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Coal and Steam Power Plants

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- World Key Coal Players
- World Market and Price Mechanism
- Coal Fuel Cycle
- Coal Mining
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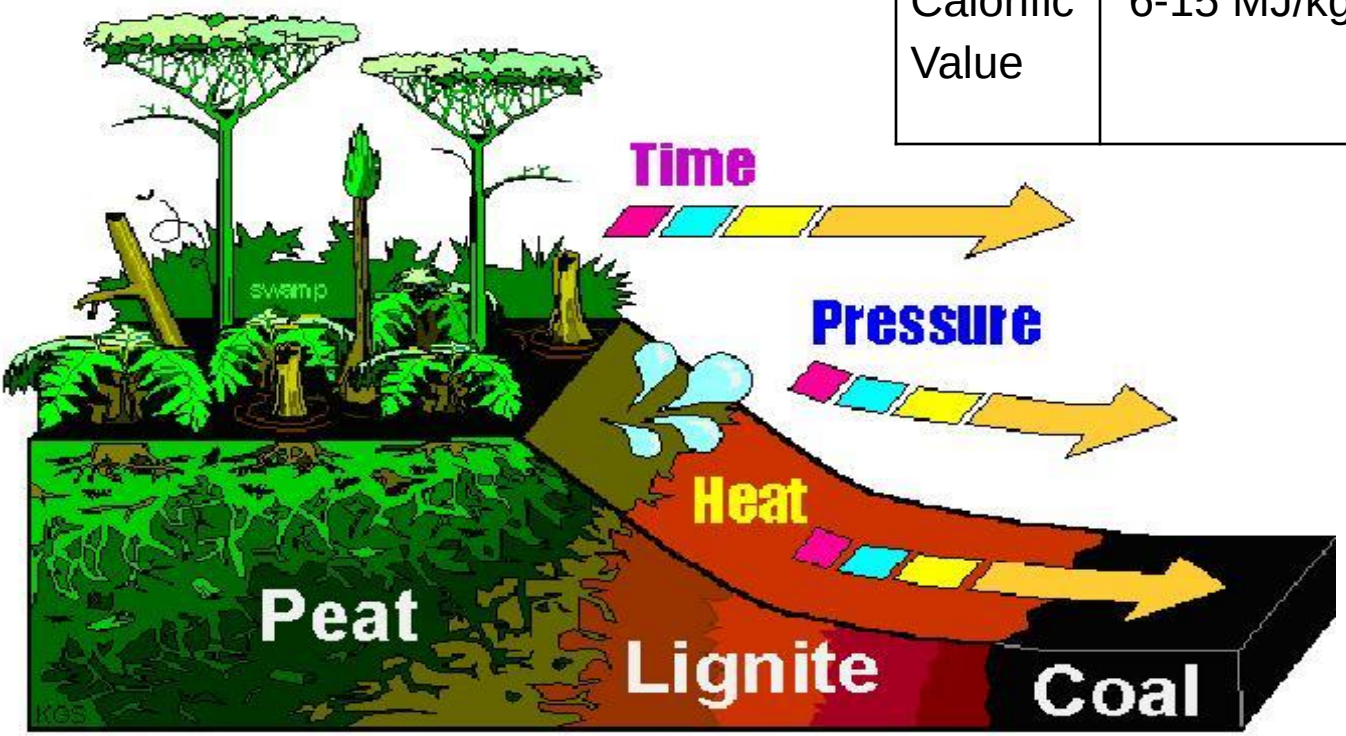
What is coal

Caustobioliths of the coal series					
	Peat	**Lignite**	**Brown coal**	**Bituminous coal**	**Anthracite**
Water Content	>75 %	19-33 %	10-19 %	2-10 %	<2 %
Carbon Content	50-60 %	<65 %	65-69 %	69-92 %	86-98 %
Calorific Value	6-15 MJ/kg	<17 MJ/kg	17-24 MJ/kg	24-33 MJ/kg	>33 MJ/kg



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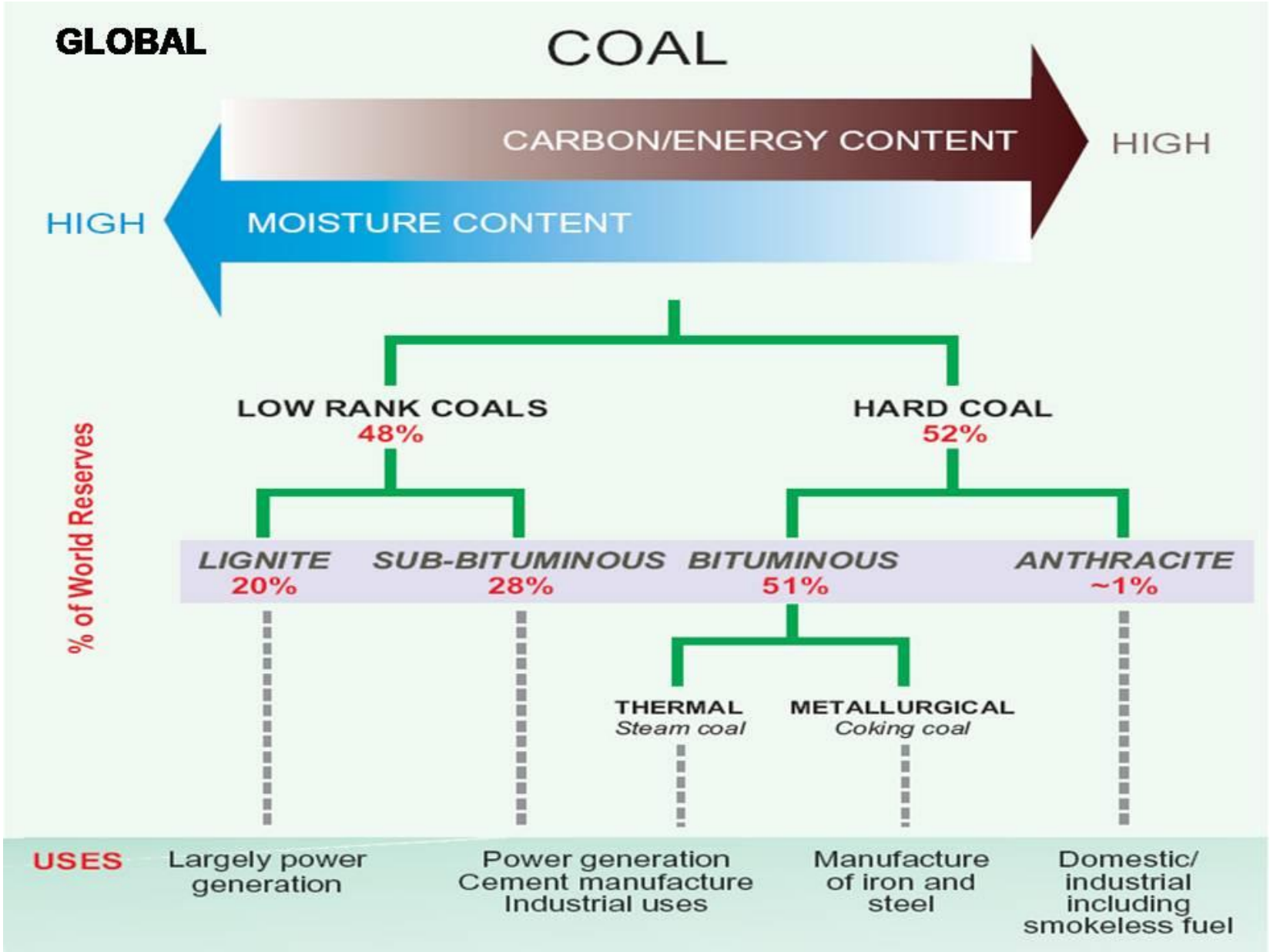
What is coal



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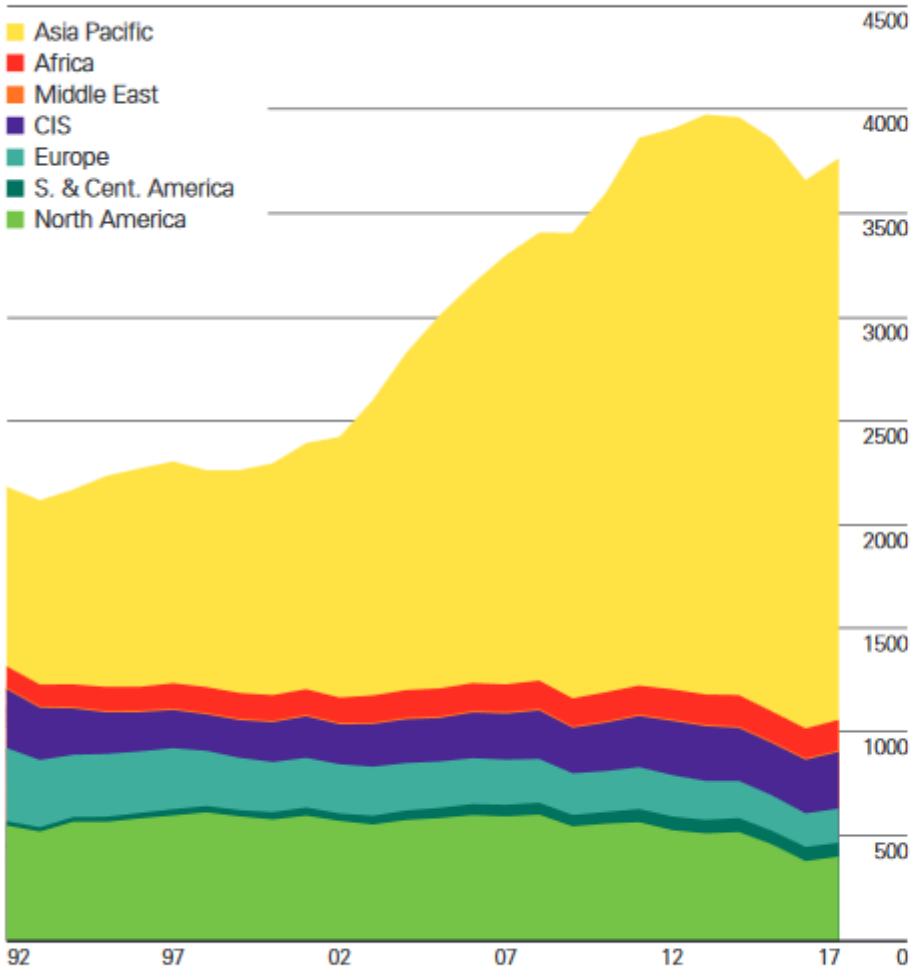
World Coal

- Coal provides 27.2% of global primary energy needs (2018) and generates 38% of the world‘s electricity (2018).
- Coal is the fastest growing form of energy outside renewables.
- Total Global Coal Production in 2018 was 8,013 Mt. (Czech Republic 44 Mt/2018)
- Total World Proved Reserves in 2018 were 1,054,782 Mt

Data from BP Statistical Review of World Energy 2019

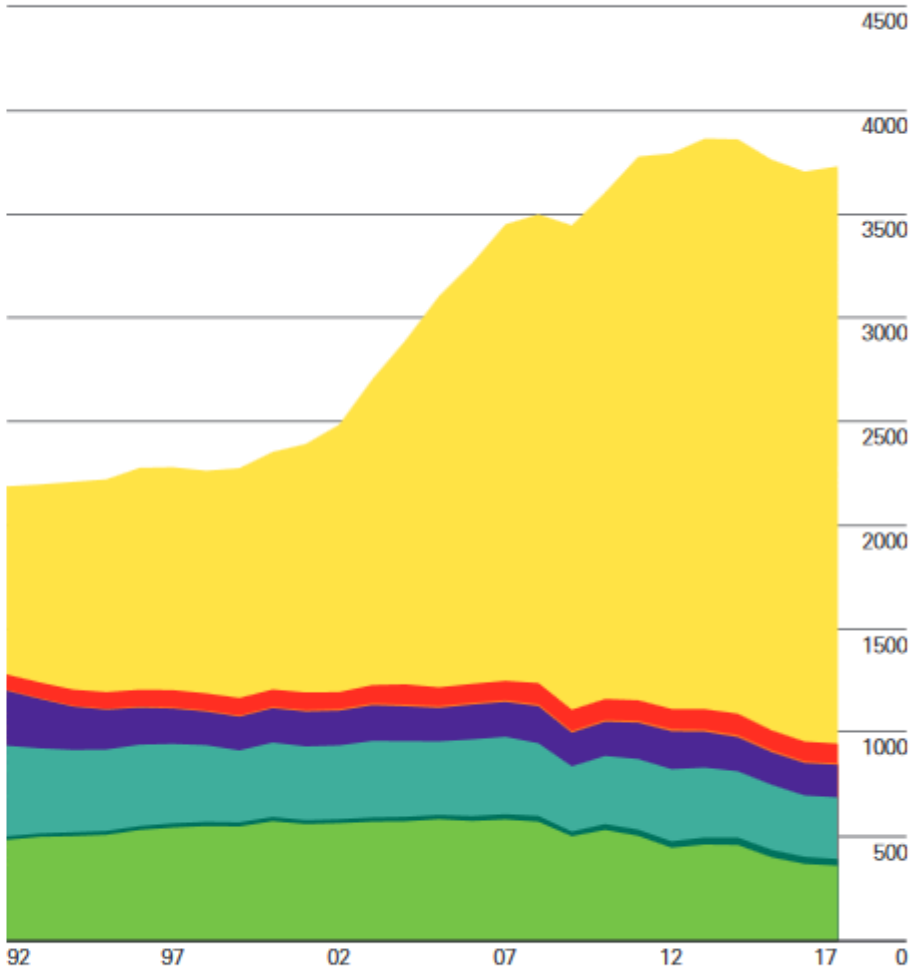
Coal: Production by region

Million tonnes oil equivalent



Coal: Consumption by region

Million tonnes oil equivalent



World coal production increased by 105 million tonnes of oil equivalent or 3.2%, the fastest rate of growth since 2011. Production rose by 56 mtoe in China and 23 mtoe in the US. Global coal consumption grew by 25 mtoe, or 1%, the first growth since 2013. Growth was driven largely by India (18 mtoe), with China consumption also up slightly (4 mtoe) following three successive annual declines during 2014-2016. OECD demand fell for the fourth year in a row (-4 mtoe).

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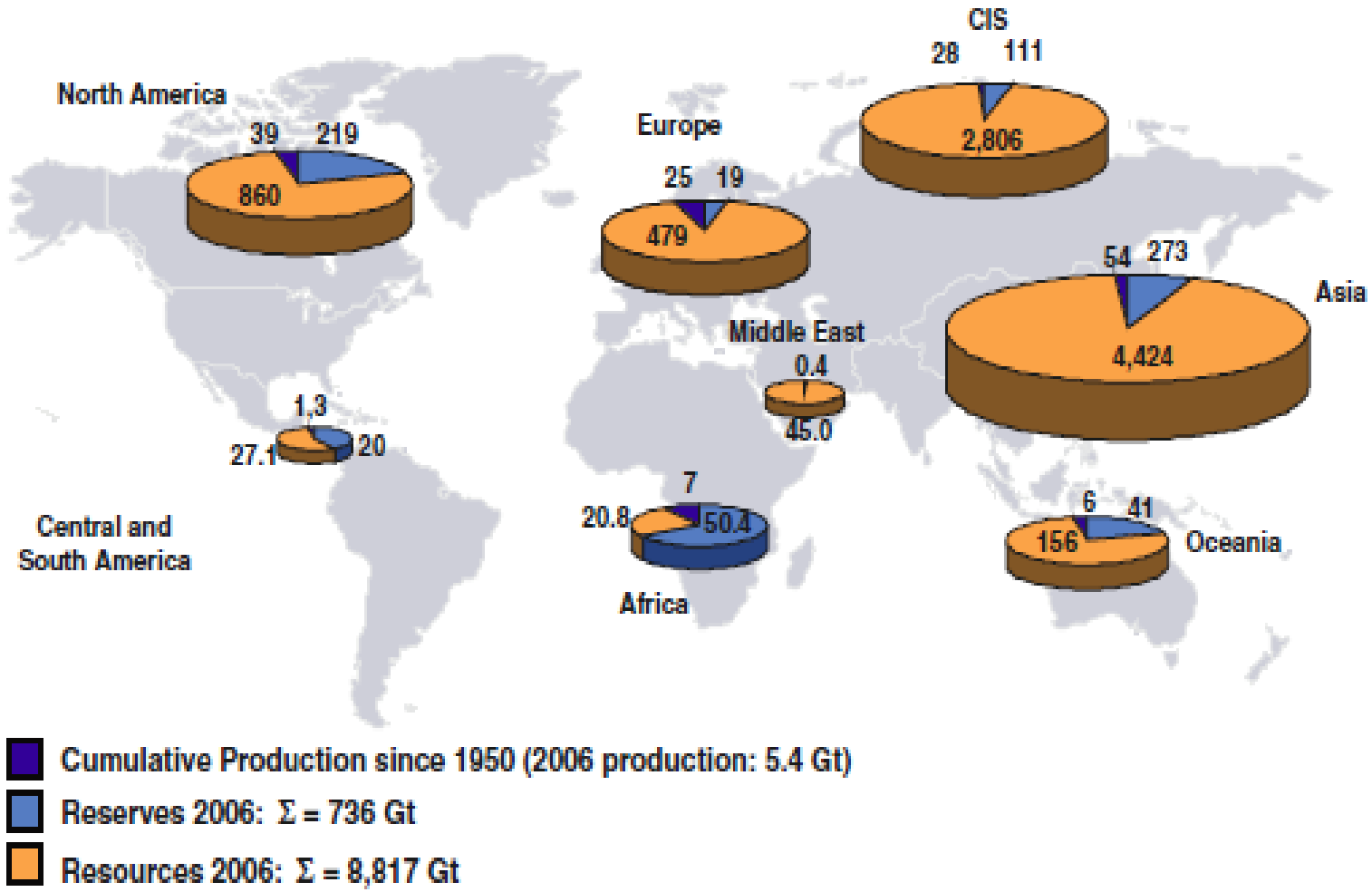
World Coal Reserves



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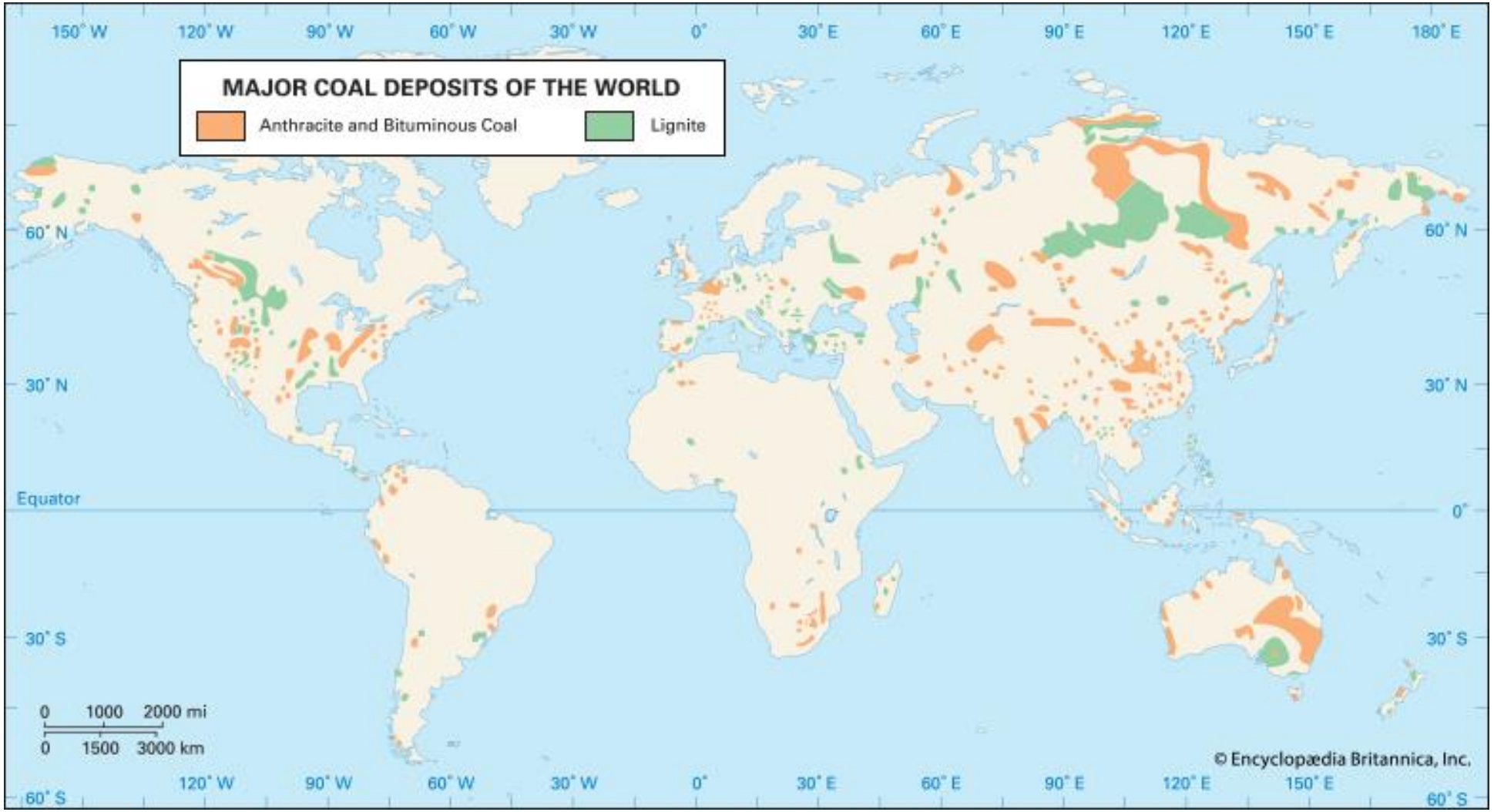
World Coal Reserves



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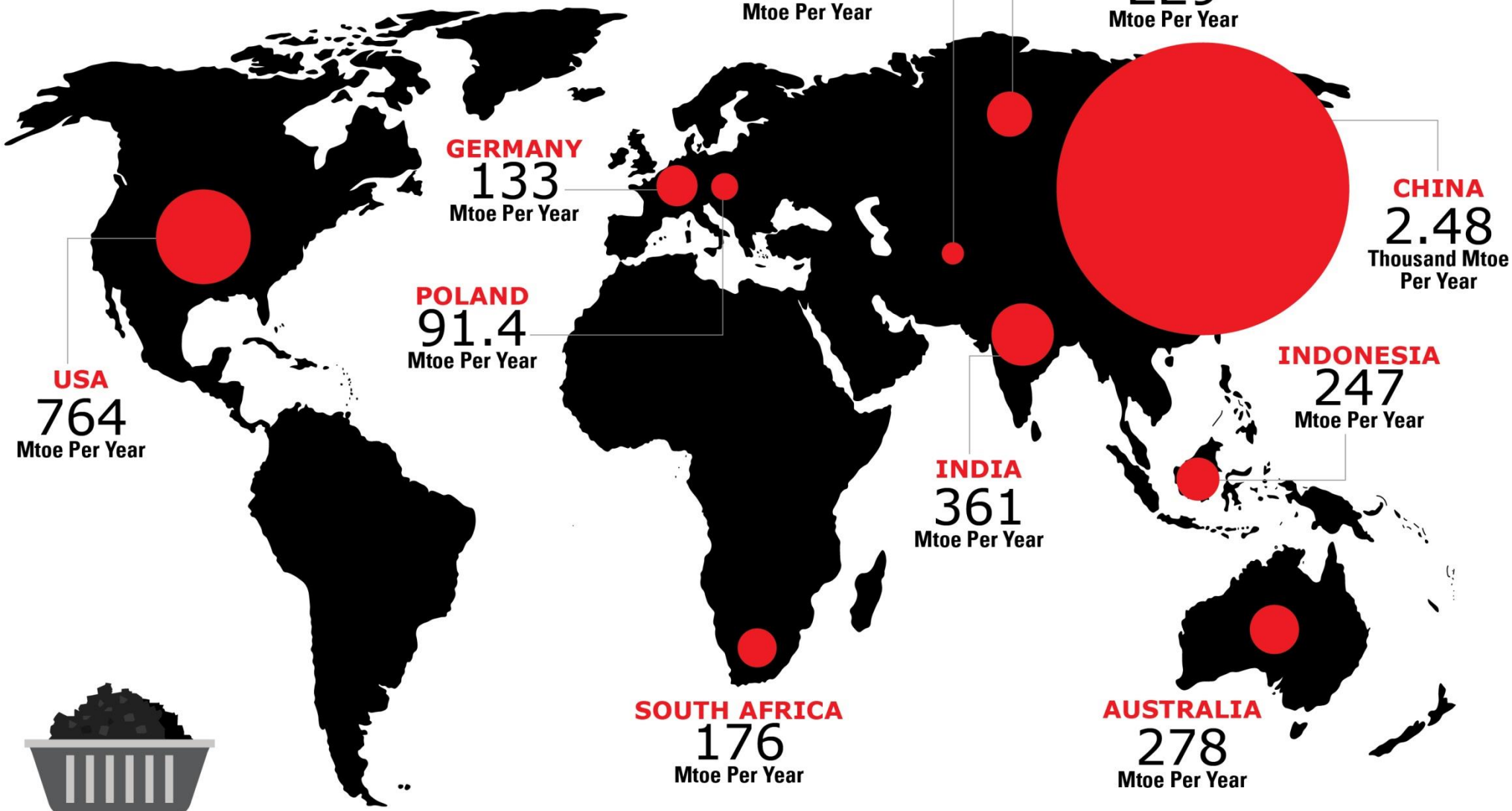
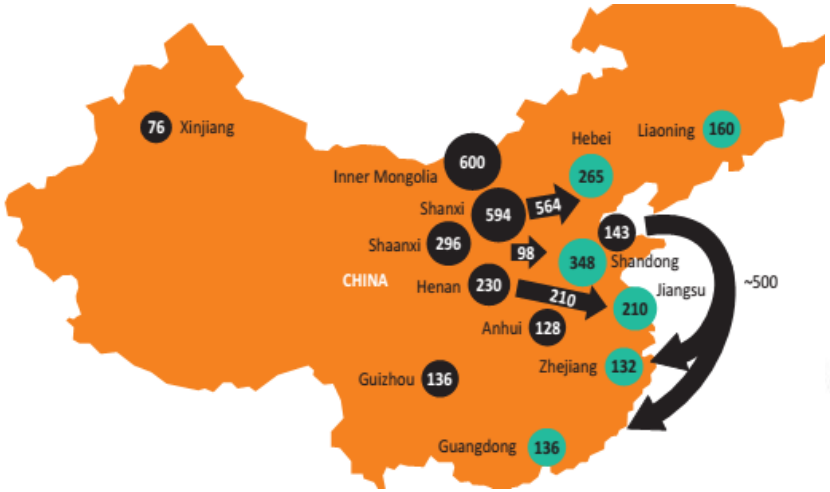
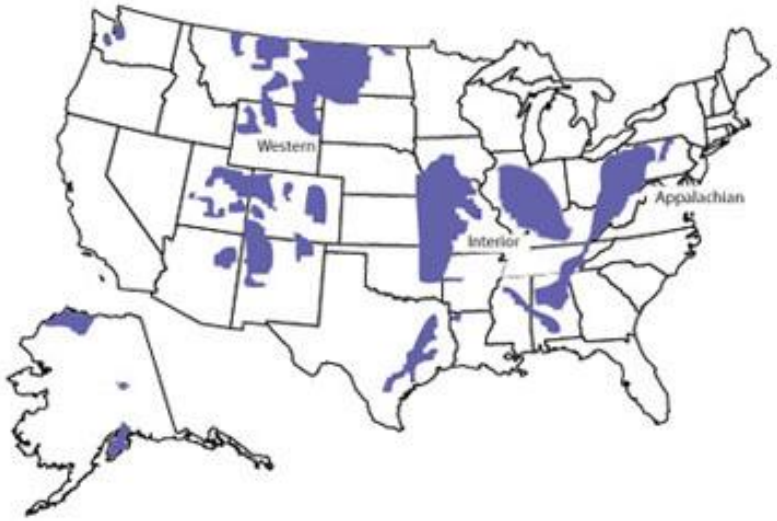
TOP COAL PRODUCING COUNTRIES

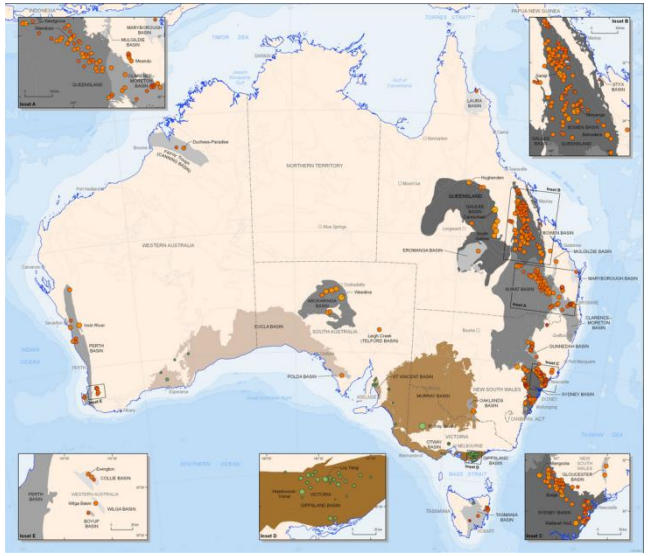
Coal is the world's largest source of electricity, accounting for around 40% of global electricity production. And China firmly holds the first place among coal producing countries.

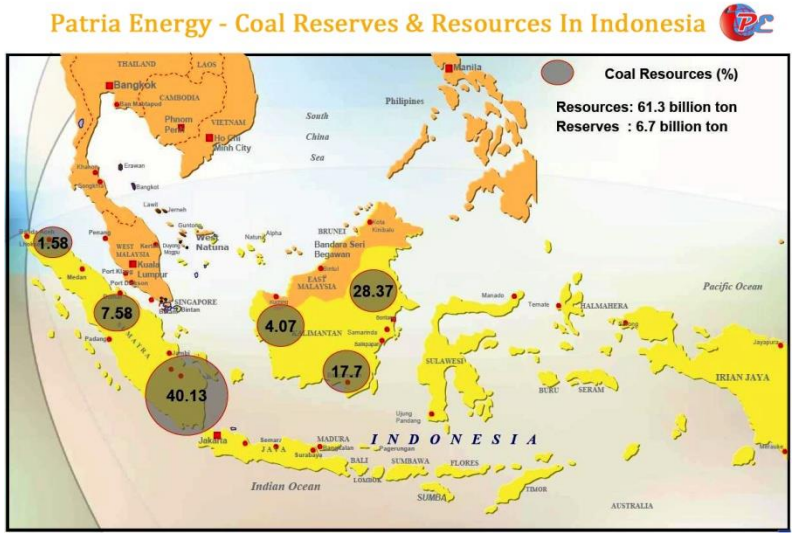


World Key Coal Producers









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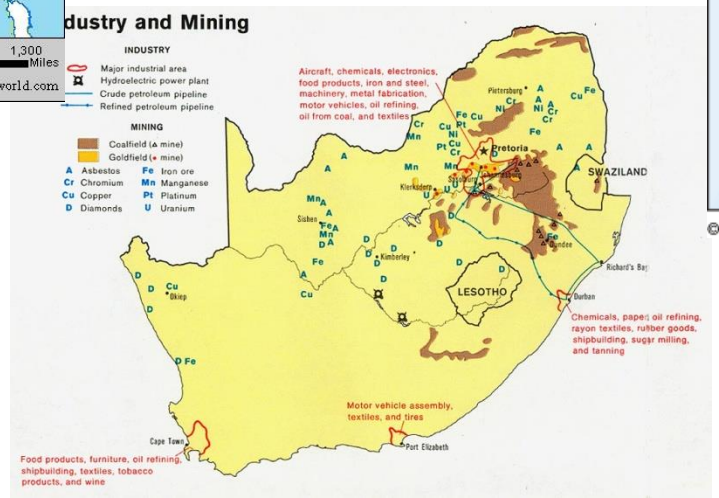
World Key Coal Producers



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Commodity Specifics

- Main use of coal: production of heat and electricity by combustion; production of metallurgical coke by carbonization of coal
- 1 kWh of electricity = combustion of 0.00049 tons of coal on average
- 1 MWh of elelctricity = 0.49 tons of coal

- 1,000 MW power plant´s 1 hour production = combustion of 490 tons of coal
- 24-hour-production = 11,760 tons
- 1-month-production = 352,800 tons

World Market and Price Mechanism

- Coal is traded all over the world, with coal shipped huge distances by sea to reach markets.

- Ships are commonly used for international transportation, in sizes ranging from:
  - Handysize - 40-45,000 DWT
  - Panamax - about 60-80,000 DWT
  - Capesize vessels - about 80,000 DWT

- Overall international trade in coal reached **1142Mt in 2011**; while this is a significant amount of coal it still only accounts for about **16% of total coal consumed**. Most coal is used in the country in which it is produced.

World Market and Price Mechanism

- Transportation costs account for a large share of the total delivered price of coal, therefore international trade in steam coal is effectively divided into two regional markets

- **the Atlantic market**, made up of importing countries in Western Europe, notably the UK, Germany and Spain.
- **the Pacific market**, which consists of developing and OECD Asian importers, notably Japan, Korea and Chinese Taipei. The Pacific market currently accounts for about 57% of world seaborne steam coal trade.

World Market and Price Mechanism

2018

World hard coal production: 7,058 Mt

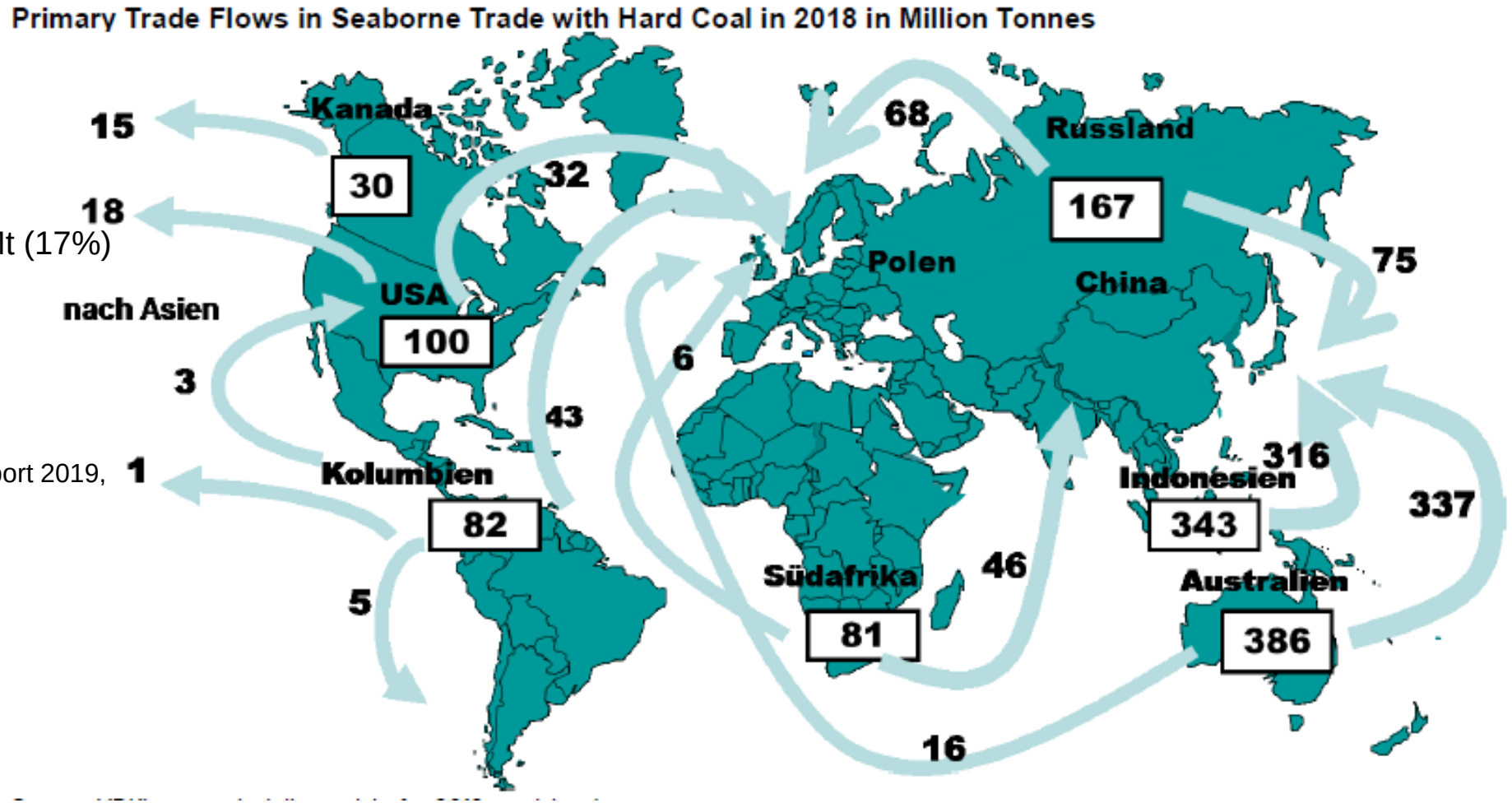
World hard coal trade: 1,344 Mt (19%)

World seaborn hard coal trade: 1,210 Mt (17%)

Seaborne steam coal trade: 906 Mt

Seaborne coking coal trade: 304 Mt

Source: Verein der Kohlenimporteure Annual Report 2019, p. 35-36



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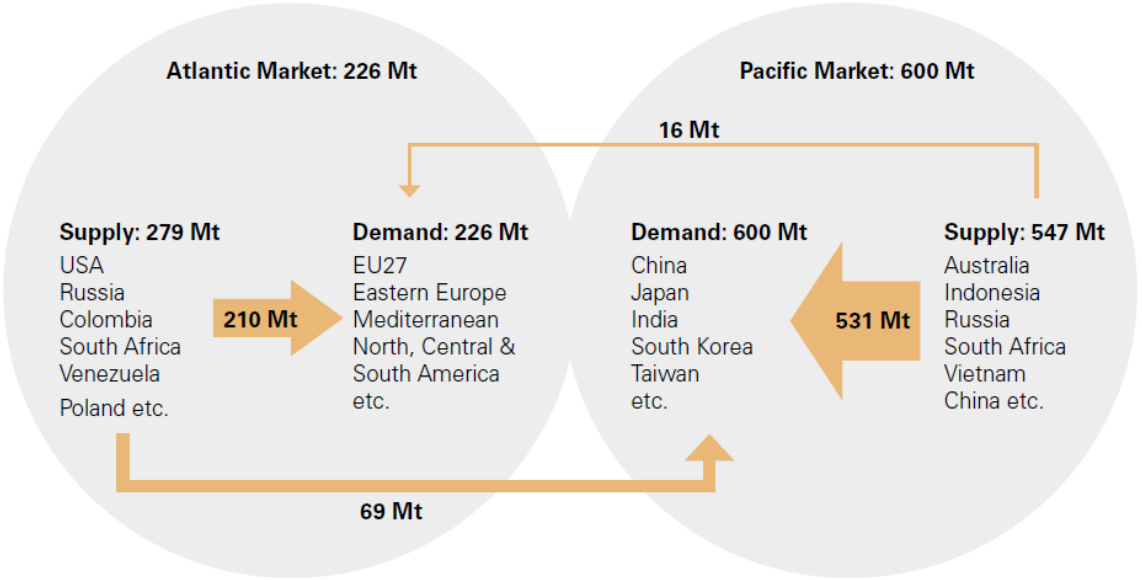
World Market and Price Mechanism

Supply and demand of steam coal in 2015

Atlantic Market: 217 Mt		Pacific Market: 616 Mt	
← 203 Mt ←		→ 561 Mt →	
Importers: 217 Mt	Exporters: 258 Mt	Exporters: 575 Mt	Importers: 616 Mt
EU-28	Colombia	Australia	Japan
Eastern Europe	South Africa	Indonesia	South Korea
Mediterranean	Russia	China	Taiwan
Americas	Poland	Russia	India
	Venezuela	Vietnam	China
	USA	South Africa	
Atlantic ← 14 Mt ← Pacific			
Atlantic → 55 Mt → Pacific			

Major steam coal flows within and between the Atlantic and Pacific markets, 2012



Source: Euracoal

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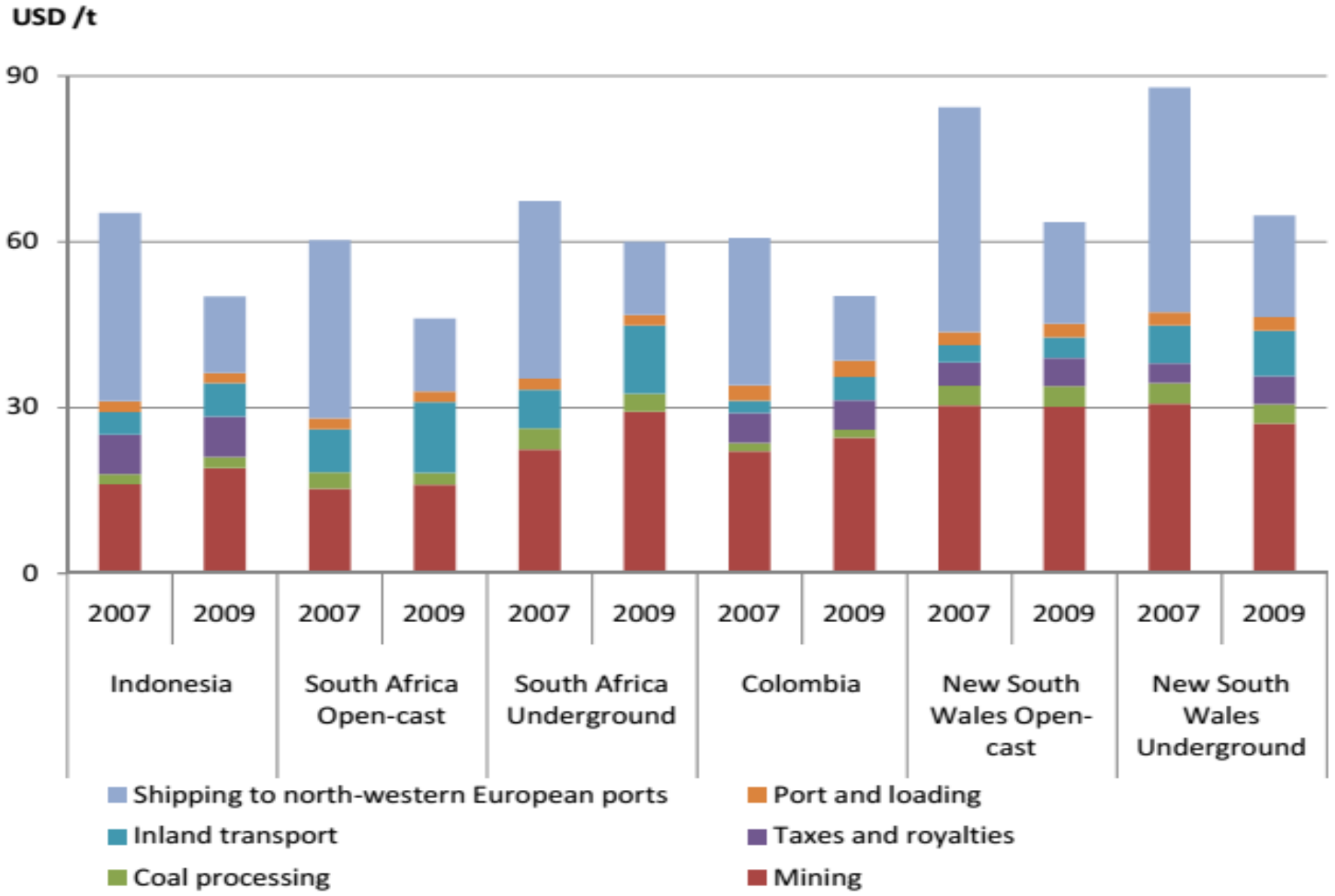
World Market and Price Mechanism

- The price of coal is influenced by:
  - **Supply** (production capacity; technology; inland transport capacity; naval transport capacity) and **Demand** (structure and condition of economy; regulations – environmental, price; competition of resources)
  - **Price of Oil** (production costs – fuel in mining operations; commodity substitutes)
  - **Cost of Equipment**
  - **Price of Naval Transportation**
  - **Exchange Rates**
  - **Speculations**

Figure 21 Breakdown of coal supply chain components for major coal mining regions (CIF north-western Europe)



Source: IEA Clean Coal Centre analysis based on data from Marston Associates, McCloskey (2011), IEA Analysis.

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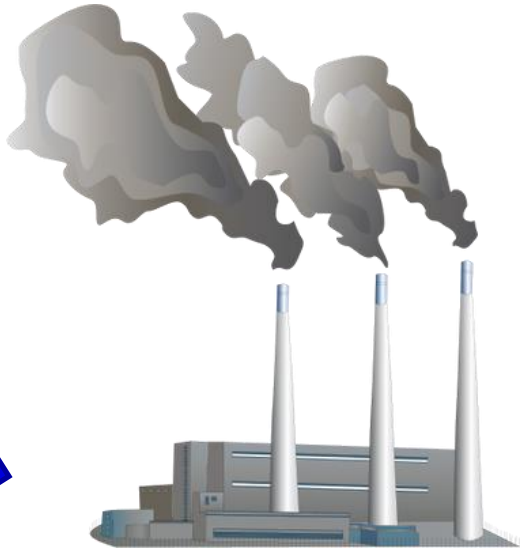
Coal Fuel Cycle

Mining

Processing



Combustion (use)

Electricity and heat (product)

Coal ash and CO_2 emissions

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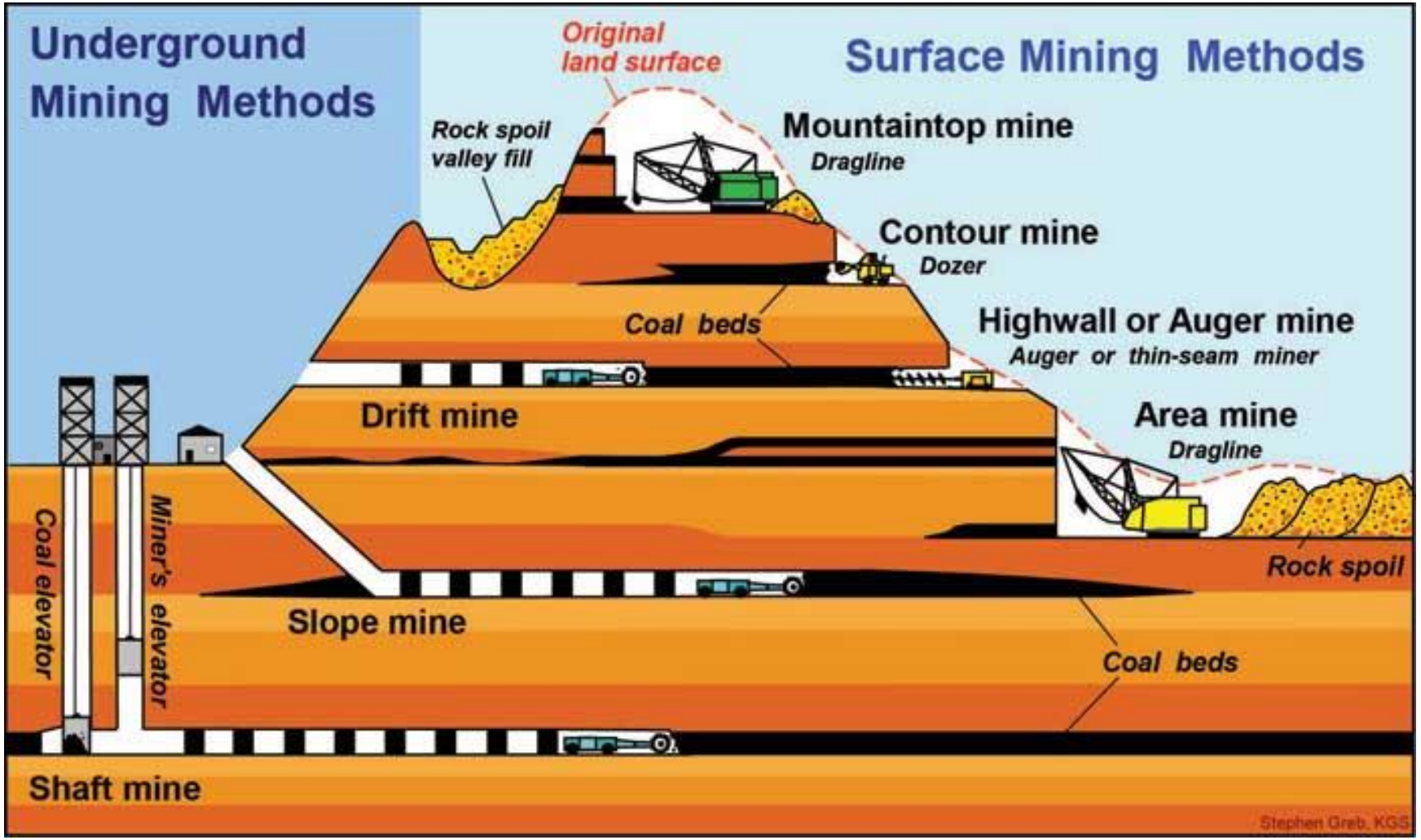
Coal Mining



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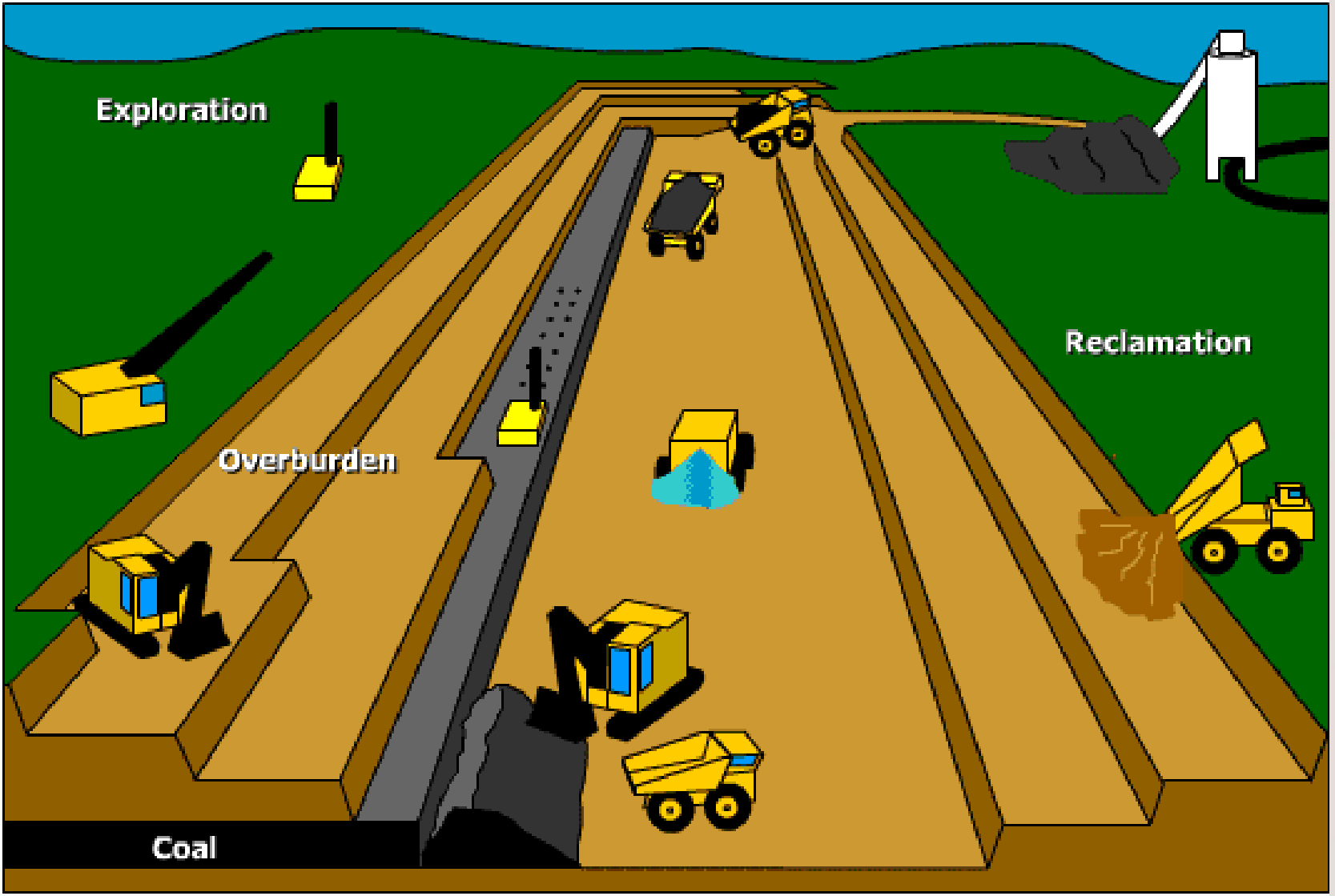
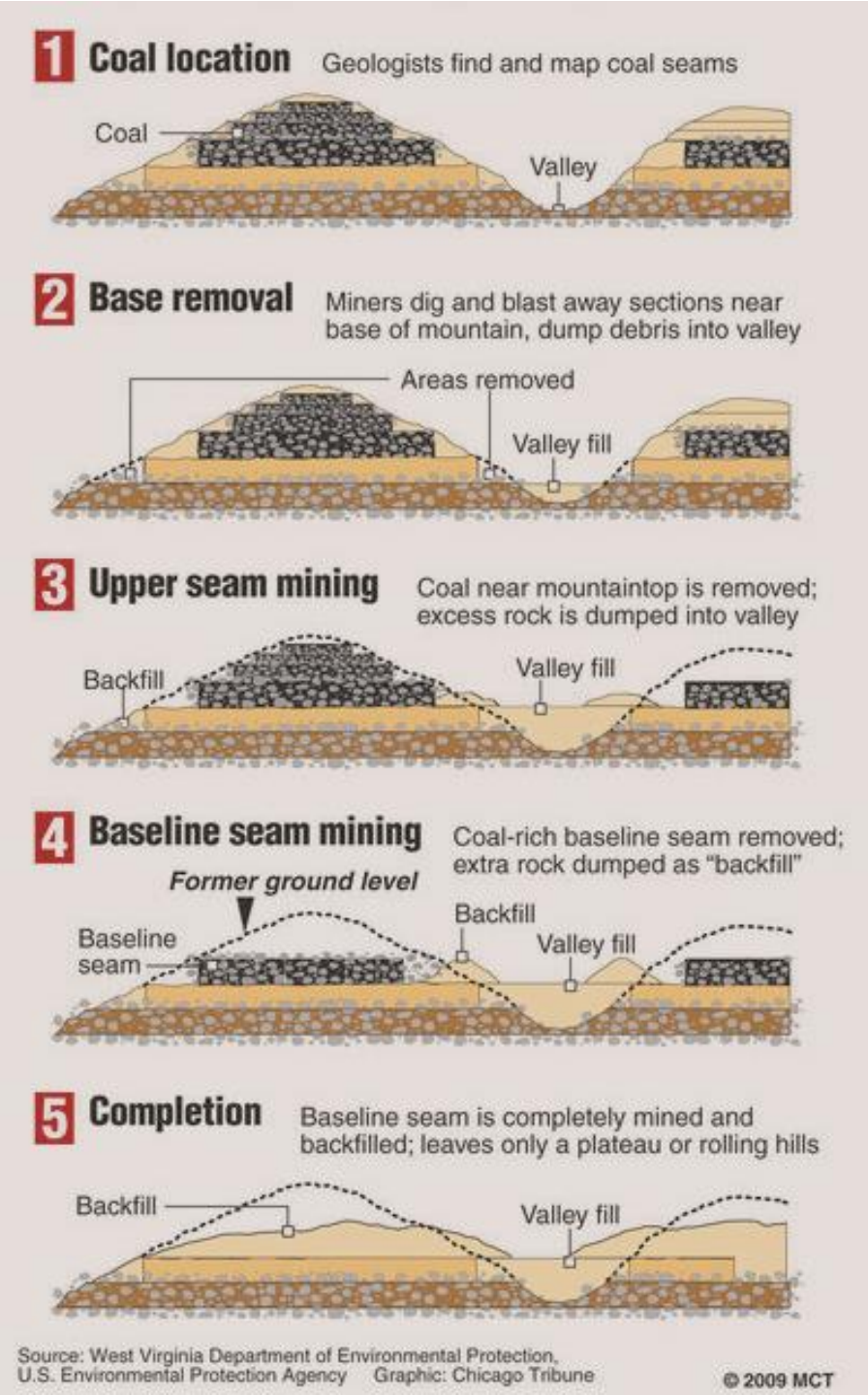
Coal Mining


Exploration
Overburden
Reclamation
Coal


1 Coal location
Geologists find and map coal seams
Coal
Valley
2 Base removal
Miners dig and blast away sections near base of mountain, dump debris into valley
Areas removed
Valley fill
3 Upper seam mining
Coal near mountaintop is removed; excess rock is dumped into valley
Backfill
Valley fill
4 Baseline seam mining
Coal-rich baseline seam removed; extra rock dumped as "backfill"
Former ground level
Baseline seam
Backfill
Valley fill
5 Completion
Baseline seam is completely mined and backfilled; leaves only a plateau or rolling hills
Backfill
Valley fill
Source: West Virginia Department of Environmental Protection, U.S. Environmental Protection Agency Graphic: Chicago Tribune
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Coal Mining

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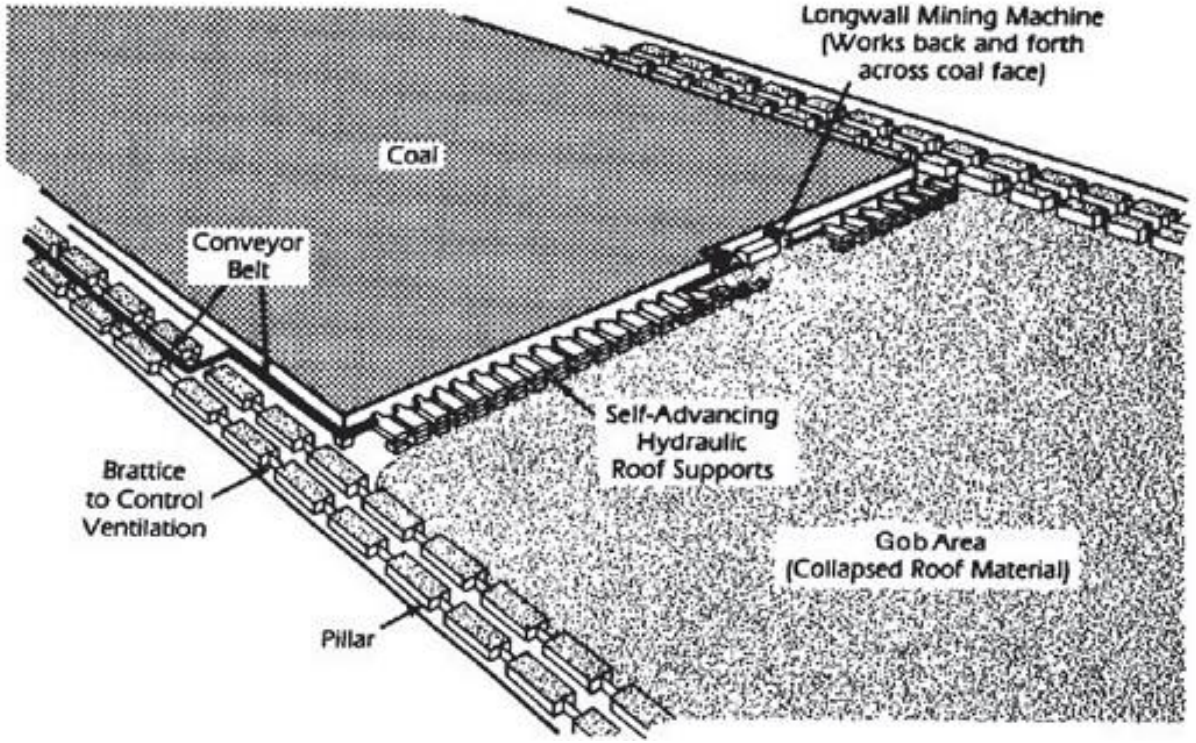
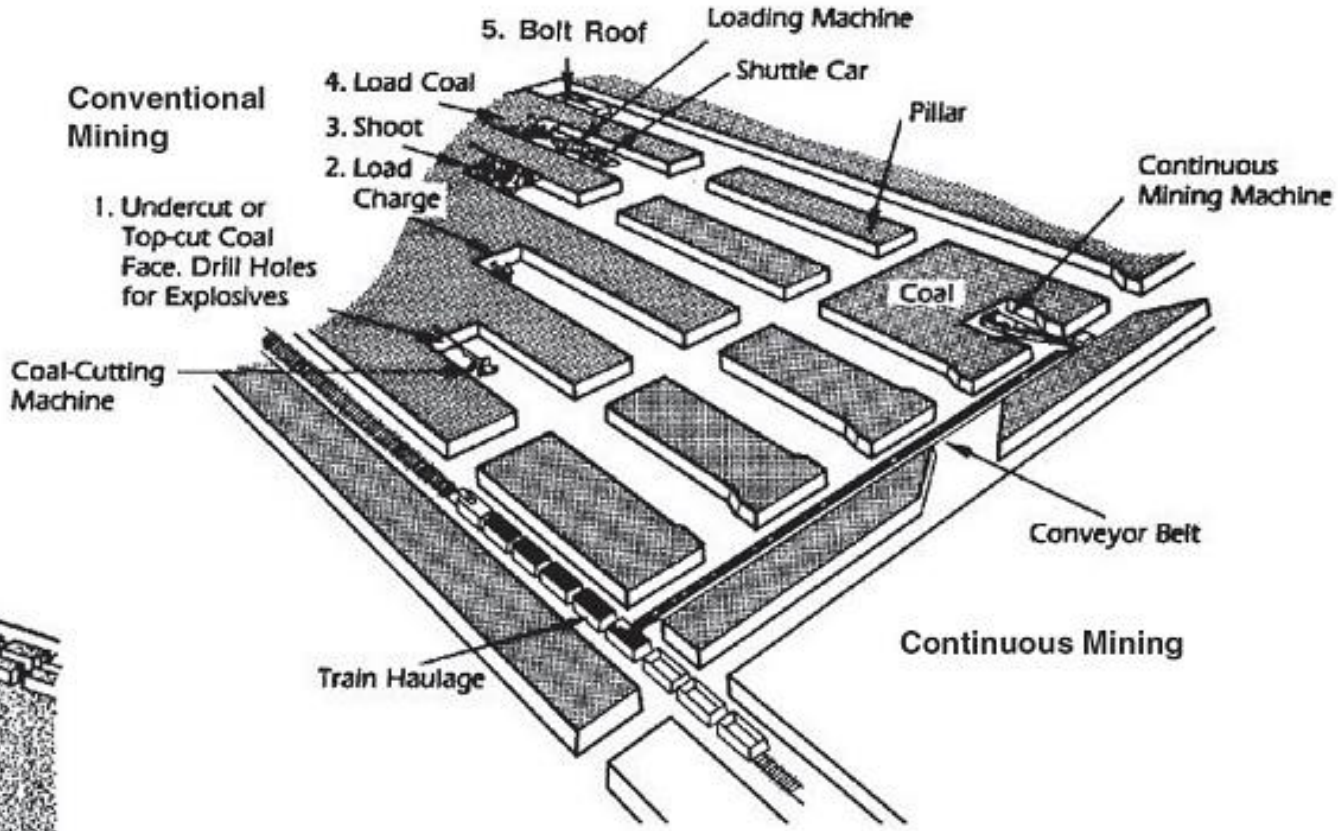
Coal Mining





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Coal Mining

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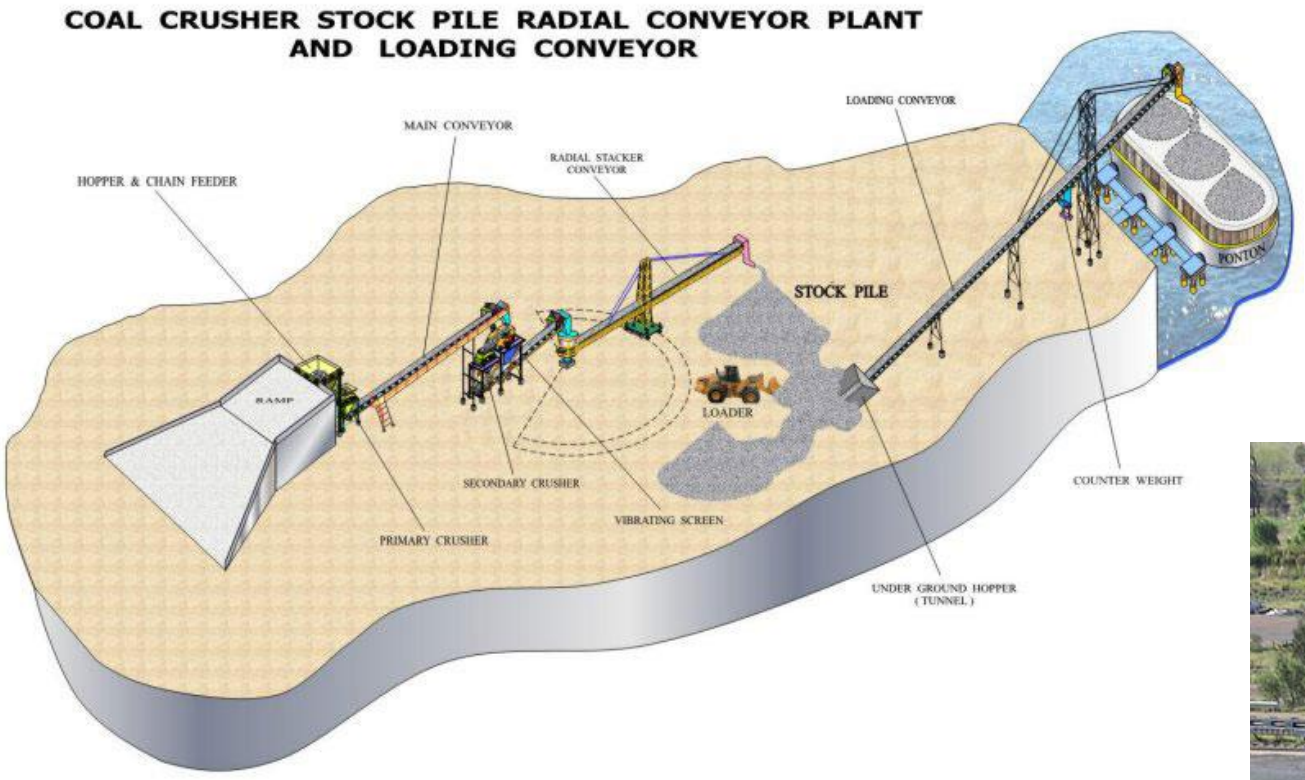
Coal Processing


HENAN HONGXING MINING
MACHINERY CO., LTD

Coal Stocking



Coal Transport

The type of land transport depends on the quantity, distance, cost, flexibility, reliability and environmental consequences. Nowadays, most of the inland coal transports are carried out by:

- freight trains (60-70%)
- river transport (5-15%)
- trucks (10-15%)
- conveyor belts (8-10%)
- or pipe (1%).


5030
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7067


TERMINAL RAILWAYS


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Coal Transport

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Coal Transport

Four basic types of cargo ships:

Capesize (80 000 to 175 000 DWT),

Panamax (65 000 to 80 000 DWT),

Handymax (35 000 to 65 000 DWT)

Handysize (10 000 to 35 000 DWT).

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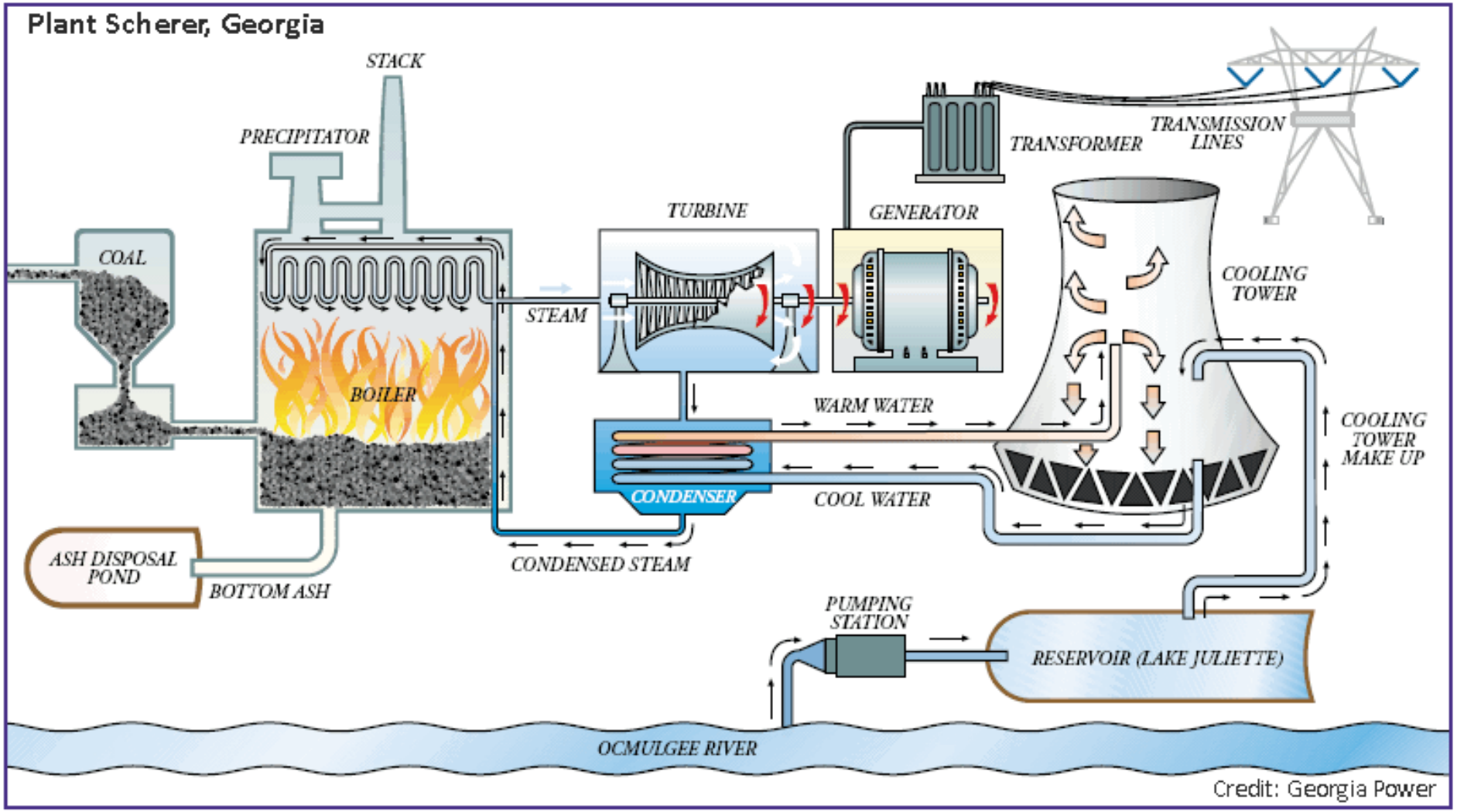
Steam Power Plants



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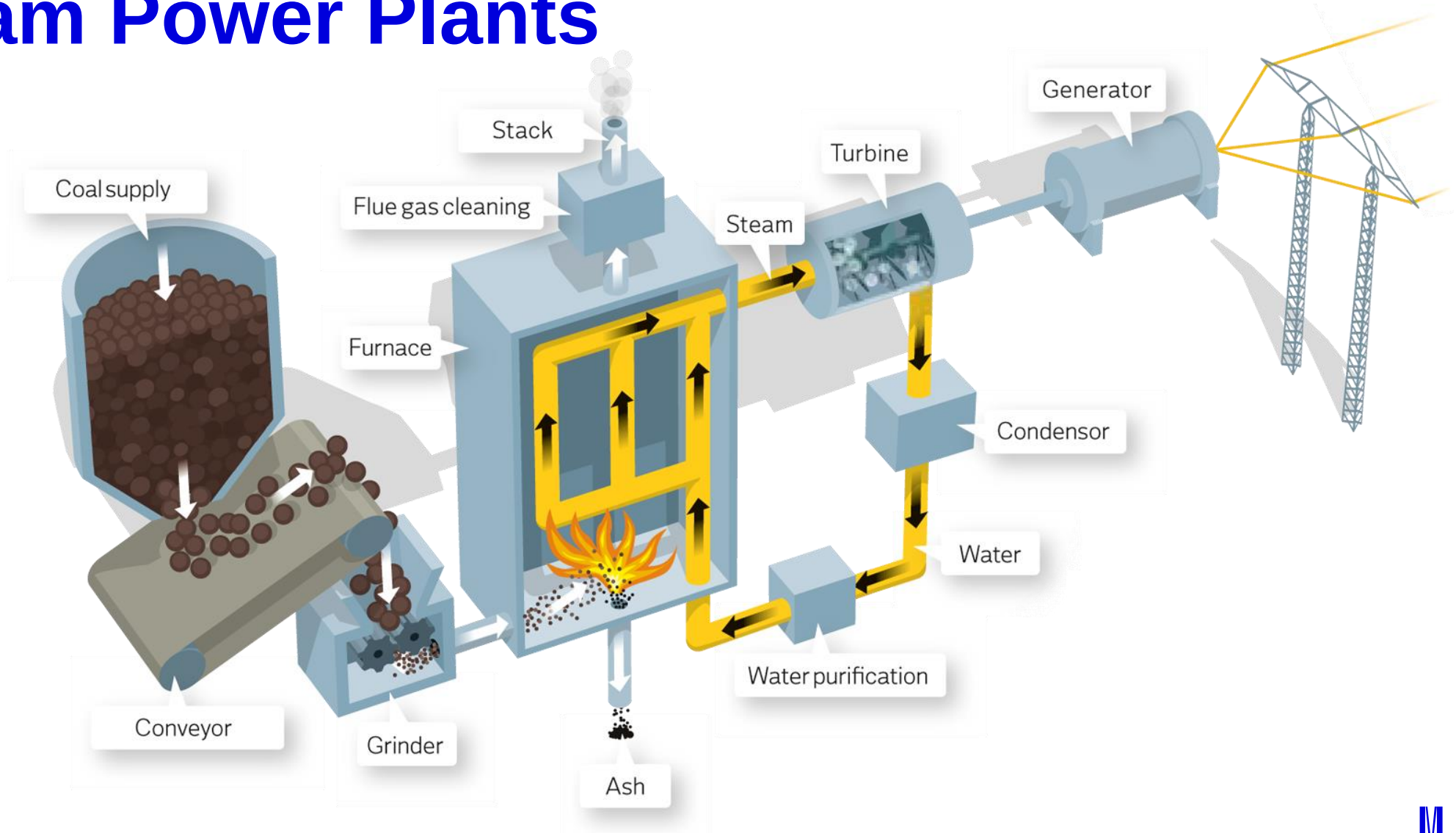
Steam Power Plants



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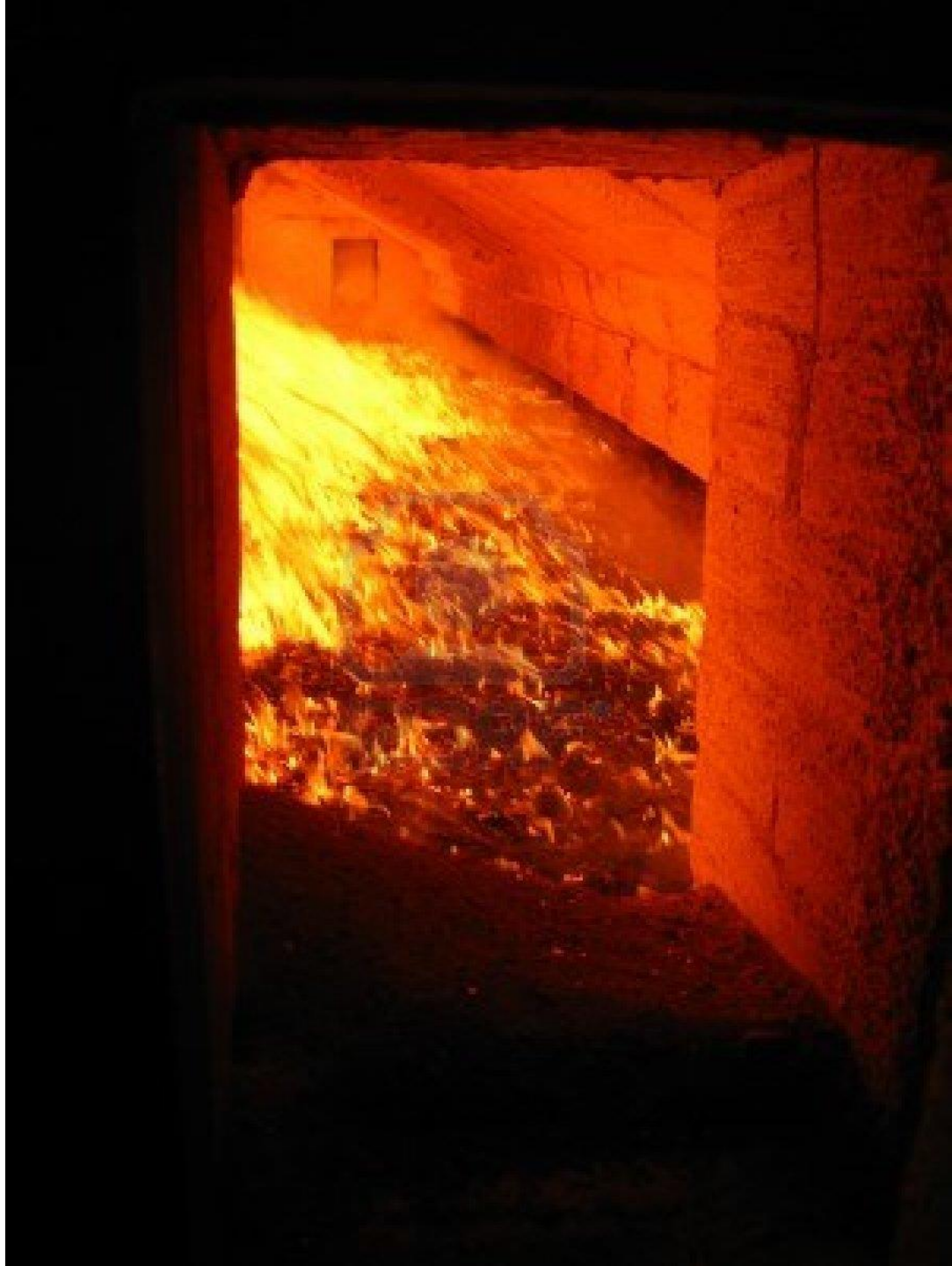
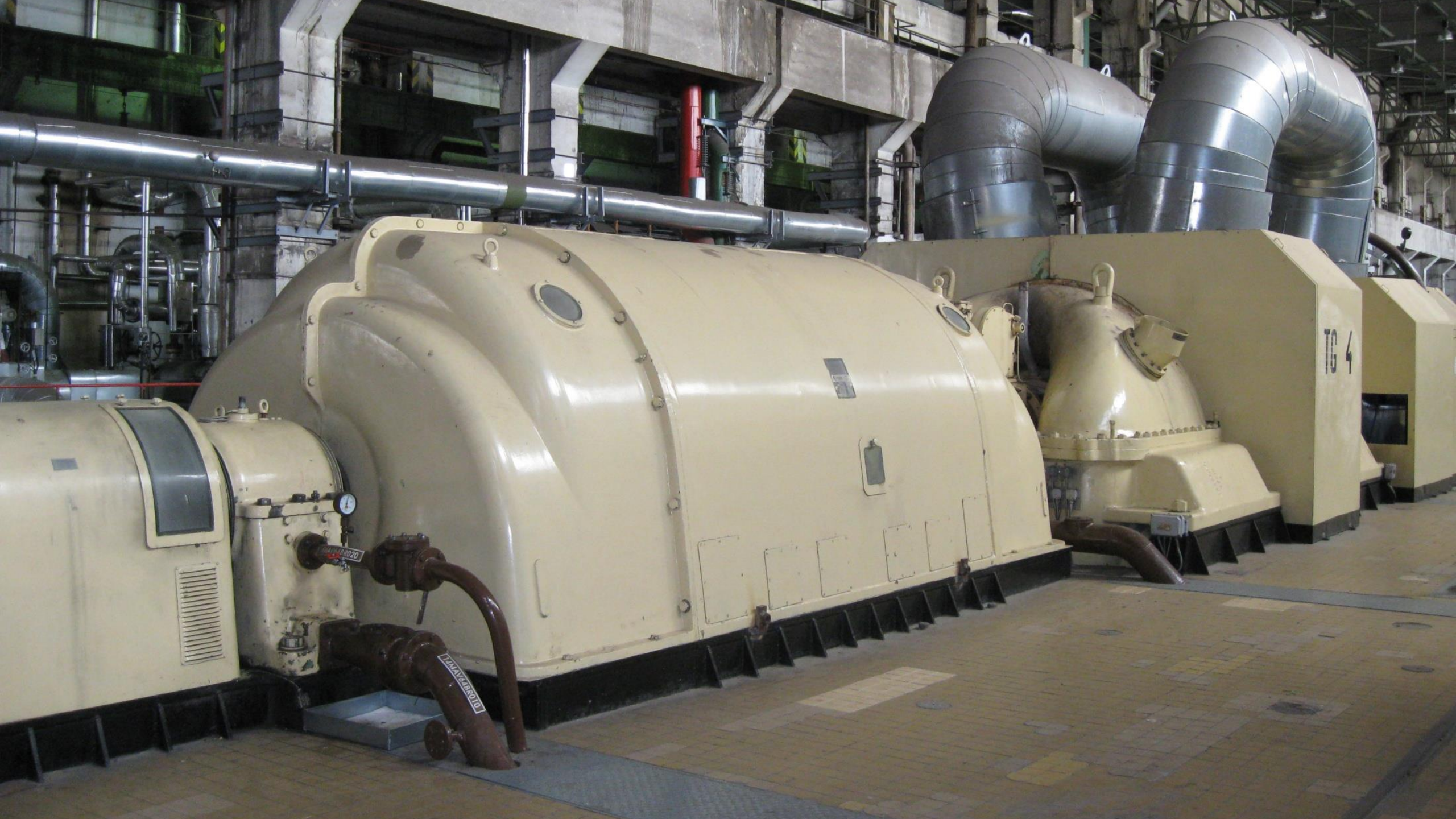
SuperScreener

Steam Power Plants

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Coal ash and CO_2 emissions

So, where is the problem with coal combustion?

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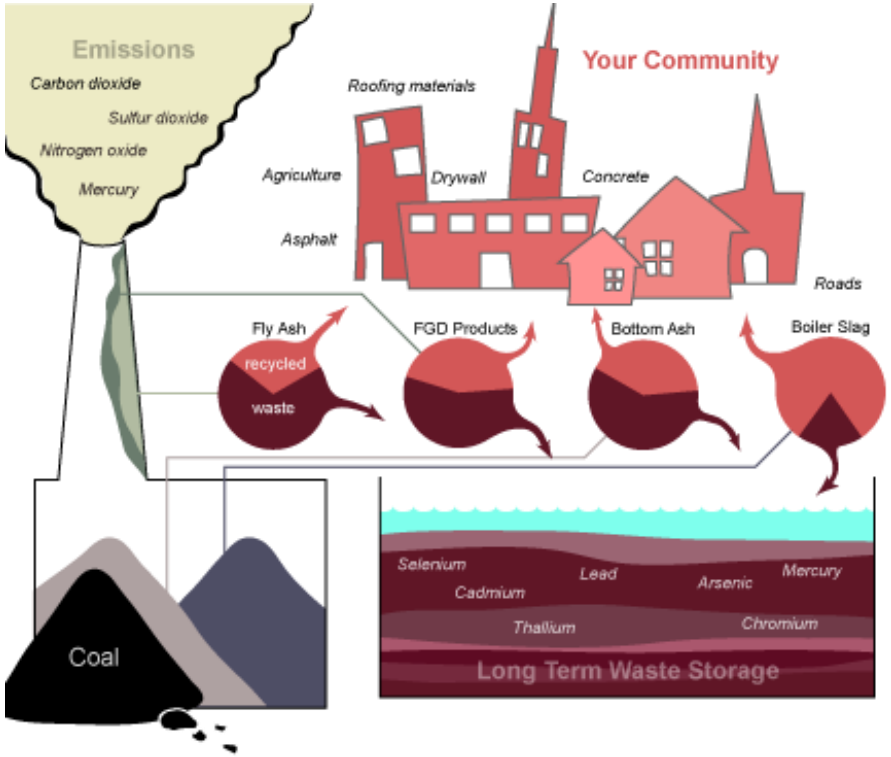
Coal ash and CO_2 emissions

- Burning of coal produces large amounts of waste, especially coal ash and scrubber sludge
- This material is generally uncleanable, unavoidable and only partially remediatable



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Alabama

Coal ash and CO_2 emmissions

- Along with oil, coal combustion produces the largest amounts of carbon dioxide as the key polutant
- 820 kg CO_2 per 1 MWh
- 1,000 MWe power plant operating for one hour produces 820 tons of CO_2

Solutions?

Switch to natural gas

Switch to renewables or nuclear energy

Install CCS

Install IGCC

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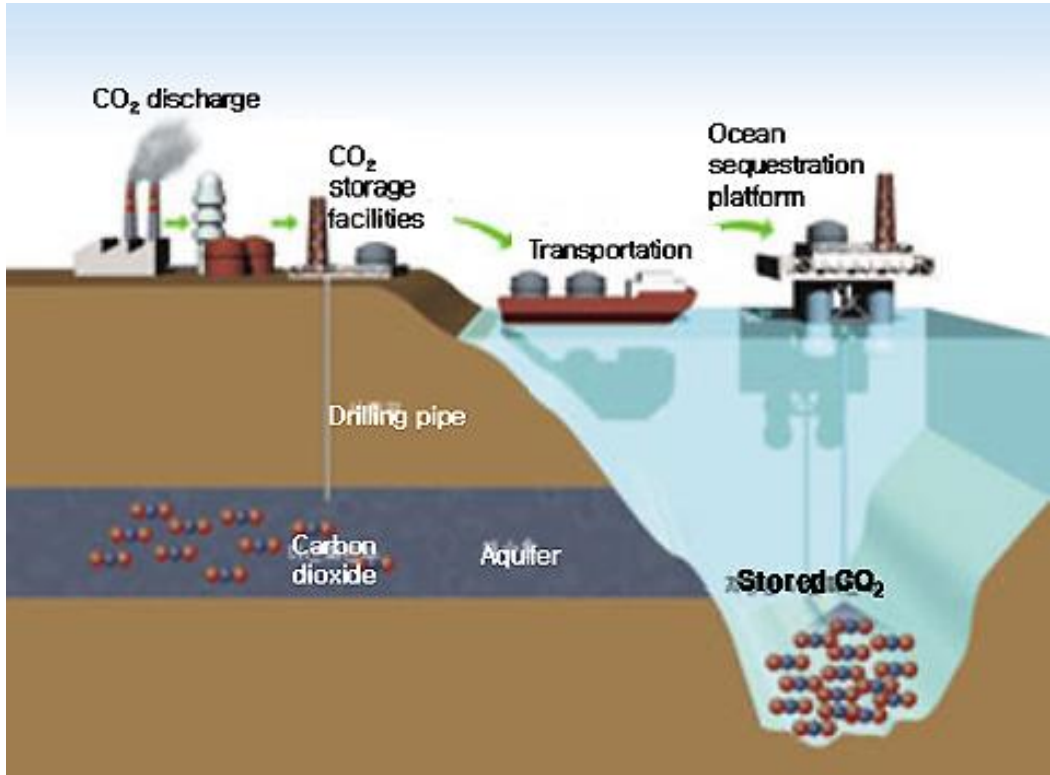
CCS

- Process of capturing waste carbon dioxide (CO2) from large sources, transporting it to a storage site, and depositing it where it will not enter the atmosphere, typically an underground geological formation.

- Up to 70% net efficiency
- Transformation efficiency reduction by 8-14 %
- Fuel consumption raised by 25-40 %
- Plus investment costs



CCS

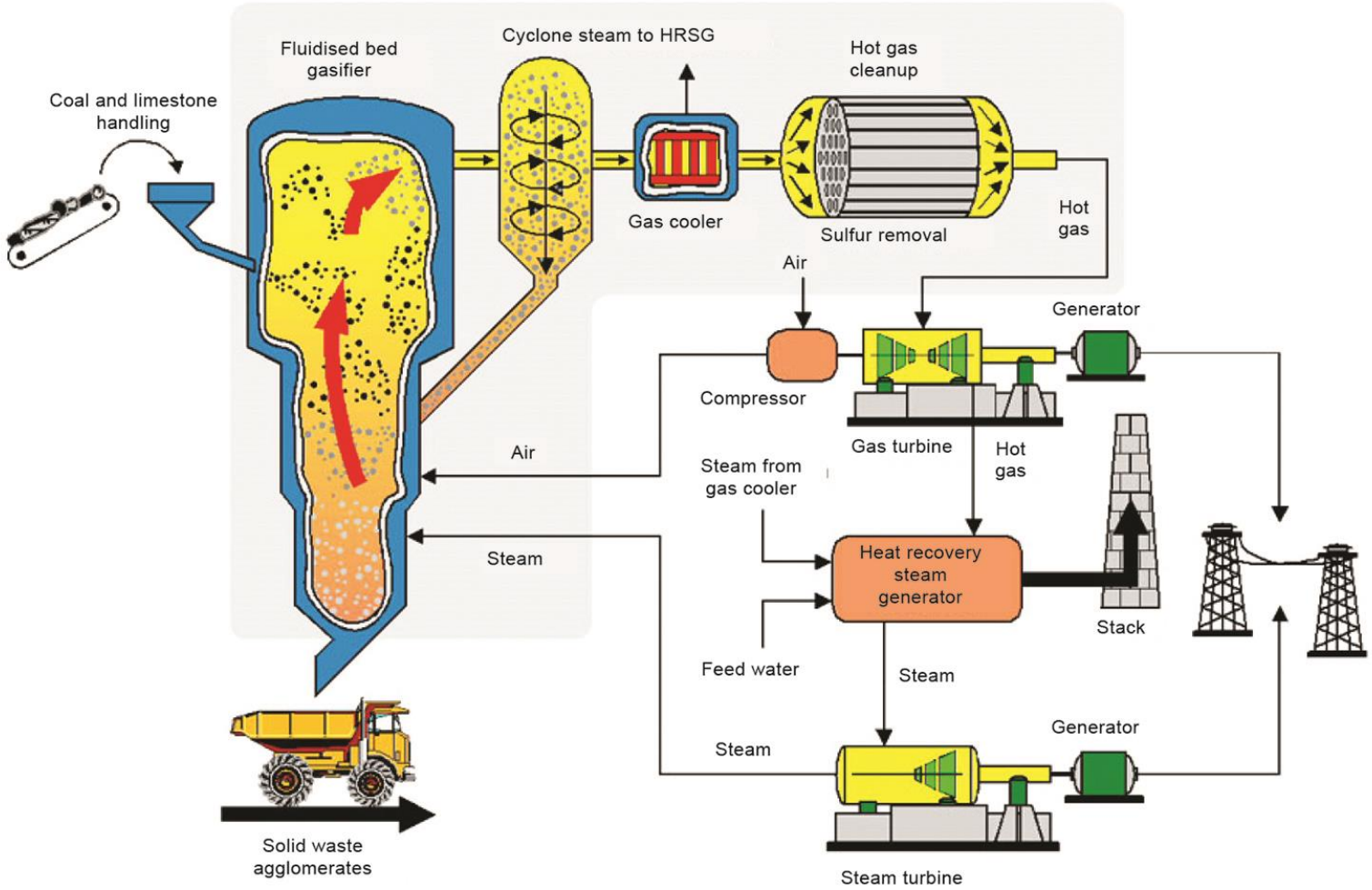
CREDIT (reduction per GJ)	%	DEBIT (increase per GJ)	%
Capture	79	Mining	3.00
		Transport	2.00
		Building of CCS plant	0.50
		Building of infrastructure	0.50
		Transport/injection/releases	1.50
		Monitoring	0.01
		Leakages	1.00
CREDIT	*79*	*DEBIT*	*8.5*
Net CO2 efficiency			**70.5**

Source: http://ccs-info.org/onewebmedia/cumulative_co2.pdf; http://ccs-info.org/climate-efficiency.html

Integrated Gasification Combined Cycle

- Gasifier
- Gas turbine
- Steam generator

- Investment costs



Downstream Industries

- Generaly very environmental unfriendly

- Steal production
- Metallurgical coke
- Chemical industry
- Pharmacy
- Dyes
- etc.

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Summary

- Key energy source in the world
- The greatest pollutant

- Worldwide solution number one if you want cheap and stable electricity production
- Low investment costs
- High fuel costs
- Extremely dependent on stable fuel supply and stable fuel prices (50-66 % of total costs)

Thank you for your attention.

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