

# Results of the 2016 Anode Effect Survey

Report on the Aluminium Industry's Global  
Perfluorocarbon Gases Emissions

25 July 2017



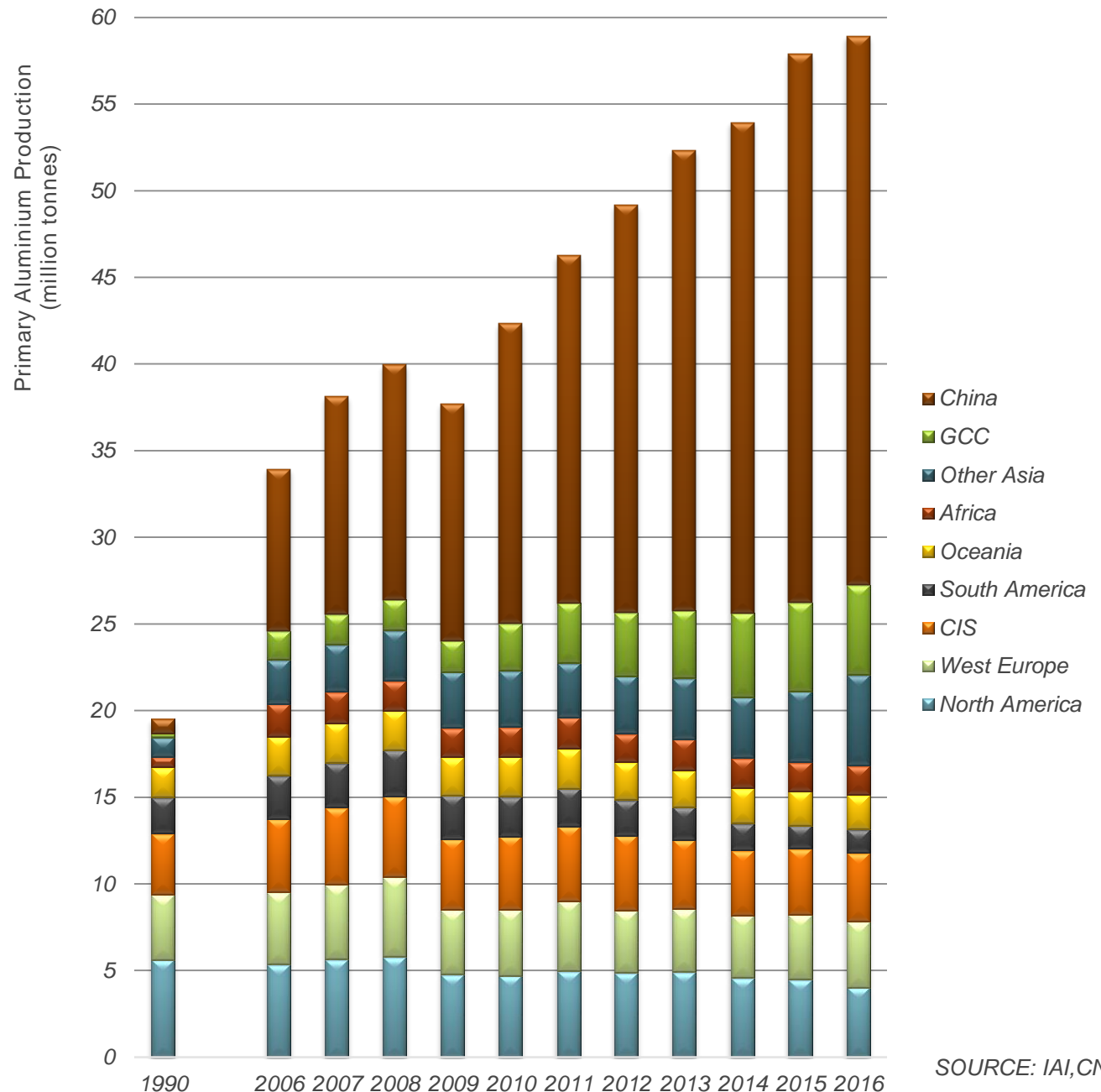
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# INDUSTRY SUMMARY

## Industry Trend

- Growth in primary aluminium production continues to be driven by countries in Asia and the Gulf area;
- 2016 global primary aluminium production is nearly 59 million tonnes, and China has contributed about 54%;
- 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](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](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_4_Ch4_Metal_Industry.pdf))
- Carbon dioxide equivalent (CO<sub>2</sub>e) 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<sub>4</sub> and 12,200 for C<sub>2</sub>F<sub>6</sub>).

# 2016 Anode Effect Survey participation by technology

TECHNOLOGY	2016 primary aluminium production (1,000 tonnes)	2016 production represented in survey (1,000 tonnes)	2016 participation rate by production	
CWPB	2,553	2,123	83%	
PFPB (Rest of World)	16,845	15,107	90 %	28%
PFPB (China)	36,062	0	0 %	
SWPB	408	372	91 %	
VSS	2,953	2,953	100 %	
HSS	69	69	100 %	
All Technologies (excluding China)	22,828	20,625	90 %	
All Technologies (Including China)	58,890	20,625	35 %	

*Note: any inconsistencies due to rounding*



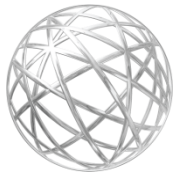
## Perfluorocarbon emission results from facility data reporting to the 2016 Anode Effect Survey

Note: any inconsistencies due to rounding

Technology	IPCC Tier	No. of reporting entities	Reported production (kt Al)	Total CF <sub>4</sub> emissions (Gg CF <sub>4</sub> )	Total C <sub>2</sub> F <sub>6</sub> emissions (Gg C <sub>2</sub> F <sub>6</sub> )	Median CF <sub>4</sub> intensity (kg CF <sub>4</sub> /t Al)	Median C <sub>2</sub> F <sub>6</sub> intensity (kg C <sub>2</sub> F <sub>6</sub> /t Al)	Mean C <sub>2</sub> F <sub>6</sub> : CF <sub>4</sub> weight ratio	IPCC 4 <sup>th</sup> GWP		
									Total PFC emissions (kt CO <sub>2</sub> e)	Median PFC intensity (t CO <sub>2</sub> e/t Al)	Mean PFC intensity (t CO <sub>2</sub> e/t Al)
CWPB	2	2	433	0.007	0.001	0.015	0.002	0.11	191	0.13	0.10
	3	4	1,690	0.015	0.001						
PFPB	2 Slope	52	5,929	0.165	0.018	0.021	0.002	0.11	2,984	0.18	0.20
	3 Slope	28	5,566	0.085	0.008						
	2 OV	14	2,359	0.069	0.008						
	3 OV	5	1,253	0.025	0.002						
SWPB	2	0	0	0	0	0.315	0.090	0.30	1,299	3.43	3.49
	3	2	372	0.118	0.035						
VSS	2	40	1677	0.198	0.011	0.142	0.008	0.05	3,573	1.14	1.21
	3	29	1277	0.247	0.013						
HSS	2	4	69	0.011	0.001	0.166	0.014	0.09	96	1.40	1.39
	3	0	0	0	0						
ALL	-	180	20,625	0.940	0.098	-	-	0.10	8,143	-	0.40



# **GLOBAL EMISSIONS ESTIMATIONS**



# Estimation of Emissions from Non-reporting Facilities

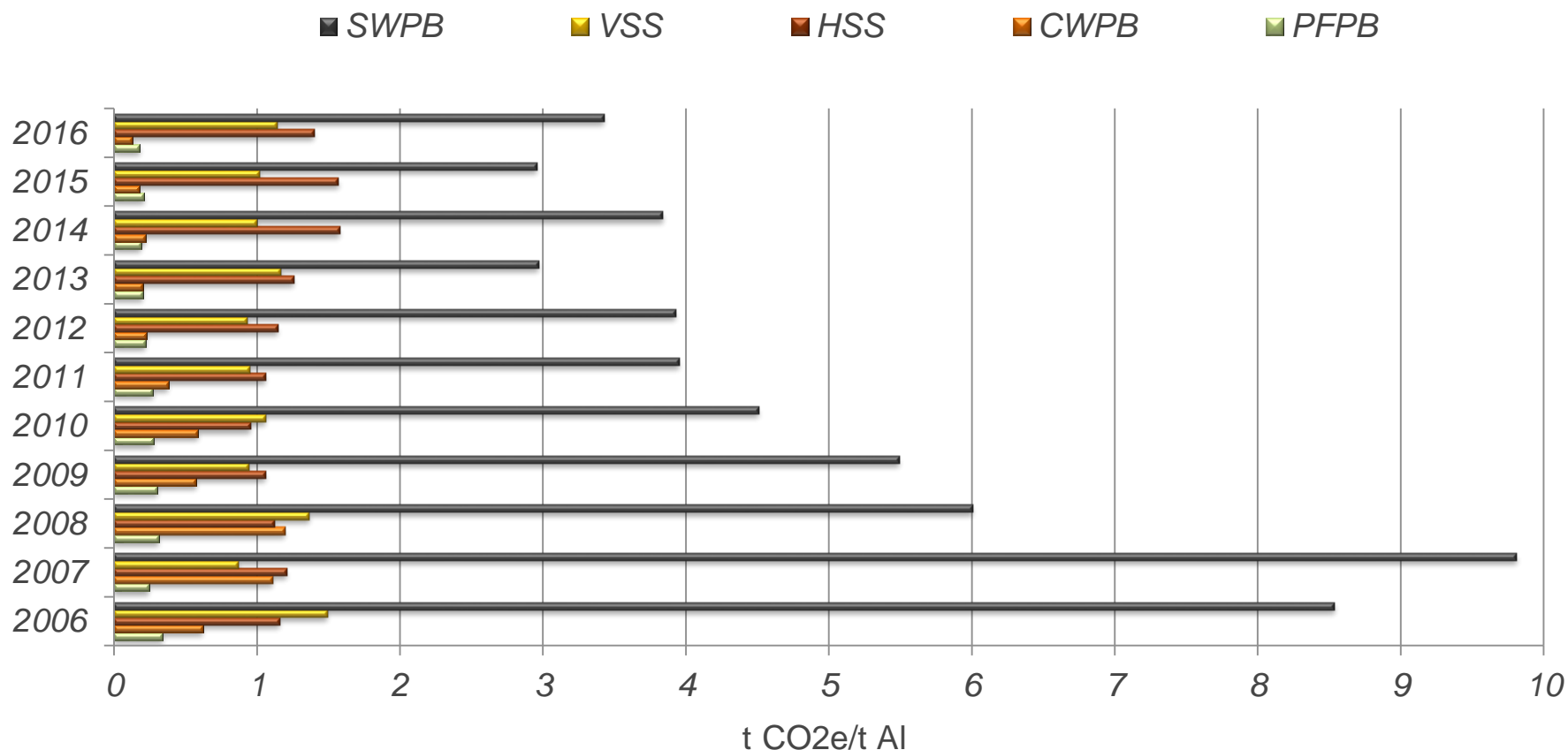
## China

- Latest measurement (2008-2013) of PFC emissions at 27 PFPB facilities in China is adopted
- Median emission factor = 0.80 t CO<sub>2</sub>e /t Al
- CF<sub>4</sub> median = 0.100 kg/t Al;
- C<sub>2</sub>F<sub>6</sub>:CF<sub>4</sub> 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<sub>2</sub>e) of reporting entities, per technology, 2006-2015



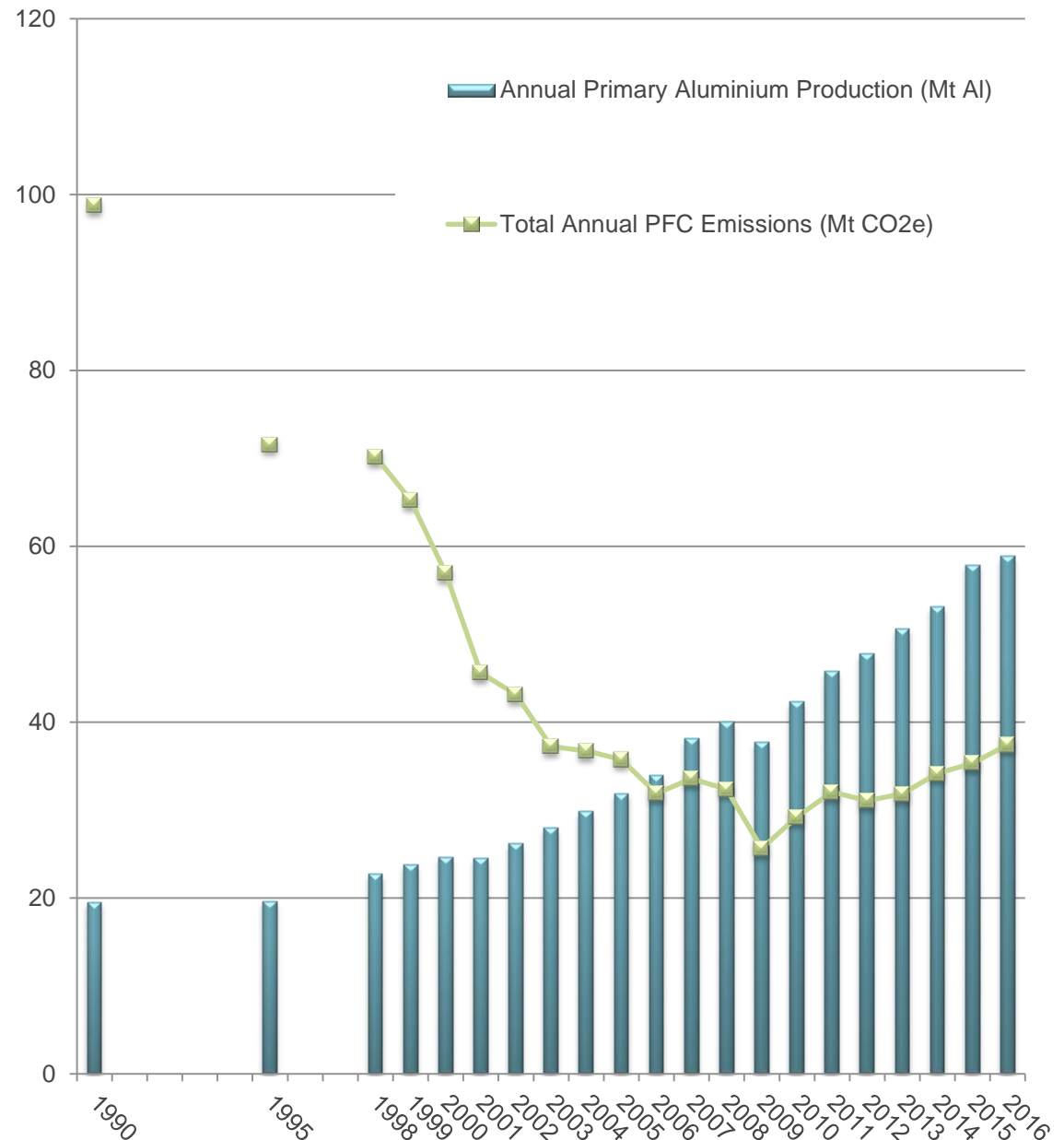
## Total global 2016 PFC emissions

	Total PFC emissions (1,000 t CO <sub>2</sub> e)	Total aluminium production (1,000 tonnes)	PFC emission factor (t CO <sub>2</sub> e/t Al)
			IPCC 4 <sup>th</sup> GWP
Reported	8,143	20,625	0.40
Calculated from non-reporters	29,280	37,265	0.79
<b>TOTAL GLOBAL</b>	<b>37,423</b>	<b>57,890</b>	<b>0.64</b>

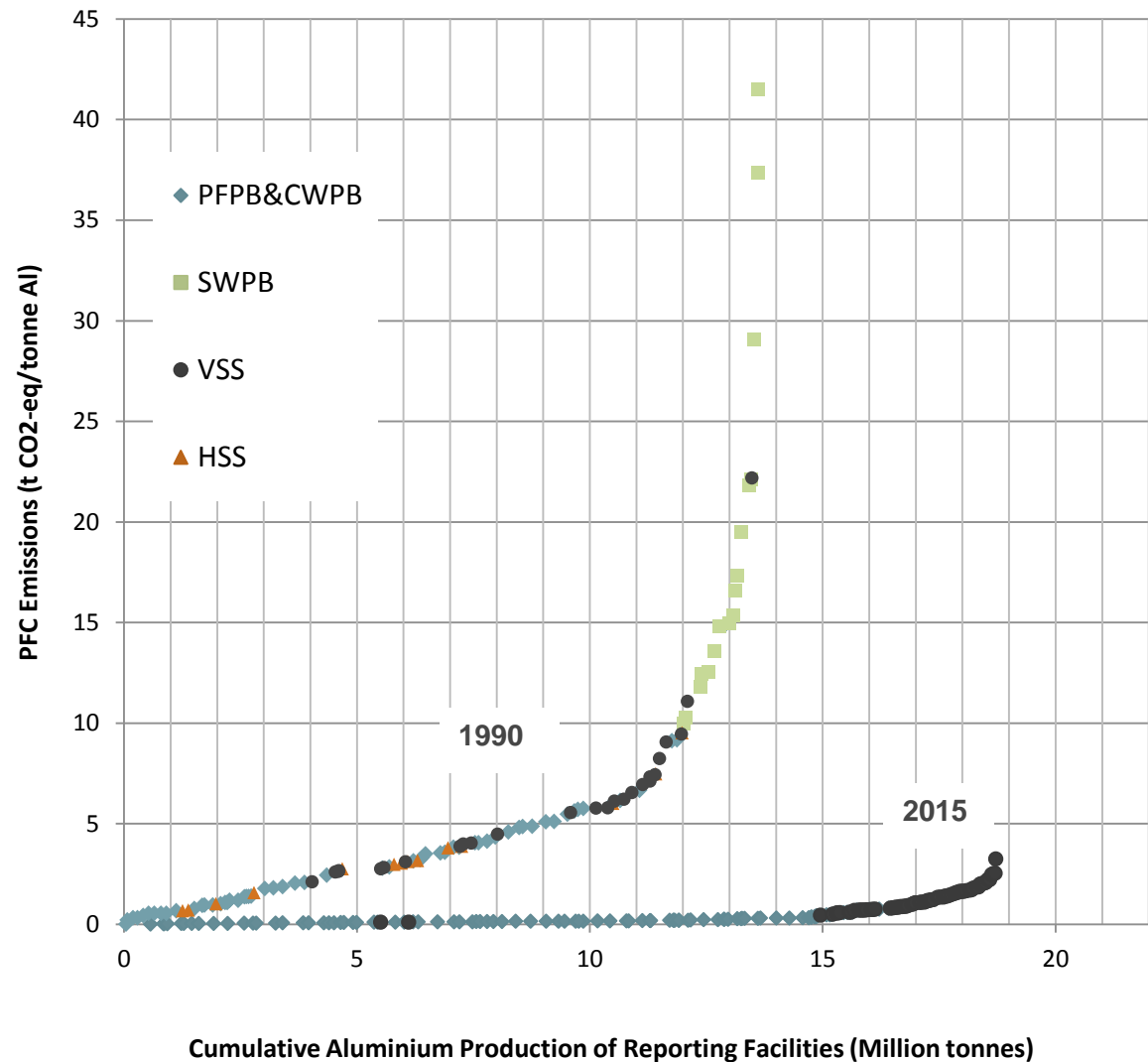
# CONCLUSION

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 CO<sub>2</sub>e in 1990 to 37 million tonnes in 2016, a fall of 62%.

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.

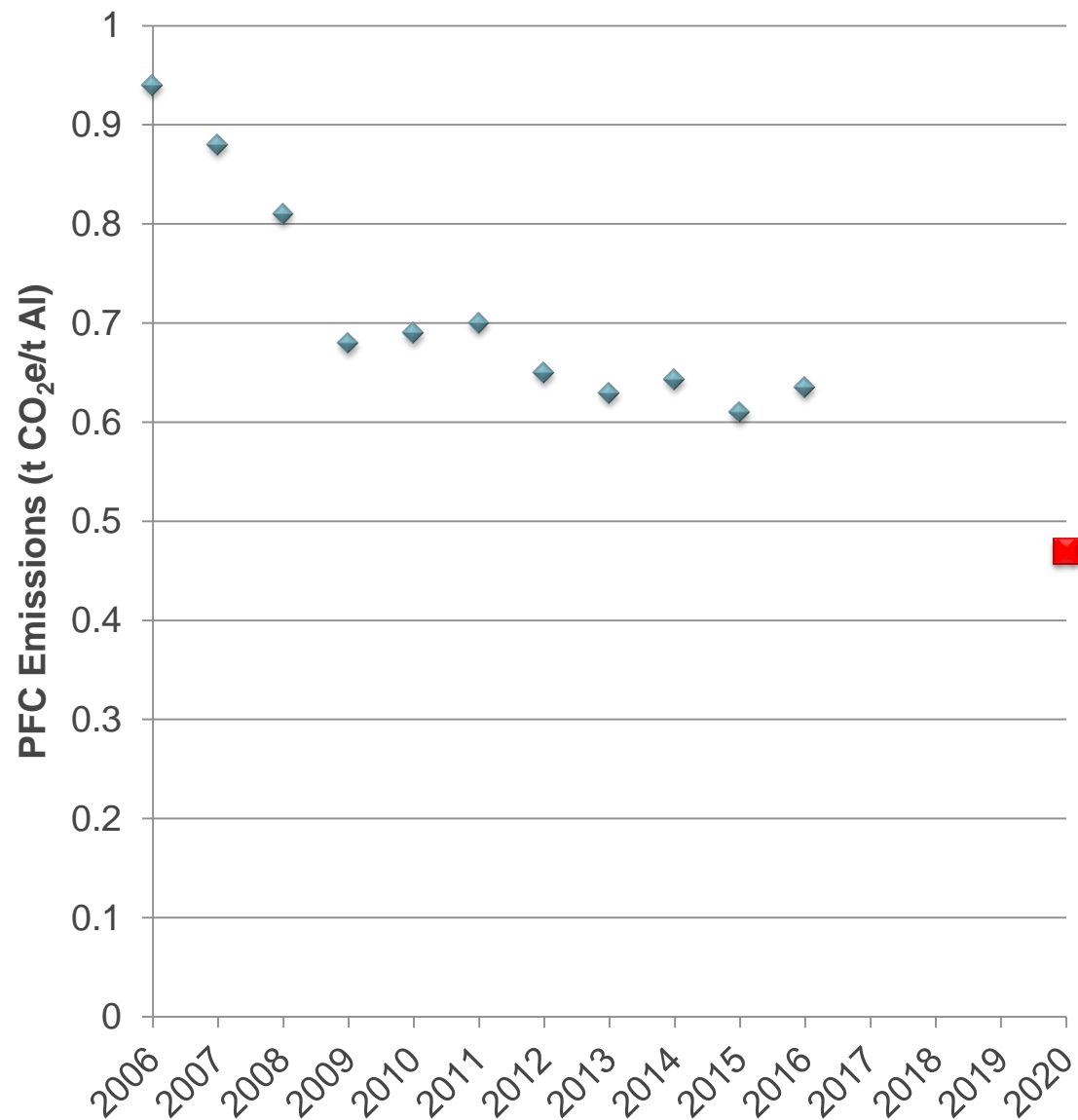


Taking the 1990 reporting cohort and plotting it against 2016 data shows improvement both from existing facilities over this time but also, importantly, the positive contribution of new (predominantly PFPB) capacity added since 1990.





- Global PFC emissions (as CO<sub>2</sub>e) per tonne of production have been reduced by over 30% since 2006, by 87% 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.



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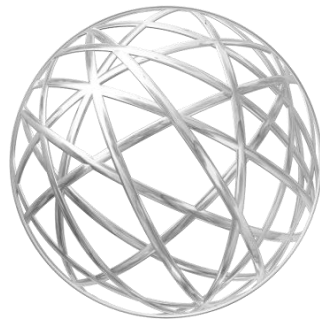
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