

2.G(a) - Fireworks

Fireworks

Short description

In this sub-category of 2.G(a) - *Other product use: Fireworks* Germany reports NO_x, SO_x, CO, TSP, PM₁₀, PM_{2.5}, Cu, Pb and Zn emissions from fireworks.

NFR-Code	~ Name of Category	~ Method	~ AD	~ EF	~ Key Category	1
= 2.G(a)	= Other Product use: Fireworks	= CS	= NS and association	= D, CS	= see superordinate chapter]	

Method

In the year 2019 measurements were made by a finish laboratory for the VPI – Verband der pyrotechnischen Industrie (Association of the pyrotechnical industry) of dust emissions during the burning of fire works. The experiments were made in a container in which the whole fireworks were burned. In 2020 the VPI and the UBA had an intensive information exchange, in which the VPI presented the results of the measurements to the UBA. The different emission factors were discussed and finally based on the expert judgement it was decided which EFs shall be used for the reporting. In the next step the activity data were updated more differentiated. Further a discussion of the other EFs was made, which led to some changes in the EFs. The results are presented below.

Activity data

For the calculation of the activity data the following formula is used: AR = production + import – export – disposal + return of the year before – return of the year The **production, disposal, return from the year before and return of the year** data are yearly updated by the VPI. **Import and export:** For the import and export data statistical data from the statistical federal office of Germany were taken (foreign statistics of federal office of statistics)¹⁾. The sold amounts of fireworks have increased strongly from 1990 to 1995. From 1995 to 1997 the emissions were relatively high but decreased from 1997 to 2005. Since then, the emissions have been relatively constant with small fluctuations.

Emission factors

The emission factors of SO₂, CO, NO_x, Cu, Pb and Zn are the Default-EFs derived from the EMEP Guidebook²⁾, page 22, table 3-14: Tier 2 emission factor for source category 2.D.3.i, 2.G Other solvent and product use, Other, Use of Fireworks.

Pollutants	Unit	Default-EF
SO ₂	g/t product	3.020
CO	g/t product	7.150

Pollutants	Unit	Default-EF
NOx	g/t product	260
Cu	g/t product	444
Pb	g/t product	784
Zn	g/t product	260

The emission factors for PM₁₀, PM_{2.5} and TSP are measured values from the VPI. The VPI plans to publish the results in a peer reviewed Journal. The Link will be added here.

Pollutant	PM₁₀	PM₁₀	PM 2.5	PM 2.5	STB	STB
	Sylvester-EF	During the period-EF	Sylvester-EF	During the period-EF	Sylvester-EF	During the period-EF
	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]	[g/t]
1990	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1991	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1992	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1993	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1994	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1995	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1996	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1997	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1998	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
1999	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2000	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2001	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2002	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2003	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2004	52.002,56	62.799,96	41.463,05	49.644,24	52.002,56	62.799,96
2005	47.509,31	72.317,11	38.129,60	57.167,68	47.509,31	72.317,11
2006	45.793,40	71.986,67	36.930,61	56.906,46	45.793,40	71.986,67
2007	45.174,65	72.071,88	36.615,74	56.973,82	45.174,65	72.071,88
2008	45.955,36	71.471,31	37.390,41	56.499,06	45.955,36	71.471,31
2009	45.701,68	70.204,58	37.132,12	55.497,69	45.701,68	70.204,58
2010	44.826,79	69.253,15	36.536,80	54.745,57	44.826,79	69.253,15
2011	44.068,30	68.877,53	36.121,87	54.448,64	44.068,30	68.877,53
2012	45.566,16	69.993,91	37.527,36	55.331,16	45.566,16	69.993,91
2013	46.098,42	67.212,39	38.026,91	53.132,33	46.098,42	67.212,39
2014	46.621,17	67.680,72	38.595,22	53.502,55	46.621,17	67.680,72
2015	47.474,24	67.313,58	39.383,93	53.212,31	47.474,24	67.313,58
2016	47.523,35	66.094,38	39.539,55	52.248,52	47.523,35	66.094,38
2017	47.853,44	65.938,58	39.907,83	52.125,36	47.853,44	65.938,58
2018	48.270,00	63.519,57	39.713,09	50.213,10	48.270,00	63.519,57
2019	48.085,00	63.217,87	40.033,58	49.974,60	48.085,00	63.217,87

The EMEP Guidebook offers Default-EFs for the pollutants Ar, Hg, Ni and Cr. But the VPI has proofed that these emissions does not occur in Germany. And the VPI has further proofed that Pb emissions does not anymore occur since 2003. See the following explanations:

AR and Hg: For Ar and Hg the members of the VPI have confirmed that Ar and Hg are not anymore used since 1980. Since 2003 the DIN EN 14035:2003 went in force, which did forbid these substances. The actual follow up norm DIN EN 15947-5 was published in February 2016 and describes the german implementation of the harmonized and in the official journal of the European union 2017, C 149/2 published norm EN 15947:2015.

Pb: As the DIN EN 14035:2003 entered into force as from 2003, which did forbid this substance, there are no Pb-emissions from fireworks from 2003 onwards. The actual follow up norm DIN EN 15947-5 was published in February 2016 and describes the german implementation of the harmonized and in the official journal of the European union 2017, C 149/2 published norm EN 15947:2015.

Cd: The members of the VPI were asked and did explain, that Cd was never used, because it has no pyrotechnical effect. Since 2013 Cd is on the candidates list of the substances of Very High Concern (SVHC), published according article 59, para. 10 of the REACH-ordinance.

Ni: The members of the VPI informed that Ni was never used, because it has no pyrotechnical effect. It is part of the harmonized assessment according the ordinance (EG) Nr. 1272/2008 (CLP). Belonging to this, it is assessed as cancerogen category 2.

Cr: According the information from the members of the VPI Cr is not anymore used since the beginning of the 1980. Since 2012 (REACH Annex XIV (Ordinance (EU) Nr. 125/2012) Cr was implemented in the REACH Annex XIV. So from that year a permission duty is necessary. So far, none of the fireworks producers has requested for a permission.

Recalculations

The **activity data** has changed as follows:

Table 1: Change of AD between Submission 2020 and Submission 2021

		Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Subm2020	AR	t	17.956,90	21.740,70	37.115,80	34.781,10	39.578,70	66.271,80	69.009,60	59.560	25.604,70	43.244,30	48.355,30	24.149,60	36.461,80	36.351,70	46.347,10	38.148,13	43.487,27	44.704,70	42.228,13	41.839,47	42.651,70	38.637,53	42.856,67	37.846,70	45.164,10	45.656,30	45.208,30	44.110,70	46.461,70
Subm2021	AR	t	13.939	16.395,80	24.555,50	26.172,30	27.152,60	51.421,30	54.412,70	48.281,20	24.179,80	24.692,50	26.282,70	21.561,30	25.993,60	25.759,40	29.286,30	28.856,20	30.491,40	33.396,30	34.461,40	30.074,50	31.439,50	29.795	33.085,50	29.130,70	33.240,60	34.998,70	32.571,70	33.935,70	32.979,70
Subm2021	AR	t	4.130,10	3.493,40	5.902,70	6.138	6.798,60	7.447,20	7.880,40	6.992,50	5.220,20	11.482,80	10.905,70	4.741,20	6.085	6.256,30	8.545,20	7.505,50	10.755,40	8.235,10	8.088,30	7.520,70	8.006,60	7.499	8.137,30	7.247,10	8.465,40	8.831,50	9.487,20	8.544	9.088
Subm2021	Sum	t	18.069,10	19.889,20	30.458,20	32.310,30	33.951,20	58.868,50	62.293,10	55.273,70	29.400,00	36.175,30	37.188,40	26.302,50	32.078,60	32.015,70	37.831,50	36.361,70	41.246,80	41.631,40	42.549,70	37.595,20	39.446,10	37.294,00	41.222,80	36.377,80	41.706,00	43.830,20	42.058,90	42.479,70	42.067,70
Difference		t	112,20	-1.851,50	-6.657,60	-2.470,80	-5.627,50	-7.403,30	-6.716,50	-4.286,30	3.795,30	-7.069,00	-11.166,90	-2.152,90	-4.383,20	-4.336,00	-8.515,60	-1.786,43	-2.240,47	-3.073,30	321,57	-4.244,27	-3.205,60	-1.343,53	-1.633,87	-1.468,90	-3.458,10	-1.826,10	-1.349,40	-4.394,00	

The **emissions** from As, Cd, Cr, Hg and Ni were deleted. The VPI proofed that these emissions does not occur. For Pb the emissions from 2003 onwards changed to NA because the VPI proofed that the usage of Pb is forbidden since 2003 by a DIN Norm. The emissions of CO, Cu, NOx, SOx, Zn and Pb are changed because of changed AD. The emissions of PM10, PM2.5 and TSP are changed because of changed AD and new EFs from the VPI.

Table 2: Change of emissions between Submission 2020 and Submission 2021

Schadstoff/Quellegruppe	Einheit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Subm2020	As	t	0,02388268	0,02891513	0,04936401	0,04625886	0,05263967	0,08814149	0,09178277	0,0792148	0,03405425	0,05751492	0,06431253	0,03211897	0,04849419	0,04834776	0,06164164	0,076102	0,05945725	0,06262767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	0,05662767	
Subm2021	As	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Difference	As	t	-0,02388268	-0,02891513	-0,04936401	-0,04625886	-0,05263967	-0,08814149	-0,09178277	-0,0792148	-0,03405425	-0,05751492	-0,06431253	-0,03211897	-0,04849419	-0,04834776	-0,06164164	-0,076102	-0,05945725	-0,06262767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	-0,05662767	
Subm2020	Cd	t	0,02057621	0,0217624	0,05493138	0,05147603	0,05857648	0,09882624	0,10213421	0,0881488	0,03789498	0,06400156	0,07156584	0,03574141	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	0,05396346	
Subm2021	Cd	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Difference	Cd	t	-0,02057621	-0,0217624	-0,05493138	-0,05147603	-0,05857648	-0,09882624	-0,10213421	-0,0881488	-0,03789498	-0,06400156	-0,07156584	-0,03574141	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	-0,05396346	
Subm2020	CO	t	128.381835	155.446005	265.37797	248.684865	282.987705	473.84337	493.41864	425.854	183.073605	308.196745	345.740395	172.68664	260.70187	259.914655	331.381765	272.759133	316.933957	318.638605	301.931153	396.132187	304.959055	276.258363	306.425167	270.603905	322.923315	326.442455	323.239345	315.391505	332.201155
Subm2021	CO	t	99.66395	117.22997	175.57825	187.131945	194.14109	367.682295	388.050805	345.21058	172.88557	176.551375	187.921305	154.163295	185.85424	184.17971	209.397045	206.31283	218.01351	238.783545	246.39901	215.032675	224.792425	236.561325	228.284505	237.67029	250.240705	232.887655	242.640255	235.804855	
Difference	CO	t	-29.530215	-24.97781	-82.04305	-43.8867	-48.00999	-53.24748	-56.34486	-49.996375	-37.2443	-82.1002	-77.97575	-33.89958	-44.50775	-44.732545	-61.09811	-33.664325	-76.90111	-58.880965	-57.831345	-53.773005	-57.24719	-53.61785	-58.181695	-51.816765	-60.52761	-63.145225	-67.83348	-64.9792	
Subm2020	Cr	t	0,80223	13,238225	47,60184	17,66622	40,23625	52,933595	48,022975	30,647045	17,213695	50,54335	79,84335	13,39325	31,33988	31,0024	40,88654	12,772983	16,019387	21,974095	2,2902167	30,3405067	22,92004	9,6062633	11,6821467	10,102635	24,724515	13,056615	22,51821	11,66165	31,4171
Subm2021	Cr	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Difference	Cr	t	-0,80223	-13,238225	-47,60184	-17,66622	-40,23625	-52,933595	-48,022975	-30,647045	-17,213695	-50,54335	-79,84335	-13,39325	-31,33988	-31,0024	-40,88654	-12,772983	-16,019387	-21,974095	-2,2902167	-30,3405067	-22,92004	-9,6062633	-11,6821467	-10,102635	-24,724515	-13,056615	-22,51821	-11,66165	-31,4171
Subm2020	Cu	t	0,28022764	0,33913452	0,57900648	0,54258516	0,61274272	1,03384008	1,07654976	0,929136	0,9943332	0,67461108	0,75434268	0,37673376	0,56880408	0,56708852	0,72301476	0,39511088	0,67840136	0,69739332	0,65873888	0,65289568	0,66536852	0,66074552	0,6686864	0,59040852	0,70455996	0,71223828	0,70512488	0,68812692	0,72480252
Subm2021	Cu	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Difference	Cu	t	-0,28022764	-0,33913452	-0,57900648	-0,54258516	-0,61274272	-1,03384008	-1,07654976	-0,929136	-0,9943332	-0,67461108	-0,75434268	-0,37673376	-0,56880408	-0,56708852	-0,72301476	-0,39511088	-0,67840136	-0,69739332	-0,65873888	-0,65289568	-0,66536852	-0,66074552	-0,6686864	-0,59040852	-0,70455996	-0,71223828	-0,70512488	-0,68812692	
Subm2020	Hg	t	0,0486168	0,822066	2,955974	1,097032	2,49861	3,2870652	2,982126	1,9031172	1,685112	1,138636	4,9581036	0,958876	1,9461408	1,925184	3,7809264	0,7931764	0,9947672	1,3645452	0,1427756	1,8844544	1,4273884	0,5965288	0,7254368	-0,6521916	1,5353964	0,8107884	1,3983336	0,724164	1,950936
Subm2021	Hg	t	0,00102354	0,0012822	0,0021156	0,00198252	0,00225399	0,00377748	0,00393355	0,00339492	0,0014947	0,00246493	0,00275625	0,00137653	0,00207832	0,00207205	0,00264178	0,00217444	0,00247877	0,00254817	0,002407	0,00238485	0,00243115	0,00220234	0,00244283	0,00215728	0,00237435	0,00260241	0,00257687	0,00251431	0,00264832
Difference	Hg	t	-0,0475933	-0,820784	-2,9547584	-1,095050	-2,4966248	-3,28329872	-2,9801048	-1,899726	-1,6836218	-1,1372596	-4,9567024	-0,9575015	-1,944676	-1,9236926	-3,7730496	-0,791232	-0,9922885	-1,3631276	-0,1403686	-1,8820736	-1,4249152	-0,5945612	-0,7230016	0,6503184	1,5332024	0,8096416	1,3961572	0,7227224	1,9483036

	Schadstoff	Qualifgruppe	Einheit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Difference	NI			t	-0,538707	-0,652221	1,133474	2,043433	1,187761	1,988154	2,070288	1,7868	-0,768141	1,297329	1,450659	-0,724888	1,093854	1,090551	1,390413	1,144444	1,304618	1,341141	-1,266844	1,255184	1,279551	1,159126	1,2857	1,135405	1,354923	1,369689	1,356249	1,323211	1,339851	
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	4,668794	5,652562	9,650108	9,043086	10,290462	17,330668	17,942496	5,4856	6,657222	11,243518	12,572378	6,278896	9,480068	9,451442	12,050246	9,91851687	11,3066893	11,623222	10,9793147	10,8782613	11,088442	10,0457587	11,1427333	9,840142	11,742666	11,870638	11,754158	11,468782	12,080042	
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	3,62414	4,262908	6,38443	6,804798	7,059676	13,389538	14,147302	12,553112	6,286748	6,42005	6,833502	5,605938	6,758336	6,697444	7,614438	7,502612	7,827764	8,683038	8,959964	7,81937	8,17427	7,7467	8,60223	7,573982	8,642556	9,099662	8,468642	8,823282	8,574722	
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	1,078826	0,908284	1,534702	1,59588	1,767636	1,936272	1,989272	1,81805	1,357252	2,985528	2,835482	1,232712	1,5821	1,266838	2,221752	1,95143	2,796404	2,141126	2,102958	1,955382	2,081716	1,94974	2,125688	1,884246	2,201004	2,296319	2,266672	2,22144	2,36288	
Difference	NI			t	0,029172	-0,48139	1,730976	0,642408	1,46315	1,924858	1,74629	1,114438	0,968778	1,837394	2,903394	0,559754	1,139632	1,12736	2,214056	0,46447267	0,58252133	0,799058	0,08360733	1,10350933	0,833456	-0,34931867	-0,42480533	0,381914	0,899108	0,817486	0,818844	0,62406	1,142444	
Substanz	2020	NI	Feuerwerk, Silvester, unterjährig	t	14,070296	17,047388	19,098782	17,248324	11,029708	11,970912	14,102264	16,09504	20,070848	13,903313	17,930522	18,933884	26,586032	16,4997338	16,3831264	19,5081385	14,0940171	15,0484848	13,1266905	10,3021419	11,4389328	10,2916261	11,5996167	19,0718128	15,4085044	15,7943392	15,4433072	14,3623788	14,4259728	
Substanz	2021	NI	Feuerwerk, Silvester, unterjährig	t	3,2379894	2,52814071	5,91576037	3,70168615	5,6907089	5,9208757	3,2074117	5,23020923	1,57409108	2,77005468	9,9739028	6,9718866	6,36997231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Difference	NI			t	-0,0876648	-2,6510475	6,89328537	7,78278609	12,4020341	23,5535041	27,9002546	36,0844442	11,208854	25,1768358	31,2823154	11,7609002	26,6514649	18,4997326	38,3361264	29,9081345	14,0940171	35,0484848	33,1068545	32,8021433	33,4389328	30,2918261	33,5996267	29,6718128	35,4080544	35,7945392	35,4433072	34,5877888	36,4259728	
Substanz	2021	PM 10	Feuerwerk, Silvester, unterjährig	t						6,62188	6,89544	5,95124	2,56842	4,32097	6,83166	2,41303	3,64326	3,63226	4,63100	3,81176	4,34525	4,46689	4,21944	4,18040	4,26176	3,86066	4,28224	3,78164	4,51280	4,56198	4,51721	4,40754	4,64245	
Substanz	2020	PM 10	Feuerwerk, Silvester, unterjährig	t						2,67404	2,82960	2,51075	1,25741	1,28407	1,36677	1,12124	1,35173	1,33935	1,52296	1,37094	1,39630	1,50867	1,58169	1,37446	1,40933	1,31301	1,50758	1,34288	1,54972	1,66154	1,54792	1,62394	1,59193	
Substanz	2021	PM 10	Feuerwerk, Silvester, unterjährig	t						467,683873	494,888817	439,128731	327,820359	721,119398	884,87754	297,747177	382,137766	392,895399	536,638231	542,780771	774,245460	593,519172	578,081406	527,987599	554,482233	516,512612	569,56148	487,09494	572,944407	594,479838	627,050634	563,379267	577,265866	
Difference	NI			t						-3480,1554	-3570,950599	-3001,36071	-973,181883	-2315,777797	-2780,01648	-894,038163	-1909,39167	-1899,81185	-2571,40157	-1898,04731	-2174,69749	-2364,70831	-2057,66761	-2278,15684	-2297,94362	-2031,13487	-2205,09756	-1951,66815	-2390,13679	-2305,96094	-2342,24645	-2220,22203	-2473,25708	
Substanz	2020	PM 2.5	Feuerwerk, Silvester, unterjährig	t						3,44216	3,58436	3,09355	1,22991	2,24611	2,51157	1,25433	1,89383	1,88811	2,40727	1,98141	2,25873	2,32196	2,19333	2,17314	2,21533	2,00683	2,22598	1,96576	2,34582	2,37139	2,34812	2,29111	2,41322	
Substanz	2021	PM 2.5	Feuerwerk, Silvester, unterjährig	t						2,13208	2,25612	2,00189	1,00237	1,03383	0,88976	895,997322	2,07777	1,06806	1,21436	1,10028	1,12607	1,22283	2,28853	2,11673	1,14670	0,97625	1,24161	1,10775	1,28239	1,37839	1,28787	1,35430	1,36973	
Substanz	2021	PM 2.5	Feuerwerk, Silvester, unterjährig	t						369,710572	391,216456	347,137337	259,152853	570,05486	541,40517	235,373263	302,08519	310,589248	424,219945	429,071993	612,051751	469,185116	456,981349	417,381501	438,325876	408,310365	450,24623	385,055288	452,82048	469,944536	495,692201	445,399104	456,336853	
Difference	NI			t						-3480,262629	-3571,025511	-344,522135	-65,188939	-455,227649	-880,408122	-124,959688	-512,96669	-509,434865	-768,149023	-452,086073	-520,610767	-429,944871	-447,821938	-439,820357	-452,304647	-522,771924	-534,117713	-472,351762	-609,974848	-521,057419	-564,536636	-601,404077	-647,158392	
Substanz	2020	S02	Feuerwerk, Silvester, unterjährig	t	44,229838	65,656914	112,089716	105,038922	119,527674	200,340838	206,468992	179,8712	17,236194	135,597786	146,03086	71,931792	110,114638	119,762131	119,866242	115,307381	131,331545	135,008394	127,578864	126,353189	128,888134	116,685351	129,427133	114,297514	136,303582	137,888208	136,229066	131,214314	140,134334	
Substanz	2021	S02	Feuerwerk, Silvester, unterjährig	t	42,09578	49,515316	74,15761	79,040346	82,000852	155,282328	164,326354	145,809224	73,022996	54,57135	79,373754	65,115126	76,500672	77,793388	88,444626	87,145724	92,084028	100,856826	104,077428	90,82499	94,94729	89,9809	99,91821	87,974714	100,386612	105,696074	98,366534	102,485814	99,598694	
Substanz	2021	S02	Feuerwerk, Silvester, unterjährig	t	12,472902	10,550068	17,826154	18,53676	20,531772	22,490544	23,798808	21,11735	15,765004	34,678056	32,932514	34,18424	18,3767	18,894026	25,800504	22,46661	32,483308	24,870002	24,426666	22,712514	24,179932	22,64698	24,574466	21,88042	25,565508	26,87113	26,651344	25,80288	27,44576	
Difference	S02			t	-0,138844	-5,59153	20,105952	7,461816	-16,99505	22,357966	20,28383	12,944626	11,461806	21,34838	33,724038	6,501758	13,237264	13,09472	25,717112	1,59502867	6,76620933	9,281366	0,97113133	12,8176853	6,680912	4,05747087	4,93427733	4,436078	10,443462	5,514822	6,511188	4,92562	13,26988	
Substanz	2020	TSP	Feuerwerk, Silvester, unterjährig	t	1,97221	2,38778	6,07643	3,82001	4,34693	7,27863	7,57932	6,54147	2,81216	4,74852	5,31086	2,85235	4,00460	3,99231	5,09030	4,18981	4,77621	4,90992	4,63792	4,59523	4,68444	4,24356	4,70695	4,15670	4,96037	5,01443	4,96523	4,84468	5,10289	
Substanz	2021	TSP	Feuerwerk, Silvester, unterjährig	t	724,863616	852,623493	1,27695	1,36103	1,41200	2,67404	2,82960	2,51075	1,25741	1,28407	1,36677	1,12124	1,35173	1,33935	1,52296	1,37094	1,39630	1,50867	1,58169	1,37446	1,40933	1,31301	1,50758	1,34288	1,54972	1,66154	1,54792	1,62394	1,59193	
Substanz	2021	TSP	Feuerwerk, Silvester, unterjährig	t	259,370121	219,383386	370,689333	385,466164	426,951818	467,683873	494,888817	439,128731	327,828359	721,119398	884,87754	297,747177	382,137766	392,895399	536,638231	542,780771	774,245460	593,519172	578,081406	527,987599	554,482233	516,512612	569,56148	487,09494	572,944407	594,479838	627,050634	563,379267	577,265866	
Difference	TSP			t	887,872759	1215,7722	2428,790246	2073,51558	2057,972723	4136,90939	4254,838612	3991,60031	1226,92446	2744,22898	2359,2175	1223,3607	2270,72813	2260,05716	3039,70133	2276,09931	2605,6561	2807,771189	2476,14842	2692,785956	2726,62196	2414,03282	2629,80713	2326,72894	2837,713302	2758,41847	2790,2607	2657,35906	2933,69253	
Substanz	2020	Zn	Feuerwerk, Silvester, unterjährig	t	4,668794	5,652562	9,650108	9,043086	10,290462	17,330668	17,942496	5,4856	6,657222	11,243518	12,572378	6,278896	9,480068	9,451442	12,050246	9,91851687	11,3066893	11,623222	10,9793147	10,8782613	11,088442	10,0457587	11,1427333	9,840142	11,742666	11,870638	11,754158	11,468782	12,080042	
Substanz	2021	Zn	Feuerwerk, Silvester, unterjährig	t	3,62414	4,262908	6,38443	6,804798	7,059676	13,389538	14,147302	12,553112	6,286748	6,42005	6,833502	5,605938	6,758336	6,697444	7,614438	7,502612	7,827764	8,683038	8,959964	7,81937	8,17427	7,7467	8,60223	7,573982	8,642556	9,099662	8,468642	8,823282	8,574722	
Substanz	2021	Zn	Feuerwerk, Silvester, unterjährig	t	1,078826	0,908284	1,534702	1,59588	1,767636	1,936272	2,048904	1,81805	1,357252	2,985528	2,835482	1,232712	1,5821	1,266838	2,221752	1,95143	2,796404	2,141126	2,102958	1,955382	2,081716	1,94974	2,125688	1,884246	2,201004	2,296319	2,266672	2,22144	2,36288	
Difference	Zn			t	-0,029172	-0,48139	1,730976	0,642408	1,46315	1,924858	1,74629	1,114438	0,968778	1,837394	2,903394	0,559754	1,139632	1,12736	2,214056	0,46447267	0,58252133	0,799058	0,08360733</											