

Coal and Steam Power Plants



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OP Vzdělávání
pro konkurenceschopnost



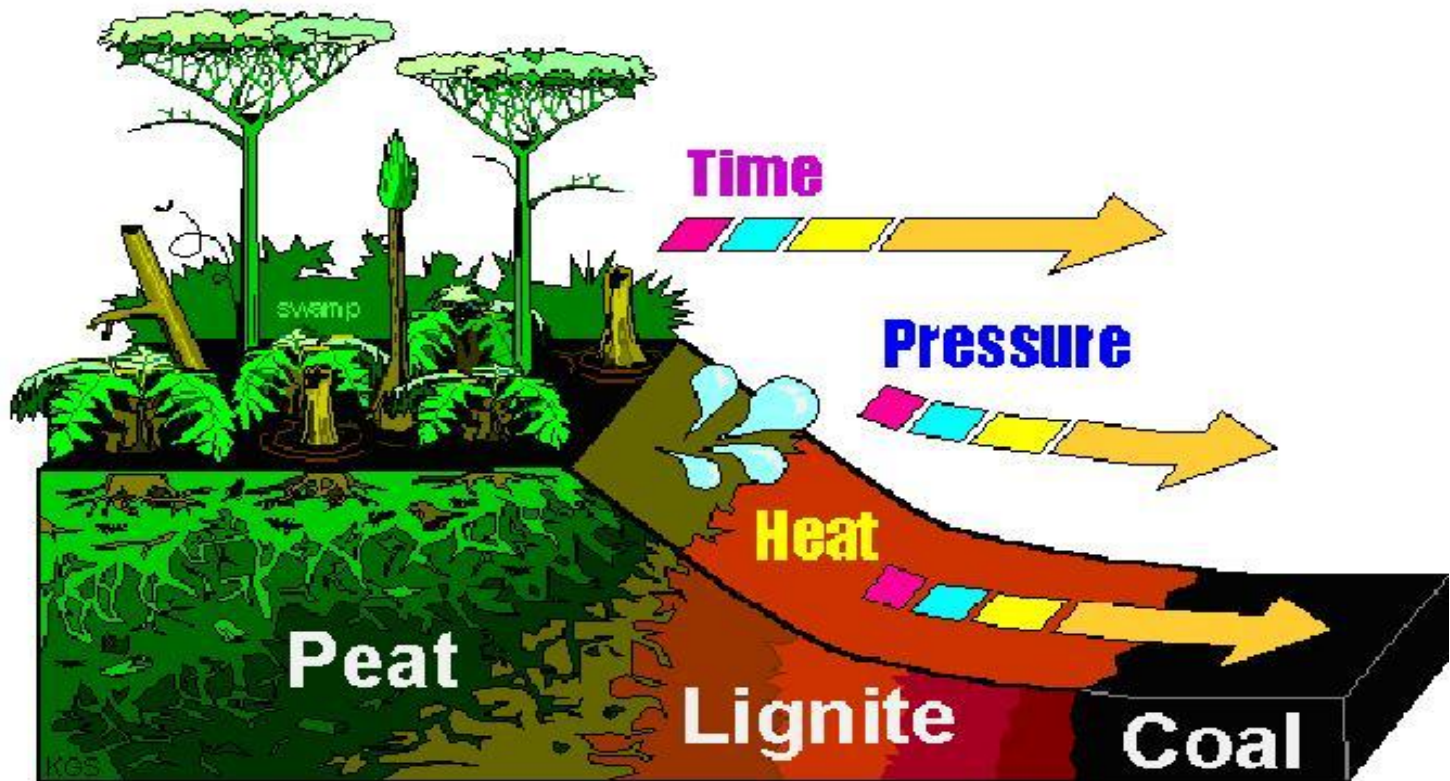
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Content

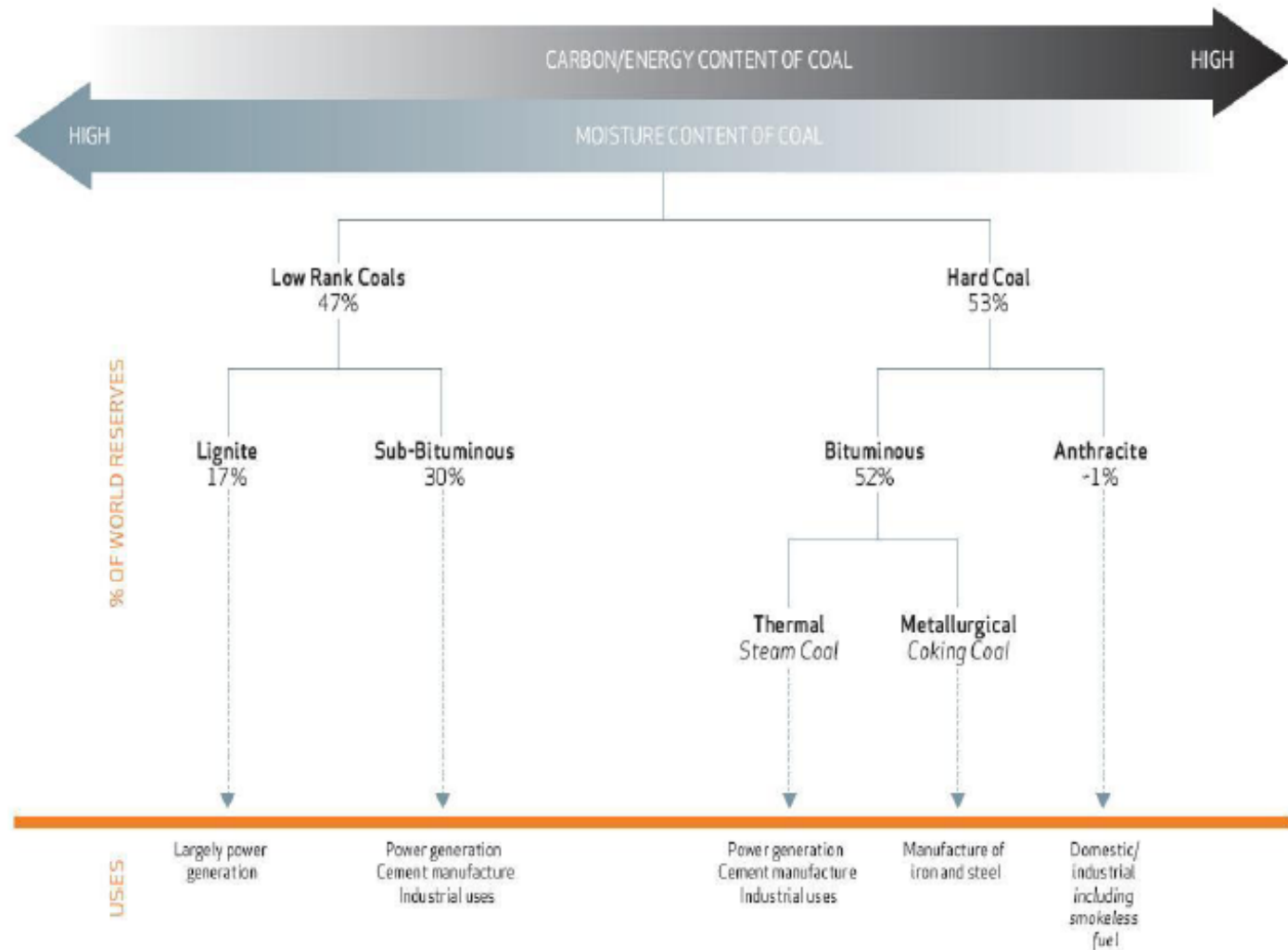
- What is Coal
- World Key Players
- World Market and Price Mechanism
- Coal Fuel Cycle
- Coal Mining
- Steam Power Plants

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



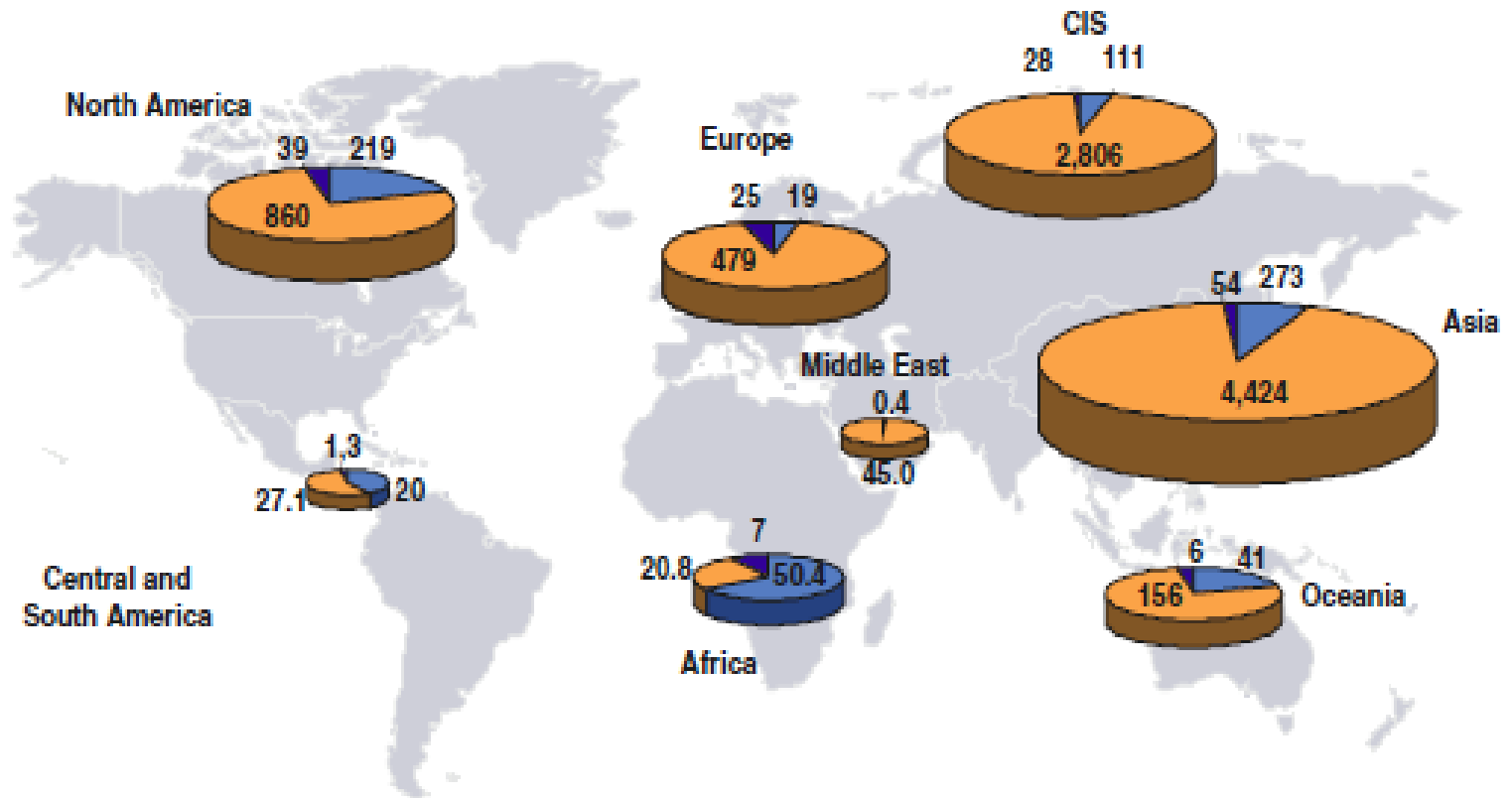
Coal Quality and Coal Use



World Coal Industry

- Coal provides 30.3% of global primary energy needs and generates 42% of the world's electricity.
- In 2011 coal was the fastest growing form of energy outside renewables.
- Total Global Coal Production in 2011 was 7,678 Mt. (Czech Republic 58 Mt/2011)
- Total world resources are 1,004,000 Mt (according to BGR/IEA), or 861,000 Mt (according to WEC/BP)

World Coal Mining



- Cumulative Production since 1950 (2006 production: 5.4 Gt)
- Reserves 2006: $\Sigma = 736$ Gt
- Resources 2006: $\Sigma = 8,817$ Gt

World Coal Mining

2016 Top Ten Hard Coal

(source: World Coal Association, 2017)

- China 3243 Mt /
- India 708 Mt /
- USA 672 Mt /
- Australia 503 Mt /
- Indonesia 461 Mt /
- Russia 366 Mt /
- South Africa 257 Mt /
- Germany 176 Mt /
- Poland 131 Mt /
- Kazakhstan 98 Mt /

2012 Brown Coal Producers

- Germany 176 Mt
- PR China 136 Mt
- Russia 78 Mt
- Turkey 74 Mt
- USA 74 Mt
- Australia 69 Mt
- Poland 63 Mt
- Greece 59 Mt
- Czech Republic 43 Mt
- India 41 Mt

Over 7269 Mt of hard coal are currently produced worldwide and 787 Mt of lignite.

World Coal Mining

2009 Top Twelve Countries Heavily Dependent on Coal in Electricity Production (source: World Coal Association, 2012)

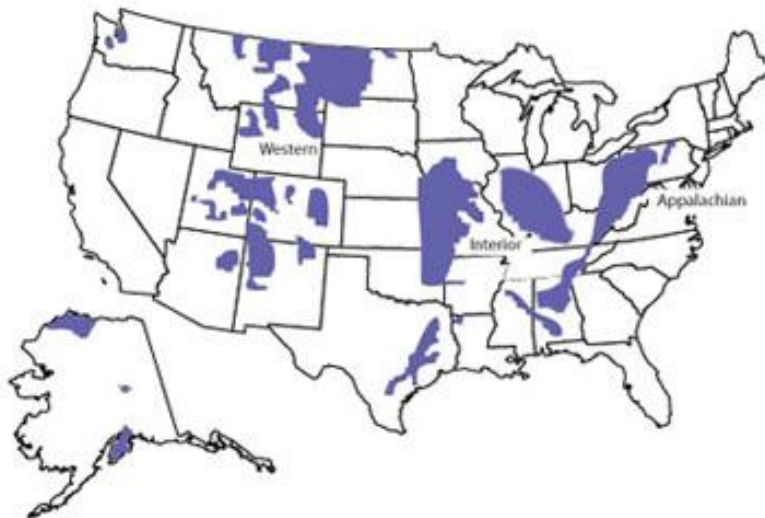
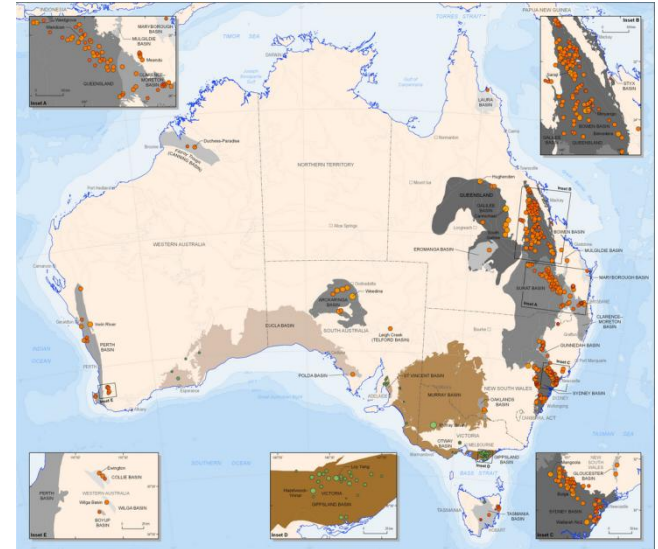
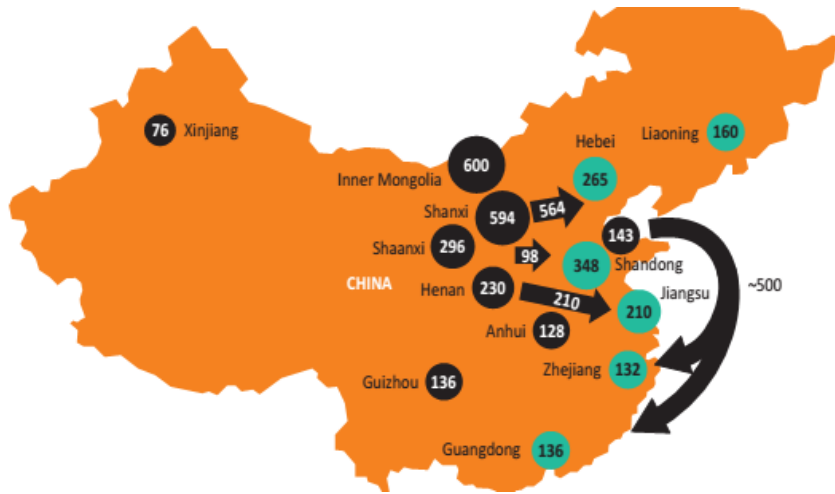
- South Africa 93 %
- Poland 90 %
- PR China 79 %
- Australia 76 %
- Kazakhstan 70 %
- India 69 %
- Israel 63 %
- Czech Rep 56 %
- Morocco 55 %
- Greece 55 %
- USA 45 %
- Germany 44 %



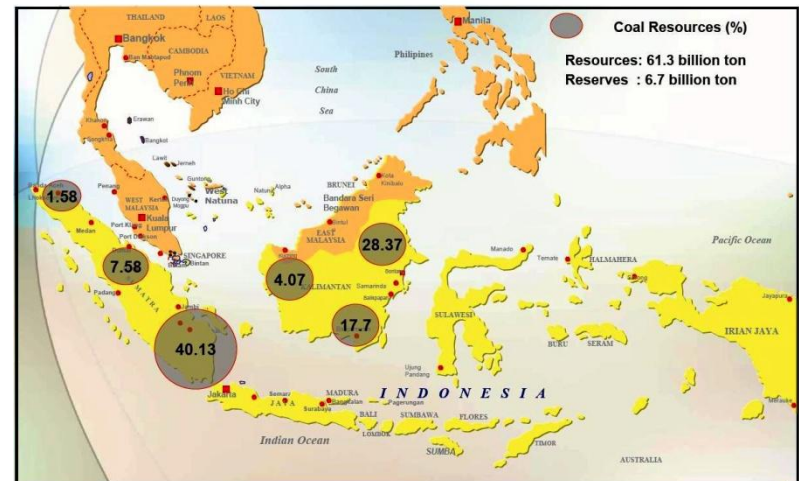
World Key Players

Production		Consumption		Export		Import	
China	2 721	China	2 721	Australia	261	Japan	165
USA	907	USA	904	Indonesia	233	China	112
India	556	India	611	Russia	108	South Korea	99
Australia	411	Germany	224	Colombia	67	India	75
Russia	311	Russia	220	USA	54	Taiwan	58
Indonesia	291	South Africa	191	South Africa	52	Germany	41
South Africa	249	Japan	164	China	23	UK	38
World	6 350	World	6 350	World	907	World	907

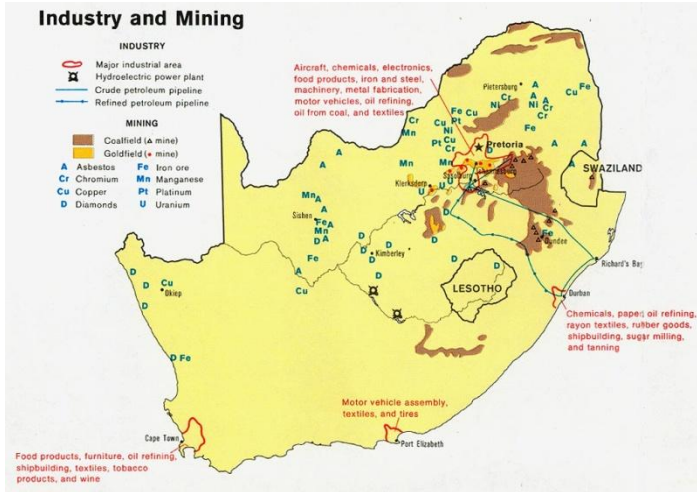
World Key Producers



Patria Energy - Coal Reserves & Resources In Indonesia



World Key Producers



RUSSIA - MAJOR COAL RESERVES LOCATION MAP



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 electricity = 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

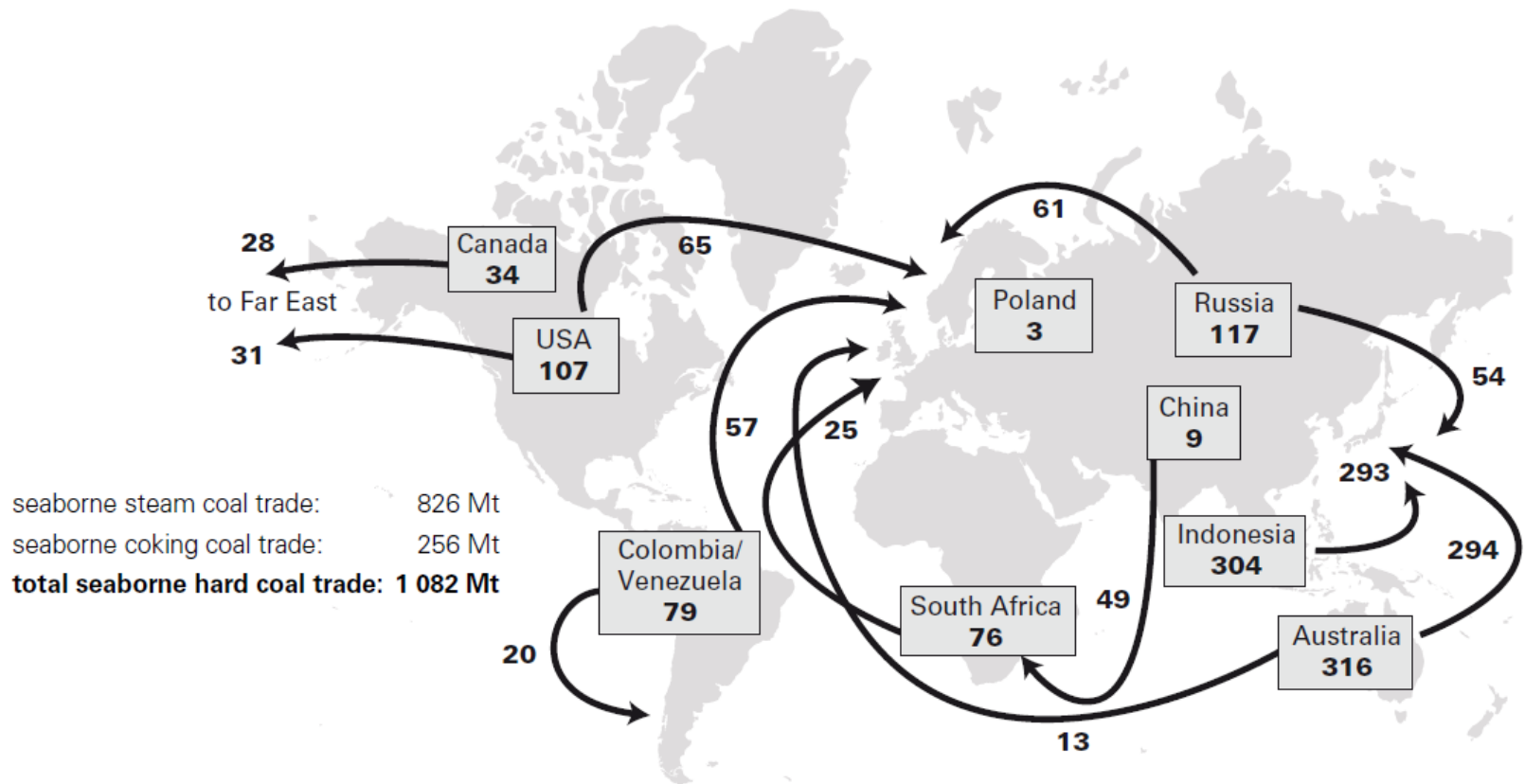
- Coal is traded all over the world, with coal shipped huge distances by sea to reach markets.
- Ships are commonly used for international transportation, in sizes ranging from:
 - Handysize - 40-45,000 DWT
 - Panamax - about 60-80,000 DWT
 - Capesize vessels - about 80,000 DWT
- Overall international 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

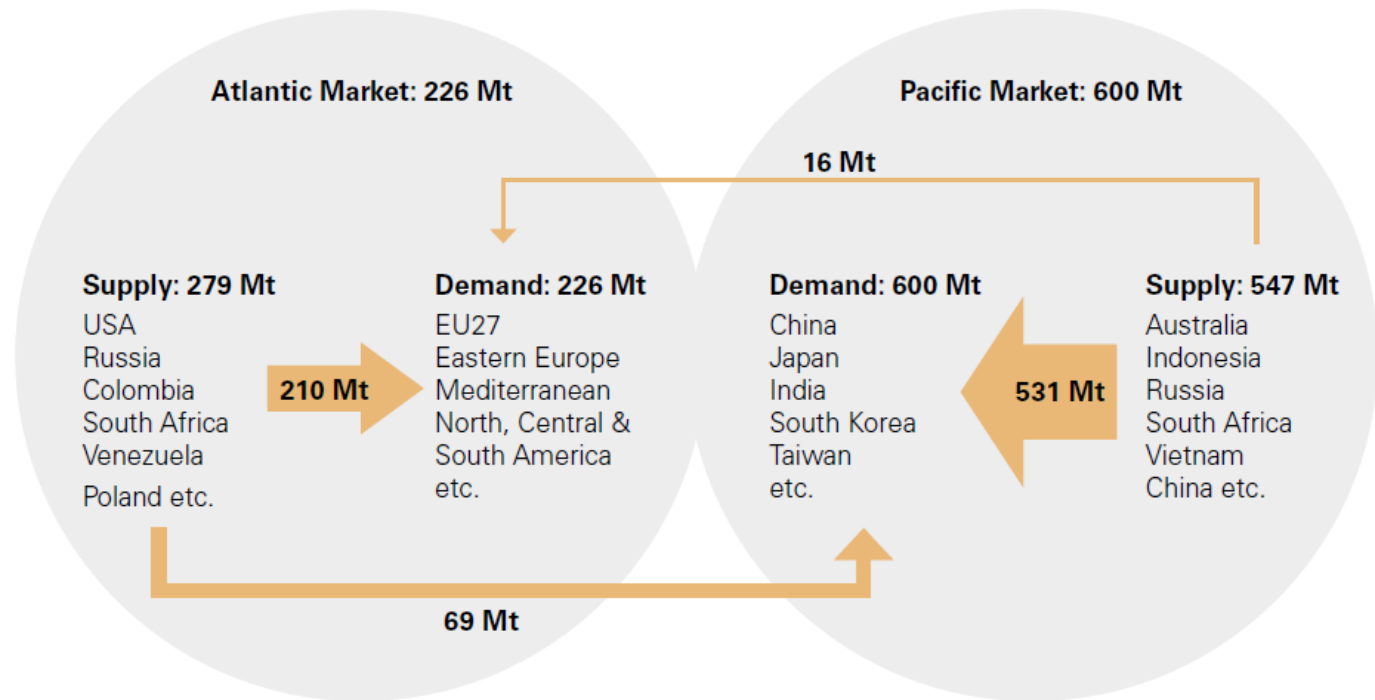
Seaborne trade flows on the international hard coal market, 2012



Source: Euracoal

World Market and Price Mechanism

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

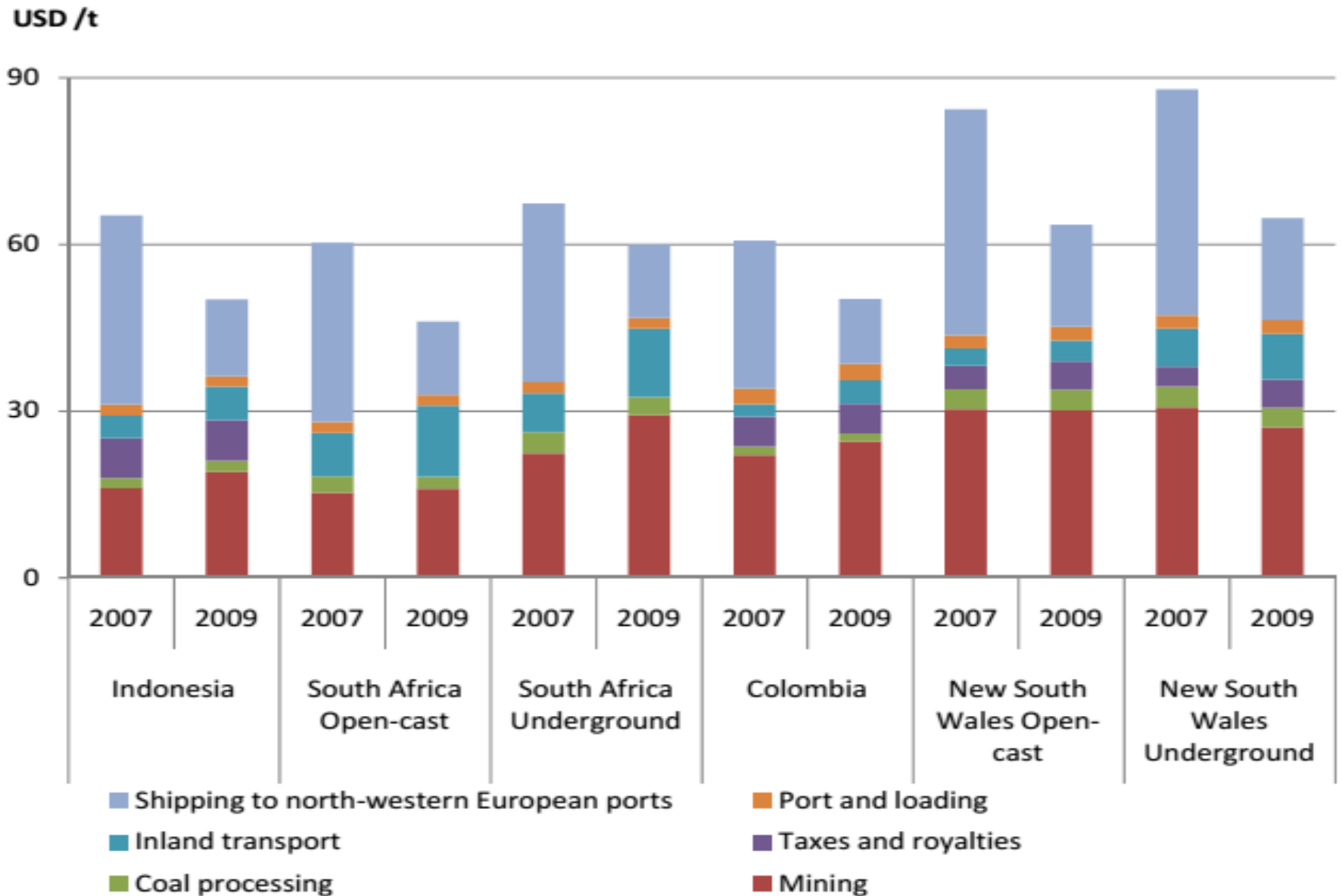


Source: Euracoal

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)



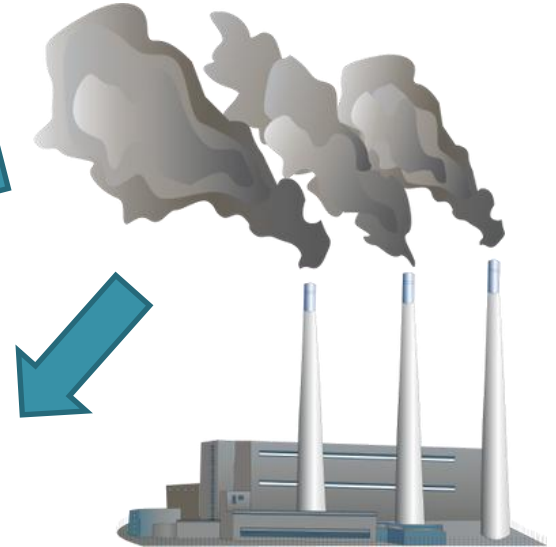
Coal Fuel Cycle



Mining



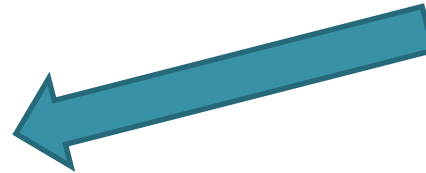
Processing



Burning
(use)

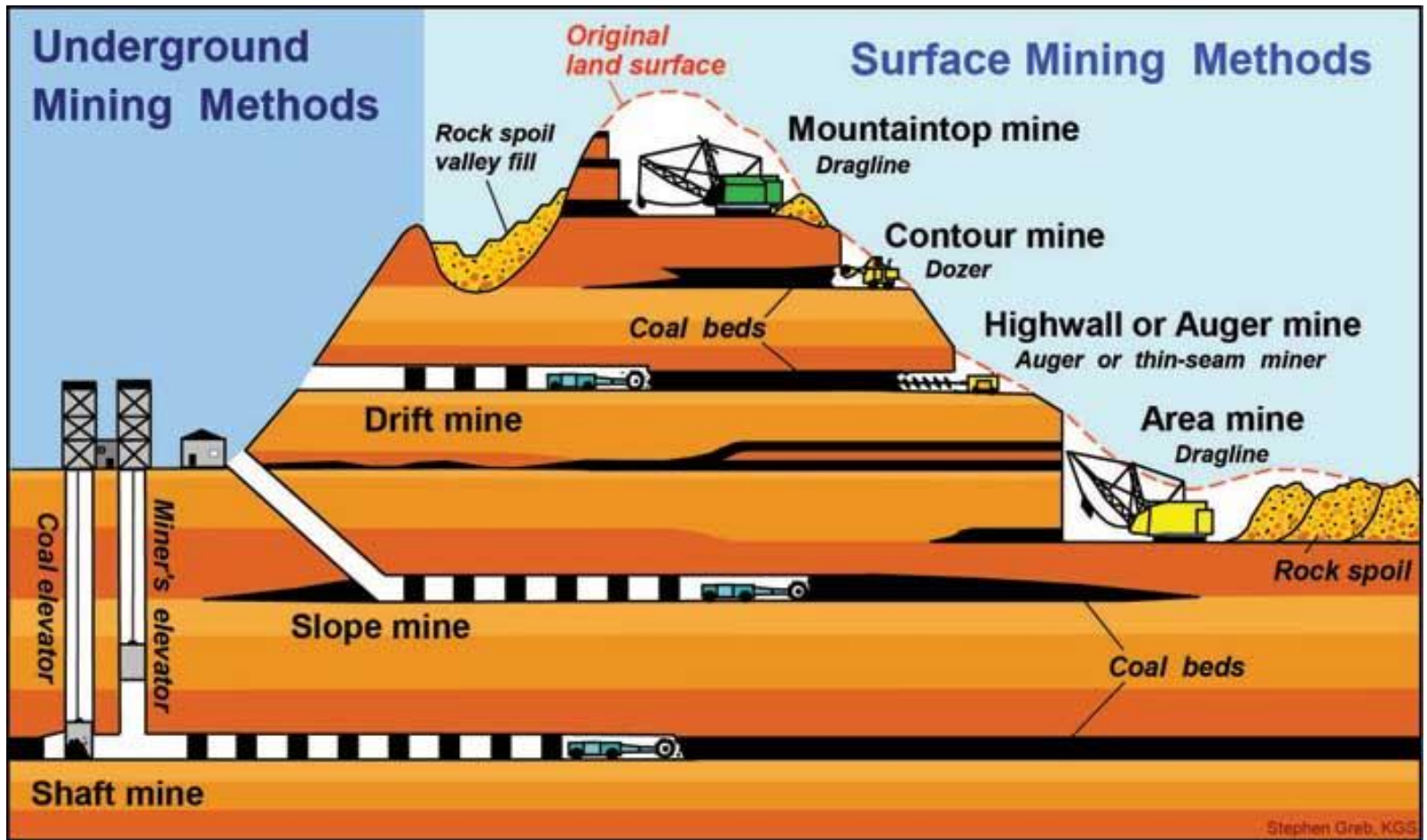


Electricity and heat
(product)



Coal ash and CO₂
emissions

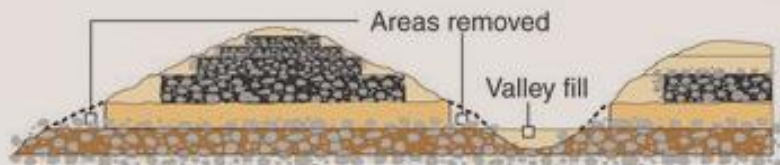
Coal mining



1 Coal location Geologists find and map coal seams



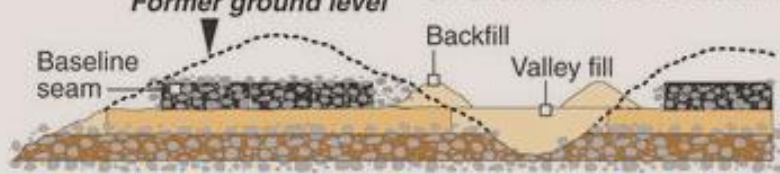
2 Base removal Miners dig and blast away sections near base of mountain, dump debris into valley



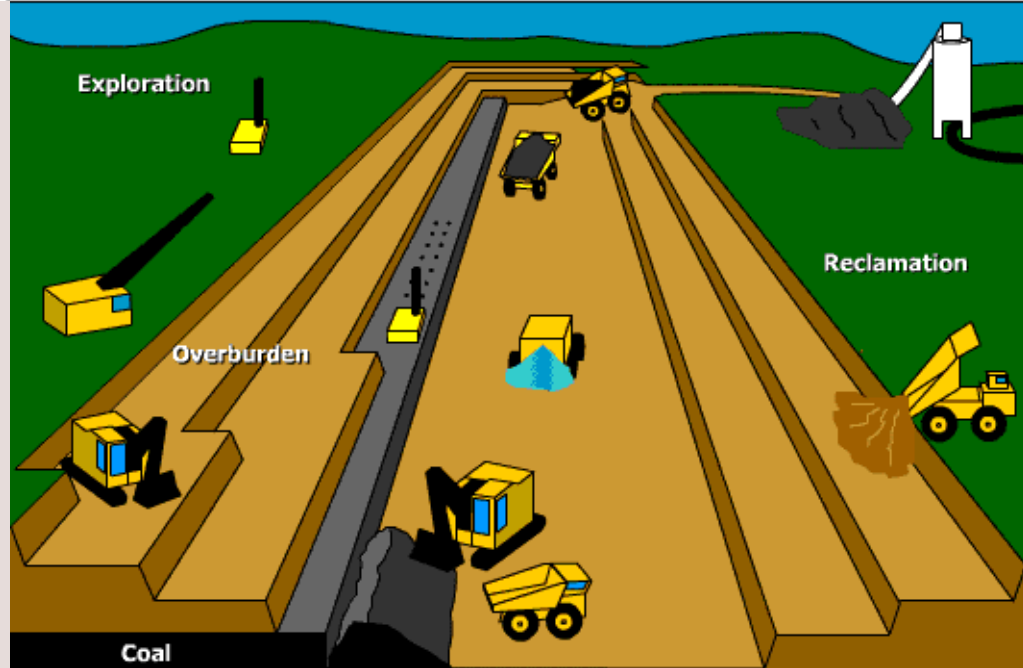
3 Upper seam mining Coal near mountaintop is removed; excess rock is dumped into valley



4 Baseline seam mining Coal-rich baseline seam removed; extra rock dumped as "backfill"



5 Completion Baseline seam is completely mined and backfilled; leaves only a plateau or rolling hills









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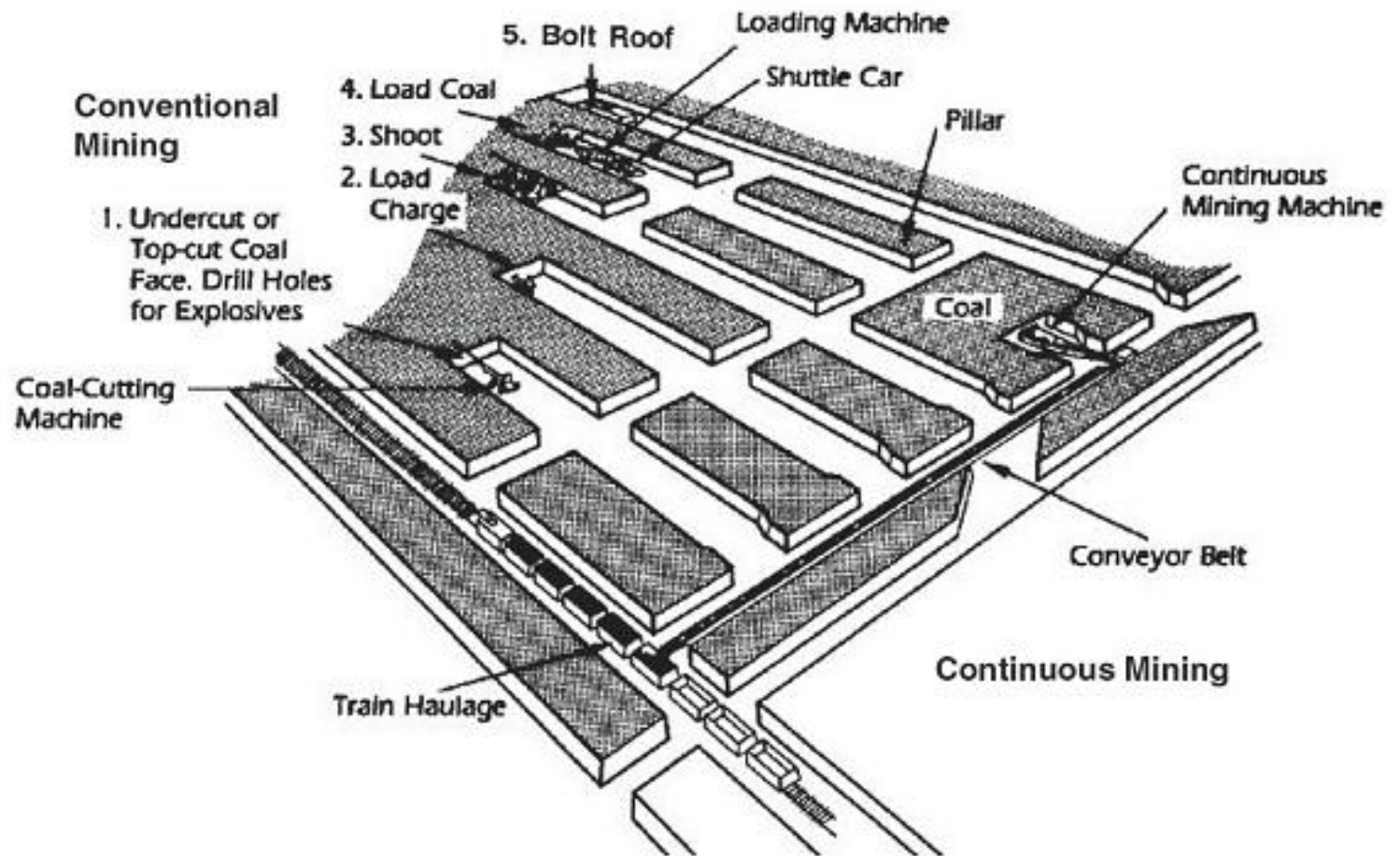
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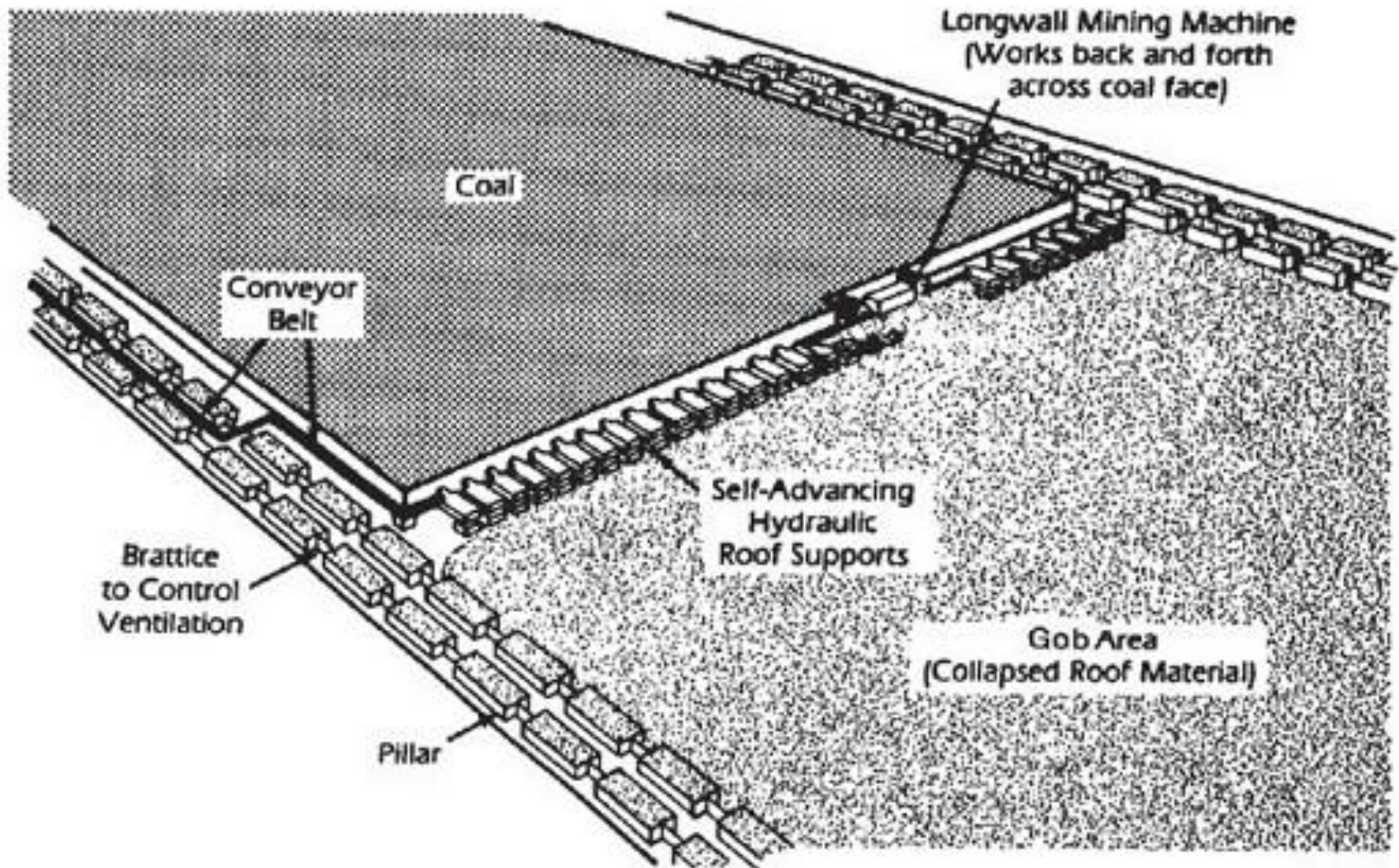




Coal Mining – underground



Coal Mining – underground



Coal mining





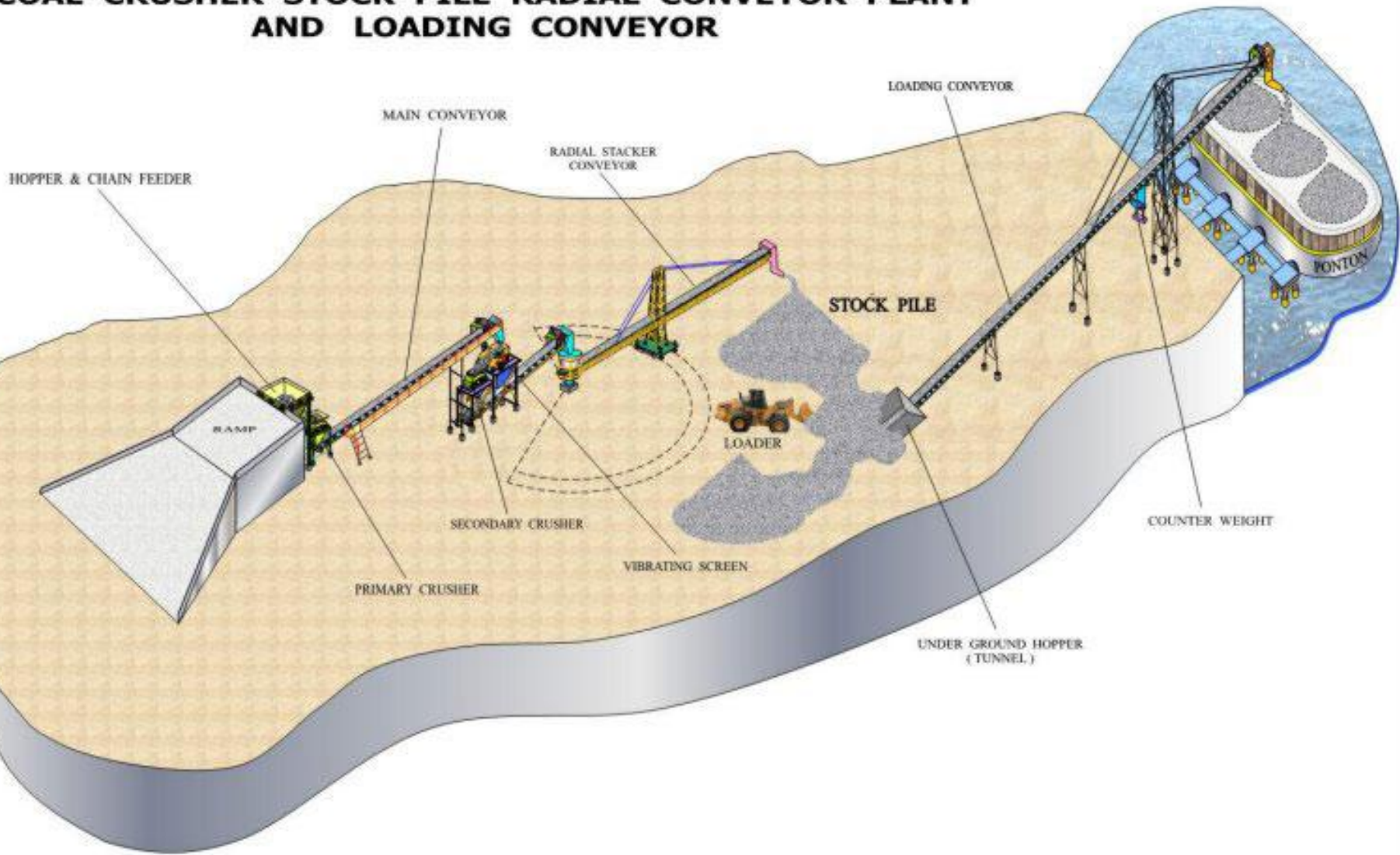


Coal Processing





COAL CRUSHER STOCK PILE RADIAL CONVEYOR PLANT AND LOADING CONVEYOR



Coal transport











Coal transport



Coal transport



Coal transport



Coal transport

Figure ES7. To move 30,000 tonnes of cargo with a Seaway-size vessel



Source: RTG analysis.

Capesize
(80 – 175 kDWT)

Panamax
(65 – 80 kDWT)

Handymax
(35 – 65 kDWT)

Handysize
(10 – 35 kDWT)



Coal transport



Coal transport



Coal transport



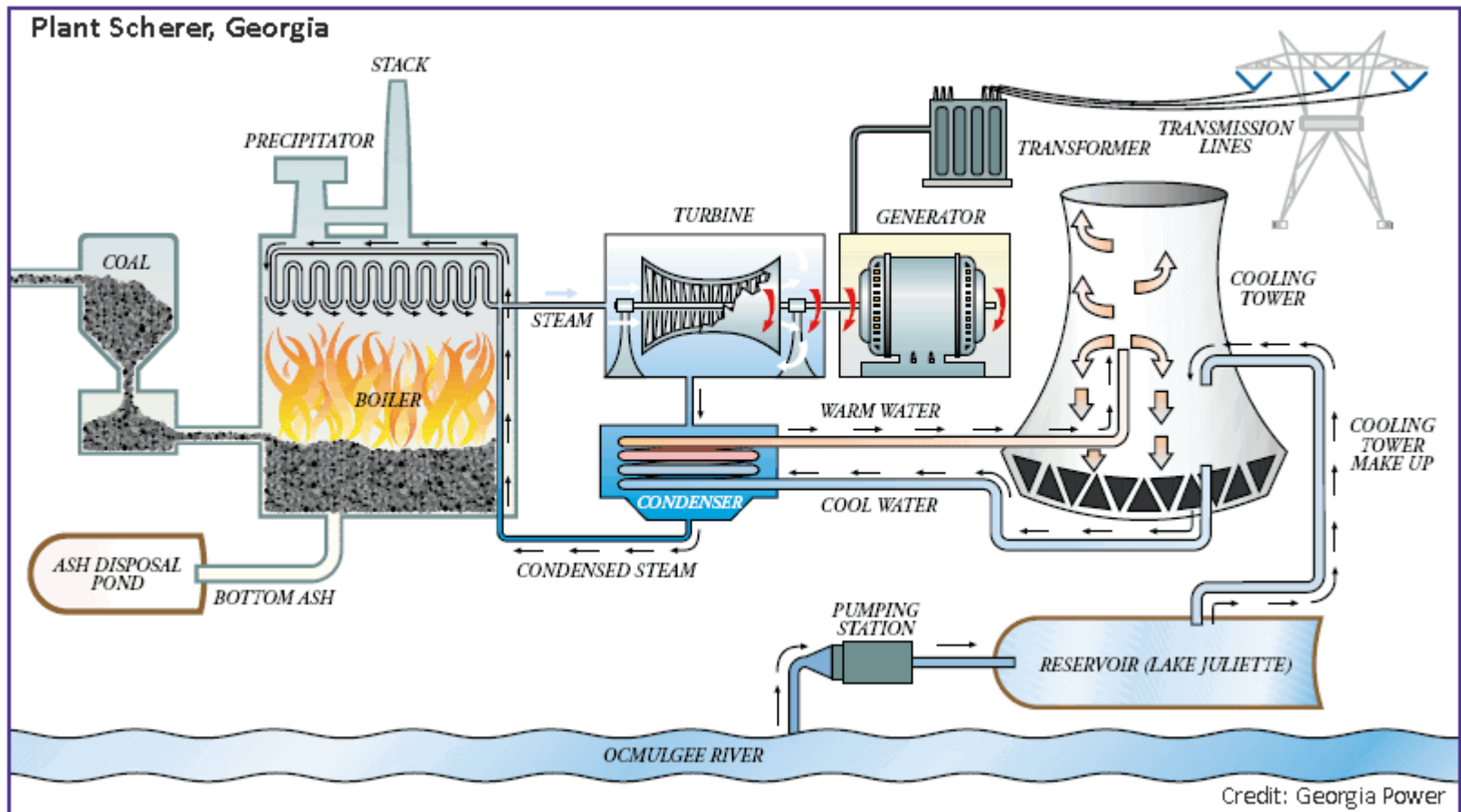
Coal transport



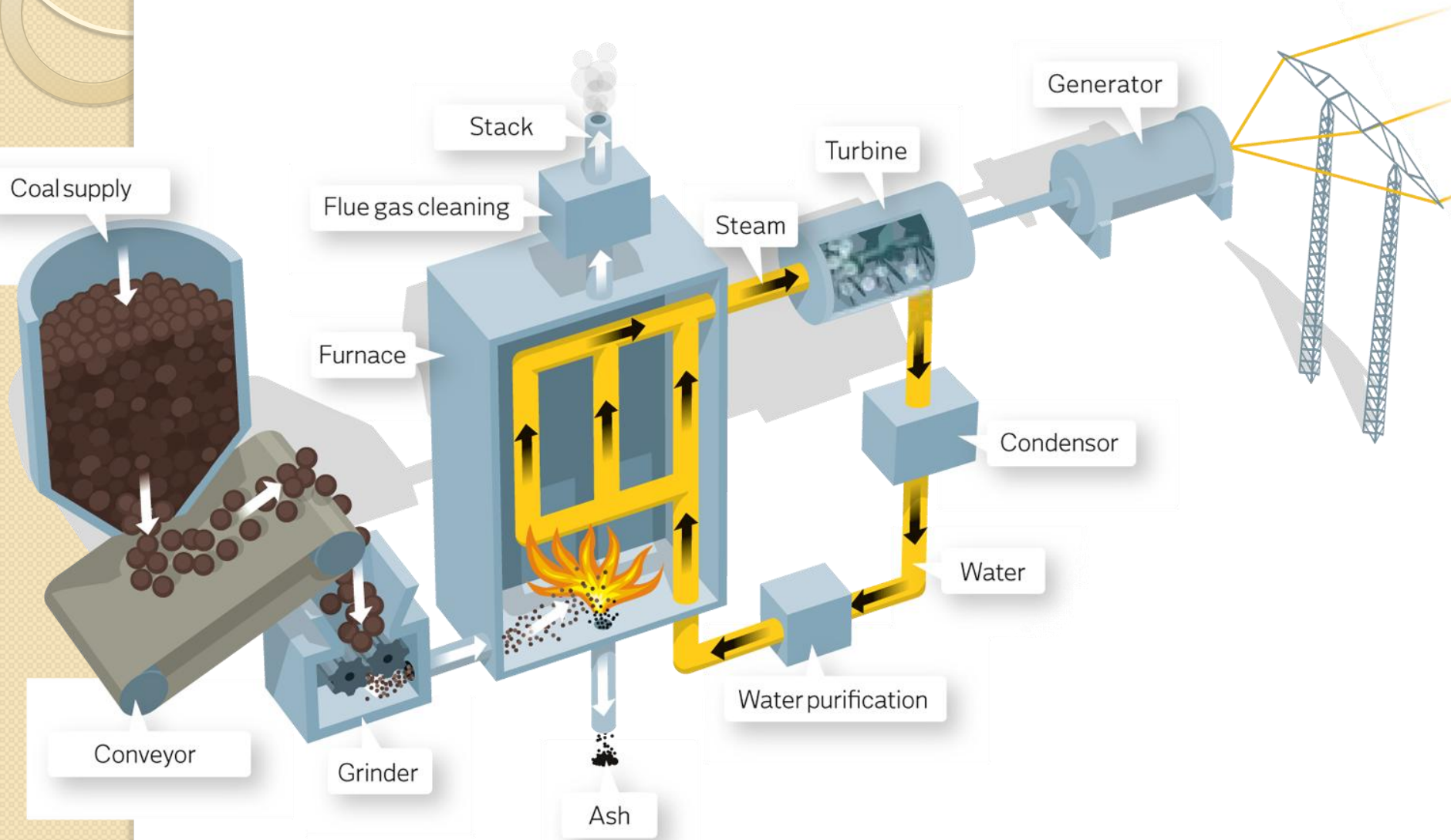
Coal transport



Steam Power Plants

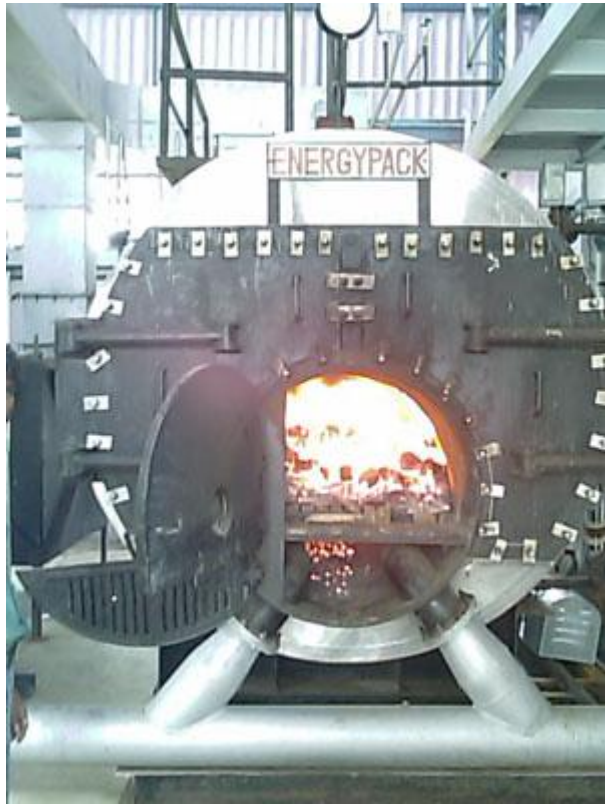


Steam Power Plants











TG 4

LEWIS & CLARK

Coal ash and CO₂ emissions

- Burning of coal produces large amounts of waste, especially coal ash and scrubber sludge



Coal ash and CO₂ emissions

- This material is generally uncleanable, unavoidable and only partially remediatable



Coal ash and CO₂ emissions

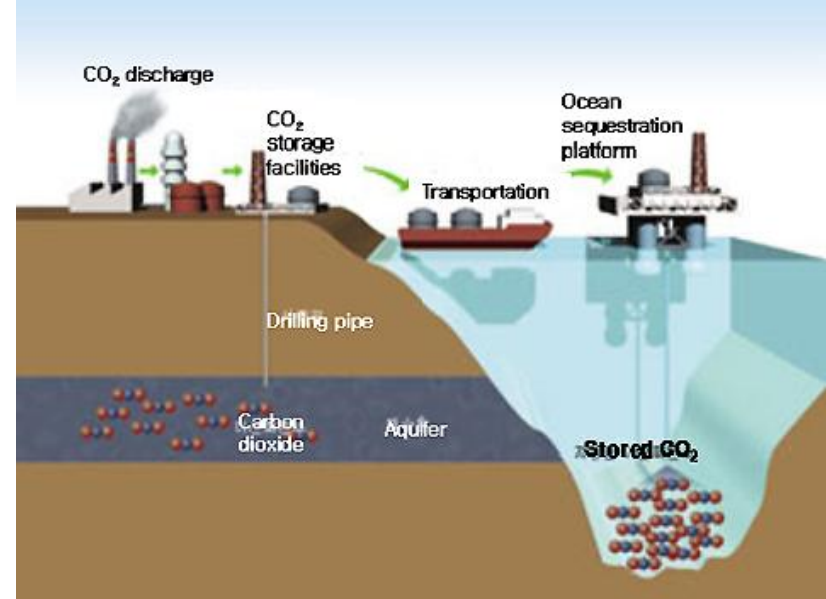
- Along with oil, coal combustion produces the largest amounts of carbon dioxide as the key pollutant
- 820 kg CO₂ per 1 MWh
- 1000 MWe power plant operating for one hour produces 820 tons of CO₂

Solutions (?)

- Switch to natural gas
- Switch to renewables or nuclear energy
- Install CCS
- Install IGCC

CCS

- Process of capturing waste carbon dioxide (CO₂) from large point sources, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation.
- Up to 85 % effectivity (ie. 220-250 kg CO₂/1MWh)
- Transformation effectivity reduction by 8-14 %
- Fuel consumption raised by 25 %
- Plus investment costs



IGCC

- Integrated Gasification Combined Cycle
- Gasification of coal
- Gas turbine + steam generator

- Investment costs

http://www.eurosolar.cz/phprs/view.php?ci_sloclanku=2007021301

Downstream Industries

- Generally very environmental unfriendly
- Steel production
- Metallurgical coke
- Chemical industry
- Pharmacy
- Dyes
- etc.



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)