

Risks to the Construction Costs due to Changes in Energy Prices

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Abstract

This paper assesses the risks associated to the construction costs of infrastructure projects due to changes in the energy prices as the energy prices have changed drastically in the last twelve months and are expected to rise further. This assessment is performed on the basis of the actual data taken from two ongoing projects in the public sector. For this purpose, major project components are identified which have substantial energy input and then the energy input in them is calculated to work out that proportion of cost which is directly sensitive to the energy prices.

Keywords Energy Price

1. Introduction

Energy is one of the major inputs in the construction projects. It is used not only in operating the equipments for the execution of the projects but it is also an important ingredient of the materials used in such projects. This is the reason that the sudden increase in the energy prices during the last year raised concerns about the possible increase in the construction costs. This research is undertaken in order to estimate the possible impact of increase in energy prices in the future on the total costs of construction projects. This research is based on a study on two projects; one is Lahore Ring Road Project (Package 1), Lahore, Pakistan and the other is Taunsa Barrage Rehabilitation Project, Taunsa, Pakistan.

In order to find out the project costs' sensitivity to the energy prices, the Lahore Ring Road Project (Package 1) and Taunsa Barrage Rehabilitation Project are decomposed into those components which have major energy input such as cement, bricks, earth and rock compaction work, asphalt, haulage of aggregate etc. After calculating the quantity of each component, the energy requirement of each is also worked out. In this way, the quantity of the total energy to be used in the project is roughly estimated. The cost of this energy is actually the component of the total project cost which is directly sensitive to the changes in energy prices. This component expressed in percentage can give us an estimate of the changes in construction costs with the changes in energy costs in the future.

2. Role of Energy in Infrastructure Projects

The construction of infrastructure projects requires energy mainly in two ways. First is that the energy is needed to operate the equipments which are used in the construction process. For example, dumpers, excavators, cranes, rollers etc.; all such machines need energy for their operations. Secondly, the energy is also required in the manufacture of all the building materials. For instance, manufacture of cement as well as bricks need energy by burning coal or furnace oil.

3. Rise in Energy Prices

In the last twelve months, a sudden rise in the energy prices has been observed. Oil prices in the international market have risen from around \$30 per barrel to around \$50 per barrel. Rise in other energy products such as coal, natural gas and uranium is also observed. Analysts are forecasting further increase in the energy prices in the future expecting oil to rise as high as \$100 a barrel. In view of the major role of energy in the construction of infrastructures, it is prudent to assess the risks to the project costs due to the rise in the energy prices in future. This assessment is performed for two projects; one is Lahore Ring Road Project (Package 1) and the other is Taunsa Barrage Rehabilitation Project.

At this point, objection may be raised that there is usually not an immediate increase in the construction costs because of increase in energy costs and thus it will not cause an increase in project costs. But this objection is not valid. This is true that the construction costs reacted to the rise in energy costs only after a certain lapse of time. But due to the role of energy in the construction, the increase in energy costs are always buffered somewhere in the economy. In other words, from the point of view of the total economy of the country, the rise in energy costs are always borne by somebody no matter the construction costs are increased or not at that time.

4. Project Components having Major Energy Input

In order to assess the impact of the rise in energy prices, that proportion of the total project cost is required to be calculated which is directly sensitive to the changes in energy prices. In each of the following six sections, the energy involved in one of the major components of the two selected projects is calculated. In the sixth section, the amount of asphalt used in the projects is worked out considering its price to be directly proportional to the energy prices as it is a constituent part of crude oil.

4.1 Cement:

495 Kwh of energy is needed to produce one ton of cement. The total cement required may be calculated from the amount of concrete used in the project on the basis of 22% of the total volume of concrete assuming 1:2:4 cement sand and aggregate proportion. The total amount of concrete, cement required and coal consumed to produce the cement for the two projects are given in table 1.

Table 1: Energy Consumed in Concrete

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4.2 Bricks:

315 Kwh of energy is needed to produce one ton of brick. The total weight of bricks required in the Ring Road project is calculated from the amount of brickwork assuming the specific gravity of brick to be 1.4.

The total amount of brickwork, weight of bricks required and coal consumed to produce the bricks for the two projects are given in table 2.

Table 2: Energy Consumed in Brickwork

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4.3 Steel:

640 to 1390 Kwh of energy is needed to produce one ton of Steel depending on the efficiency of the furnaces. In view of the inefficient furnaces in Pakistan, energy required to produce one ton of steel is supposed to be 1390 Kwh.

The total amount of steel requirement and the coal consumed to produce that steel for the two projects are given in table 3.

Table 3: Energy Consumed in Steel

	Units	Lahore Ring Road Project (Package 1)	Taunsa Barrage Rehabilitation
Steel	Tons	1,773.00	9,036.18
Coal Consumed	Kg	360,809.36	1,838,882.87

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4.4 Compaction and Excavation Work:

The energy required in the compaction is calculated on the basis of the actual energy spent in Core compaction in Satpara Dam. This was 2.965 liters of diesel per Cu.M of compacted core. The compaction in the Ring Road project consists of compacting the embankments, earth filling, Granular Subbase, and waterbound macadam. Apart from this, the volumes of Asphalt Base Course and Asphalt Wearing Course are also included in it as energy is also required to compact them.

The energy required in the earthwork excavation is calculated on the basis of the actual energy spent in excavation in Satpara Dam. This was 1.01 liters of diesel per Cu. M of earthwork. The total volume of compaction and excavation in the two projects and the total energy needed in them is given in Table 4.

Table 4: Energy Consumed in Compaction and Excavation Works

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4.5 Haulage of Aggregate:

Energy is required to bring the aggregate from the quarry to the project site. Assuming a distance of 200 miles from the quarry to the project sites, the energy used to bring the aggregate from quarry to the project site is calculated. It is assumed that a truck carrying 250 cu.ft. of aggregate covers 18 miles consuming one gallon of diesel.

The total volume of aggregate needed for the concrete in both the projects and oil to be consumed for its haulage is calculated in Table 5

Table 5: Energy Consumed in Haulage of Aggregate

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4.6 Asphalt:

Asphalt is a constituent of crude oil and is extracted from oil. Therefore, its price is assumed to be increasing with the increase of oil prices proportionately. The weight of Asphalt in the Lahore Ring Road Project (Package 1) is calculated assuming that by weight percentage proportion of asphalt in Asphalt Base Course and Wearing Course is 4%.

Table 6: Consumption of Asphalt

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5. Proportion of Project Cost Sensitive to Energy Prices

The proportion of the project cost directly sensitive to the energy prices is the costs of total coal to be consumed, total oil to be consumed and total asphalt to be used. The total quantities of these three factors, their total costs and total costs of the projects are given in Table 7. In the end of the table that proportion of the total project cost is also calculated which is directly sensitive to the energy prices.

Table 7: Factor of Project Costs Directly Sensitive to the Energy Prices

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On the basis of the results of Table 7, the projections about the sensitivity of the costs of the two projects to the rise in oil prices may be made as given in Table 8.

Table 8: Increase in the Costs of Projects with Increase in Oil Prices

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6. Conclusion:

From table 8, it may easily be concluded that with each dollar increase in oil price, construction projects may escalate in millions of rupees. The actual rise in costs would be even more than this as the project components with small energy inputs are ignored in this study. In addition to this, there is no mention here on many other cost factors which are affected indirectly by the rise in energy costs. Thus it may also be concluded that the possibility of increase in construction costs should be taken into account in allocating the funds for the large infrastructure projects the construction of which spans over long periods.

7. Appendix

7.1 Assumptions, Conversion Factors And Other Parameters Used In The Study:

7.1.1 Assumptions:

This study is based on the following assumptions:

- The oil consumption in compaction work is assumed to be equal to the actual oil consumed in the Core Compaction of the Satpara Dam Project Skardu.
- The oil consumption in earthwork excavation is equal to the actual oil consumed in the excavation work of Satpara Dam Project Skardu.
- The percentage of asphalt by weight in the Asphalt Base Course and Asphalt Wearing Course is assumed to be 4%. This figure varies from 3% to 6% depending on the design of the asphalt mix.
- The specific gravity of the compacted Asphalt Base Course and Asphalt Wearing Course is assumed to be 2.5.
- The distance of the origin of the aggregate is assumed to be 200 miles from the Ring Road Project.
- The specific gravity of bricks is assumed to be 1.4.

7.1.2 Conversion Factors:

1 Barrel	=	42 Gallons
1 Gallon	=	4.546 litres
1 Ton	=	1016 Kg.
1 cu. meter	=	35.32 cu. ft.

7.1.3 Other Parameters:

Energy Content of Coal	=	10061 BTU/lb
Energy in 1 Barrel of Oil	=	Energy in 249 kg of coal
Price of Coal	=	Rs. 12/kg
Price of Asphalt	=	Rs. 20/kg
Price of diesel	=	Rs. 29/litre

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