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	PAH1-4	HCB	PCBs
-/-	-/-	-/-	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 completly.

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 about general percentage decreases and additionally in 2019 five percentage points decrease corresponding to various cancels due to forest fire risk. In 2020 and 2021, an additional 70 percent decrease was modeled due to cancellations for pandemic response (but no complete cancellation in Germany because there were exceptions and follow-up events). For 2022 no restrictions were modelled, only the known slight decreasing trend. 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	2020	2021	2022
431,394	414,276	397,157	380,038	362,919	345,800	135,170	134.297	324.915

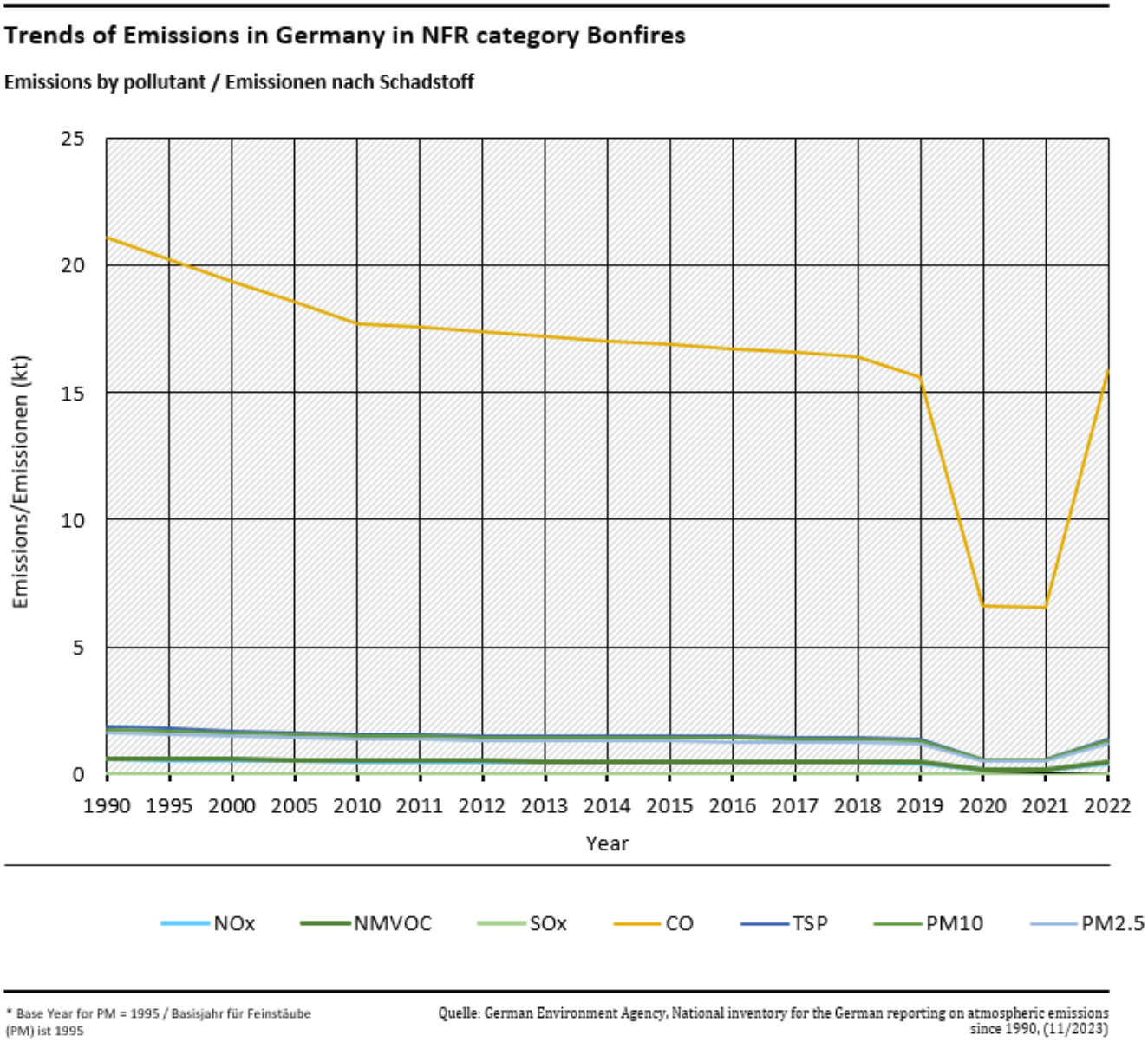
Emission factors

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. But the most EF are from GB 2023 for 5.C.2, evaluated and corrected in use, as shown in the following table:

	value	unit	Current reference
CO	48.8	kg/ t	GB 2023 5.C.2, table 3-2
NO_x	1.38	kg/ t	GB 2023 5.C.2, table 3-2
SO_2	0.03	kg/ t	GB 2023 5.C.2, table 3-2
NMVOC	1.47	kg/ t	GB 2023 5.C.2, table 3-2
TSP	4.31	kg/ t	GB 2023 5.C.2, table 3-2
PM_{10}	4.13	kg/ t	GB 2023 5.C.2, table 3-2
$PM_{2.5}$	3.76	kg/ t	GB 2023 5.C.2, table 3-2
BC	1,05	kg/ t	GB 2023 5.C.2, table 3-2 (28% of PM2.5)
PCDD/F	10.0	µg/ t	GB 2023 5.C.2, table 3-1
PAH	3.39	g/ t	sum of single compounts
B[a]P	1.3	g/ t	IIR Ireland [2)]
B[b]F	1.5	g/ t	IIR Ireland [3)]
B[k]F	0.5	g/ t	IIR Ireland [4)]
I[...]P	0.09	g/ t	IIR Ireland [5)]
Pb	0.32	g/ t	GB 2023 5.C.2, table 3-2
Cd	0.13	g/ t	GB 2023 5.C.2, table 3-2

Trends in emissions

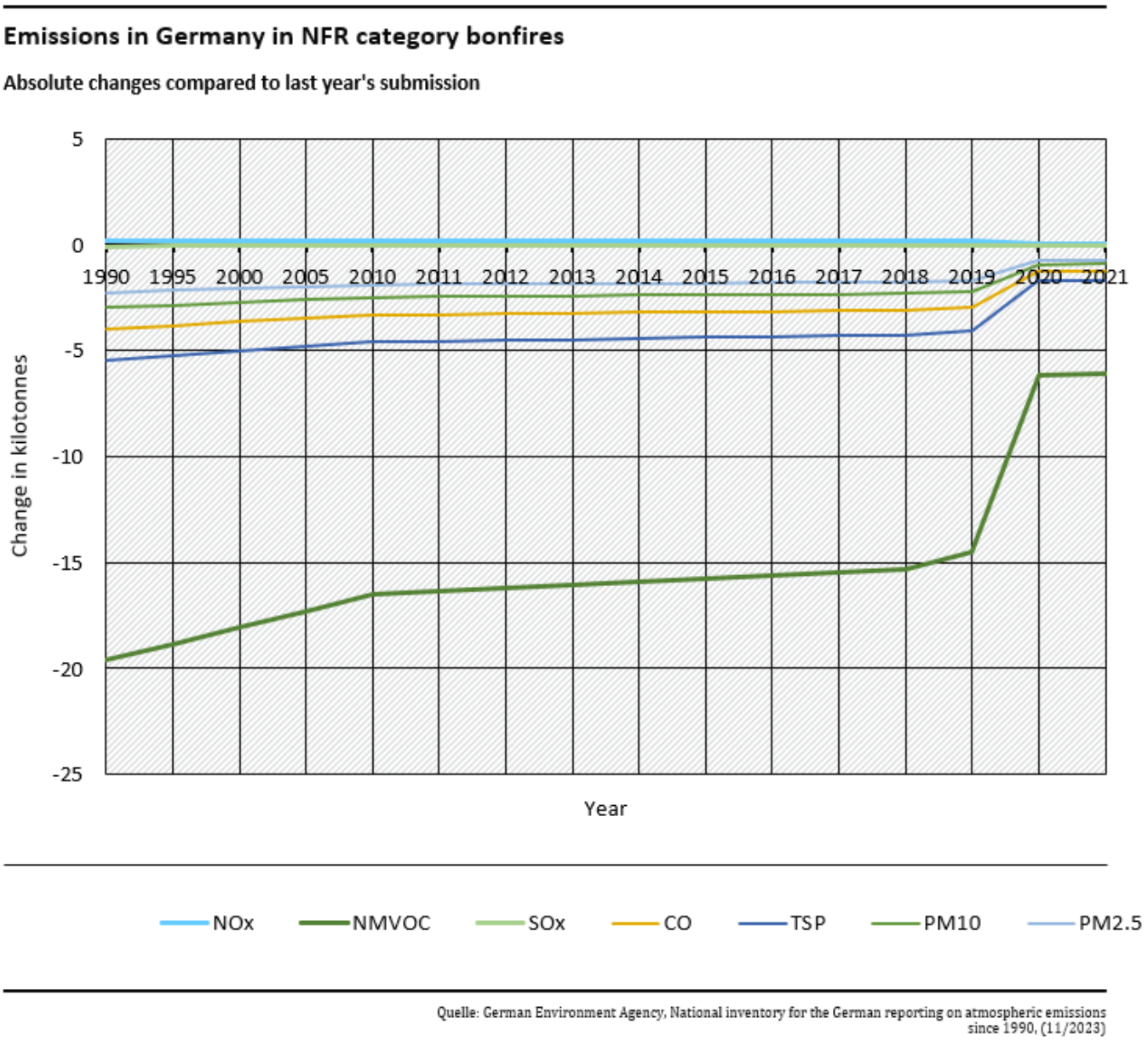
All trends in emissions correspond to trends of AD. No rising trends are identifiable in the long term.



Emission trends of bonfires

Recalculations

Recalculations were necessary due to corrected emission factors. The significant changes can be shown as an absolute difference over time as follows:



Recalculations in NFR 5.C.2

For **pollutant-specific information on recalculated emission estimates for Base Year and 2021**, please see the pollutant specific recalculation tables following chapter 8.1 - Recalculations.

[1)] Wagner & Steinmetzer, 2018: Jörg Wagner, Sonja Steinmetzer, 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), 5)] (EF is referenced to a former research project called 'Use of charcoal, tobacco etc.'. This was a literature research, which is only available via UBA library in German. The EF is relating wood burning as it was documented in Ireland's IIR