

# **GREENHOUSE GASES EMISSIONS FROM ALUMINIUM PRODUCTION**

**-INDUSTRY REDUCTION EFFORTS AND  
THE ROLE OF VOLUNTARY AGREEMENTS  
IN EMISSION REDUCTIONS**

**By EIRIK NORDHEIM, EUROPEAN  
ALUMINIUM ASSOCIATION**



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## **Presentation Outline**

- The aluminium industry and climate change
- Industry's response to the challenge
- The results to date
- Voluntary agreements
- Current industry actions
- Conclusions

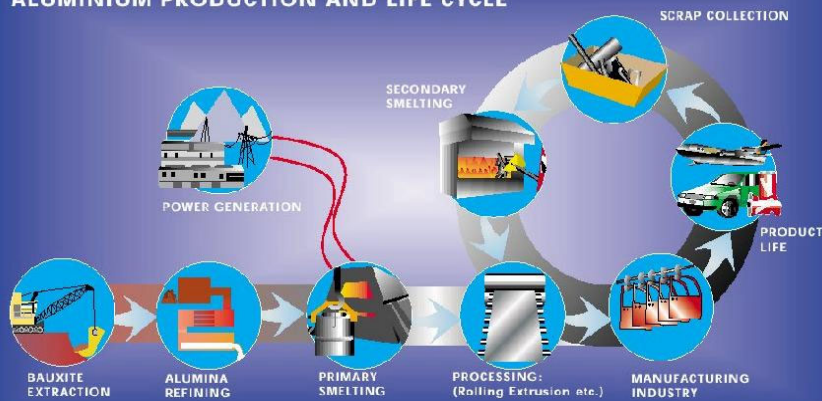


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## Life Cycle for Aluminium

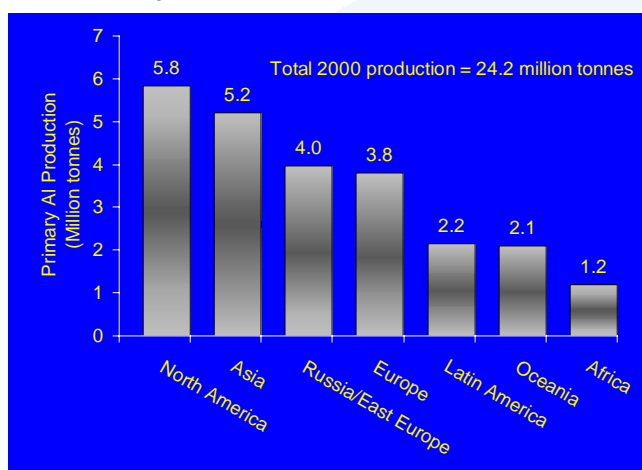
### ALUMINIUM PRODUCTION AND LIFE CYCLE



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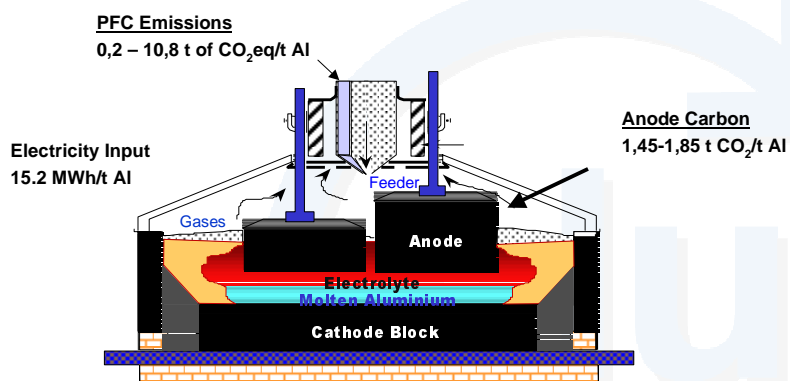
## Primary Aluminium is Global



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## GHGs from Primary Aluminium Production



### GHG from Primary Aluminium Production

Two PFC (perfluorocarbon compounds - CF<sub>4</sub> and C<sub>2</sub>F<sub>6</sub>) contribute about 48% of primary aluminium GHG emissions

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## How to decrease GHG Emissions?

- Increase the recycling rate
- Increase the electrical conversion efficiency and reduce electricity consumption
- Reduce anode effects that produce PFCs
- Change the reduction technology to eliminate carbon

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*Increase recycling rate*

## Aluminium Recycling

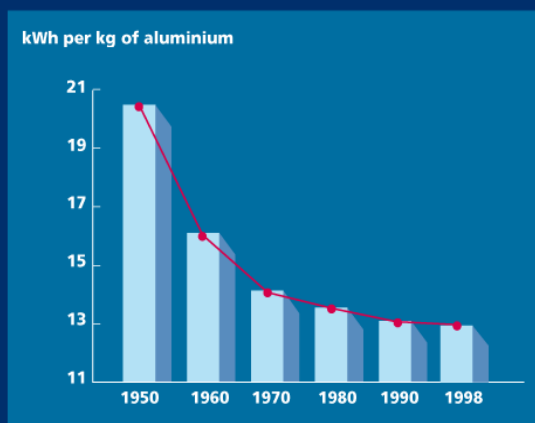
- Aluminium is not consumed but is used through multiple product life cycles
  - “Cradle to next product”  
Instead of “cradle to grave”
  - Aluminium maintains its value in recycling
- **There is an in-use inventory of aluminium products eventually to be recycled of 400 to 600 million tonnes**



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## Reduced electricity consumption at the electrolysis stage



■ Electricity consumption reduced by 33% since 1950



## Understanding PFC emissions

- PFCs result from anode effects
  - Anode effects result from temporary imbalances in the raw material feed rate with aluminium production rate
- The amount of PFCs produced from anode effects is a function of:
  - Anode effect frequency
  - Duration of anode effects
  - Cell amperage
  - Anode effect voltage



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## Understanding PFC Emissions

- The specific PFC emissions (kg CF<sub>4</sub>/t Al) is primarily a function of anode effect minutes per cell day
- Emissions per anode effect minute strongly dependent on reduction technology



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## Global Warming Potentials (GWP)

GWP for  $\text{CF}_4$  = 6500  
GWP for  $\text{C}_2\text{F}_6$  = 9200

5700 Revised values proposed  
11900 In 3<sup>rd</sup> assessment report



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## International Aluminium Institute (IAI) sponsored PFC initiatives

- Survey member companies on anode effect data
- Conduct workshops for benchmarking and good practices for reduction of anode effects
- Collaborate with national regulatory agencies, regional aluminium associations and member companies in developing better PFC inventories
- Sponsor fundamental atmospheric research to better understand how PFCs affect climate change
- Sponsor measurements of PFCs in historical air samples to establish the relationship with aluminium production



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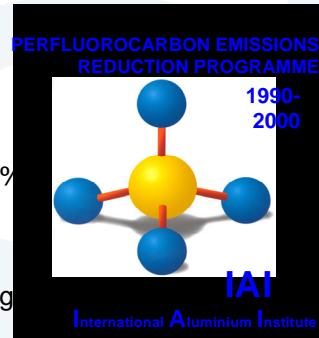
## The results

### IAI PFC Survey Report for 1990 – 2000

#### Results

- Specific PFC emissions reduced by 60%
- Total PFC emissions reduced by 46% with primary aluminium up by 36%
- Benchmarking data provided comparing individual facility performance

✓ Still room for improvement

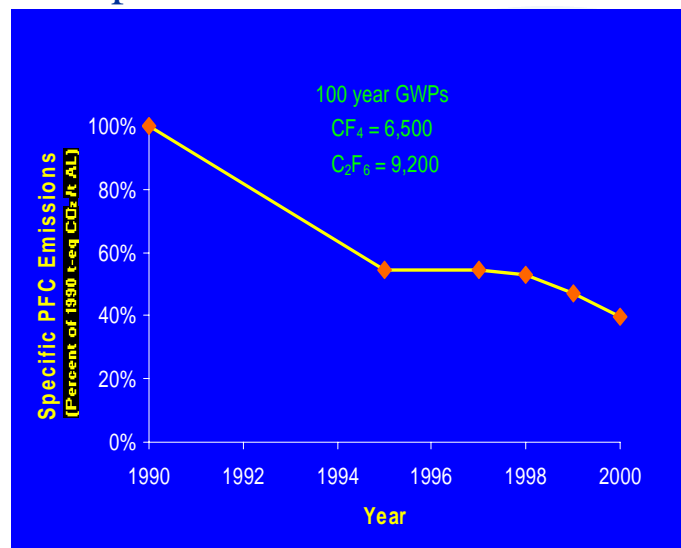


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## The results

### Specific Emissions of PFCs



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## Current voluntary agreements

- Several types of agreements
- Vary from industry commitments, through signed agreements to negotiated agreements with benefits and penalties
- Negotiated agreements also have third party verification of emissions



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## Countries with voluntary agreements

Country	Coverage	Start date	End date
Australia	PFC and CO <sub>2</sub>	1990	2000/-
Bahrain	PFC	1995	2000
Brazil	PFC and CO <sub>2</sub>	1994	2000
Canada	PFC and CO <sub>2</sub>	1990	2007
France	PFC and CO <sub>2</sub>	1990	2000/-
Germany	PFC	1990	2005
New Zealand	PFC and CO <sub>2</sub>	1990	2000
Norway	PFC and CO <sub>2</sub>	1990	2005
UK	PFC	1990	2000/2010
US	PFC	1990	2000/2005



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## Targets for voluntary agreements

- Gases involved and targets vary from country to country
- Starting point and potential reduction depends on the state of the technology
- The achieved results also depends on change in production volume



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## Reductions in Annex I countries(2000)

Country	Production	Red Target	Achieved	Gases
Australia	+ 43%	+ 9%	+20%	GHG
Canada	+ 52	Varies	+7	GHG
France	+ 35	- 63	- 73	PFC
Germany	- 11	- 50	- 85	PFC
Norway	+ 18	- 50	- 53	GHG
UK	+ 5	- 89	- 87	PFC
US	- 9	- 45	- 56	PFC



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## Reductions achieved

- The specific emissions have in all cases been reduced
- Where total emissions targets have not been achieved this is linked to production increases



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### *Current IAI Actions*

## Improve Quality of PFC Inventory

- Conduct annual surveys of member companies
- Working to increase coverage of survey
- Give member companies benchmark data to evaluate performance
- Have developed global standards for inventory methodology building on WBCSD protocols
- Working with IPCC to improve Tier 2 calculation coefficients
- Moving member companies to Tier 3 reporting
- Working with USEPA to establish a standard PFC measurement protocol globally



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## Conclusions

- Excellent Progress made by worldwide aluminium industry in reducing greenhouse gas emissions
  - Specific PFC emissions reduced by 50% over the period 1990 – 2000 by worldwide aluminium industry (60% by IAI member companies).
  - Total PFC emissions reduced by 38% by worldwide aluminium industry (46% by IAI member companies) from 1990 to 2000 while primary production increased by 24%.



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## Conclusions

- Voluntary programs have been effective in reducing PFC emissions.
- Further reductions in PFC emissions are possible through adoption of best practices, technology improvements and increased recycling.
  - IAI working to facilitate transfer of best practices to reduce the frequency of anode effects and to teach measurement techniques worldwide.



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## Conclusions

- Future voluntary programs should be based on:
  - Clearly defined targets and plants/gases included
  - Penalties and benefits – several models used
  - Regular reporting and verification of results



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