# Energy Challenges in 2030

Ijaz Hossain

The facts with respect to our reserves are indeed disturbing. In the last 15 years less than 1 Tcf of gas has been added to the 2P (proven+probable) reserves, but more than 7 Tcf of gas has been consumed. In the last 3 years less than 0.5 Tcf has been added to the reserves, but more than 2.5 Tcf of gas has been used up. Fortunately, however, the country has experienced reserve growth, and existing reserves have been adjusted upward. This has prompted the ministry to enhance production from the existing reserves. As much as 1000 MMcfd enhancement have been achieved (500 from the IOC field Bibiyana; 500 from Petrobangla fields).

The government has made plans to expand the energy sector consistent with Bangladesh becoming a middle income country by 2021, and by 2030 it expects to move further up the ladder. To achieve this status projection of electricity has been made to 2030 and beyond. According to the PSMP-2015, the peak electricity demand will be over 25,000 MW, and 100% of the country will be electrified.

Table 1 summarizes the present primary energy consumption and electricity production in the country. As can be seen compared to world standards for 160 million people the commercial energy supply is meager. In 2015, the total consumption of commercial energy was around 32 million Tons of Oil Equivalent (ToE). To achieve the target of 2030 this will have to be increased several fold to beyond 100 million ToE. Achieving the 2030 goal will also mean achieving a huge expansion of the existing energy and electricity infrastructure.

The principal source of primary energy, i.e., natural gas is running out fast. With no major discoveries in the last decade, the government is considering importing LNG to meet gas shortfall. The financial burden undoubtedly will be huge. Add to this, the repayment for all the large infrastructures that have been built up to 2030. There will not only be a heavy pressure on the foreign exchange rate, but also the sheer burden of foreign debt repayment may prove to be an onerous one.

To meet the energy demand in 2030, the government has decided to rely upon imported fuels. A study conducted by the PMRE Department of BUET estimated that in 2030, 92% of the total commercial energy requirement for power generation will have to be imported according to this strategy. What are the consequences of a strategy that relies heavily on imported fuels? How is energy security ensured when a country has to depend on imported fuels? This strategy and its consequences are analyzed in this article.

## Gas Demand in 2030

Petrobangla is producing around 2700 MMcfd, while the demand remains at more than 3200 MMcfd. Thus approximately 500 MMcfd of shortfall exists, which has been prevailing for more than five years. Since 2700 MMcfd corresponds to 1 Tcf per year, and the 2P reserves is approximately 15, the static Reserve-to-Production (R/P) ratio is around 15. With increasing demand this will fall below 10. In fact supply constraints will be felt in 5-6 years because of well deliverability and other field management issues.

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Theoretically, these production enhancements are possible, but the stark reality is that our gas will simply run out sooner. Bibiyana is a relatively new discovery, and production enhancement can be justified, but the Titas gas field, which some claim is a 9 Tcf field, has been producing for more than 40 years. Further production enhancement without in-depth reservoir and well deliverability studies may cause a sudden decline in production as has been experienced with the Bakhrabad and Sangu fields.

The thumb rule of energy security is that once the R/P ratio becomes small, a country needs to find as much gas as it consumes in a year, otherwise R/P ratio will reach a point where gas supply has to be curtailed. How many drillings are needed to ensure this energy security? In Bangladesh, we have been very fortunate that by drilling less than 100 exploratory wells we have been able to find most of our gas and our success ratio is still close to 1:3. It is totally unrealistic that the old success ratio of 1:3 will still prevail. Therefore, we must be prepared to drill 5 or more wells to get 1 strike. The other question is how much reserve we can expect per strike. Apart from Bibiyana, most discoveries have been less than 1 Tcf. For the sake of argument if we assume discovery of 1 Tcf of gas for every 5 drillings, then in the next 5 years we must drill at least 25 exploratory wells. Over the years not only would the success ratio drop, but also the sizes of the discovered fields will decrease. We have to be prepared to drill 8-10 exploratory wells per year to maintain a healthy R/P ratio.

Exploring our natural gas resource is becoming expensive. Two

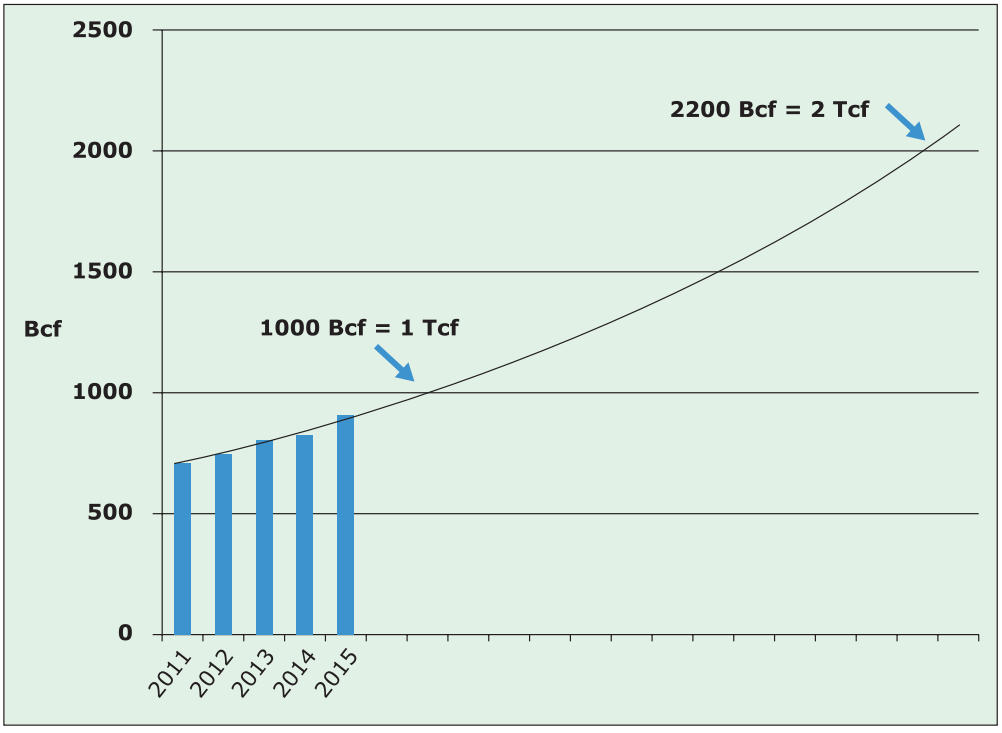
**Table 1: Energy Supply in Bangladesh**

| | Consumption (2016) | Oil Equivalent | Percent |
|---|---|---|---|
| Primary Energy | | | |
| Natural Gas | 2700 MMcfd (1 Tcf) | 24 Million ToE | 75% |
| Oil | 6 Million Tons | 6 Million ToE | 19% |
| Coal | 4 Million Tons | 2 Million ToE | 6% |
| | Power (2014-15) | Megawatt-hour (2014-15) | |
| Electricity (grid) | | | |
| Natural Gas | 6,800 MW | 29,700 GWh | 68% |
| Oil | 3,200 MW | 9,100 GWh | 21% |
| Coal | 200 MW | 900 GWh | 2% |
| Hydro + Imports | 230 + 500 MW | 4,000 GWh | 9% |
| Electricity (captive) | ~ 2,500 MW | ~ 14,000 GWh | |

shallow offshore drilling by Santos have been dry; Chevron has not had much success; importantly, BAPEX has not been able to add much to our reserves in the last 10 years. These conclusively prove that finding gas is becoming harder and harder and that more and more drillings are needed to find gas.

The chances of finding a giant field like Titas or Bibiyana is remote, but there is good prospect of finding smaller fields. The Northeastern part is so rich in gas that there exists huge potential of finding hundreds of gas pockets of 100 to 300 Bcf size. However, these can only be produced if gas price is increased.

Figure 1: Gas Demand Projection up to 2030




Gas demand is increasing at more than 8% per year. Figure 1 shows the gas consumptions in the years 2011 to 2015 and projections up to 2030. As can be seen using an exponential growth rate, which is consistent with the plans of the government the demand of natural gas is expected to go from 1 Tcf in 2016 to 2.2 Tcf in 2030. Even if a linear growth rate is used the demand would reach 1.8 Tcf. This projection does not take into consideration the suppressed demand that exists in 2016, which is close to 500 MMcfd, or 0.35 Tcf. Therefore, by any estimation, if gas is the principal fuel, then more than 2 Tcf of gas must be supplied.

### LNG & Gas Price in 2030

The demand for gas at 2030 is projected to be more than 5000 MMCFD. If no new gas is found, then all reserves would be exhausted and the full supply would have to be met through imported LNG. The 2P estimate of remaining reserves is less than 14 Tcf . Even if the 3P remaining reserve, which is 18 Tcf, is considered, the 2030 demand cannot be met. The gas resources are moderate (USGS Study - 32 Tcf at 50% probability), and cannot be relied upon beyond 2030 to fulfill demand in all sectors. In such a situation, therefore either:

**1.** some of the demand for gas must be shifted to other fuels, or

**2.** the shortfall in supply can be met with LNG, or

**3.** a combination of domestic gas, LNG, other fuels (including renewables) and conservation/energy efficiency can be used to meet demand

If LNG to meet shortfall is the principal strategy then the immediate question that arises is what will be the price of gas in 2030. This question is difficult to answer because the quantity of gas that may be discovered between now and 2030 is a key parameter. This issue is best analyzed by looking at different scenarios. The following three scenarios are envisaged:

**I.** No new gas is found

**II.** Reserves discovered are able to meet 50% of the increasing gas demand

**III.** Reserves discovered are able to meet 25% of the increasing gas demand

To compute the price of gas in 2030 two assumptions must be made; first is the price of LNG and second, is the price of domestic gas. Before recent sudden fall in oil price most energy analysts in their studies were using a LNG price of approximately $15/MMBtu in 2015. The price of LNG in 2030 has been considered conservatively at US$ 20/1000 ft3. There are projections that put the price beyond US$ 30/1000 ft3. The price of LNG is discussed further later.

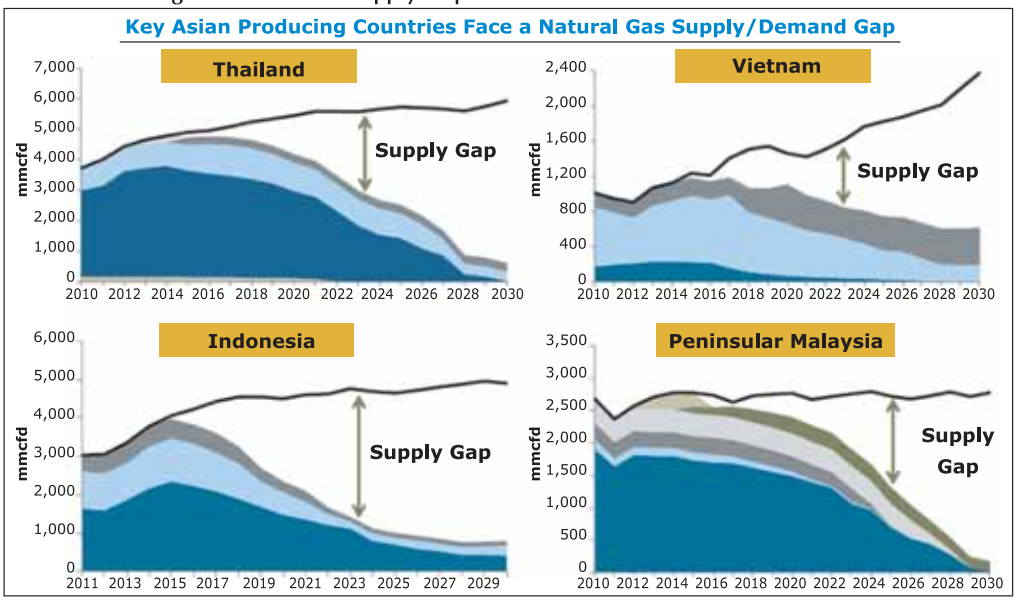
Table 2: Price of Gas under Different Scenarios

| Scenario | Gas Price* US$/1000 ft3 | Assumptions |
|---|---|---|
| I | 20 | Full demand met through LNG import - 100% LNG |
| II | 16.5 | 75% LNG |
| III | 13 | 50% LNG |

**Note: 1000 ft3 is considered equivalent to mmbtu (million Btu)*

There are no guidelines that can be used to estimate the price of domestic gas in 2030. Since the government is trying to raise the gas price in all sectors an average gas price of $6/Mmbtu has been assumed in 2030, up from approximately $3/Mmbtu in 2016. Using these two assumptions, the price of gas in Bangladesh in 2030 according to the 3 scenarios envisaged is shown in Table 2.

Figure 2: Demand Supply Gap of Natural Gas in Four Asian Countries




*Source: Various Government Statistics & TLG Analysis*

The present tariff for gas for industrial consumers is $3.8/1000 ft3. Therefore even in the best scenario industries will have to pay nearly three and a half times the present tariff, and in the worst scenario, which is as probable as the best, the price of gas will be more than five times

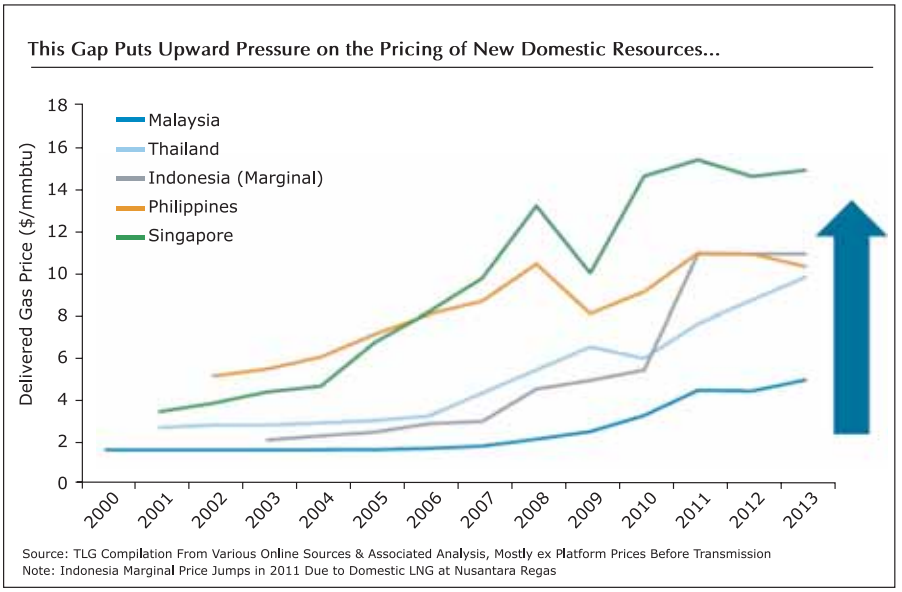
The LNG trade is limited to few sellers and buyers. More than 90% of the LNG business is in Asia with Japan, China and India being the major purchasing countries. Up to 2015 most Asian countries have either been self sufficient in gas, or have imported gas through pipelines. The situation is projected to change dramatically as can be seen from Figure 2, which shows the demand and supply gap for natural gas in four countries. As can be seen Bangladesh's situation is very similar to that show in the Figure. Even gas rich countries like Indonesia and Malaysia will face supply shortfall beyond 2020. Thus most Asian countries will be importing LNG in the near future. This is bound to exert an upward pressure on the price of LNG. Since LNG production, sea transport and regasification cannot respond quickly to the demand increase, LNG prices will not be greatly influenced by future short term dips in oil prices.

**Bhola gas field**

To understand the pricing dynamics it is instructive to look at the delivered gas price in $/mmbtu in several Asian countries, as shown in Figure 3. The prices can be put into three categories - in the first category is Singapore with a high gas price of 15 $/mmbtu; in the second category are the mid gas price countries Indonesia, Thailand and Philippines with a gas price around 10 $/mmbtu; in the last category is Malaysia, which in 2013 still had very low gas price at 4 $/mmbtu. As can be seen there is a clear upward trend in gas prices implying that all these countries are getting

prepared to import LNG. Before the recent dramatic fall in oil price, all predictions of LNG price in 2015 was around 15-16 $/mmbtu. The price of gas has fallen but no long term contract price can be expected below 12 $/mmbtu. Spot prices may have gone down to $8-10 per mmbtu, but those cannot be considered for long term planning of the energy sector. Therefore the price of LNG in 2030 cannot be expected to be less than $20 per mmbtu (or 1000 ft3).

Figure 3: Delivered Gas Price in Asian Countries from 2000 to 2013




## Coal

With regard to developing coal resources, no progress has been made. Coal mining appears to be bogged down. Bangladesh is blessed with one of the finest quality coal. Not only is it low in sulphur, but also a good portion of it is the high value coking coal. If open pit mining is employed, more than 90% of the reserves can be extracted. Even 50% of our known reserves will allow 10,000 MW to be generated for over 20 years.

Regarding importing coal Government should have at least started work on coal receiving facilities a long time back. Without good port facilities there is no possibility of building more than 5000 MW of coal-fired power plants. At the present moment three joint ventures and 2 private coal based power plants are at various stages of implementation. The total generating capacity of these 5 power plants is more than 6500 MW. Since all are based on imported coal, the challenges are significant. Three major hurdles can be anticipated, namely:

**1.** Timely financing

**2.** Construction of coal receiving facilities

**3.** Coal purchase contracts

If building coal-fired power plant based on imported coal is a challenge for BPDB having all government support at all levels, how difficult would it be for a private company?

## Primary Energy Requirement in 2030

The projection of natural gas demand has been presented and discussed in an earlier section. Since gas is the principal primary energy in Bangladesh, users are very well accustomed to it. Natural gas is a convenient and clean burning fuel. Since the infrastructure for transmission and distribution already exists the government intends to continue supplying natural gas. As has been discussed the 2030 demand for natural gas will be more than 2 Tcf assuming that all sectors continue to use gas in the same proportion as prevailing now.

At present coal is used mainly by brick kilns. The Boropukuria coalmine produces about 1 million tons of coal, which is mainly used for power generation. The total consumption is around 4 million tons. For the proposed 15,000 MW of coal fired power plants approximately 45 million tons of coal will be required. Along with coal for brick production, which is projected to increase to 5 million tons, the total coal requirement will be 50 million tons.

The oil demand in 2030 has been projected in Figure 4 using consumption data of 2011 to 2015. The increase will be mainly due to diesel for road transport and furnace oil for power generation. The increase in oil demand will not be as large as gas or coal demands because it has been assumed that the growth of the CNG sub-sector will continue unabated. Since CNG is a sector where the gas tariff is close to the international LNG price, it is not totally unrealistic to expect that the CNG sector will continue to grow.

Table 3: Estimate of Fuel Demand in 2030

| Fuel | 2030 Demand | Reserves/ Resources | Supply Plan | Remarks |
|---|---|---|---|---|
| Gas | 2 Tcf | 15 Tcf 30-40 Tcf (50% probability) | 25-40% from own fields; balance IMPORTED | Very weak exploration activity |
| Coal | 50 million tons | 1 billion tons 2.5 billion tons | 10% from own mines; balance IMPORTED | No plans to mine coal |
| Oil + LPG | 12 million tons | None | IMPORTED | |

The other imported fuel which must be taken into serious consideration is LPG. LPG use is

projected to rapidly increase because it may replace more than 50% of the gas use in the residential sector. LPG may be a transport fuel for cars and three-wheelers. LPG may also be an industrial fuel. Its requirement is projected to exceed 4 million tons by 2030. Because of the importance of LPG it is discussed in greater detail in the following section. The total requirement of oil and LPG is projected to be 12 million tons in 2030.

Figure 4: Projection of Oil demand up to 2030

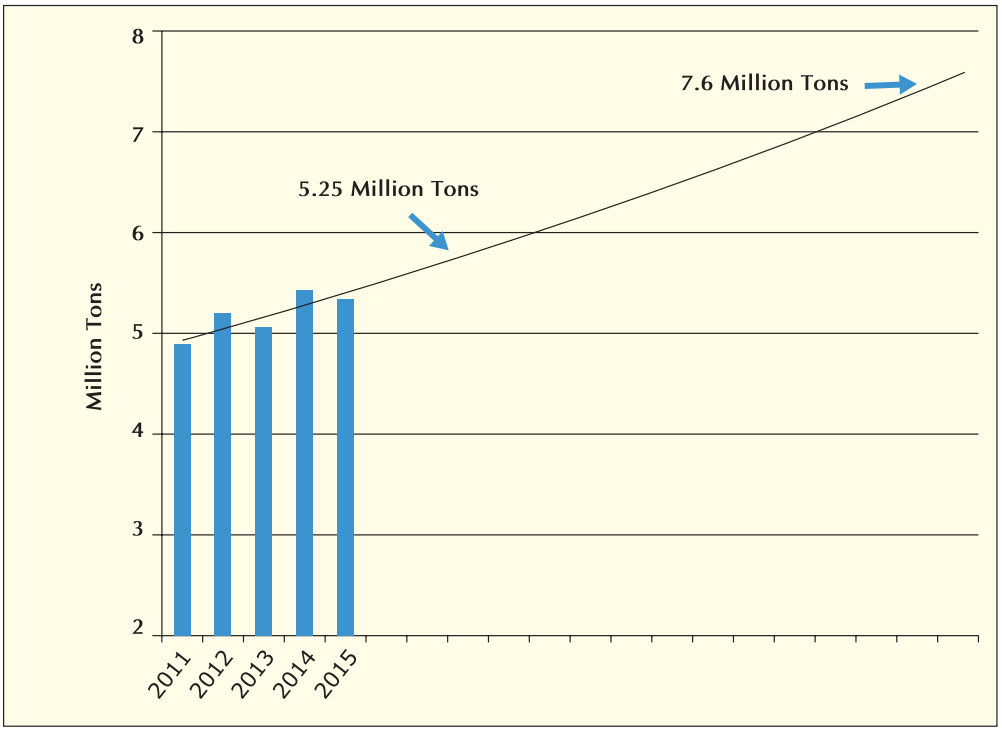



Table 3 gives a snapshot view of the energy requirement in the year 2030 and the domestic resources available.

As can be clearly seen there is huge gap between demand and the resources to meet the demand. How will the gap be filled? The Government proposes the following:

**1.** LNG to meet the shortfall in gas

**2.** Imported coal to supply 50% of the total power generation needs

**3.** Oil to fill gaps in power generation and to supply transport fuel

**4.** LPG to meet domestic cooking needs

Apart from the cost involvement the logistical requirement of such a strategy is huge. For LNG, a regasification terminal would have to be built. For coal, a deep sea port would be required. For oil and LPG, more receiving and storage facilities have to be built. These will not only require billions of dollars of investment, the location and siting of these facilities will prove to be a challenge.

What about the cost of such an import based strategy? First is the infrastructure building cost. Depending on the size of the regasification terminal, the cost would exceed 4-5 billion dollars. The cost of the coal receiving facilities will also exceed 4-5 billion dollars and the oil receiving terminal plus inland oil, gas and coal infrastructure will amount to another 4-5 billion dollars. Therefore, a total of 12-15 billion dollars will be required for building the infrastructure. Then the cost of purchasing the fuels shown in the Table 3 must be added. If 2000 MMcfd of LNG, 4 million tons of LPG, 8 million tons of oil and 50 million tons of coal per year is imported, the total expense on account of purchasing fuels will easily cross 25 billion dollars.

### Importance of Energy Efficiency

Using the best technologies available today, most countries especially developing ones can cut their primary energy demand in half. Lack of awareness and adequate funds remain the main barriers. Significant energy efficiency improvement potential exists in power generation, distribution loss reduction, urea fertilizer plants, boilers, motors, air-conditioning and cogeneration in captive generation plants. More than 2000 MW of electricity is generated in industries at an average efficiency of 35%. In 90% of the cases the waste heat is not utilized. Cogeneration or Combined Heat and Power (CHP) can be a tremendous option for saving a large quantity of natural gas now used in boilers. The required retrofit is the addition of a simple waste heat boiler to the exhaust of the generator.

The potential of conservation and energy efficiency have been studied in great detail by a JICA consulting team for the Sustainable and Renewable Energy Development Authority (SREDA). The result of this study is a masterplan for conservation and energy efficiency. The study, which looked only at the demand sectors, found savings potential in the residential, industrial and building sectors. Figure 5 shows the projection of energy demand in the large industry sub-sectors and the energy efficiency potential. As can be seen savings potential of 21% exists in the industry sector. The study found similar potential also exist in the residential (devices such as lights, fans, refrigerators, TV and ACs) and building sectors.

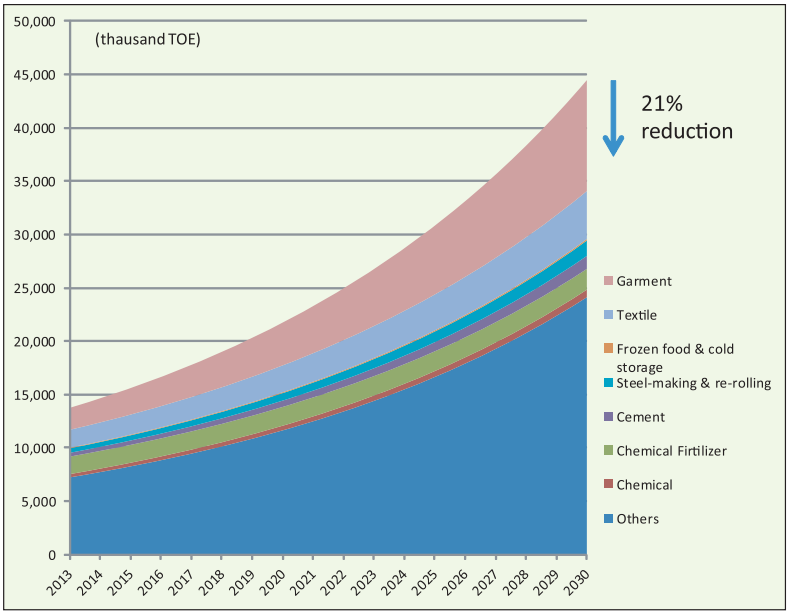
A study done by the author has revealed that if the gas presently used by all the gas based power plants was used in state-of-the-art CCGTs and simple cycle aeroderivative gas turbines more electricity could be generated than the present total generation from all fuels, hydro and import. Similarly if the fertilizer plants were new plants then no fertilizer would need to be imported. These two glaring examples of inefficient use of energy clearly reveal the importance of energy efficiency in going forward. Many analysts believe the financial burden of supplying primary energy in the future will be so high that without adequate attention to energy efficiency it would not be possible to maintain reliable supply.

### Integrated Energy Planning

Bangladesh has never practiced Integrated Energy Planning (IEP), and as a result, the discord between fuels requirement for electricity generation and supply of fuels, mainly gas, has never been resolved. BPDB has made plans for large scale expansion of gas based power generation without consulting Petrobangla. Thus despite warning from Petrobangla BPDB has continued to build gas based power plants. This has forced Petrobangla to increase gas supply from existing fields thus drastically reducing the R/P ratio.

Energy planners have never really appreciated the concept of IEP. Thus we see - Gas sector plans; Electricity sector plans; plans for oil, coal and even biomass. These so-called energy plans are in reality no more than utility plans. This practice has led to the situation where power plants have been built with no guarantee of primary energy. The fact that the country is running out of GAS has never in the past been considered by the electricity sector planners. Even today we see plans of thousands of megawatts of gas-fired power plants with no assurance of gas supply. The most blatant example of this type of planning is the 2010 Power System Master Plan (PSMP). The PSMP-2010 made two great errors. The first error is assuming that a good supply of natural gas from Bangladesh's fields will be maintained and the second error is assuming that open pit coal mining will be

Figure 5: Potential of Energy Efficiency in the Large Industry Sub-sectors




undertaken. BPDB is nearly finished with revising PSMP-2010 to produce PSMP-2015. This kind of haphazard planning is typical of the existing energy plans.

Policies and plans in developing countries are dominated by short term considerations. Market forces are not allowed to operate or do not exist, and government decides how energy demand will be met. To take the case of Bangladesh, which has relied heavily on natural gas for more than 50 years, it can be seen that because of scarcity the allocation of gas in the various demand sub-sectors is proving to be a challenge. If gas is used in the fertilizer sector, it displaces imported urea. If used as CNG it displaces gasoline and diesel. If used in the residential sector, it displaces LPG. If used in the industry sector it has a multiplier effect of more than 3, and yet, huge quantities of gas is being used for power generation, which is the lowest value use – that which can easily be displaced by the cheapest fossil fuel – coal.

Most disturbing thing about the plans and polices being pursed in the energy sector are their ad hoc nature. Some examples of unanswered questions and uncertainties in the energy/power sectors are:

**1.** What will be the fate of the CNG subsector? If it is continued, what will be the price structure and who will build the country-wide infrastructure

**2.** Will captive generation continue? If not, will those who already have connections continue to enjoy the benefit of cheap gas, while new industries have to pay exorbitant prices

Future energy consumers in Bangladesh especially those that will contribute the most to the economy, i.e. the industrialists, remain totally in the dark. No definite direction for either the energy or the power sector has been established. Reality looks very different from the roadmaps. Expensive short term solutions bearing great potential negative consequences for the future remain the mainstay of crisis management.

### Conclusions

Challenges to meet the 2030 primary energy demand (gas, oil and coal) are many. Not only will the plans laid out by the government require huge funding, but also the logistical challenges in many cases may be insurmountable. Then comes low implementation capabilities of the various agencies and utilities involved. Therefore, prudent planning is the key to future

development in the energy sector. Unplanned growth can prove to be costly, and may frustrate the main aim of energy supply, i.e., to foster fast economic growth and achieve 100% rural electrification. Integrated energy planning to develop the energy sector must be made the principal focus of all plans and utility plans should not be regarded as sectoral plans. Making use of national experts and listening attentively to the needs of the business community must be given importance. To achieve sustainable growth in the energy sector the government must take the serious consideration the issues discussed in this article.

Drilling at Barapukuria coal mine

Prices of fuels have never been rationalized in Bangladesh. This has created uneven competition between fuels and has not allowed the market for fuels other than natural gas to develop. As a result natural gas is the predominant fuel. Additionally it has made Bangladeshi industrialists over-dependent on low priced natural gas, and entrepreneurs feel discouraged to set up industries when subsidized natural gas is not available. They rightly point out that new industries using coal, furnace oil or LPG cannot compete with natural gas based industries. The government will have to find a way to price natural gas correctly so that the heavy dependence on it is lessened and alternatives can compete with it.

The pricing dilemma will reach a new height when the import of LNG starts. Domestic gas and LNG will have to be priced correctly to encourage industrial development. Otherwise, if the industrial sector is left to shoulder the burden of imported LNG, gas prices will become abnormally high in 2030 – thus affecting industrial growth and the economy.

Gas extraction commensurate with the gas reserves and reserve augmentation through vigorous exploration should be the principal focus of the gas sector. The present rate of gas extraction is clearly unsustainable. It not only seriously endangers our reserves, but also will cause the reserves to be exhausted earlier. This has serious implications for security, especially in times of internal and external political instability. To bring dynamism to the gas sector, IOCs must be given full access to onshore blocks. Additionally, an attractive price for the IOC's share of gas must be ensured. Not allowing IOCs to explore in the onshore blocks for over a decade can easily be linked to the present gas crisis in the country.

Depending on imported coal for 50% of the 2030 electricity generation is ambitious and risky. Experts have warned that without huge investments in coal receiving and handling facilities not more than 3000-4000 MW of coal fired power plants based on imported coal is possible. Coal prices are low at the present time as a result of the collapse in oil prices. It is true that domestic coal would be more expensive than the imported coal at the present price. But one must remember that such low oil prices cannot prevail for a long time. Therefore, attention must be paid to mining coal. Since the yield from underground mining is extremely low, and Bangladesh has few coalfields, open-pit mining is the only real option to meet the coal demand.

Vigorous promotion of conservation/energy efficiency is one of the major tools to achieve energy security. Energy efficiency can not only bring financial benefits but also it can foster sustainable development. For Bangladesh, energy efficiency also means GHG mitigation which can result in carbon credits to be sold to developed countries. In the second national communication (SNC), it was shown that as much as 25% of the primary energy in 2030 can be saved if a vigorous energy efficiency program is undertaken. The principal areas of energy efficiency improvements are - cogeneration in captive power plants, converting steam thermal power plants to CCGTs, replacing old fertilizer plants with state-of-the-art plants and cross-cutting technologies and devices such as boilers, chillers, motors, lights, fans and refrigerators.

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