

COAL-PHOSPHATE FERTILIZER COMPLEX PROJECT

SUMMARY OF THE DRAFT REPORT  
ON THE

**YAYU COAL MINE-THERMAL POWER-  
FERTILIZER PLANTS COMPLEX**

DETAILED TECHNO-ECONOMIC VIABILITY STUDY (DTEVS)

PREPARED BY

CHINA NATIONAL COMPLETE PLANT IMPORT & EXPORT  
CORPORATION (GROUP)-COMPLANT

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## Abstract

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## Abstract

### 1. Description

#### 1.1 Name of the project and the sponsor unit

The name of project: the Combined Mine-Fertilizer-Power Plant Complex of Ethiopia

The name of the sponsor unit: Coal Phosphate Fertilizer Complex Project (COFCOP).

#### 1.2 Background of the project

Ethiopia, a developing country, lies in the northeast of Africa. The present economy of the country mainly relies on agriculture with more than 90% population involved in and nearly half of GDP comes from it. The development of national economy depends largely on the development of agriculture. Therefore, Ethiopian government proposed the strategy of "Agriculture Development Led Industrialization". In order to improve the agricultural productivity, Ethiopia imports a lot of chemical fertilizers every year. Presently, the demand for chemical fertilizer is increased by 20% each year, which is expected to continue in the coming decade. The import of fertilizer costs a lot of foreign exchange, which directly influences the development of national economy of Ethiopia. Therefore, Ethiopian government hopes to use Chinese experience in fertilizer development as a reference and make full use of Ethiopian natural resources to build its own chemical fertilizer industry.

From the angle of long-term benefit, whole benefit and overall planning of Ethiopia, it is of significance for Ethiopia to invest in the coal, fertilizer and thermal power plant complex. To invest in the construction of the coal, fertilizer



and thermal power combined enterprise can maintain a sustainable and stable national economic development. Use the nation's own existing resources and labor force to develop national industry can increase the self-sufficiency capability gradually and meanwhile decrease rely on import; it is helpful to develop the national technological capability, enhance the whole technical level of the country as well as to promote the progress of national industrialization; it can enforce national power and advance the capability of enduring international changes; it develops relevant industries, changes the nation's industrial structure and creates employment opportunities, etc. This project was proposed under this requirement by the conditions.

## **2. Market and production capacity of the plant**

### **2.1 Market**

Ethiopia is a developing country and most of the farmers have no accession to chemical fertilizers. At present, Ethiopia does not produce any mineral fertilizer and all fertilizers used are imported. The endurance of the farmers limits the application of chemical fertilizers, so the application rate is quite low compared with world average application.

Based on the forecasting of Ethiopian fertilizer consumption above, the demand for urea product is at least 991.3kt/a and the maximum is 2784kt/a in the year of 2025. Shortage of urea supply is quite big. It will cost a lot of foreign currency to make up this shortage solely by import.

### **2.2 Anticipated sales value**

The nominal capacity of this plant is 100kt/a urea, but the actual capacity is 110kt/a urea. Based on the retail price of 287\$/MT, the annual sales will be US\$31.57 millions. The sulfur, the by-product, with capacity of 2282MT and retail price of 450 Birrs/MT, the annual sales will be US\$0.116 millions. In total,

the annual sales of the chemical fertilizer plant will be US\$31.686 millions.

### 2.3 Production capacity of the plant

Annual operating time: 8000h

**Table 1.1 Production capacity of the Complex**

No.	Item	Unit	Nominal Capacity	Actual Production Capacity
1	Coal	Kt / a	450	608
2	Electricity	MW / h	30	30
3	Synthetic ammonia	Kt / a	60	66
4	Urea	Kt / a	100	110

### 3 Location and plant site

The chemical fertilizer plant to be built is near the Achibo-Sombo Coal Mine. Achibo-Sombo area is located in the southwest part of Ethiopian Plateau and is a part of Wittete block of Yayu Coal Field, which is under the administration of Yayu Town of ILLubabour Administrative Region.

The local transportation and water supply conditions are good. The site is near to GEBA River in the northeast, and 1000m from No. 43 highway in the south. This highway passes from east to west to link up Jima City, Metu City and the capital Addis Ababa.

### 4 Project design

#### 4.1 Scope of the project

The project includes process unit and associated utilities (including offsite facilities).

The process unit in plant area mainly includes:

- (1) Coal mine with a nominal production capacity of 450kt/a of coal;
- (2) Thermal power plant with 2x15 MW generator sets;
- (3) Chemical fertilizer plant with a nominal production capacity of 60kt/a synthetic ammonia unit and a 100kt/a urea unit.

The associated auxiliary units for production include water intake station, transformer substation, comprehensive building, machine maintenance factory, etc. The associated civilian facilities outside the plant include public buildings such as dwelling houses, kindergartens, nursery, churches, rendezvous, high schools and elementary schools, etc.

## 5 Plant organization

The head office of the coal-based chemical fertilizer combined enterprise is set in the office building of the coal mine; 11 functional departments and 4 factories

- (1) The 11 functional departments are:

General manager's office, comprehensive office, financial department, marketing and transportation department, administration department, personnel & Educational department, dispatching & information department, production technology department, safety and technical department, machinery & power department and security department.

- (2) 4 plants are:

Coal mine, thermal power plant, chemical fertilizer plant and machine repair plant.

## 6 Manpower

List of Manpower

No.	Department	No. of persons	Remarks
I	Functional department	161	
II	Coal mine	1282	
III	Thermal power plant	268	
IV	Chemical fertilizer plant	600	
V	Machine repair plant	•	Manpower has not been included
	Total	2311	



**7 Implementation time schedule**

The construction period of the plant is about 48 months from the date after the viability study report is reviewed and approved, and the contract of the engineering design is signed and become effective, pre-phase preparation time is excluded.

**8 Financial & economic evaluation**

**8.1 General situation of investment**

The overall investment estimate of the combined Mine-fertilizer-power plant complex is US\$212,623,150, of which: construction investment is U.S.\$ 195,571,410, interest in construction period is US\$12,712,246, working capital is US\$4,339,494.

**8.2 Fund source**

The initial investment of the combined Mine-fertilizer-power plant complex is US\$195,571,410, of which, local currency is US\$44,717,283 that is 396,642,300 Birr, accounting for 22.86%, and foreign currency is US\$ 150,854,127 accounting for 77.14%. In this feasibility study report, the fund source is considered as follows: The local currency in the investment shall be taken as the equity capital, which shall be provided by the Ethiopian government. In the investment, the foreign exchange shall be applied for from foreign commercial banks and the loan principal is US\$123.21 million that makes up 63% of the initial investment; the remaining foreign exchange of US\$27,644,127, accounting for 14.14% of the initial investment, which is the down payment of the project as a common practice, shall be raised by the Ethiopian government.

**8.3 Financial evaluation**

The FIRR of the total investment for the combined mine-fertilizer-power plant





complex is 8.31%, which is bigger than the benchmark rate of return of 6%. The financial net present value of the total investment is 64.598 million US dollars, which is bigger than 0. The internal rate of return of the capital is 8.82%, the profitability of the investment for the project is 3.03% and the recovery period of the investment is 14.93 years. The profit after tax during the production period is 6.444 million US dollars. The project is average in financial benefit and the financial evaluations are feasible.

#### 8.4 National economic evaluations

The Federal Republic of Ethiopia lies in the northeast of Africa, which is a developing country. Now, the national economy takes agriculture as the main industry with agricultural population making up above 90% of the nation's total and agricultural incomes taking up nearly half of GDP. The development of the national economy mainly depends on the growth of agriculture. Therefore, the Ethiopian government has worked out a general policy of agriculture development led industrialization. In order to increase the agricultural productivity, Ethiopia needs to import a large amount of chemical fertilizers every year. Currently, the yearly growth rate of the demand for chemical fertilizers is 20%, which is expected to continue within the future 10 years. Importing chemical fertilizers needs to consume a lot of foreign exchange, which will directly influence the development of Ethiopian national economy. Hence, the Ethiopian government hopes to learn from Chinese experience on the development of chemical fertilizer industry and make full use of domestic natural resources to build its own chemical fertilizer industry.

The economic internal return rate is 12.15%, which is higher than social discount rate of 10%, and the economic net present value exceeds 0. These indicate that the overall economic benefit of the project is good, and the economic evaluation is workable. The urea produced is used to substitute for

import, which can save 70.626 million US dollars of foreign exchange every year. The economic saving cost is 8.30Birr/US\$, which is lower than the current foreign exchange rate of 8.87Birr/US\$ with obvious efficiency for foreign exchange saving.

Starting from the angle of the overall benefits & general planning of Ethiopia, the construction of this project has great significance and huge social benefits.

Firstly, to invest for the construction of this combined mine-fertilizer-power plant complex is the basis for sustainable economic development of Ethiopia. The construction of this combined Mine-fertilizer-power plant complex can take advantage of domestic existing resources and labor to develop & strengthen the national industries, step up the process of national industrialization, cultivate technical force, improve the country's overall technical level, enhance the national strength, raise the capability of resisting changes in international situation, develop relevant industries, change the country's industrial structure, increase employment opportunities, etc. Domestic resources are used to manufacture chemical fertilizers, which will exert an enormous promotion to the development of national economy.

Secondly, to reverse the situation of depending on imports of chemical fertilizers for a long time and make chemical fertilizers by itself are one of the important preconditions for the strengthening of national defense and growth of national economy. Agriculture is an important basis for national and social stability. Chemical fertilizers are necessities for agricultural development. Only after the production and supply of chemical fertilizers are solved properly, can the agriculture develop stably for a long time, the national economy grow with a basis and the country become prosperous & strong.

## 9 Conclusion

The market and demand study show that the urea demand in Ethiopia is great, and this project is a urgent project needs to be constructed in Ethiopia; The conditions for the location of the plant to be constructed are good and the selected process technological scheme is advanced and feasible.

According to the financial evaluations on the total investment for this project, the FIRR is 8.31%. The financial assessment on FIRR for the own fund investment of this project is 8.82%. The financial evaluation on the investment to built this combined project in Ethiopia is feasible.

Known by economic evaluation calculation, the economic internal return rate of the project is 12.15%, which is higher than social discount rate of 10%, and the economic net present value exceeds 0. These indicate that the overall economic benefit of the project is good, and the economic evaluation is feasible. The urea produced is used to substitute for import, which can save 70.626 million U.S. dollars of foreign exchange every year. The economic saving cost is 8.30Birr/US\$, which is lower than the current foreign exchange rate of 8.87Birr/US\$ with obvious effect in foreign exchange saving.

From the angle of the overall benefits of Ethiopia, to construct this project has great significance and huge social benefits, and the project is feasible.

Therefore, the Ethiopian government is advised to refer to the development of Chinese chemical fertilizer industry and adopt some measures to give strong support to this project as much as possible, which will enable considerable economic benefits for this project and enable the start up and the development of this new industry of coal-based chemical fertilizer production in Ethiopia.



## 10 Problems existing in the complex project and suggestions

### 10.1 Problems existing

This project serves to explore and utilize Ethiopian existing coal resource for the construction of coal mine, thermal power plant and chemical fertilizer plant. The investment for the construction of this project is US\$195,571,410, of which foreign exchange is US\$150,854,127 and domestic currency is US\$44,717,283. According to the financial evaluations on the total investment for this project, the FIRR is 8.31%. For the financial assessment on the self-investment for this project, the FIRR is 8.82%. If Ethiopia invests to build up this complex project, the financial evaluation is feasible, but the economic benefit is not so ideal and the production cost of the major product urea is fairly high. The main reasons are as follows:

- (1) At present, what is to be developed is the lignite in Achibo-Sombo Region of the Yayu coal field, which has been laboratory tested and pilot tested with "Ash Fusion & Agglomeration Fluidized Bed Gasification Process" at the pilot test base of Shanxi Coal Chemistry Institute of the Chinese Academy of Science. The test result shows the lignite in the Archibo-Sombo Region of the Yayu coal field in Ethiopia can use the powdered coal based ash fusion & agglomeration fluidized bed gasification technique to produce conversion gas. However, the coal is lignite with a high water ( $\geq 25\%$ ), ash (25.56%) & sulfur content in the coal and a low effective content ( $< 50\%$ ) & caloric value, which will greatly affect the techno-economic figures for the production of synthetic ammonia.

Restricted by the compositions of the coal, the components of the gas for the gasification process is not so good with a high content of  $\text{CO}_2$  and methane, which will increase the loads for  $\text{CO}_2$  removal & compression and result in a high content of purging gas in the ammonia synthesis at the same time. Although some  $\text{H}_2$  can be recovered through hydrogen recovery, more power

for compression will be consumed and the loss of effective gases will be very big at the same time, which is the reason for a high consumption of feed & fuel coal and also the main reason for a high cost for the production of chemical fertilizers.

- (2) Due to a very poor industrial foundation in Ethiopia, to construct a chemical fertilizer factory, the thermal power plant must be built to match it, which will lead to a much more investment in chemical fertilizer construction than in other countries. Further more, the equipment manufacture capability in Ethiopia is poor and the varieties are not complete, spare parts & materials mainly rely on imports. Ethiopia has few large-scale industrial enterprises, especially that large-scale machinery fabrication & processing enterprises are even fewer. There is only a relatively big tool factory and parts manufacturing plant named Akaki, but it can not produce and manufacture the needed mechanical, electrical and instrumental equipment for this combined project. The above mentioned reasons will lead to a high investment for this combined project, which will also increase the cost for the production of chemical fertilizers.

## 10.2 Suggestions

The Ethiopian government is advised to refer to the development of Chinese chemical fertilizer industry and adopt the following several measures for this project as much as possible, which will enable considerable economic benefits for this project to start & develop this new industry of coal-based chemical fertilizer production in the future in Ethiopia.

- (1) The governmental support in tariff should be striven for to carry out a quota system for imports of chemical fertilizers. Within the quota, low tariffs are imposed on imported chemical fertilizers, while for chemical fertilizers beyond domestic demand, non-quota imports are adopted and high tariffs are imposed, which can not only ensure the demand of normal

agricultural production for chemical fertilizers in Ethiopia, but also weaken the price advantages of imported chemical fertilizers to some extent so as to decrease the risks of this project.

- (2) Strive for governmental subsidy for chemical fertilizers to indirectly lower the sale prices of chemical fertilizers and endowed this project with certain advantages in price compared with imported chemical fertilizers.
- (3) Strive for governmental subsidy on interest payment or low-interest loans from foreign governments, decrease the interests and financial fees during the construction period, lower the initial investment & production cost and improve the profits of this project as much as possible.
- (4) Because of Ethiopian weather, the application of chemical fertilizers mainly concentrated in the short rainy season (BELG, February ~ March per year with a consumption of about 15~20%) and the long rainy season (MEHER, June ~ September per year with a consumption of about 80~85%) with a large stock of chemical fertilizers. According to the currently actual sales of urea in Ethiopia, the loan interest in the sales stage is 107.93 Birr/MT. In order to make urea produced by this project more competitive than imported urea, this part of interest is not considered when calculating the ex-works price of urea produced by this project. As for the urea procurement loan for sellers at the sales stage, the Ethiopian government is advised to allocate a special fund for chemical fertilizers and the loan shall be exempt of interest.
- (5) Restricted by the coal compositions, the production cost of chemical fertilizers for this project is relatively high. Therefore, it is recommended to continue seeking more appropriate coal resources for producing synthetic ammonia to replace the existing feed coal.