

Results of the 2015 Anode Effect Survey

Report on the Aluminium Industry's Global
Perfluorocarbon Gases Emissions

8 August 2016



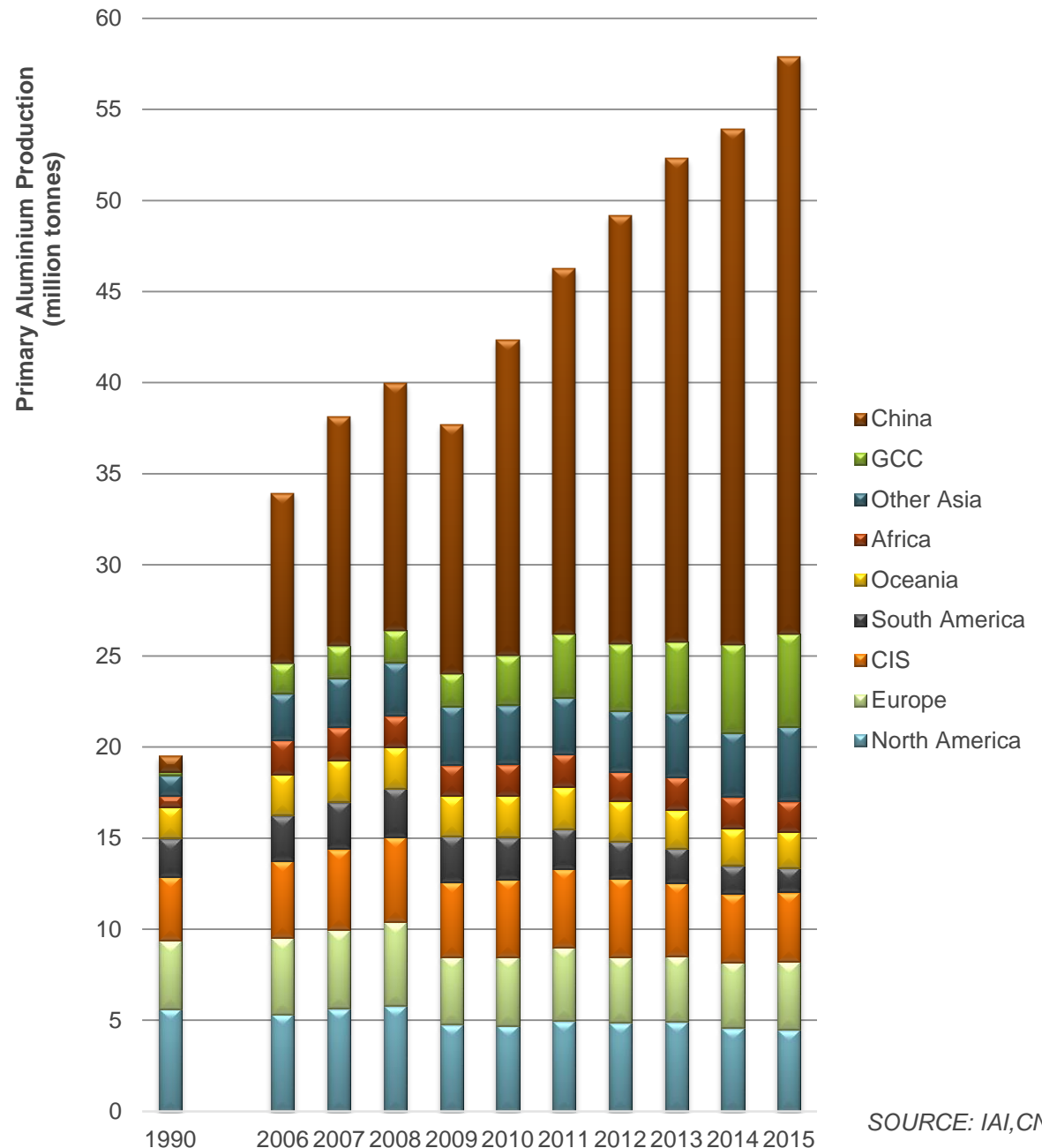
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INDUSTRY SUMMARY

Industry Trend

- Growth in primary aluminium production continues to be driven by China and the GCC countries;
- 2015 global primary aluminium production is nearly 58 million tonnes, and China has contributed about 55%;
- Among all technologies, PFPB kept increasing and the rest were decreasing.



2015 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/2013/01/15/pfc001.pdf).
- 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).

2015 Anode Effect Survey participation by technology

TECHNOLOGY	2015 primary aluminium production (1,000 tonnes)	2015 production represented in survey (1,000 tonnes)	2015 participation rate by production	
CWPB	2,508	2,067	82%	
PFPB (Rest of World)	20,570	15,108	73 %	29%
PFPB (China)	31,413	0	0 %	
SWPB	437	395	90 %	
VSS	2,895	2,895	100 %	
HSS	67	57	100 %	
All Technologies (excluding China)	26,477	20,531	78 %	
All Technologies (Including China)	57,890	20,531	35 %	

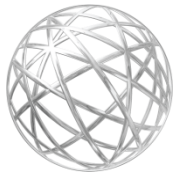
Note: any inconsistencies due to rounding

Perfluorocarbon emission results from facility data reporting to the 2015 Anode Effect Survey

Note: any inconsistencies due to rounding

Technology	IPCC Tier	No. of reporting entities	Reported production (kt Al)	Total CF ₄ emissions (Gg CF ₄)	Total C ₂ F ₆ emissions (Gg C ₂ F ₆)	Median CF ₄ intensity (kg CF ₄ /t Al)	Median C ₂ F ₆ intensity (kg C ₂ F ₆ /t Al)	Mean C ₂ F ₆ : CF ₄ weight ratio	IPCC 4 th GWP		
									Total PFC emissions (kt CO ₂ e)	Median PFC intensity (t CO ₂ e/t Al)	Mean PFC intensity (t CO ₂ e/t Al)
CWPB	2	2	426	0.009	0.001	0.020	0.002	0.11	328	0.18	0.12
	3	3	1,640	0.020	0.002						
PFPB	2 Slope	59	5,697	0.197	0.024	0.025	0.003	0.11	5,038	0.21	0.26
	3 Slope	29	5,832	0.116	0.014						
	2 OV	14	2,336	0.116	0.012						
	3 OV	5	1,243	0.018	0.001						
SWPB	2	0	0	0	0	0.278	0.074	0.29	1,318	2.96	3.02
	3	2	395	0.110	0.032						
VSS	2	60	2,413	0.394	0.021	0.127	0.007	0.05	3,438	1.02	1.19
	3	5	482	0.035	0.001						
HSS	2	4	67	0.013	0.001	0.187	0.016	0.09	109	1.57	1.63
	3	0	0	0	0						
ALL	-	183	20,531	1.027	0.108	-	-	0.11	10,231	-	0.43

GLOBAL EMISSIONS ESTIMATIONS



Estimation of Emissions from Non-reporting Facilities

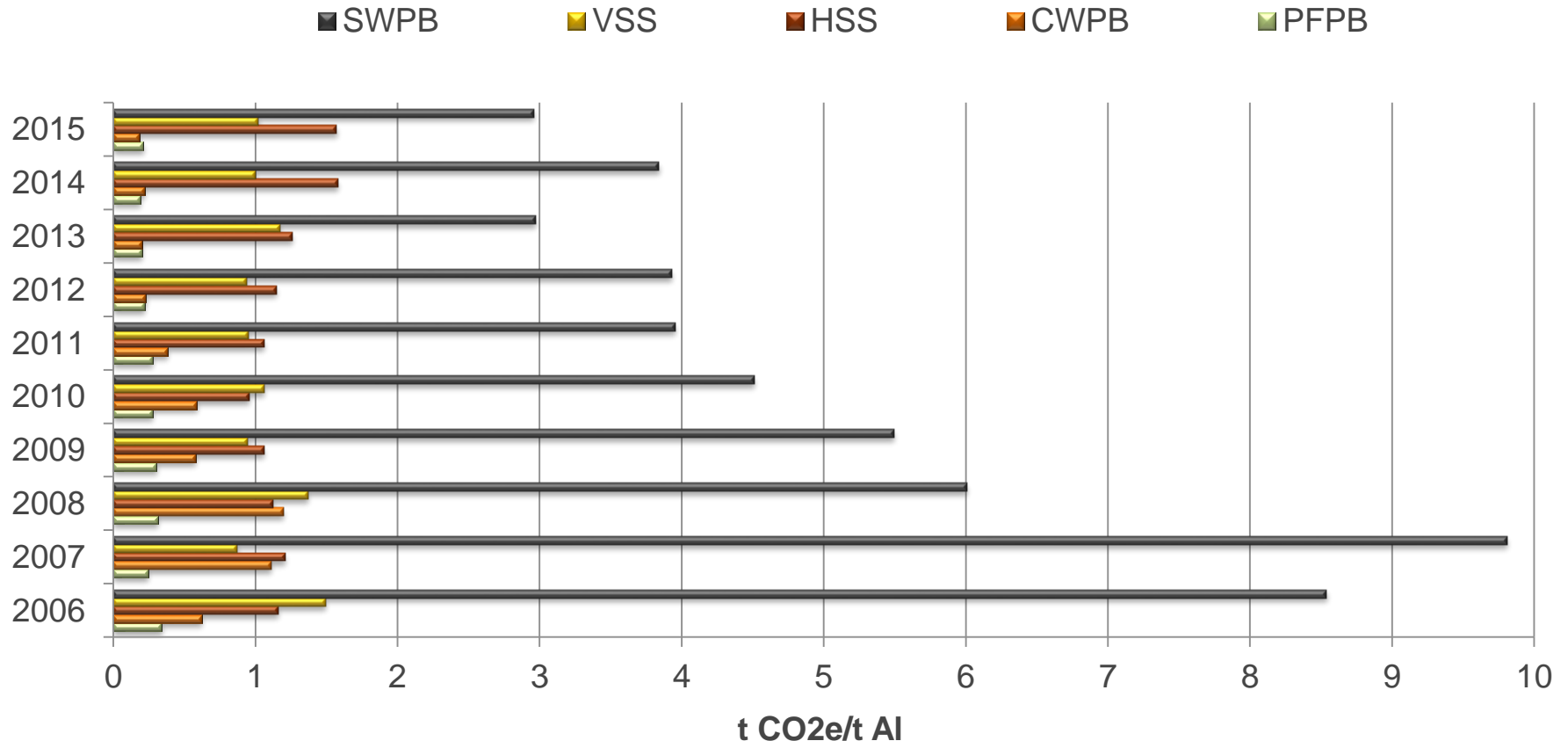
China

- 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 CO₂e) of reporting entities, per technology, 2006-2015



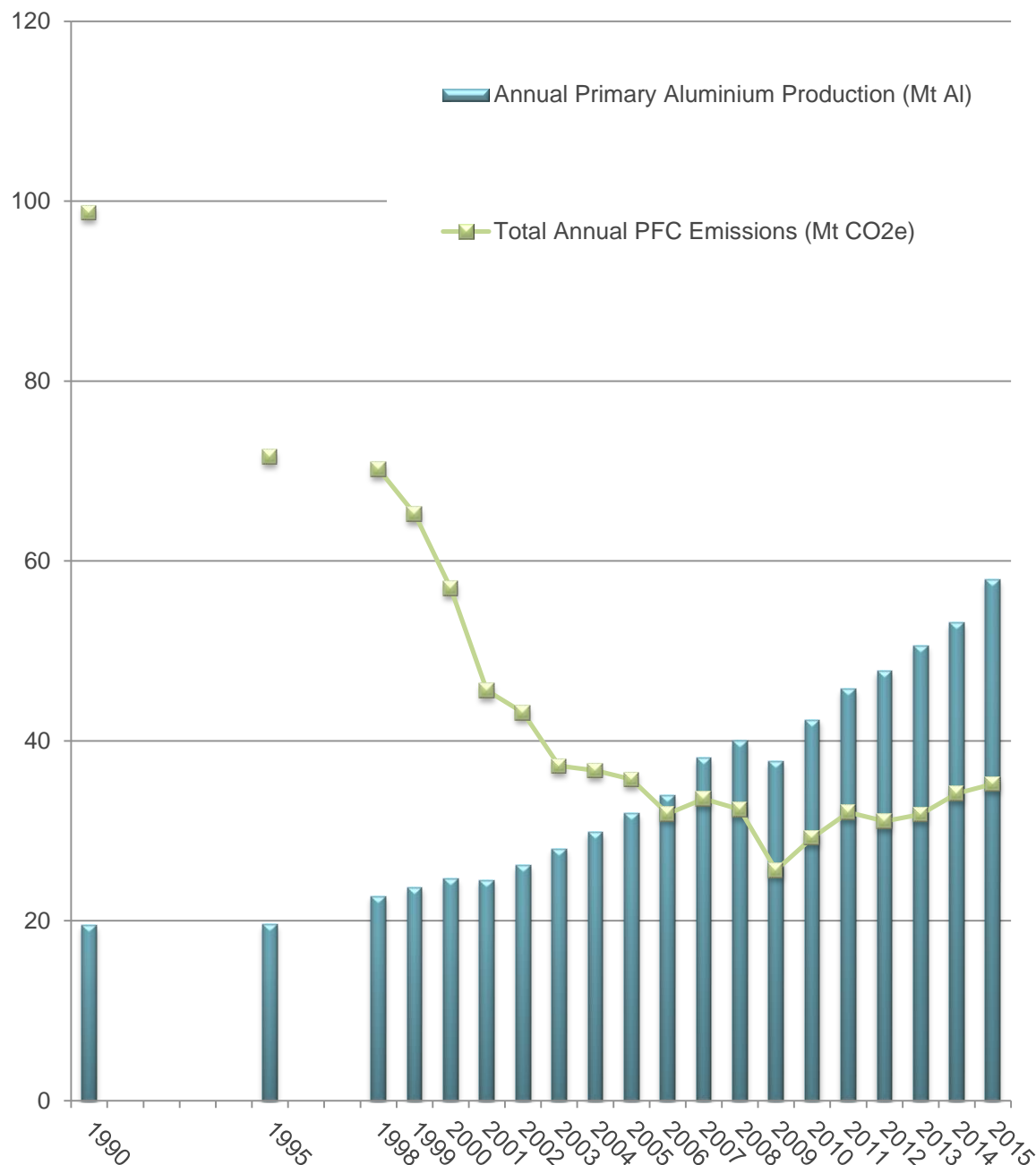
Total global 2015 PFC emissions

	Total PFC emissions (1,000 t CO ₂ e)	Total aluminium production (1,000 tonnes)	PFC emission factor (t CO ₂ e/t Al)
			IPCC 4 th GWP
Reported	8,901	20,531	0.43
Calculated from non-reporters	26,307	37,359	0.70
TOTAL GLOBAL	35,208	57,890	0.61

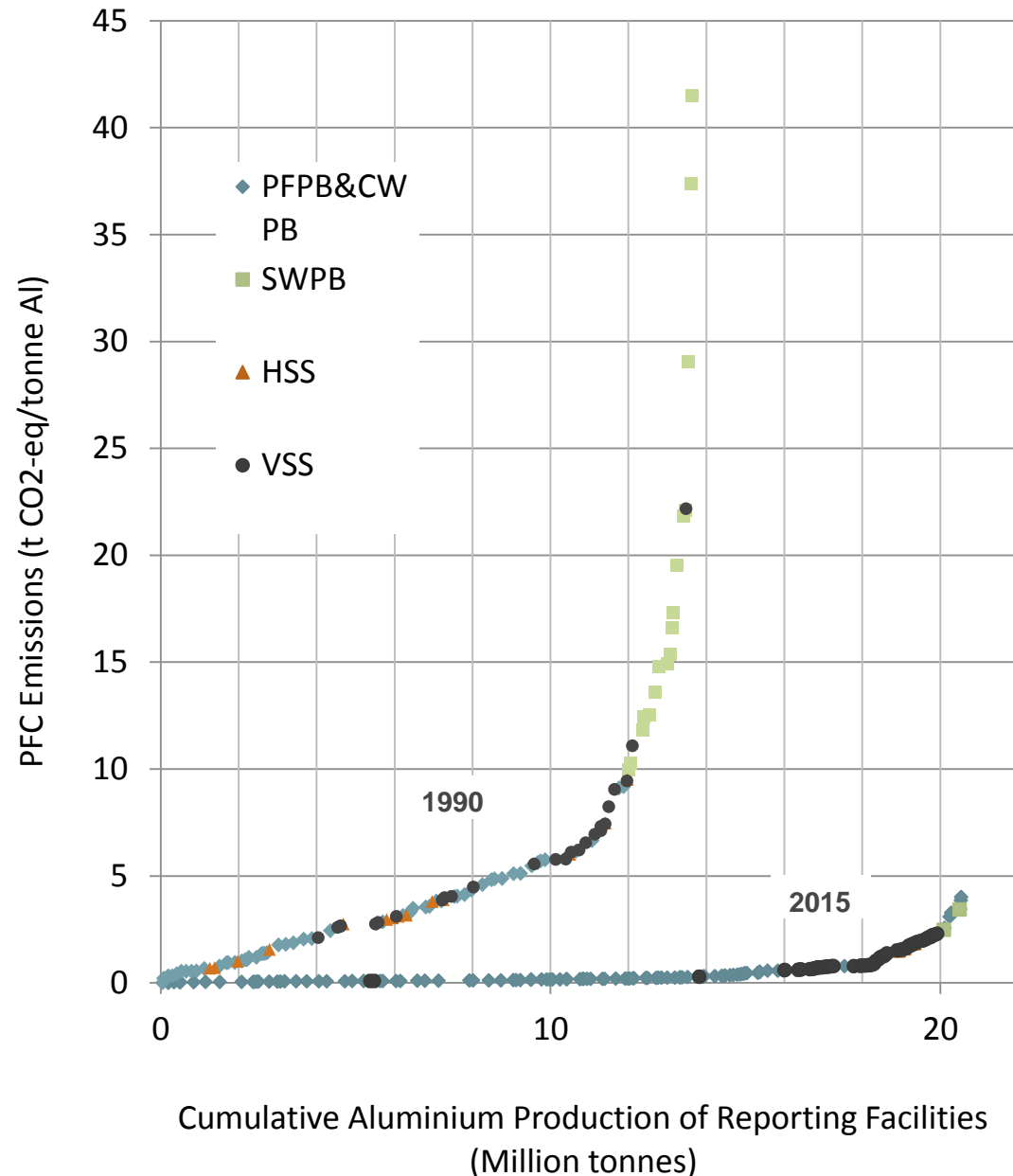
CONCLUSION

With PFC emissions per tonne cut by almost 90% since 1990 and primary aluminium production having grown by almost 200% over the same period, absolute emissions of PFCs by the aluminium industry have been reduced from approximate 100 million tonnes of CO₂e in 1990 to 35 million tonnes in 2015, a fall of 64%.

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.

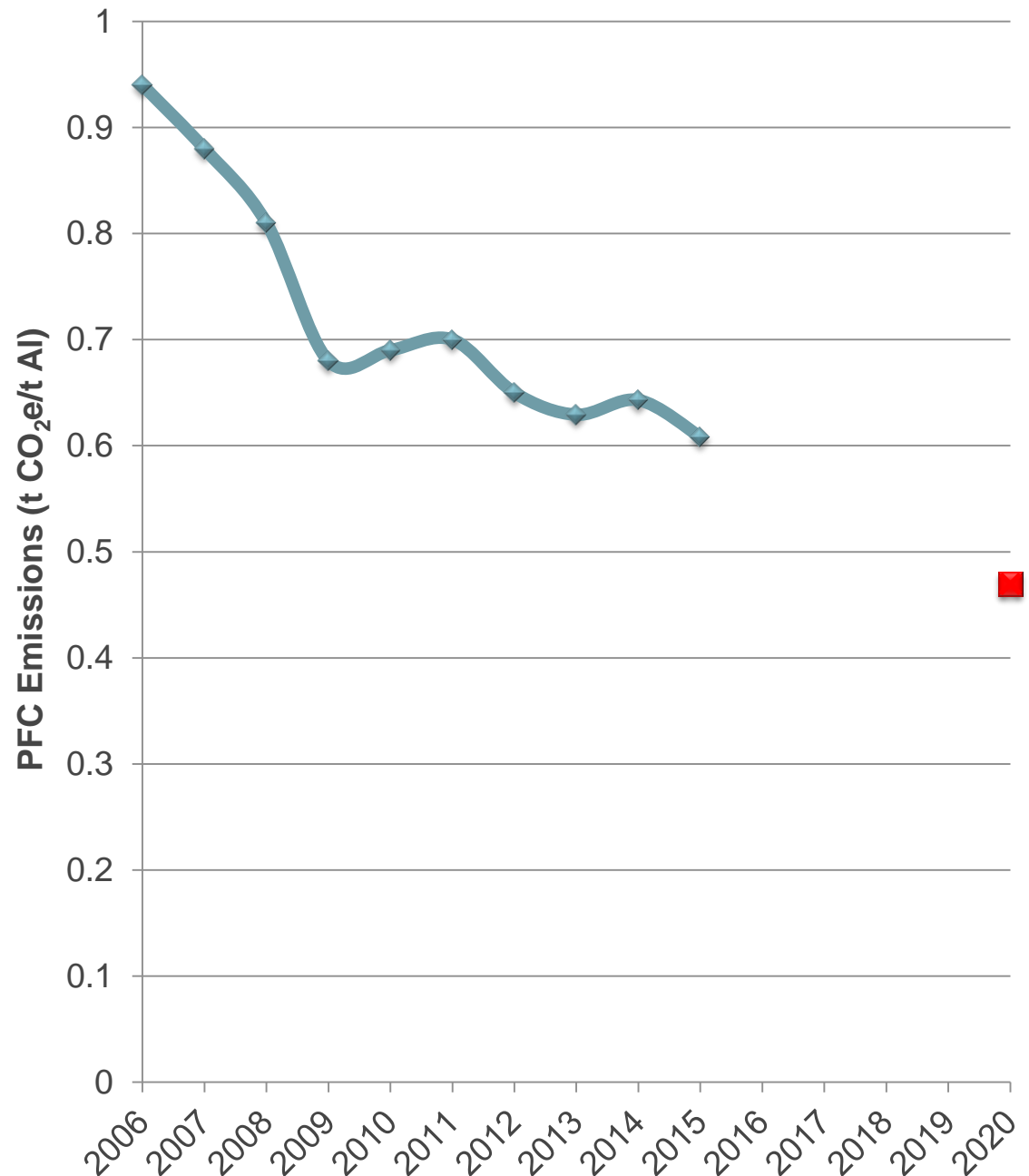


Taking the 1990 reporting cohort and plotting it against 2015 data shows improvement both from existing facilities over this time but also, importantly, the positive contribution of new (predominantly PFPB) capacity added since 1990.





Global PFC emissions (as CO₂e) per tonne of production have been reduced by 35% since 2006, by 88% since 1990 -- on course to meet the IAI voluntary objective of a 50% reduction by 2020 on a 2006 baseline.



INTERNATIONAL ALUMINIUM INSTITUTE

10 Charles II Street

London SW1Y 4AA

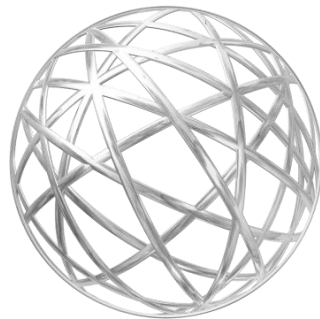
United Kingdom

Tel: + 44 (0) 20 7930 0528

Email: wu@world-aluminium.org

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