

Supplementary information

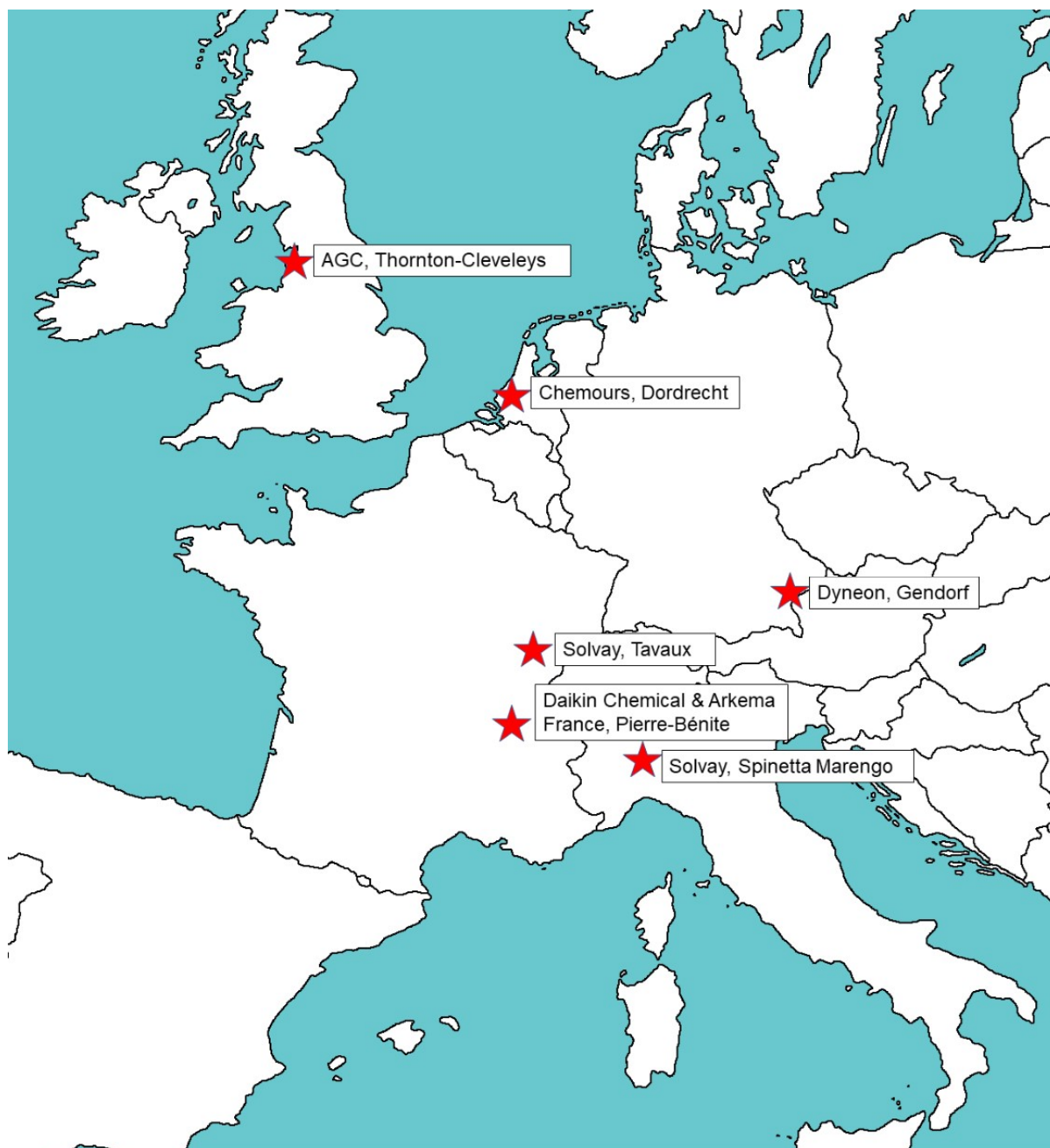


Figure S1. Fluoropolymer production sites in Europe.

Table S1. Overview of fluorosurfactants used in fluoropolymer production in Europe.

Full chemical name	Formula	Synonyms	Users in EU
2,2-difluoro-2-[1,1,2,2-tetrafluoro-2-(1,1,2,2,2-pentafluoroethoxy)ethoxy]acetic acid	C ₆ HF ₁₁ O ₄	EEA, perfluoro-3,6-dioxaoctanoic acid, PFO2OA, SAA-1000*, Asahi's Product	AGC
2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid	C ₆ HF ₁₁ O ₃	Hexafluoropropylene oxide dimer acid (HFPO-DA), GenX*, FRD-903, FRD-902*	Chemours
2,2,3-Trifluoro-3-(1,1,2,2,3,3-hexafluoro-3-(trifluoromethoxy)propoxy)propanoic acid	C ₇ H ₂ F ₁₂ O ₄	ADONA* 4,8-dioxahexafluoropropylperfluorononanoic acid	Dyneon (3M)
2-(3-trifluoromethoxy-1,1,2,2,3,3-hexafluoropropoxy)-2,3,3,3-tetrafluoropropanoic acid	C ₇ HF ₁₃ O ₄	MV31	Dyneon (3M)
(difluoro{[2,2,4,5-tetrafluoro-5-(trifluoromethoxy)-1,3-dioxolane-4-yl]oxy}acetic acid)	C ₆ HF ₉ O ₆	cC6O4, F-DIOX acid, C6O4 cyclic	Solvay
3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctane-1-sulfonic acid	C ₈ H ₅ F ₁₃ O ₃ S	6:2 FTS, Capstone FS-17**, Capstone FS10	Chemours, Arkema
Undecafluorohexanoic acid	C ₆ HF ₁₁ O ₂	PFHxA, C6	Daikin Chemical
1-Propene, 1,1,2,3,3,3-hexafluoro-, telomer with chlorotrifluoroethene, oxidized, reduced, hydrolyzed	Cl(C ₃ F ₆ O) _n (C ₂ F ₄ O) _m CF ₂ COOH	ADV*, Cl-PFPECAs, Fluorolink 7800 and 7850, Chloro-Galden, Solvay's product	Solvay
Pentadecafluorooctanoic acid	C ₈ HF ₁₅ O ₂	PFOA, C8, APFO* FC-143*	All manufacturers (phased out)
Heptadecafluorononanoic acid Henicosfluoroundecanoic acid Pentacosfluorotridecanoic acid	C ₉ HF ₁₇ O ₂ C ₁₁ HF ₂₁ O ₂ C ₁₃ HF ₂₅ O ₂	Surflon S-111*	Arkema (phased out)

*Refers to the ammonium salt(s) of this substance

** Refers to the potassium salt of this substance

Table S2. Emissions of fluorinated gases (kg/yr) in the municipalities of Solvay-Solexis (France) from INERIS database.

Tavaux/A-la-Ronce	2004	2007	2012
C3F8	0.1	0.0	0.0
C6F14	17.5	0.0	0.0
HFC-125	29.9	143.7	109.8
HFC-134a	581.8	761.8	479.4
HFC-142a	1302.4	1359.3	82.7
HFC-152a	14.4	38.6	23.2
HFC-227ea	256.7	288.6	334.2
HFC-23	10.7	12.0	13.8
HFC-32	4.4	12.8	30.4
HFC-365mfc	2475.4	1373.4	24.3
HFC-4310mee	15.7	20.4	4.2
Sum	4708.9	4010.8	1102.0

Table S3. Emissions of fluorinated gases (kg/yr) in the municipality of Arkema-Daikin (France) from INERIS database.

Pierre-Bénite	2004	2007	2012
C3F8	0.147	0	0
C6F14	4.009	0	0
HFC-125	9835	5811	3015
HFC-134a	13760	6190	6427
HFC-143a	19170	10960	8094
HFC-152a	29.22	60.68	46.07
HFC-227ea	130.7	147.9	174.7
HFC-23	26070	17700	5608
HFC-32	5439	883.3	816.7
HFC-365mfc	10.23	1380	1221
HFC-4310mee	31.201	40.648	8.276
SUM	74479	43173	25410

Table S4. Substances mentioned on the emission permits of European producers with substance specific information.

	AGC	Chemours	Solvay SP
Substances on emission permit PFAS in bold	TFE, HFP , TrFE, HCFC-22, HFC-23, HFC-125 , EEA-NH₄	TFE, HFP , VDF, PFC-318 , PFIB , HCFC-22, HFC-23, H(C)FCs, PMVE , PPVE , PEVE , HFC4310-mee , E1 , Ether A/B , PFAC , HFPO-DA , 6:2 FTS , C4-C14 PFCAs , PFBS	TFE, HFP , VDF, PFIB , PFC-318 , PFOA* , HCFC-22, PMVE , PPVE , DIOFE , DIOFB , DIOFH , inert particulate fluoropolymers, cC6O4** , ADV** , FSVE**

*Currently phased out **Mentioned in an addition to the original permit

Table S5. Overview of the different fluorinated organic substances, their uses and permitted and reported air emissions (t/yr) on emission permits of the European companies with substance specific information on the permit and from emission reports.

Substance use	Substance	AGC	Chemours	Solvay Specialty Polymers	Arkema-Daikin
Monomer	TFE	12	8.9	7.5	Amount unknown
	HFP	5	19.1	Amount unknown	12.18
	VDF	-	1.02	Amount unknown	Amount unknown
	TrFE	7	-	-	-
Monomer production	HCFC-22	2.35	1.98	Amount unknown	Amount unknown
	HFC-23	1.75	40.32	-	15.4
	HFC-32	0.35	-*	-	
Fluoroether monomers	PPVE/PEVE	-	0.139	Amount unknown	-
	PMVE	-	3.8	Amount unknown	-
By-product	PFIB	Amount unknown	0.056	Amount unknown	Amount unknown
Monomer production/byproduct	PFC-318	Amount unknown	2.53	Amount unknown	Amount unknown
Chain transfer agents	DIOFE	-	-	Amount unknown	-
	DIOFB	-	-	Amount unknown	-
	DIOFH	-	-	Amount unknown	-
Coolant	HFC-125	0.35	-*	-	-
Various uses	(H)(C)FCs and Halons	-**	54.231	Amount unknown	34.9 (HCFCs) 29 (HFCs) 0.152 (CFCs) 0.889 (BTFM)
By-product	Ether A/B	-	21	-	-
By-product	PFAC	Amount unknown	1.4	Amount unknown	Amount unknown
Fluorinated solvent	HFC-4310mee	-	0.9	-	-
Fluorinated solvent	1H-PFHx	30.9			-
Fluorosurfactants	HFPO-DA	-	0.004	-	-
	6:2 FTS	-	0.002	-	0.01
	C4-C14 PFCAs and PFBS	Amount unknown	~0.002	Amount unknown	0.01
	EEA	<0.1	-	-	-
	cC6O4	-	-	Amount unknown	-
	ADV	-	-	Amount unknown	-

*Part of the H(C)FC category **Mentioned individually

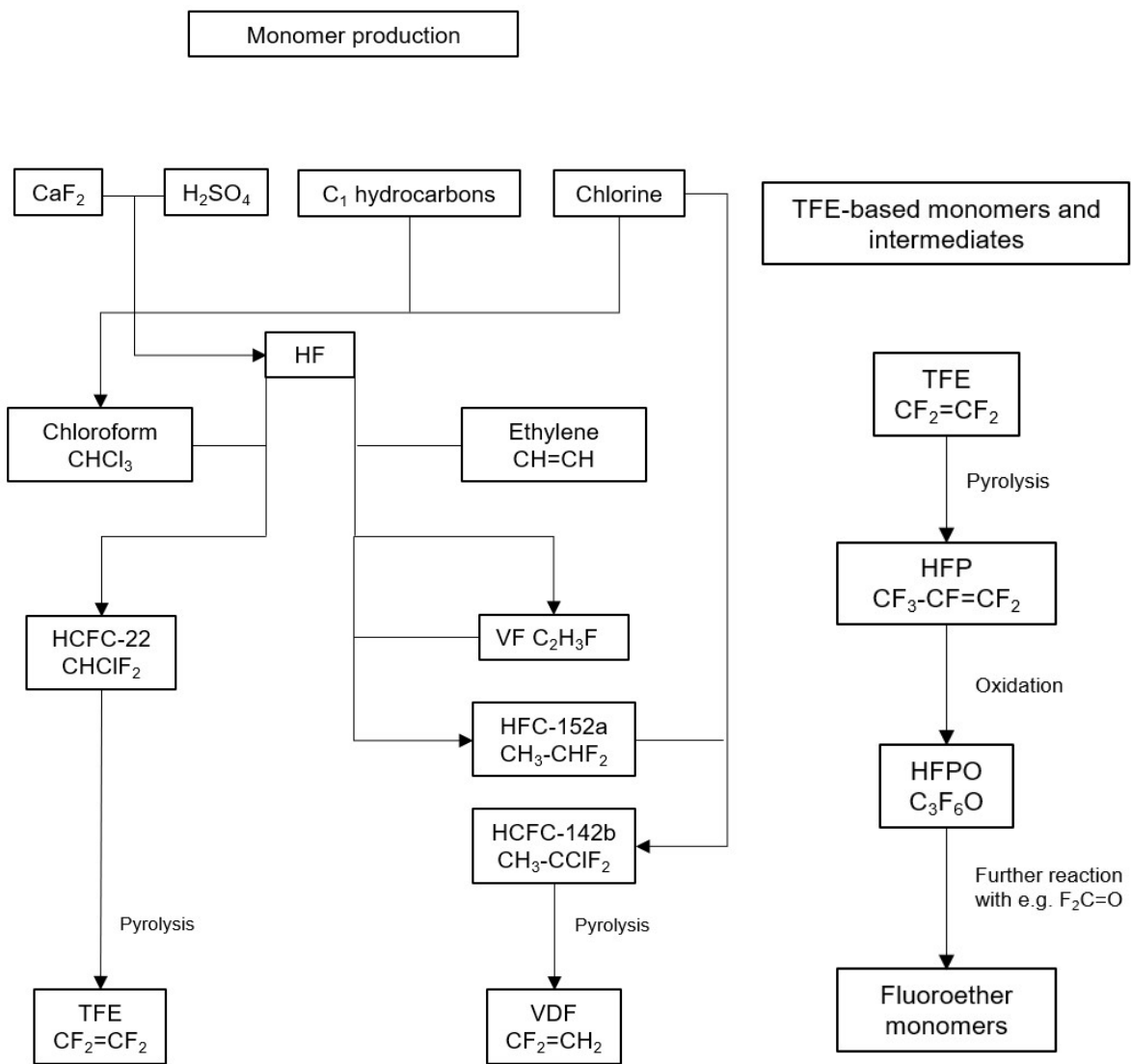


Figure S2. Schematic representation of fluoromonomer production, adjusted from Hintzer et al., 2014.

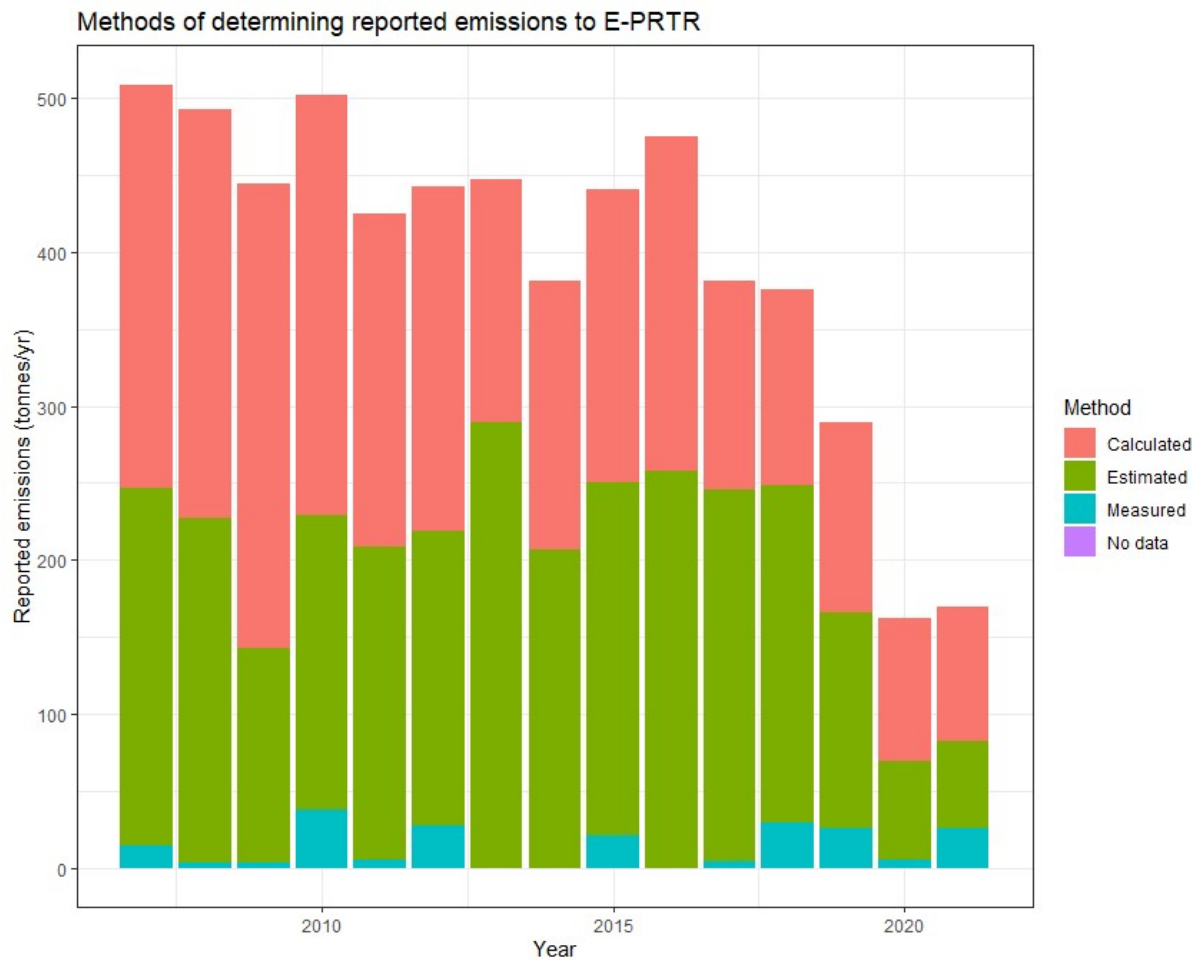


Figure S3. Amount of PFC, CFC, HFC and HCFC emissions reported to the E-PRTR of all fluoropolymer producers in this study per reporting year and the method of quantification.

Table S6. Reported emissions of HCFCs, HFCs, PFCs and CFCs by all European fluoropolymer producers to the E-PRTR in tonnes per year.

Name	Substance class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
AGC	HCFCs	13.1	2.27	2.29	2.52	2.61	2.52	3.14	2.66	2.32	1.97	2.04	1.86	2.16	0	2.64
	HFCs	1.5	0.905	0.68	1.36	2.24	12.478	14.3	9.25	9.11	16.3	17.3	13.5	7.78	0	9.73
	PFCs	0	0	0	0	0	12.478	14.3	9.25	9.11	16.3	17.3	13.5	7.78	0	9.73
Arkema-Daikin	CFCs	5.59	4.22	2.17	0.434	0.013	0.019	0.117	0.045	0.011	0.062	0.016	0.152	0.066	0.06	0.069
	HCFCs	61.6	42.8	30.7	51.4	40.9	36.8	45.4	35.8	43.2	43.8	31.4	34.9	23.7	36	21
	HFCs	39.5	61.7	46.7	33.9	22.9	21.3	16.7	24.3	41.7	54.3	40.3	29.1	26.2	18.5	11.5
Chemours	CFCs	8.62	6.28	20.2	8.83	9.19	3.13	3.61	1.2	2.6	20.6	5.06	20.7	10.5	2.46	4.63
	HCFCs	104	126	120	121	105	126	96.1	76.5	85.9	83.5	45.9	17.3	26.5	21.7	22.1
	HFCs	31	24.4	70.1	67.7	23.3	25.3	23	8.53	15.3	12.4	9.12	17.8	35	14.1	27.4
	PFCs	0.943	0	0.206	0.576	0.212	0.402	0	0	0	0.272	0	0.654	0	0	0
Dyneon	CFCs	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HCFCs	0	0.029	0.023	0.026	0.026	0.036	0.015	0.015	0.016	0.015	0.016	0.023	0.018	0.016	0.225
	HFCs	0	0	0	0	0	0	0	0	0	0.231	0.234	0.231	0.198	0.14	0.138
Solvay-Solexis	HCFCs	17.3	17.2	11.7	23.5	13.9	11.4	1.57	3.32	0	0	3.64	2.35	3.16	2.26	1.37
	HFCs	2.88	1.67	3.27	1.9	1.74	2.68	1.22	3.19	1.99	2.39	4.782	4.583	6.78	3.202	2.848
Solvay SP	HCFCs	11.4	4.77	4.46	8.57	7.12	5.62	13.6	13.7	16.5	16.8	16.1	4.209	4.516	4.931	4.912
	HFCs	1.62	0.6	2.11	4.5	1.21	0.9	1.07	3.29	3.27	4.21	27.4	10.887	17.548	2.547	11.67
	PFCs	210	200	130	176	195	182	213	190	210	202	161	204.5	117.7	56.5	39.4
	CFCs	0	0	0	0	0.172	0.095	0.1	0.09	0.07	0.09	0.094	0.08	0.08	0.084	0.041