Pages: 8 Vol: X Special Edition
July 08 — 14, 2019
www.TechnologyTimes.Pk

Technical insight of Thar Coal Mining Project

Ali Iqtidar

With a rising population and an expanding economy, Pakistan's energy needs have outpaced its national energy supply. Exacerbating the demand-supply gap is Pakistan's unsustainable power generation fuel mix, which contains a high share of oil-based power generation up to 32%, resulting in high cost of electricity production. Moreover, there is a heavy reliance on imported fuels which results in constant depletion of foreign exchange and insufficient control over the fuels supply chain. This inappropriate fuel mix leads to energy losses at each level of the value chain and inadequate recoveries lead to power outages, unaffordable electricity and circular debt. There has been a 5,000-7,000 MW shortfall in the country during peak hours, which has resulted in almost 8-12 hours of load shedding in various parts of the country. The sustainability of Pakistan's power sector would only be possible if the power distribution system is improved by controlling electricity theft, inefficacy and improvising recoveries.

Thar Coal Mining project is being undertaken by Sindh Engro Coal Mining Company (SECMC) - a Joint Venture Agreement (JVA) between Government of Sindh (GoS), Engro Energy Limited (formerly Engro Powergen Limited) and its Partners namely; Thal Limited (House of Habib), Habib Bank Limited (HBL), Hub Power Company (HUBCO) and China Machinery Engineering Corporation (CMEC); whereas Houlinhe Open Pit Coal Mine, subsidiary of SPI (State Power International) Mengdong (SPIM), formerly CPIM, has joined the SECMC board as strategic investor with preference shares' subscription. The total allocated area of 95.5km2 has been leased to SECMC for 30 years, further extendable to another 30 years for extraction of coal. The approximate project cost for the 3.8 Mt/annum coal mine is expected to be USD ~845 Mn with a construction timeframe of 42 months. However, SECMC is ahead on the completion schedule of the project by about 4 months and under the projected cost by a margin of 10%.

Bankable Feasibility Study (BFS) was developed by Sinocoal International Engineering Research & Design Institute of China, RWE of Germany, SRK (UK) and Hagler Bailly, Pakistan in 2010, for a Mine capacity of 6.5 Mt/annum. The study concluded that the project is technically, commercially, environmentally and socially feasible. In 2012-13 RWE amended the original Feasibility Study for the Mine size of 3.8 Mt/annum, which was done to reduce the capital cost of the overall project. In 2016, Xenith Consultants also developed a Competent Person Statement (CPS) for the Lignite Resources in Thar Block II, confirming that the total resources in Thar Block II are 2.4 Bn tons of which 1.030 Bn tons are measured while 0.740 and 0.630 Bn tons are indicated and inferred resources respectively. The Thar mining project is categorized amongst the 'early harvest' projects under CPEC to generate electricity utilizing Thar's untapped coal reserves. The total planned mining capacity of the project will be 20.6 Mt/annum with a capacity to scale it to 30.4 MT/annum while the power generation capacity is projected to be ~5000 MW at full capacity.

The geology of the Thar Coal Block II is not very complex, having Aeolian sand overlaid on alluvial limonitic siltstones. It encompasses of three main stratigraphic sedimentary formations i.e. Bara - coal bearing (oldest), sub-recent and dune sand (youngest). Coal is bounded with unconformity from top and bottom while the basement is granitic. Block II mining operations are ongoing since Apr 2017 with the aim to produce 3.8 Mt per annum of coal as part of first phase. The initial mine surface area is 1.60 Km2 whereas the targeted pit bottom depth is 190m. The designed box-cut size is 600m*200m and mine will advance 200m per annum to meet annual coal production target. The average stripping ratio of phase 1 mine is 6.1, and the total overburden volume estimated is 112 Mm3. To date, the project is nearly on its completion with 4 months ahead of schedule and has extracted the first coal from Thar Block-II in Jan 2019 from 150 meters below the surface. Power generation from Thar Coal extracted from Block II mine commenced on 10th Apr'19 when electricity from the both the units was successfully pumped into the system by Engro Powergen Thar (Private) Limited.

Detailed Environmental and Social Impact Assessment (ESIA) studies have been conducted for both mining and pow-

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Thar coal: claims vs facts

Ajaz Ali Khan

The total lignite reserves estimated by Geological Survey of Pakistan in Thar are around 175 billion tons which are spread over an area of 9,000 square-kilometres. The US Geological Survey also undertook the estimation of Thar coal reserves and issued a report in 1994 confirming the presence of huge lignite coal reserves. The Asian Development Bank carried out a study on Thar in 2007 which says: "Figures provided by the Geological Survey of Pakistan (GSP) state that the resource has a potential of 175 billion tons… From examination of the detailed material provided by the GSP, there is no reason to doubt that a resource exists of the scale claimed".

As per the US Geological Survey format, Thar coal resources are categorised in measured (proven), indicated and inferred categories based on the spacing of drill-hole data which is collectively called 'total reserves'. Measured (proven) reserves: located within 400-metre radius of the drill hole. Indicated reserves: located within 1.2-kilometre radius of the drill hole. Inferred reserves: located within 4.8-kilometre radius of the drill hole. Sindh Engro Coalmining Company (SECMC), a joint venture of Engro PowerGen and Government of Sindh for coalmining in Thar Block II, has utilised previous studies to confirm the reserve situation. It has already developed a geological model to identify the initial and final mining areas. It has been confirmed that total reserves for Block II are above two billion tons and are enough to supply fuel for power plants of more than 4,000MW capacity for at least 30 years of operation.

Thar reserves could be compared to Saudi Arabia's oil reserves in terms of energy contents. The calculation can be done by converting the total energy of Thar coal reserves into tons or barrels of crude oil. As for the lenders' interest in the financing of coal projects, in past the World Bank has financed a

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er projects in Thar Block II by international consultants SRK-UK and Hagler Bailly. Strategic ESIA study for the 3,960 MW power park in Thar Block II has also been conducted by Hagler Bailly. As per the latest environmental audit report, mining project is fully complaint with NEQS and SEQS standards while power project is also fulfilling with IFC guidelines on emissions indicating that present CO2 emissions from Thar Coal combustion are negligible. Incremental impact on ambient air quality are also within the standard guidelines.

Thar coal mine is being operated with shovel and truck mining technology having 18 shovels of 7m3 and 125 dump trucks of 30m3. Several auxiliary equipment's are also in-placed like wheel loaders, crawler bulldozer, grader, vibrating roller, hydraulic backhoe and water sprinkler. On the later stages of the mine i.e. during mine expansion, the combination of bucket wheel excavators with shovels and trucks technology will be adopted.

Thar Coal Block II generally consist of three underground aquifers. Since all the coal seams/ sequence are interbedded between coal seam roof (2nd Aquifer) and coal seam bottom aquifer (3rd Aquifer), continuous depressurizing and dewatering (underground and surface) of these aquifers is of vital importance in order to mine Thar coal. The geological and hydrogeological situation of Thar coal field suggests that the most appropriate proposed method of mine dewatering will be by utilizing advance borehole dewatering technique. Presently, robust dewatering network is installed at Block II mine which includes 27 mine peripherals with 06 in-pit dewatering wells. The surface drainage system is also installed by constructing drainage ditches and sumps at benches and mine bottom where pumps being installed. The overall dewatering volumes extracted from the start of dewatering operations (Apr'17) to date (May'19) is 58 Mm3 aiming to achieve 65 Mm3 dewatering volumes until project commercial operations date.

A key element of water management is the use or disposal of the pumped water. The dewatering volumes from Block II mine are presently being utilized in various green drive and bio-saline projects located at mine periphery. The pumped water is also being used as part of mining operations like water sprinkling and for dust suppression. The remaining groundwater volumes are disposed-off through a 26 Km long pipeline to Gorano pond (5.79 Km2 area) located at the south of Block II. This pond has been selected due to its huge natural depression and adequate hydraulic capacity of dune sand to receive and percolate the water without causing downstream flooding to nearby villages. However, nearly half of the disposed-off groundwater volume influx (from mine to Gorano pond) has now been directly diverted to mine mouth power plants after their recent commissioning.

Thar region is a desert place where diversity of plants and micro-organisms is poor due to surface water scarcity (rivers and streams) and lack of rainfall. Because of the disposal of Block II mine groundwater to Gorano pond, the accumulated water has already covered nearly 20% of the pond surface which has significantly enhanced biodiversity at this deserted area, various fish species have been placed in the pond which lead to the development of biological diversity and foster attraction of avifauna and other species.

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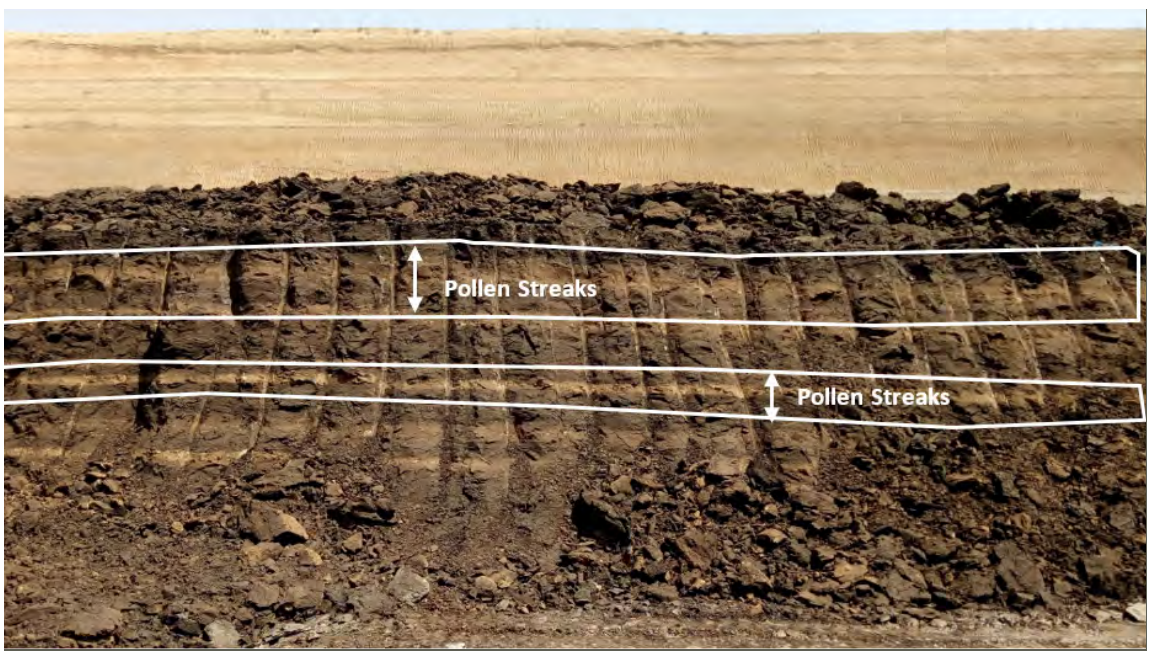
From page 1: Thar coal: claims vs facts

$3.7 billion coal-based power project in South Africa with a capacity of 4,800MW. The proposed strategy for the utilisation of Thar lignite is to generate power from mine-mouth power plants, which have been successfully installed in many countries including Germany, Greece, China and Australia where the major dependence of power generation is on coal. This is the only cost-effective approach when compared to the other expensive option of the imported furnace oil-based power plants.

RWE of Germany undertook a detailed bankable feasibility study for the Thar coalmining and power generation project in 2003. China's Shenhua also did a feasibility study in 2006 and contested for a power tariff which was not approved by the then government. Hence, there is no doubt that the Thar coalmining and power project is technically and economically viable. The proposed Thar coal project is a potential fortune-turning proposition for the country which will not only address the severe power crisis and bring energy sufficiency to the country, but will also create huge economic activity besides developing human capital through the execution and operation of the state-of-the-art mining and power generation projects.

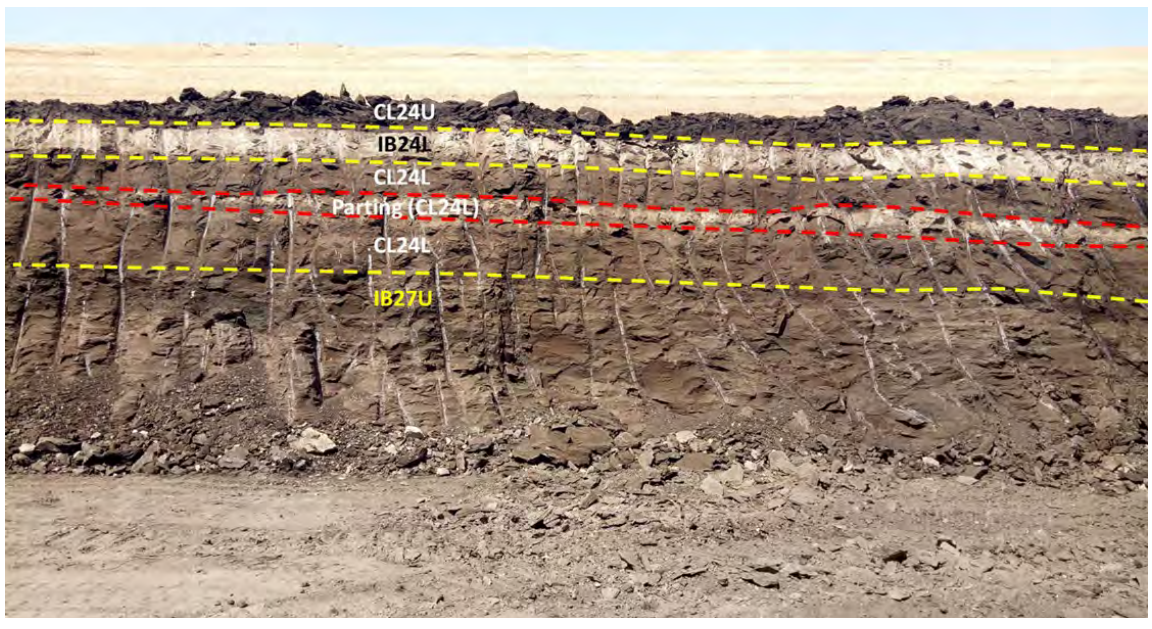
Author is the former Managing Director,
Thar Coal and Energy Board.

From page 3: Thar Coal Mine Block II – geological correspondence



normal fault tectonics. The ash content of CL2-4L is very high i.e. >13% while its net calorific value is low (<9.5 MJ/Kg). Based on the field evidences, it has been observed that CL2-4L comprises of various parting layers (waste – white claystone) which is believed to be one of the main causes of its bad quality. Partings are waste layers and are supposed to be mined along with coal seam due to their low thickness (<0.5m). The influence of parting layers in CL2-4L quality can also be seen from its average insitu sulfur content which is quite low (1.36%). White claystone layers are generally very bad in quality in terms of ash, qnet and fixed carbon but has very low sulfur content. The parting layers (white claystone) present within CL2-4L are variable in elevations and have an irregular structural appearance making it very hard for the shovel operators to separate them from coal seam. Other than parting layers, CL2-4L in general is composed of very dirty and un-matured lignite which is another reason for its low quality.

Thar region generally consist of three underground aquifers namely 1 – Recent dune sand perched aquifer (fresh water - localized), 2 - Sub-recent confined aquifer (saline water - coal seam roof) and 3 – Bara confined aquifer (saline water - coal seam floor). In addition, Thar region also contains few perched sand lens water bodies (saline – localized) within Sub-Recent and Bara formation which were not been reported before and not considered as part of Thar Geology. These sand lenses were first identified/interpreted from geophysical logs of exploratory boreholes during detailed hydrogeological investigation at mining project feasibility stage. These lenses are small confined aquifer bodies which were exposed during the overburden removal activity of open pit mining operations at Thar Coal Mine, Block II confirming the precision of hydrogeological interpretation done at project feasibility phase. The sand lenses present within Sub-Recent formation are laterally persistent and occur in the form of various stratigraphic intervals (each 0.5 – 1 meter thick) bounded by silty claystone layers. On the other hand, sand lenses within Bara formation are also found at numerous vertical intervals, but the thickest sand lens lies just between the main minable coal seam (2-7) and has a thickness of 4-6 meters. The similar water quality of this sand lens and 3rd aquifer is an indication that they both might be connected by cracks and faults.



Ali Iqtidar

Thar Coal Mine Block II geological correspondence

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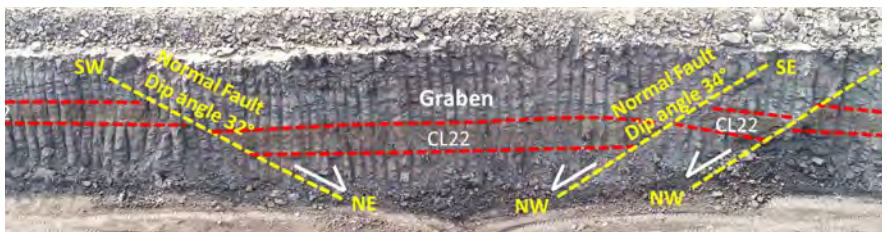
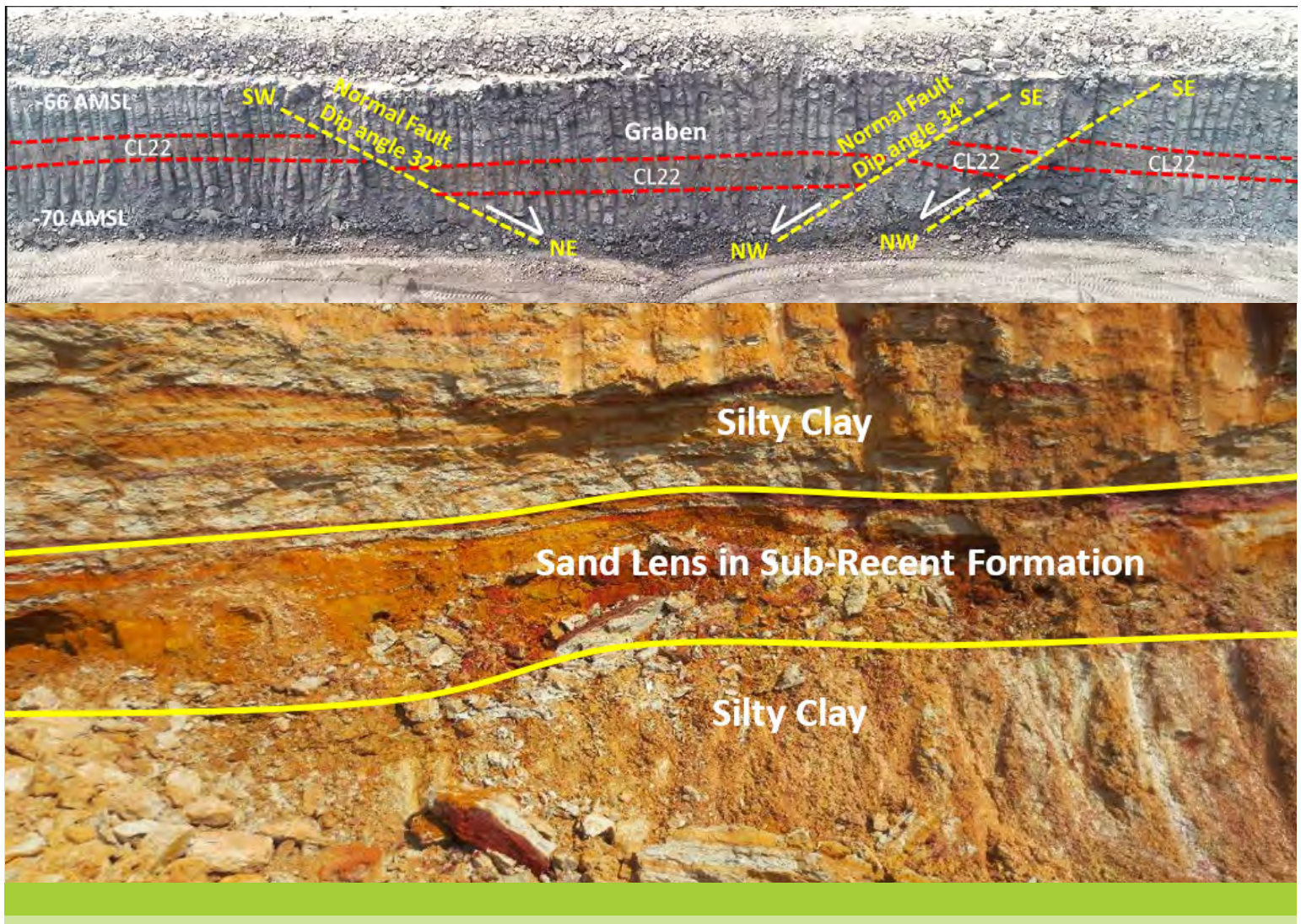


Thar Coal Mine Block II geological correspondence

Coal seams at Thar Coal Mine is dominant of pollen streaks which are plant micro-organisms and generally found in lignite indicating the un-maturity and low grade of coal. Pollens can be easily identified in coal seams by its shiny luster (yellow color). These pollen streaks are rich in CL2-3 coal seam which has the highest sulfur content (2.1%)



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Pakistan's first largest open pit coal mining is on-going at Thar Block II which is located at the center of Thar region. As part of phase – 1 coal mining operations plan, 3.8 Mt per annum of coal production is targeted which will further increase in phase – 2 mine expansion of 7.6 Mt per annum. Thar geology comprises of three sedimentary formations i.e. Bara - coal bearing (oldest), sub-recent and dune sand (youngest). These formations are overlain on granitic igneous basement throughout the Thar region. The coal-bearing layers at Thar Coal Mine are divided into 02 main groups (non-minable and minable). The non-minable coal group includes 1-1, 1-2, 2-1 and 2-2 coal seams while the minable coal group contains 2-3, 2-4, 2-7 and 2-8 coal seams. These coal seams are separated by non-coal layers (waste material) which are dominantly composed of carbonaceous claystone. The cumulative average coal thickness in Thar Coal Mine is 25 meters. The overall weighted average net calorific value of minable coal seams at Thar Coal Mine is 11.2 MJ/KG while its ash content is 8.5% with a very low sulfur value of 1.5%. The 2-7 coal seam is the main mineable coal seam and is laterally spread all over the Block II. This seam is the thickest and most persistent among all seams and makes up approximately 73% of the total coal resource. As a result, the coal quality of seam 2-7 has the largest degree of influence on the overall coal resource quality.

Structurally, Thar Coal Field is comprised of one major tectonic fault which is located at the western boundary of Thar region and extends from north to south covering complete Thar region. The Thar Block II is location at the east limb of the syncline where the strata dip angle is very gentle (2-40). Historically, Thar Block II is considered as no tectonic fault zone but recently at Thar Coal Mine, a major geological development took place where several localized normal faults have been explored within Bara formation during coal mining operations. The normal faults are foremost in thin coal seams (1-1, 2-2 and 2-4) with the vertical extent of around 5-6 meters. The average dip angle of these faults is 30-35 degrees with the maximum fault throw of about 2 meters. At some places, geological structure named Graben was also observed between oppositely dipping normal faults.

Coal seams at Thar Coal Mine is dominant of pollen streaks which are plant micro-organisms and generally found in lignite indicating the un-maturity and low grade of coal. Pollens can be easily identified in coal seams by its shiny luster (yellow color). These pollen streaks are rich in CL2-3 coal seam which has the highest sulfur content (2.1%). The geochemistry of pollen streaks was studied separately to evaluate its influence in the overall coal quality. The results revealed that it contains very high sulfur content along with high net calorific and ash values. Thus, pollens are considered as one of the main contributors of sulfur in CL2-3 coal seam. Another contributing factor for the presence of sulfur in Thar coal is the occurrence for pyrite mineral which is very common in coal deposits since coal formation is mainly takes place in reducing environment.

The lower part of coal seam CL2-4 laterally consistent and has an average thickness of 1.6 meters but structurally disturbed due to the presence of numerous

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Thar coal: some submissions

By Akhter Ali

Thar coal is larger than the oil resources of our rich brothers of the Middle East. Total Middle East Oil and gas resources add up to equivalent of 385 billion tons of Brown coal, out of which Iran and Saudi Arabia own 110 billion tons of coal equivalent each. Pakistan's Thar coal is 185 billion tons. We should, however, remember that Saudis would have been quite poor had they had 189 million people to support, instead of their current population of 25 million only

Our energy crisis is so huge and worsening that one finds it only appropriate to belabor the known facts and bring forward new thoughts and solutions that come to ones mind. By this time, it should have become obvious that there is no escape from fast tracking the Thar coal project. Hydro power is also an equally viable option which solves water storage problem also , but suffers from seasonal factors . The two resources together offer optimal opportunities to meet Pakistan's Energy demands. Here we are focusing on Thar coal.

The bureaucratic circles tend to show that there is progress on Thar coal. But the fact remains, that there is almost none. Allocation of blocks, MOUs and even feasibility studies do not mean much, as many such things have been done in the past. Under-ground coal gasification project has raised false hopes among the public. Without casting doubts on the scientific credentials of its eminent promoters and on the technological potential of the route adopted, the problem of scaling up would remain for which there is no capability in the country of a level that would be acceptable to the lending banks. While the existing gasification would yield useful data, we would be back to the square one, which is of requisite financing.

The bad news is that under criticism and pressure from international Green lobbies, World Bank has discontinued its technical assistance program on Thar coal, amidst news that government of Sindh has persuaded them to renew it. Even if they do renew, it sends us ample signals on difficulties that we are going to face towards financing Thar coal. With time, the opposition to coal would increase. Our problem is immediate and the renewables are still to be perfected and improved to be cost effective and competitive. In any case, renewables are projected to have a share of 20% even by the year 2050 .What are we to do in the meantime. The threat is that by the time we put our act together, although fossil based power age may not be over, the financing regime may become too difficult and hostile against coal.

The residual issue as it stands today is not the financing issue of the mining and power parts of the projects, however difficult it may itself be, it is the financing of infrastructure part which is proving to be a stumbling block. Various estimates put these requirements to between 1 to 2 billion US dollars. More money is required for infrastructure, than the first coal mine and power plant itself .Government of Sindh, obviously would not have such resources, nor would the federal government. And in these days of emphasis on provincial autonomy, where is the appetite for common projects. There are also issues as to the technical and management capability of the provincial bureaucracy, as the project continues to be run from the narrow confines of the Sindh secretariat. Apparently, there is no shaft of light at the end of this tunnel, although it is not the only one.

In all humbleness, this scribe makes the following proposals. There are two options. One is to tender for a large project of 5000 MW or so, which may be able to assume the infrastructural development costs. The cake becomes big enough to absorb all kinds of interests. This is not new. In India, this size of coal projects are being planned already. The feasibility of this proposal in Pakistan context can only be tested once it is actually tendered. The second option would be to float tenders for establishing a mining development company that undertakes to develop and finance the infrastructure and manages the Thar coal operations on behalf of Sindh government, within the framework of the relevant rules and regulations. The company recoups its investments by granting mining leases and charging a fee on coal production by individual companies. Obviously such a company would be a multinational which may have a joint venture with local private sector and government of Sindh's share in it. Such a company would offer many advantages. First of all to bring in finances, which appear to be well-nigh impossible for Sindh government to finance? Secondly, the operations would be more commercial like and would be on fast track. Ironically, I have made a case of yet another feasibility study? Not necessarily.

Certain issues related to the 18th Amendment need to be sorted out. After the amendment, Electricity sector becomes a federal only subject, as there is no concurrent list any more. Earlier Electricity was in concurrent list. Coal was and is a provincial subject. If I understand correctly, federal responsibility and role in Electrical power sector should be larger than it was prior to the amendment. Thar coal power development , therefore, ought to occupy higher priority in Federal budgeting system. It may not be a bad idea considering some kind of linkage between investments in Hydro and Thar coal power; one project in hydel, and one in Thar coal. There is a technical requirement to balance hydel power as well. Gas being no more and oil unaffordably expensive and imported, thermal energy in future should mean Thar coal energy. Politicians from Sindh can suitably make a convincing case, provided they are also prepared to readily agree to federal involvement.

Let me close with good news, if at all. Some politicians lately made a statement that Thar coal is larger than the oil resources of our rich brothers of the Middle East. Many people cast a doubt on such an assertion. This scribe has collected facts and data and has made some calculations and is happy to report that these claims are by far correct with the following details and provisos. Total Middle East Oil and gas resources add up to equivalent of 385 billion tons of Brown coal, out of which Iran and Saudi Arabia own 110 billion tons of coal equivalent each. Pakistan's Thar coal is 185 billion tons. We should, however, remember that Saudis would have been quite poor had they had 189 million people to support, instead of their current population of 25 million only.

Authro is a former Harvard University fellow, and has authored the book " Pakistan's Energy Development; the road ahead".