary Air Pollution (CLRTAP). This is Malta's sixth Informative Inventory Report (IIR). The emission inventory team at ERA is responsible for all the work related to the national emission inventory of air pollutants, including the estimation of emissions and respective drafting of reports.

1.1. National Emission Inventory Background and Institutional arrangements

The Emission Inventory is compiled on an annual basis. The activity data used for the preparation of this inventory was obtained from the National Statistics Office (Malta), the Energy and Water Agency (EWA), the waste team at ERA as well as from other relevant public entities (such as Ministries, Departments, Regulatory Agencies), private establishments and official published reports.

1.2 The Process of Inventory Preparation

The Inventory Team is responsible for the work on the emissions inventory, which includes data collection through the relevant authorities, calculating emissions and preparing relevant reports. During this process, meetings with the relevant officers from other public authorities were also held as the need arises.

1.3 Methods and data sources

The methodology used in compiling the 2017 emission inventory was mainly based on the 2016 EMEP/EEA Air Pollutant Emission Inventory Guidebook.

The basic equation for the compilation of the emission inventory is the following:

$$\textit{Emission load} = \textit{Activity Data} \times \textit{Emission Factor}$$

EQUATION 1: BASIC EQUATION TO ESTIMATE EMISSION LOADS

Emission projections of the relevant sectors were compiled based on the same methodology used for the historical inventory. All policies implemented prior to 2017 were included in the WM scenario while all policies planned for implementation as from 2017 onwards were included in the WAM scenario.

With regards to the energy sector, the activity data for both historical and projected emissions was sourced from EWA, which models and outputs were developed explicitly for the purposes of energy system modelling. Moreover, the data sources used reflect those developed for the first draft of Malta's National Energy and Climate Plan (NECP). It is to be pointed out that since then, the EWA has revised this data; however this was not available at the time the air emission projections were being compiled. Future submissions will be based on updated activity data.

At the time this submission was being compiled, it was not clear for which years data on fuel consumption prior to 2013 for the various sectors is available. In the absence of this data, the historical fuel consumption used for the estimation of emissions was based on 2013 - 2017 averages. Future submissions will be revised based on available statistical data.

1.5 Key Categories analysis

A key category is one that is prioritised within the national inventory system because it is significantly important for one or a number of air pollutants in a country's national inventory of air pollutants. In this submission, the *level of assessment* of emissions was calculated based on the approach found in the EMEP/EEA Air Pollutants Emission Inventory Guidebook 2016. The below key category analysis outlines the percentage contribution of each sector to the total national emissions. This percentage contribution is provided for each pollutant covered by Malta's national emission inventory.

Pollutant	NFR	NAME	%
NO_X	1A3biii	Road transport: Heavy duty vehicles and buses	28.6
	1A3bi	Road transport: Passenger cars	22.4
	1A3bii	Road transport: Light duty vehicles	10.8
	1A3ai(i)	International aviation LTO (civil)	9.7
	1A1a	Public electricity and heat production	9.0
NMVOC	1A3bi	Road transport: Passenger cars	21.9
	2D3a	Domestic solvent use including fungicides	16.2
	5A	Biological treatment of waste - Solid waste disposal on land	12.6
	1A3bv	Road transport: Gasoline evaporation	11.8
	3B1b	Manure management - Non-dairy cattle	4.5
	1B2av	Distribution of oil products	4.5
	1A3biv	Road transport: Mopeds & motorcycles	3.7
	1A3biii	Road transport: Heavy duty vehicles and buses	3.5

	1A3dii	National navigation (shipping)	3.2
SO_2	1A1a	Public electricity and heat production	86.9
NH_3	3Da2a	Animal manure applied to soils	22.5
	3B1a	Manure management - Dairy cattle	13.6
	3B4h	Manure management - Other animals (please specify in IIR)	13.4
	3B4gi	Manure management - Laying hens	9.8
	3B1b	Manure management - Non-dairy cattle	9.6
	3B4gii	Manure management - Broilers	8.9
	3B3	Manure management - Swine	7.9
$PM_{2.5}$	1A3dii	National navigation (shipping)	24.9
	1A3bi	Road transport: Passenger cars	15.1
	1A3biii	Road transport: Heavy duty vehicles and buses	13.2
	1A3bvi	Road transport: Automobile tyre and brake wear	12.4
	1A3bii	Road transport: Light duty vehicles	12.2
	1A1a	Public electricity and heat production	5.1
PM_{10}	1A3dii	National navigation (shipping)	18.5
	1A3bvi	Road transport: Automobile tyre and brake wear	17.8
	1A3bi	Road transport: Passenger cars	11.2
	1A3biii	Road transport: Heavy duty vehicles and buses	9.8
	1A3bii	Road transport: Light duty vehicles	9.0
	1A3bvii	Road transport: Automobile road abrasion	6.6
	2G	Other product use	4.9
	1A1a	Public electricity and heat production	4.6
TSP	1A3bvi	Road transport: Automobile tyre and brake wear	16.9
	1A3dii	National navigation (shipping)	13.9
	3B4gi	Manure management - Laying hens	11.1
	1A3bvii	Road transport: Automobile road abrasion	9.8
	1A3bi	Road transport: Passenger cars	8.3
	1A3biii	Road transport: Heavy duty vehicles and buses	7.3
	1A3bii	Road transport: Light duty vehicles	6.7
	1A1a	Public electricity and heat production	4.6
	2G	Other product use	4.0
BC	1A3bi	Road transport: Passenger cars	33.3
	1A3bii	Road transport: Light duty vehicles	25.9
	1A3biii	Road transport: Heavy duty vehicles and buses	25.3
CO	1A3bi	Road transport: Passenger cars	72.4
	1A1a	Public electricity and heat production	5.0
	1A3dii	National navigation (shipping)	5.0
Pb	1A3bvi	Road transport: Automobile tyre and brake wear	55.7
	2G	Other product use	36.5
Cd	1A3bvi	Road transport: Automobile tyre and brake wear	51.5

	1A1a	Public electricity and heat production	31.3
Hg	2G	Other product use	84.6
As	1A1a	Public electricity and heat production	56.3
	1A4ai	Commercial/institutional: Stationary	16.0
	1A3dii	National navigation (shipping)	13.0
Cr	1A3bvi	Road transport: Automobile tyre and brake wear	84.9
Cu	1A3bvi	Road transport: Automobile tyre and brake wear	94.9
Ni	1A4ai	Commercial/institutional: Stationary	71.3
	1A3bvi	Road transport: Automobile tyre and brake wear	11.0
Se	1A1a	Public electricity and heat production	58.2
	5C1bv	Cremation	20.3
	1A3bvi	Road transport: Automobile tyre and brake wear	11.2
Zn	1A3bvi	Road transport: Automobile tyre and brake wear	56.9
	1A1a	Public electricity and heat production	30.4
PCDD/PCDF	5C1bv	Cremation	96.8
Benzo(a) pyrene	1A1a	Public electricity and heat production	30.3
	1A3bi	Road transport: Passenger cars	28.6
	1A4ai	Commercial/institutional: Stationary	18.0
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other	11.5
benzo(b) fluoranthene	1A4ai	Commercial/institutional: Stationary	37.4
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other	31.7
	1A3bi	Road transport: Passenger cars	11.4
benzo(k) fluoranthene	1A1a	Public electricity and heat production	27.1
	1A3bi	Road transport: Passenger cars	21.9
	1A4ai	Commercial/institutional: Stationary	19.4
	1A3biii	Road transport: Heavy duty vehicles and buses	15.3
Indeno (1,2,3-cd) pyrene	1A1a	Public electricity and heat production	30.3
	1A3bi	Road transport: Passenger cars	28.5
	1A4ai	Commercial/institutional: Stationary	20.0
	1A2gviii	Stationary combustion in manufacturing industries and construction: Other	8.9
HCB	5C1bv	Cremation	98.9
PCBs	5C1bv	Cremation	99.3

TABLE 1: KEY CATEGORY ANALYSIS FOR 2017 DATA

1.6 QA/QC and Verification methods

The inventory team has identified the need for an ongoing development of a Quality Assurance/Quality Control (QA/QC) system within the national emission inventory. During the compilation of the inventory, efforts were made to ensure as high a level of quality and reliability as possible. Work to develop a QA/QC system has started, in order to ensure the quality and reliability of the activity data, emission factors and emission estimates, in line with the principles of transparency, accuracy, consistency, comparability and completeness. In this submission, the best available sources of data have been used and in specific sectors, such as power generation and cremation, in-situ monitoring data was used.

1.7 General uncertainty evaluation

In an inventory process, uncertainty estimates are an essential element. Uncertainties are associated with both the activity data and emission factors, and are therefore reflected in the final result. For this submission, Malta did not perform a quantitative uncertainty assessment for any pollutants in the emission inventory, however it is being envisaged to tackle this matter in future submissions.

1.8 General Assessment of Completeness

This submission includes the estimation of emissions from all the relevant sources and emissions listed in the NFR-14 template and explained in the EMEP/EEA air pollutant emission inventory guidebook 2016.

2. Explanation of Key Trends

2.1. Trends for Nitrogen Oxides emissions

The emissions of NO_x, as shown in the figure below, have decreased across the time series. The majority of NO_x emissions were generated from the energy sector (NFR Sector 1).

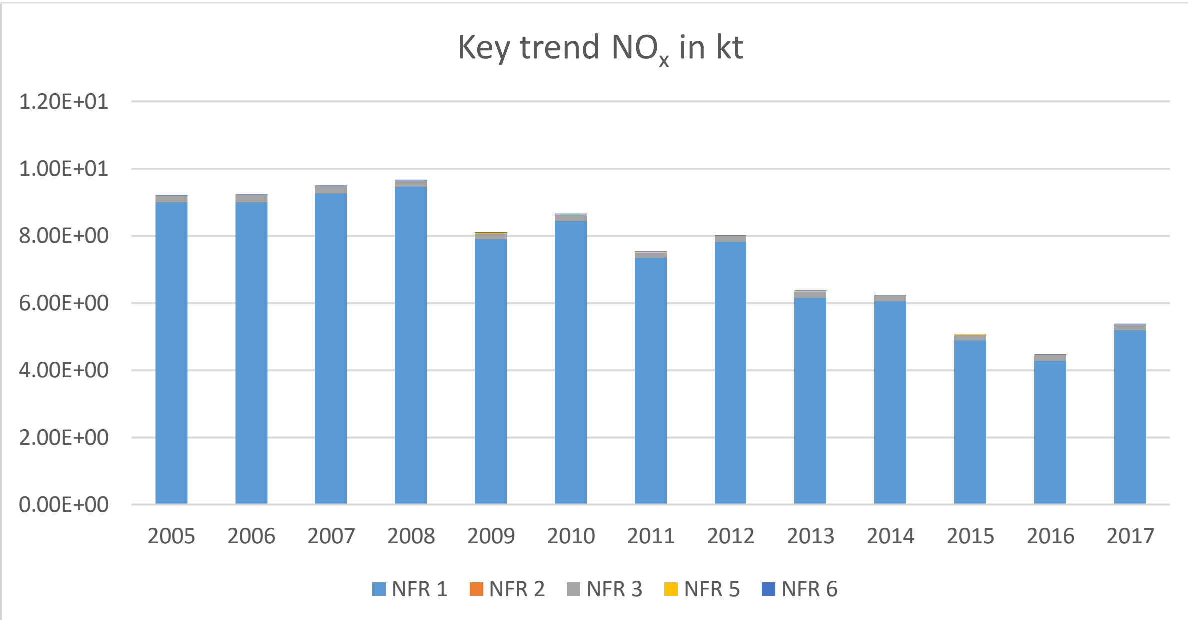

FIGURE 1: KEY TREND NO_x IN KT

It is important to highlight again that road transport was updated with new input data only for the year 2017 and this could be the reason why there is a slight increase in NO_x from previous years. Efforts will be made to update previous years using the same methodology.

2.2 Trends for Non-Methane Volatile Organic Compounds (NMVOC)

The figure below shows that NMVOC emissions decreased from 2005 to 2016, and then increased in 2017. The Energy sector (NFR Sector 1) is the greatest contributor to NMVOC emissions; however, there are significant contributions from Industrial Processes and Product Use (NFR Sector 2), Agriculture (NFR Sector 3), and Waste (NFR Sector 5).

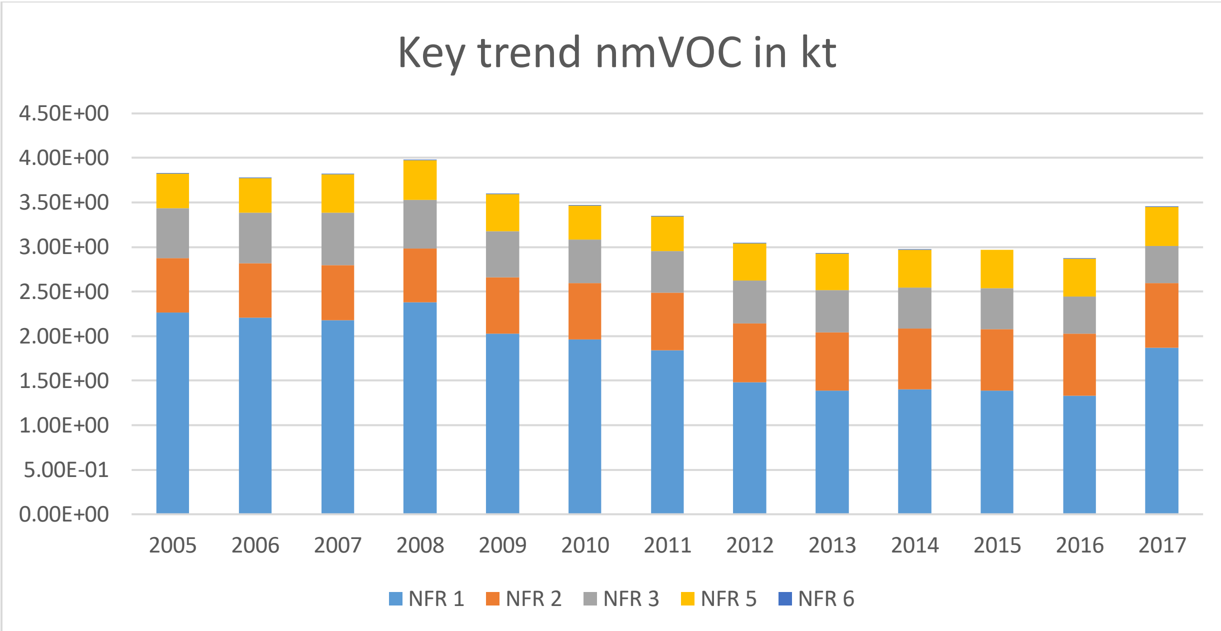

FIGURE 2: KEY TREND NMVOC IN KT

3.3. Trends for Sulphur Dioxide (SO_2)

The below figure shows that SO_2 emissions steadily decreased from 2005 to 2017. The Energy sector (NFR sector 1) is the main contributor of SO_2 emissions.

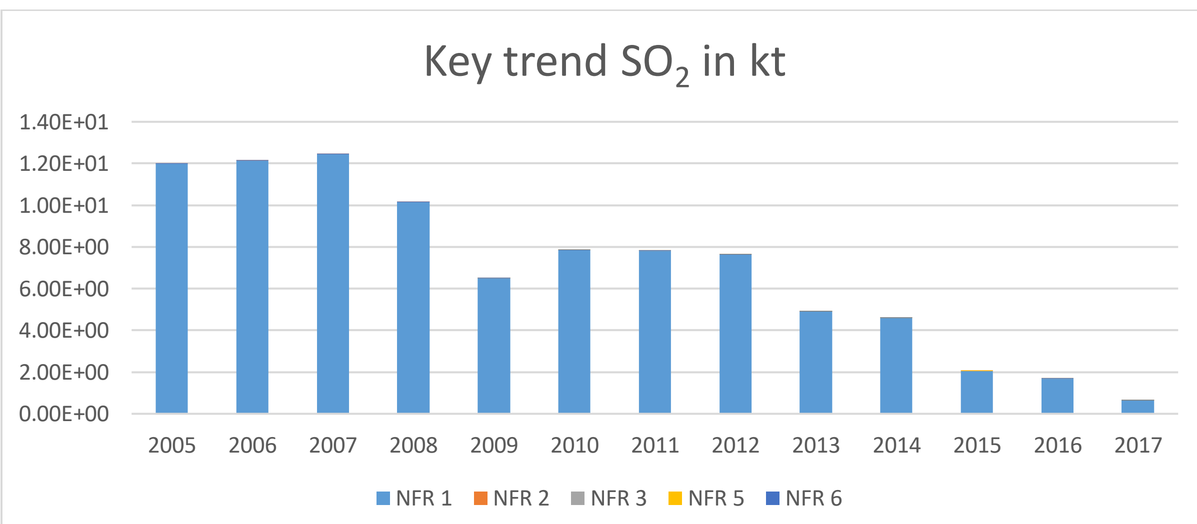

FIGURE 3: KEY TREND SO_2 IN KT

3.4. Trends for Ammonia (NH_3)

The below figure shows that NH_3 emissions slowly decreased from 2005 to 2017. The Agricultural sector (NFR sector 3) is the main contributor of NH_3 emissions.

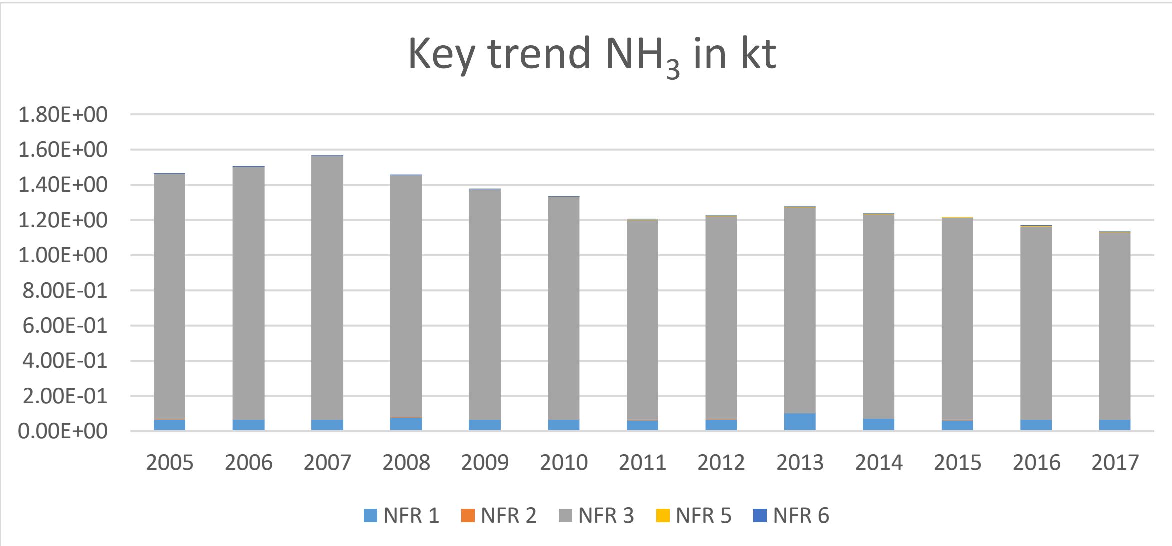

FIGURE 4: KEY TREND NH_3 IN KT

3.5. Trends for $PM_{2.5}$

The figure shows that $PM_{2.5}$ emissions slowly decreased from 2005 to 2017. The Energy sector (NFR sector 1) is the main contributor of $PM_{2.5}$ emissions.

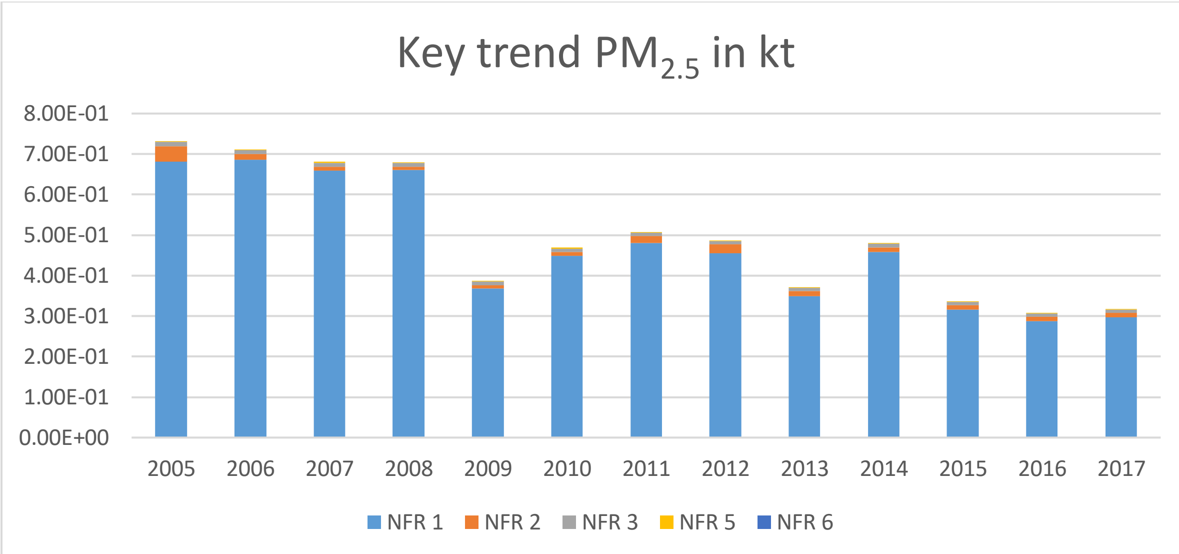

FIGURE 5:KEY TREND $PM_{2.5}$ IN KT

3. Energy (NFR 1)

1A1a: Public Electricity and heat production

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category	NFR-Code
1A1a	Power Generation and Electricity Production	2016GB	AER	Tier 2 & direct measurements (Tier 3)	NOx, SO_2, $PM_{2.5}$, PM_{10}, TSP, CO, Cd, As, Se, Zn, Benzo(a)pyrene, Benzo(k)fluoranthene	2019 submission

Emissions estimated from this sector originated from the three companies responsible for the generation of electricity from different fossil fuels and were reported under NFR code 1.A.1a. Reported emission estimates were calculated either through the procedure outlined in the 2016GB or obtained directly through continuous and discontinuous emission monitoring systems for the year 2017. There was no need to update the time series since there were no changes in activity data. Emissions were also reported for projected years 2020, 2025 and 2030 both for the WM and WaM scenarios.

In 2017, a major change in local electricity production took place due to the introduction of two privately owned power plants running on natural gas; *Electrogas Malta* (EGM) and *D3 Power Generation Limited (D3pg)*. Both plants joined *Enemalta,* the state owned Energy producer, in the local production of electricity.

The plant of *Electrogas Malta* consists of three combined cycle gas turbines (CCGT) which run on natural gas while D3 Power Generation Limited (D3pg) started operating four diesel engines (DPS 6 C,D and DPS 6 A,B) on natural gas in 2017. Enemalta retained DPS 1 steam turbine (running on HFO) until it was decommissioned in April 2017 and DPS 2, 3, 4 and 5 gas turbines (running on GDO) throughout 2017. Enemalta also operates another power plant situated in Marsa of which sole operating gas turbine is MPS5, which has been put on standby and permitted to operate for testing or emergency purposes.

The table below shows the set-up of the electricity generating plants present locally across 2017;

Operator	**Plant**	**Technology**	**Fuel**	**Months in operation during 2017**
Electrogas Malta	CCGT 1	Combined Cycle Gas Turbines	Natural gas	January 2017 to December 2017
	CCGT 2	Combined Cycle Gas Turbines		
	CCGT 3	Combined Cycle Gas Turbines		
Enemalta	DPS1	steam turbine (including boilers)	HFO	January 2017 to April 2017

		(it was fully decommissioned by 2018)		
	DPS2	gas turbine	Gasoil	January 2017 to December 2017
	DPS3	gas turbine		
	DPS4	gas turbine		
	DPS5	gas turbine		
	DPS6 A	diesel engines	HFO/Gasoil	January 2017 to March 2017
	DPS6 B	diesel engines	HFO/Gasoil	
	MPS 5	gas turbine	Gasoil	January 2017 to December 2017
D3pg (D3 Power Generation Limited)	DPS6 C	diesel engines	Natural gas/ Gasoil	January 2017 to December 2017
	DPS6 D	diesel engines		
	DPS6 A	diesel engines	Natural gas	April 2017 to December 2017
	DPS6 B	diesel engines		

TABLE 2: SET-UP OF ELECTRICITY GENERATING PLANTS

The main benefits from this change in technology was to give start to the phasing out of heavy fuel oil and the introduction of natural gas as the main fuel for electricity generation. In addition to gaseous and liquid fuel plants, there were other sources of electricity feeding into the grid i.e. the interconnector (electricity imported to Malta from mainland Europe) and electricity from photovoltaic (PV) cells. Below, there is the historical percentage share of the energy mix from 2013 to 2017 and the projected percentage share i.e. 2020, 2025 and 2030.

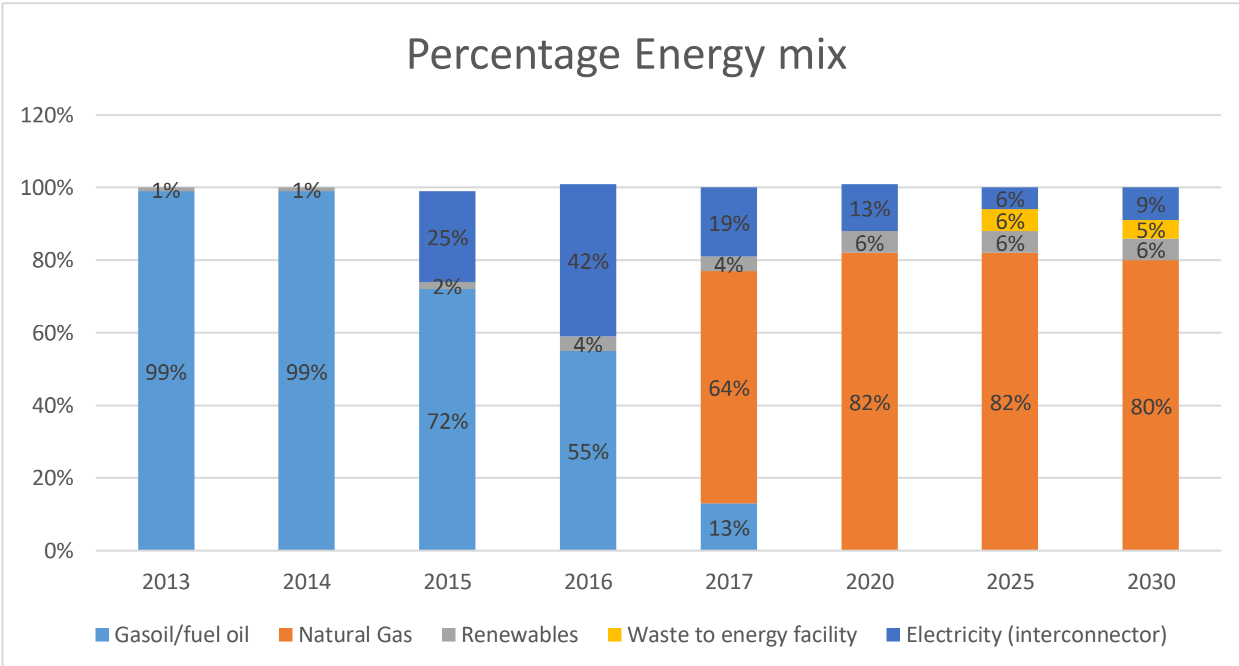

FIGURE 6: PERCENTAGE CONTRIBUTION OF ELECTRICITY FROM EACH DIFFERENT ENERGY SOURCE. THE PROJECTED ENERGY MIX REFLECTS THE WAM SCENARIO AND INCLUDES THE PROJECTED WASTE-TO-ENERGY FACILITY WHICH SHOULD START ITS OPERATION IN 2024 (DATA OBTAINED FROM EWA).

The decrease in electricity contribution from gasoil/fuel oil started with the introduction of the interconnector in 2015. The share of electricity sources from the interconnector increased in 2016 with the decrease of liquid fuel combustion, which kept on decreasing in 2017 with the introduction of natural gas. Contribution from PVs in 2016 was very similar to that of 2017.

Activity data in relation to each of the four plants was obtained from the annual environment reports (AERs) submitted by Enemalta, Electrogas and D3 Power Generation Limited to ERA as part of their obligations under the Industrial Emissions Directive.

The NO_x, SO_x and filterable TSP pollutant load emitted from each stack was measured by means of the continuous emission monitoring system (CEMS) and reported in each of the three AERs for each respective power plant. The conditions of measurements were set at a temperature of 273k, a pressure of 101,3 kPa and a standardized O_2 content of 3%.

Carbon Monoxide emitted from the D3pg and EGM was reported by the plant operator while, the CO contribution from the Enemalta plant was estimated by multiplying the concentration with the flow rate as reported in the AER.

No monitoring data was available for NMVOC in the AERs of the different plants, hence these were estimated using Tier 2 default factors in the 2016GB. Particulate matter was estimated from the ratio of default factors of TSP against that of PM_{10} and $PM_{2.5}$ from the 2016GB. Below there is the list of pollutants and their respective EF source;

Pollutants	Enemalta	Electrogas	D3pg
NMVOC, PM_{10}, $PM_{2.5}$	GDO/GT = Table 3-18 HFO/DBB = Table 3-11 GDO/DIESEL = Table 4-8	Gaseous fuels/GT = Table 3-17	Gaseous fuels/GT = Table 3-17

TABLE 3: 1A1A - TIER 2 DEFAULT EMISSION FACTORS IN 2016GB USED TO ESTIMATE NMVOC, $PM_{2.5}$, AND PM_{10}

Black Carbon was estimated using a default factor available in the 2016GB for each of the three plants.

Since the Delimara power station has plants running on HFO, discontinuous monitoring was used to monitor heavy metals i.e. As, Cr, Co, Cu, Mn, Ni, Pb, Sb, V. It was not possible to remove the contribution of certain metals which were not included in the NFR-14 template and hence the sum of concentrations was multiplied with the total flue gas volume emitted from DPS1 and DPS 6. Moreover, the notation key 'IE' was included under the following heavy metals listed in the inventory; As, Cr, Cu, Mn, Ni since their respective contribution was included under Pb.

No discontinuous monitoring measurements were available for Pb, As, Cr, Cu, Mn, Ni originating from EGM and D3pg hence these were estimated using Tier 2 EF in the 2016GB (page 33, Table 3 -17) and results also included under Pb. Other metals i.e. Hg, Se and Zn emitted from the each of the three plants were also estimated using default emission factors found in the 2016GB.

POPs emitted by plants operated by Enemalta were estimated by means of a country specific emission factor based on emissions measured in the past. The PAHs emitted from Electrogas and

D3pg were estimated through default emission factors in the 2016GB (page 33, Table 3 -17), since no direct measurement data was available in the AERs. Moreover, since no emissions factors for PCDD/F were available in the 2016GB for the plants operated by Electrogas and D3pg, it was assumed that no such emissions were emitted from these specific technologies.

HCB and PCB data were calculated for the power plant operated by Enemalta only since as in the case of dioxins and furans, the other two power plants did not have an emission factor in the 2016GB.

The same methodology used to estimate historical emissions was used to project emissions to future years. Activity data used was that of projected fuel consumption as made available from the EWA. The only fuel type projected for future years was natural gas since it is being assumed that the Enemalta power station will only be used in case of emergency and the main plants for producing electricity will be those running on gas i.e. EGM, D3pg. The below graph shows the trend of projected fuel consumed in GJ, which is the activity data used to project emissions for both the WM and WAM scenario.

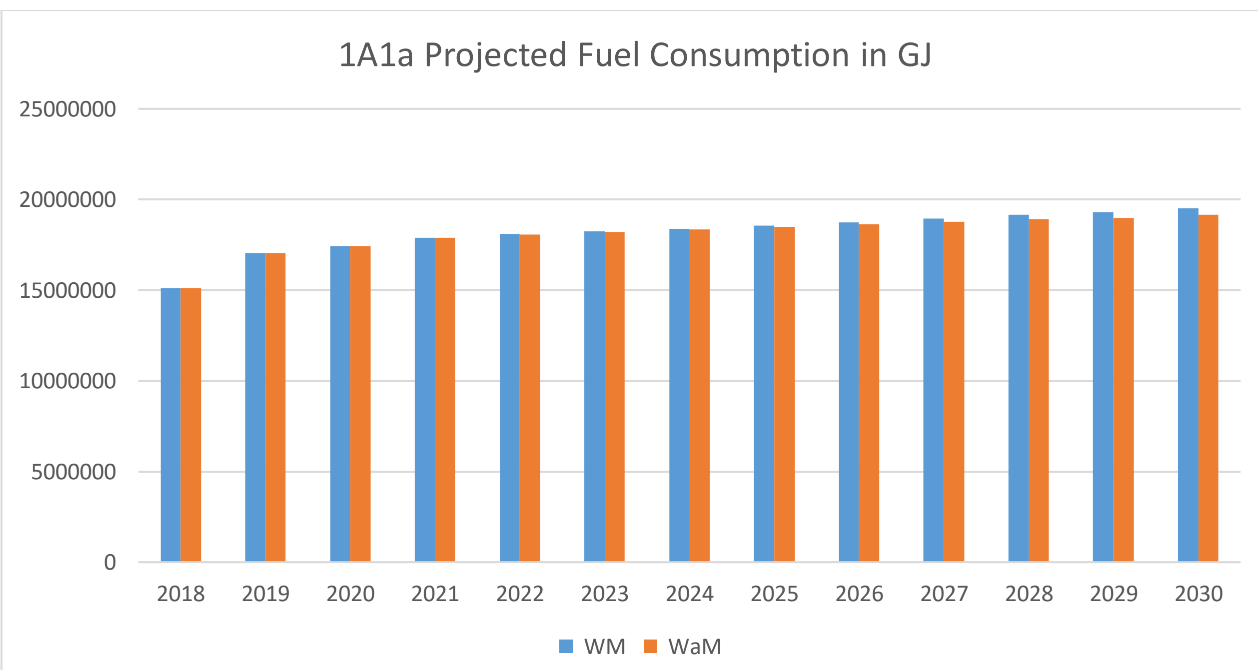

FIGURE 7: 1A1A PROJECTED FUEL CONSUMPTION IN GJ TIME SERIES (WM AND WAM), SOURCED FROM EWA

No further new technologies in the local production of electricity are envisaged for future years. The emission factors used to project emissions were the same as those used in the compilation of the inventory 2017-baseline; hence either country specific, measured through CEMS or obtained from the guidebook as in case of historical emissions. Since the difference in terms of fuel consumption between the WM and WaM scenarios was very small, so were respective emissions. The difference in projected fuel consumption is due to the use of renewable energy sources.

The below graphs show the trend of emissions across the time series, 2005 to 2017, 2018, 2020, 2025 and 2030.

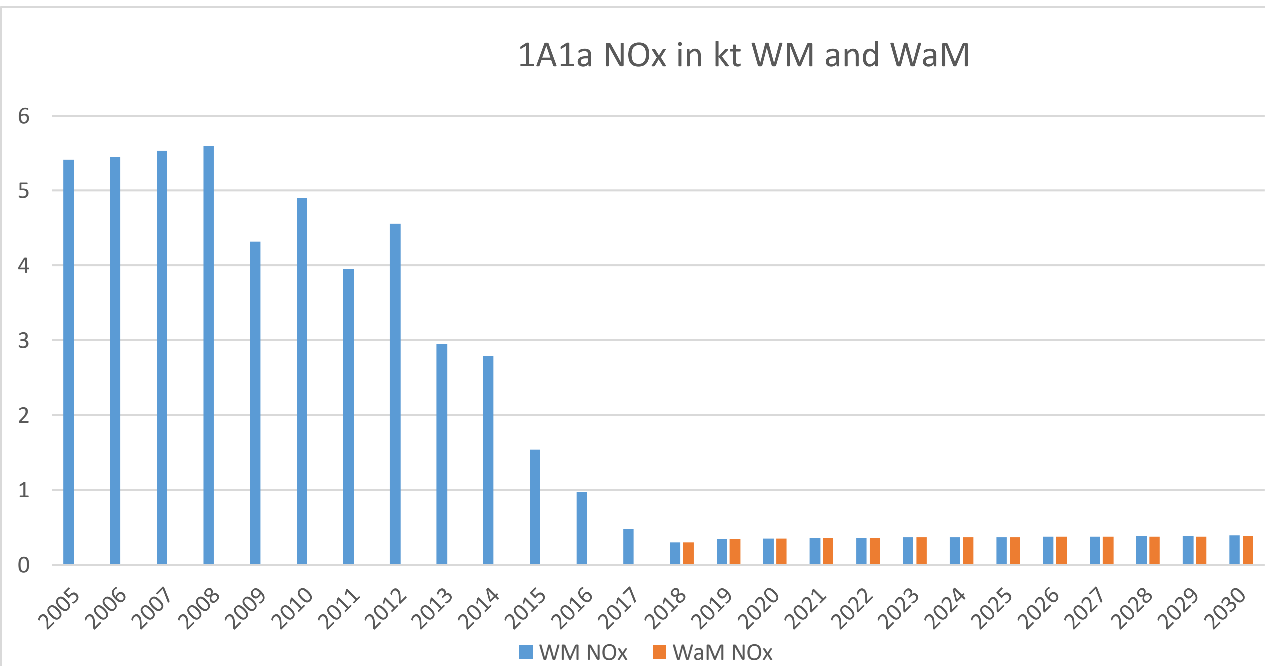

FIGURE 8: 1A1A NO_X IN KT TIME SERIES (WM AND WAM)

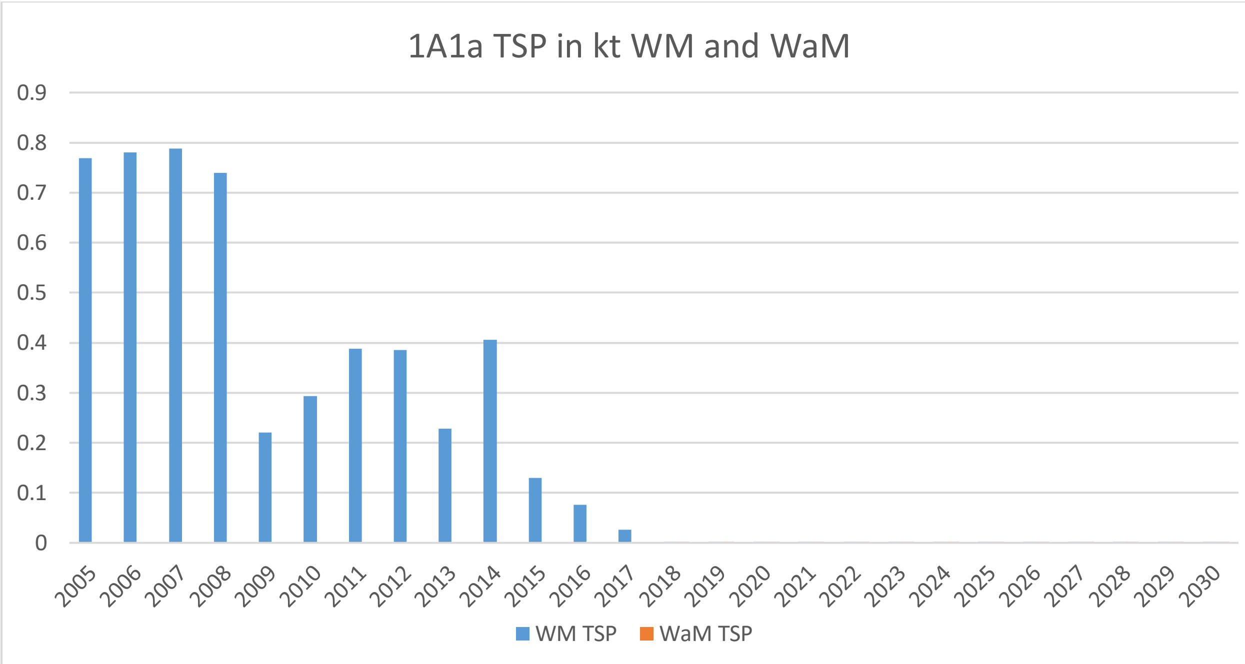

FIGURE 9: 1A1A TSP IN KT TIME SERIES (WM AND WAM)

There has been an overall decrease in emissions with regards to NO_x and this is most likely due to more efficient technologies, use of the interconnector and the use of SCR at the Delimara power station (DPS6) and D3pg. The trend of TSP emissions show the same decrease across the time series. However, the determining factor in the decrease of emission loads is considered to be the use of gaseous fuel instead of liquid fuel. Gasoil-based generation capacities are available as back-up in case of emergencies or when other sources are not available. It must be pointed out that the energy system modelling tools assume that electricity will be generated by the natural gas-fired units and therefore gasoil consumption is projected to remain zero until the end of the projected period, hence the low TSP emissions.

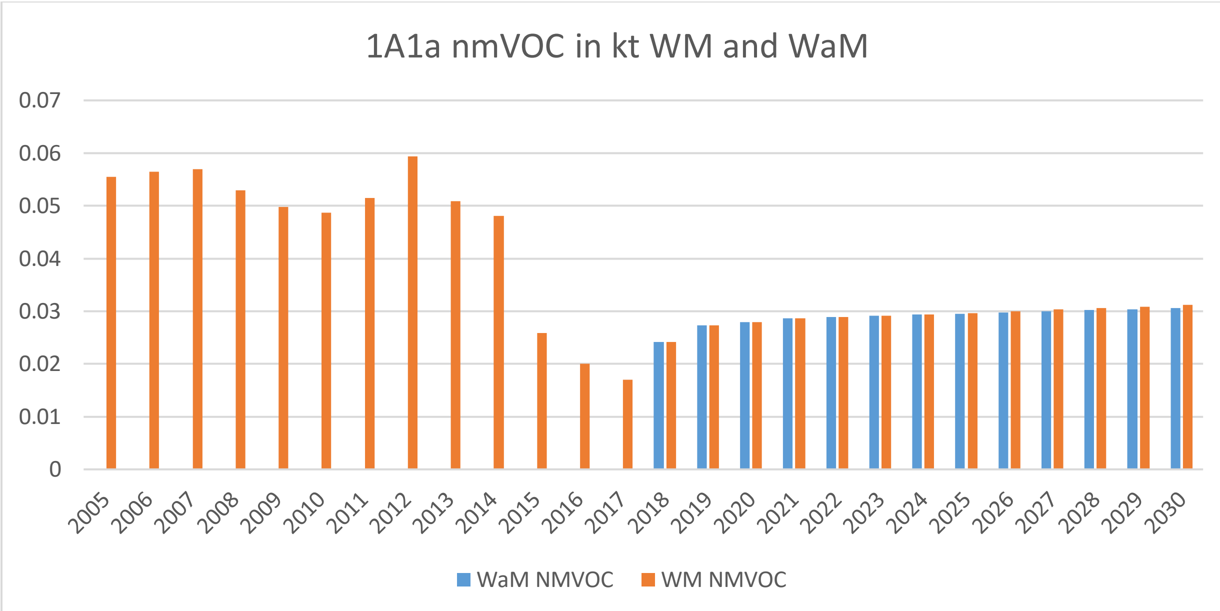

FIGURE 10: 1A1A NMVOC IN KT TIME SERIES (WM AND WAM)

The time series shows an overall decrease in NMVOC emissions until 2017 and then a constant trend until 2030. This was estimated from default factors hence emissions were directly proportional to activity or fuel consumed in GJ.

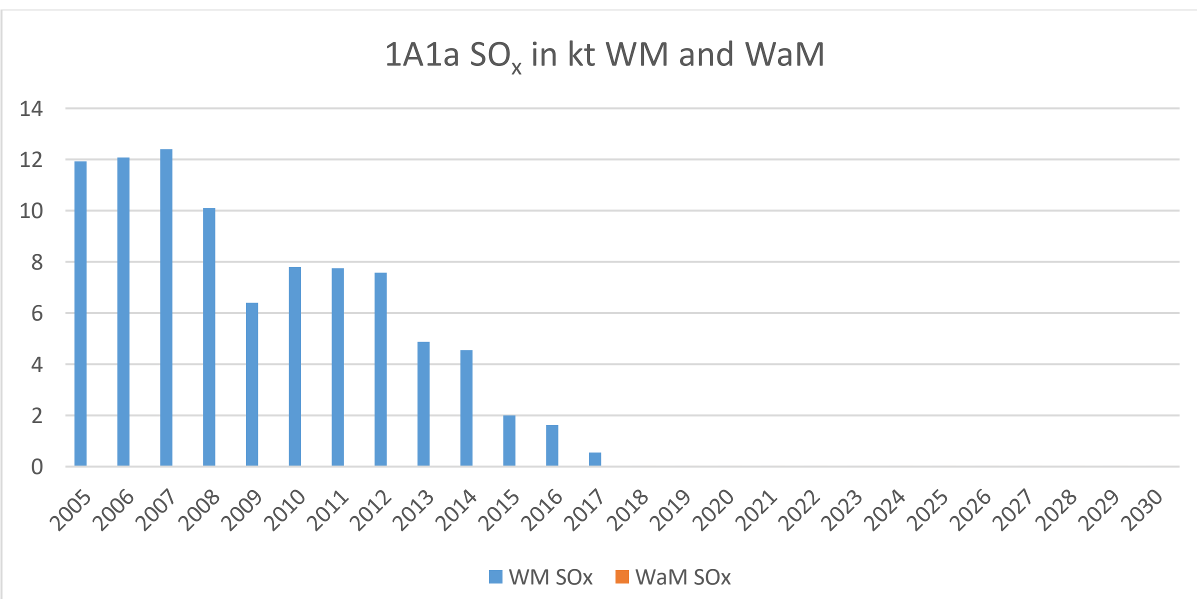

FIGURE 11: 1A1A SO_X IN KT TIME SERIES (WM AND WAM)

SO_x emission loads were estimated directly from the percentage sulphur content of fuel which was obtained from the Regulator for Energy and Water Services (REWS). The time series plot above shows a drastic decrease in emissions along the years which is attributed to better fuel quality.

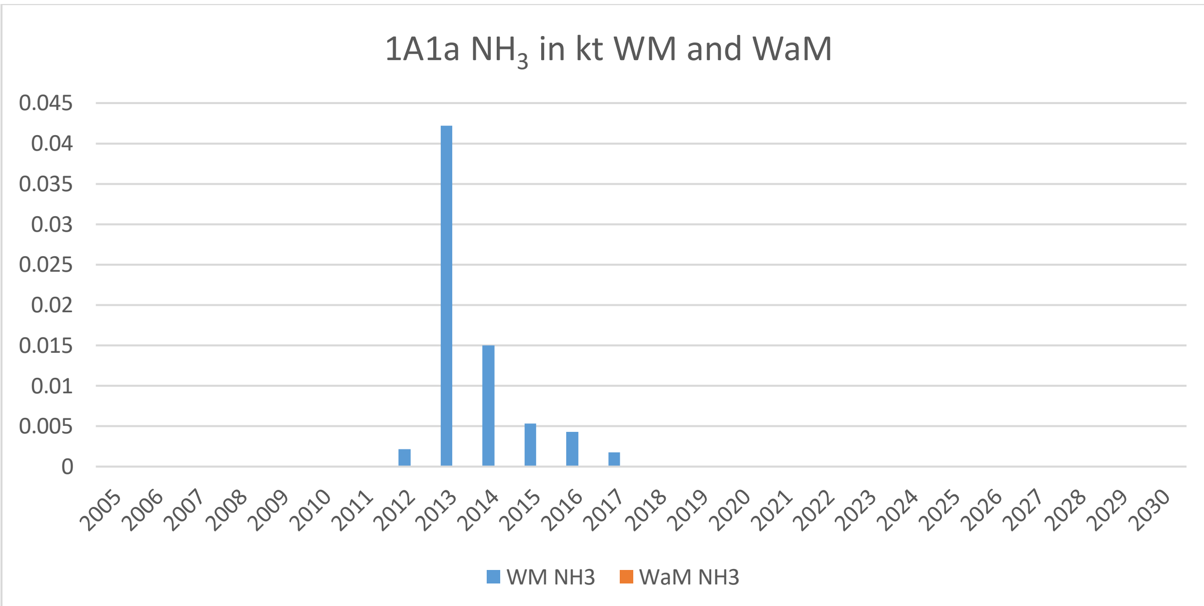

FIGURE 12: 1A1A NH_3 IN KT TIME SERIES (WM AND WAM)

Selective catalytic reduction was present at the Delimara power station since 2012 but not available in all other plants. The high annual average of ammonia concentration recorded in 2013 was due to spent catalyst in NO_x abatement. An additional layer of new catalyst was installed and values were back to normal.

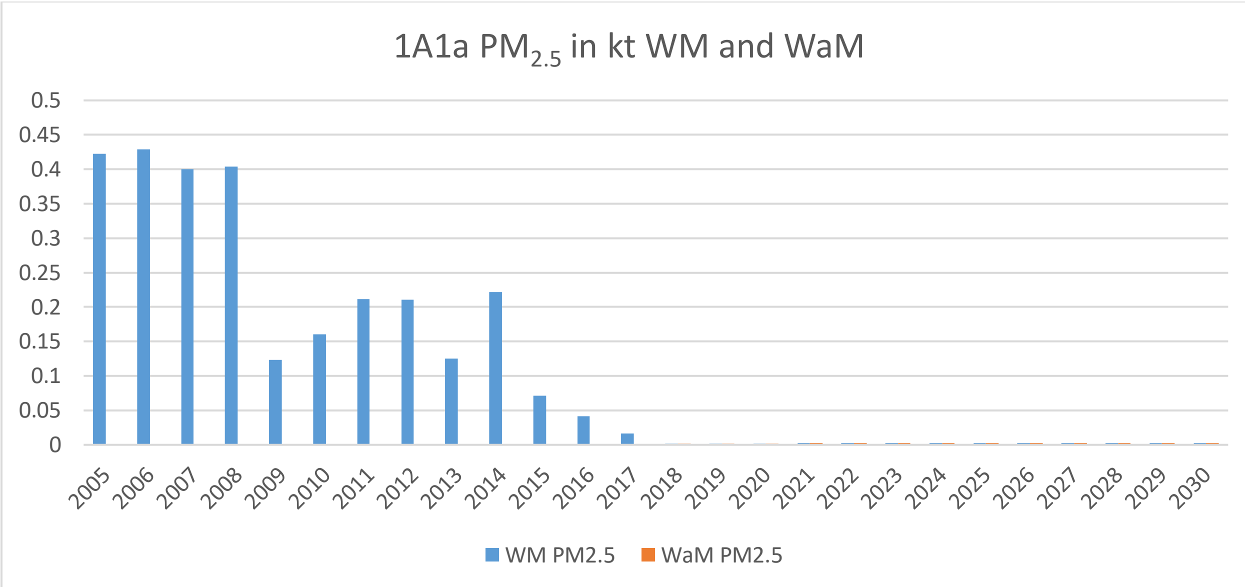

FIGURE 13: 1A1A $PM_{2.5}$ IN KT TIME SERIES (WM AND WAM)

The trend in $PM_{2.5}$ emissions shows a substantial decrease of emissions from 2014 onwards in line with that of TSP.

1A2gviii: Stationary Combustion in Manufacturing Industries and Construction

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
1A2gviii	Stationary Combustion in Manufacturing Industries and Construction	2016GB	EWA/NSO	Tier 1	Benzo(a)pyrene, Benzo(b)fluoranthene, indeno (1,2,3-cd) pyrene	2019 submission

Emissions from 'Stationary Combustion in Manufacturing Industries and Construction' were reported under group sector 1A.2.g.viii. Emissions estimated in this sector originated from the fuel consumed by activities falling under NACE code B to F i.e. mining and quarrying, manufacturing, electricity, gas, steam and air conditioning supply and construction. Fuel data consumption was sourced from the fuel survey conducted by EWA and NSO for years 2013 to 2017. Activity data for the years 2005 to 2012 were missing hence the average of the fuel survey data was calculated and used to complete the time series calculation. EWA also provided projections for fuel used in the industrial sector and this data was used to project emissions to 2020, 2025 and 2030, for both the WM and WaM scenarios, which in this case are identical. Estimation of emissions was done by following a tier 1 approach obtained from the 2016GB.

The below graph shows the trend of fuel consumption for the historical and projected time series in TJ.

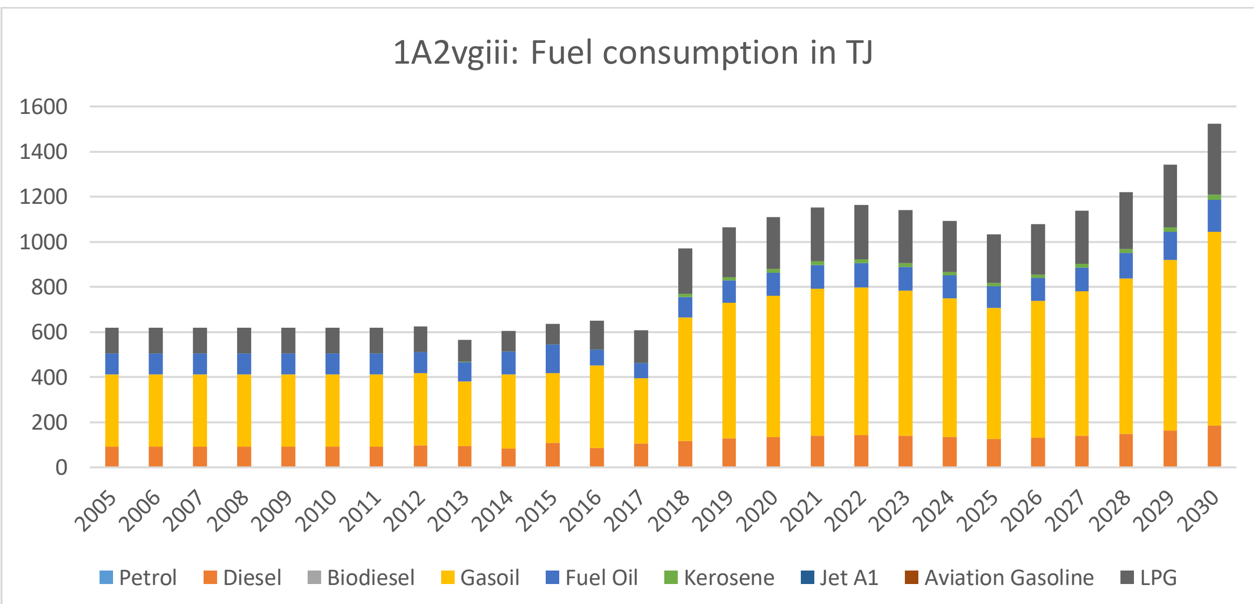

FIGURE 14: 1A2VGIII: FUEL CONSUMPTION IN TJ TIME SERIES

As expected, emissions calculated show the same trend as that of fuel consumption.

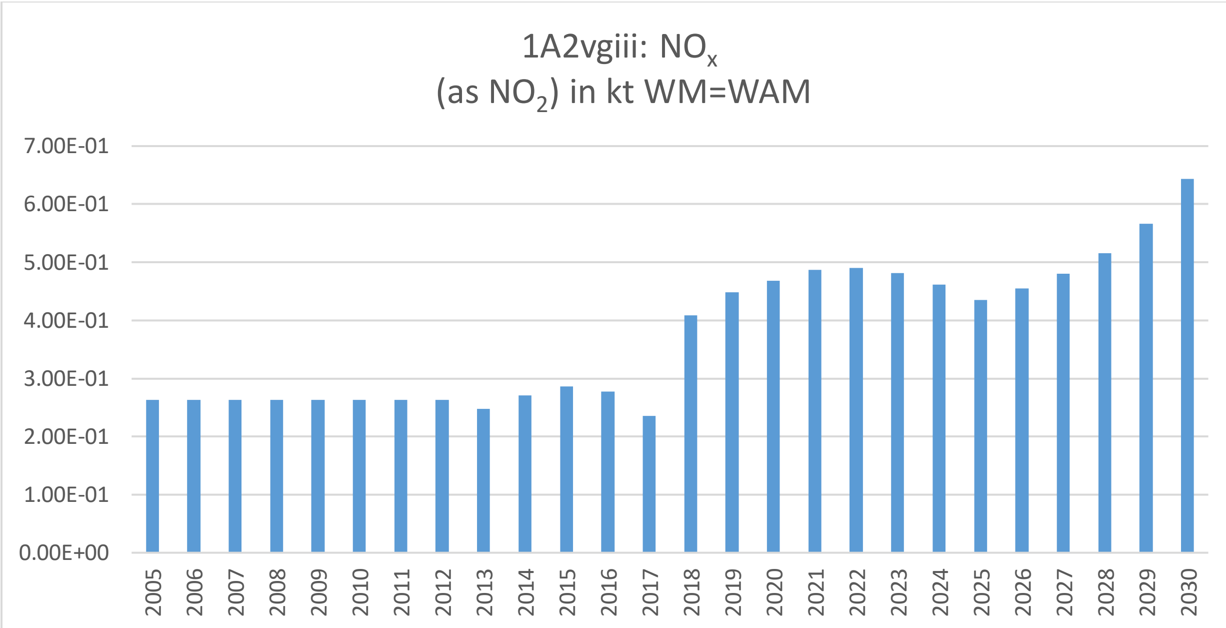

FIGURE 15: 1A2VGIII: NO_x (AS NO_2) IN KT TIME SERIES

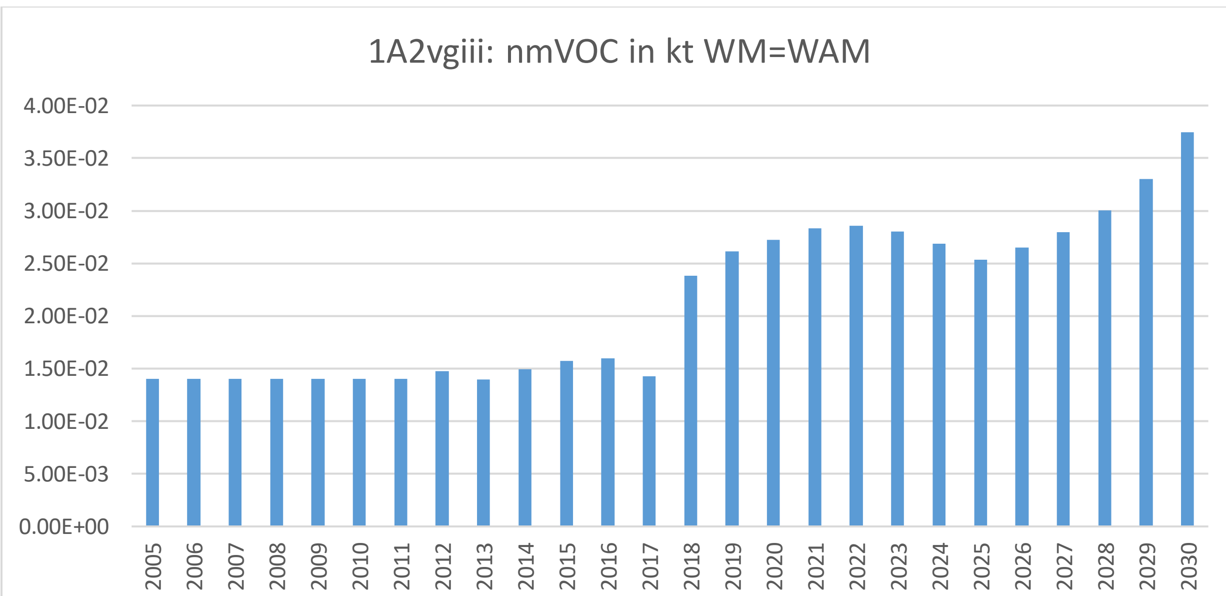

FIGURE 16: 1A2VGIII: NMVOC IN KT TIME SERIES

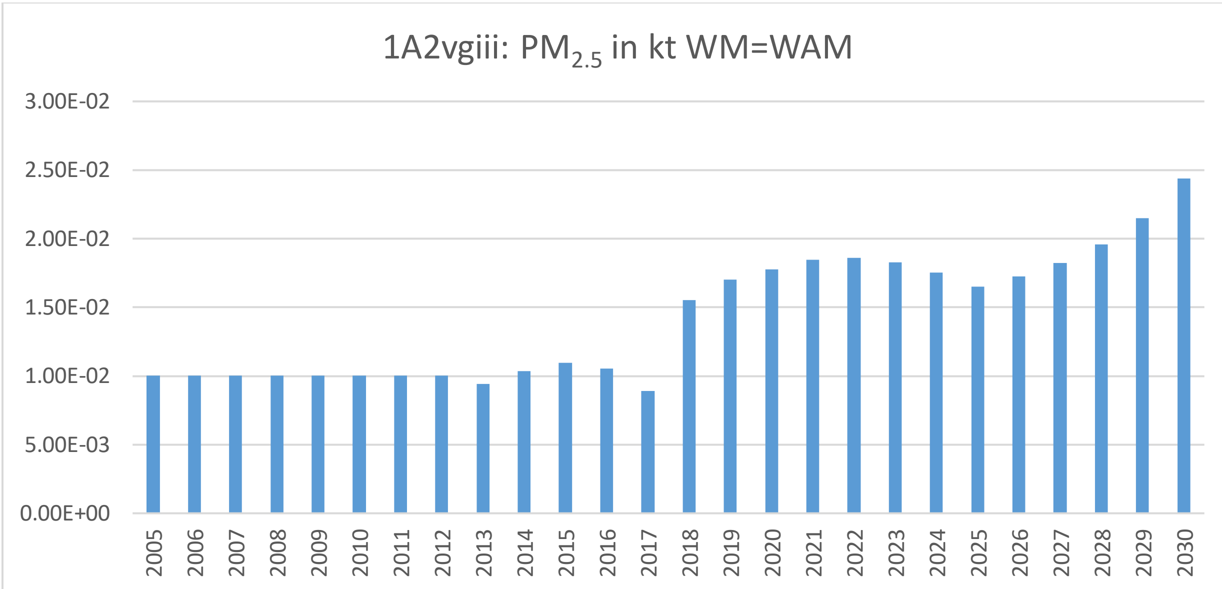

FIGURE 17: 1A2VGIII: $PM_{2.5}$ IN KT TIME SERIES

The percentage sulphur content obtained from REWS was used to estimate SO_x for some years and fuels. Data was available for 2014 to 2017. The latter three years were very different from that of 2014. The 2016 percentage sulphur content was in the middle between the lowest (2014) and the highest (2017) and hence used across the time series (2005 – 2017).

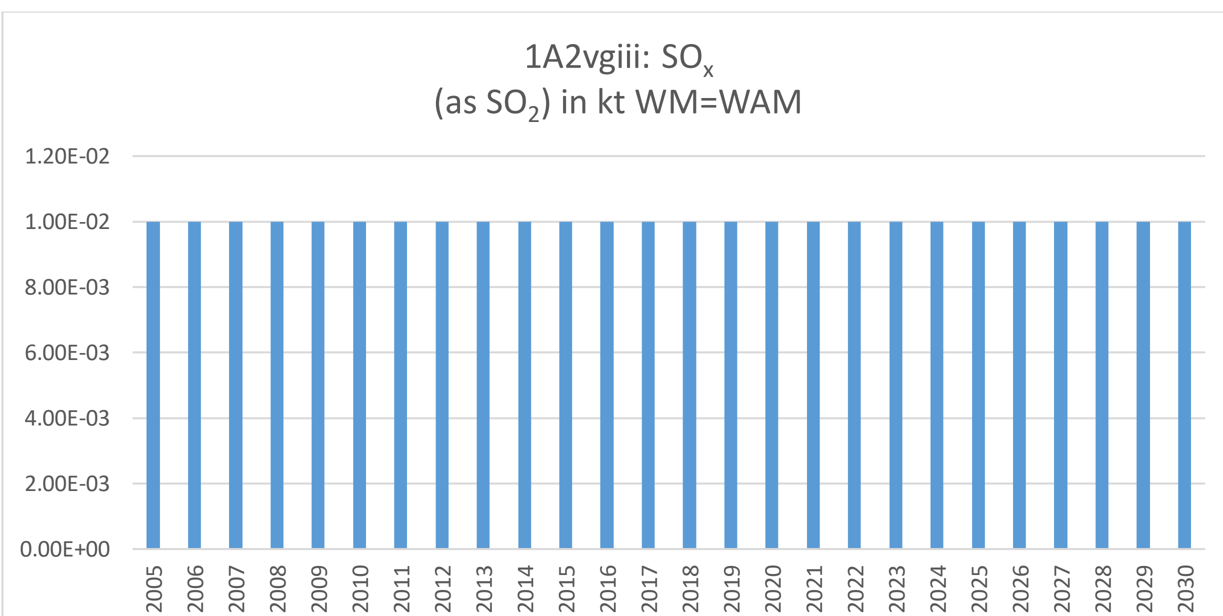

FIGURE 18: 1A2VGIII: SO_x (AS SO_2) IN KT TIME SERIES

Ammonia was not estimated since no information on availability of selective catalytic reduction equipment was available.

1A3. Transport

The transport sector covered in this submission includes the following group of sectors; 1A3ai(i) International aviation Landing and Take Off (LTO) (civil), 1A3aii(i) Domestic aviation LTO (civil), 1A3bi-bvii Road transport and 1A3dii National navigation (shipping).

1A3a Aviation

NFR-Code	Name of sub-Category	Method	Activity Data Source	EF	Key Category for pollutants
1A3a	Domestic Aviation LTO (civil), International Aviation LTO (civil)	Master emissions calculator	Malta International Airport for historical emissions and EWA/NSO for projected emissions	Master emissions calculator (by EUROCONTROL)	NO_x

Emissions were calculated separately for each of the following categories; Domestic Aviation LTO (civil) (1A3ai(i)) and International Aviation LTO (civil) (1A3ii(i)) and reported under each respective NFR code. This submission includes an update of the historical emissions of the time series ranging from 2005 to 2017, together with emission projections for 2020, 2025 and 2030 for the WM and WaM scenarios, which in this case are identical. The only airport present on the island i.e. Malta International Airport (MIA) provided the number of LTO cycles split into domestic and international flights for 2005 to 2017 for each aircraft model.

Domestic LTO is defined as the number of flights performed locally by flight schools and other trips around the Maltese Islands for leisure. All other flights, which departed from the Luqa international airport to land in foreign airports, were considered as international.

The EWA projected aviation kerosene consumption for future years without distinguishing between international and domestic consumption. The trend in fuel consumption projected by EWA across 2018 to 2040 was used to project the LTOs to future years, whilst 2017 LTO figures for both domestic and international flights respectively were used as baseline. The aircraft models landing locally in 2017 were assumed to remain the same for the projected years since no other information was available.

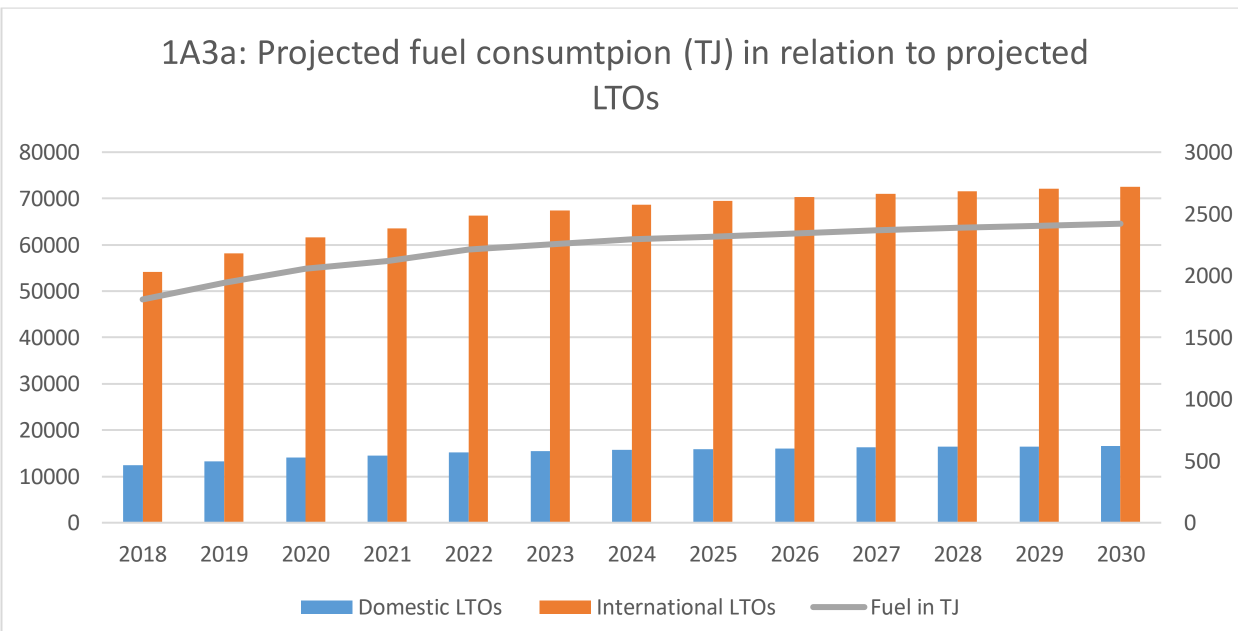

FIGURE 19: 1A3A: PROJECTED FUEL CONSUMPTION (TJ) IN RELATION TO PROJECTED LTOS

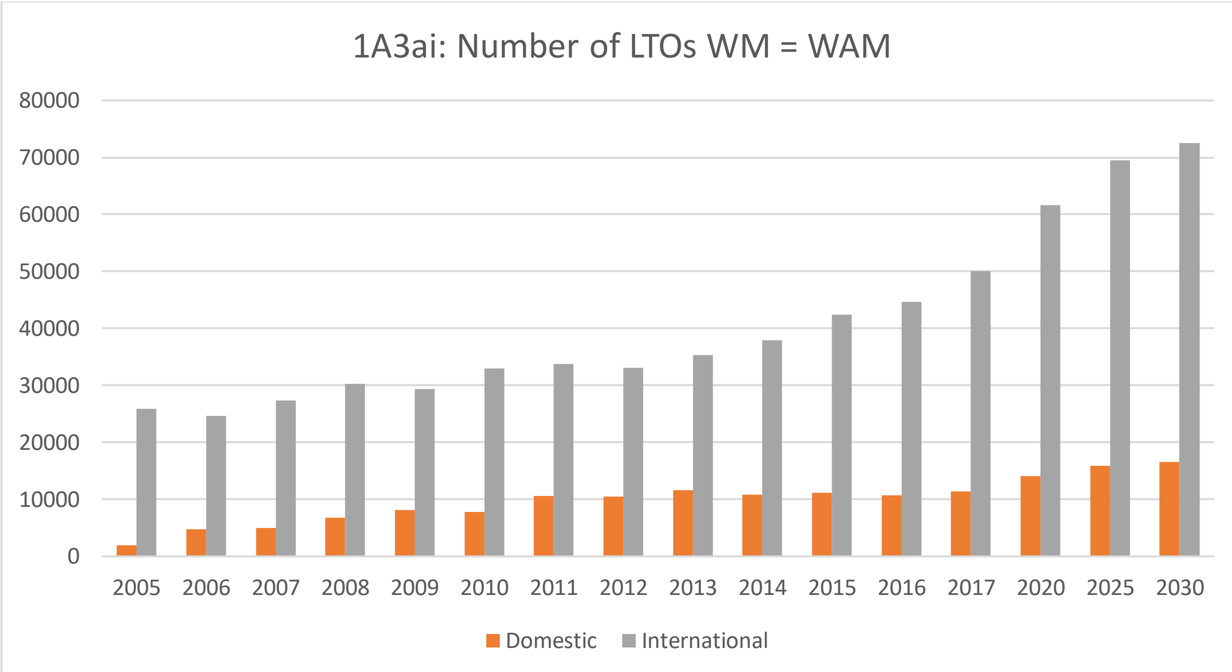

FIGURE 20: 1A3AI: NUMBER OF LTOS TIME SERIES

Emissions factors were extracted from the model developed by EUROCONTROL known as 'Master emission calculator' and multiplied with the number of LTOs.

The emission factors were based on the following parameters;

Phases	ICAO default
Taxi	00:26:00
Take off	00:00:42
Climb out	00:02:12
Approach	00:04:00
TOTAL	**00:32:54**

TABLE 4: ICAO DEFAULT PARAMETERS

The emission factors sourced from the EMEP/EEA model were specific for certain pollutants (NO_x, SO_x, NMVOC and CO) for only certain types of aircraft models.

Hence, since a considerable number of emission factors associated with domestic flights were missing for 2017, respective emissions were also very low. This resulted in a considerable decrease in emissions in 2017 and this trend was projected forward as can viewed in the below graphs.

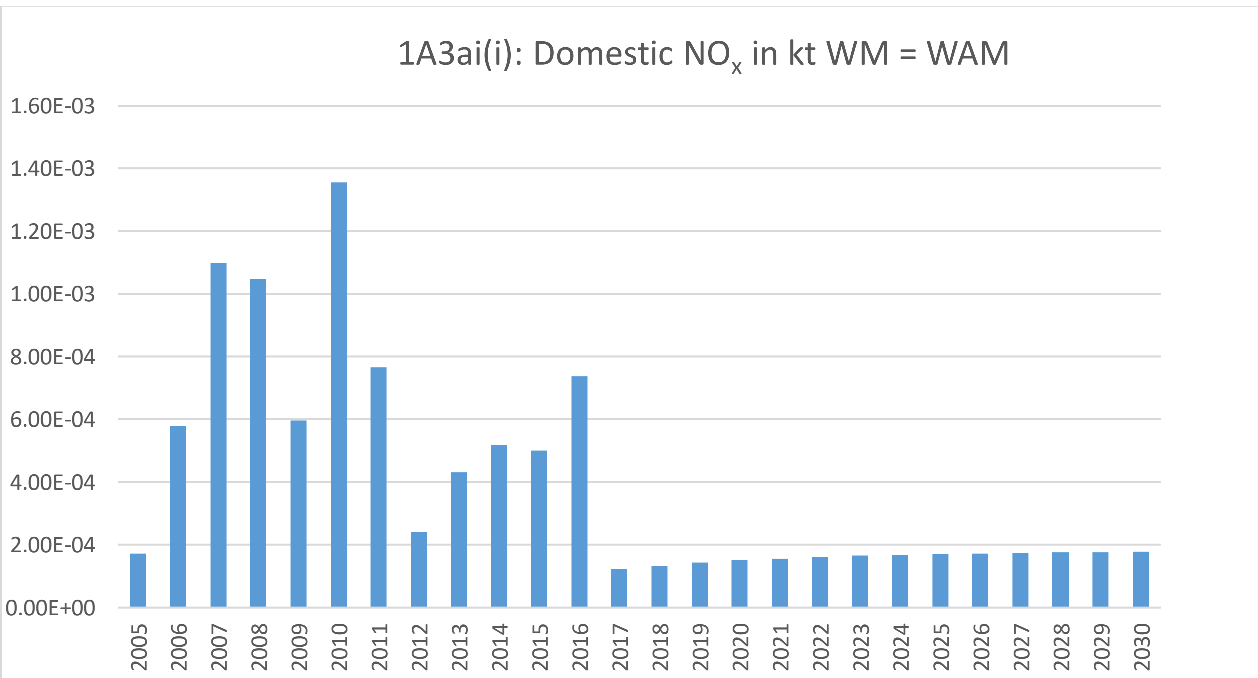

FIGURE 21: 1A3AI(I): DOMESTIC NO_x IN KT TIME SERIES

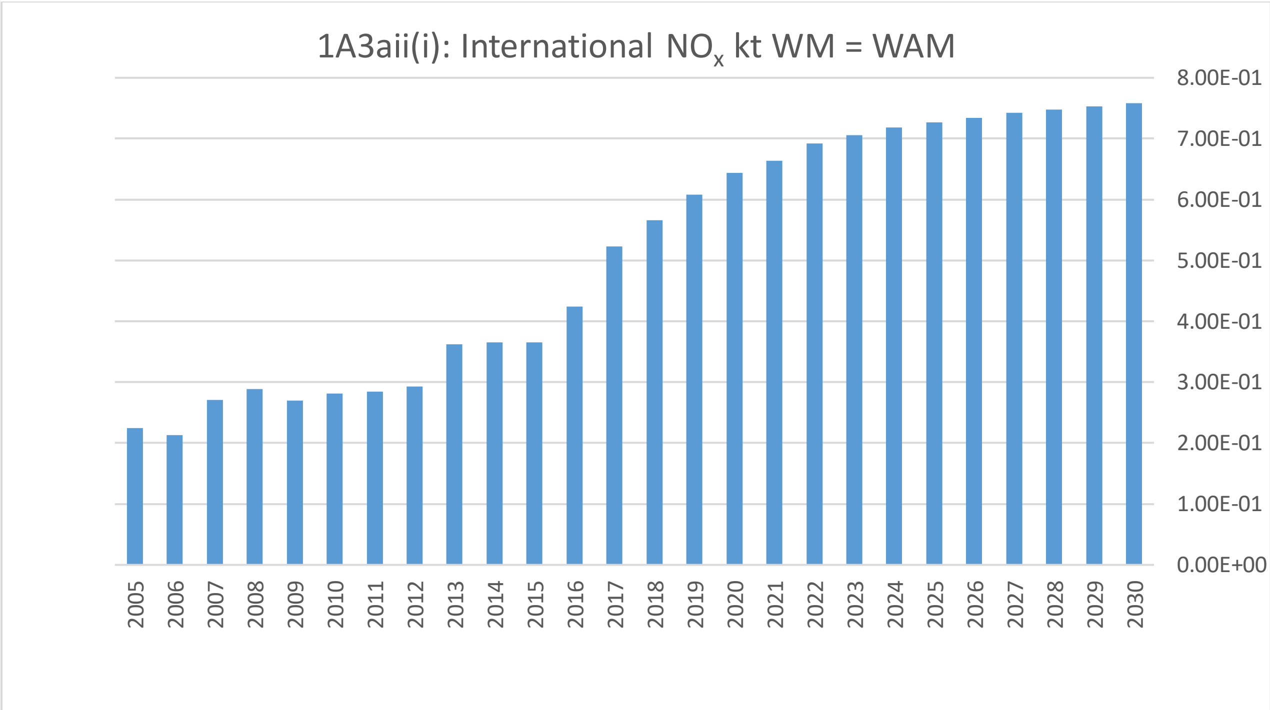

FIGURE 22: 1A3AII(I): INTERNATIONAL NO_x KT TIME SERIES

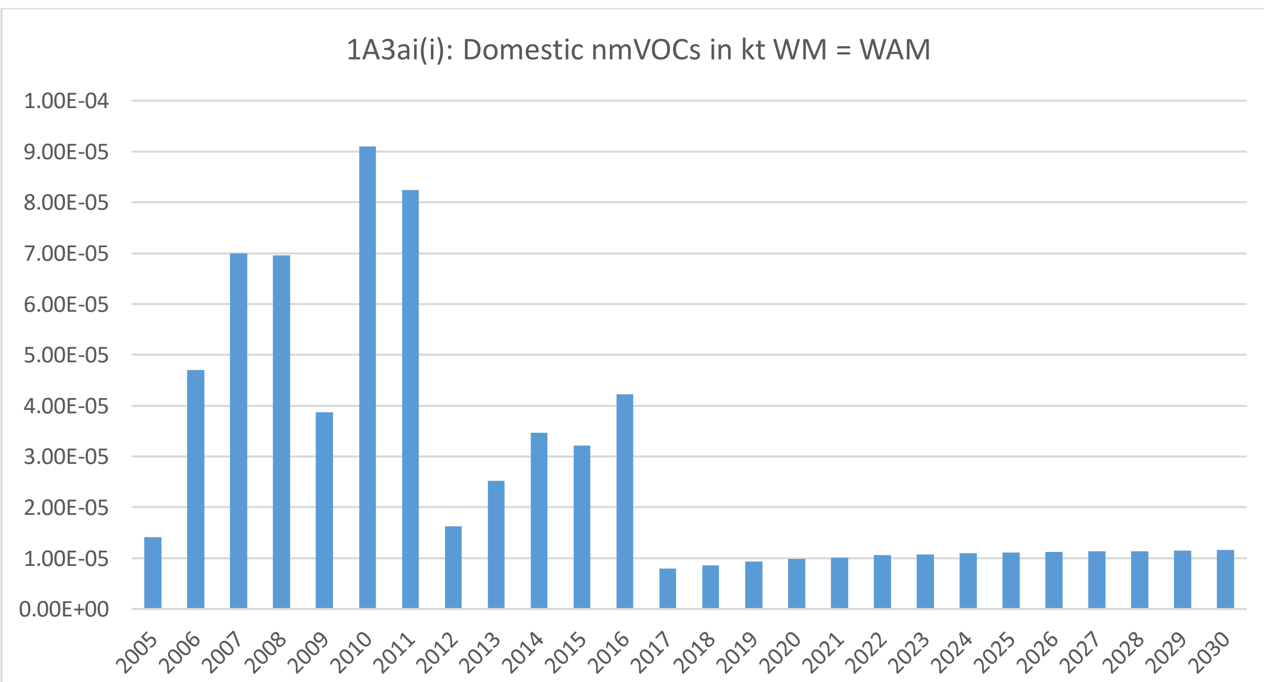

FIGURE 23: 1A3AI(I): DOMESTIC NMVOCS IN KT TIME SERIES

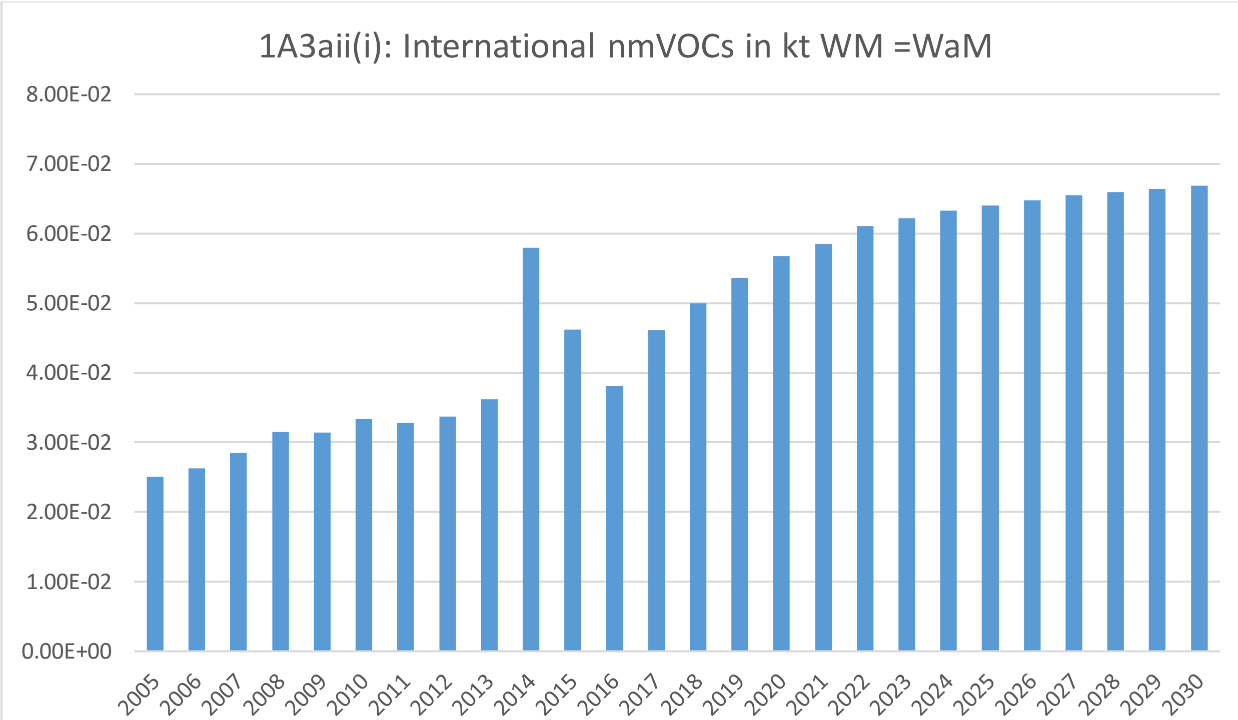

FIGURE 24: 1A3AII(I): INTERNATIONAL NMVOCS IN KT TIME SERIES

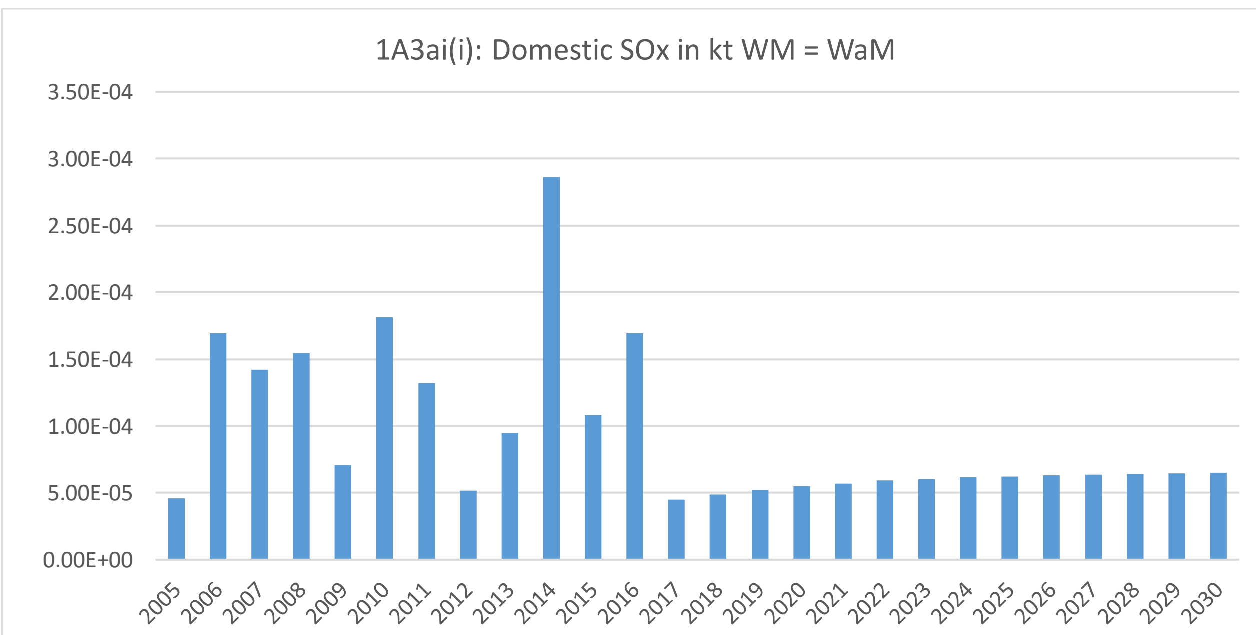

FIGURE 25: 1A3AI(I): DOMESTIC SO_x IN KT TIME SERIES

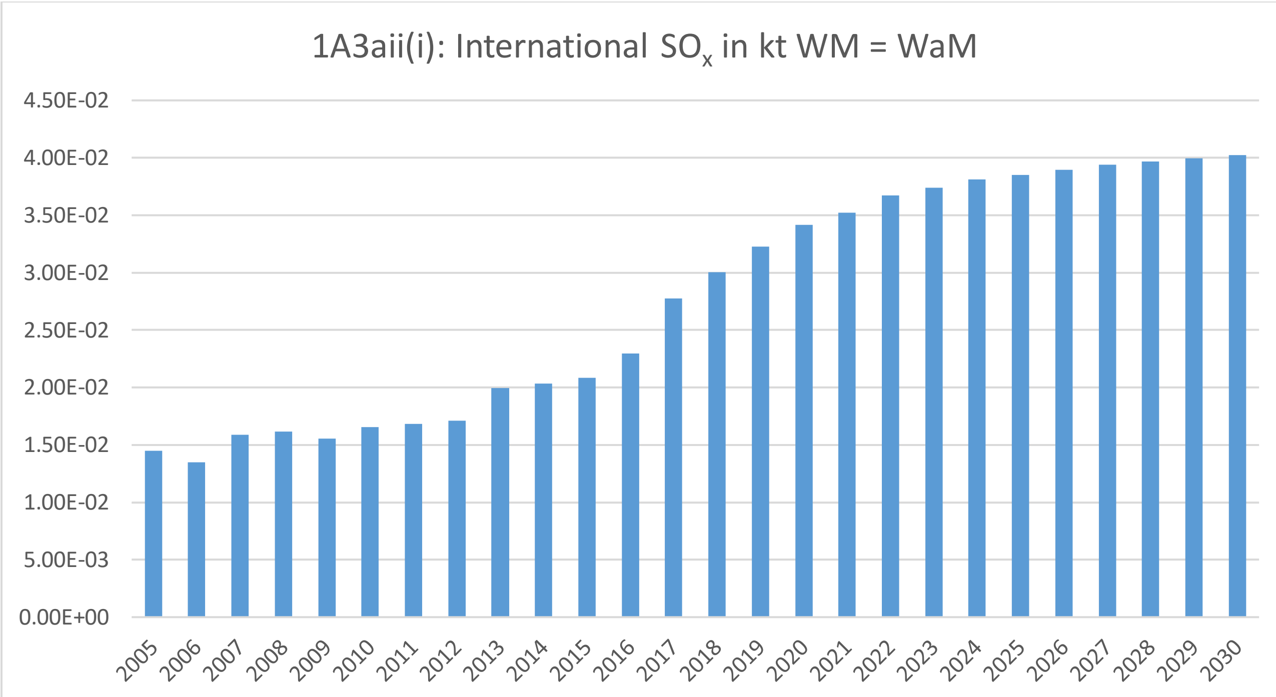

FIGURE 26: 1A3AII(I): INTERNATIONAL SO_X IN KT TIME SERIES

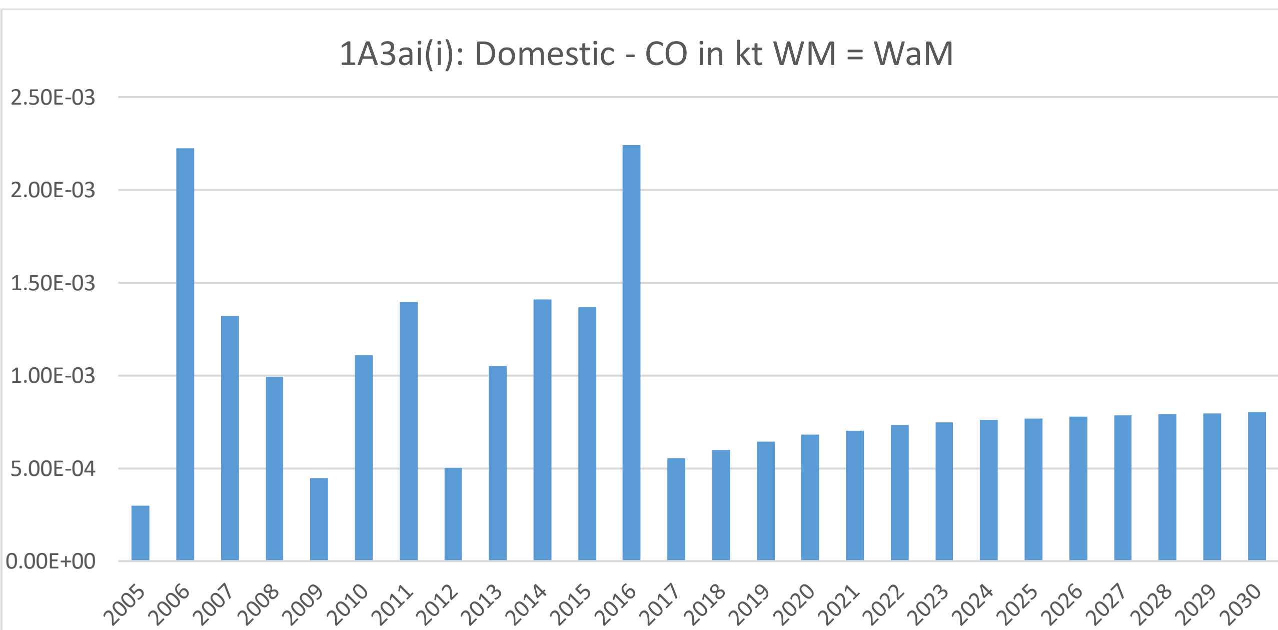

FIGURE 27: 1A3AI(I): DOMESTIC - CO IN KT TIME SERIES

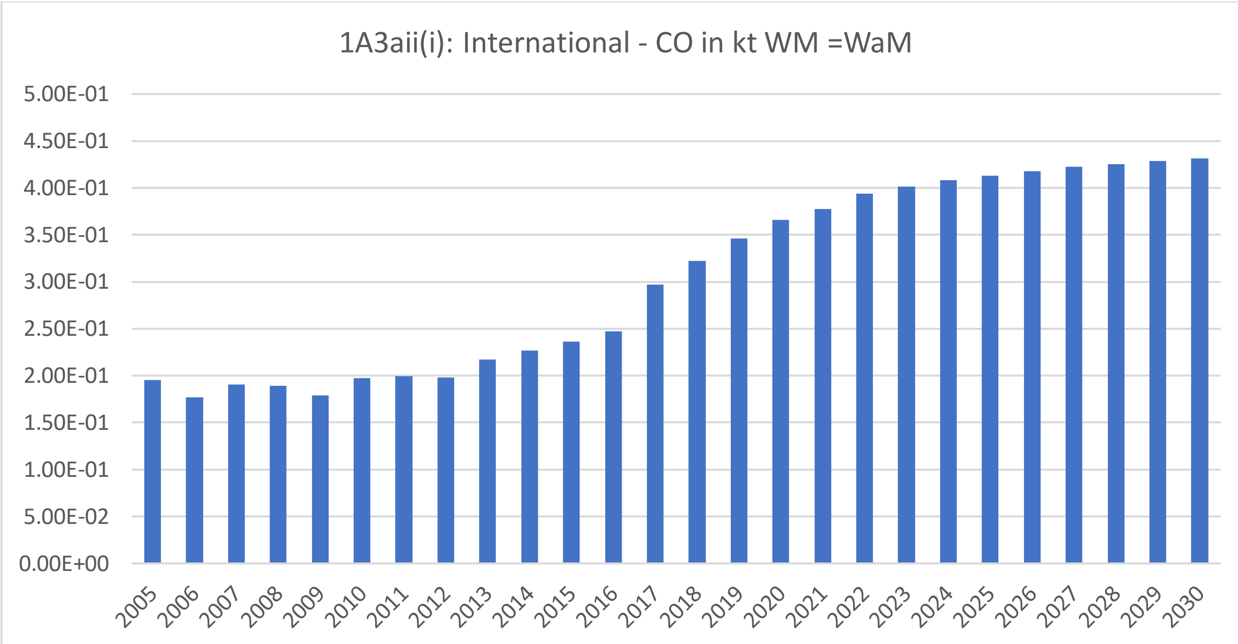

FIGURE 28: 1A3AII(I): INTERNATIONAL - CO IN KT TIME SERIES

International aviation is clearly the major source of emissions from the aviation industry for each pollutant since the degree of activity (LTOs) is very high compared to that of domestic aviation.

1A3b: Road Transport

NFR-Code	Name of sub-Category	Method	Activity Data Source	EF	Key Category for pollutants	Year of last update
1A3b	Road Transport	COPERT 5.2	EWA, TM, REWS, MRA	Tier 3	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, TSP, BC, CO, Pb, Cd, Cr, Cu, Ni, Se, Zn, PAHs	2019 submission

Emissions from motorised road vehicles in Malta were reported under group sector, 1A.3.b. Emissions estimated under this sector were based on the vehicle fleet circulating on public roads excluding agricultural and military transport.

Emissions were calculated for each of the following categories: 1A.3.bi, Passenger Cars; 1A.3.bii, Light Duty Vehicles; 1A.3.biii, Heavy-Duty Vehicles and Buses; 1A.3.biv, Mopeds and Motorcycles; 1A.3.b.v, Gasoline Evaporation; 1A.3.b.vi, Tyre & brake Wear and 1.A.3.b.vii, Road Surface Abrasion.

In this submission, road transport emissions were estimated by means of COPERT 5.2 for 2017, based on historical activity data and for 2020, 2025 and 2030 for the WM and WAM scenarios, based on projected activity data. Efforts will be made to update the next submission for 2005 to the year 2018.

The updated parameters are listed in the table below:

Parameters used for historical input parameters	Source of parameters used
Environmental Information	Data was obtained from the climate change team at MRA, who obtained the data from the National Meteorological Office
Trip Characteristics (average trip duration and average trip length)	Transport Malta (TM) – National Transport Model
Fuel Specification	Percentage sulphur content in fuel was obtained from the Regulator of Energy and Water Services (REWS), COPERT default figures were used for the remaining fuel parameters.
Statistical consumption	Energy and Water Agency and the National Statistics Office - 2019 fuel survey
Reid Vapour Pressure	COPERT 5 Default figure – EMISIA S.A
Stock and Activity	The model developed by the Energy and Water Agency generated historical data for both stock and total mileage
Circulation (Average speed and percentage mileage share per road type)	Transport Malta (TM) – National Transport Model
Fuel blend	Regulator for Energy and Water Services; E0 and B7
Lifetime cumulative mileage	Energy and Water Agency

TABLE 5: COPERT PARAMETERS FOR 2017 EMISSION CALCULATIONS

Projections of air quality pollutants were also calculated using the same COPERT methodology. The table below outlines the source of information for each projected parameter used to run the COPERT model.

Parameters and dataset for projected input parameters	Source of information
Environmental Information	An average of the maximum and minimum temperature for years 2015, 2016 and 2017 was calculated and used for each projected year for both WM and WaM scenarios.
Trip Characteristics (average trip duration and average trip length)	TM provided trip length and duration for each projected year and scenario.
Fuel Specification	An average of the 2015, 2016 and 2017 percentage sulphur content in fuel was calculated and used for the projected years.
Statistical consumption	The Energy and Water Agency projected fuel for 2020, 2025 and 2030 for both WM and WAM scenarios.
Reid Vapour Pressure	The same as those used in 2017
Stock and Activity	The Energy and Water Agency projected fleet annual mean for each projected year and scenario.
Circulation	Transport Malta (TM) – National Transport Model
Fuel blend	The Regulator for Energy and Water Services did not have this information hence the 2017 blends were used for the projected years.
Lifetime cumulative mileage	The same data source and procedure used for the historical inventory.

TABLE 6: COPERT PARAMETERS USED FOR PROJECTIONS

Circulation data was provided by TM. Each of the road types in COPERT (urban, rural and highway) have both a speed and a respective mileage share driven. The percentage share was calculated and inputted into COPERT. TM also provided both morning and evening peak hour speed data for every road type and for WM and WAM scenarios. The average was calculated and inputted into COPERT. Since no data was made available for urban off-peak hours speed, data was taken from another project in which speed data was measured at a small number of roads for a week.

The speed at off-peak hours was averaged and inputted into COPERT. No distinction was made between different vehicle types since the information was not available at this level of detail. Below there is a table of the data inputted in the model:

	urban peak % share	urban off peak % share	rural % share	highway % share	urban peak speed km/hr	urban off peak speed km/hr	rural speed km/hr	highway speed km/hr
WaM								
2030	51.1	12.7	1.6	34.6	12.7	51	7.6	24.35
2025	50.5	13.3	1.6	34.6	13.48	51	8.05	26.4
2020	50.6	13.2	1.6	34.6	13.3	51	8.1	23.9
WM								
2030	52.3	11.5	1.6	34.6	11.2	51	7.2	17.4
2025	51.7	12.1	1.6	34.6	11.9	51	7.5	18.4
2020	51.3	12.5	1.6	34.6	12.5	51	7.8	19.55
2017	51.4	12.4	1.6	34.6	12.5	51	7.8	19

TABLE 7: PERCENTAGE VKM SHARE AND RESPECTIVE SPEED

SCR, A/C usage and mileage degradation functions were checked and default factors were used when running the model with the above input parameters. The fuel balance function was not checked since actual mileage data was considered representative of the real scenario. Other parameters included in COPERT such as average trip length and distance, were obtained from the national road transport model and kept the same for all projected years and scenarios, since no better data was available.

As previously explained, historical fuel consumption was provided through the fuel survey and projected for future years by the EWA. This data consisted of consumption of petrol, diesel, biodiesel and LPG. However, only petrol and diesel were projected for the WM scenario and petrol, diesel and biofuels were projected for the WAM scenario. The decision to extend the substitution of conventional fuels through the use of biofuel after 2020 was taken after 2017, and hence this was included in the WAM scenario only.

The following text is a summary of the procedure followed by the EWA to generate the stock and respective mileage databases from NSO data. This information was sourced from the Methodological Note of the road transport model developed by the EWA.

Annual Average vehicle per km (vkm)

The 2017 - 2018 VRT (Vehicle Roadworthiness Testing) data provided by NSO to EWA included vkm data. This was used to determine the annual mean mileage a vehicle is expected to drive, based on its year of manufacture. A database was generated with the total mileage of each car aged between 4 and 100 years. Outliers were eliminated and data on vehicles older than 25 years vehicles were ignored (since sample size was not significant). Vehicles under 5 years of age were not subject to VRT hence a constant vkm figure was used for these vehicles. The resulting normalized plot indicated that as a vehicle gets older, the respective annual mileage decreases. The cumulative mileage was calculated by summing up the annual mean mileage of each year the vehicle has been on the road.

Total vehicle kilometres

Moreover, total vehicle kilometres were projected for each of the five major vehicle types for future years. This was done by using historic information to estimate the elasticity of total vkm of each vehicle type against a macroeconomic indicator.

Vehicle category	**Macroeconomic driver to estimate total vkm**
New PC	Population
New LDV	Wholesale and Retail GVA
New HCV	Wholesale, Retail and construction GVA
New MC&QUAD (L-category)	Population
New Buses	MB: Population (4 -15 years) CPB: Inbound tourists (Air passengers) RB: No driver used

Table 8: Macroeconomic drivers used to project vkm

The total mileage of each of the five vehicle types between 2018 and 2040 was estimated using the following equation;

$$VKM_t = VKM_{t-1} + (1 \times m \times g_t)$$

EQUATION 2: EQUATION TO ESTIMATE TOTAL MILEAGE BY VEHICLE TYPE

Where:

- VKM_t = The estimate of total VKM driven by a vehicle category at period *t*;
- VKM_{t-1} = The estimate of total VKM driven by a vehicle category at period *t-1*;
- m = The elasticity of total VKM of a vehicle category against a macroeconomic indicator which is expected to drive the demand for that vehicle's use;
- g_t = annual growth rate of the indicator between period *t-1* and *t*

The model was used to estimate annual vkm between 2010 and 2017 for each vehicle category. The resultant data was used to calibrate the model against energy balance statistics. The projected vkm for 2018 - 2040 was considered to be equivalent to the demand to be matched by what remains of the stock as at end of 2017.

Stock of vehicles

Vehicle stock data was provided by NSO for the five main vehicle categories (Passenger cars, Light Duty Vehicles, Heavy Duty Vehicles, Buses and L-categories) and aggregated by fuel type and year of manufacture (YOM). The stock profile of the 2010 - 2017 database was extracted and used to create a survival profile for each vehicle type using the below equation:

$$Survival\ rate_v = Average\left(\frac{Stock_v - Stock_{v-1}}{Stock_v}\right) * (1 + Survival\ rate_{v-1})$$

EQUATION 3: EQUATION FOR THE SURVIVAL RATE PROFILE OF VEHICLES

v = vehicle's age

The survival profile was used to generate both historical and projected stock. The number of new vehicles being introduced on the market was estimated by finding the difference between the total vehicle demand and the actual service demand provided by the existing stock.

Fuel data was sourced from the survey conducted by NSO/EWA and this was then projected for future years (methodology explained in the Projections section). Thebar graphs in the next page show the fuel mix projected both for the WM and WaM scenario.

Further manipulation of data was required to organize data into COPERT format.

- Each subcategory was further broken down into the respective Euro standards based on the year of manufacture of the vehicle.
- The total mileage generated for each vehicle category was multiplied with the mileage share of each sub-category aggregated by Euro standard of the vehicle stock reported in 2017. The list of sub-categories can be found below:

Vehicle category	COPERT classification
Passenger Cars	Small (0.8 - 1.4L)
	Medium (1.4-2.0L)
	Large (Large (>2.0L)
Light Commercial Vehicles	N1-I (GVW<=1305kg)
	N1-II (1305kg<GVW<=1760kg)
	N1-III (1760kg<GVW<=3500kg)
Heavy Commercial Vehicles	Rigid <=7,5 t
	Rigid 7,5 - 12 t
	Rigid 12 - 14 t
	Rigid > 14 t
L-Category	Motorcycles < 50 cm³
	Motorcycles > 50 cm³
	Motorcycles < 250 cm³
	Quad and ATVs
Buses	Coaches Standard <=18 t
	Urban Buses Standard 15-18 t
	Urban Buses Midi <=15 t

TABLE 9: VEHICLE SUB-CATEGORIES

- The total mileage of each sub-category aggregated per Euro standard was divided by the respective number of stock to get the average annual vkm.

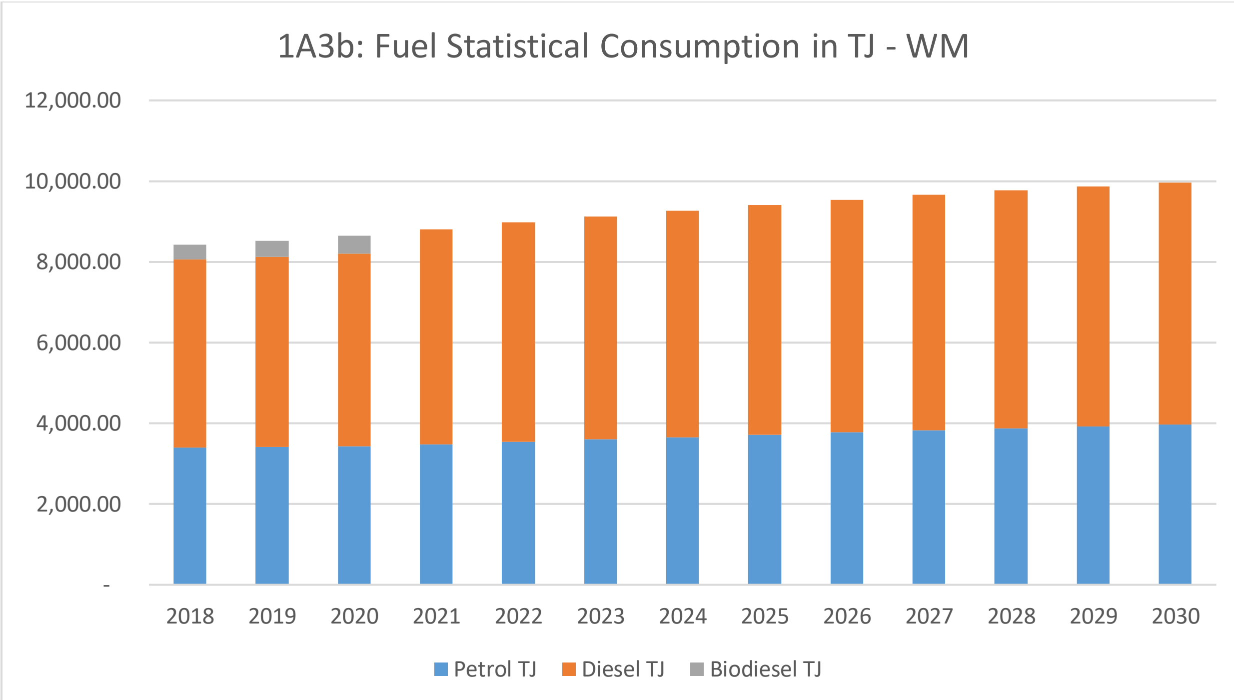

FIGURE 29: 1A3B: FUEL STATISTICAL CONSUMPTION IN TJ - WM

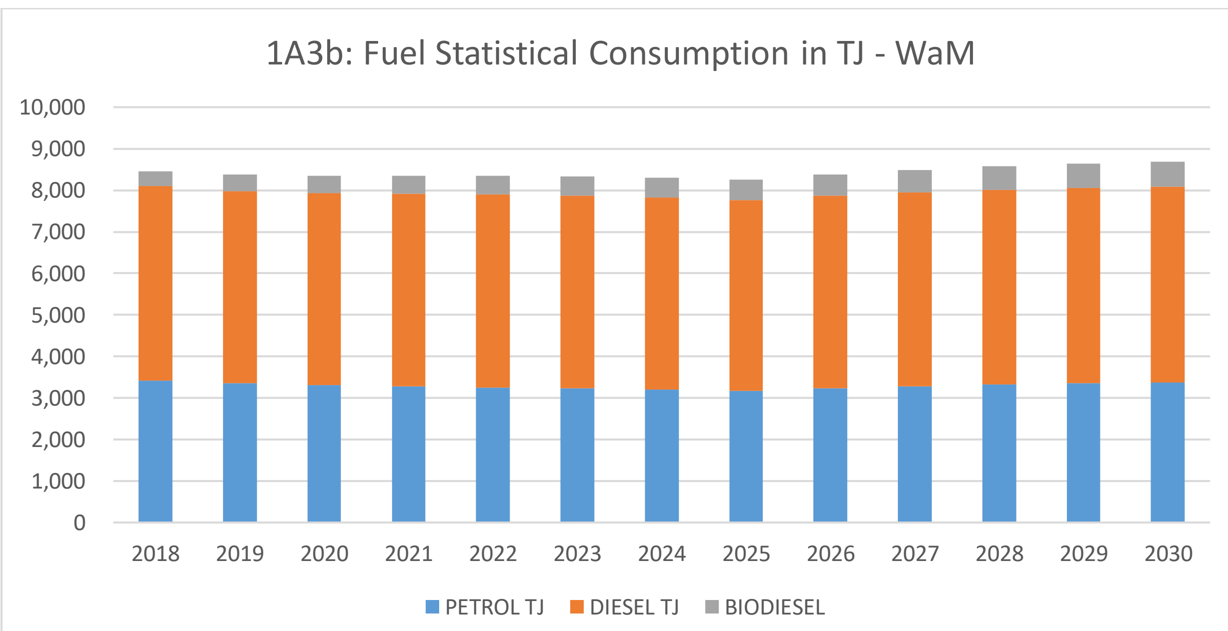

FIGURE 30: 1A3B: FUEL STATISTICAL CONSUMPTION IN TJ - WAM

Data on the percentage sulphur content in fuel was obtained from REWS for both petrol and diesel while COPERT default figures were used for other fuel parameters. The average sulphur content of 2015, 2016 and 2017 to project SO_2 emissions into the future. COPERT 5.2 default figures were used for reid vapour pressure and kept constant across all historical and projected years. Following consultation on the fuel blend with REWS, E0 and B7 were used across 2017 and the projected time series. Other parameters such as load and road slope were assumed to be 50% and 0% respectively since no actual data was available at the time of writing. Moreover, environmental data was obtained from the climate change team at MRA, who in turn, sourced this data from the National Meteorological office.

Historical and projected emissions are shown below.

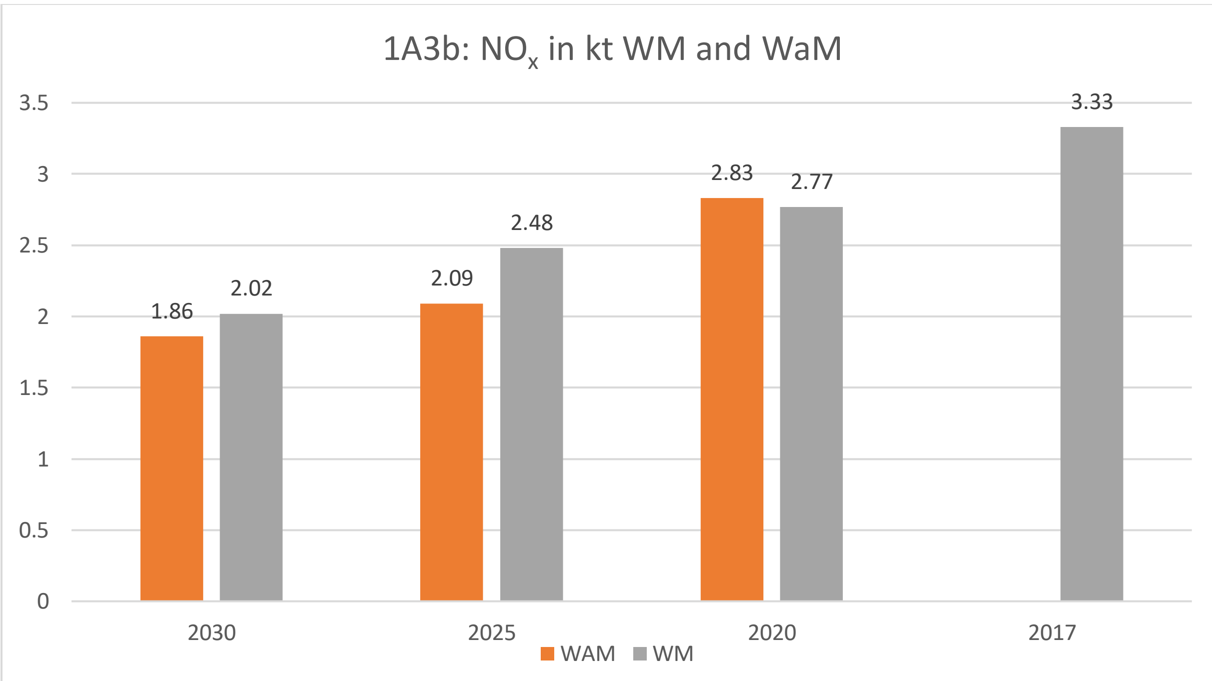

FIGURE 31: 1A3B: NO$_x$ IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

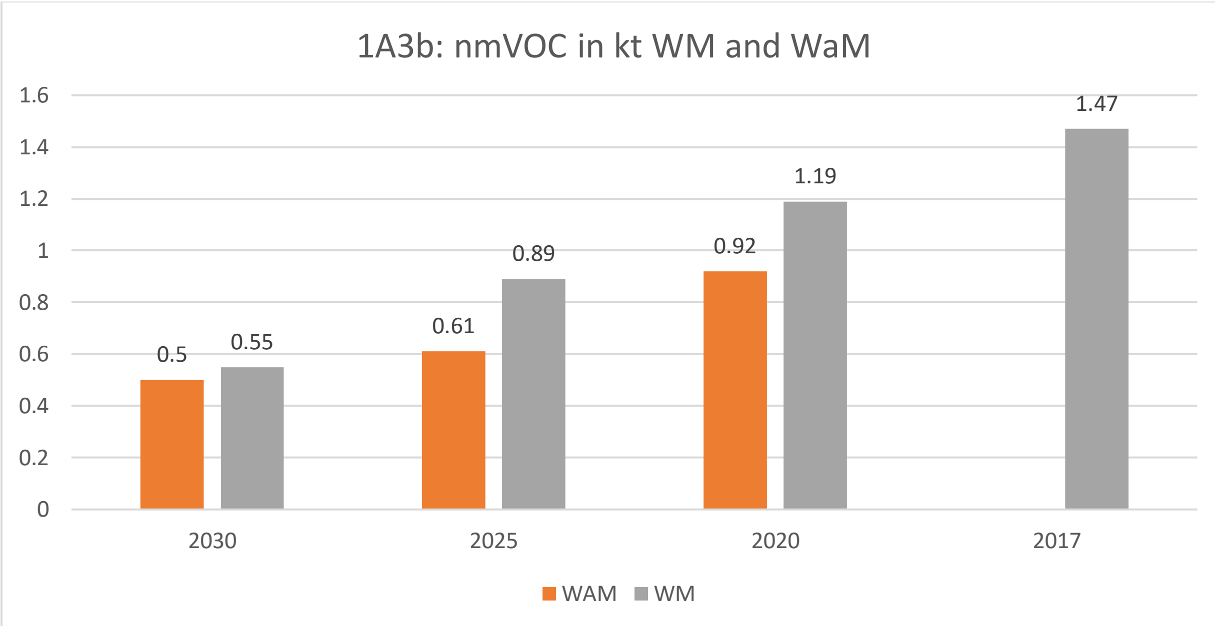

FIGURE 32: 1A3B: NMVOC IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

FIGURE 33: 1A3B: SO_x IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

The time series shows that a decrease in NO_x and NMVOC and SO_x emissions is envisaged for future years. The overall difference between WaM and WM is not significant.

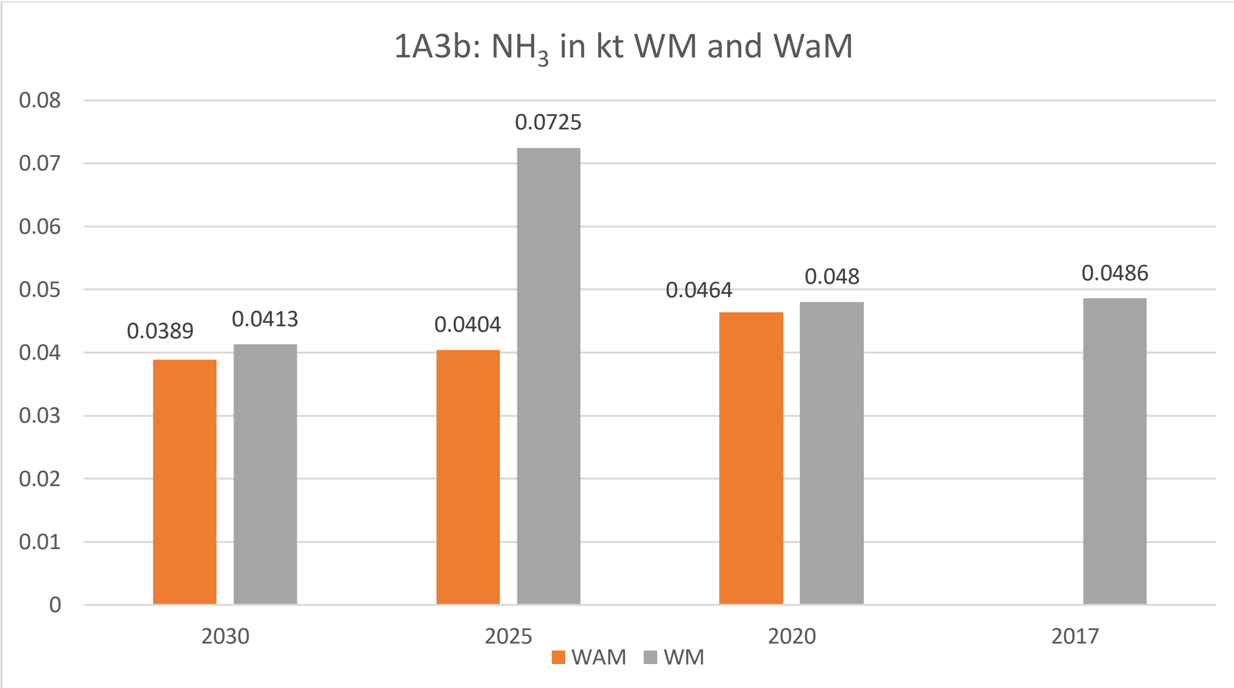

FIGURE 34: 1A3B: NH_3 IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

Ammonia emissions also show a decrease across the years. There is a slight increase in 2025 WM scenario which needs further investigation.

The emissions from sector 1A.3.b.vi, Automobile Tyre & brake wear and sector 1.A.3.b.vii, Automobile Road Surface Abrasion for Internal Combustion Engine (ICE) vehicles were calculated by means of COPERT. At present, the COPERT stock dataset template does not include electric vehicles. Hence, in order to include the contribution of electric vehicles in sector 1A.3.b.vi, Automobile Tyre & brake wear and sector 1.A.3.b.vii, Automobile Road Surface Abrasion, an alternative methodology was used. Timmers and Achten (2005) conducted a study on emissions from electric vehicles and the set of default factors made available from this research was used to estimate emissions from this sector.

Pollutants	EVs EF from Tyre Wear	EVs EF from Road Wear
PM_{10}	7.2 mg/vkm	8.9 mg/vkm
$PM_{2.5}$	3.7 mg/vkm	3.8 mg/vkm

TABLE 10: PM EMISSION FACTORS FOR EVS

The annual mean mileage of electric vehicles was multiplied by the above emission factors and the results summed to the emission total of PM_{10} and $PM_{2.5}$. The drawback of this approach is that no emission factors were available for TSP and for each vehicle category respectively.

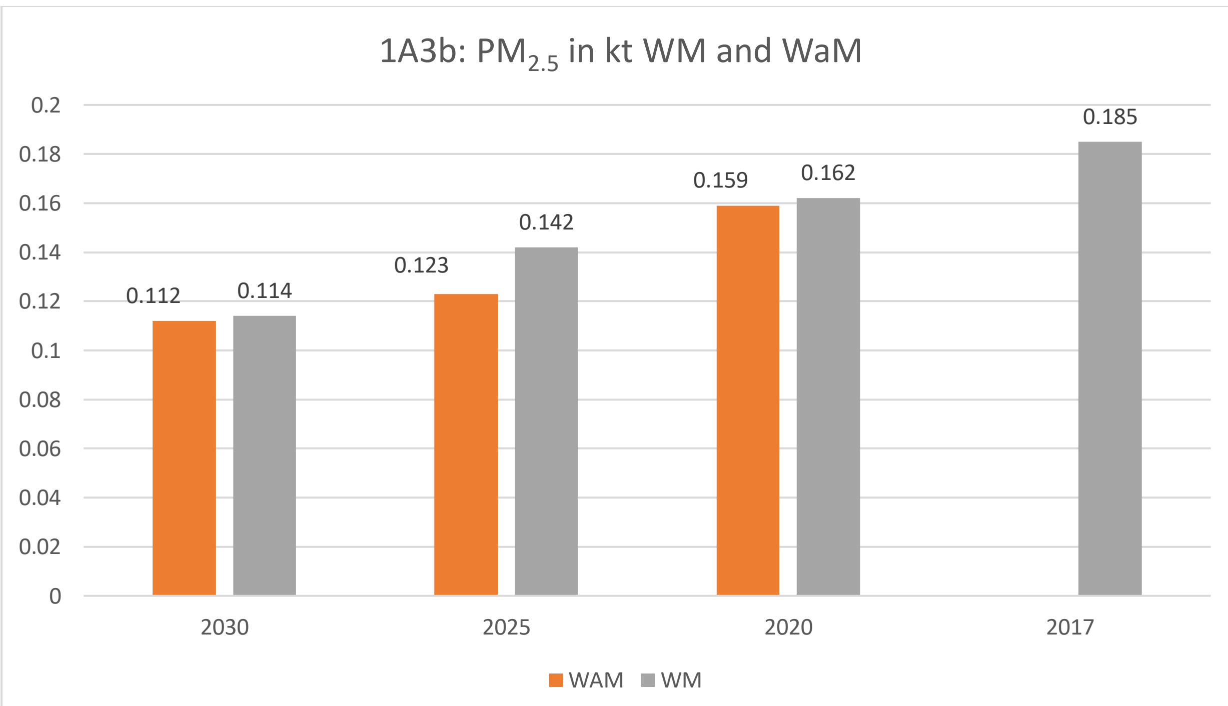

FIGURE 35: 1A3B: $PM_{2.5}$ IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

BC also shows a constant decrease across the time series.

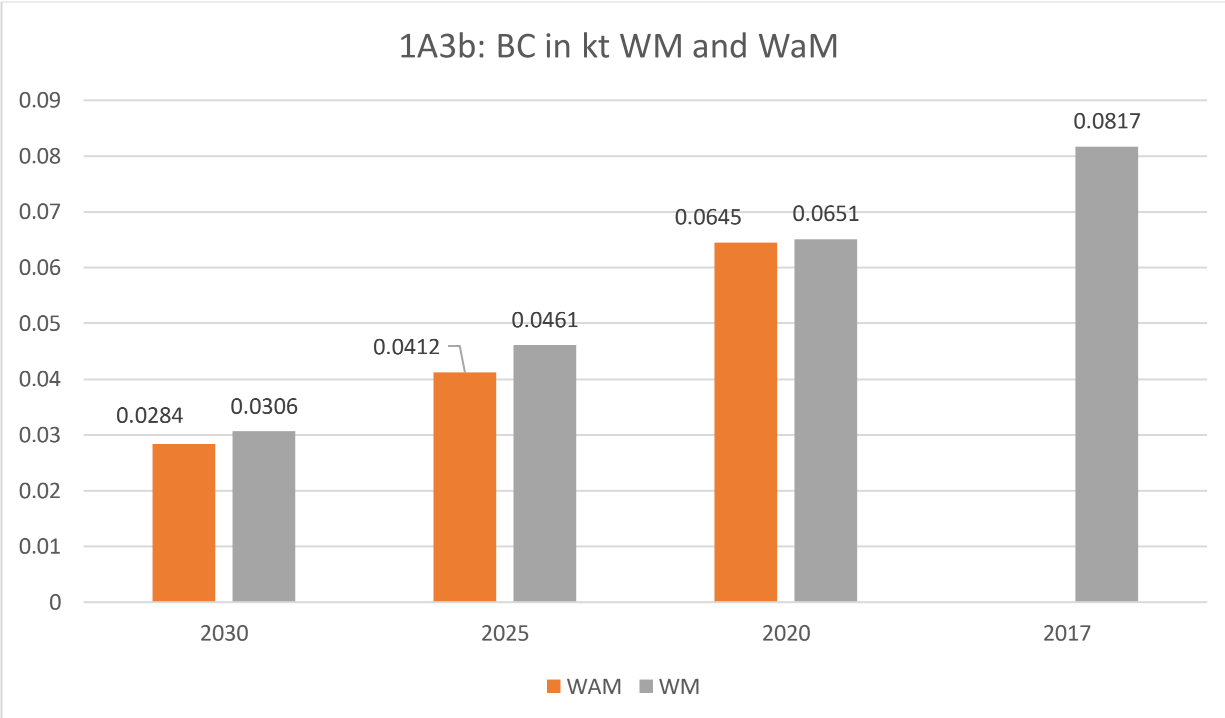

FIGURE 36: 1A3B: BC IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

All resulting emission estimates show that there is minimal difference between both scenarios; however, the WAM scenario is considered to be the most effective since emissions do decrease for all of the five main pollutants except in the case of NO_x in 2020. The main parameters affecting these changes are total vehicle kilometres, speed, fuel consumption, and the penetration of new vehicle technologies (hence lower emitting engines).

1A3dii National Navigation

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants
1.A.3dii	National Navigation	2016GB	Fuel survey (EWA/NSO)	Tier 1 & 2	NMVOC, PM_{10}, TSP, CO, As

This submission includes an update of the National Navigation sector, from Tier 1 to Tier1/2 for the entire historical time series i.e. 2005 to 2017 and the projection of emissions for 2020, 2025 and 2030. The main activities comprising this sector in Malta are the recreational crafts and the Gozo channel ferry (main ferry connecting Malta to Gozo). In addition to these activities, two new services will be introduced in future years; a fast ferry, which will start operating in 2020 for commuters crossing the Maltese Islands and a tunnel connecting Malta and Gozo which will start operating by the end of 2026 (simultaneous to the outmoding of the fast ferry).

The EEA/EMEP model made available in the 2016GB for the estimation of emissions from national navigation has also the function to generate fuel consumption based on vessel power data. However, when this function was tested and compared to actual data, the resulting outcome was very different. Hence, the fuel consumption of both activities was obtained from the EWA fuel survey while the emission factors were obtained from the 2016GB.

The fuel survey consisted of fuel data (MDO, petrol, diesel and HFO) for 2013 to 2017. The average of these years was calculated and used to fill the missing data gap for 2005 to 2012. The

Energy and Water Agency also provided projected fuel (MDO, petrol and diesel) for this sector which was used to estimate emissions for 2020, 2025 and 2030 for both WM and WAM scenarios. HFO was not projected for future years since its consumption was negligible during historical years. Projected fuel data did not differentiate between the Gozo Channel ferry and the recreational craft activities. Hence, in order for specific fuel consumption of each respective activity to be known, the mean percentage share of fuel consumed by the ferry during historical years was calculated and this figure was multiplied with total fuel consumed by the national navigation sector. Fuel consumption by the Gozo channel differs between the WM and WAM scenario, while consumption from recreational crafts remains constant across both scenarios.

The below graph shows, that the biggest contributor in terms of fuel consumption from this sector was, and is estimated to remain, recreational crafts.

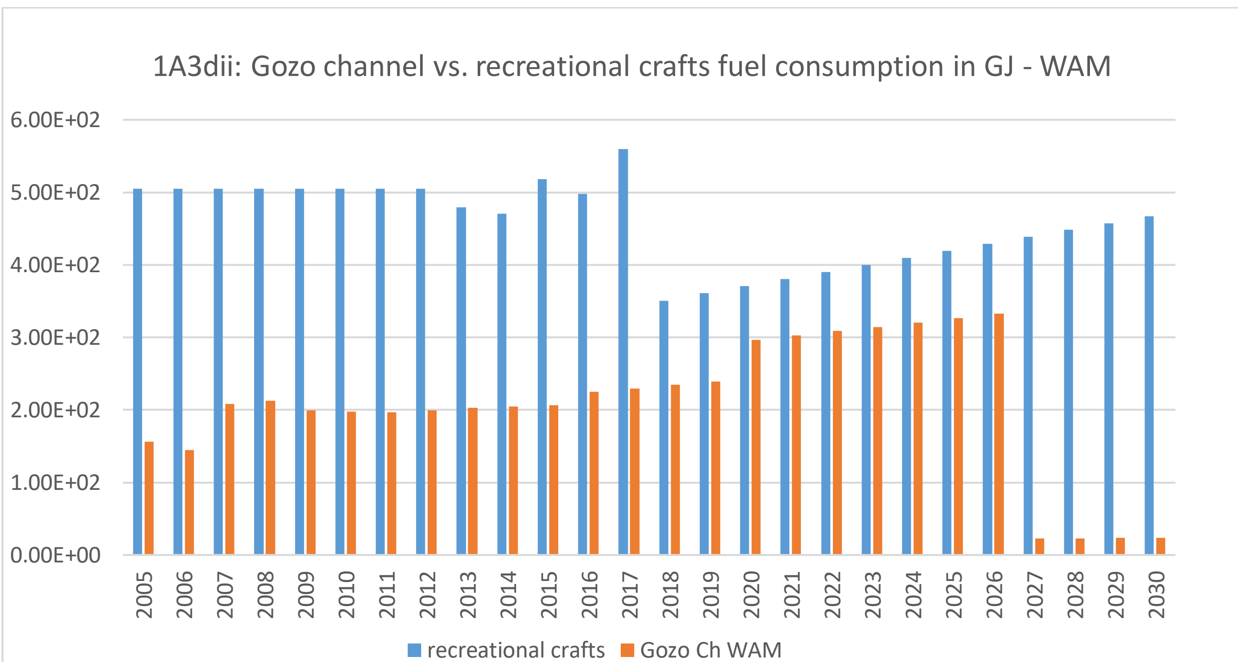

FIGURE 37: 1A3DII: GOZO CHANNEL VS. RECREATIONAL CRAFTS FUEL CONSUMPTION IN GJ - WAM

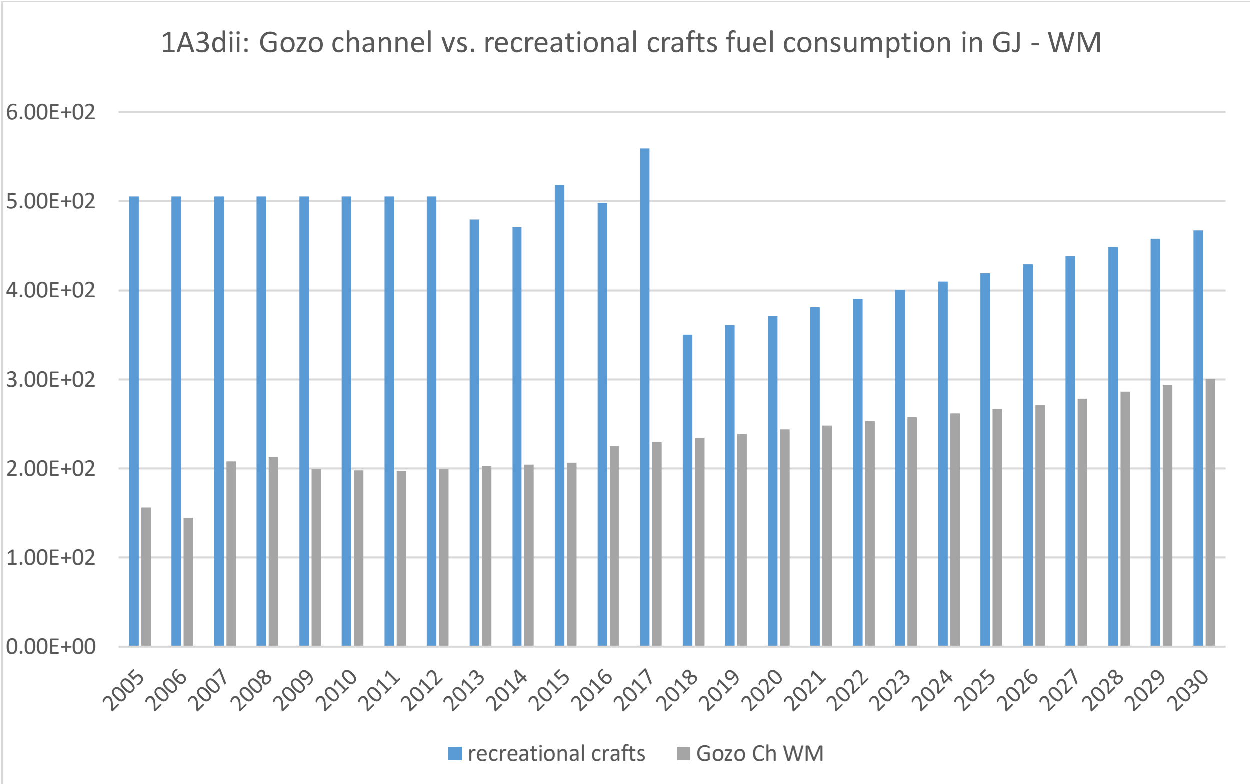

FIGURE 38: 1A3DII: GOZO CHANNEL VS. RECREATIONAL CRAFTS FUEL CONSUMPTION IN GJ - WM

The main difference between the WM and WAM scenarios is shown in the below table:

Activity	**WM**	**WAM**
Recreational crafts	Same amount of fuel for both scenarios	
Gozo channel ferry	• 3 Gozo Channel ferries in operation	• 1 fast ferry in operation from 2020 till 2026 • Reduced operation of the Gozo Channel ferry service as from 2027 • 1 Gozo Channel ferry in operation as from 2027

The introduction of the fast ferry will result in increased fuel consumption as observed in the WAM scenario but this will last only for the duration of its operation and hence between 2020 and 2026.

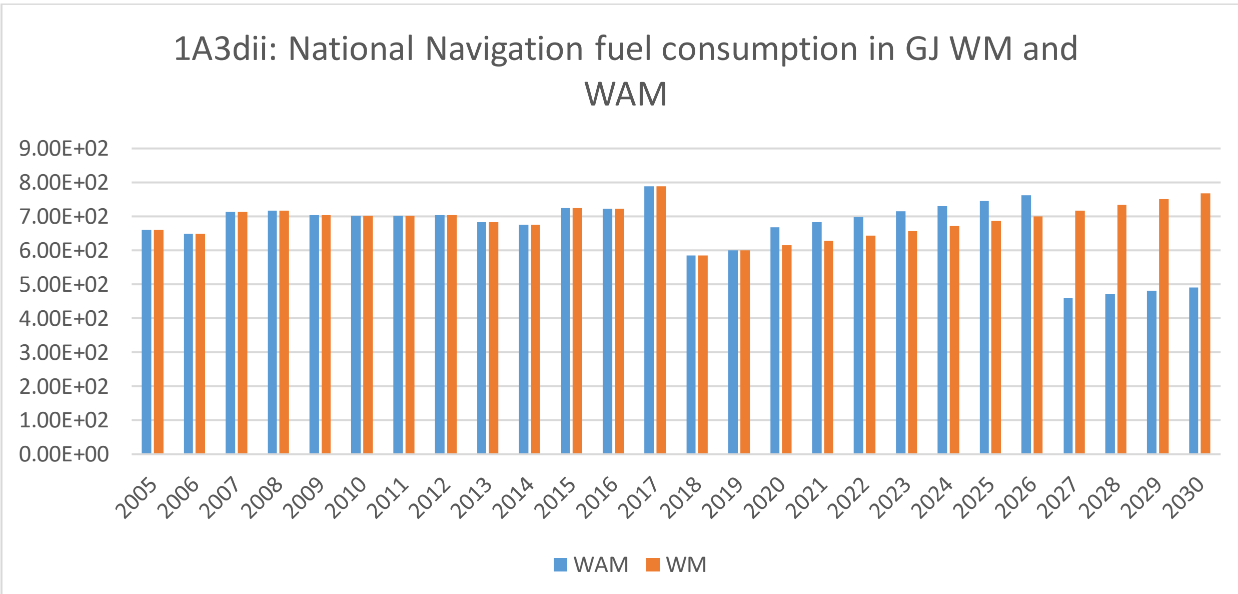

FIGURE 39: 1A3DII: NATIONAL NAVIGATION FUEL CONSUMPTION IN GJ (WM VS WAM)

Following initiation of the operation of the tunnel connecting Malta to Gozo in 2027, this will lead to the outmoding of the fast ferry and a reduction in the activity of the Gozo Channel ferry. Both changes will result in a substantial decrease in the overall fuel consumption from this sector (WaM scenario).

The below graphs show the overall trend of pollutants across the time series for both scenarios.

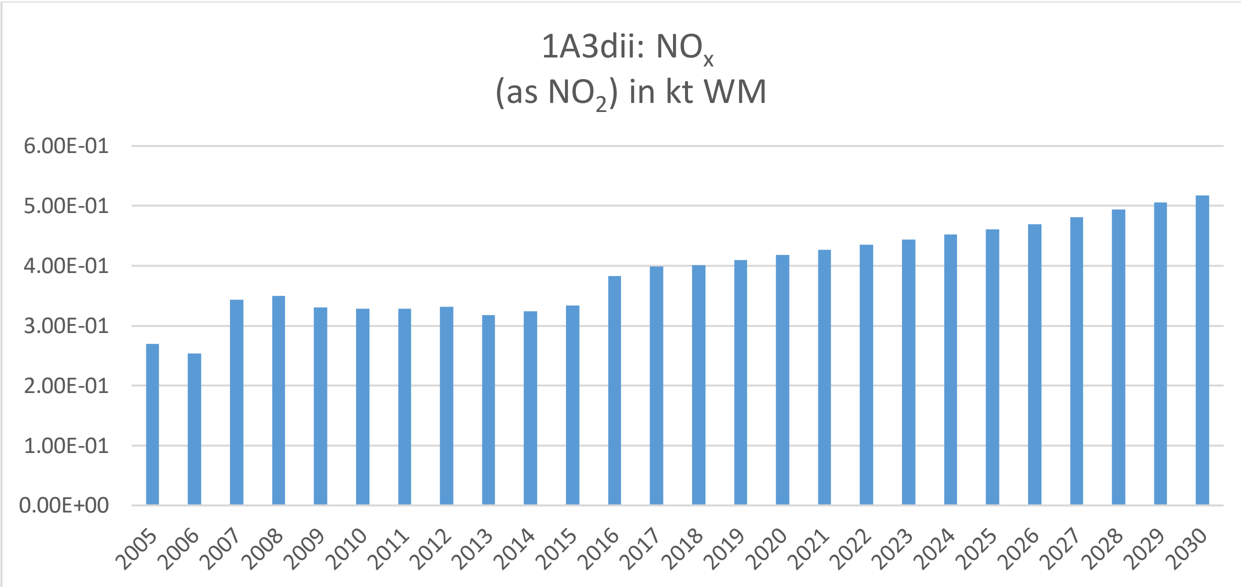

FIGURE 40: 1A3DII: NO_X (AS NO_2) IN KT WM

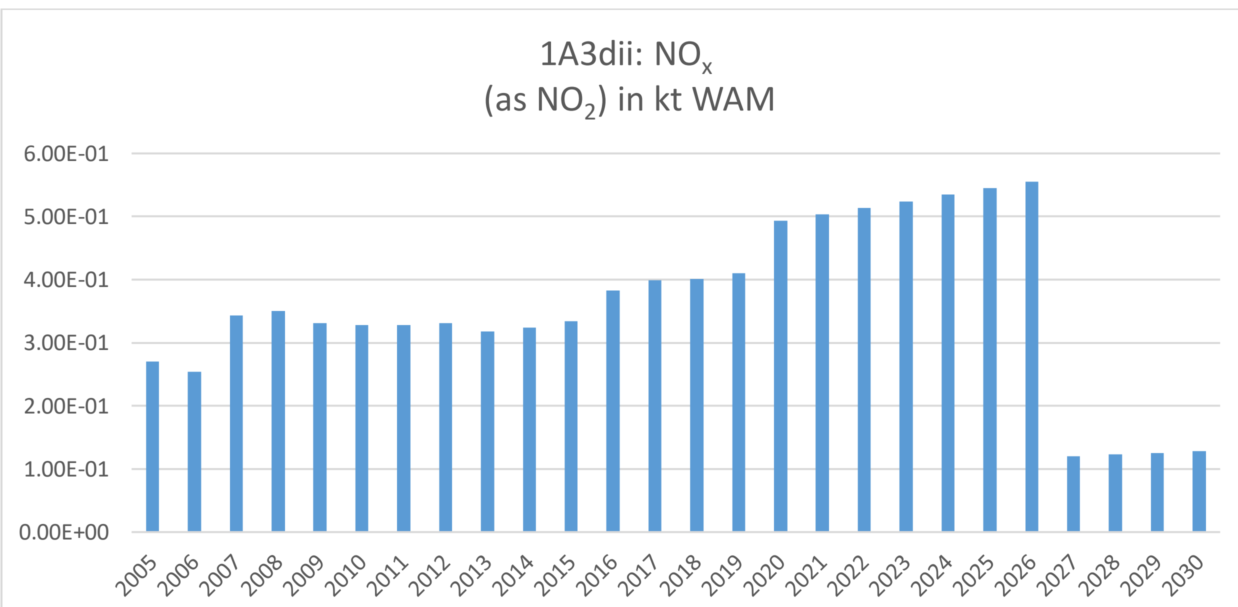

FIGURE 41: 1A3DII: NO_X (AS NO_2) IN KT WAM

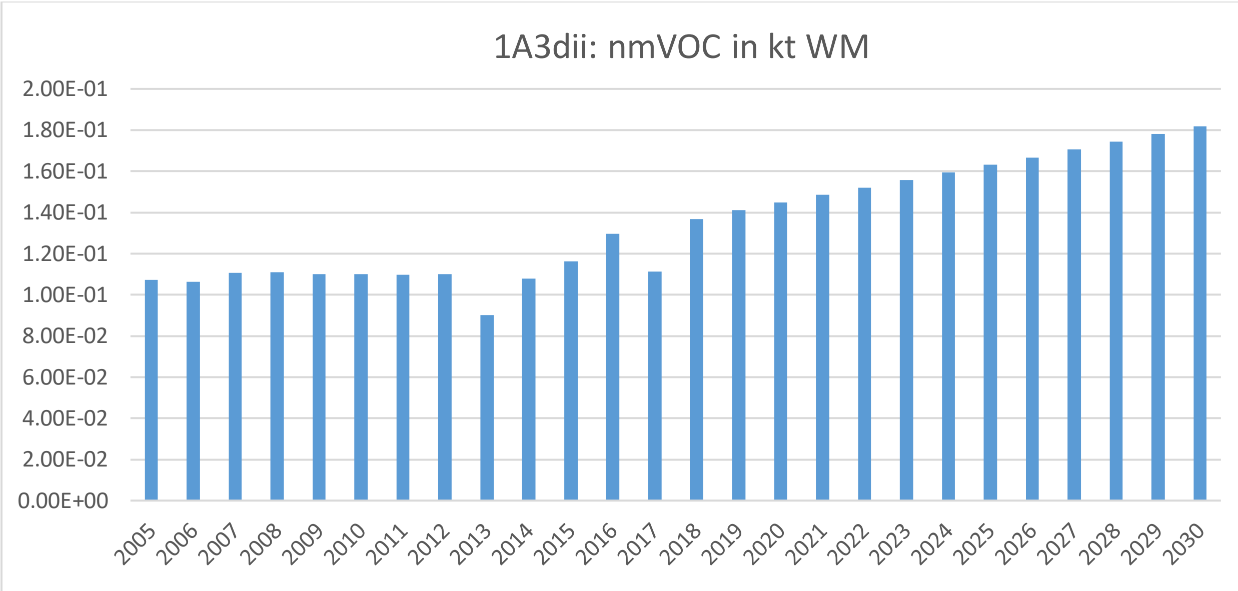

FIGURE 42: 1A3DII: NMVOC IN KT WM

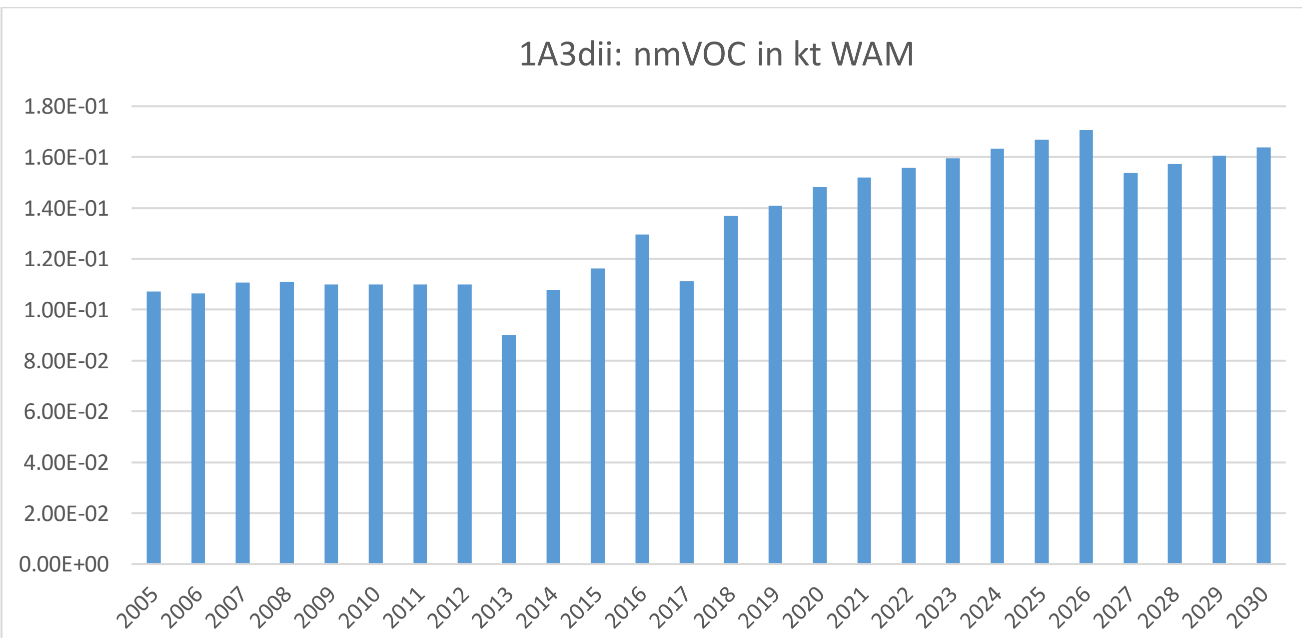

FIGURE 43: 1A3DII: NMVOC IN KT WAM

The trend of NO_x and NMVOC across the time series follows that of fuel consumption for both WM and WAM scenarios since both were estimated through an emission factor.

Moreover, heavy fuel oil data was sourced from the fuel survey and hence respective emissions estimated in the historical time series; however as already explained above, it was not projected for future years by EWA. In order to estimate SO_2 emissions, HFO was projected by following a linear trend of increase. A limit of 0.5% sulphur content by mass was taken to be the maximum concentration of sulphur allowed in marine fuel as per Directive (EU) 2016/802 from 2020 onwards. This was considered to be the with measures (WM) scenario and since the projected sulphur content is higher than that in historical estimates, the emissions of SO_2 are slightly higher. It is acknowledged that ideally, the WM scenario should have an average of the same sulphur content as in historical years since it is much lower than that stipulated in the Directive. However one cannot assume this will occur, therefore the worst case scenario was considered.

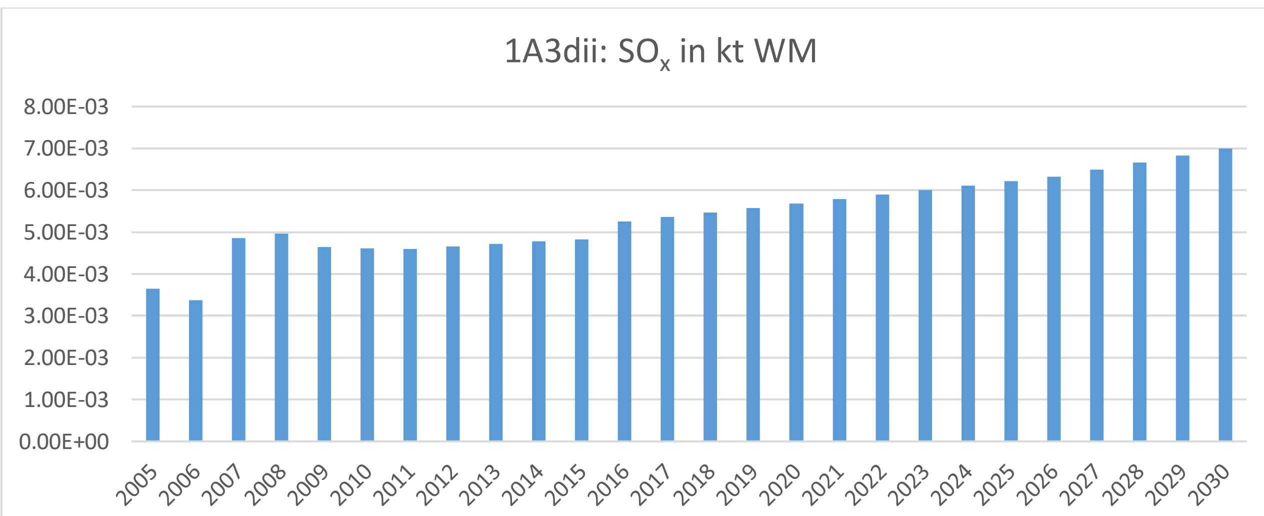

FIGURE 44: 1A3DII: SO_x IN KT WM

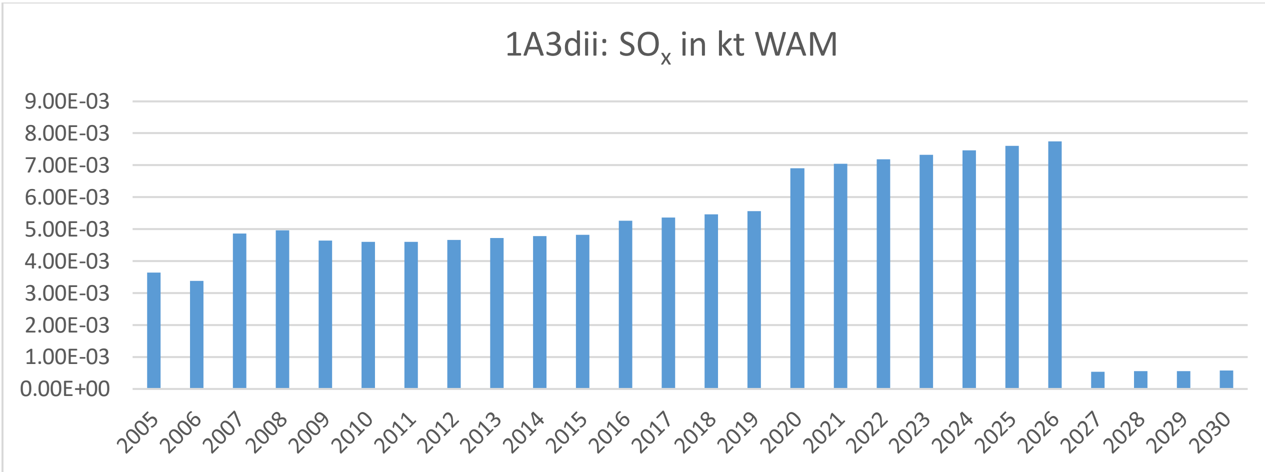

FIGURE 45: 1A3DII: SO_x IN KT WAM

The SO_x trend also follows that of fuel consumption.

Moreover, the below graphs show that emissions of NH_3 and $PM_{2.5}$ were estimated only from recreational crafts running on gasoline and diesel fuels since only emissions factors for these fuels were available in the guidebook. The resulting emissions follow the same trend as that of fuel consumption.

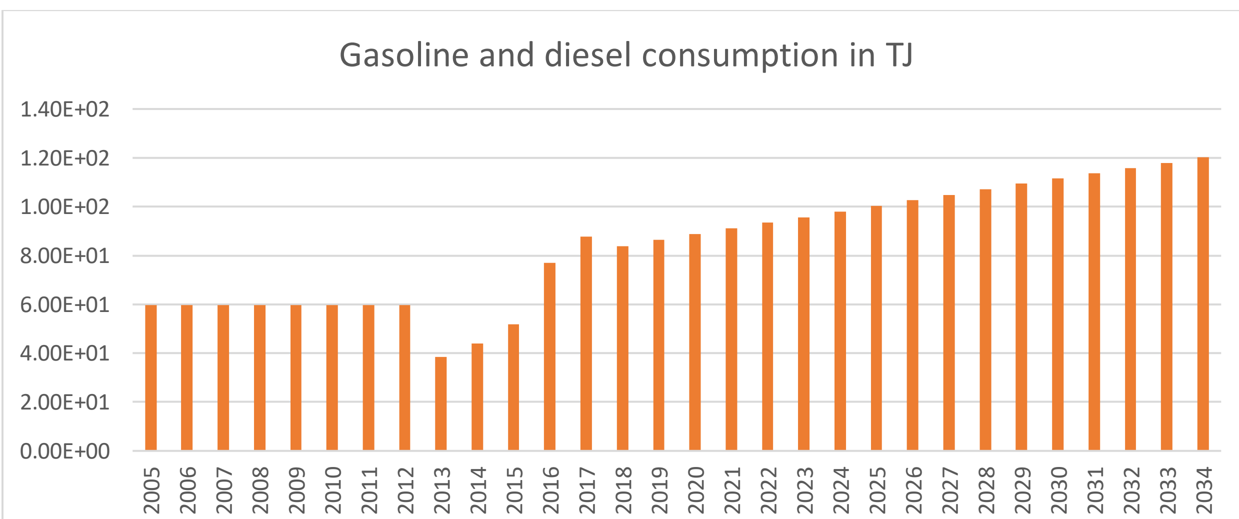

FIGURE 46: GASOLINE AND DIESEL CONSUMPTION IN TJ

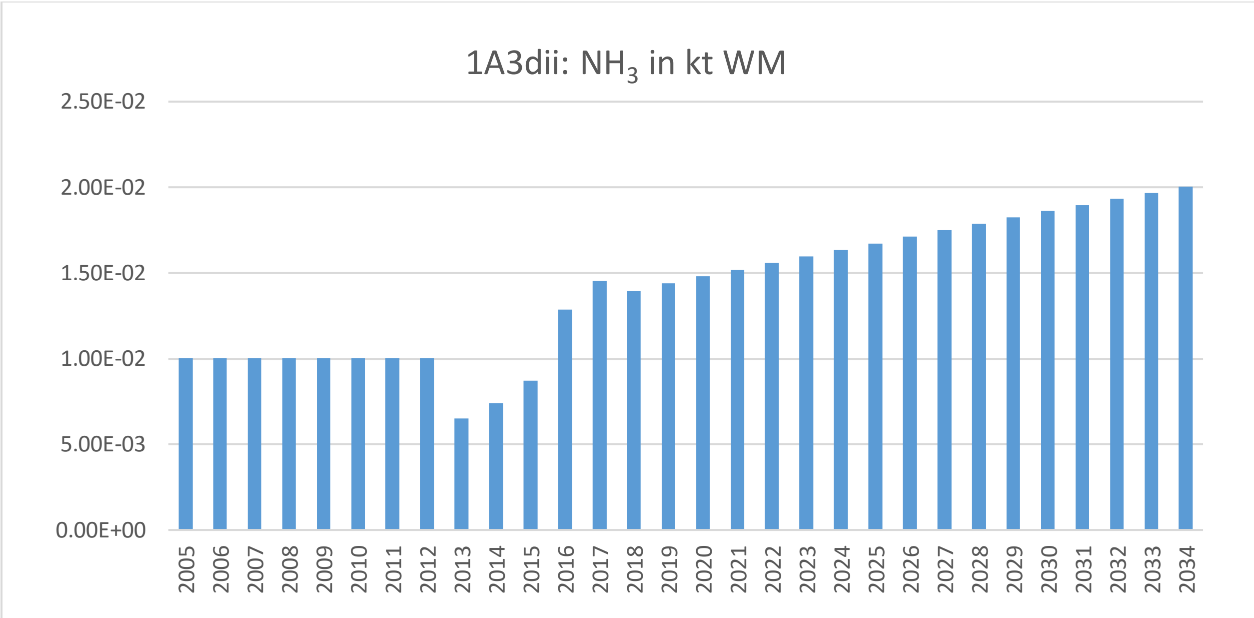

FIGURE 47: 1A3DII: NH_3 IN KT WM

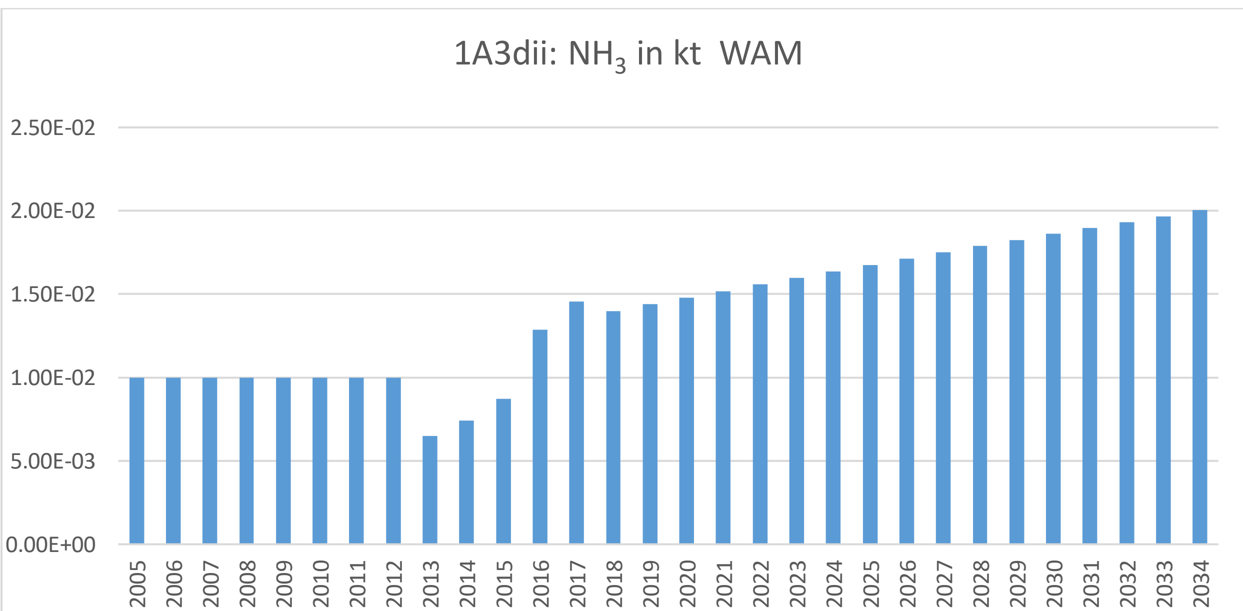

FIGURE 48: 1A3DII: NH_3 IN KT WAM

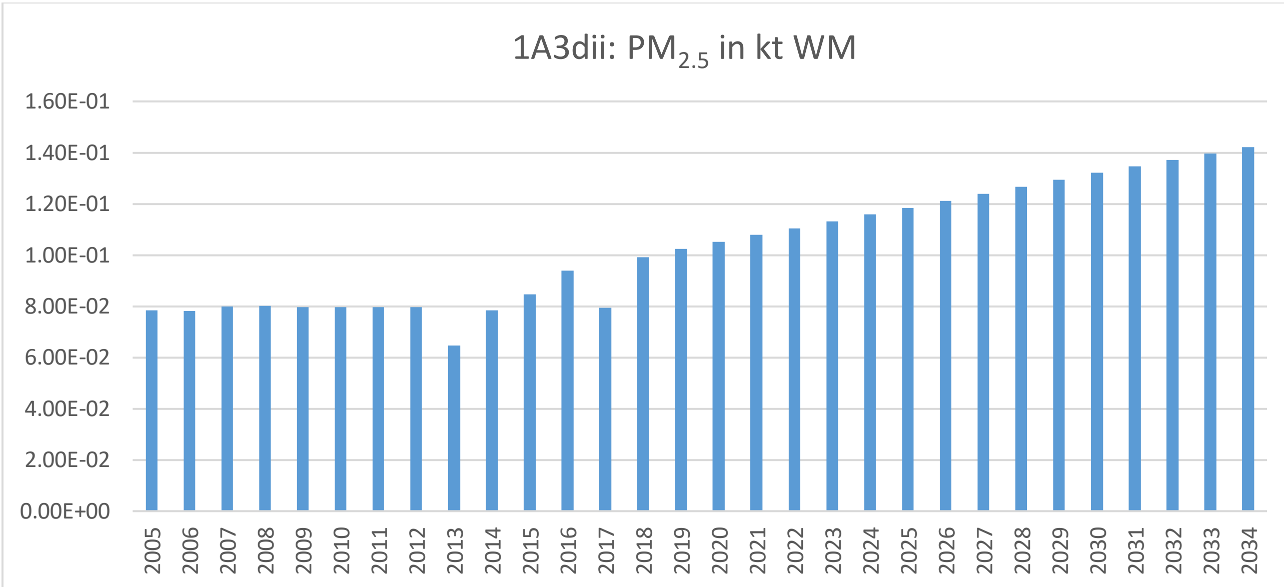

FIGURE 49: 1A3DII: $PM_{2.5}$ IN KT WM

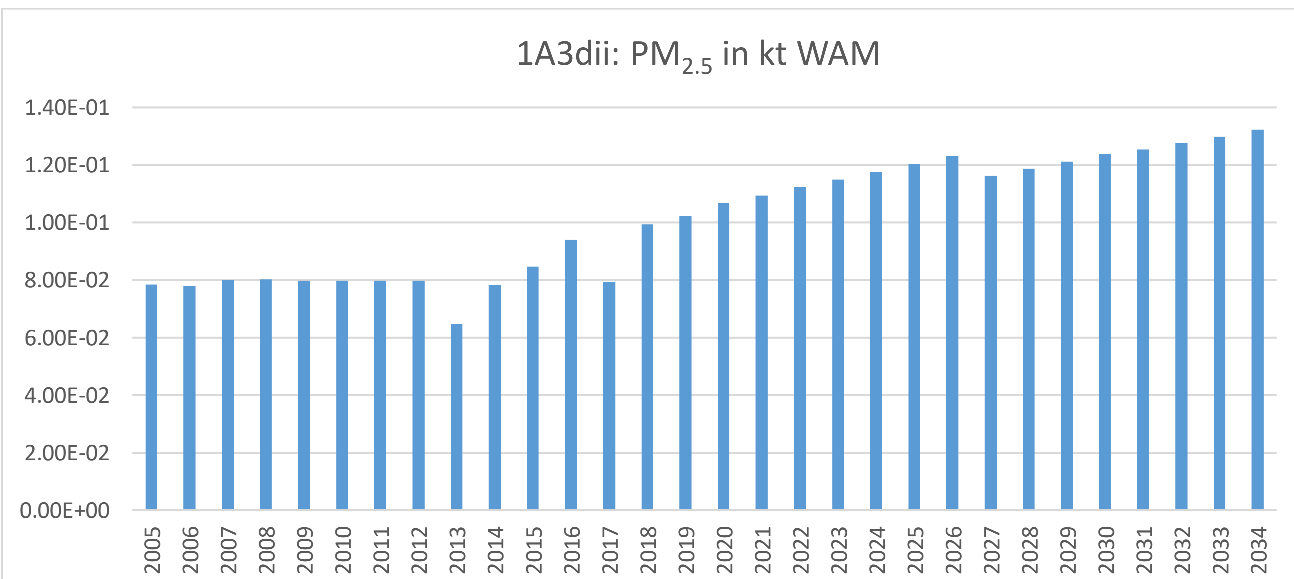

FIGURE 50: 1A3DII: $PM_{2.5}$ IN KT WAM

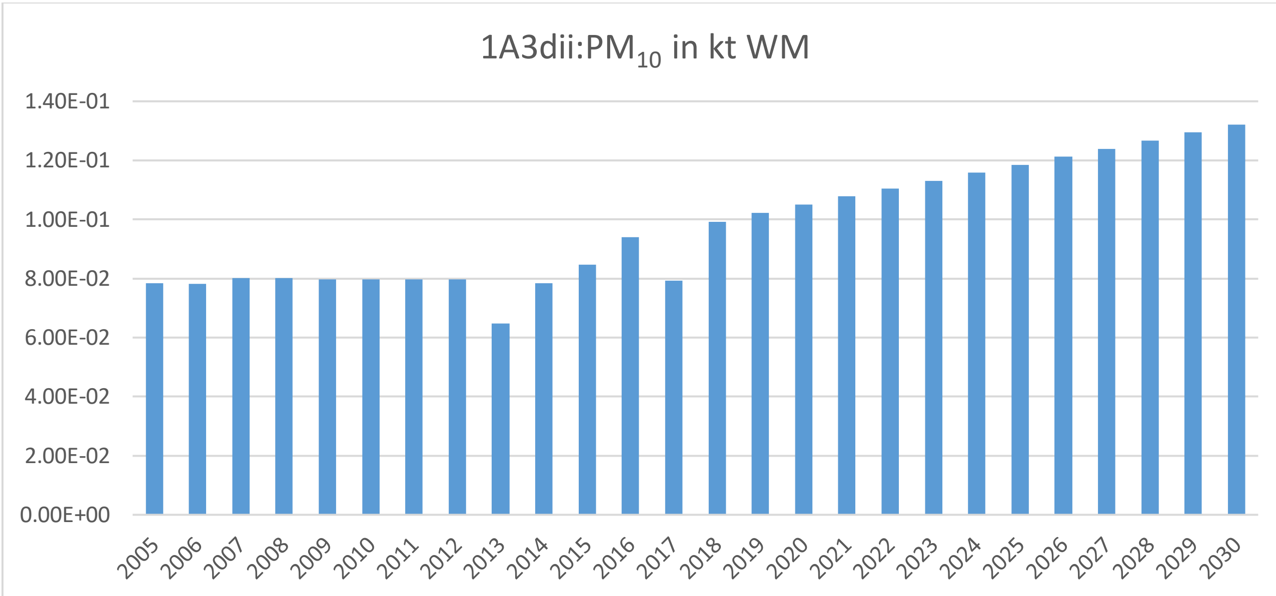

FIGURE 51: 1A3DII: PM_{10} IN KT WM

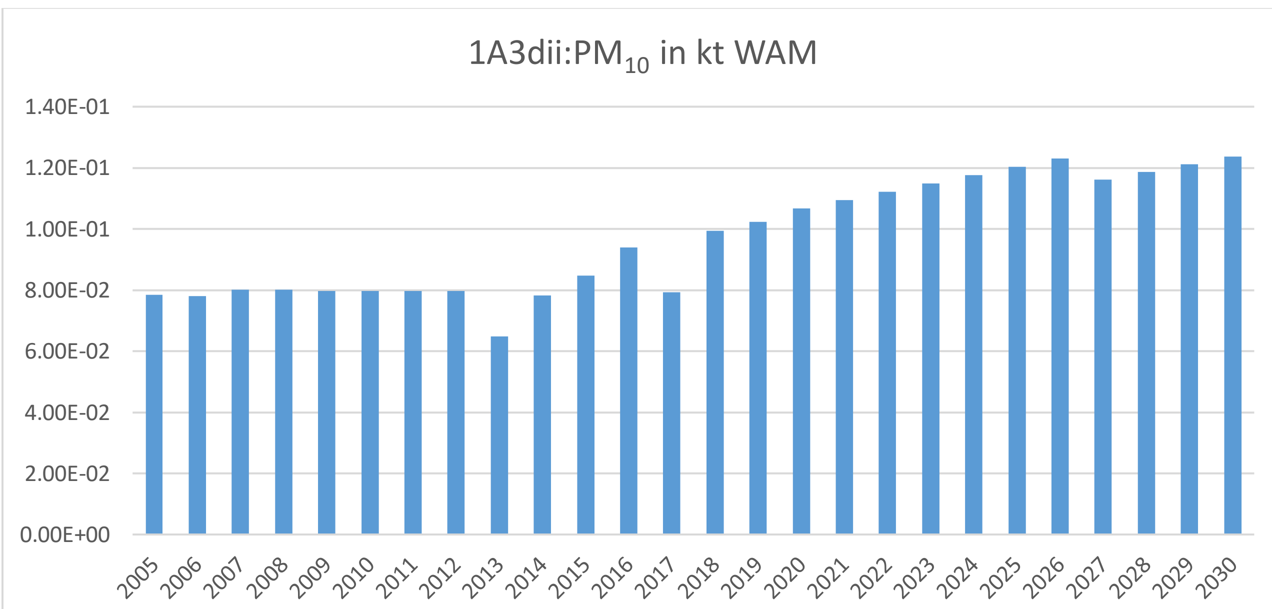

FIGURE 52: 1A3DII: PM_{10} IN KT WAM

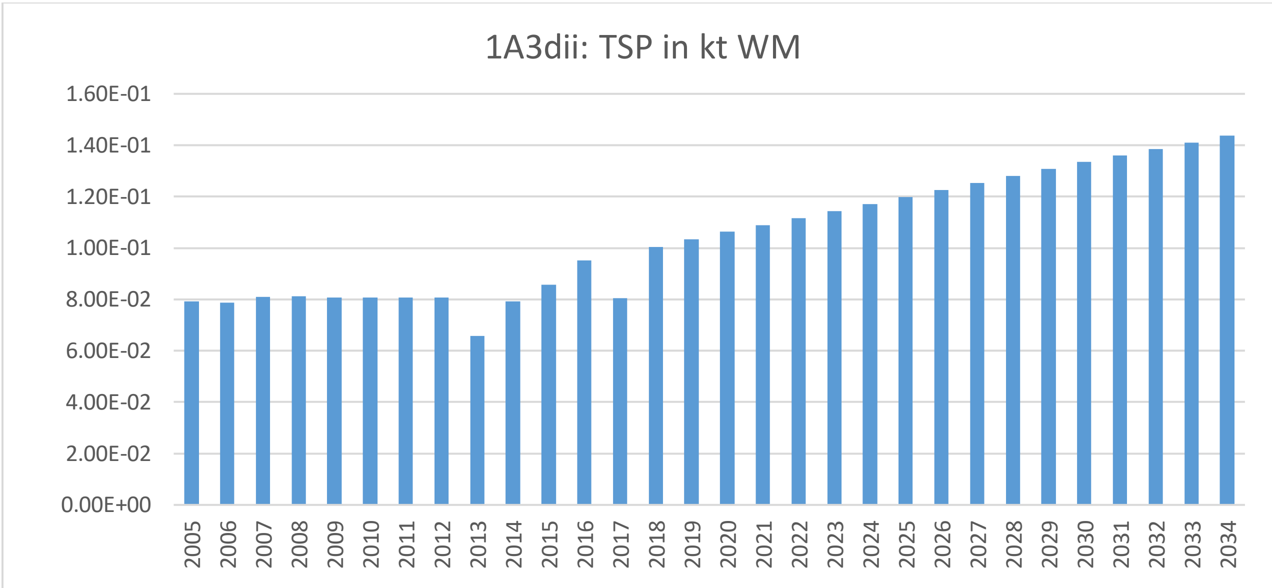

FIGURE 53: 1A3DII: TSP IN KT WM

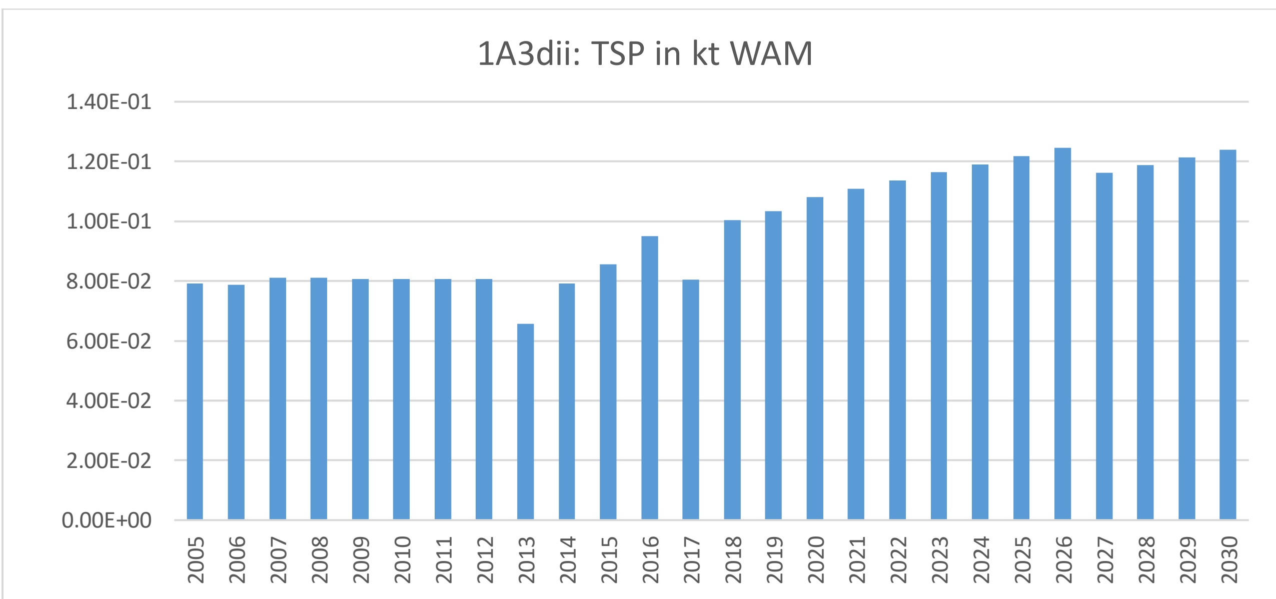

FIGURE 54: 1A3DII: TSP IN KT WAM

The above graphs follow the same trend as the fuel consumption in TJ, hence further highlighting the direct relationship between fuel and emissions.

1A4ai: Commercial/institutional: Stationary

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
1.A.4.ai	Commercial/institutional: Stationary	2016GB	EWA/NSO	Tier 1	As, Ni, benzo (a) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene, indeno (1,2,3-cd) pyrene	2019 submission

Emissions from 'Commercial/institutional: Stationary' were reported under group sector 1A.4.ai. Emissions estimated in this sector originate from the fuel consumed by certain type of activities (cooking, electricity production, industrial processes, spatial cooling, spatial heating) falling under NACE code G to S and reported in the fuel survey by EWA and NSO. EWA also projected fuel for this category, for the years 2020, 2025 and 2030 where the WM scenario is identical to WaM. The time series for this sector was updated with recent activity data i.e. 2005 to 2017. The methodology used was based on that of the 2016GB (Table 3.8 for liquid fuels and Table 3.9 for gaseous fuels).

NFR 1.A.4.a.ii Commercial/institutional: Mobile was included in NFR 1.A.4.ai.

1A4bi Residential: Stationary

NFR-Code	Name of sub-Category	Method	Activity Data source	EF for pollutants	Key Category	Year of last update
1A4bi	Residential: Stationary	2016GB	Fuel survey by EWA/NSO	Tier 1	NA	2019 submission

Emissions from combustion in the residential sector were reported under NFR code 1A4bi. This sub-category includes emissions from small combustion activities such as domestic internal heating. The main fuel used in this sector is LPG together with a very small amount of gasoil. Fuel data was obtained from the fuel survey by EWA and NSO. An average of the fuel consumed during these years was calculated to replace missing fuel consumption values for the years 2005 to 2012. This sector's fuel was projected to future years for 2020, 2025 and 2030 where the WM and WaM scenarios are identical. The methodology followed was obtained from the 2016GB and emission factors were obtained from Table A-18 page 133.

1A4cii: Agriculture/Forestry/Fishing: Off-road vehicles and other machinery

NFR-Code	Name of sub-Category	Method	Activity Data source	EF for pollutants	Key Category	Year of last update
1A4cii	Off-road vehicles and other machinery	2016GB	Fuel survey by EWA/NSO	Tier 1	NA	2019 submission

Emissions from 'Off-road vehicles and other machinery' were reported under group sector 1A4cii. Emissions estimated in this sector originated from the fuel consumed by machines used in agriculture and reported under NACE code A in the fuel survey by EWA and NSO for the years 2013 to 2017. An average of the fuel consumed during these years was calculated to replace missing fuel consumption values for the years 2005 to 2012. EWA also projected fuel for this category, for the years 2020, 2025 and 2030 whereby WM and WaM scenarios are identical. The methodology used was based on that of the 2016GB (Table 3.2 for diesel and gasoline fuels).

1A4ciii: Agriculture/Forestry/Fishing: National fishing

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants
1.A.4ciii	**National fishing**	**2016GB**	**Fuel survey**	**Tier 1 & 2**	**NA**

Fishing was estimated for the first time in this submission. Estimates were calculated for the entire time series i.e. 2005 to 2017 and projected for 2020, 2025 and 2030. The activity data for estimating historical emissions (2013 – 2017) was obtained from the EWA/NSO fuel survey. Emissions originating from this activity prior to 2013 were estimated by calculating the average of the fuel consumed during 2013 to 2017. No data on fuel consumption for 2020, 2025 and 2030 was available hence 2017 emissions were carried forward to projected years. Emission factors were obtained from the 2016GB.

The only fuel reported for this activity was marine diesel oil and gasoline, however emission factors were available only for the former. Hence the contribution from the latter was ignored.

According to the fuel survey, there has been a higher fuel consumption in 2013 and 2016 and this explains the increase in emissions observed in these two years for each of the five main pollutants as shown below.

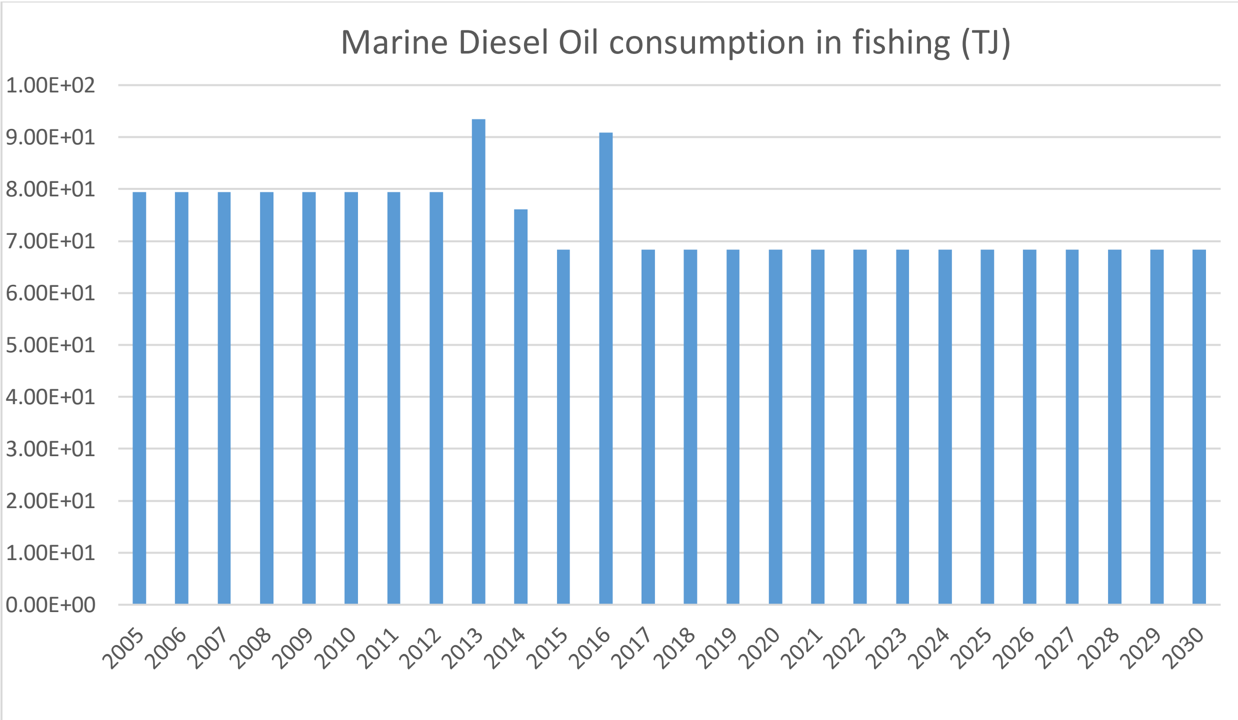

FIGURE 55: 1A4CII MARINE DIESEL OIL CONSUMPTION IN FISHING IN TJ TIME SERIES

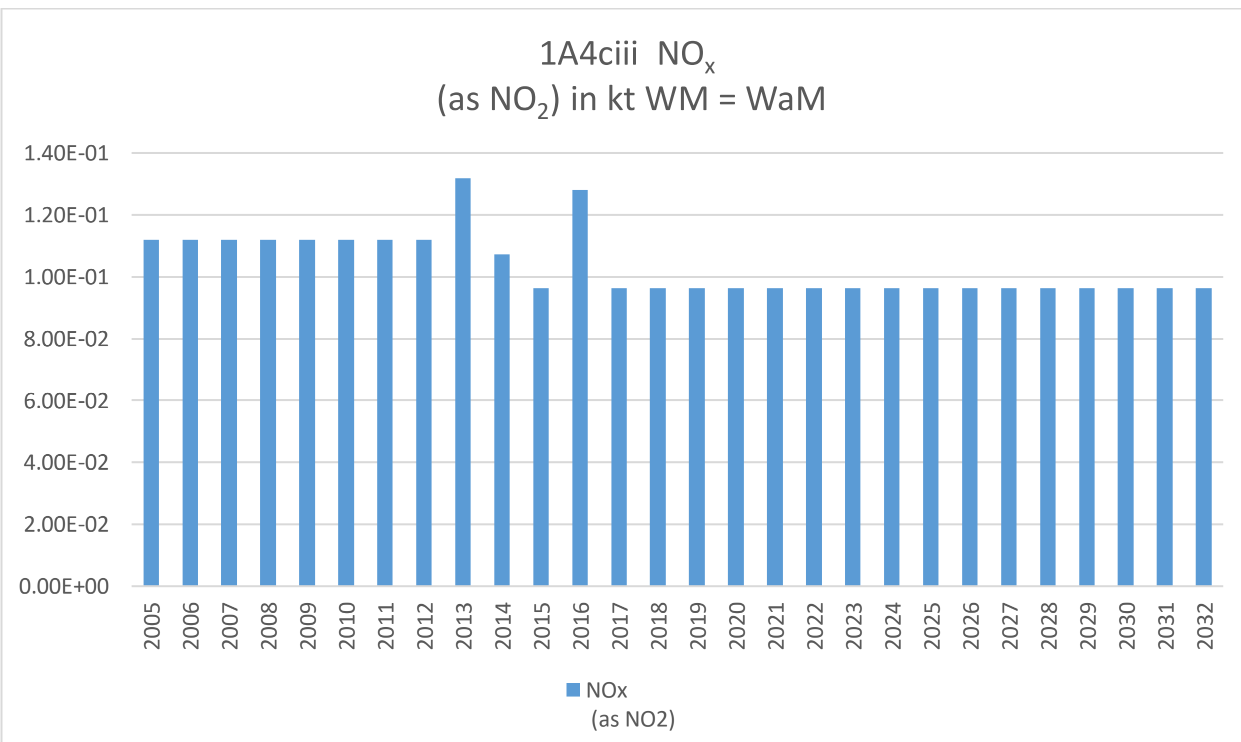

FIGURE 56: 1A4CIII NO_x (AS NO_2) IN KT WM =WAM

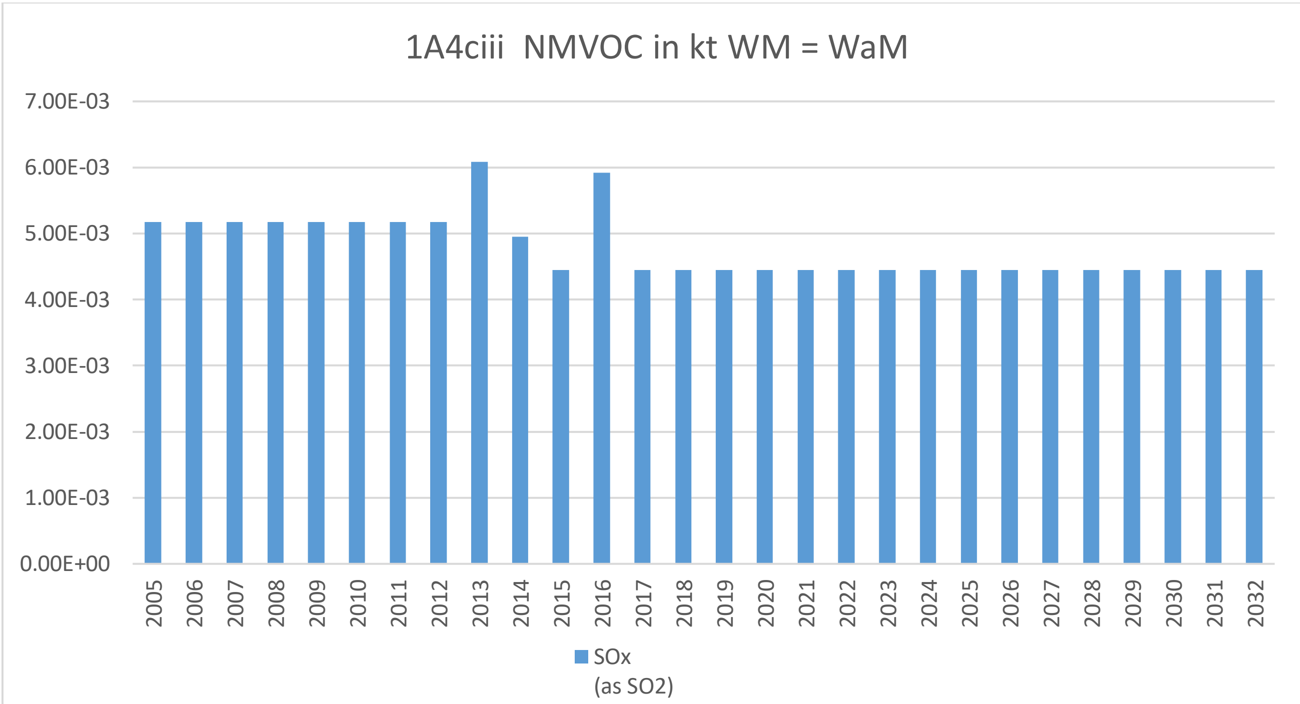

FIGURE 57: 1A4CIII NMVOC IN KT WM = WAM

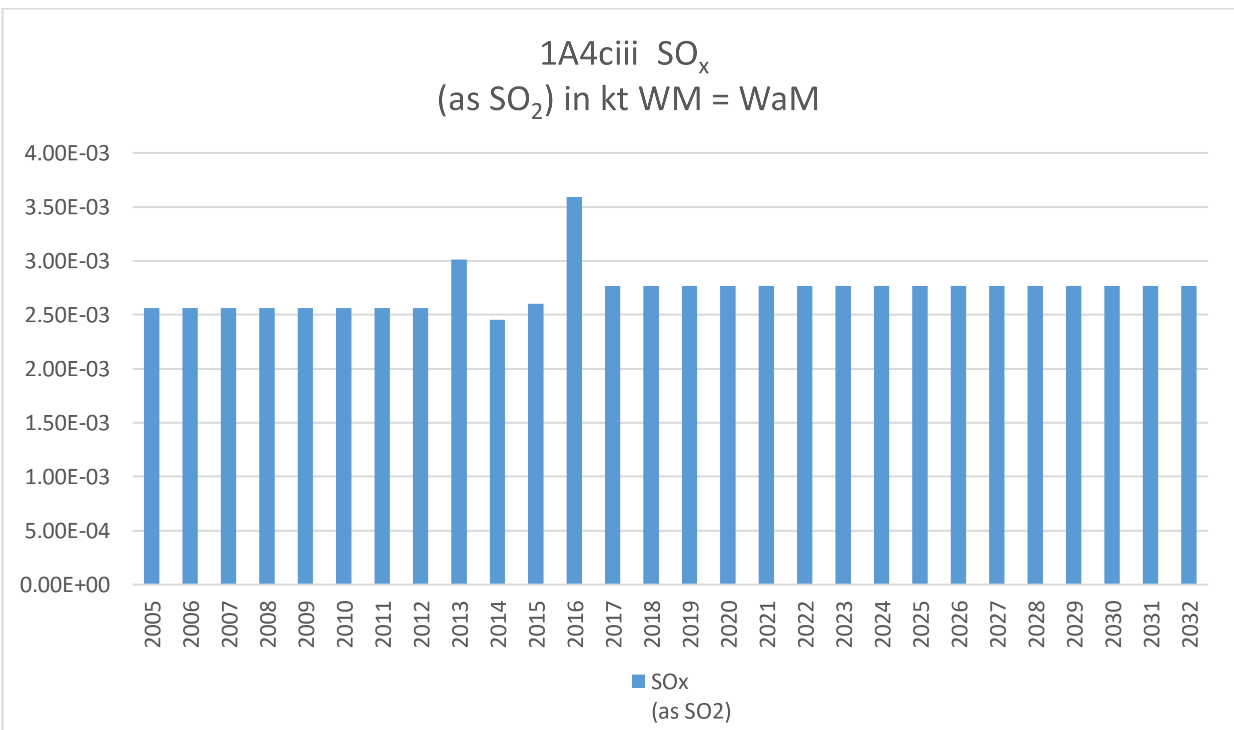

FIGURE 58: 1A4CIII SO_x (AS SO_2) IN KT WM = WAM

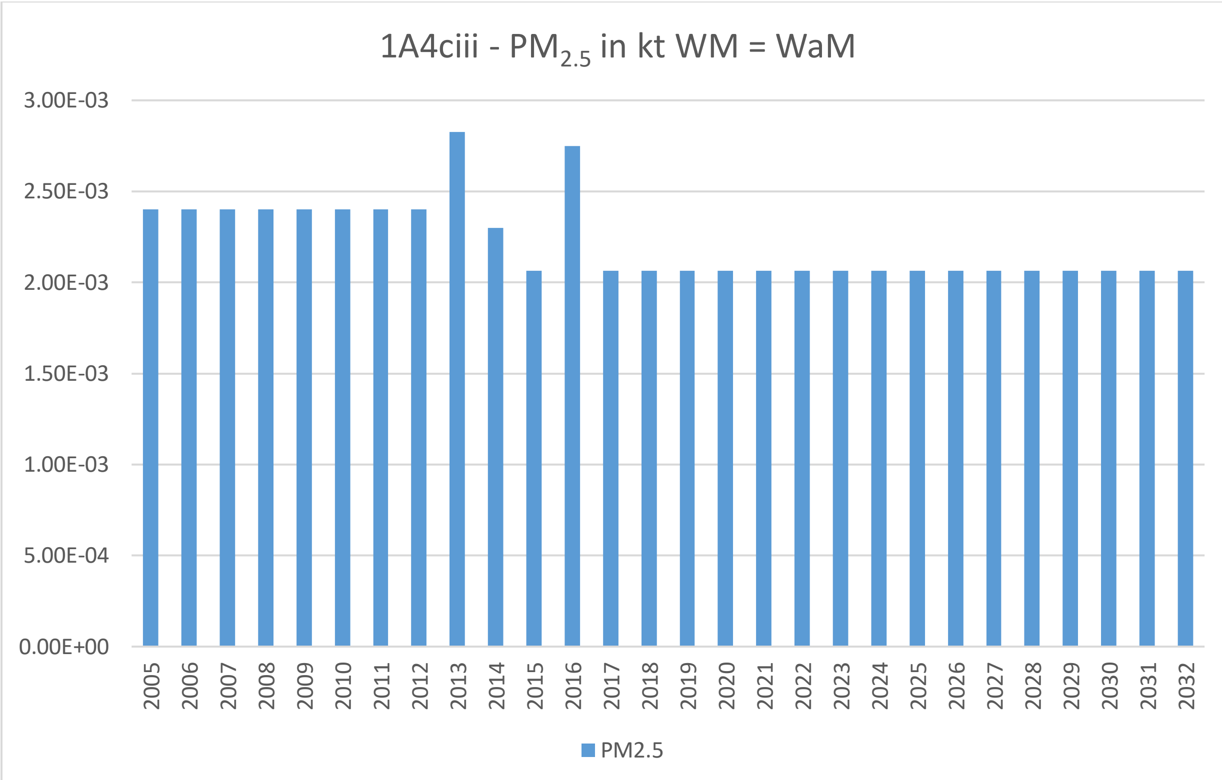

FIGURE 59: $PM_{2.5}$ IN KT WM =WAM

The emissions reflect the same trend across the time series as the marine diesel oil trend in TJ, which emphasizes further the dependence of emissions on fuel.

1B2av: Distribution of oil products

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
1B2av	Distribution of oil products	2016GB	EUROSTAT (Supply, transformation and consumption of oil - annual data)	Tier 1	NMVOC	2018 submission

Emissions from 'Distribution of oil products' were reported under group sector 1A.2.av and due to time constraints, these were last updated in the 2018 submission. Emissions estimated in this sector originated from the gross inland consumption of gasoline (gasoline without bio component and aviation gasoline) consumed locally. This activity data was obtained from EUROSTAT for 2005 to 2016 and the NMVOC emission factor was obtained from the 2016GB. This approach was suggested by NECD reviewers during the 2017 review. The 2016 value was carried forward for the projected years 2020, 2025 and 2030 and will be updated in the next submission based on the latest activity data.

This category is a key source for NMVOC and the below graph shows the respective emission profile across the time series.

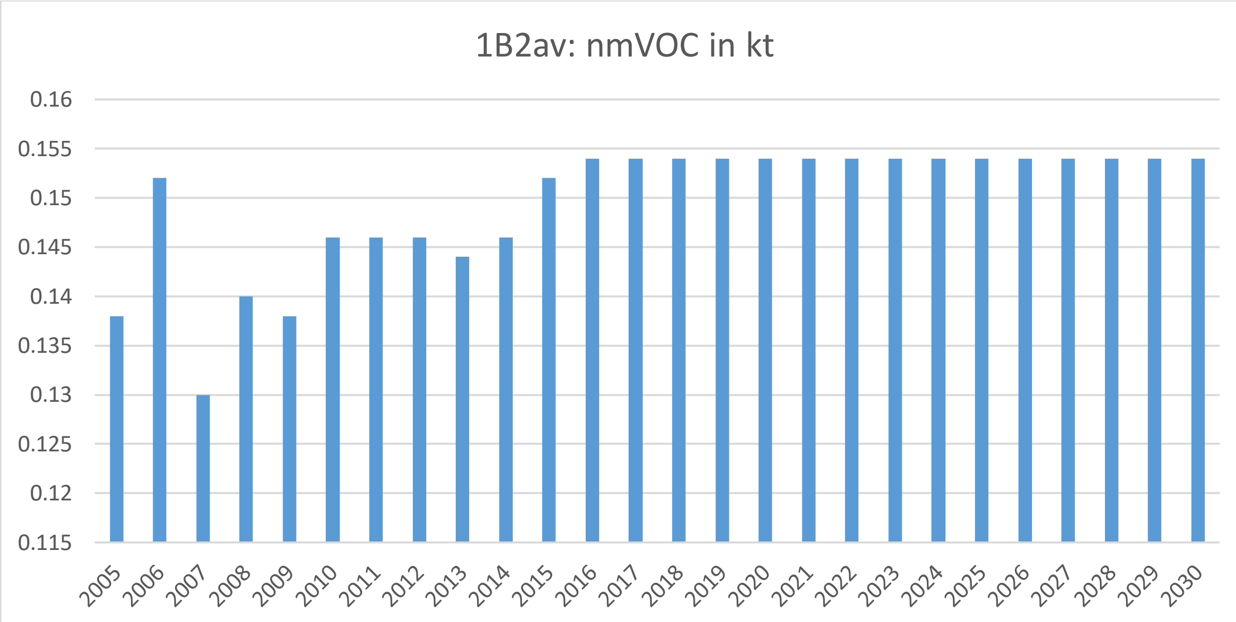

FIGURE 60: 1B2AV: NMVOC IN KT TIME SERIES

4. 2D3a: Domestic solvent use including fungicides

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
2.D.3.a	Domestic solvent use including fungicides	2016GB	The Databank –world bank	Tier 1	NMVOC	2019 submission

Emissions from ‘Domestic Solvent use including fungicides’ were reported under group sector 2.D.3.a. Emissions estimated in this sector were calculated by multiplying the total population of the Maltese Islands with an emission factor for NMVOC (1.2kg/capita, 2016GB). This approach was suggested by the NECD reviewers during the 2017 review. The 2017 value was carried forward for the projected years 2020, 2025 and 2030 as no projected activity data was available. There was no new historical activity data hence no reason to update the time series for historical years.

Efforts will be made to carry out further research in this area so as to attempt to develop a better methodology to estimate emissions from this sector.

2G. Other product use (NFR 2)

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
2G	Other product use; Use of fireworks, Tobacco combustion	Scientific paper by Camilleri. R and Vella (2016) and AFM (to estimate emissions from fireworks) and 2016GB to estimate emissions from cigarette combustion	Armed forces of Malta (fireworks) and Eurostat (cigarettes)	Tier 2	PM_{10}, TSP Pb, Hg	2019 Submission

Emissions from 'Use of fireworks' and 'Tobacco combustion' were reported collectively under group sector 2G. The entire time series from 2005 to 2017 was estimated and emission loads were summed up for both sub-categories under sector *2G. Other Product Use*. No projected activity data was available and hence 2017 emission estimates were assumed to remain the same for 2020, 2025 and 2030.

1. Use of fireworks

Fireworks are very commonly let off during local village feasts which mostly take place during the summer season. Some of these explosives are imported from abroad into the island while the majority are manufactured locally from raw material purchased from the Armed Forces of Malta by licensed enthusiasts. Since the amount of fireworks manufactured locally was not available, the amount of raw material used to manufacture them was used to estimate total production of explosives to be let off locally. The Armed Forces of Malta (responsible for the secure storage of Potassium Chlorate and Potassium Nitrate) provided this information and through a national study carried out by Camilleri and Vella (2016), the amount of manufactured fireworks was estimated.

In addition to locally manufactured fireworks, there is also a small amount of imported pyrotechnics. This data was obtained from Eurostat for CN codes 36041000 and 36049000. The total mass of pyrotechnical products were multiplied with the EF obtained from the 2016GB. The emission loads estimated from manufactured fireworks were summed with those from imported fireworks and results inputted in the NFR-template.

Data was available for potassium chlorate and potassium nitrate from 2011 to 2017. Data for previous years was obtained through extrapolation since no actual figures were available. Missing quantities for aluminium powder were replaced with a two year annual average available in the study by Camilleri and Vella (2016) and applied to the entire time series.

Potassium Chlorate in kg	Q1	15050
Aluminium in kg	Q2	2035
Potassium Nitrate in kg	Q3	60325

TABLE 11: ANNUAL AVERAGE OF IMPORTED OXIDANTS AND FUELS USED IN FIREWORK MANUFACTURE IN MALTA FOR THE PERIOD 2012 TO 2014 (CAMILLERI AND VELLA, 2016)

The below list of equations were used to estimate quantities of flash crackers, coloured stars and black powder in Malta.

Type of firework	Equation to determine annual quantities in kg each firework type
Flash Crackers in kg	Q4=Q2/0.3
Flash Crackers in kg	Q4=Q2/0.3
OX used for flash comp in kg	Q5=0.7Q4
OX used for star comp in kg	Q6=Q1-Q5
OX used for red STARS in kg	Q7= Q6/3
OX used for blue STARS in kg	
OX used for green STARS in kg	
Red stars in kg	Q8=Q7/0.7
Blue stars in kg	Q9=Q7/0.65
Green stars in kg	Q10=Q7/0.833
Black Powder	Q11=Q3/0.75
OX used for flash comp in kg	Q5=0.7Q4
OX used for star comp in kg	Q6=Q1-Q5
OX used for red STARS in kg	Q7= Q6/3
OX used for blue STARS in kg	

OX used for green STARS in kg	Q8=Q7/0.7
Red stars in kg	Q9=Q7/0.65
Blue stars in kg	Q10=Q7/0.833
Green stars in kg	Q11=Q3/0.75

TABLE 12: CALCULATIONS AND ASSUMPTIONS USED FOR ESTIMATING THE YEARLY AVERAGE QUANTITIES OF FLASH CRACKERS, COLOURED STARS AND BLACK POWDER IN MALTA IN 2012-2014 (CAMILLERI AND VELLA, 2016)

Once the total quantity of manufactured fireworks was calculated, 2016GB emission factors were used to estimate respective emissions. The 2017 emissions estimates were assumed to remain the same in 2020, 2025 and 2030 and projected data was submitted for the WM and WaM scenarios.

2. Tobacco combustion

The methodology to estimate emissions from cigarette combustion was obtained from the 2016GB. The activity data required was quantity of tobacco combusted locally which was obtained from Eurostat. The CN codes related to this activity under which quantity of tobacco was reported in the Eurostat portal were the following; CN codes 24022090 (cigarettes, containing tobacco (excl. containing cloves)), 24021000 (cigars, cheroots and cigarillos containing tobacco) and 24029000 (cigars, cheroots, cigarillos and cigarettes consisting wholly of tobacco substitutes). Other related codes did not include any data. EU 28 intra import data were summed with EU 28 extra import data and the total subtracted from the sum of EU28 intra export and EU 28 extra export. The result was assumed to be equal to the amount of tobacco combusted locally. Emission factors from the EU 2016GB were used to estimate emissions. The 2017 emissions estimates were assumed to remain the same in 2020, 2025 and 2030 and projected data was submitted for the WM and WaM scenario.

2H2. Industrial Processes and Product Use (NFR 2)

Other Industry Production

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
2H2	Industry	2016GB	NSO	Tier 2	NA	2019 submission

The National Statistics Office provided most of the activity data, in particular: production of home killed meat poultry, animal feed, and fish and seafood landed in Malta. The total mass of bread produced was not available. Hence, the total imported flour of common wheat and spelt and rye flour were used to calculate the mass. Previous communication with the Malta Baker's Cooperative had established that a sack of flour weighing 50kg would produce approximately 100 loaves. In turn, each baked loaf weighed around 540g. The calculation can be visualised below:

First, the weight of flour per loaf was calculated:

$$1\ sack = \frac{50kg\ of\ flour}{100\ loaves} = 500g\ of\ flour\ per\ loaf$$

EQUATION 4: EQUATION TO CALCULATE THE WEIGHT OF FLOUR PER LOAF

Then, the number of loaves was calculated:

$$Number\ of\ loaves = \frac{x\ kg\ of\ flour}{500g\ of\ flour}$$

EQUATION 5: EQUATION TO CALCULATE THE NUMBER OF LOAVES

Finally, the mass of bread was calculated:

$$Mass\ of\ bread\ produced = Number\ of\ loaves * Mass\ per\ loaf\ \ (540g)$$

EQUATION 6: EQUATION TO CALCULATE THE MASS PER LOAF

Concerning beverages, no information was available on the amount of wine and beer produced locally. Beer production could not be estimated due to the confidentiality of the activity data. However, the volume of wine produced was calculated by converting the mass of wine crops processed, as provided by Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) for the years 2005 until 2014. A conversion factor of 140kg of crop for 1hl of wine was used, as provided in the Oxford Companion to Wine (Robinson, 2006). Since FAOSTAT did not provide the data for 2015 until 2017, the values were extrapolated by means of the dragging method. The emission factors used were derived from the 2016GB.

No projected data was available for the years 2018 to 2030. A relationship was sought between historical data and past GDP and population data; however there was no relationship between the food and beverage sector, and neither GDP or population. As a result, a number of regression tests were carried out for each food or beverage type. Only the total bread produced showed a correlation for a simple linear regression, as it had a p-value below the 0.05 level of significance with an R^2 of 94.7%. Thus, the values for all the food and beverage types, except for bread production were kept constant. Whereas, bread production was assumed to experience a linear increase until 2030.

5. Agriculture (NFR 3)

3B: Manure Management

NFR-Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
3B1a, 3B1b, 3B2,3B3,3B4d, 3B4e,3B4gi, 3B4gii, 3B4giii, 3B4giv, 3B4h	AgriLivestock	2016GB	NSO	Tier 1, 2	NH_3, NMVOC, TSP	2019 submission

For this submission, the entire time series was updated to a Tier 2 methodology, as presented in the 2016GB. The notation NO was provided for the following categories: 3B4a 'Buffalo', 3B4f 'Mules and Asses', and 3B4giii 'Turkeys', since there was no activity data. The graph below shows how NH_3 emissions have increased with the use of a Tier 2 methodology. Notably, the graph also shows a decreasing trend in NH_3 emissions across the time series, as a result of a decrease in livestock numbers (AAP).

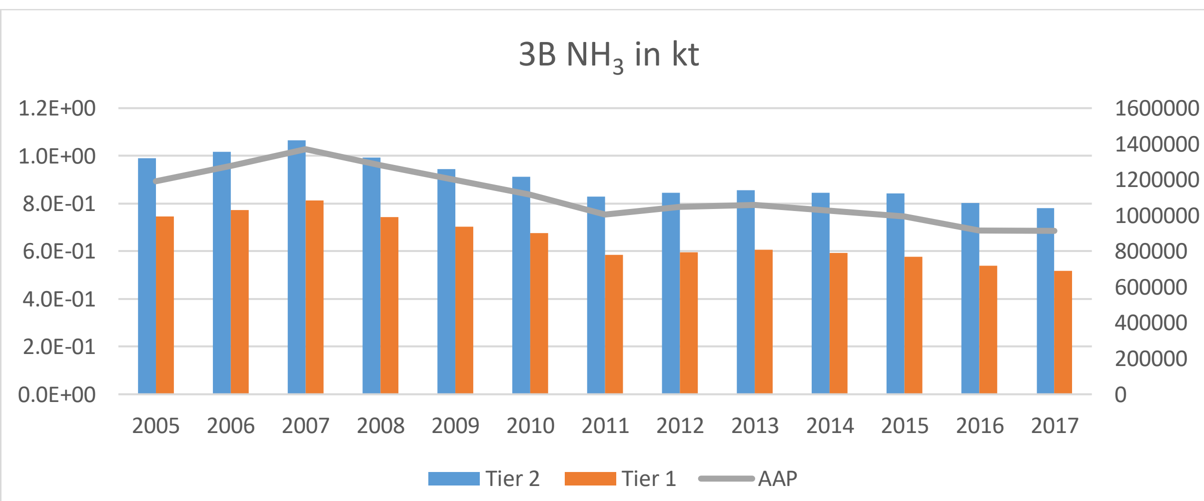

FIGURE 61: 3B NH_3 IN KT TIME SERIES

The shift to a Tier 2 methodology required additional activity data. The number of animal heads was taken from the climate change (MRA) model, to ensure consistency between both models. Nitrogen Excretion (Nex) values were calculated using the equation in chapter 10 of the IPCC 2006 Guidelines. Moreover, the data utilised to calculate the Nex was the same as that used in the climate change models. Livestock were assumed to spend all their time in buildings. Finally, the manure type produced per livestock type was determined following consultation with the Department of Agriculture and is shown below:

Livestock	Manure type	Proportion by manure type
Cattle	solid	50%
	slurry	50%
Fattening pigs	solid	5%
	slurry	95%
Sows	solid	5%
	slurry	95%
	outdoor	N/A
Layers	(Semi) solid	100%

TABLE 13: PROPORTION FOR MANURE TYPE BY LIVESTOCK

The key source categories for this chapter were as follows: 3B1a, 3B1b, 3B3, 3B4gi, 3B4gii, and 3B4h for NH_3, 3B1b for NMVOC, and 3B4gi was identified as being a key source for TSP. The graphs below show the trend of emissions for each key source:

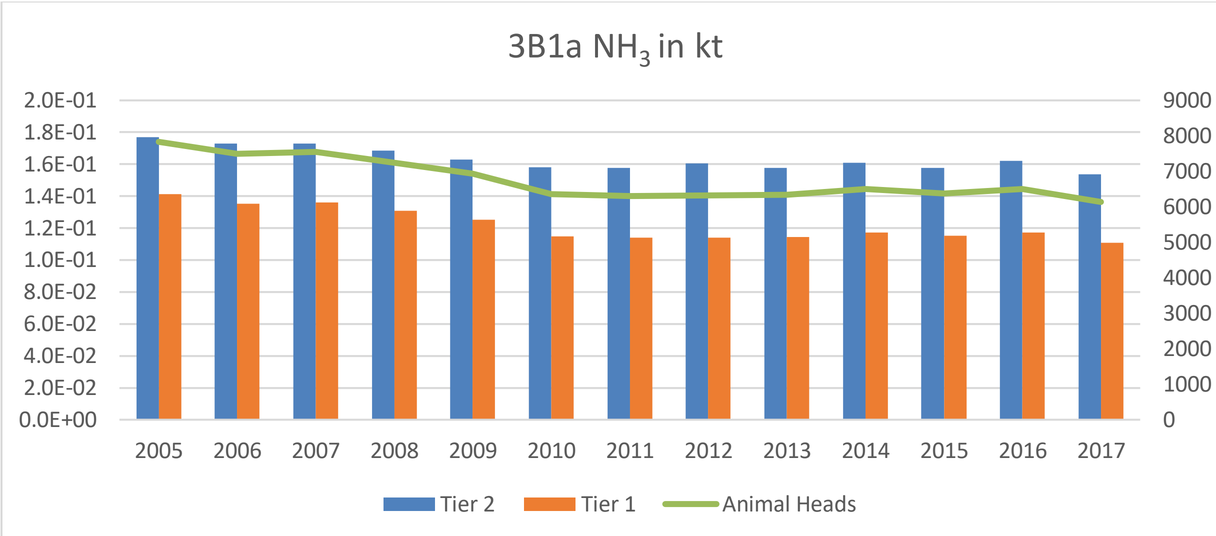

FIGURE 62: 3B1A NH_3 IN KT TIME SERIES

NH_3 emissions from dairy cattle have decreased across the time series. The recalculation with a Tier 2 methodology shows an increase in emissions compared to a Tier 1 methodology.

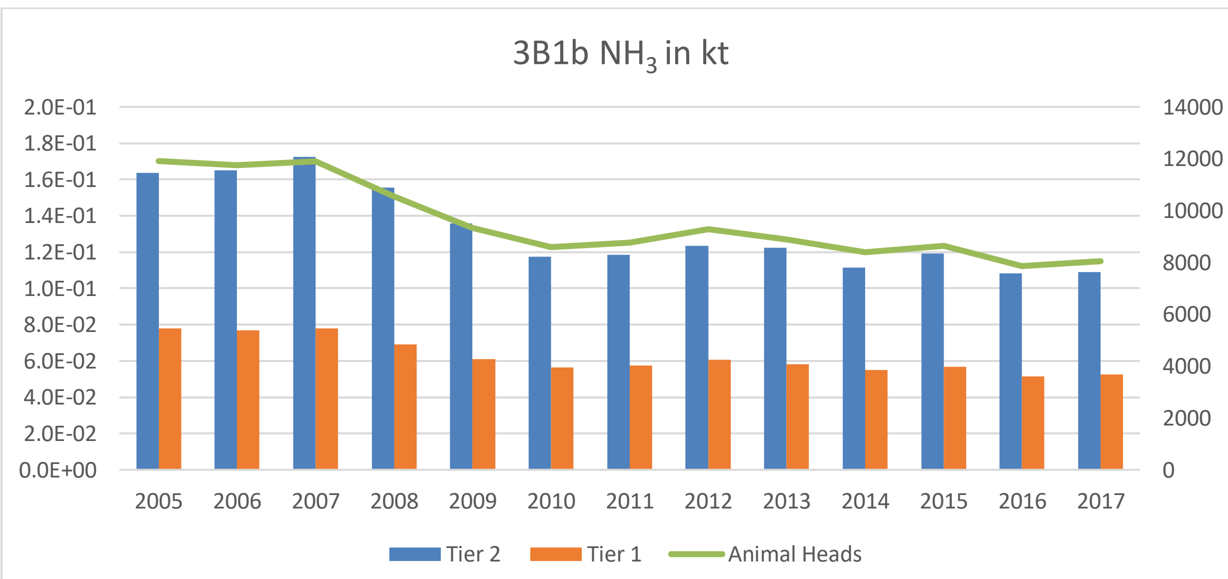

FIGURE 63: 3B1B NH_3 IN KT TIME SERIES

The trend for non-dairy cattle NH_3 emissions is similar to the one for dairy cattle. A decrease is observed across the time series. The recalculation with a Tier 2 methodology shows an increase in emissions.

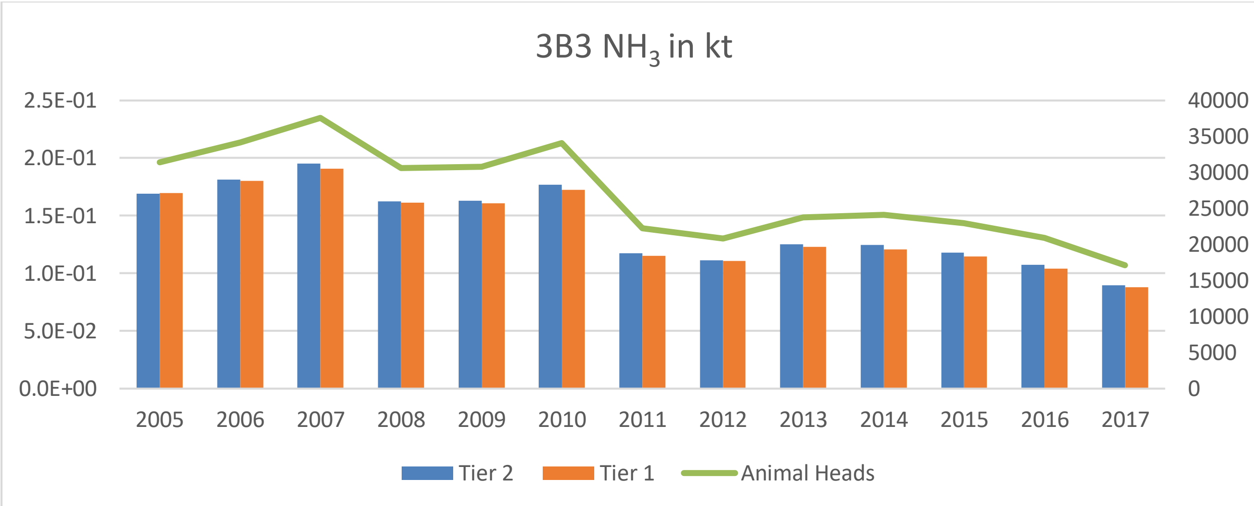

FIGURE 64: 3B3 NH_3 IN KT TIME SERIES

Swine NH_3 emissions have decreased along the time series. Furthermore, the recalculation with a Tier 2 methodology resulted in small emission increases.

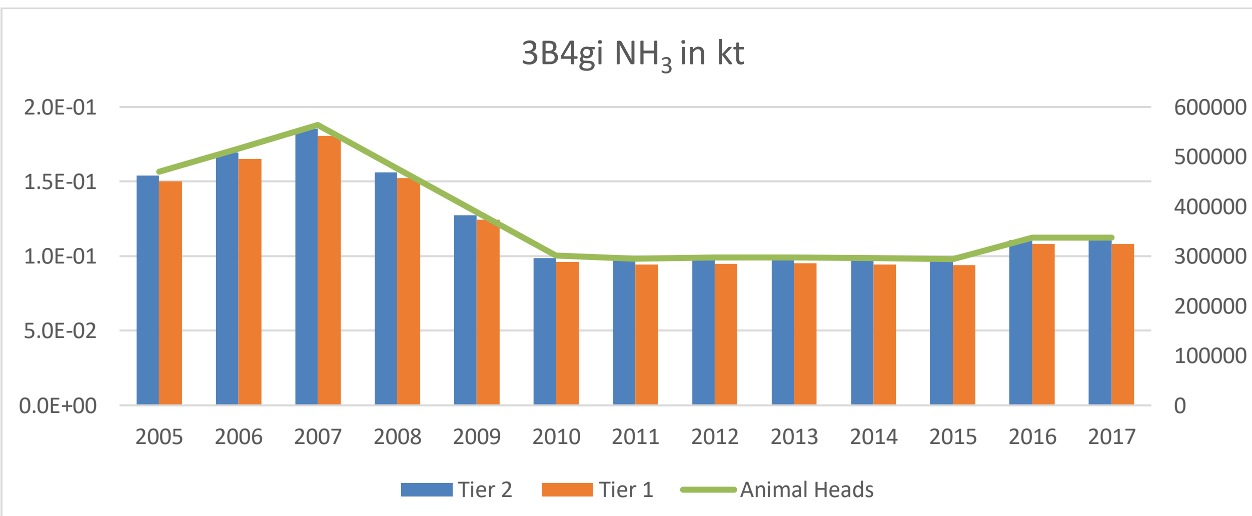

FIGURE 65: 3B4GI NH_3 IN KT TIME SERIES

NH_3 emissions from laying hens decreased overall across the time series. The recalculation to a Tier 2 method resulted in a small increase in emissions.

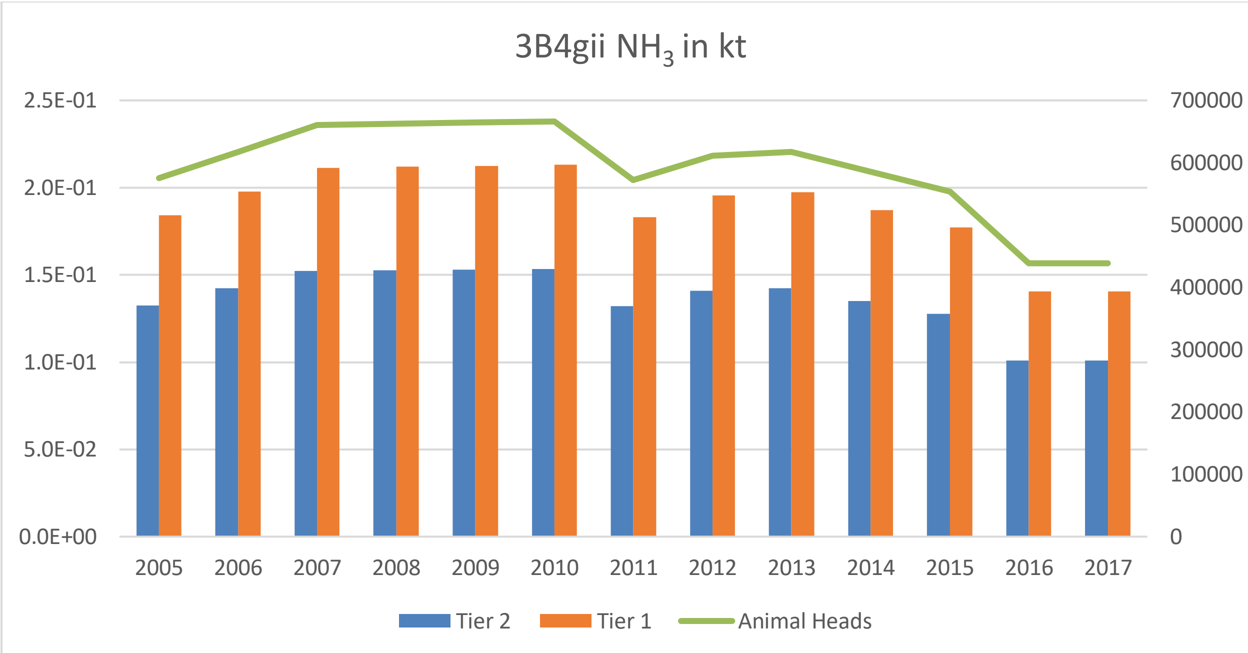

FIGURE 66: 3B4GII NH_3 IN KT TIME SERIES

NH_3 emissions decreased along the time series, mostly from 2013 onwards. Unlike for other livestock categories, the recalculation with a Tier 2 methodology resulted in a decrease in emissions for broilers.

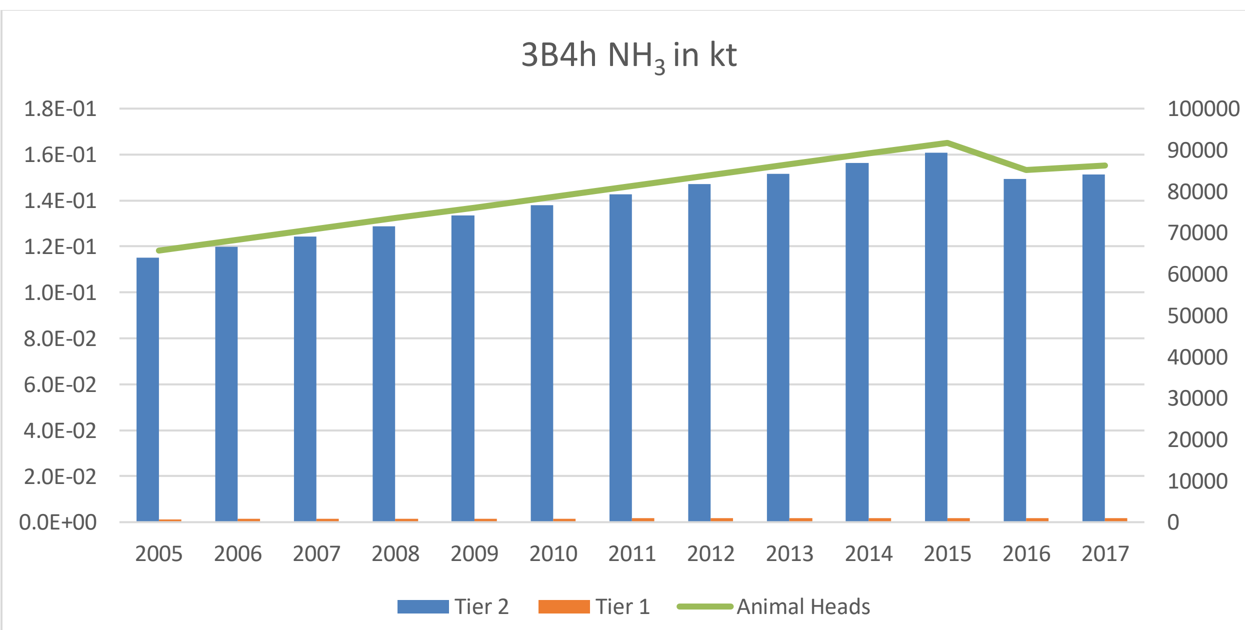

FIGURE 67: 3B4H NH_3 IN KT TIME SERIES

NH_3 emissions from other animals refer to emissions from rabbits. The trend shows a slow increasing trend across the time series. The shift to a Tier 2 methodology increased emissions significantly.

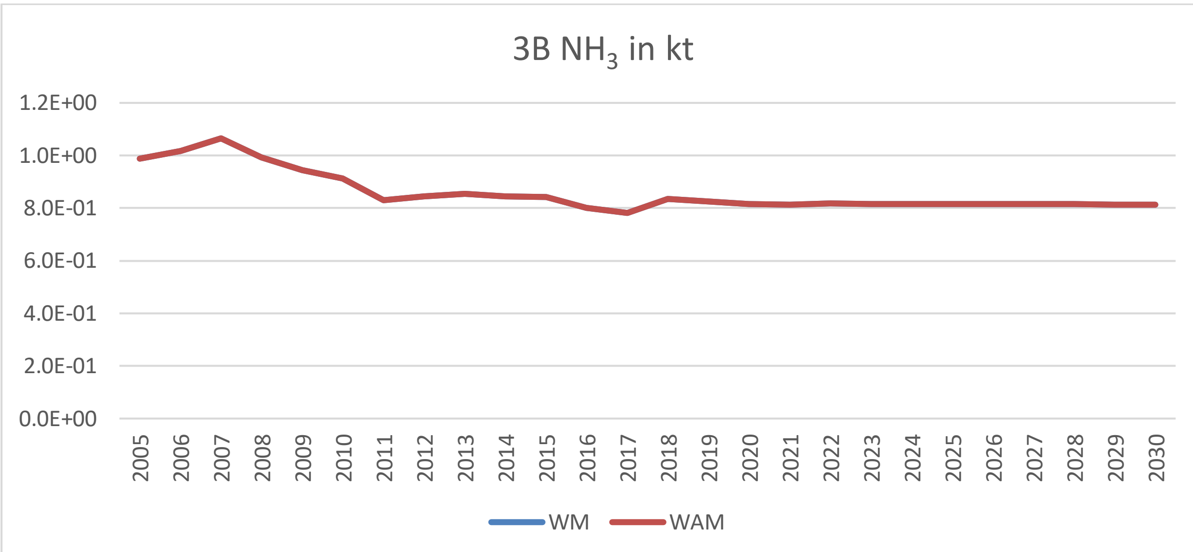

FIGURE 68: 3B NH_3 IN KT TIME SERIES (WM AND WAM)

Concerning projections, Chapter 3B was a key category for NH_3. No projected activity data was available, therefore the historical activity data, such as livestock numbers and Nex values, was extrapolated in line with the climate change (MRA) model. Furthermore, the WM and WAM scenarios were assumed to be identical, as there was no activity data. The graph above shows a stable trend for NH_3 emissions.

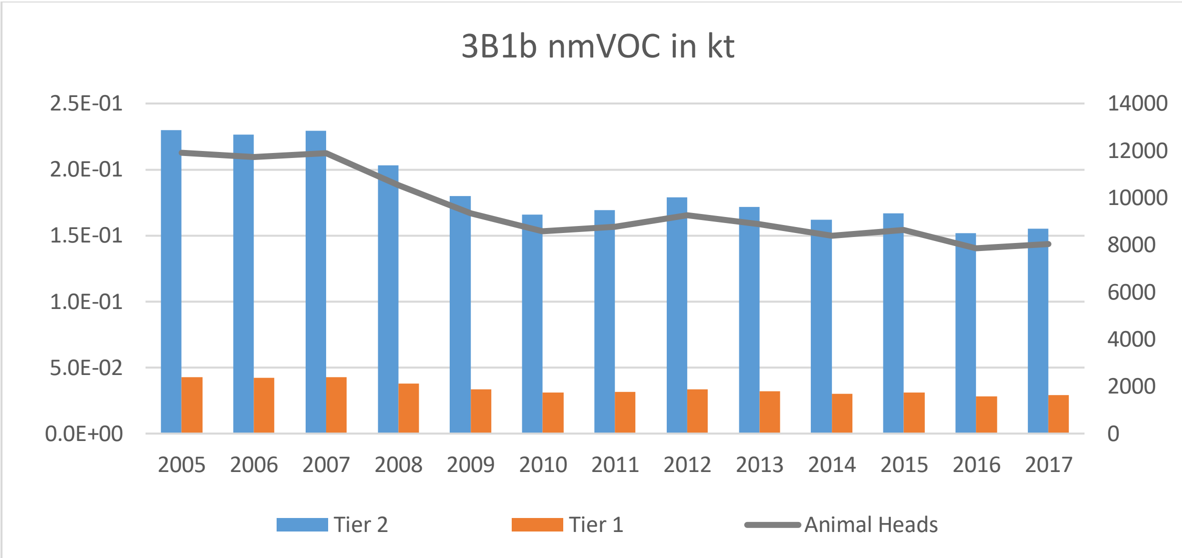

FIGURE 69: 3B1B NMVOC IN KT TIME SERIES

NMVOC emissions gradually decrease across the time series. As with NH_3, the recalculation with a Tier 2 methodology led to an increase in emissions.

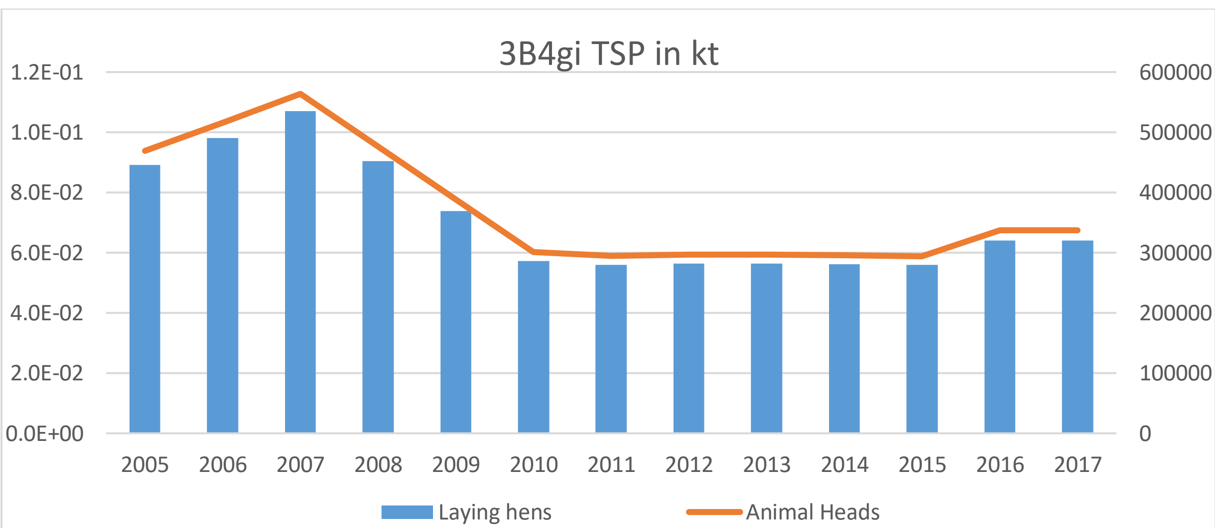

FIGURE 70: 3B4GI TSP IN KT TIME SERIES

Laying hens were the only key category for TSP. The emissions were calculated with a Tier 1 methodology. The overall trend shows a decrease along the time series.

3D: Crop production and agricultural soils

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
3Da1, 3Da2a, 3Da2b, 3Da2c, 3Da3, 3Da4, 3Db, 3Dc, 3Dd, 3De	AgriOther	2016GB	NSO	Tier 1, 2	NH_3	2019 submission

The sectors in this section were calculated for the first time with this submission. NMVOC emissions from sector 3De or 'Cultivated crops' were estimated through a Tier 2 methodology in line with the 2016GB. The other sectors were estimated through a Tier 1 methodology, also in line with the 2016GB, namely: 3Da1 'Inorganic N fertilisers (includes urea), 3Da2a 'Livestock manure applied to soils', and 3Dc 'Farm-level agricultural operations, including storage, handling and transport of agricultural products'. Sector 3Da2c or 'Other organic fertilisers applied to soils' was classified as IE, as these are sent to a landfill, and are thus covered under chapter 5A 'Biological treatment of waste - Solid waste disposal on land'. The annotation NO was used for sector 3Da2b 'Sewage sludge applied to soils', as slurry spreading is prohibited under national legislation S.L. 549.66 (Nitrates Action Programme Regulations). Similarly, emissions from 3Da3 'Urine and dung deposited by grazing animals' were also classified as NO, since no grazing activity takes place locally.

3Da1: Inorganic N fertilisers (includes urea)

The activity data used to estimate emissions from this category was the nitrogen input to soil from synthetic fertilisers. This data was obtained from climate change (MRA) model. As per the 2016GB, the main pollutants emitted from this sub-category were NH_3 and NO. Respective emission factors were taken from the 2016GB.

3Da2a: Livestock manure applied to soils

Livestock manure applied to soils is the only key category within Chapter 3D. The trend for NH_3 emissions shows a steady decrease across the years, which is attributed to a decrease in livestock numbers. The activity data required included the AAP per livestock category, and the proportion of manure that is solid and slurry. The sources of this activity data are explained under Chapter 3B: Manure Management.

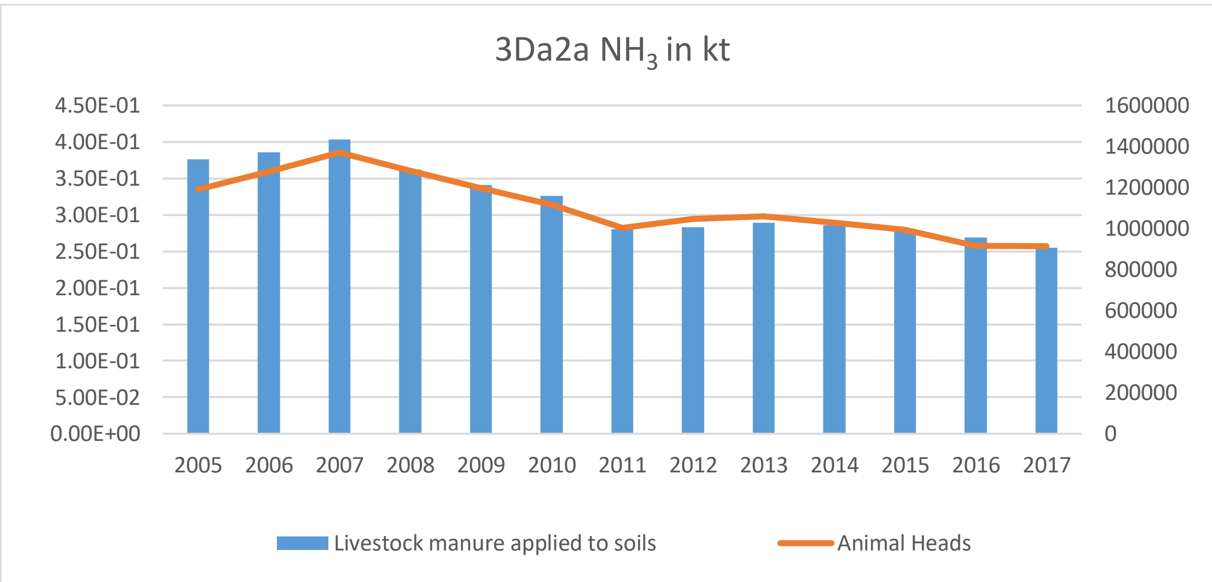

FIGURE 71: 3DA2A NH_3 IN KT TIME SERIES

3Dc: Farm-level agricultural operations including storage, handling and transport of agricultural products

$PM_{2.5}$, PM_{10} and TSP Emissions from this sector were calculated by multiplying the utilised agricultural area (UAA) by an emission factor in the 2016GB. The UAA was taken from the climate change (MRA) model.

3De: Cultivated crops

NMVOC emissions from this sector were calculated according to the Tier 2 methodology proposed in the 2016GB. The UAA was divided by area according to the area of each crop that was cultivated. The area was then multiplied by each crop's respective emission factor. The area per cultivated crop was the same as in the climate change (MRA) model.

3D: Projections - Plant production and agricultural soils

Categories under Chapter 3D: Crop production and agricultural soils are all reported under Chapter 3D: Plant production and agricultural soils. This chapter is a key category for NH_3 in 2030. The chapter covered all the sectors used for estimating historical emissions. As for Chapter 3B, no projected activity data was available. The historical data such as livestock numbers, nitrogen excretion (Nex) values, and the utilised agricultural area (UAA), was extrapolated in line with the climate change (MRA) model. Furthermore, since no projected data was available, the WM and WAM scenarios were assumed to be equal. The graph above shows a stable trend from 2018 to 2030 (EEA, 2016).

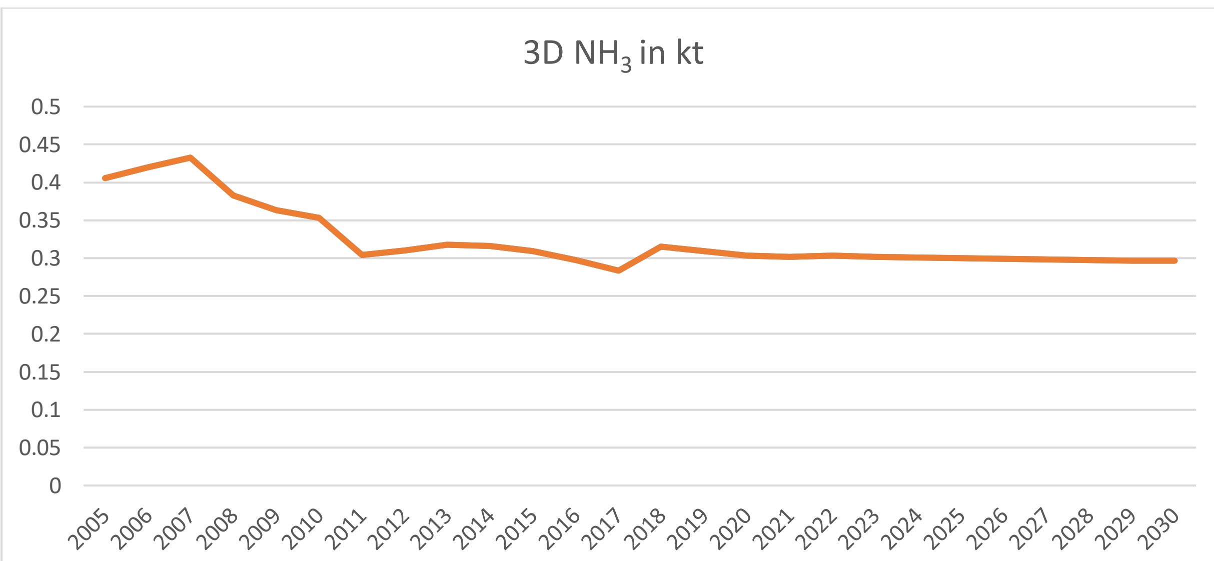

FIGURE 72: 3D NH_3 IN KT TIME SERIES

6. Waste (NFR 5)

5A Biological treatment of waste – Solid waste disposal

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5A	Waste	2016GB	AER	Tier 3	NMVOC	2019 submission

The methodology was updated to a Tier 3 approach as made available in the 2016GB to calculate NMVOC. The activity data consists of waste disposed of in landfills, excluding anaerobic digestate and animal manure. The Waste Team at the Environment & Resources Authority (ERA) provided this data. The emissions from these two contributions were already estimated in other sectors. Additionally, the mean wind speed was taken from a study by Galdies (2011), and a default factor provided in the 2016GB was used for the moisture content of the materials landfilled.

This submission includes an update of the entire time series with activity data from the annual environment reports (AERs) of the landfill. The methodology will be updated as from the next submission to a country specific methodology developed by the TERT. For the new methodology, NMVOC emissions will be in line with CH_4 emissions as estimated in the climate change (MRA) model. At present, the current model over-estimates NMVOC emissions from Solid Waste disposal on land.

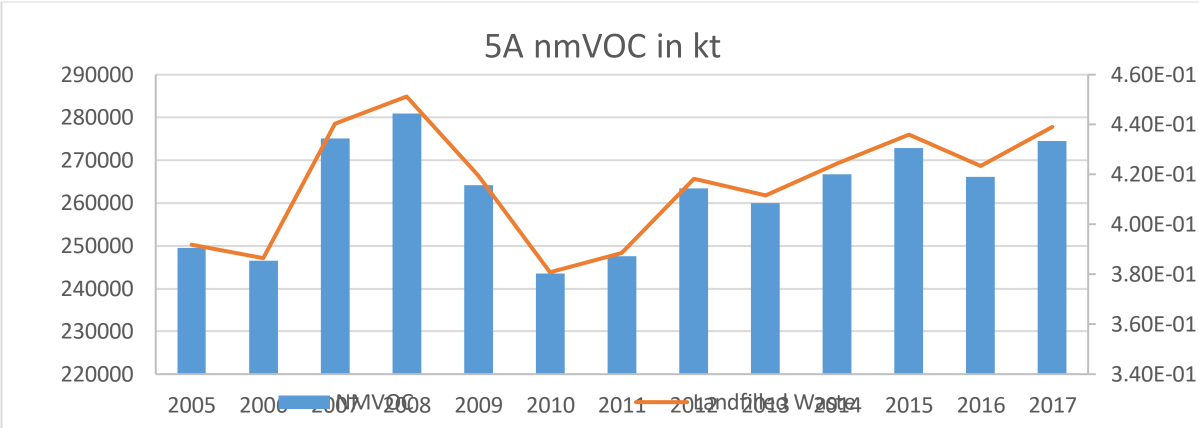

Figure 73: 5A NMVOC in kt time series

The graph above shows an increasing trend for NMVOC emissions from 2010 onwards, as waste entering the landfill increased.

5B2: Biological treatment of waste – anaerobic digestion at biogas facilities

NFR-Code	Name of Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5B2	Waste	2016GB	AER	Tier 2	NA	2019 submission

This submission includes NH_3 emissions from biological treatment of waste - anaerobic digestion at biogas facilities for the period ranging from 2011 to 2017. The Waste Team at the Environment & Resources Authority (ERA) provided this data. The Sant'Antnin Anaerobic Waste treatment facility was established in 2010; however, no data for that year was made available. Therefore, no emissions were calculated for 2010.

A tier 2 methodology based on the 2016GB was used to estimate emissions. The following equation was used to estimate NH_3 emissions:

$$E_{NH3} = AR_{feedstock} * \sum_{stages} EF_{NH3\text{-}N,\ stage\ I} * 17/14$$

EQUATION 7: EQUATION TO CALCULATE NH_3 EMISSIONS FROM ANAEROBIC DIGESTION

Where, *AR feedstock* refers to the total annual amount of N in feedstock (organic fraction entering the biogas facility). This was estimated by multiplying the organic fraction made available in the AER with the respective N content default factor made available in the 2016GB. Emission factors of NH_3, *stage i* refers to NH_3 emission factors at different stages. The pre-storage and storage of non-separate digestate were the only two stages considered to be relevant for local practices. This sector is not a key source to any of the pollutants in the national emission inventory.

5C1bv Cremation

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5C1bv	Waste	2016GB	AER	Tier 1, 3	Se, PCDD/PCDF, HCB, PCBs	2019 Submission

Waste covered in the following categories within the 2016GB: Municipal Solid Waste (5C1a); Industrial Waste (5C1b); Clinical waste (5C1biii); and Cremation (5C1bv) are incinerated together within the Marsa Thermal Treatment Facility (MTTF). Thus, the emissions were all added to the Cremation sector (5C1bv), and the other categories, namely: 5C1a, 5C1b, and 5C1biii are all classified as IE.

The facility commenced its operation in late 2007; however, the first activity data available is from 2009. The Waste Team at the Environment & Resources Authority (ERA) provided the activity data, and emissions from continuous monitoring available from the AERs. A Tier 3 methodology was used for the following pollutants, as the emissions were directly measured at the site: NO_x, NMVOC, SO_2, NH_3, $PM_{2.5}$, PM_{10}, TSP, CO, Pb, Cd, Hg, As, Cr, Ni, PCDD/PCDF. Certain pollutants had missing data for some years. In these cases, a country-specific emission factor was calculated, by obtaining an average emission load per mass of waste entering the facility. The mass of waste entering the facility in a year was then multiplied by the country-specific emission factor.

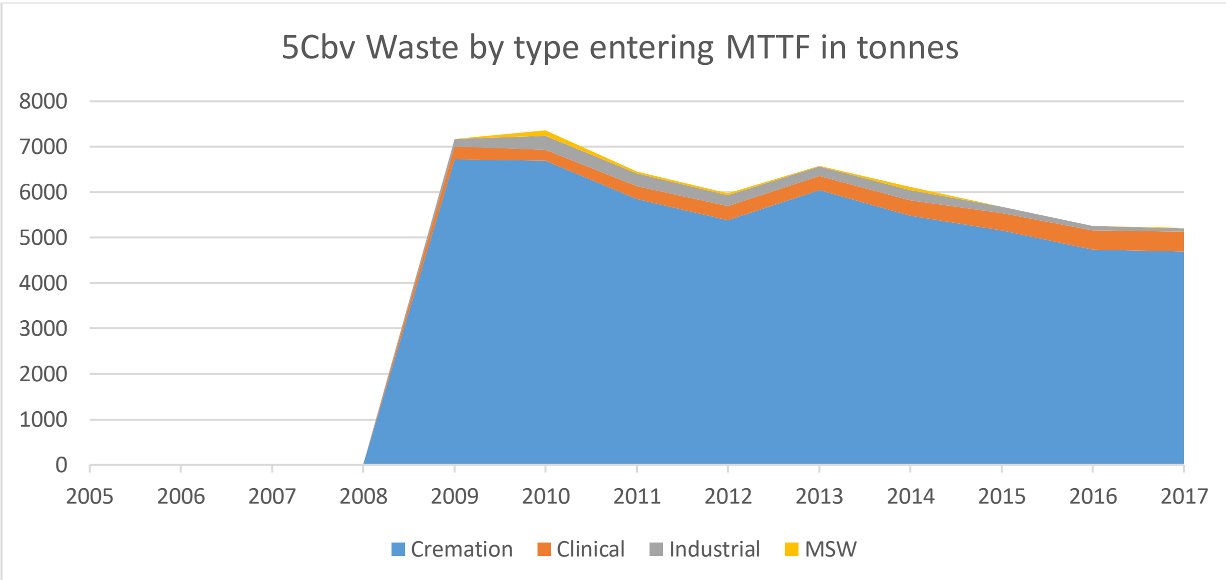

FIGURE 74: 5CBV WASTE TYPE ENTERING THE THERMAL TREATMENT FACILITY - TIME SERIES

The chart above shows the waste entering the MTTF, classified by waste type. The largest waste type is animal waste, which is closest to the waste described in the Cremation sector (5C1bv). Clinical waste is the second largest source of waste, while municipal solid waste and industrial waste are considerably smaller. The general trend shows a decrease in waste entering the facility, mostly attributed to the cremation sector. In contrast, clinical waste has increased across the time series.

No direct emissions data was available for other pollutants, and thus these had to be calculated using the Tier 1 methodology provided in the 2016GB. The pollutants whose emissions were calculated in this manner are as follows: BC, Se, Zn, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total 4 PAHs, HCB, PCBs. The total waste entering the facility was classified according to EWC code. The EWC was then used as a guidance, to separate the waste into four categories: Municipal solid waste (5C1a), Industrial waste (5C1b), Clinical waste (5C1biii), and Cremation (5C1bv). The mass of waste from each category was multiplied by the emission factor provided in the 2016GB. The emissions from the four categories were summed to obtain a single emission load per pollutant.

5.D Wastewater handling 2016

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5D	Waste	2016GB	AER	Tier 1	NA	2019 Submission

This section covers emissions from treated wastewater, as estimated through a Tier 1 methodology provided in the 2016GB. The activity data consisted of the total wastewater treated annually from 2005-2017 at four facilities: Ta' Barkat, Iċ-Ċumnija, Sant' Antnin (Malta) and Ras il-Ħobż (Gozo). The Water Services Corporation (WSC) provided the activity data. This sector generates NMVOC emissions, and these were calculated by multiplying the activity data with the Tier 1 emission factors in the 2016GB. This sector is not a key source to any of the pollutants in the national inventory.

5E. Other Waste

NFR- Code	Name of sub-Category	Method	Activity Data	EF	Key Category for pollutants	Year of last update
5E	Waste	2016GB	Civil Protection Department (CPD)	Tier 2	NA	2018 Submission

The Civil Protection Department (CPD) provided the activity data. A tier 2 approach was used and this sector was not a key source for any of the pollutants. The activity data made available did not diversify between different types of dwellings, hence the NSO 2011 census was used to determine the share of detached houses, undetached houses, apartments and hotels, which comprise the local housing market. The following assumptions were made as suggested by CPD:

- Hotel: only 1 or 2 rooms are assumed to catch fire from the entire building

- Factory: 60% of the entire building is assumed to catch fire at a time
- Household: 1 room is assumed to catch fire at a time

Waste Projections

Projections from all waste categories are reported together under Chapter 5: Waste. The projected activity data for: 5A, 5B2, and 5C1bv was provided by the Ministry for the Environment, Sustainable Development and Climate Change (MESDC), whereas projected activity data for 5D was provided by the Water Services Corporation (WSC). Concerning 5B2, the activity data provided did not include total biological treatment waste going to the anaerobic digester. Thus, the percentage of waste sent to the anaerobic digester from the mechanical and biological treatment plant was calculated for the years 2012 till 2017. These percentages were averaged, and the average value was applied to the projected waste entering the mechanical and biological treatment plant.

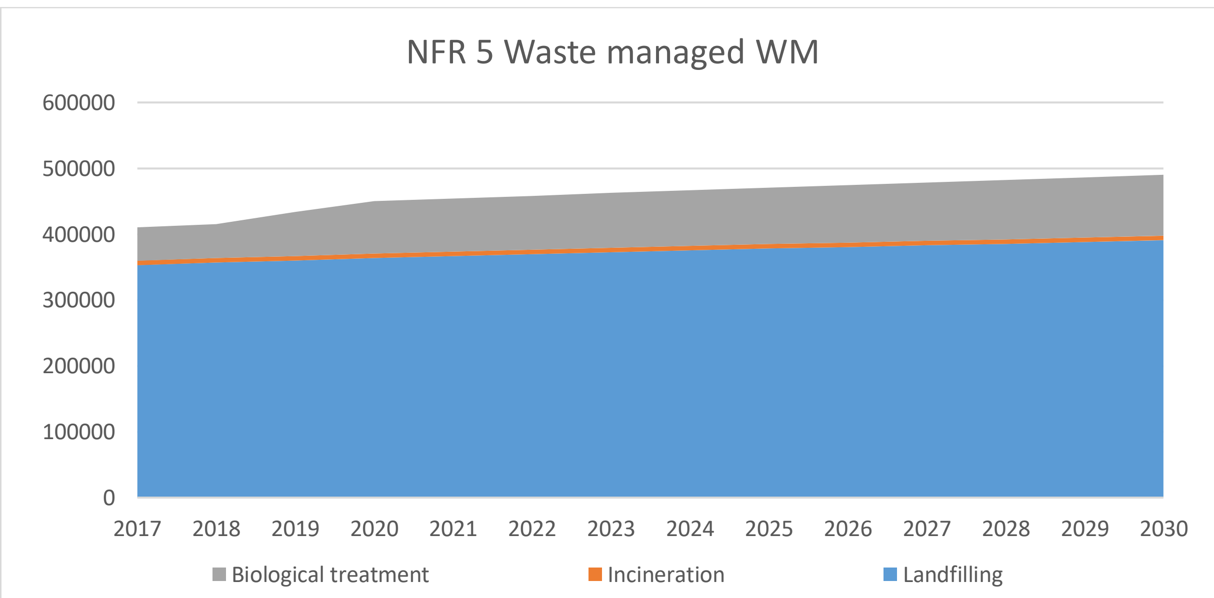

FIGURE 75: NFR 5 WASTE MANAGED IN DIFFERENT WASTE FACILITIES TIME SERIES WM

The chart above for the with-measures (WM) scenario shows a moderate increase in for all three waste categories.

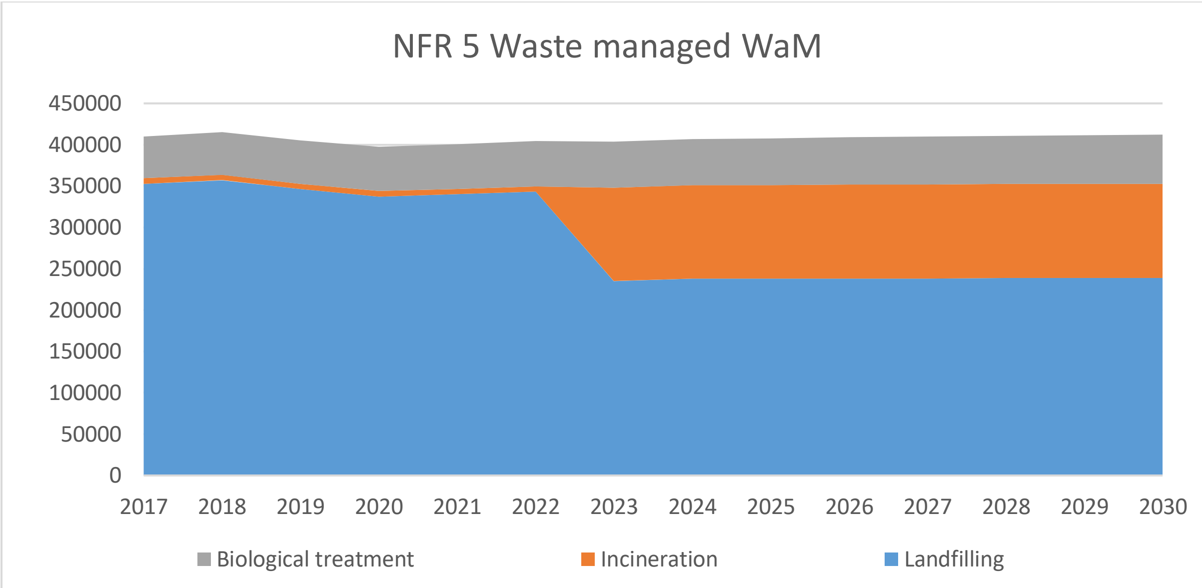

FIGURE 76: NFR 5 WASTE MANAGED TIME SERIES WAM

In contrast, the with-additional-measures (WAM) scenario shows a sudden decrease in landfilling at around 2023, since it is planned that a significant amount of previously landfilled waste will start entering a newly constructed Waste-to-Energy Facility. The EFs for the Waste-to-Energy Facility will be in line with the requirements of the Industrial Emissions Directive 2010/75/EU, and it will operate utilizing Best Available Techniques (BATs). The emission levels were therefore assumed to comprise of those in Best Available Techniques (BAT) Reference Document for Waste Incineration. Since these emission levels correspond to those used for the MTTF, the same emission factor was used.

Treated wastewater projected by WSC assumes that all wastewater will be treated prior to discharge to sea as required by the Urban Wastewater Treatment Directive. Moreover, the with-measures (WM) and with-additional-measures scenario (WaM) are identical.

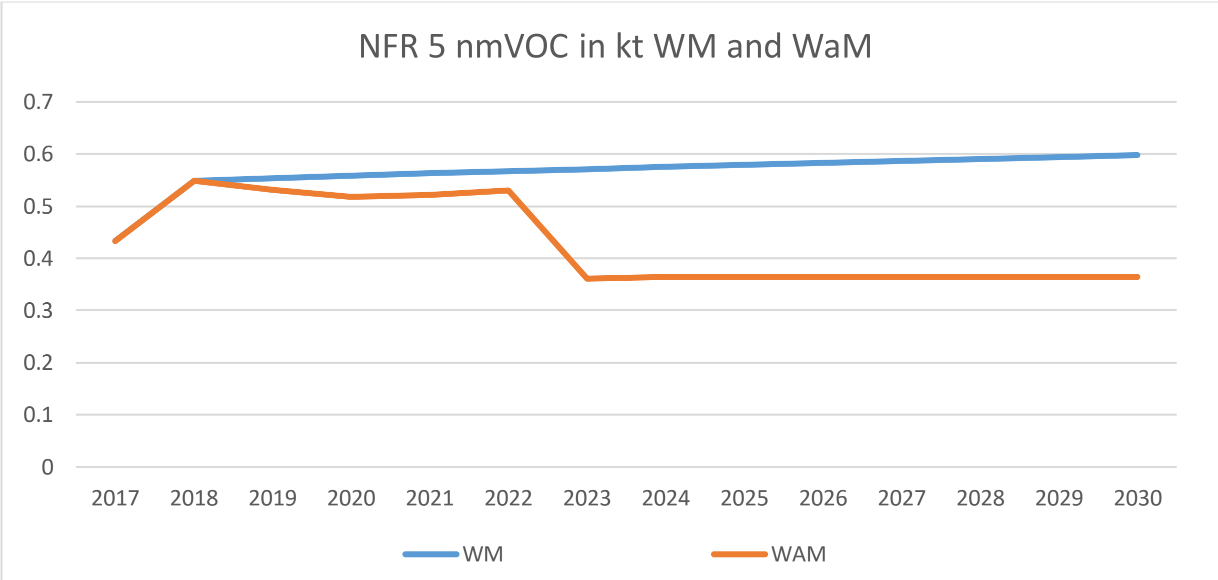

FIGURE 77: NFR 5 NMVOC IN KT TIME SERIES (WM AND WAM)

Waste is a key category for NMVOC, and sector 5A Solid waste disposal on land comprised around 99% of emissions from the waste sector. The chart above shows a sudden decrease in 2023 for the WaM scenario, as a significant amount of waste will be transferred to a waste to energy facility, rather than to a landfill.

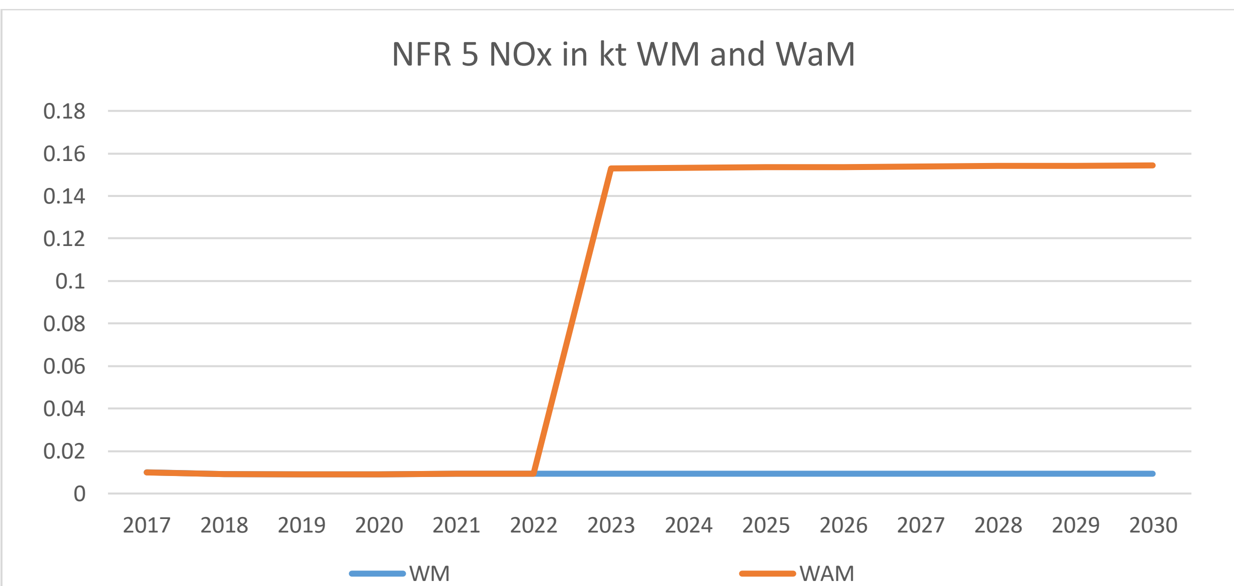

FIGURE 78: NFR 5 NO_X IN KT TIME SERIES (WM AND WAM)

Waste is not a key category for NO_x. Nevertheless, the operation of a waste to energy facility as from 2023 is expected to increase NO_x emissions. The chart above shows how emissions increase from just under 0.01kt to over 0.15kt.

7. Other (NFR 6)

This sector includes emissions that have been recurring from past submissions of which little or no information is currently available.

8. Projections

8.1. Trends for NO_x

NO_x emissions are projected to decrease from 2017 until 2030. The projections show that NO_x emissions, under both the WM and WaM scenarios, will be lower than the 2020 ceiling but higher than the 2030 ceiling.

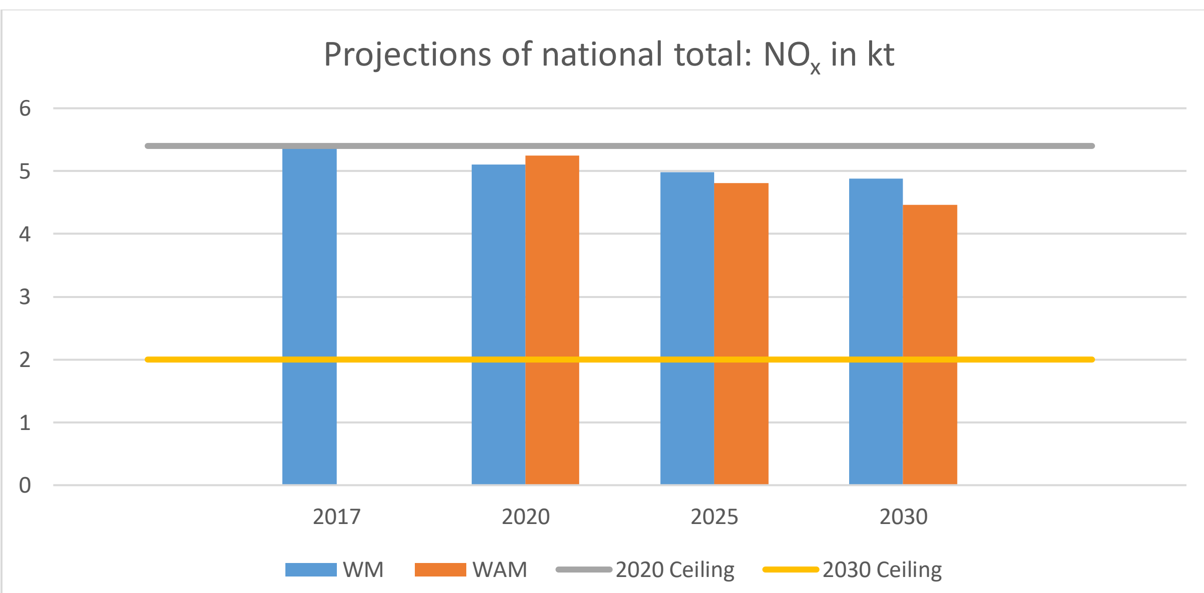

FIGURE 79: PROJECTIONS FOR NO_x IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

8.2. Trends for NMVOC

NMVOC emissions are projected to decrease from 2017 until 2030. The projections show that NMVOC emissions, under both the WM and WaM scenarios, will be higher than the 2020 ceiling but lower than the 2030 ceiling.

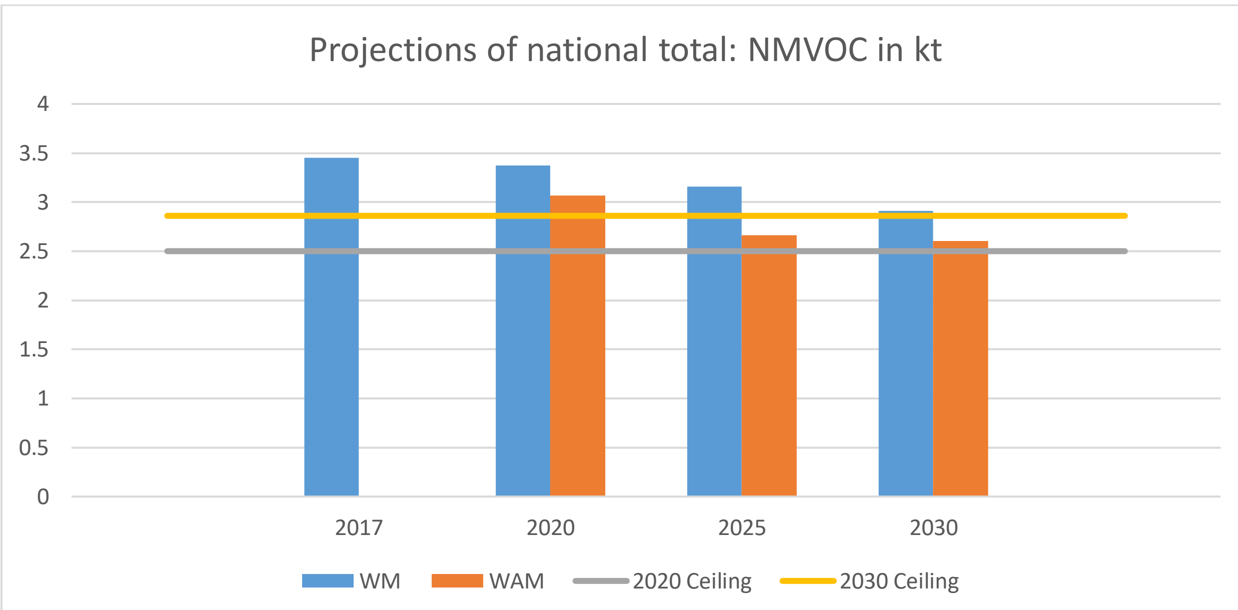

FIGURE 80: PROJECTIONS FOR NMVOC IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

8.3. Trends for SO_x

SO_x emissions are projected to decrease from 2017 until 2030. The projections show that SO_x emissions, under both the WM and WaM scenarios, will be lower than both the 2020 and 2030 ceilings.

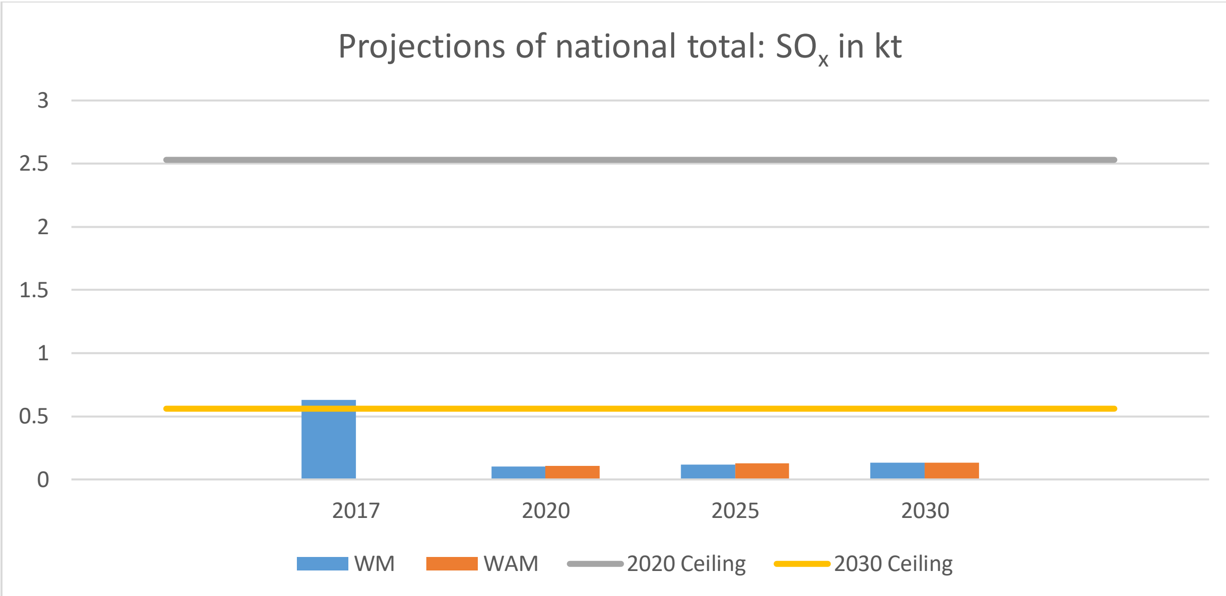

FIGURE 81: PROJECTIONS FOR SO_x IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

8.4. Trends for NH_3

NH_3 emissions are projected to decrease from 2017 until 2030. The projections show that NH_3 emissions, under both the WM and WaM scenarios, will be lower than both the 2020 and 2030 ceilings.

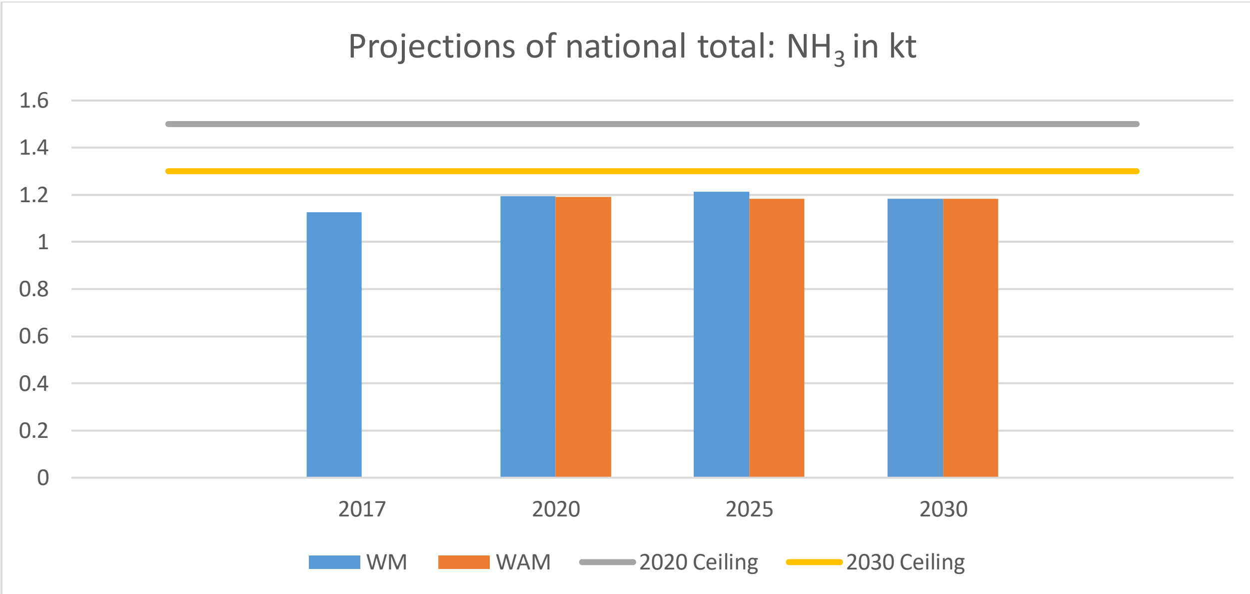

FIGURE 82: PROJECTIONS FOR NH_3 IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

8.5. Trends for $PM_{2.5}$

$PM_{2.5}$ emissions are projected to decrease from 2017 until 2030. The projections show that $PM_{2.5}$ emissions, under both the WM and WaM scenarios, will be lower than both the 2020 and 2030 ceilings.

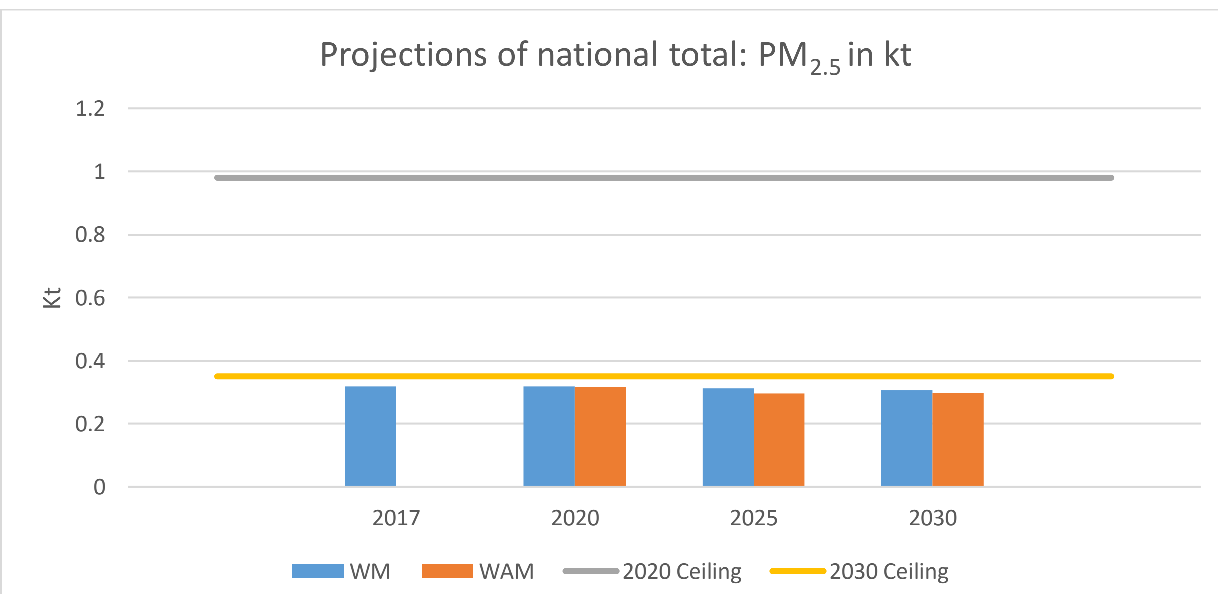

FIGURE 83: PROJECTIONS FOR $PM_{2.5}$ IN KT FOR 2017, 2020, 2025, 2030 (WM AND WAM)

9. References

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