5.C.2 - Open Burning of Waste

Category Code	Method	AD	EF
5.C.2	CS	Q	D, CS

Method(s) applied	
D	Default
T1	Tier 1 / Simple Methodology *
T2	Tier 2*
T3	Tier 3 / Detailed Methodology *
C	CORINAIR
CS	Country Specific
M	Model
* as described in the EMEP/EEA Emission Inventory Guidebook - 2019, in category chapters.	
(source for) Activity Data	
NS	National Statistics
RS	Regional Statistics
IS	International Statistics
PS	Plant Specific
As	Associations, business organisations
Q	specific Questionnaires (or surveys)
M	Model / Modelled
C	Confidential
(source for) Emission Factors	
D	Default (EMEP Guidebook)
CS	Country Specific
PS	Plant Specific
M	Model / Modelled
C	Confidential

NO_x	NMVOC	SO_2	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Se	Zn	PCDD/F	B(a)P	B(b)F	B(k)F	I(x)P	PAHs	HCB	PCB
-/-	-/-	-/-	NE	-/-	-/-	-/-	-/-	-/-	-/-	-/-	NE	NE	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	-/-	NE	NE

L/-	key source by **L**evel only
-/T	key source by **T**rend only
L/T	key source by both **L**evel and **T**rend
-/-	no key source for this pollutant
IE	emission of specific pollutant **I**ncluded **E**lsewhere (i.e. in another category)
NE	emission of specific pollutant **N**ot **E**stimated (yet)
NA	specific pollutant not emitted from this source or activity = **N**ot **A**pplicable
*	no analysis done

Within NFR sub-category 5.C.2 - Open Burning of Waste, the German emissions inventory provides only emissions from allowed bonfires and from other wooden materials burnt outdoors. Emissions from bonfires are key source for $PM_{2.5}$ and PM_{10}, but in principle of minor priority due to discontinuous appearance.

Please see chapter regarding farming/plantation waste: 3.F - Field burning of agricultural residues - this is banned by law in Germany. So there is no gap of reporting.

Emissions from open burning of wood and green waste for traditional purposes, so-called bonfires such as Easter fires, are reported model-based. In addition to biogenic carbon dioxide, emissions of NO_x, SO_2, CO, NMVOC, particulate matter ($PM_{2.5}$, PM_{10} and TSP), Polycyclic Aromatic Hydrocarbons (PAHs) and Heavy Metals are covered so far.

Method

For developing of a estimation frame a survey regarding the number of such bonfires was carried out by an expert work [1)].

As the result, questionnaires from municipalities and statistical projections for Germany for the year 2016 were checked. The project has shown a declining trend since 1990. On the basis of expert judgement, a further reduction of emissions in the future is expected.

As discussed on Review 2020 regarding all relevant sources: A comparison shows that the volume of bonfires is significantly higher than the volume of campfires. In terms of number, however, the two types of fires are similar. Due to the large fluctuations of the minimum/maximum values, the median was proposed in study.

In our view, the estimation of bonfires emissions is conservative and complete.

Activity data

Activity data for this category are based on data from a step by step calculation: After the evaluation of the questionaires an extrapolation of the volume and the number of bonfires was made for Germany. For the years since 2019, it became visible that, in addition to the model-based continuous decrease in activities, special aspects must be taken into account: Because of the restrictions on public activities during the pandemic, modeling of less traditional events was searched for.

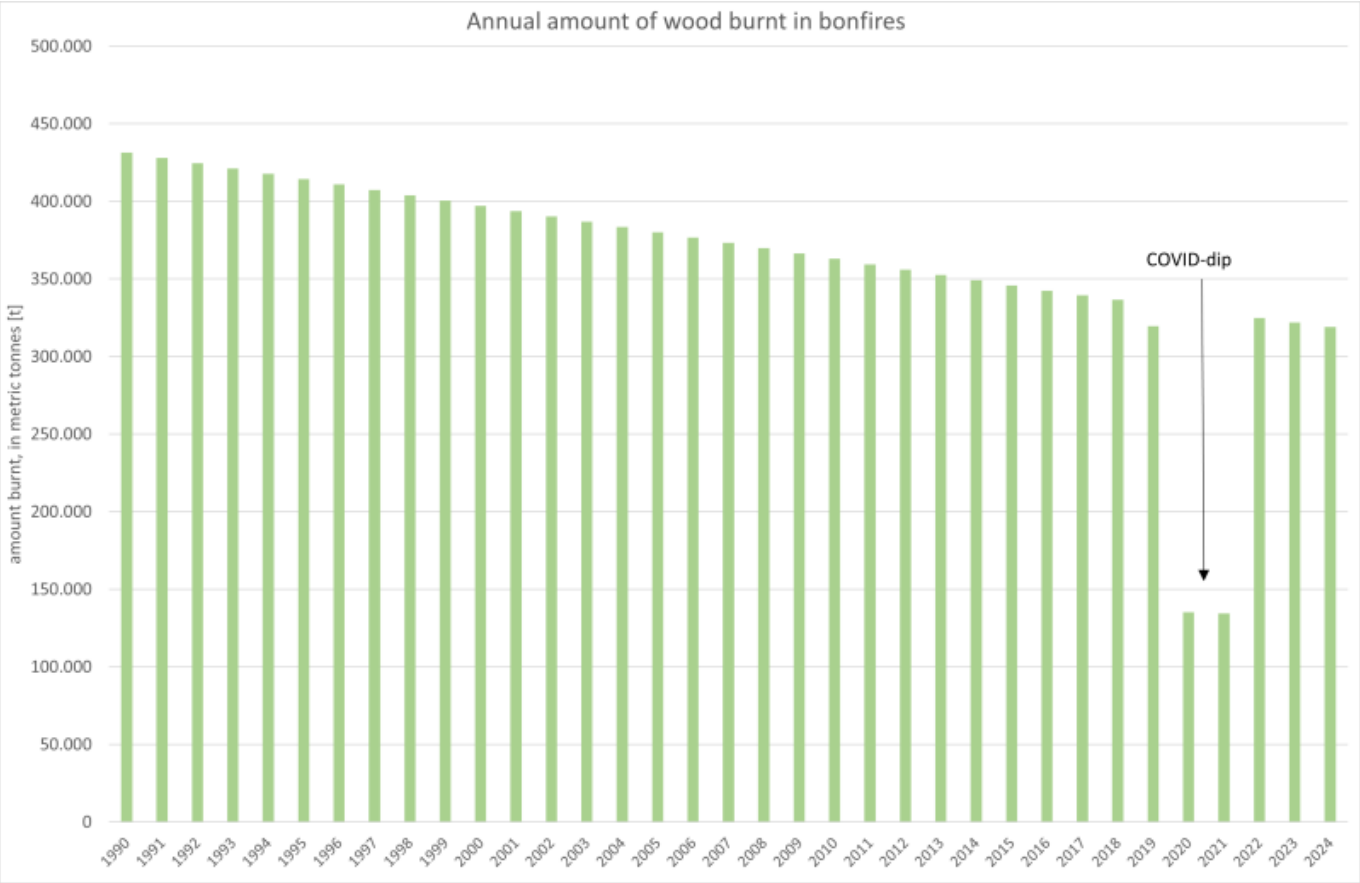
Two types of fires were already classified in the expert project: camp fires in the more private sector and, most importantly, Easter Fires in the more public sector. The calculations are now considered separately and the camp fires are modeled with a continued steady decline.

Here, Easter fires follow an approach based on a general percentage decrease of ~0.9% per year. Apart from this general approach, 2019 shows an additional 5 percentage points decrease due to a exceptionally high risk for forest fires that lead to a ban on open fires. Furthermore for 2020 and 2021, an additional 60 percent decrease was modeled due to cancellations for pandemic response (no 100% collapse due to local exceptions and follow-up events). For all years as of 2022 no such additional restrictions were modelled with the trend returning to the path left after 2018.

The following values are the result of evaluation:

Table 1: Total annual mass of bonfires, in metric tonnes [t]

1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
431,394	414,275	397,157	380,038	362,919	345,800	342,376	339,466	336,556	319,531	135,170	134,297	324,915	322,005	319,094



Emission factors

As discussed on Review 2020 regarding EF used and referenced: We use different EF from different references suitable for the burning of wooden wastes. We consider both fresh wood (garden and park waste) and dry wood (without coatings etc.). We have tried to find relevant parallels, for example because of the burning of fresh wood with regard to forest fires.

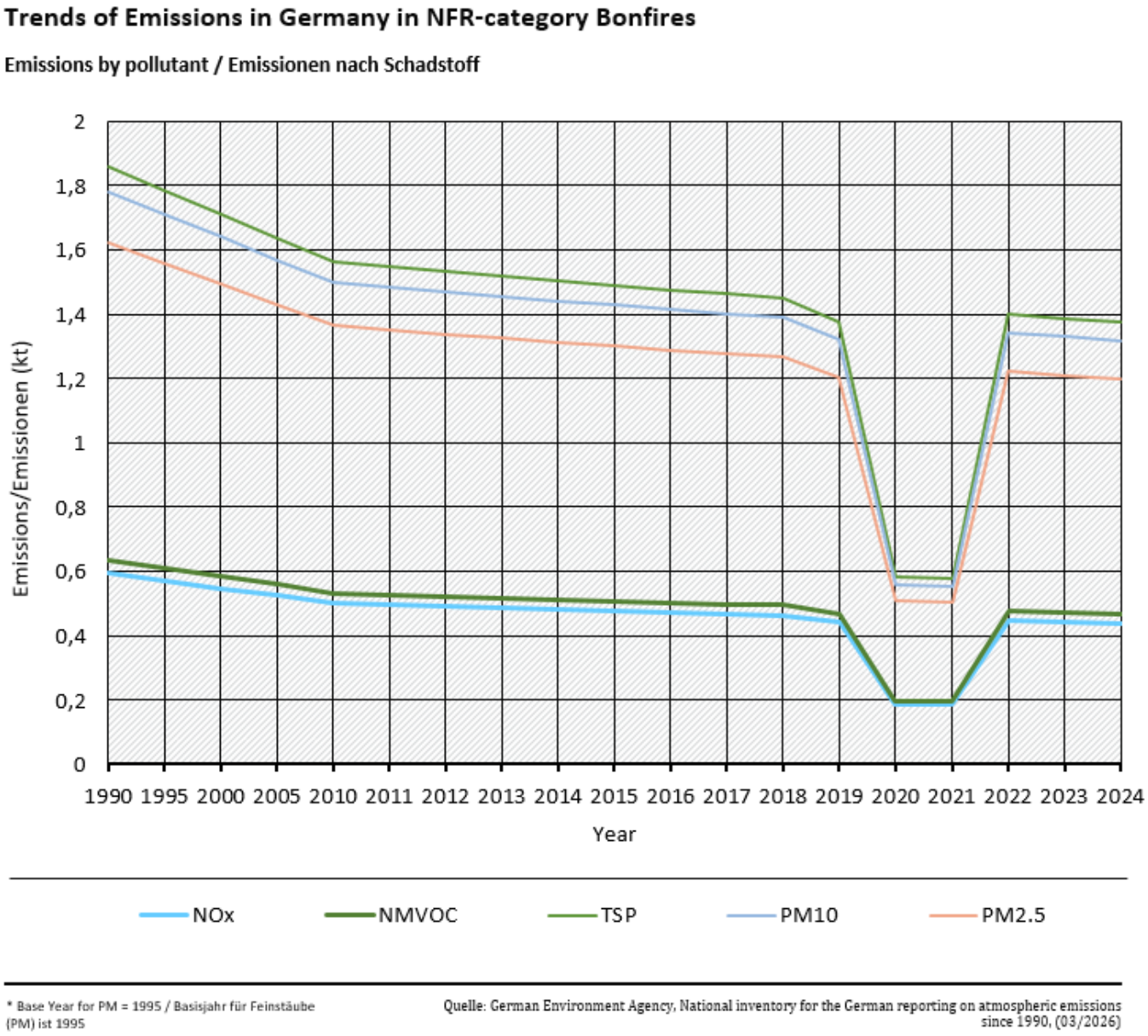
However, the majority of emission factors is derived from the EMEP/EEA Guidebook 2023 for 5.C.2, evaluated and corrected in use, as shown in the following table:

Table 2: Emission factors applied for emissions from bonfires

	value	unit	Current reference
CO	48.8	kg/t	EMEP/EEA Guidebook 2023, Chapter 5.C.2 Open burning of waste, table 3-2: Tier 2 emission factors for source category 5.C.2 Small-scale waste burning, forest residues [2)]
NO_x	1.38	kg/t	
SO_2	0.03	kg/t	
NMVOC	1.47	kg/t	
TSP	4.31	kg/t	
PM_{10}	4.13	kg/t	
$PM_{2.5}$	3.76	kg/t	
BC	1,05	kg/t	EMEP/EEA Guidebook 2023, Chapter 5.C.2 Open burning of waste, table 3-2: f-BC = 28% of $PM_{2.5}$ [3)]
PCDD/F	10.0	µg/t	EMEP/EEA Guidebook 2023, Chapter 5.C.2 Open burning of waste, table 3-1 - Tier 1 emission factors for source category 5.C.2 Small-scale waste burning [4)]
PAH	3.39	g/t	sum of single compounds
B[a]P	1.3	g/t	IIR Ireland: EFs are referenced to a former research project called 'Use of charcoal, tobacco etc.', a literature research, which is only available via the UBA library and in German. The EFs are relating to wood burning as it was documented in Ireland's IIR. [5)]
B[b]F	1.5	g/t	
B[k]F	0.5	g/t	
I[...]P	0.09	g/t	
Pb	0.32	g/t	EMEP/EEA Guidebook 2023, Chapter 5.C.2 Open burning of waste, table 3-2: Tier 2 emission factors for source category 5.C.2 Small-scale waste burning, forest residues [6)]
Cd	0.13	g/t	

Trends in emissions

With no annual emission factors (no emission reduction measures implemeted or to be expected), emission development correspond to the trend of activity data. Accordingly, 2020 and 2021 show a strong decrease for all covered pollutants due to the Covid pandemic and the restrictions on public life visible such as locally organized traditional bonfires (Easter or solstice fires etc.).



Emission trends of bonfires

Recalculations

With **activity data and emission factors remaining unrevised**, no recalculations were carried out compared to the previous submission.

Planned improvements

At the moment, no category-specific improvements are planned.

[1)] Wagner, J. & Steinmetzer, S., 2018: INTECUS GmbH Abfallwirtschaft und umweltintegratives Management: Erhebung der Größen und Zusammensetzung von Brauchtums- und Lagerfeuern durch kommunale Befragungen; URL:

https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2018-02-19_texte_11-2018_lager-brauchtumsfeuer.pdf; UBA-Texte 11/2018

[2), 3), 4), 6)] EMEP/EEA, 2023: EMEP/EEA air pollutant emission inventory guidebook 2023; 5.C.2 Open burning of waste, https://www.eea.europa.eu/en/analysis/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/5-waste/5-c-2-open-burning/@@download/file, EEA, Copenhagen, 2023