Metallurgical COAL

Building the Future

RAMCOAL

What Is Coal?

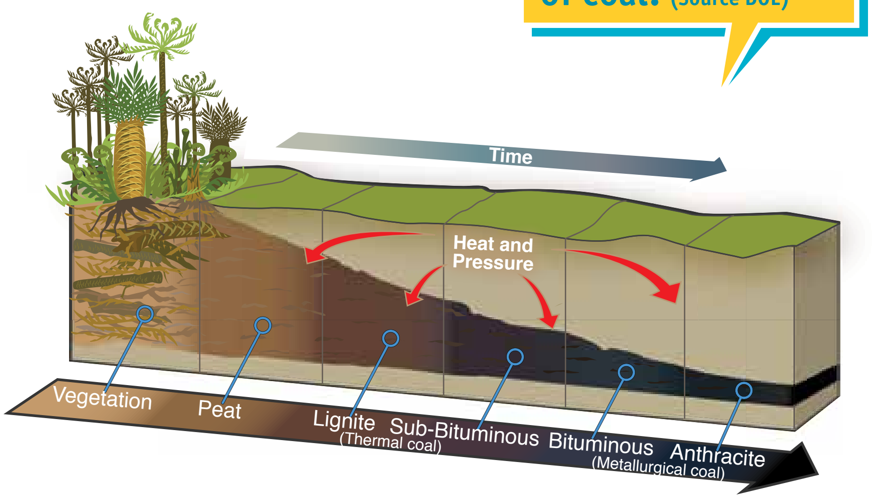
Coal is a fossil fuel.

It is a mineral substance formed from the remains of land-based plants buried in swamps and bogs hundreds of millions of years ago. Coal formation began during the Carboniferous Period – the first coal age – which spanned 290 million to 360 million years ago. The build-up of silt and other sediments, together with movements in the earth's crust – tectonic movements – buried swamps and bogs, often to great depths. The buried plant material was subjected to high temperatures and pressures. This caused physical and chemical changes in the vegetation, transforming it into peat and then into different types of coal.

Fossil Fuel (coal, gas, oil) is a hydrocarbon deposit and a natural fuel created in geological formations over long periods of time from the remains of living organisms.

Ten feet of prehistoric plant debris was needed to make one foot of coal. (Source DOE)

Formation of Coal



Metallurgical Coals

Coal is the world's most plentiful fossil fuel and by far Canada's most abundant fossil fuel, with over 6.6 billion tonnes of recoverable coal reserves. Canada has both Metallurgical coal (anthracite and bituminous) and Thermal coal (sub-bituminous and lignite) deposits.

Coal is used mainly for two purposes, for steel making and power generation. Only the higher-ranking hard coal (metallurgical) with specific coking properties can be used to make steel, although in theory, all coals from lignite to anthracite can be used as thermal coal to generate electricity.

Metallurgical coal is more scarce and valuable than thermal coal, so in practice metallurgical coal is rarely used to generate electricity. Metallurgical coal is also commonly referred to as coking coal. Coking coal has physical properties that when heated cause it to soften, liquefy and then resolidify into a harder substance known as coke.

Coal is not a homogenous commodity. In addition to ranks, coal can be split into dozens of blends and products. Coal is classified according to the degree of transformation of the original plant material into carbon, moisture content and composition. The quality of each coal deposit is determined by the varying types of vegetation from which the coal originated, depths of burial temperatures and pressures at those depths, and the length of time the coal has been forming in the deposit.

Metallurgical, or often referred to as Steelmaking coal has the most intrinsic value and right chemical make up and physical properties to be used in the process of making steel.

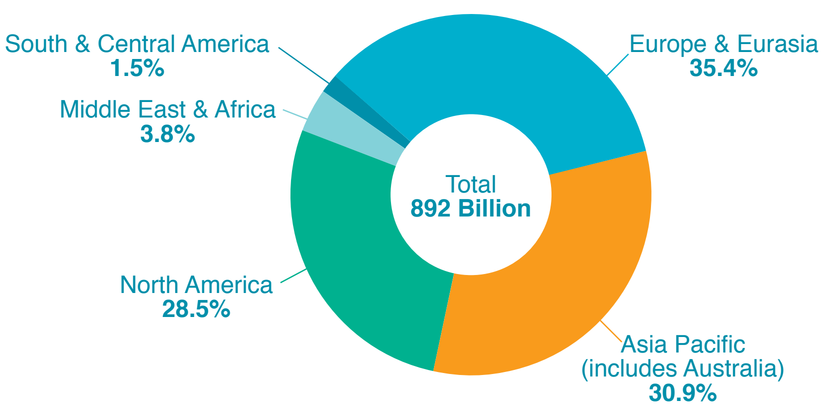
The degree of change undergone by a deposit as it matures is known as coalification. This change in coal's physical and chemical properties is referred to as the "rank" of the coal. Ranking is determined by the degree of transformation of the original plant material to carbon. The ranks of coals, from those with the least carbon to those with the most carbon, are lignite, sub-bituminous, bituminous and anthracite.

Where Coal Is Found

Primary Coal Basins

Relative to other fossil fuels, coal reserves are relatively evenly dispersed geographically.

Distribution of proven coal reserves

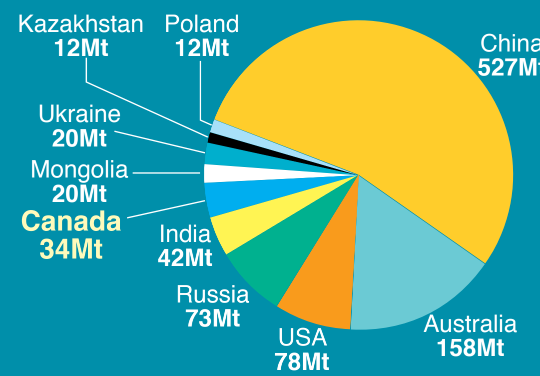


Source 2013 BP Statistical Review (www.bp.com)

Total world coal production reached a record level of 7,822.8Mt in 2013.
(Canada is among the top 10 metallurgical coal producers)

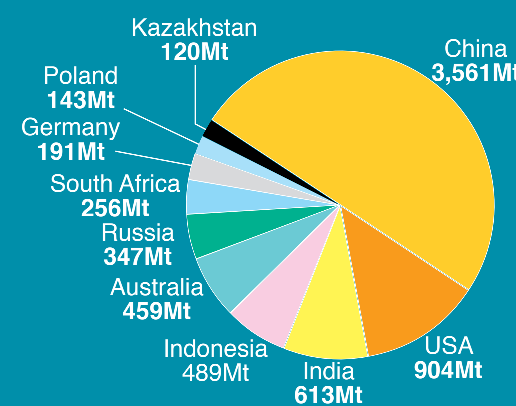
Top Ten Metallurgical Coal Producers

Total 976Mt



Top Ten Thermal Coal Producers

Total 7,083Mt

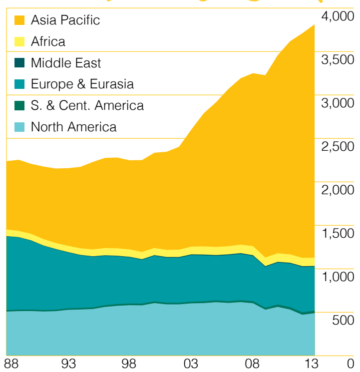


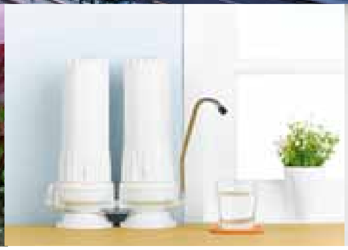
Who Uses Coal?

Coal has many important uses worldwide. The most significant uses of coal are in steel production, electricity generation, cement manufacturing and as a liquid fuel. Since 2000, global coal consumption has grown faster than any other commodity.

The biggest market for coal is Asia, which accounts for over 70% of global coal consumption, China is responsible for a significant part of this. Many countries do not have the natural resources sufficient to cover their resource needs, and therefore need to import coal to help meet their requirements. Japan, Taiwan and Korea, for example, import significant quantities of metallurgical coal for steel production and thermal coal for electricity generation.

Consumption by region (2013)





Other important users of coal include alumina refineries, paper manufacturers, and the chemical and pharmaceutical industries. Several chemical products can be produced from the by-products of coal. Refined coal tar is used in the manufacture of chemicals, such as creosote oil, naphthalene, phenol and benzene. Ammonia gas recovered from coke ovens is used to manufacture ammonia salts, nitric acid and agricultural fertilisers. Thousands of different products have coal or coal by-products as components: soap, aspirins, solvents, dyes, plastics and fibres, such as rayon and nylon.

Coal is also an essential ingredient in the production of specialist products:

Activated carbon – used in filters for water and air purification and in kidney dialysis machines.

Carbon fibre – an extremely strong but light weight reinforcement material used in construction, aircrafts, boats, bicycles and rackets.

Silicon metal – used to produce silicones and silanes, which are in turn used to make lubricants, water repellents, resins, cosmetics, hair shampoos and toothpastes.

Metallurgical Coal VS Thermal Coal

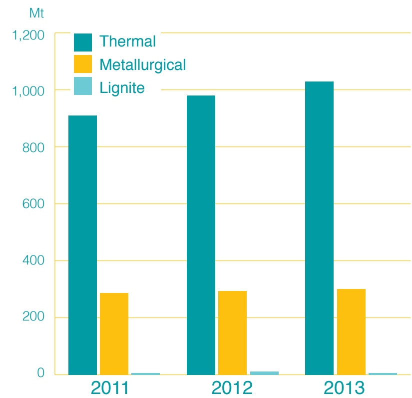
Different types of coal have different uses.

Metallurgical coal – also known as coking coal, is a key ingredient for the production of steel by creating the coke necessary during the reduction process of making iron and steel. Coke is a porous, hard black rock of concentrated carbon that is created by heating bituminous coal without air to extremely high temperatures.

Thermal coal – also known as steam coal, is mainly used in power generation. It is burned to generate steam which drives turbines to generate electricity for either public electricity grids or industries that consume electrical power.

Canada is currently the 3rd largest exporter of metallurgical coal. Almost all of Canada's metallurgical coal production is exported.

World Coal Trade



Top Coal Importers

	Met	Ther.	Total
China	77Mt	250Mt	327Mt
Japan	54Mt	142Mt	196Mt
India	38Mt	142Mt	180Mt
South Korea	31Mt	95Mt	126Mt
Chinese Tapei	7Mt	61Mt	68Mt
Germany	8Mt	43Mt	51Mt
UK	6Mt	44Mt	50Mt

Top Coal Exporters

	Met	Ther.	Total
Australia	154Mt	182Mt	336Mt
USA	60Mt	47Mt	107Mt
Canada	34Mt	4Mt	37Mt
Russia	22Mt	118Mt	141Mt
Indonesia	3Mt	423Mt	426Mt
Colombia	1Mt	73Mt	74Mt
South Africa	0Mt	72Mt	72Mt

(ranked by Met coal exports)

Metallurgical Coal and Steel

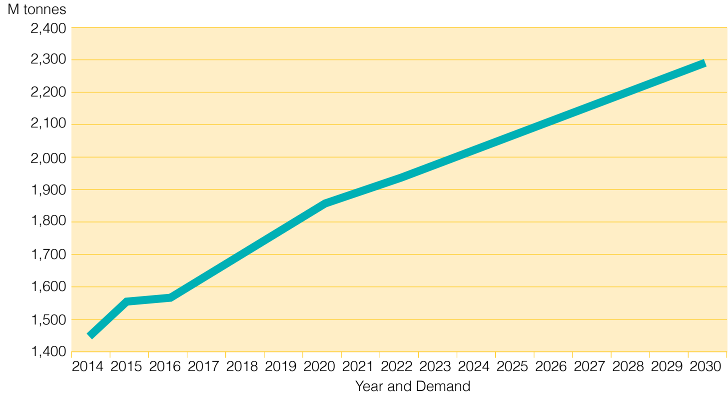
Metallurgical coal and steel are vital components of our modern way of life and critical to economic growth. The intrinsic benefits of steel make it a sustainable choice in a growing number of applications. Almost everything that we use is either made from, or manufactured with, steel. It is a uniquely versatile material and is widely regarded as a high performance, contemporary engineering material continuously being improved to meet new market demands. In 2014, world crude steel production was 1.7 billion tonnes, a new record for global crude steel production.

Steelmaking Process

Key raw materials needed in the steel-making process include metallurgical coal, iron ore, limestone and recycled steel. There are two main steel production processes and their related components are:

- The integrated steel-making process, based on the blast furnace (BF) and basic oxygen furnace (BOF), which uses raw materials including iron ore, metallurgical coal, limestone and recycled steel. On average, this process uses 1,400 kg of iron ore, 800 kg of coal, 300 kg of limestone, and 120 kg of recycled steel to produce 1,000 kg of crude steel.
- The electric arc furnace (EAF) process uses primarily recycled steels and direct reduced iron (DRI) or hot metal and electricity. On average, the recycled steel-EAF process uses 880 kg of recycled steel, 160 kg of coal and 64 kg of limestone to produce 1,000 kg of crude steel.

World Steel Demand



Source: Statista, 2015

Long term steel demand fundamentals remain robust based on urbanization of developing countries such as China and India.

Without coal, there is no steel.

Steel production is a measurement of development and economic growth.

Production of crude steel has risen from 28 million tonnes per year at the beginning of the last century to over 1.7 billion tonnes. Asia accounts for almost 40% of global steel production, with Europe and Russia producing 36% and North America 14.5%.

Of interest...

- Around 800 kg of met coal is needed to make 1,000 kg of steel
- Average steel content in a vehicle is 1,123 kg which requires about 865 kg of met coal to produce
- 1 MW of wind turbine capacity requires 230 tons of met coal for the steel requirements
- The Eiffel Tower used approximately 7.3 million kg of steel, requiring about 5.6 million kg of met coal

Coal and the Making of Steel

Steel is an essential material for modern life. The manufacture of steel delivers the goods and services that our societies need – healthcare, telecommunications, improved agricultural practices, better transport networks, clean water and access to reliable and affordable energy.

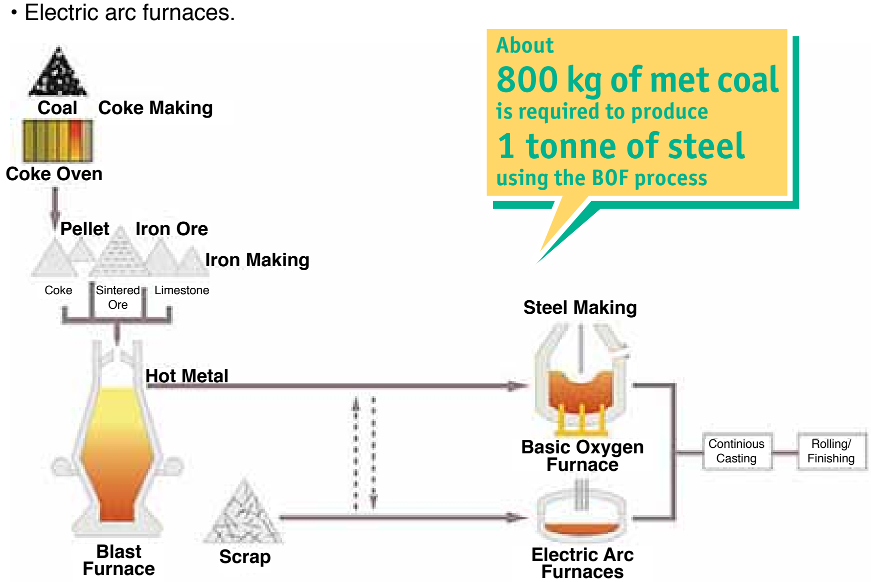
Global steel production is dependent on metallurgical coal as it is a vital ingredient in the steel-making process. With a world crude steel production of approx 1.7 billion tonnes, around 876 million tonnes of metallurgical coal was used in the production of steel.

Steel demand increases when economies are growing, as governments invest in infrastructure and transportation, and as new factories and housing units are built. There was a 65% increase in steel use worldwide between 2003 and 2013. Today most steel is consumed by China – 47.3%, in comparison to only 27.3% in 2002.

How Is Steel Produced?

As iron occurs only as iron oxides in the earth's crust, the ores must be converted, or "reduced," using carbon, and the primary source of this carbon, is metallurgical coal. Steel is produced using two main processes:

- Integrated smelting involving blast furnace iron making followed by the basic oxygen furnace.
- Electric arc furnaces.



Source: The World Coal Association. Copyright permission by the World Coal Association, London, UK. www.worldcoal.org


This is what Coke looks like

Coke Making

Almost all of the metallurgical coal mined today is used in coke ovens. Metallurgical coal is converted to coke by driving off impurities to leave almost pure carbon. The physical properties of coking coal cause the coal to soften, liquefy and then resolidify into hard but porous lumps when heated in the absence of air. It is important for metallurgical coal to have low sulphur and phosphorous contents.

The coking process consists of heating metallurgical coal to around 1000-1100ºC in the absence of oxygen to drive off the volatile compounds (pyrolysis). This process results in a hard porous material – coke. Coke is produced in a coke battery which is composed of many coke ovens stacked in rows into which coal is loaded.

The coking process takes place over long periods of time – between 12-36 hours in the coke ovens. Once pushed out of the vessel, the hot coke is then quenched with either water or air to cool it before storage or is transferred directly to the blast furnace for use in iron making.

Iron Making

Iron ore is mined in around fifty countries – the largest producers are Australia, Brazil and China. Around 98% of iron ore is used in steel making.

During the iron making process, a blast furnace is fed with the iron ore, coke and small quantities of fluxes (minerals, such as limestone, which are used to collect impurities). Air which is heated to about 1200°C is blown into the furnace through nozzles in the lower section, causing the coke to burn which reacts with the iron ore, as well as heat to melt the iron. Finally the tap hole at the bottom of the furnace is opened and molten iron and slag (impurities) are drained off.

Basic Oxygen Furnace ("BOF")

Metallurgical coal is converted to coke, which is then used in the blast furnace to smelt iron ore. The resulting molten iron is then taken to the BOF, where steel scrap and limestone are added. A stream of high purity oxygen is blown through the molten bath causing a temperature rise to 1700°C. The scrap melts, impurities are oxidised, and the carbon content is reduced by 90%, resulting in liquid steel.

Other processes can follow – secondary steel making processes – where the properties of steel are determined by the addition of other elements, such as boron, chromium and molybdenum, ensuring the exact specification can be met.

Optimal operation of the blast furnace demands the highest quality of raw materials therefore, the carbon content of coke plays a crucial role in the furnace and on the hot metal quality. A blast furnace fed with high quality coke requires less coke input, results in higher quality hot metal and better productivity. Overall costs may be lower, as fewer impurities in the coke mean smaller amounts of flux must be used.

Currently almost 70% of global steel is produced in basic oxygen furnaces (BOF).

Approximately 28% of steel is produced using electric arc furnaces. The electricity used in this process is typically generated from coal-fired power stations.

About 160 kg of coal is required to produce 1 tonne of steel in electric arc furnaces process.

Electric Arc Furnaces

The electric arc furnace (EAF) process, or mini-mill, does not involve iron making. It re-uses existing steel, avoiding the need for raw materials in its processing. The furnace is charged with steel scrap but can also include direct reduced iron or pig iron for chemical balance.

The EAF operates on the basis of an electrical charge between two carbon electrodes providing the heat for the process. The power is supplied through the carbon electrodes placed in the furnace, which produce an arc of electricity through the scrap steel (around 35 million watts), which raises the temperature to 1600˚C, melting the scrap. Any impurities may be removed through the use of fluxes and draining off slag through the taphole.

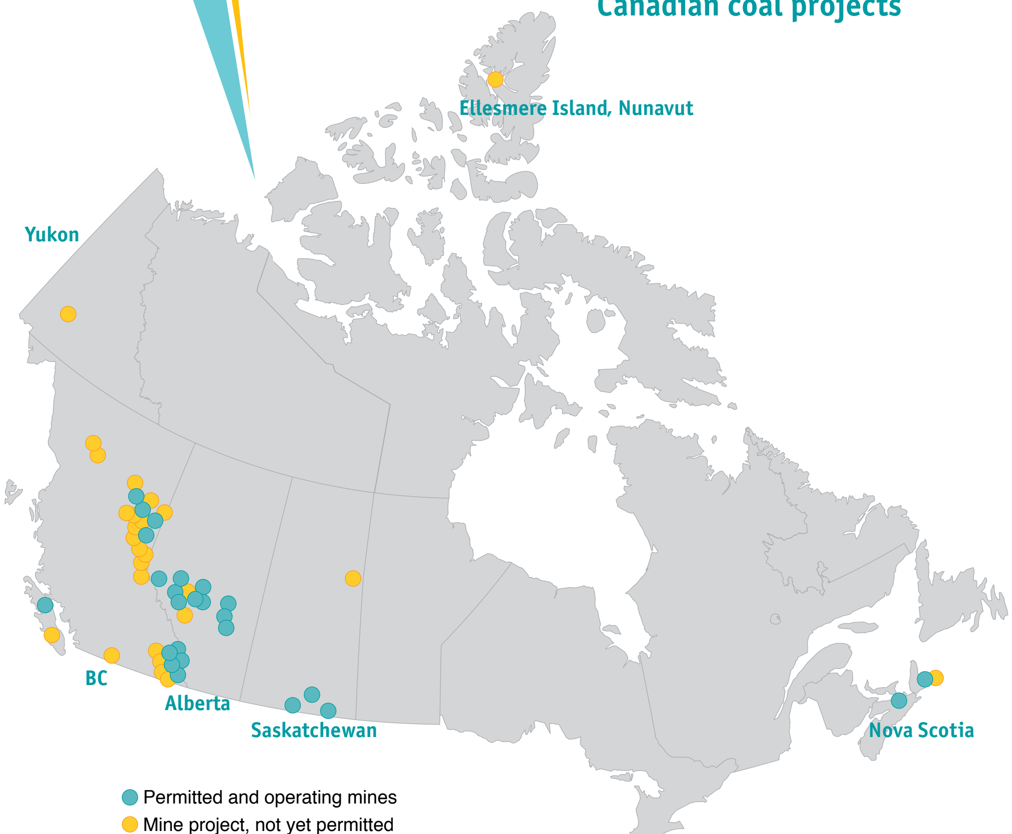
EAFs do not use coal as a raw material, but many are reliant on the electricity generated by a coal-fired power plant elsewhere on the grid. Around 160 kg of coal is used to produce 1 tonne of steel in electric arc furnaces.

Coal in Canada

Canada produced close to 67 million tonnes of coal in 2013 of which 34 million tonnes was metallurgical coal. Most of the coal produced in Canada is mined in Alberta and British Columbia.

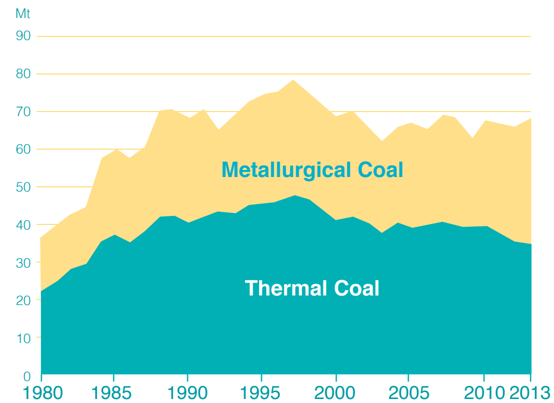
Canada has some of the largest coal reserves in the world. Reserves of around 6.6 billion tons are equivalent to more energy than Canadian oil and gas reserves combined.

Canadian coal projects



Source: careersincoal.ca

Canadian Coal Production, 1980-2013

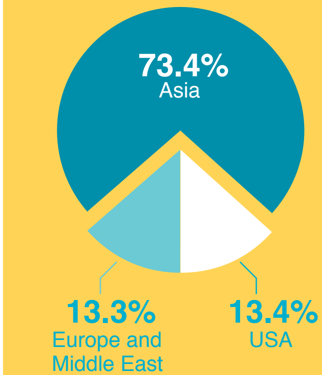


Cost-effective and reliable coal-fired electricity contributes to a strong economic advantage for Alberta and Saskatchewan. The abundance of locally sourced coal is harnessed through a "mine-mouth" operation where coal is removed from the earth and moved to a nearby power generation plant to be converted to electricity.

According to the World Bank, almost 12% of the electricity produced in Canada during 2012 was from coal-fired power plants.
In Alberta, coal fired power plants account for about 43% of the province's generating capacity.

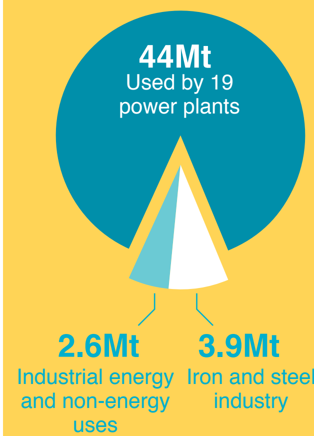
To meet its rapid infrastructure growth and consumer demand, Asia has turned to Canada for high-quality steel making coal. As Canada's largest coal trading partner, Asia imported approximately 73% of Canadian exports in recent years.

Total Canadian coal exports



Canada's coal consumption

50.5 million tonnes
(mostly coal-fired electricity)



In 2013;

- Canada produced 33 Mt of thermal coal
- Canada imported 11 Mt of thermal coal
- 44 Mt of thermal coal was used by Canadian power plants.

COAL – A Dynamic Alberta Industry

The coal industry is essential to Alberta as a catalyst for economic development, as a creator of employment for thousands of people, and as a financial contributor to government social programs through taxation and royalty payments.

There are two types of coal produced in Alberta – metallurgical coal, a key ingredient in the steel-making process, and thermal coal, used for power generation. With over 33 billion tonnes of coal resources, coal plays an important role in Alberta's economic present and future. Over the next 20 years, global demand for metallurgical coal is expected to increase significantly. Alberta is able to capitalize on this export potential due to its high quality coal. New coal mining projects will help diversify the economy, pay billions of dollars in taxes and royalties to the government and create thousands of high paying, long term jobs particularly in rural areas of Alberta. Coal has a bright future in Alberta.

Alberta's Coal Industry

- Alberta has the majority of Canada's coal resources, dispersed over almost half of all Alberta.
- Alberta has nine producing coal mines – two metallurgical coal mines and seven thermal coal mines.
- In 2013 Alberta's raw coal production totalled 34.5 million tonnes of coal. The vast majority was thermal coal used for local power generation, the remainder exported to Asia, mainly Japan and South Korea.
- It is important to remember, coal mining is a temporary use of the land with over 75% of the land used to date for mining having been reclaimed in Alberta.

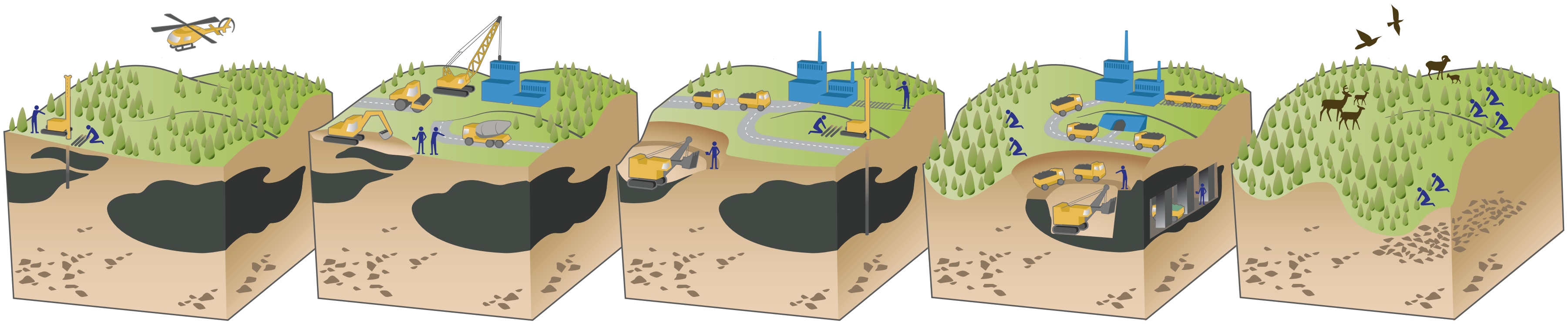
Benefits to Albertans – Employment, Taxes, Royalties.

- In 2012, approximately 7,000 Albertans were employed in the coal industry, the majority in rural Alberta.
- The mining industry is also the largest employer of Aboriginal people in Canada and works with educational institutions and governments to provide training and employment opportunities.
- Over the last five years, the Alberta Government received over $91 million in royalties from coal companies which financially support government programs and services to enrich the lives of all Albertans.

Significant New Coal Mining Potential in Alberta

- Over the next 20 years, global demand for coal is expected to significantly increase.
- New coal mining projects will create new benefits for Albertans:
  - New metallurgical coal projects in western Alberta have the potential to generate over $15 billion in new Alberta government revenues and create over 15,000 new jobs.
  - Coalspur's Vista Project near Hinton, a thermal coal export project, is projected to generate over $200 million in new Alberta Government revenues and create over 500 direct jobs in Phase 1 alone.
  - For example, an estimated average wage of $80,000 per year for the potential 15,000 new jobs, would result in almost $500 million annually in provincial and federal income tax which supports education and health care programs in the province.

Life Cycle of Mining



EXPLORATION

No profit to company

Operating and capital expenditure.

Value add through employment and taxes

Money spent with suppliers, directly generating sales taxes. Employment taxes are paid, in addition to payments to contractors. Suppliers and contractors will also, in turn, pay their own taxes.

DEVELOPMENT

No profit

Operating and significant capital expenditure.

Value add through increased employment and taxes

Significant amounts are spent with suppliers in developing the mine and infrastructure, generating sales taxes and import duties. Increasing levels of taxes are generated directly from employment, as well as payments being made to contractors. Suppliers and contractors will also, in turn, pay their own taxes.

EARLY PRODUCTION

No profit

Recovery of investment.

Value add through additional employment and taxes

Many mining tax regimes include a royalty based on production volumes or revenues; these revenues will start to flow to government even before the operation has made any profit.

Significant employment taxes are also generated, as well as payments being made to contractors. Suppliers and contractors will also, in turn, pay their own taxes.

FULL PRODUCTION

Profitability

Net profit.

Value add through employment, royalties and taxes

Corporate income tax will be paid on profits from production. Royalties and employment taxes continue to be generated, as well as payments being made to contractors. Suppliers and contractors will also, in turn, pay their own taxes.

RECLAMATION

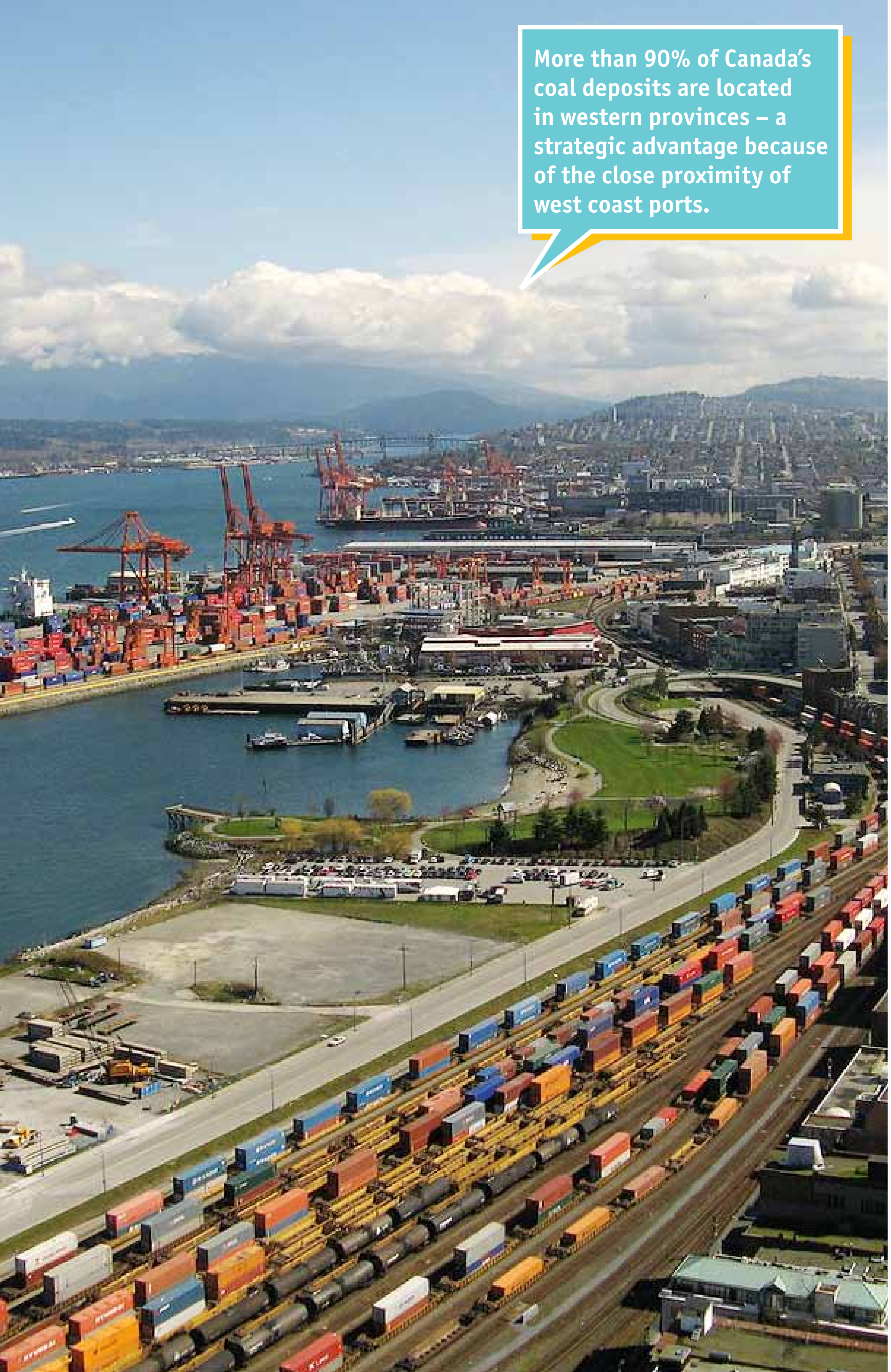
No profit

Closure and rehabilitation costs.

Value add through employment, and taxes

Significant amounts are spent with suppliers in closing down the mine and rehabilitating the land, generating sales taxes and import duties. Employment taxes will continue to be paid. Corporate income taxes may also be paid. Suppliers and contractors will also, in turn, pay their own taxes.

More than 90% of Canada's coal deposits are located in western provinces – a strategic advantage because of the close proximity of west coast ports.



Coal Transportation

Coal is the leading dry bulk commodity transported by rail and handled by ports in Canada. About 80% of Canada's coal exports are shipped through British Columbia. Canada has two major rail operators, Canadian National (CN) and Canadian Pacific (CP), which transport Canadian coal.

- Canada's railroads move over 30 million tonnes of coal annually.
- Recently both CN and CP invested almost $3 billion on infrastructure and fleet upgrades. A significant amount of that investment supports coal shipments.
- Both CN and CP are making major efforts to support the coal industry through increased cooperation and track sharing.

Coal Powers the World

Across the world there are 1.3 billion people without access to electricity.

Without targeted global action, the International Energy Agency (IEA) estimates that in 2035 there will still be 1 billion people without access to electricity and 2.7 billion without access to clean cooking fuels.

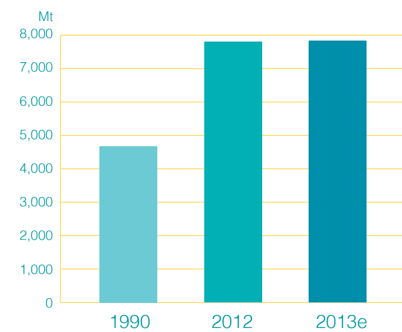
Coal is an essential resource for meeting the challenges facing the modern world. It is fundamental in the creation of steel and concrete, and plays a major roll in providing electricity across the globe.

Coal will play a major role in complimenting renewable energy sources as metallurgical coal and steel are vital components throughout the construction and maintenance phases of renewable energy projects.

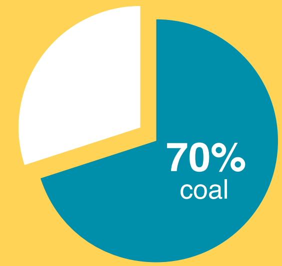
Thermal coal will also play a important roll by addressing energy gaps in wind or solar powered electricity.

Coal mining is a critical contributor to many economies and makes a substantial contribution to improving the livelihoods of many. This is especially true in developing countries, allowing the countries to address the challenges of poverty and development.

Total Global Coal Production



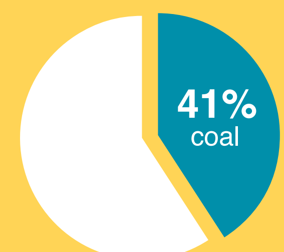
70% of global steel production is dependant on coal



Metallurgical coal and steel are essential ingredients in the creation of all forms renewable energy.

Coal-fired power plants currently fuel 41% of global electricity. In some countries, coal fuels a higher percentage of electricity.

Global electricity generation



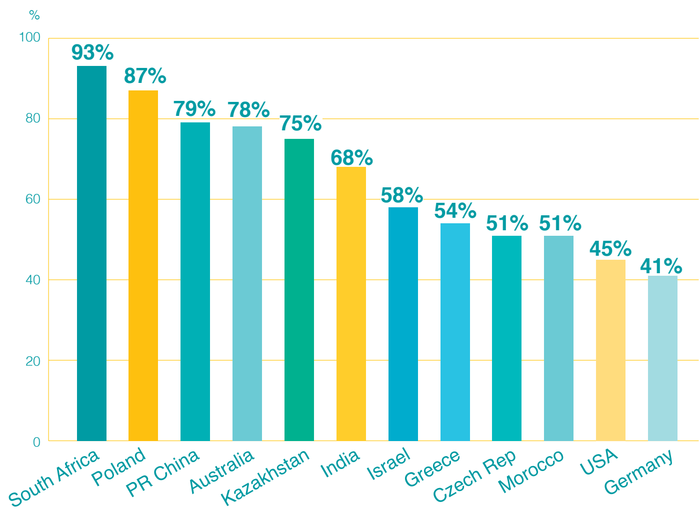
In some countries, reliance on coal for electricity can be upwards of 90%.

Coal and the Generation of Electricity

Modern life is unimaginable without electricity. It lights houses, buildings, streets, provides domestic and industrial heat, and powers most equipment used in homes, offices and machinery in factories. Improving access to electricity world-wide is critical to alleviating poverty.

Coal plays a vital role in electricity generation worldwide. This includes both the metallurgical coal used in the steel required to produce or help transport the electricity, or the thermal coal used in the power stations to generate the electricity.

Global Use of Coal in Electricity Generation



Source: IEA 2012

According to the World Bank, almost 12% of the electricity produced in Canada during 2012 was from coal-fired power plants.

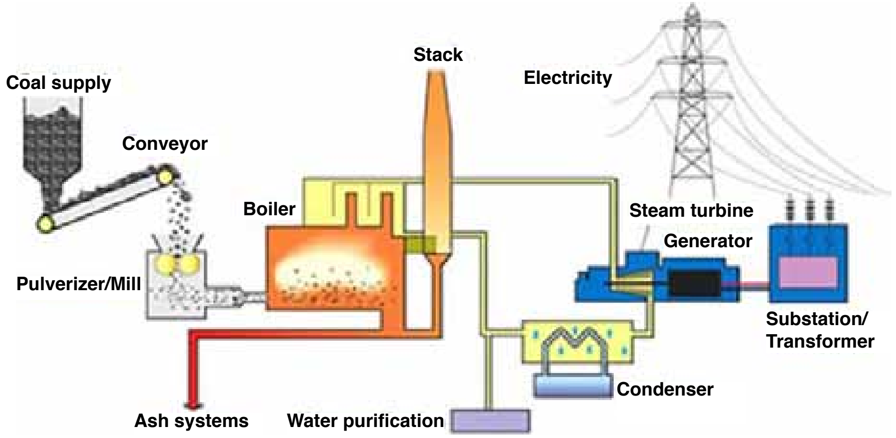
In Alberta, coal fired power plants account for about 43% of the province's generating capacity.

How Coal Is Converted to Electricity?

Steam coal, or thermal coal, is used in power stations to generate electricity. Coal is milled to a fine powder to increase the surface area and burn more quickly. In the pulverized coal combustion (PCC) systems, the powdered coal is blown into the combustion chamber of a boiler and burnt at high temperature. The hot gases and heat energy produced converts water – in tubes lining the boiler – into steam.

The high pressure steam is passed into a turbine containing thousands of propeller-like blades. The steam pushes these blades causing the turbine shaft to rotate at high speed. A generator mounted at one end of the turbine shaft consists of carefully wound wire coils. Electricity is generated when these are rapidly rotated in a strong magnetic field. After passing through the turbine, the steam is condensed and returned to the boiler to be heated once again.

The electricity generated is transformed into the higher voltages (up to 400,000 volts) used for economic, efficient transmission via power line grids. When it nears the point of consumption, such as our homes, the electricity is transformed down to the safer 100-250 voltage systems used in the domestic market.



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Efficiency Improvements

Innovations continue to be made in conventional pulverized coal combustion power station design and new combustion technologies are being developed. These allow more electricity to be produced from less coal – known as improving the thermal efficiency of the power station. Efficiency gains in electricity generation from coal-fired power stations will play a crucial part in reducing CO_2 emissions at a global level.

Efficiency improvements include the most cost-effective and shortest lead time actions for reducing emissions from coal-fired power generation. These improvements are needed particularly in developing countries where existing power plant efficiencies are generally lower and coal use in electricity generation is increasing. Not only do higher efficiency coal-fired power plants emit less carbon dioxide per megawatt, the plants are also more suited to retrofitting with CO_2 capture systems.

Improving the efficiency of pulverized coal-fired power plants has been the focus of considerable efforts by the coal industry. There is huge scope for achieving significant efficiency improvements as the existing fleet of power plants are replaced over the next 10-20 years with new, higher efficiency supercritical and ultra-supercritical plants and through the wider use of Integrated Gasification Combined Cycle (IGCC) systems for power generation.

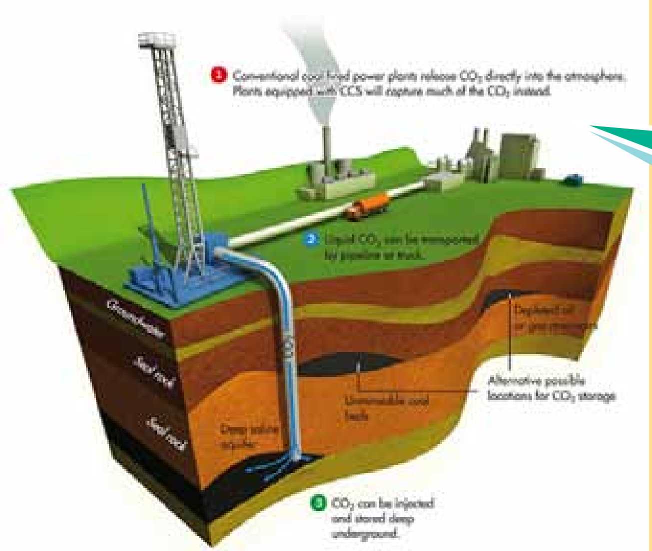
A one percentage point improvement in the efficiency of a conventional pulverised coal combustion plant results in a 2-3% reduction in CO_2 emissions.

Coal Mining Today

There are currently 22 Carbon Capture & Storage (CCS) projects in operation or under construction across the globe. The combine CO_2 capture capactity of these projects is around 40 million tonnes per year.

- Power plants being built today emit 90% percent less pollutants than the plants they replace from the 1970s, according the National Energy Technology Laboratory.
- Boundary Dam Power Station, located in Saskatchewan, has commissioned a fully integrated CCS system capable of cutting CO_2 emissions by up to 90%, or approximately 1,000,000 tonnes a year.
- Coal plants in the 21st century emit 40% less CO_2 than the average 20th century coal plant, according to the World Coal Institute.

A Clean Energy Source



Source: Transition Network

Carbon dioxide is a colourless, odourless gas produced by the combustion of carbon and organic compounds. Carbon dioxide is the most prevalent form of greenhouse gas and is required to sustain plant growth. New coal plant technology captures carbon dioxide.

Carbon Capture and Storage (CCS) technology was developed to capture carbon dioxide emissions and store them in deep geological formations. CCS technology was developed in response to rising environmental concerns relating to greenhouse gas emissions.

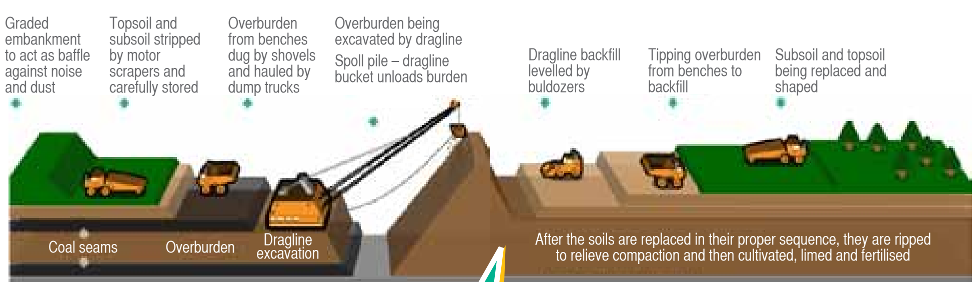
Mining Coal

Coal is mined by one of two ways: surface and underground mining.

The majority of coal in Canada is produced by surface mining methods utilizing either strip mining or open pit mining techniques. The method used is mainly determined by the geology and depth of the deposit. The strip ratio – the total volume of waste rock removed to the total volume of coal mined –typically is the largest determinant of cost and the deciding factor between surface and underground mining. In coal, strip ratios are stated in bank cubic metre waste per tonne of coal (BCM/t) rather than cubic metre waste to cubic metre of ore mined as in base metal mining.

Surface Mining

The surface mining method uses large electric or diesel-powered shovels or draglines to remove overburden, or heavy rock covering the coal, which is used to backfill pits after coal removal. Shovels load coal into haul trucks for transportation to the coal preparation plant or transportation loading facility. Productivity depends on equipment, geological composition and the ratio of overburden to coal.



Source: The World Coal Association. Copyright permission by the World Coal Association, London, UK. www.worldcoal.org

Drag-line: a piece of heavy equipment used in surface mining to excavate large volumes of coal. The dragline moves the waste rock – in special applications it will be used to mine the coal. This system uses a large bucket suspended from a boom with wire ropes or chains.

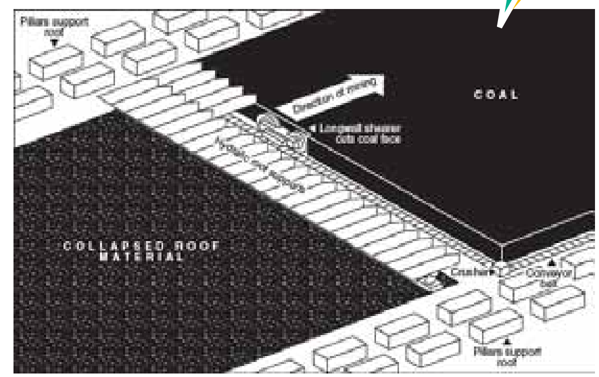
Underground mining uses either longwall or room-and-pillar techniques.

Longwall Mining

Longwall mining is an underground mining method that uses hydraulic shields, varying from five feet to 12 feet in height, to support the roof of the mine while a shearing machine traverses the coal face removing a two to three foot slab of coal with each pass. An armored face conveyer then moves the coal to a standard deep mine conveyer system for delivery to the surface.

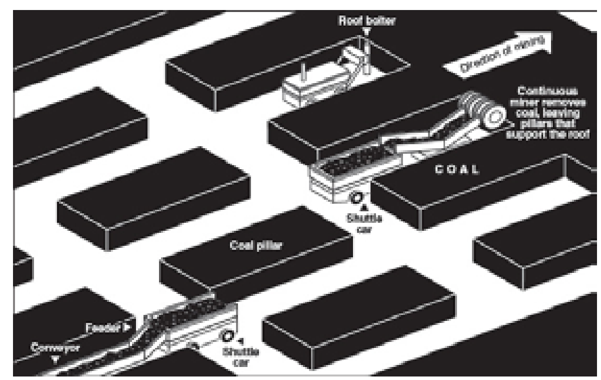
Underground mining is a mining technique used to extract coal from a seam buried deep within a geological formation.

The following diagram illustrates a typical underground mining operation using longwall mining techniques:



Room-and-Pillar Mining

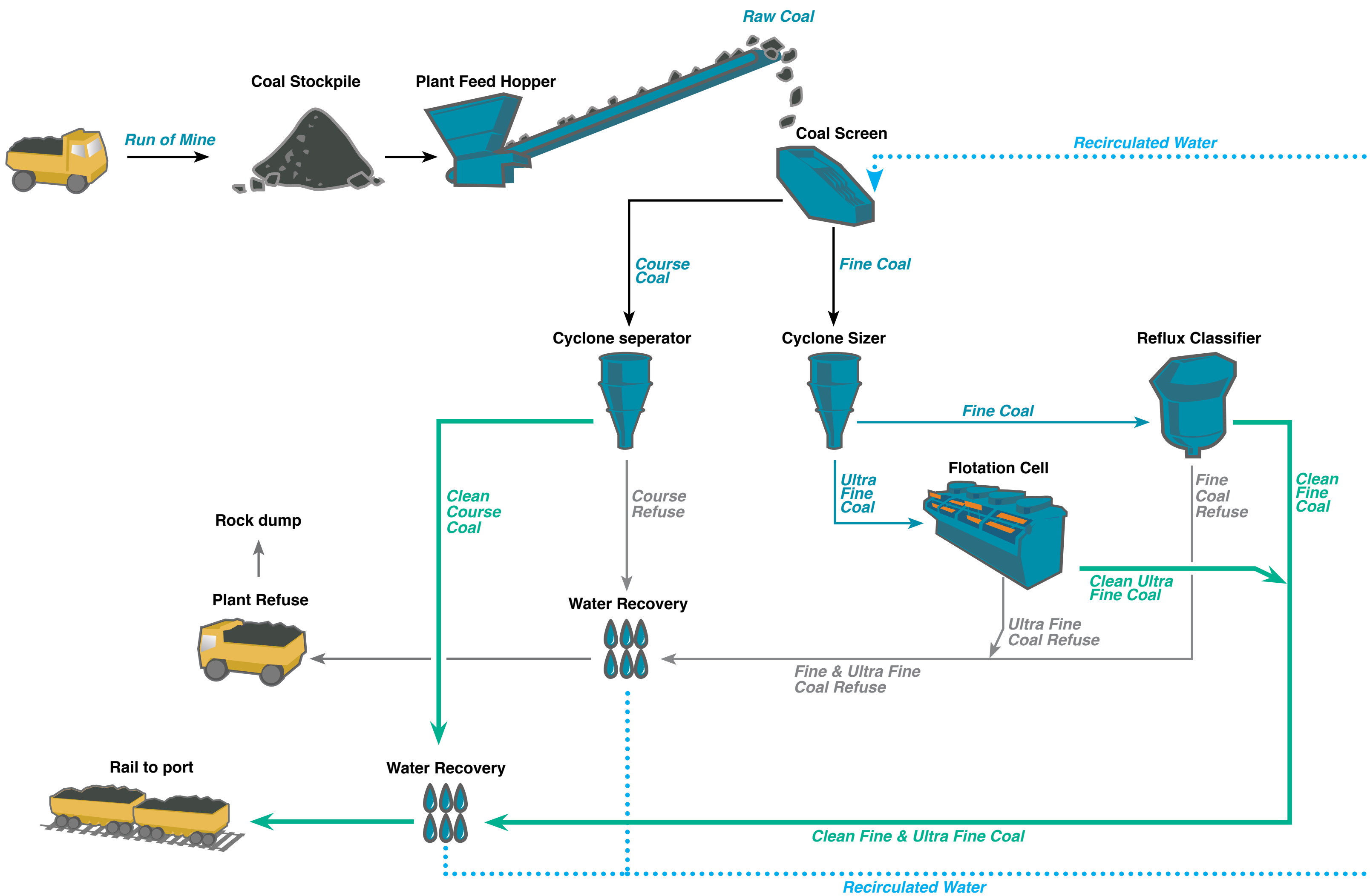
The room-and-pillar mining method uses a technique where pillars of coal are left behind to support the roof as the continuous mining machinery advances. Pillars may be subsequently mined to allow the roof to cave in after mining. Room-and-pillar mining is generally more capital-efficient than longwall mining. Room-and-pillar uses mobile machinery that can be significantly lower capital cost than long-wall mining equipment.



Source: Patriot Coal

A typical coal preparation plant will include crushing, screening, heavy media and flotation circuits.

Coal mined straight from the ground, or run-of-mine (ROM) coal, can be inconsistent in size and often contains impurities such as ash. The treatment of ROM coal to convert it to a more consistent quality is referred to as coal beneficiation or coal washing. Processed coal suitable for the end user's purpose is referred to as saleable or clean coal.



Sustaining the Environment

Reclamation at Cardinal (Teck) coal mine in Alberta
Photo courtesy BC TRCR

Mining activities involve areas of land being temporarily disturbed. Through progressive reclamation, continuous monitoring of the surrounding environment, and implementation of control measures through operational changes, the industry has reduced the environment effects of its activities.

Land Disturbance

The collection of environmental baseline data prior to the development of a mining operation helps identify any existing conditions and potential concerns from a proposed mine. The data is used in various models to identify potential impacts from mining on surface and ground water, soils, local land use, native vegetation and wildlife populations. Prior to any disturbance, the findings are reviewed by technical parties, local stakeholders and government authorities prior to the awarding of a mining permit by the relevant government authorities.

Water use

Mine operators strive to reduce water demand through efficiency, technology and the use of lower quality and recycled water. The water around a mine site is constantly being monitored with reports being presented to local regulators. Water which conforms to applicable regulations, can be discharged into surrounding water courses, while other water can be reused for dust suppression and in coal preparation plants.

Rehabilitation

Mining is a temporary use of land and it is vital that reclamation of the land takes place during or soon after mining operations have ceased. In Canada, prior to receiving an approval to mine, a reclamation plan must be designed and approved, covering the period from the start of operations until well after mining has finished.

As mining operations cease in one section of a surface mine, equipment is used to reshape the disturbed area. Drainage within and off the site is carefully designed to make the new land surface as stable and resistant to soil erosion as the local environment allows.

Mine reclamation activities are undertaken gradually – with the shaping and contouring of overburden piles, replacement of topsoil, seeding with grasses and planting of trees taking place on the mined-out areas. Reclaimed land can have many uses, including agriculture, forestry, wildlife habitation and recreation.

Companies carefully monitor the progress of rehabilitation and may prohibit the use of the land until the vegetation is self-supporting. The cost of the rehabilitation of the mined land is factored into the mine's operating costs.

Where the mining is underground, the surface area can be simultaneously used for other uses – such as forests, cattle grazing and growing crops – with little or no disruption to the existing land use.

Underground mining and Subsidence

A thorough understanding of subsidence patterns in a particular region allows the effects of underground mining on the surface to be quantified. The industry uses a range of engineering techniques to design the layout and dimensions of its underground mine workings so that surface subsidence can be anticipated and controlled. This ensures the safe, maximum recovery of a coal resource, while providing protection for other land users.

What have we learned?

Metallurgical coal and Thermal coal while similar in origin, are completely different in their respected use.

Metallurgical coal & steel are essential ingredients to almost everything we use today.

Canada is the 3rd largest metallurgical coal exporter across the globe and has some of the largest coal reserves in the world.

The Coal industry provides substantial local benefits via employment and is a financial contributor to government programs through royalty and tax payments. The royalty and tax payments help build schools, hospitals and roads which enrich the lives around us.

Coal mining temporarily disturbs concentrated areas of the land. Through progressive reclamation, continuous monitoring of the surrounding environment and operational control measures, mining companies have been able to reduce the environmental effects and rehabilitate the landscape to a productive state for future generations.

Sphinx Lake reclamation at Cardinal (Teck) coal mine in Alberta

Fisheries habitat and population monitoring indicates that Sphinx Lake meets all of the hydrological, physical and chemical criteria for an ecologically healthy lake.

Photo courtesy BC TRCR

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