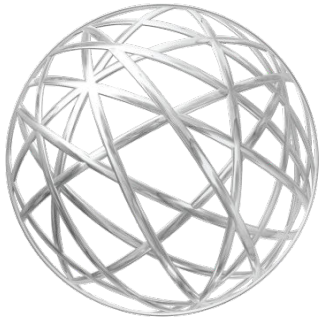
Results of the 2019 Anode Effect Survey

Report on the Aluminium Industry's Global Perfluorocarbon Gases Emissions

August 2020



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Contents

Industry Summary

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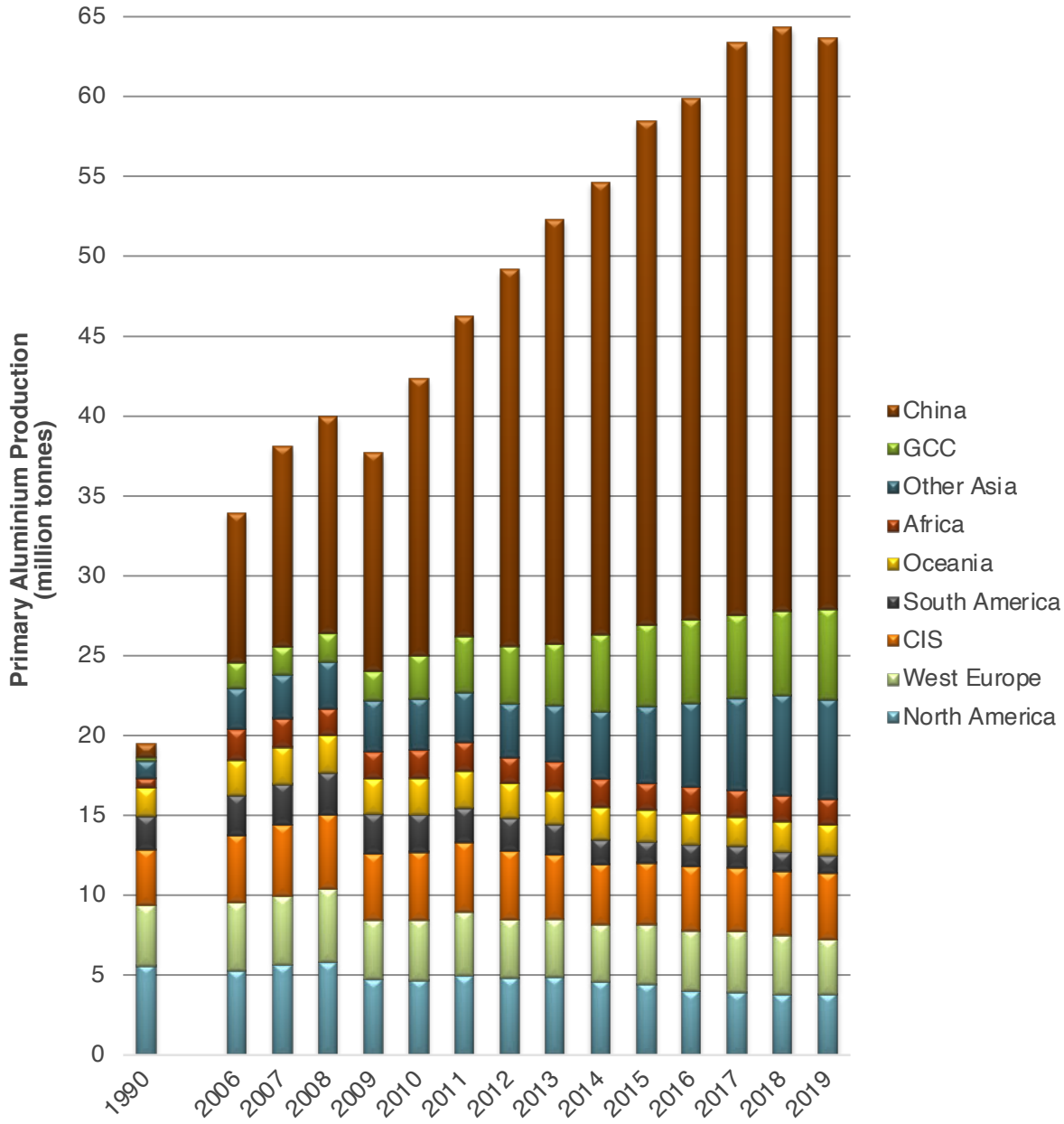
Industry Trend

- In 2019, growth in primary aluminium production ceased in for the 1st time over the decade;
- 2019 global primary aluminium production is less than 64 million tonnes, dropped by 1% as compared to 2018;
- PFPB is the most used technology among all, which is nearly 95% by production.



2019 Anode Effect Survey

Survey Methodology

- The IAI Anode Effect Survey requests all aluminium smelting facilities to report data by potline (where possible), via IAI member companies, direct correspondence with non-member producers and regional industry associations. The reporting form and guidelines (*PFC001*) can be found from the IAI website (http://www.world-aluminium.org/media/filer_public/2018/07/31/pfc001_-_version2018.xls).
- Data calculation follows 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Chapter 4, Section 4.4 --- Primary Aluminium Production, (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf)
- Carbon dioxide equivalent (CO_2e) emissions for survey participants are calculated by multiplying the total tonnes of each PFC component gas by the Global Warming Potential (GWP) values reported in the IPCC 4th Assessment Report (i.e. 7,390 for CF_4 and 12,200 for C_2F_6).

2019 Anode Effect Survey participation by technology

TECHNOLOGY	2019 primary aluminium production (1,000 tonnes)	2019 production represented in survey (1,000 tonnes)	2019 participation rate by production	
CWPB	843	441	52%	
PFPB (Rest of World)	23,766	17,241	73 %	29%
PFPB (China)	35,795	0	0 %	
SWPB	403	366	91 %	
VSS	2,818	2,818	100 %	
HSS	73	73	100 %	
All Technologies (excluding China)	27,902	20,938	75 %	
All Technologies (Including China)	63,697	20,938	33 %	

Note: any inconsistencies due to rounding

Perfluorocarbon emission results from facility data reporting to the 2019 Anode Effect Survey

Technology	IPCC Tier	No. of reporting entities	Reported production (kt Al)	Total CF_4 emissions (Gg CF_4)	Total C_2F_6 emissions (Gg C_2F_6)	Median CF_4 intensity (kg CF_4/ t Al)	Median C_2F_6 intensity (kg C_2F_6/ t Al)	Mean C_2F_6: CF_4 weight ratio	IPCC 4th GWP		
									Total PFC emissions (kt CO_2e)	Median PFC intensity (t CO_2e/ t Al)	Mean PFC intensity (t CO_2e/ t Al)
CWPB	2	2	441	0.012	0.001	0.026	0.003	0.12	109	0.23	0.25
	3	0									
PFPB	2 Slope	34	5,398	0.128	0.015	0.015	0.002	0.11	3,050	0.13	0.18
	3 Slope	51	7,828	0.124	0.014						
	2 OV	14	2,357	0.072	0.009						
	3 OV	6	1,659	0.024	0.002						
SWPB	2	0				0.230	0.076	0.33	985	2.62	2.69
	3	2	366	0.086	0.029						
VSS	2	2	69	0.009	0.0005	0.066	0.004	0.06	1,525	0.54	0.54
	3	65	2,749	0.178	0.011						
HSS	2	0				0.060	0.004	0.070	36	0.50	0.50
	3	4	73	0.004	0.0003						
ALL	-	180	20,938	0.637	0.082	-	-	0.13	5,704	-	0.27

Note: any inconsistencies due to rounding

Global Emissions Estimations

Estimation of Emissions from Non-reporting Facilities

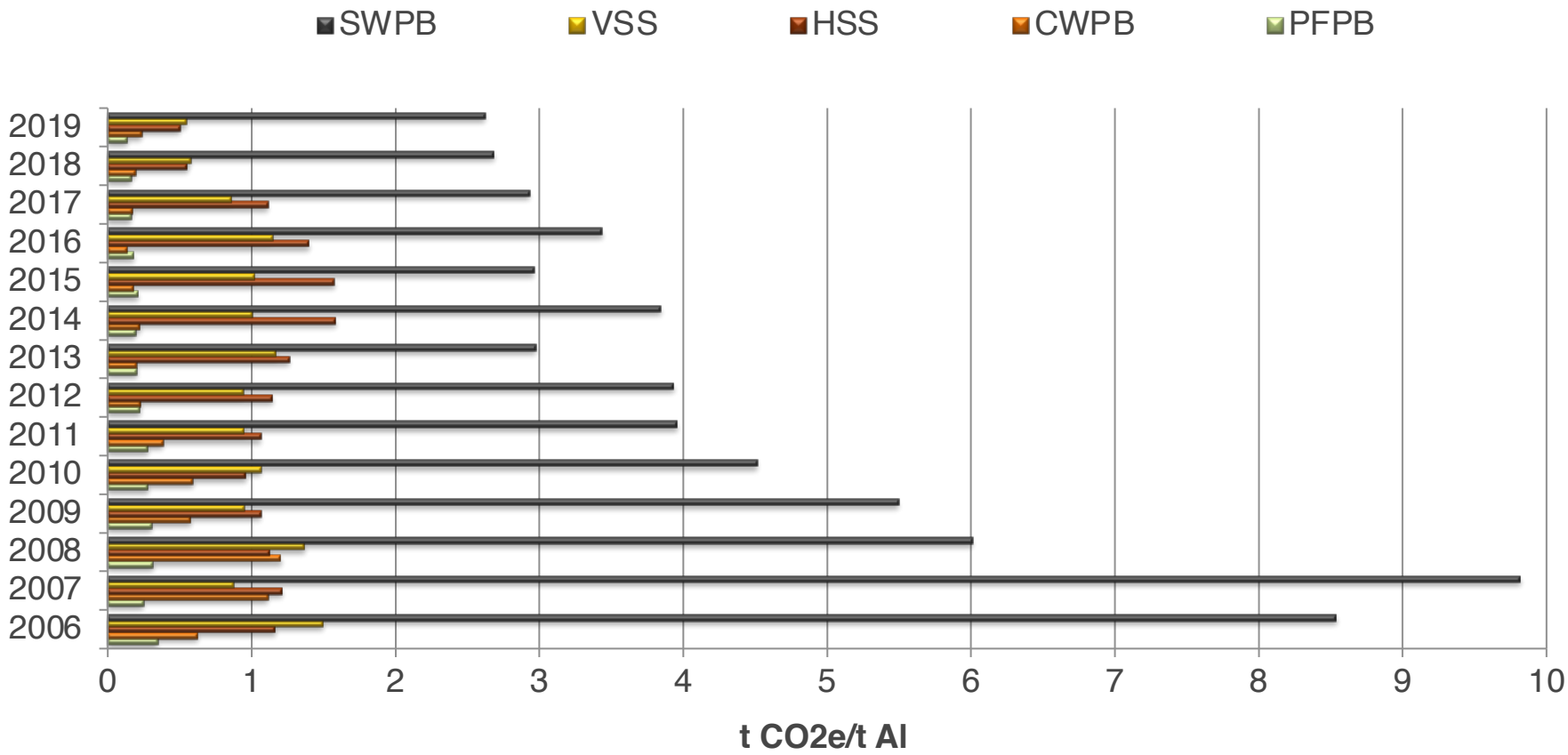
China

- Latest measurement (2008-2013) of PFC emissions at 27 PFPB facilities in China is adopted
- Median emission factor = 0.80 t CO2e /t Al
- CF4 median = 0.100 kg/t Al;
- C2F6:CF4 weight fraction = 0.046

Rest of World

- Median PFC emissions performance per technology from the survey result is applied to non-reporting production by technology

Median PFC emission rates (as CO_2e) of reporting entities, per technology, 2006-2019

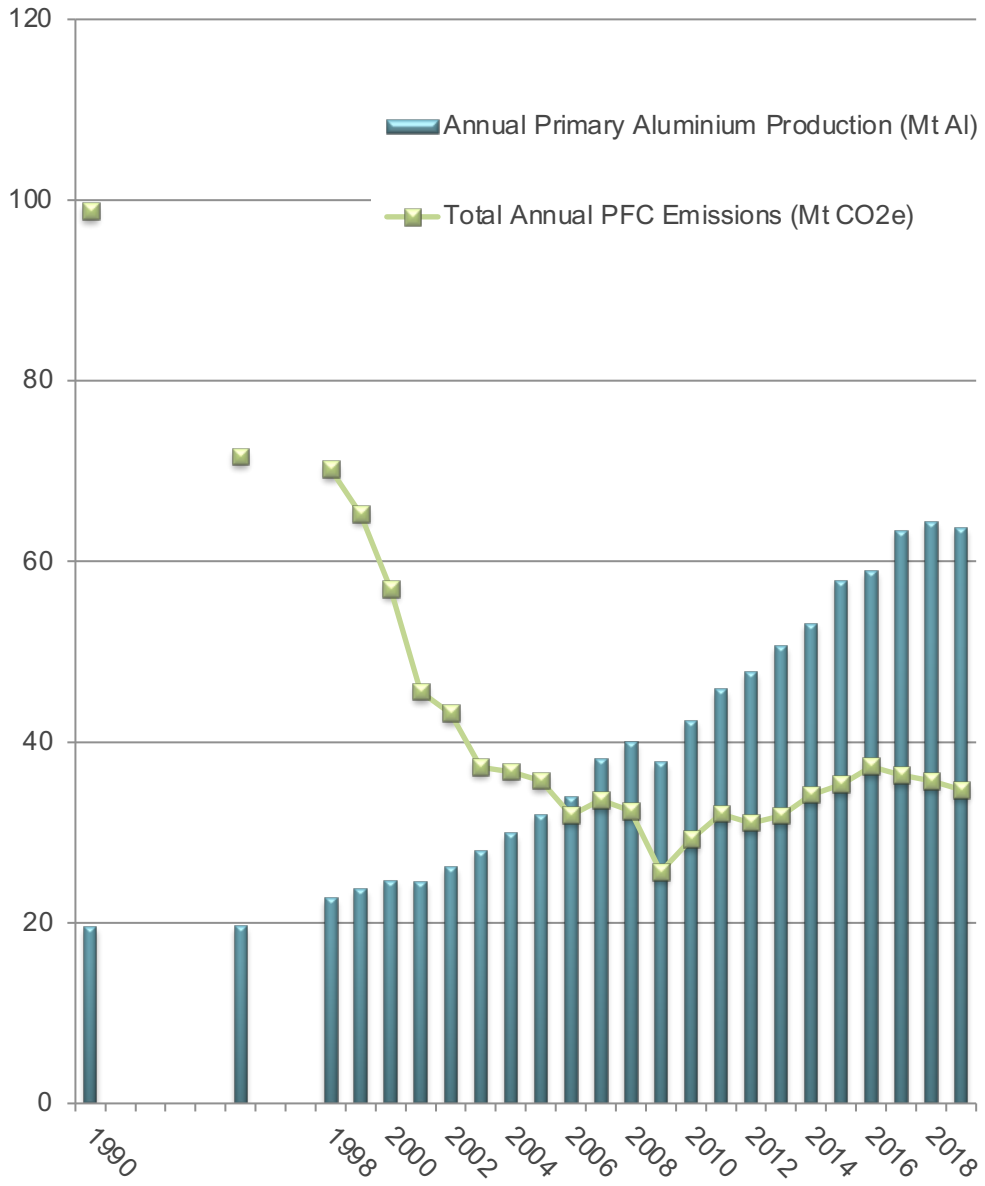


Total global 2019 PFC emissions

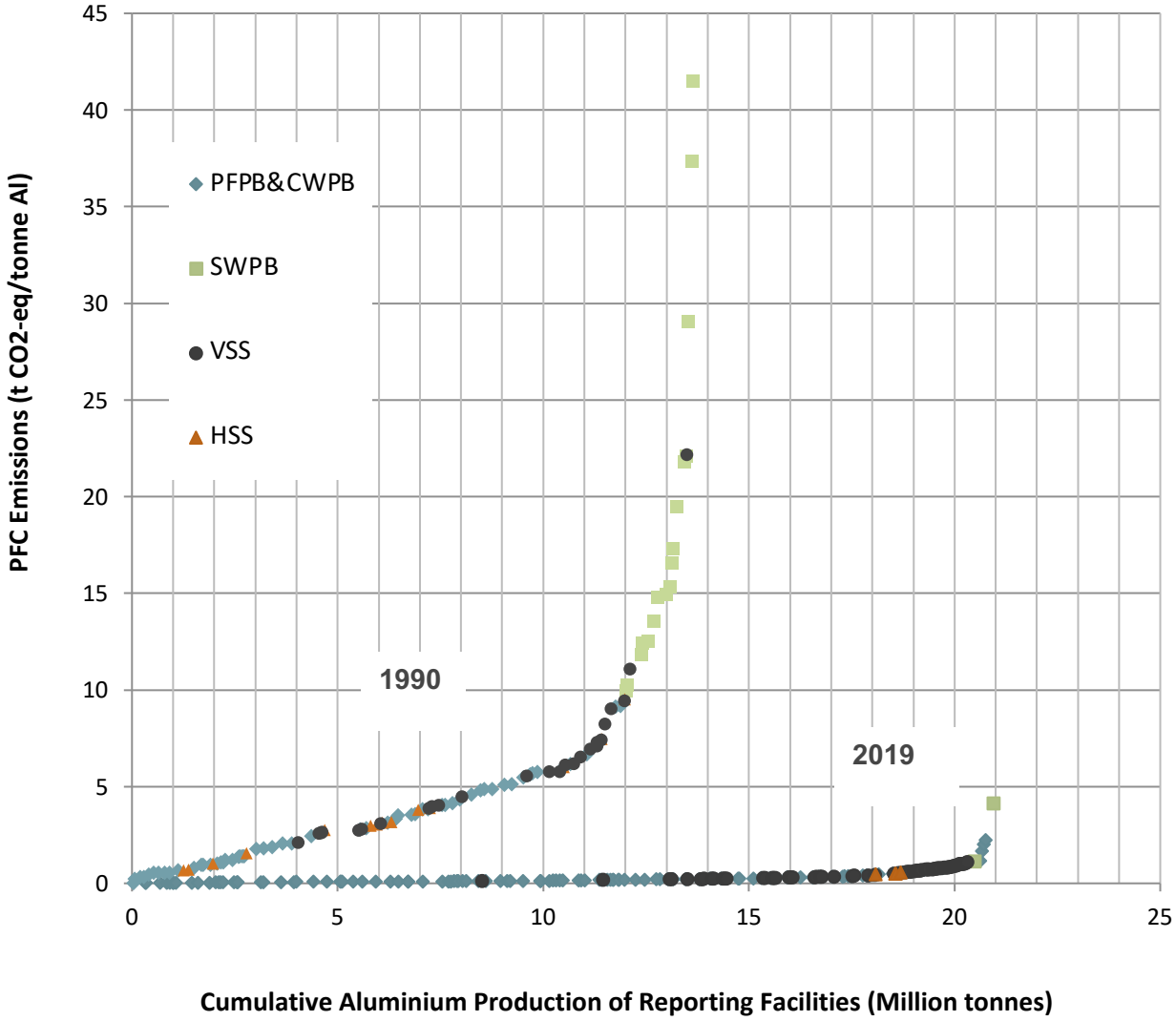
	Total PFC emissions (1,000 t CO_2e)	Total aluminium production (1,000 tonnes)	PFC emission factor (t CO_2e/t Al)
			IPCC 4th GWP
Reported	5,704	20,938	0.27
Calculated from non-reporters	29,014	42,759	0.68
TOTAL GLOBAL	34,718	63,697	0.55

Conclusion

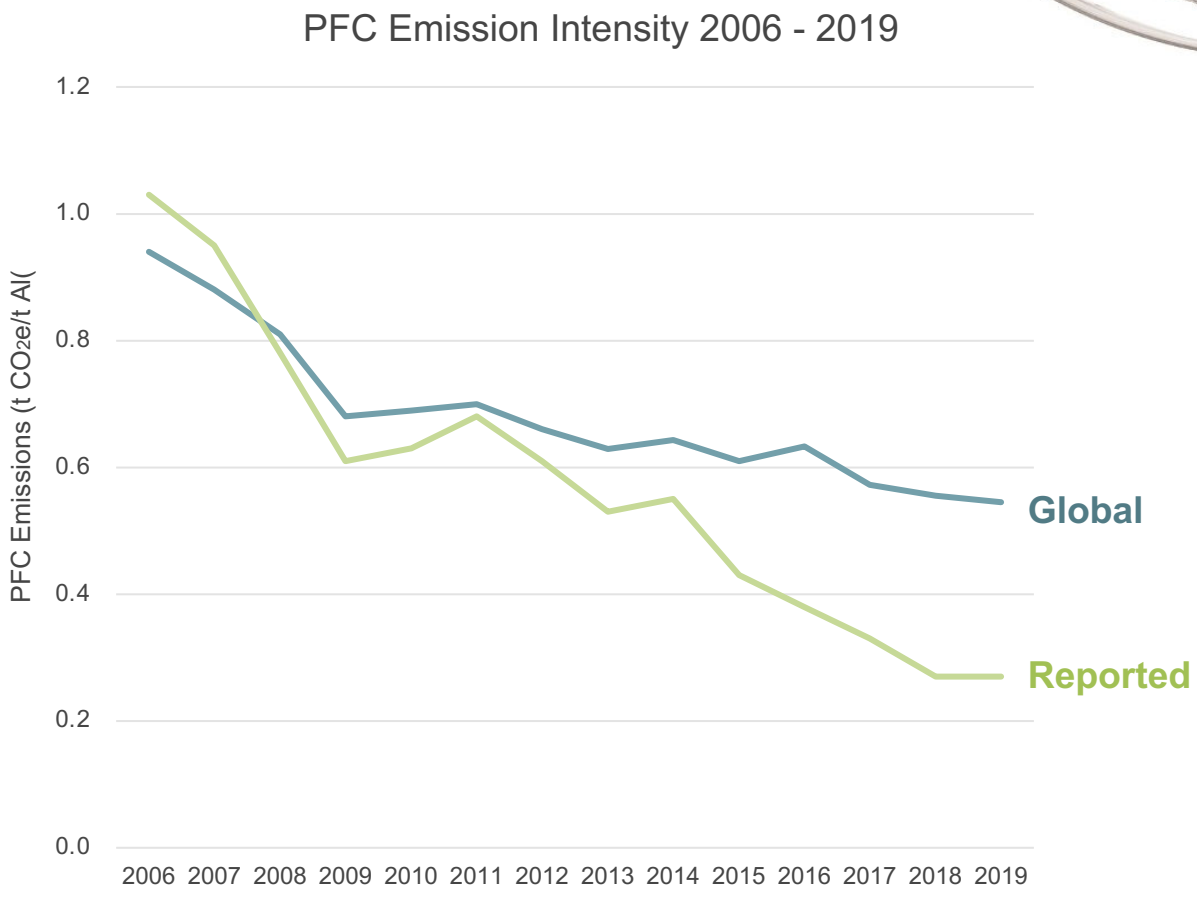
- With PFC emissions per tonne cut by nearly 90% since 1990 and primary aluminium production having grown by over 200% over the same period, absolute emissions of PFCs by the aluminium industry have been reduced from approximate 100 million tonnes of CO_2e in 1990 to 35 million tonnes in 2019, a fall of 65%.
- An increase in total emission estimates since 2009, however, reflects the growth in Chinese PFPB production. This has a high uncertainty given the low number of emission measurements (27 facilities) on which a Chinese average is based.



Taking the 1990 reporting cohort and plotting it against 2019 data shows improvement both from existing facilities over this time but also, importantly, the positive contribution of new (predominantly PFPB) capacity added since 1990.



- Global PFC emissions (as CO_2e) per tonne of production have been reduced by nearly 40% since 2006, by nearly 90% since 1990
- The global PFC emission intensity remains stable since 2009 due to China, where emission intensity is based on an assumed average, majority of PFC emission is from this area, in correspondence to its significant aluminium production.
- The average PFC emission intensity of the reporting cohort, which presents ¾ of the global production without China, is about half of the modelled global emission intensity.



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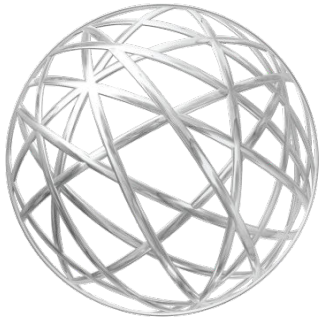

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