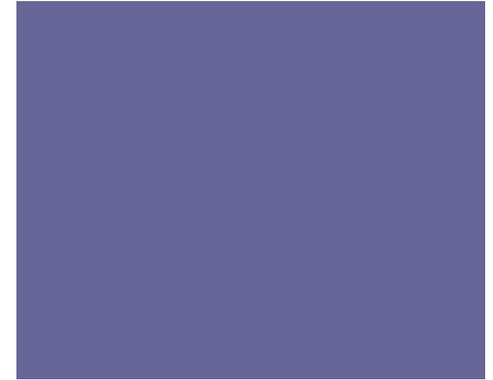
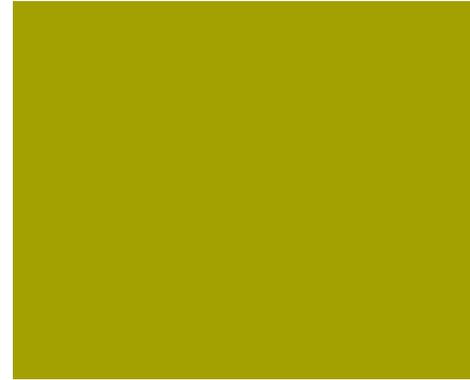




Joachim Feuerborn,
ECOBA, Europe
Craig Heidrich,
ADAA, Australia



Global Opportunities and challenges for Coal Combustion Products with a Circular Economy



World Wide Coal Combustion Products Network



 ACAA American Coal Ash Association	 ADAA Ash Development Association of Australia	 Asian CAA Asian Coal Ash Association	 CCAPC China Coal Ash Professional Committee
 CAII Coal Ash Institute of India	 ECOBA European Coal Combustion Products Association e.V.	 IACEE MPEI - Russia Informational & Analytical Center "Ecology of Power Engineering" of MPEI	 JCOAL Japan Coal Energy Center
 NCAB National Coal Ash Board	 UPS Polish Union UPS	 SACAA South African Coal Ash Association	 UKQAA UK Quality Ash Association

www.wwccpn.net

+ Why we exist...



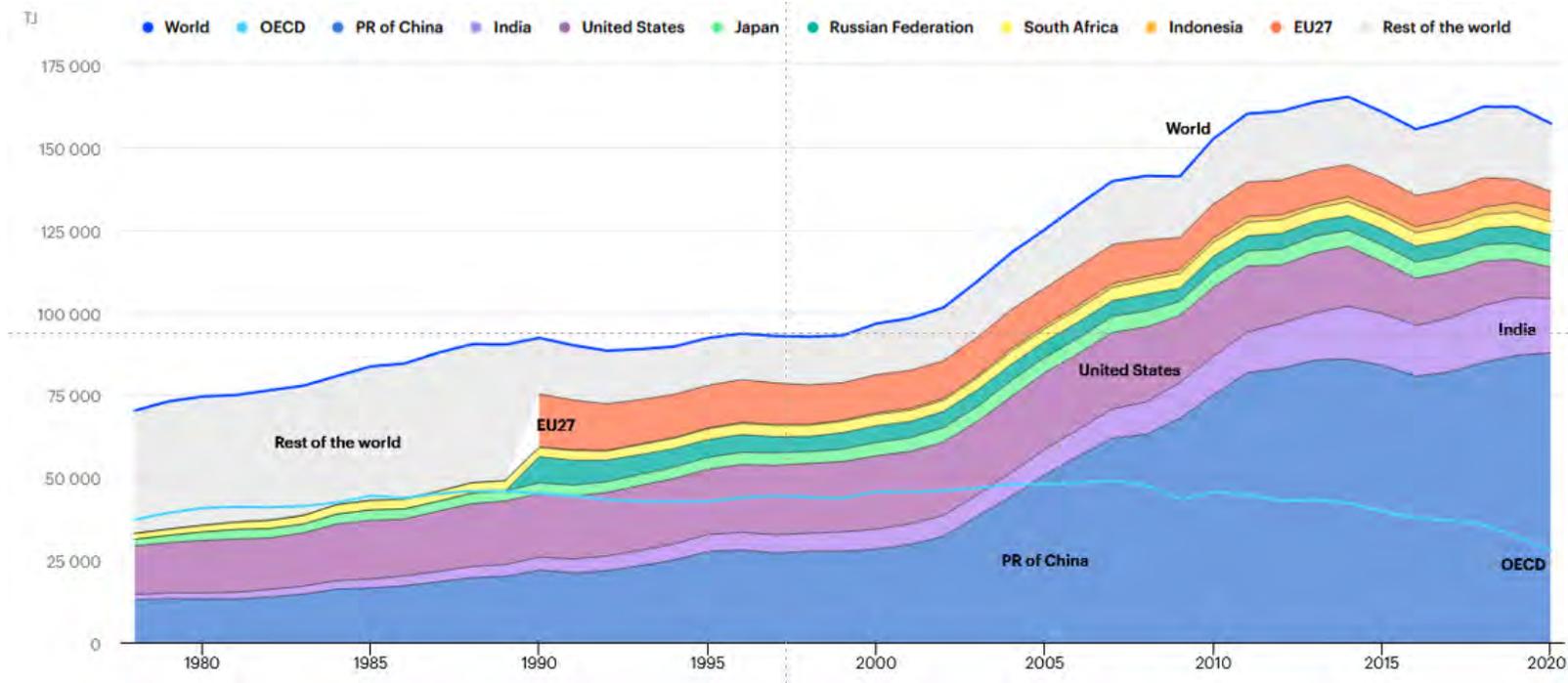
- **Stimulate** sharing/transfer of technical information;
- **Co-operate** internationally for harmonization of appropriate codes, specifications and guides;
- **Promote** internationally consistent appropriate regulations; and
- **Facilitate** awareness and understanding of the environmental, economic, engineering, manufacturing and societal benefits derived from use of CCPs.



Content

- **Role of coal**
 - Developments, Impacts
- **Coal Combustion Products**
 - Status, Production, Trade
 - Role, options in Circular Economy
- **Summary (Outlook**

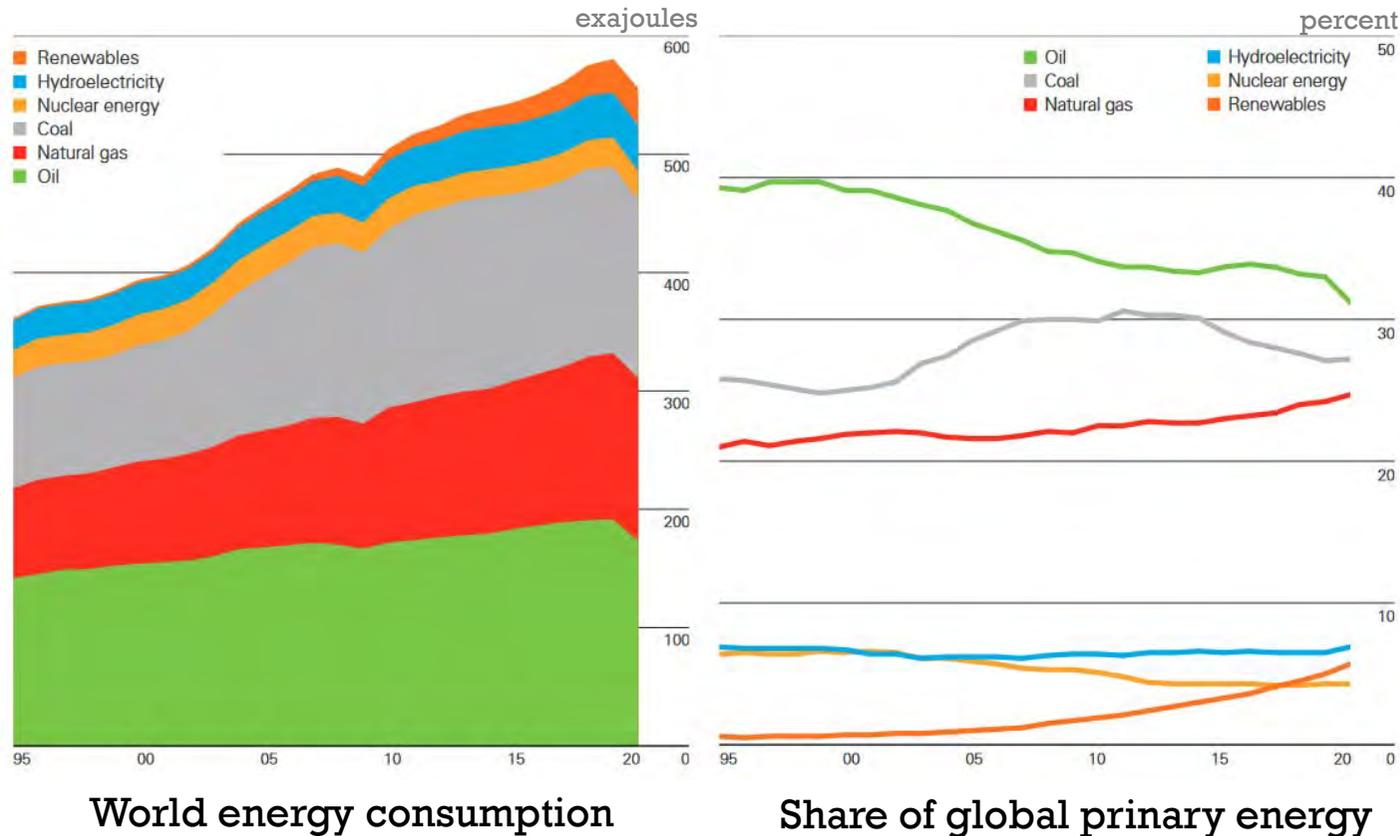
+ World total coal consumption



Source: International Energy Agency
<https://www.iea.org/reports/coal-information-overview/production>

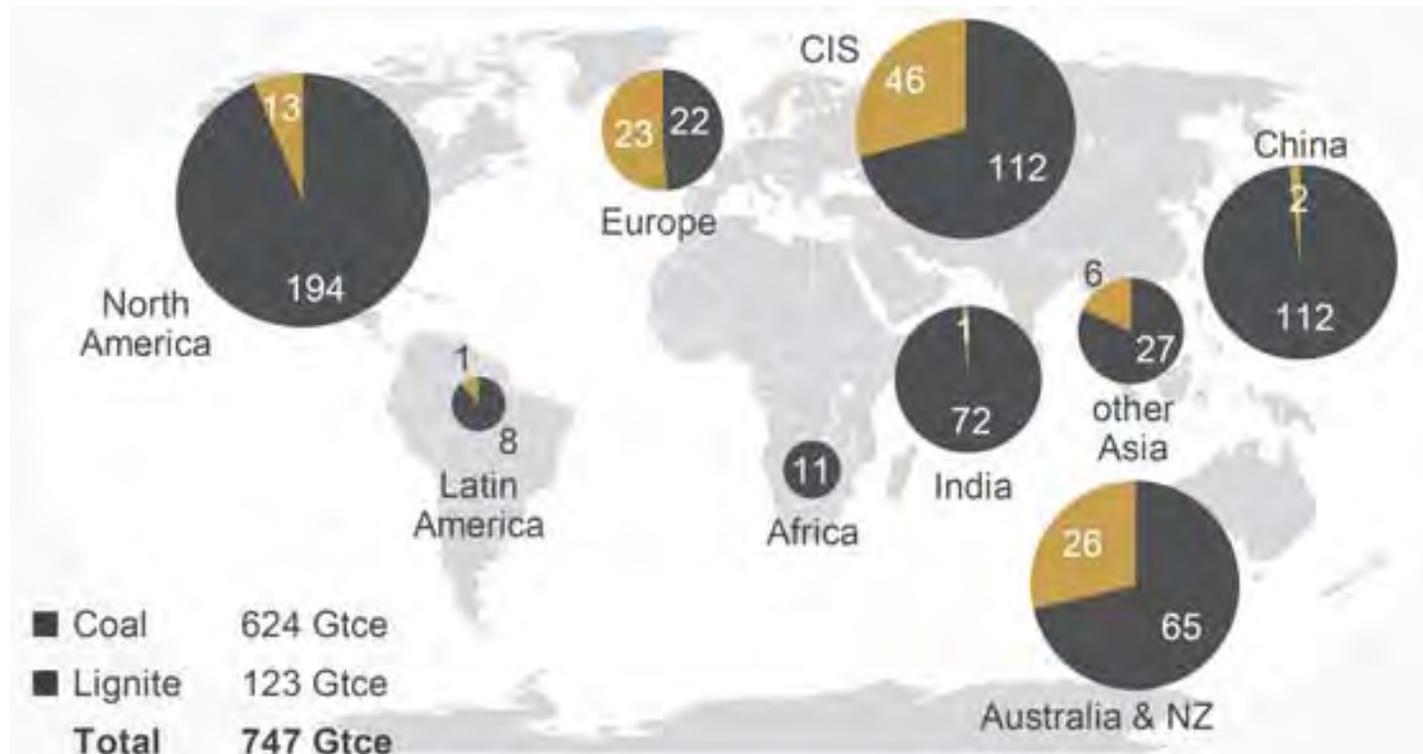


World primary energy consumption / share primary energy



Source: BP Statistical Review of World Energy

+ Global hard coal and lignite reserves



BGR 2019: in <https://euracoal.eu/coal/coal-use-worldwide/>



United Nations Framework on Climate Change – UNFCCC

The UNFCCC entered into force on 21 March 1994. It aims to cooperate to limit global temperature increase and climate change. Parties having ratified the Convention are called Parties to the Convention (COP).



United Nations
Climate Change

Home COP 26 Process and meetings Topics Calendar Climate action Documents and decisions About us

Latest Information on COP26

[Main conference page](#)

FROM THE PODIUM
COP 26 President Designate Reflections Note

SESSION INFORMATION
COP 26

SESSION INFORMATION
CMP 16

SESSION INFORMATION
CMA 3

SESSION INFORMATION
SBSTA 52-55

SESSION INFORMATION
SBI 52-55

<https://unfccc.int/>

**GLASGOW CLIMATE CHANGE
CONFERENCE – OCTOBER-
NOVEMBER 2021**

31 Oct - 12 Nov 2021



United Nations Framework on Climate Change – UNFCCC



- **The Convention**
recognised that there was a problem
- set lofty but specific goals
- puts onus on developed countries to lead the way
- charts the beginning of a path to strike a delicate balance
-

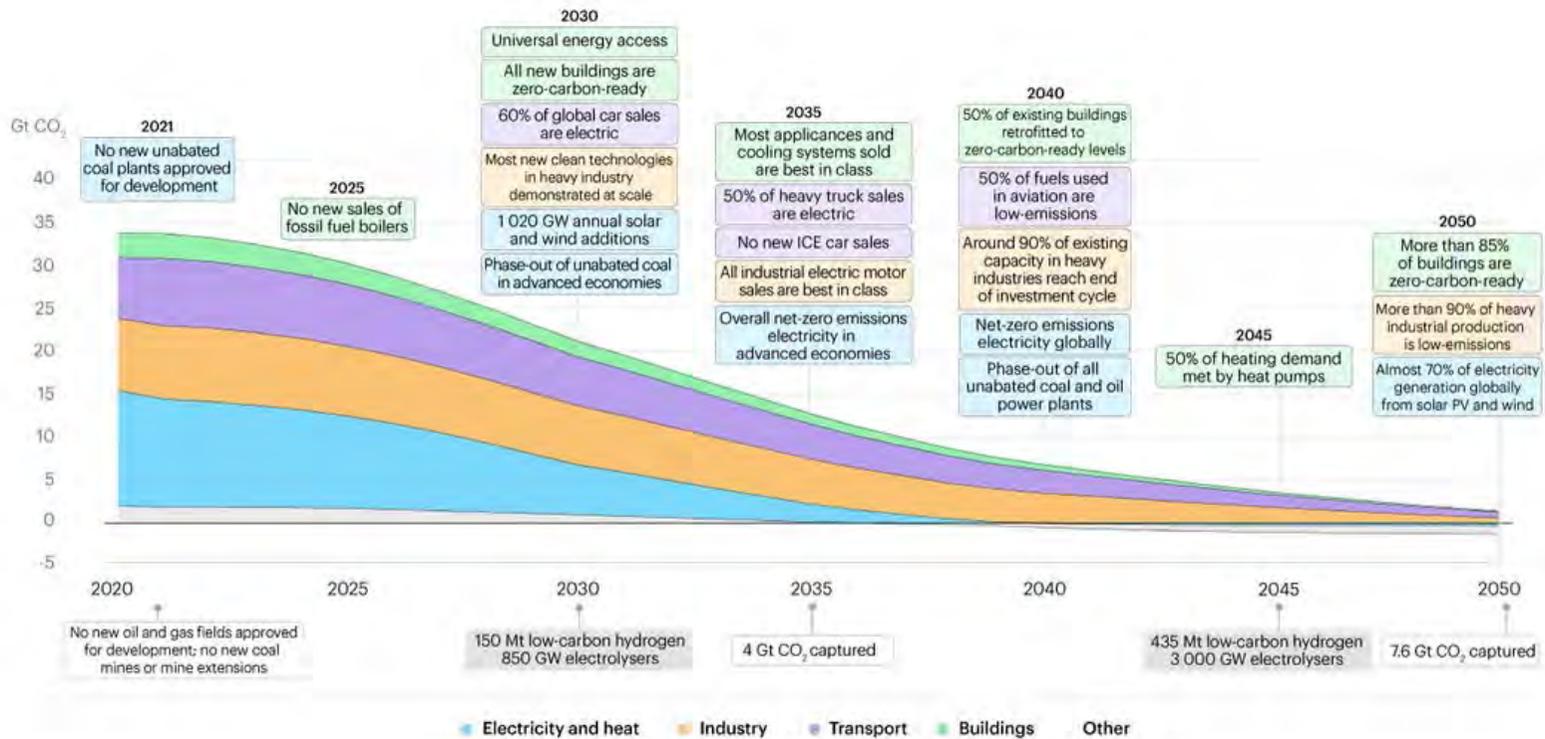
- **Kyoto Protocol**
 - introduced legally binding emission targets for developed countries
 - at least 18 % reduction below 1990 levels (first period 2013-2020)
 - partly increased to 40 % and now climate neutrality
- **Paris Agreement**
 - i.a. keep global warming at 1.5°C above pre-industrial level

<https://unfccc.int/process#:d8f74df9-0dbd-4932-bf3c-d8a37f8de70e>

+ IEA report

Net Zero by 2050

A Roadmap for the Global Energy Sector



<https://www.iea.org/reports/net-zero-by-2050>



Content

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+ Global definitions for CCPs



Term	Definition
Coal Combustion Products	Coal combustion products (CCPs) include fly ash, bottom ash, boiler slag, fluidized-bed combustion (FBC) ash, or flue gas desulfurization (FGD) material produced primarily from the combustion of coal or the cleaning of the stack gases of coal fired power stations. The term coal ash is used interchangeable for the different ash types.
Fly ash	The finer ash produced in a coal fired power station, which is collected using electro-static precipitators. This is also known as Pulverised Fuel Ash (PFA) in some countries. About 85+% of the ash produced is fly ash.
Furnace Bottom Ash (FBA)	The coarse ash that falls to the bottom of a furnace. The molten ash adheres to the boiler tubes, eventually falling to the base of the furnace. Usually <15% of the ash produced is FBA
Cenospheres	Hollow ash particles that form in the furnace gas stream. They float on water and are usually collected from lagoons, where ash/water disposal systems are being used.
Conditioned ash	Where fly ash is mixed with a proportion of water (10 to 20% by dry mass typically) in order that it can be transported in normal tipping vehicles without problems with dust for sale or disposal.
Flue Gas De-sulfurisation	Where a source of calcium is injected into the furnace gas stream to remove sulfur compounds. The sulfur compounds convert the calcium carbonate to calcium sulfate, or gypsum, which is used in the wallboard industry for general construction

+ Status and classification



Countries	Defined as Waste	Defined as <u>haz.waste</u>	Basel <u>Convencion</u> adopted	REACH adopted	<u>Int'L</u> Treaty on Mercury ³	Utilis. Env. Condit.
United States	Yes	No	Yes	No	Yes	Yes
Australia	Yes	No	Yes	No	No ⁴	Yes
Canada	Yes	No	Yes	Ref	Yes	Yes
China	Yes	No	Yes	Yes ²	Yes	Yes
Europe	Yes ¹	No	Yes	Yes	Yes ⁴	Yes
India	Yes	No	Yes	No	Yes	Yes
Indonesia	Yes	No	Yes	No	Yes	?
Israel	No	No	Yes	No	No	Yes
Japan	Yes	No	Yes	No	Yes	Yes
Russia	Yes	No	Yes	No	Yes ⁴	Yes
South Africa	Yes	No	Yes	No	Yes ⁴	Yes

¹ – in some member states defined as by-products or products

² – China REACH is similar to EU REACH

³ – International Treaty on Hg, under UN Environment Program; ⁴ – partly not ratified yet

Governmental Regulation No 22/2021 on environmental protection, April 2021



Annual production and utilisation rates of CCPs by country/region



Country/Region	CCPs Production (Mt)	CCPs Utilisation (Mt)	Utilisation Rate %
Australia	12.6	5.9	46.8
Asia			
- China	585	404	69.1
- Korea	7.5	6.2	82.7
-India	226	191	84.5
-Japan	12.3	12.1	96.9
- Other Asia	22.4	13.2	58.9
Europe	103		
-EU15	19.4	21.5	110.8
Middle East & Africa	33.9	3.9	11.5
Israel	0.6	0.5	83.3
United States of America	45.8	27.3	59.6
Brazil	4.1	1.2	30.0
Canada	3.2	3.0	93.8
<u>Russian Federation</u>	30.2	3.1	10.3
Total	1086.6	692.1	63.9

2010: 780 Mt;  2017: 1200 Mt  2019: 1100 Mt

+ Circular Economy



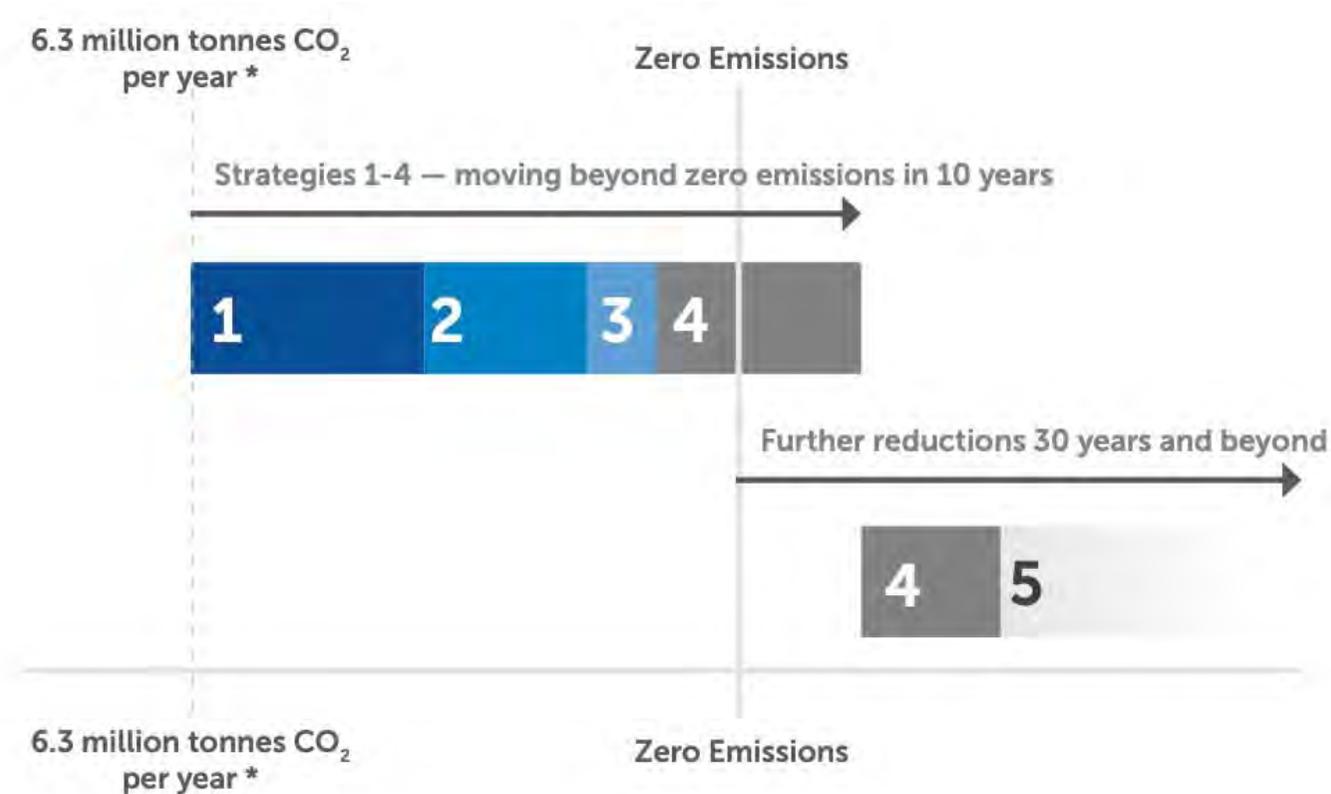
The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the **life cycle of products is extended**. In practice, it implies **reducing waste to a minimum**.



<https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits>



Pathway to zero emissions cement in Australia



Source: Beyond Zero Emissions, 2017



Strategies to zero emissions cement in Australia



		Target	Emissions reduction (CO ₂)	
			10 years	30+ years
Strategy 1	Using geopolimer cements that contain no Portland cement	replacing 50% of cement market	2.7 MT	
Strategy 2	Using high-blend cements with a low volume of Portland cement	replacing 50% of cement market	1.9 MT	
Strategy 3	Carbon mineralisation	reducing remaining Portland cement emissions to nearly zero	0.8 MT	
Strategy 4	Minimising the use of cement	reducing cement use by 15%	0.9 MT* 1.4 MT*	3 MT
Strategy 5	Carbon negative magnesium-based cements.	developing commercial carbon negative cements	—	2-3 MT*

* Estimated process emissions from Australian cement production in 2027 (business as-usual)

□ Avoided emissions from reducing cement use

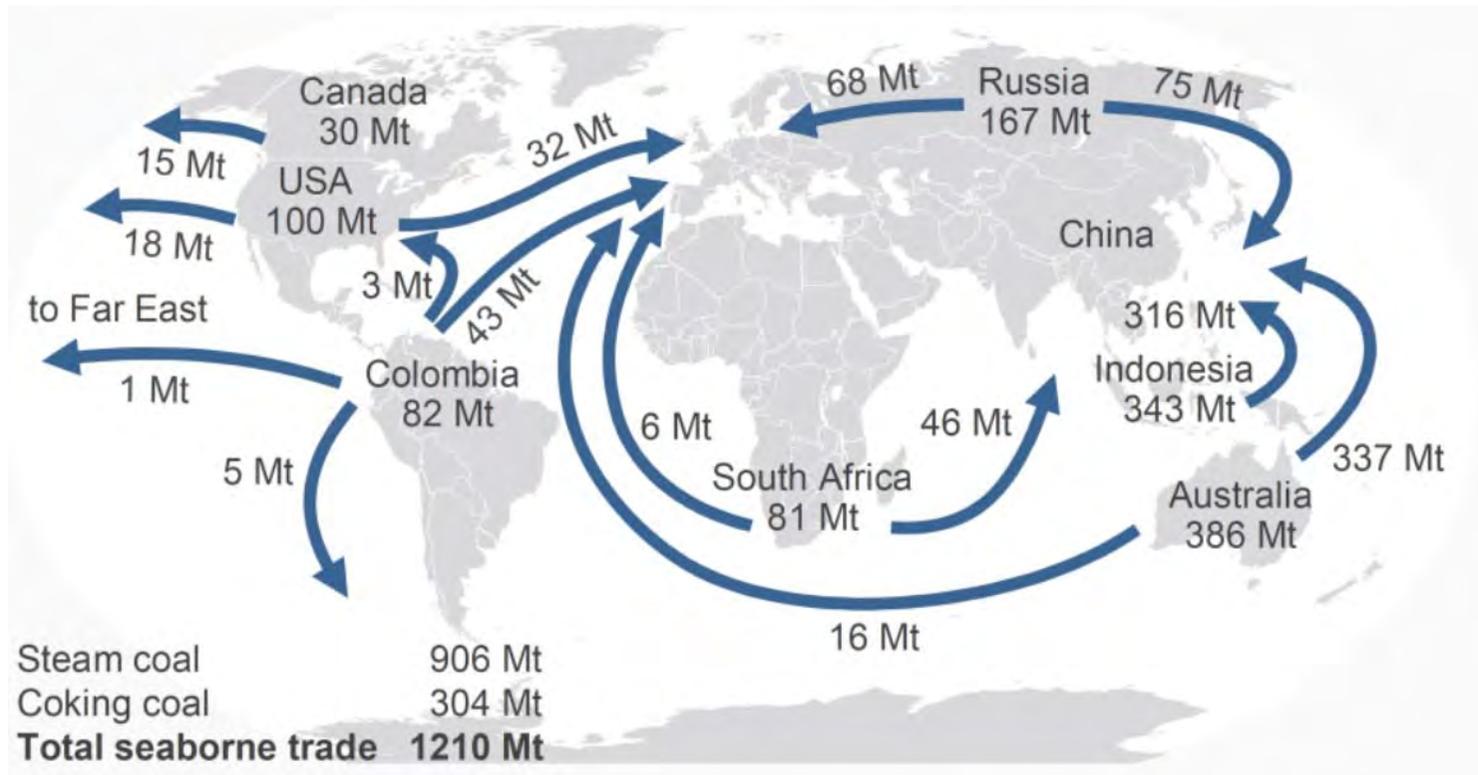
* Carbon sequestered in structural timber

~ Carbon sequestered in concrete (uncertain)

Source: Beyond Zero Emissions, 2017



World traded coal flows in 2018



Total seaborne trade in 2016: 1104 Mt

Source EURACOAL: Total Coal Trade (Source VDKI 2019)
<https://euracoal.eu/coal/international-coal-trade/>

+ Global Trade changes

2010

- More than **3.5 mts** of CCPs traded globally or cross border
- Generated over **USD \$101 million**
- 6 countries reporting trade of CCPs, only 4 countries were able to determine value attributable for these transactions
- The long-term trend in trade and value are both increasing

2016+

- More than **6 mts** of CCPs traded globally or cross border (figure still seen a minimum!)
- Generated over **USD \$123.9 million**
- 8 countries reporting trade of CCPs across 9 different HS Codes
- The long-term trend in trade expected to further increase

+ International Standards



Chemical properties of siliceous fly ash in international standards

COUNTRY	Europe	USA	India	Australia	Australia	Australia	China	Russia	Japan
Standard	EN 450-1	ASTM C 618	IS 3812-1	AS/NZS 3582.1			GB/T 1597	GOST 25818	JIS 6201
Classification	siliceous	Class F	siliceous	spec.grade	grade1	grade2	Class F	siliceous	
				fine	medium	coarse			
Loss on ignition, max, %	<5; <7; <9 (cat A;B;C)	6.0 (12.0)	5.0 (7.0 ²)	3	4	6	≤5; ≤8 ¹ ; ≤10 (class I; II; III)	<10;<15 (type I;II) ¹	5
CaO free, max, %	1.5 (>1.5)						≤ 1.0		
SO ₃ , max, %	3.0	5.0	3.0 (5.0 ²)	3	3	3	≤ 3.0 (≤ 3.5 ¹)	<3;<5 (type I;II)	
Cl, max, %	0.1		0.05						
CaO, %		18		<10 (AS) / < 25 (NZS)					
Reactive CaO, max, %	10		< 10					< 10	
Reactive SiO ₂ , min, %	25		20						
SiO ₂ , min %			35						45
SiO ₂ + Al ₂ O ₃ + Fe ₂ O ₃ min, %	70	70	70	70 (AS) / 60 (NZS)			≥ 70	≥ 70	
Na ₂ O equ., max, %	5		1.5					< 3	
MgO, max, %	4		5					< 5	
P ₂ O ₅ sol., max, mg/kg	100								
P ₂ O ₅ %	5								
Moisture %		3.0	2.0	0.5	0.5	0.5	≤ 1.0	≤ 1.0	1

+ Summay/Outlook



- Coal still plays an important role in worldwide energy production
- Further growth expected in South-East Asia and India; stabilisation in China, Japan and Korea; reduction in US, EU and Australia
- Resulting CCPs are used as raw and construction materials. CCPs on stock to be considered as resource
- CCPs contribute to Circular Economy and Sustainability of construction materials and constructions.
- Due to existing markets more transport of ash is expected. Comparable standards exist.



**Global Aspects on
Coal Combustion Products**

**Coal Combustion Products
are global!**

Thank you for your attention.

<http://www.wwccpn.com>