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A STUDY ON "THE ROLE OF COAL"

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ABSTRACT

Coal is at the centre of debate on energy and climate policy. In a growing number of countries, the elimination of coal-fired generation is a key climate policy goal while in others; coal is abundant and affordable and remains the key source of electricity. Ultimately, despite significant media attention being given to divestments and moves away from coal, market trends are proving resistant to change.

INTRODUCTION

Coal has dominated the world energy scenario since the Eighteenth century, up to 1970 and in 2013 it accounts for approximately 28.9% of the primary consumption of energy. In the years between 2003 and 2006, it is estimated that coal demand increased almost 67%; China accounted for 73% and if we also consider India, the percentage rises to 82%. China is the leading producer and consumer in the world: in 2015 coal consumption in China amounts to 1920 million tonnes per year, with a production of 1827 million tonnes per year. The greatest limit of coal is that it is the most polluting source of energy and it negatively affects the state of the climate. When compared to natural gas, production of one kilowatt-hour of electricity from coal generates more than twice the amount of nitrogen oxide, eight times the amount of heavy metals, ten times the amount of fine dust, and it also produces a large amount of sulphur oxides.

Keywords: History of Coal, Coal knowledge, Use of Coal, Extraction and Distribution, Environment and territory, etc.

HISTORY

The age of coal starts towards the mid 1600s, stimulated by the need for finding an alternative energy source to wood. Up to then, wood had been the most commonly used energy source, and also a good building material; however, the excessive exploitation of woods led many European countries to progressively destroy their forests, and wood started to be rare. Pit coal emerged as the best available alternative. It was present underground in many countries of central Europe and was a very suitable energy source for the first steam engines. In a few decades the demand for coal increased remarkably to provide energy to the increasingly flourishing European industry. In particular, England, thanks to its large coal fields, took an economic advantage and consolidated its technological and industrial supremacy. Starting from 1750 the Industrial Revolution began in England, leading to radical changes in the economic and social systems. Then it spread to the other European countries and reached the U.S. too. The enthusiasm for the "coal rush" led to an increasingly intensive exploitation of coal fields especially in England, Russia, Germany and France. During that period the world coal output passed from a little more than 10 million tonnes in 1700 to approximately 70 million tonnes in 1850 and 800 million tonnes in 1900. Up to 1960 coal was the most widely used fossil fuel, then is suffered from the competition of oil, the extraction and transportation of which were easier. The role of coal is still important as an alternative fuel to oil. The size of its ascertained reserves in 2013 (i.e. the reserves known at present which can be exploited with an economic advantage) world-wide is remarkable: approximately 891,5 billion tonnes of coal as compared to 239,4 billion tonnes of oil. The current consumption rate (in the absence of new discoveries or the opening of new fields currently not exploited because they are too expensive) the ascertained reserves of coal will last for 110 years, i.e. a longer time than that forecast for other hydrocarbons (58 years for natural gas and 51 for oil) but still a finite period.

COAL KNOWLEDGE

Coal is a fossil fuel just like oil and natural gas. Unlike them, coal is a solid fuel and as such it is the most exploited solid fuel for the production of electric energy in the world. Their different state is explained by the different origin of such three fuels. Whereas oil and natural gas come from the rests of microscopic organisms living in water (plankton, seashells, coral, etc.) deposited at the bottom of ancient seas, coal formed from the rests of plants of the past,

the structure and form of which, albeit modified, can still be identified by means of a microscope. Carbon is the main component of coal after the other basic components of the original living matter (hydrogen, oxygen and nitrogen) progressively decayed during chemical and physical processes transforming it. The combustion of coal frees the energy of the sun stored in plants thanks to the photosynthesis millions of years ago: therefore it is an invaluable container of "fossil" solar energy.

WHERE IS THE COAL

The favourable environment for the formation of coal includes the vast coastal, lagoon(pond) or swampy(wet) plains where in the past the hot and humid climate developed a rich vegetation. The low sinking of the soil led the vegetal organisms to be quickly buried by sand and clay carried by rivers. Underground, in the absence of oxygen, the vegetal matter pressed by the weight of sediments and owing to the heat undergoes a process of compression and slow transformation into materials progressively poorer in water and rich in carbon. Peat is the first result, i.e. an accumulation of partially decomposed vegetal organism full of water. Then lignite, a brown and soft type of coal containing 70% carbon. Then lythanthrax, the most commonly coal used to produce electric energy containing the highest carbon percentage (from 93% to 98%). It is the best and less polluting coal (with a high calorific value), but is not widely used because it is hard to find and consequently very expensive. The formation of coal fields required from millions to hundreds of million years, according to the final product. 95% of coal fields are in the northern hemisphere (almost 60% shared between China, USA and former USSR). In Europe, the belt of large fields covers central-northern countries: Great Britain, northern France, Belgium, Holland, Germany, Poland and Russia. Italy has small quantities of "poor coal" (lignite). That unequal distribution depends on the fact the formation of great masses of vegetal rests calls for dry land and ad hoc climate. In the Palaeozoic age (from 530 to 245 million years ago), the regions of today's central Europe were occasionally invaded by shallow seas: the optimum condition to develop abundant vegetation and slowly transform it into coal. On the contrary, today's regions of southern Europe date back to the Mesozoic age (from 245 to 65 million years ago) or are more recent, and formed in the sea far away from the coats: that is why they contain small unimportant coal fields.

USES OF COAL

Coal is a widely used energy source and it is the main fuel source for the production of electric energy. Many countries strongly depend on electricity deriving from coal: in 2015 China consumed 1920 million tonnes, India 407 million tonnes and USA 396 million tonnes. In electric energy plants the coal is burnt to heat water until it turns into steam that, under pressure, turns a turbine, which is connected to a generator. The mechanic energy of rotation is then transformed into electric energy. Moreover, in developing countries the use of coal is still important for household tasks: heating and food cooking. The steel and metal industry uses coke: it is a solid and hard fuel obtained by heating the coal at high temperature. Coke is the raw material to produce steel. Other industrial processes use coal gases to produce fertilisers, pharmaceuticals, pesticides, etc. Tar is also obtained from coal through distillation. The natural dislike of its colour and smell did not prevent the chemistry experts of the 1700s from discovering its virtues: wood painted with tar becomes water proof and resilient against microbes. Moreover, in developing countries coal is still used for household tasks: heating and food cooking.

EXTRACTION AND DISTRIBUTION

Coal extraction

The set of operations leading to the identification of coalfields and to their assessment is called mining prospecting. As with oil, an analysis of airplane pictures is conducted to identify physically interesting areas, and then soil samples are studied to get more detailed information. After having identified the coalfield and its position and shape, the mine building site is started. If the coal is found at a depth not exceeding 30 m, it is extracted in open pit mines, where the field is made accessible after the elimination of the top layers of rocks and soil by means of explosive charges. If the coal is deeper than 30m, the field is accessed by digging underground mines including at least two galleries to let miners and machines reach the coal.

In open pit mines the coal is extracted after having removed the rocks above. In the case of underground mines, the extraction is carried out in two ways: the method of “abandoned pillars” and that of “long faces”. The first method consists in extracting coal while leaving “pillars” to support the roof of the mine. The second method envisages the use of a series of supporting structures called “scaffoldings” which can be easily removed and support the roof in the mining area. While the extraction goes on, the scaffoldings are removed and the roof

collapses. The two methods differ in terms of their impact on the ground. The removal of coal, if the mine is not supported, leads to a more or less gradual sinking of the ground above it. In environmentally valuable areas, the method of abandoned pillars is preferred. In other areas the preference goes to the long faces, which, thanks to a more intensive exploitation of the mine, lead to a coal output, which is 4/5 times greater. After being extracted, coal is processed in order to make it suitable for commercial needs. In particular, it is milled and riddled to obtain the size required on the market and is washed to remove impurities. Mine rehabilitation Coal mining has impacts on superficial and underground waters, soil, local land use and native flora and fauna. Each mine must have a reclamation or rehabilitation plan that covers all the phases of the mine lifecycle. The reclamation activities must be undertaken gradually: the land contour must be restored, the topsoil replaced and vegetation replanted on the mined out areas. Both before and during the mining activity, extreme care must be taken to preserve the wildlife, historical sites and all the resources of particular value to the territory. During mining operations, dust pollution, noise pollution and water contamination must be minimized. When mining activities have stopped, disused mine pits can be utilised to build tanks or for recreational activities using water. The reclaimed land can be put to use in different ways: for agriculture, forestry, recreation, building areas for industries or wildlife habitation and habitat. Today the coal industry is committed to protecting the environment and land rehabilitation is an integral part of most of the mining activities. Coal mining companies are investing a lot (in both expertise and financial resources) to restore the land to a condition that is equal to or better than the pre-mining one. Treatment, transport and storage The market requires coal to have a high quality and purity.

The coal extracted from mines contains a mixture of fractions of different sizes, sometimes containing rocks or compost. Therefore a preparation stage is needed, called “beneficiation” and the raw coal is divided into a series of clean, uniform and classified products, ready to be sold. In some cases raw coal has a high quality that satisfies consumers’ needs. In these cases the “beneficiation” is not necessary and the coal can be simply broken into pieces and sieved in order to obtain a specific product. A good preparation of coal before its combustion increases the homogeneity and efficiency of this combustible reduces transport costs and its displacement inside the plant produces less dust and reduces the emission of sulphur oxides. Once coal has been extracted, it is necessary to transport it to the plants where it will be used. For short distances, trucks will be used, while for longer distances trains, barges and ships will be employed. Recently coal pipes have been tested: the mineral is pumped after being

transformed into dust and mixed with water. Preventive measures are taken at any stage during transport and storage, in order to reduce any environmental impact. For example, the superficial flow of contaminated water is limited by the design of storage equipment and all waters are carefully treated before being reused and disposed of. The dusts can be controlled by using water spray and compacting the coal to be stored. Road or sea transport systems can be used to transport the coal from the storage place to combustion sites. However, more than 60% of the coal used to produce energy is consumed at 50 km from the extraction mine.

ELECTRIC PLANTS WITH COAL

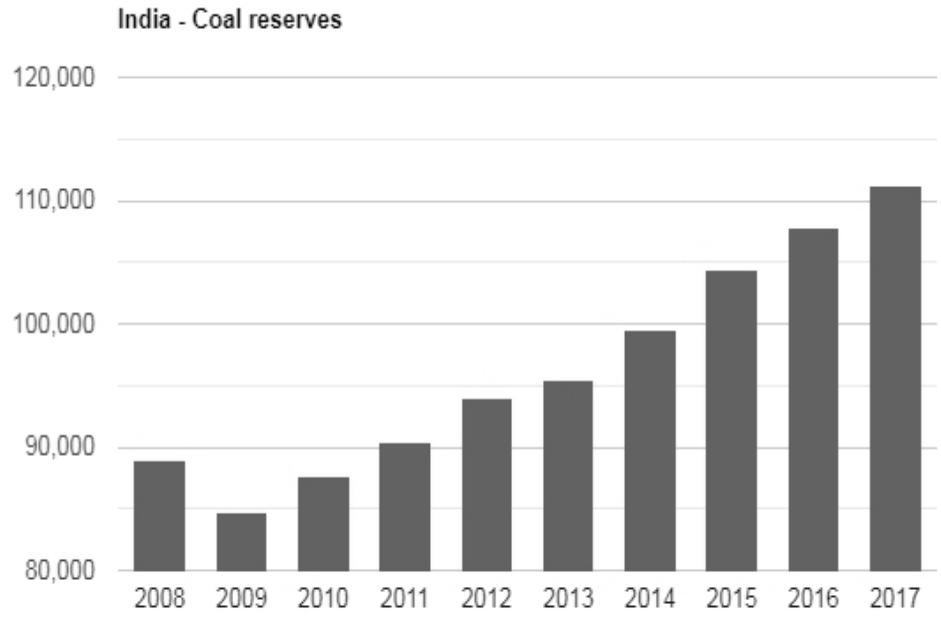
Due to its wide availability, assured supply, competitiveness and its very safe handling, transport and use (it is not inflammable, nor explosive, nor polluting for the soil or water), coal is the primary fuel for the creation of electric energy in the world and in Europe. The first step for energy creation in a coal plant starts in the steam generator area, where the burners are located for the combustion of coal fuel oil. The steam generator is generally made up of a furnace where air and fuel are inserted. When they burn, they heat and vaporize the water that runs in the pipes and serpentines that form the generator. In modern plants the coal is first grilled into very fine dust by increasing combustion speed; it is then driven to the kiln combustion chamber, where it is burnt at 1400°C. The high temperature of combustion gases determines the transformation of the boiler water contained in the pipes into steam. The vapour, through big pipes, reaches the turbine and makes it turn at 3000 turns per minute. The turbine is a machine that converts the kinetic energy of a moving fluid (liquid or gas) into mechanic energy. With regard to coal plants, the fluid is superheated steam. The main element of the turbine is the rotor, made up of a wheel with “blades”. The mechanic energy is then transmitted, through an axle, from the rotor to an electric generator, called alternator. The alternator, connected to a turbine, produces electric energy. The fumes, once they have released their heat into the steam generator, are sent to the chimney after having passed through the denitrificators, dust collectors and desulphurizers in order to eliminate nitrogen oxides, dusts and sulphur dioxide. The steam, after transmitting a large part of its energy to the turbine, is driven to the condenser where, without ever getting in contact with it, transfers its residual heat to the seawater collected with adequate pumps. This steam is then transformed into water, which is taken back to the steam generator in order to repeat the cycle. The energy produced by the alternator is subject to a tension increase of up to 380 kilovolts in order to be introduced into the electric network.

ENVIRONMENT AND TERRITORY

In certain production sectors coal is still an important energy source. At present 39% of the world-wide electric energy output is obtained by burning coal. Moreover coal plays a vital role in the production of steel. On the other hand, the size of its reserves still does not envisage any problems in terms of depletion in the future. Moreover, the use of coal was decisive in the past for the industrial development and the prosperity of European countries, whereas today it is questioned because of the high pollution level deriving from its use as a fuel. The combustion of coal generates great quantities of carbon dioxide (CO2), greater than those produced by oil or natural gas. It should be remembered that carbon dioxide is the main culprit for the greenhouse effect, i.e. the increase of the earth's temperature. All fossil fuels produce greenhouse gas and coal contributes by slightly less than 20% to the greenhouse effect increase. Other polluting gases generated by the combustion of coal are nitrogen oxides (NOX) and sulphur oxides (SOX) which, by combining in the atmosphere with steam, turn into nitric acid and sulphuric acid and cause acid rain, which damage the vegetation and surface water. At the moment 100% of ashes and chalk produced from coal are recycled. In fact, they are used for the production of concrete, cement, road floors, and building products.

INDIA COAL RESERVES

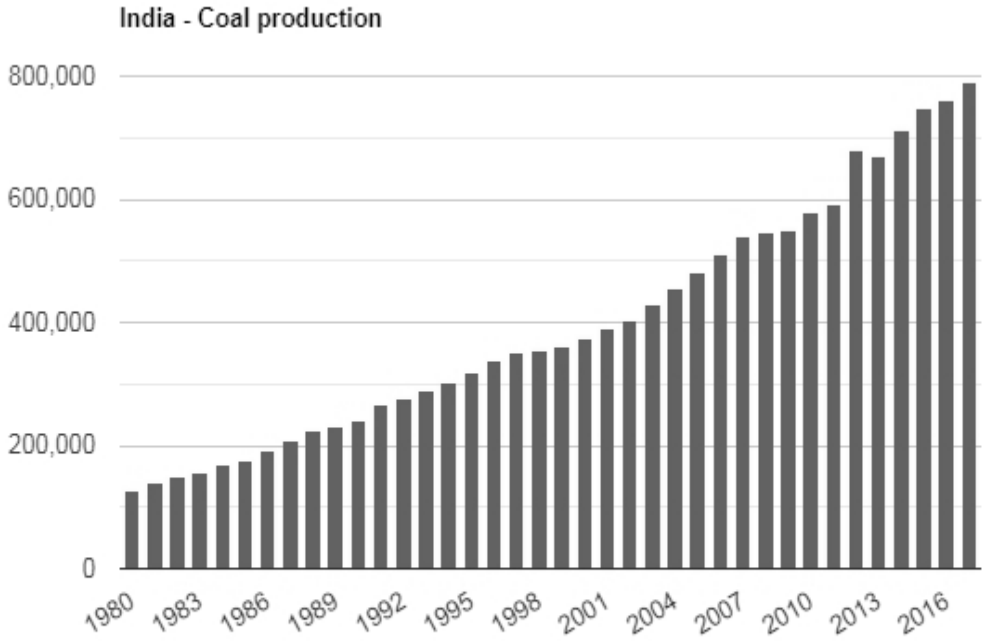
India: Coal reserves, million short tons: For that indicator, The U.S. Energy Information Administration provides data for India from 2008 to 2017. The average value for India during that period was 96414.7 million short tonnes with a minimum of 84772.05 million short tonnes in 2009 and a maximum of 111190.56 million short tonnes in 2017.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

INDIA: COAL PRODUCTION, THOUSAND SHORT TONS

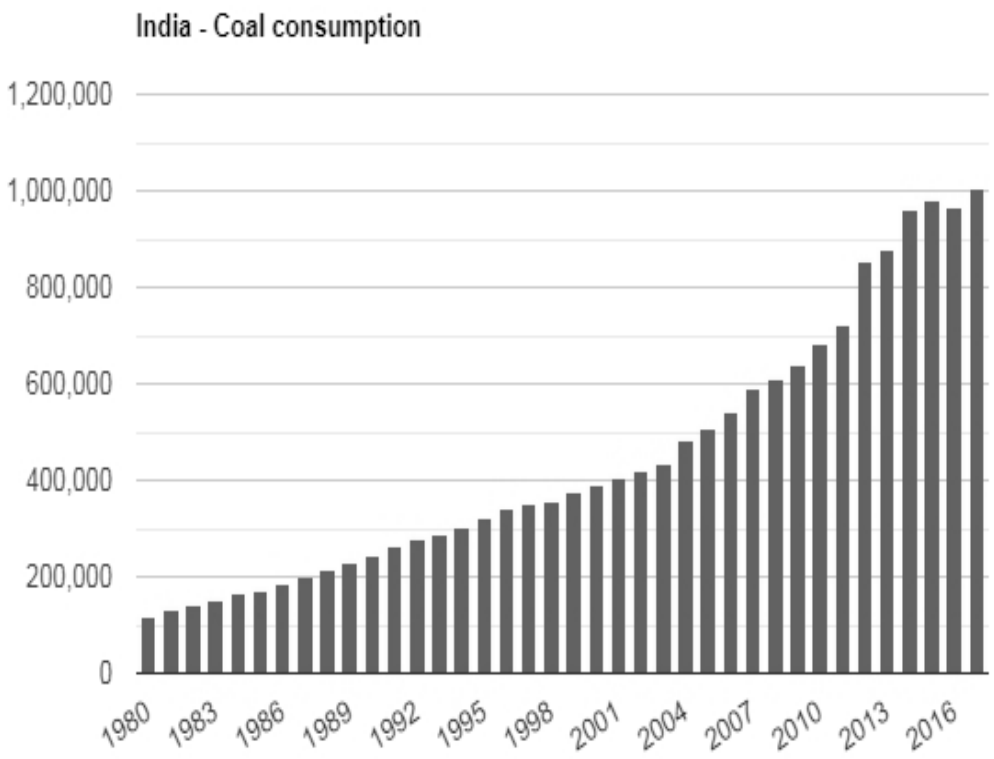
For that indicator, The U.S. Energy Information Administration provides data for India from 1980 to 2017. The average value for India during that period was 396659.31 thousand short tons with a minimum of 127989.21 thousand short tons in 1980 and a maximum of 790476.19 thousand short tons in 2017.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

INDIA: COAL CONSUMPTION, THOUSAND SHORT TONS

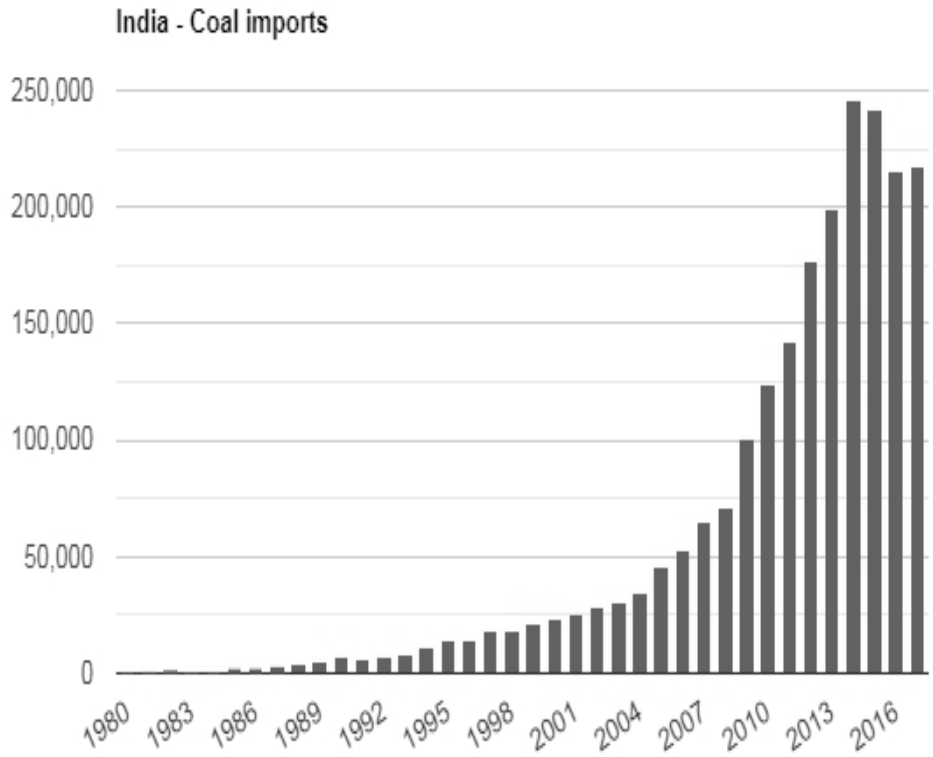
For that indicator, The U.S. Energy Information Administration provides data for India from 1980 to 2017. The average value for India during that period was 444718.36 thousand short tons with a minimum of 118600.73 thousand short tons in 1980 and a maximum of 1007229.06 thousand short tons in 2017.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

INDIA: COAL IMPORTS, THOUSAND SHORT TONS

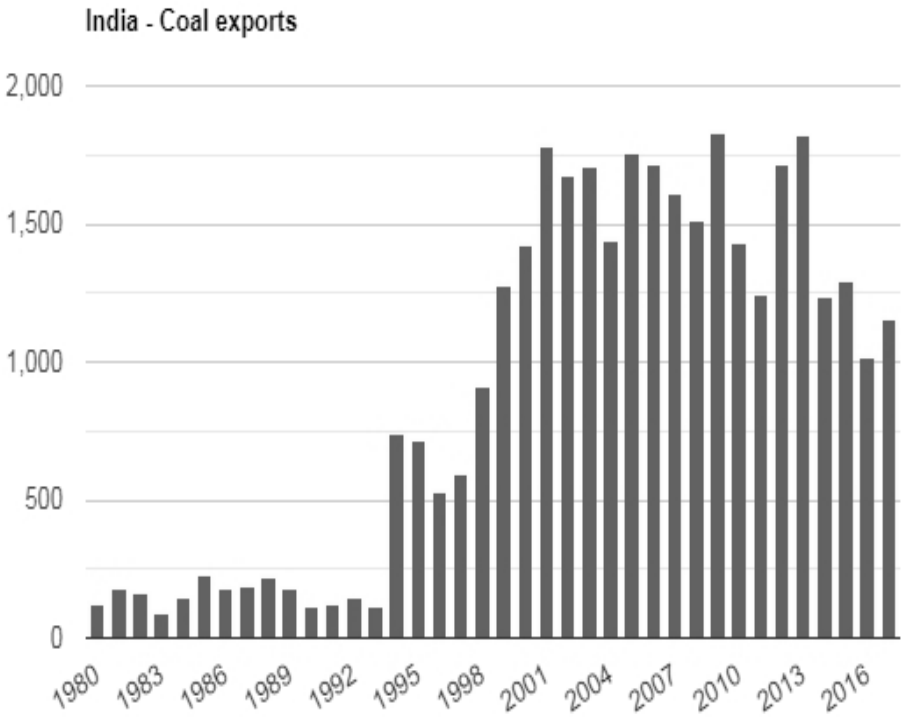
For that indicator, The U.S. Energy Information Administration provides data for India from 1980 to 2017. The average value for India during that period was 57544.07 thousand short tons with a minimum of 507.06 thousand short tons in 1983 and a maximum of 245712.33 thousand short tons in 2014.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

INDIA: COAL EXPORTS, THOUSAND SHORT TONS

For that indicator, The U.S. Energy Information Administration provides data for India from 1980 to 2017. The average value for India during that period was 902.58 thousand short tons with a minimum of 88.18 thousand short tons in 1983 and a maximum of 1830.89 thousand short tons in 2009.



Source: TheGlobalEconomy.com, The U.S. Energy Information Administration

CONCLUSION:

Coal is the nation's most abundant fossil fuel yet, it is used to fill only certain percentage of the nation's energy needs. Well identified recoverable coal reserves exist within the United States in sufficient quantity and with suitable mining characteristics to provide an annual production 3.5 times the 1976 production for the next 100 years. Filling these requirements at a reasonable cost requires that the recent decrease in coal productivity per man-day, particularly in underground mining, be reserved without sacrificing health and safety standards. An increase in productivity will decrease coal mine capital and operation cost and each ton of increased productivity per man-day can be expected to save nation approximately $7 billion in the price paid for coal over the next 10 years. A reduction in strikes, absenteeism and labour turnover and an improvement in worker training and acceptance of grievance procedures would make important contributions to improved productivity.

Reference: 1. Source: International Energy Agency (IEA) – Key World Energy Statistics 2015.

2. Source: BP Statistical Review of World Energy 2016.
3. Fonte: eni, World Oil & Gas Review 2015; BP Statistical Review of World Energy 2016.
4. Source: BP Statistical Review of World Energy 2016.
5. Source: The U.S. Energy Information Administration.

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