

Coal power – costs, impacts and the future

By DR JANAKA RATNASIRI

There were two news items on coal power recently, one on the plant being commissioned at Norochcholai (*Sunday Island* of 20.02.2011) and the other on the proposed coal plant at Sampur (*The Island* of 17.02.2011), both of which deserve some comment.

Cost of electricity generation

In the first news item, the Minister of Power and Energy (P&E) was reported to have said "at current prices the cost of generating a unit of power from coal was Rs. 6.40". However, based on the latest information and data available on power plant operation, this appears to be a gross underestimate. The plant cost was given in media reports as US\$ 455 million comprising a soft loan of US\$ 300 from China, which means that an interest component needs to be added. Furthermore, a Flue-gas Desulphurisation (FGD) unit has been added enabling using of coal having sulphur content more than the earlier stipulated value of 0.65% maximum sulphur, and its cost too will have to be added to the total cost. Hence, to take all these into account a conservative figure of 20% is added to the above cost. The annualization payment on the capital cost worked out assuming 10% discount rate over the 30 year life time, is then UScts. 3.48 per kWh.

The unloading of coal into barges in mid-sea and transporting it to the jetty would involve additional expenditure as the barges will have to make several trips between the carrier and the jetty for each ship-load and this cost was estimated as US\$ 25 a tonne which works out to UScts. 1.02 per kWh. The operation and maintenance (O&M) costs were taken from the 2008 Generation Expansion Plan of CEB enhanced by 10% to account for any inflation and it works out to UScts 0.4 per kWh. The first shipment of 65,500 tonnes (t) of coal was said to cost US\$ 7 million according to media reports, and this works out to UScts. 4.46 per kWh, on the basis that the plant would operate at 75% plant factor and 35% efficiency. This makes the total cost of generation of one kWh of electricity from coal to be UScts. 9.36 or Rs. 10.53.

According to the website of the Ministry of P&E sometime back, there has been a proposal to introduce LNG to operate the existing combined cycle gas turbine (CCGT) generators, which is a very sensible idea and has even sought the advice of some foreign consultants on this. In fact, the present CCGT plant on the west coast was granted approval on condition that it converts to gas operation once gas is available in the country because its operation with heavy oil as is done at present does not comply with environmental requirements. Importing of LNG to the west coast, however, would face the same problem that was encountered with coal import if conventional LNG carriers are to be used. That is because of the shallowness of the sea off the west coast which prevents the carrier to unload its shipment to a terminal built on-shore. However, today the technology is available to unload LNG in mid-sea after gasification using carriers with on-board re-gasification facilities. The gas could then be transferred to storage tanks on shore via pipelines laid on sea bed. For this purpose, especially built or converted LNG carriers having storage and re-gasification facilities on board are used. Such floating storage and re-gasification units (FSRU) are generally leased out for periods of about 10 years, but it is only a nascent industry compared to the conventional on-shore terminals. However, because of its flexibility and economics, it is gaining grounds, particularly for small countries and even in developed countries where building on-shore terminals pose problems – technical and social.

Using the current price rate for LNG fired CCGT plants taken as US\$ 900/kW (being cheaper than diesel fired plants and more efficient), the cost of LNG delivered to sites in South Asia on long term contracts taken as



Norochcholai power plant

US\$ 8 per MBtu, the cost of leasing a FSRU taken as US\$ 50 million annually and cost of capital investment on other infrastructure such as storage tanks and pipelines taken as US\$ 50 million, the cost of generating of one unit of electricity from LNG works out to be about UScts 8.32 (Rs. 9.36) assuming 90% plant factor and 50% efficiency. It should be noted that his figure is slightly below that for coal. This price comprises per kWh, UScts. 1.68 for annualized capital cost, UScts. 5.46 for fuel cost, UScts. 0.88 for the leasing of FSRU and annualized infrastructure costs and UScts. 0.30 for O&M costs (which is less than that for a coal plant since there is nothing to clean up). If the LNG price increases to US\$ 9 per MBtu, the cost of electricity would become UScts. 9.00 per kWh, still cheaper than coal power. In view of the many variables, this difference is not exact, but the important thing is that one cannot claim that coal power is the cheapest.

Impact on the environment

This difference, however, becomes significant when we consider their impacts on the environment and human health and the cost of such damages. With regard to the environmental impacts, even if the emissions and other factors are made to conform to environmental regulations, it does not mean that things are OK. In the first instances, Sri Lanka has no gazetted, legally binding emission standards for power plants. Some draft standards were available for decades, and all the previous EIA studies had been based on these. Also, Sri Lanka has no system of monitoring the ambient air quality on a regular basis except at Fort Station, which was installed in 1996. Though the cabinet of ministers had approved at least twice setting up of more stations island-wide, the matter appears to have not been pursued. There are several thermal power plants running on high sulphur fuel at Sapugaskanda, Kerawalapitiya, Colombo Port and in outstations, but there does not appear to be any monitoring of emissions from these plants.

In order to determine whether the new power plant at Norochcholai would cause any damage to the environment or not, an essential pre-requisite would have been the availability of a set of ambient air quality data taken over the past few years on a continuous basis at several sites around the plant location, as recommended in its EIA report. Without such data, it will not be possible to say to what extent the plant causes damage to the environment. Even if the draft emission standards are enforced, it will remove only a fraction of the emissions and not the total, which is not practicable and also raising the standards would cause heavy expenditure to the operator. For example, the Electro-Static Precipitator (ESP) is expected to remove fly ash coming out of the stack by more than 99.5%, but in practice it may not remove that much, especially after a lapse of a couple

of years, when typically the efficiency would reduce to about 99% or even less. Even if a 99% removal is assumed, about 1% of the total fly ash produced will escape to the atmosphere. For a 300 MW unit, the total ash generated is estimated to be 12 t/hour or 288 t/day based on 11% ash content in coal as given in its EIA report. In practice, this could be more or less depending on the actual ash content. Out of this, about 80% will go into the stack and the balance will remain in the combustion chamber (and hence called the bottom ash). This means that daily about 2.9 t of fly ash will get dispersed around the plant or beyond depending on the wind pattern. During the south-western monsoon period, there is the possibility that these pollutants could be carried far into the country. When all the three units are in operation, the amount that will get dispersed will be about 9 t a day or about 2,400 t annually assuming that the plants operate about 75% of the time.

Once the proposed 1000 MW coal power plant comes up near Trincomalee, a similar amount of fly ash will find its way into the interior of the country during the north-eastern monsoon period. Thus the entire north-central province will be "blessed" with hazardous toxic showers the year round except perhaps in the inter-monsoon periods. Out of the 288 t of ash generated, assuming 1% will escape to the atmosphere, the balance 285 t will get collected at the bottom of the chamber and will have to be removed daily. Since the ash coming out of the chamber is extremely hot, it has to be first kept in a large pond before it could be disposed of. Coal ash is said to contain traces of heavy metals including mercury, arsenic and even radio-active substances, the actual composition depending on the source. There is no reference to the presence of these metals in the EIA report and I believe in the plant specifications. The presence of these pollutants is to be seen after carrying out an analysis of the ash.

The addition of a FGD unit in the Norochcholai plant is expected to bring the sulphur dioxide emissions within the maximum permissible amount specified in the draft standards which is 0.52 g per unit MJ of heat input. With only the 300 MW plant operating within this limit, about 10,000 t of sulphur dioxide will be released into the atmosphere annually and about 30,000 t when all the 3 units are operating. Similarly, from the proposed Trincomalee plant about 33,000 t will be released. As mentioned earlier, all this sulphur dioxide will find their way into the interior of the country blown with the monsoon winds and finally return to the ground as acid rain. By having coal plants at Norochcholai and Trincomalee, we will be creating a problem that will cause irreparable damage to our agriculture and forests.