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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Energy Conservation and GHG Emissions in Chinese TVEs-Phase II
Replication of Waste Heat Power Generation in Coking

Final Report

Project No. **EG/CPR/99/G31**

Contract No. **05/072ML**

P.O. NO. **16000940**

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Shanxi Taixiang Engineering Consulting Co. Ltd.

January 25, 2007

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1 Introduction and Acknowledgements

This report is the Final Report for the project entitled "Energy Conservation and GHG Emissions Reduction in Chinese TVEs-Phase II- Replication of Waste Heat Power Generation in Coking" (UNIDO Project No. EG/CPR/99/G31, Contract No. 05/072ML), which is reached between the United Nations Industrial Development Organization (hereinafter referred to as UNIDO) and Shanxi Century Central Test Electric Science & Technology Co. Ltd. (hereinafter referred to as SCCTEST or the Contractor) and Shanxi Taixiang Engineering Consulting Co. Ltd.

The report summarizes activities conducted and results achieved during the period from October 24, 2005 to January 25, 2007 and the detailed contents include mainly the following two parts:

1) Technical renovation summaries
(a) contract task
(b) achievements summary
(c) activities summary
2) Technical renovation suggestions

Under the support of Ms. M Latrech, UNIDO Project Officer, Ms. Wang Guiling, PMO Executive Director, Dr. Xu Litong, UNIDO Technical Advisor, Mr. Wang Hai, Mr. Song Dongfeng and Mr. Tian Yishui from Beijing HongYuanHuanNeng Technology Company, the contractor has successfully accomplished all technical services stipulated in the contract. We give our faithful and deep appreciations to the people mentioned above, and we also would like to thank everybody involved for their contribution.

2 Technical Services Delivered

2.1 Contract Tasks

The project entitled "Energy Conservation and GHG Emissions Reduction in Chinese TVEs-Phase II- Replication of Waste Heat Power Generation in Coking", which is aimed at reducing greenhouse gas emissions form Chinese TVEs and to remove key policy, market, technology and financing barriers to the adoption of energy-efficient technologies.

The project aims to demonstrate and replicate successful experiences of technical renovation in promoting energy-efficiency and product quality of the polit coking companies to the replication coking companies. UNIDO and PMO selected 7 qualified coking companies as replication TVEs that are introducing or going to introduce waste heat power generation systems into their coking ovens. According to the contract consigned by UNIDO and the contractor, the 7 selected replication TVEs will receive consulting services including comprehensive assessment and feasibility study on waste heat power generation, establishment of energy-efficiency management system and technical training. Based on the actual situation of the selected companies, the detailed tasks are as follows:

1) Summary on the best practices and experiences in technical renovation and energy management of the pilot companies, and demonstrate and replicate these in the 7 replication TVEs through training activities.

2) Feasibility study on each of the 4 companies that will introduce waste heat power generation system into their coking ovens.

a) Conduct a comprehensive assessment of each of the 4 coking plants, including but no limited to the following aspects:

i. Production processes
ii. Technology and equipment
iii. Raw materials
iv. Energy and electricity use
v. Products, output and markets
vi. Production workers and technical personnel
vii. Ownership, fixed assets, loans, and other financial information.

b) Based on the above assessments and in consultation with plant management, propose a list of measures and investments to the company management to upgrade the existing production technologies and equipment, which will result in improved product quality, less energy consumption, and a more profitable enterprise in the long run. The energy-saving target for each replication project should be at least 42,300 tons of coal equivalent (tce), i.e. 120,000,000 kWh, and CO_2 emissions reduction should be 120,000 tons, per year on average. The Contractor may draw on the successful experiences of the pilot companies in terms of technology, equipment, and management, but the proposed renovation measures and investments must suit the conditions of the potential replication TVEs.

c) Conduct feasibility study with a feasibility study report to the proposed measures and investments (including energy savings). The feasibility study must abide by the applicable regulations in China as well as other documents related to the technical renovation project.

3) Assist each plant's management to set up a system, or strengthen the existing system if one already exists of production management, energy management, quality inspection, personnel training, and other areas that may require attention.

4) Organize the replication TVEs to participate in project promotion activities, such as training and on-site demonstration, and provide full support to the relevant project activities.

2.2 Results Achieved

In accordance with the TOR, SCCTEST, the Contractor, have completed Feasibility Studies of waste heat power generation plants in 4 replication coking TVEs, delivered training courses for the 7 replication TVEs, and established comprehensive management systems for the 7 replication TVEs. As a result, a total capacity of 8.01×10^8 kWh/a. Can be reached in the 7 TVEs, equivalent to 306,783 tce of energy savings or 764,811 tons of CO_2 emissions reduction annually. The project target has been reached in general. Detailed results achieved include the following:

1) Waste heat power plant's Feasibility Study Reports have been completed for the 4 replication TVEs that will introduce waste heat power generation systems onto their

coking ovens, namely Shanxi Jiexiu Luxin Coking Co. Ltd., Shanxi Fenyang Longquan Foundry Coking Co. Ltd., Shanxi Fenyang Wenfeng Coking Co. Ltd., and Shanxi Gujiao Nanhai Coking Co. Ltd., respectively.

In the past time, these companies only paid attention to products' quantity and quality. The flue gas with high temperature from the coking ovens was wasted greatly and even emitted entirely. After technical renovation, the waste heat will get good use and become recycled. The 4 replication TVEs can save 217,161 tons of coal equivalent (tce), or reduce 541,383 tons of CO_2 emissions annually. While waste heat power plants in the other 3 TVEs can save 89,622 tons of coal equivalent (tce), or reduce 223,428 tons of CO_2 emissions annually.

2) Successful experiences of the 2 polit coking TVEs (i.e. Shanxi Gaoping Xinggao Coking Co. Ltd. and Shanxi Taiyuan Gangyuan Coking Co. Ltd.) were summarized and disseminated into the 7 replication TVEs. They are: (1) Shanxi Fenyang Longquan Foundry Coking Co. Ltd., (2) Shanxi Fengyang Wenfeng Coking Co. Ltd., (3) Shanxi Gujiao Nanhai Coking Co. Ltd., (4) Shanxi Lvliang Yaolong Coking Co. Ltd., (5) Shanxi Lvliang Fuli Coking Co. Ltd., (6) Shanxi Jiexiu Luxin Coking Co. Ltd., and (7) Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd. On-site visit and on-site communion have also been arranged for the 9 companies involved in the project.

   By training, on-site visit and on-site communion, each companies widen their views and realize that energy-saving technical renovation do not increase their burden, but improve their economic interests. Such activities facilitate their enthusiasm to construct waste heat power plant and help them promote their operation management skill in the existing power plants.

3) Assisted each plant's management to set up or strengthen their energy-saving & emission-reduction management systems

   In the past time, the enterprises did not pay attention to the recycling of flue-gas with high temperature. The waste heat was discharged without any use and the utilization ratio of the secondary-energy was very low. After introducing advanced management experience of the 2 polit companies, the energy-consuming index involved in each production processes are formulated, confirmed and decomposed to every links, which prompts energy-saving & emission-reduction in a scientific way.

4) Enterprises' production/EE management have been improved significantly

   By project promotion activities, the TVEs' long-term development plans have been worked out. Detail procedures to improve product quality, energy-saving and emission-reduction, enterprise management and technical training have all been planed. This will benefit the TVEs in the market competition.

5) After the operation of all the power plant projects, in the 7 replication TVEs, it is expected that a capacity of generation 8.01×10^8 kWh, which means to save 306,783 tons of coal equivalent, or reduce 764,811 tons of CO_2 emission per year.

2.3 Project Activities Summary

In June 2005, the contractor received TERMS OF REFERENCE (hereafter referred as to TOR) of the project entitled "Energy Conservation and GHG Emissions Reduction in Chinese TVEs-Phase II- Replication of Waste Heat Power Generation in Coking" from UNIDO. In

response to UNIDO's invitation, the contractor submitted the Project Proposal in written form in June 20, 2005 and cosigned the contract with UNIDO in October 24, 2005 after audited by UNIDO and PMO. From then on, the contractor were formally awarded the subcontract of the project and start a series of activities. Now the contractor reports project activity to UNIDO and PMO.

As stated in the Briefing Report dated December 24, 2005, the contractor has completed 2 main tasks including 13 activities that listed briefly as follows:

Activity 1. Analyze the contract, work out project implementation scheme, and prepare the Briefing Report.

Task 1. Summarize on the successful experiences in technical renovation and energy management of the pilot TVEs and disseminate into the replication TVEs via training and consulting.

Activity 2. On-site survey on technical renovation, management and operation situations, summarize experiences and achievements of the polit TVEs, write "Energy-saving and Emission-reduction Summary Report of the Polit Coking Companies" as a part of training materials.

Activity 3. Collect suggestions and requirements from the 7 replication TVEs, prepare training program and compile training materials.

Activity 4 to Activity 6. Assist the enterprises establishing or improving their management system via training, and on-site visit and seminar

Task 2. Carry out feasibility study for the replication TVEs to introduce waste heat power generation.

Activity 7. Evaluate each of the 7 replication TVEs and collect raw materials for feasibility study

Activity 8. Propose technical renovation measures and investment list
Activity 9. Carry out feasibility study, write Draft Feasibility Study Report
Activity 10. Evaluate Draft Feasibility Study Report and obtain revision suggestions.
Activity 11. Improve and finalize the formal Feasibility Study Report.
Activity 12. Write the Draft Final Report
Activity 13 Improve and finalize the Final Report

The coke ovens adopted by all the 7 replication TVEs are branded as QRD, with Q denoting clean (*qingjie*), R heat recovery (*rehuishou*), and D stamping (*daogu*). The distinct features of the QRD-type coke ovens are: 1) It does not recover any chemical by-products. 2) It can use any kinds of coal resources not limited to fine-coal and thus save fine-coal greatly. 3) It can produce high quality coke with low pollution and construction cost. More important, the QRD-type coke ovens do not produce any wastewater, waste gas, and waste materials that generally produced in traditional coking engineering. Consequently, the gas-pollutant emission is lower than State Medium-size Coke Ovens Emission Standard. However, the flue gas from coke ovens is generally at a high temperature about 900 centigrade or so. Once discharged into atmosphere directly, the thermal energy is wasted, and heat pollution occurs. If waste heat power generation technique is adopted to convert thermal energy into electric energy, not

only the wasted thermal energy will be reused, but also the electricity generated will meet the need of the company themselves. For the above mentioned environmental benefit and economic benefit, the contractor organized project team with many senior engineers majoring in specialty such as coking coal, electric power, environment and management et al. Mr. Du Jie leads the project team.

Now, the contractor have obtained the following achievements through Activity 1 to13:

Activity 1. Preside briefing meeting, respond to the TOR, analyze contract task, finalize project implementation scheme, and organize project team.

Task Members: Du Jie, Fan Zhong, Cheng Changye, Wang Zengping, Meng Haoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhang Jianwei, and Zhong Lei

Completion Time: October 24, 2005.

Task 1: Summarize the successful experiences in technical renovation and energy management of the 2 pilot TVEs and disseminate into the 7 replication TVEs via training and consulting.

Activity 2: After on-site investigation on technical renovation, management and operation situation of the polit TVEs, we summarized achievements and experiences and completed "Energy-saving and Emission-reduction Summary Report of the Polit Coking Companies", which includes: (1) Basic situation of the polit TVEs, coking production processes, and main devices. (2) Essential conditions for coking companies to introduce waste heat power plant, production processes of waste heat power generation, operational management problems and technical problems encountered in the polit companies. (3) Environmental quality standards, approved pollutant discharge standards, pollution protection problems and its' related environment benefit. (4) Economic benefit resulted form the enterprise energy consumptions (electricity, heat, and water) and waste heat power generation project. (5) Suggestions on the technical renovation project of waste heat power generation.

Task Members: Du Jie, Fan Zhong, Cheng Changye, Wang Zengping, Meng Haoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhang Jianwei, and Zhong Lei

Completion Time: November 27, 2005

Activity 3. Based on the suggestions and requirements collected from the 7 replication TVEs and the 2 polit TVEs, the training courses' notes have been completed. The main context of the notes involves economic management, electrical technology, thermal systems and environment protection of waste heat power plant. The notes have been submitted to PMO and the corresponding abstracts have been submitted to UNIDO, see also the "Progress Report II" dated November 2, 2006.

Task Members: Cheng Changye, Zhang Qi, Fan Zhong, and Han Yongkui

Completion Time: March 20, 2006

Activity 4: Assist the related TVEs to master power generation and waste heat power generation technique, establish and strenghten their management systems and post management training systems. Enterprise managers, chief technical personnels and management personnels, and other staffs in critical

positions from the 7 replication TVEs and 2 polit TVEs attended the training course. The trainees amount to 20. The training course mainly involves: (1) Power plant management including the administration management, technical management, economic management and quality management etc. (2) Electrical technology of waste heat power plant including generator systems, step-up substation, relay protection, electrical instrument, and electrical control room etc. (3) Thermal systems of waste heat power plant including design criteria, main steam systems, feed-water systems, waste heat boiler and its' systems, turbine-generator and its' systems etc. (4) Environmental protection of waste heat power plant including environmental protection requirements and pollutant discharge standards, impacts of waste heat power plant on CO_2 emission-reduction, energy-saving and emission-reduction related techniques and policies etc. By teaching and self-learning with the uniformly prepared lecture notes and combining with on-site visit, discussion and communion, the trainees have obtained many knowledges they never known.

Task Members: Cheng Changye, Zhang Qi, Fan Zhong, Han Yongkui, and other local expers

Completion Time: April 21 to April 23, 2006

Activity 5: On-site visit and on-site communion. All of the trainee visited the Thermal Power Plant of the Taiyuan Xishan Coal & Power Group, Shanxi Gaoping Xinggao Coking Co. Ltd., and Shanxi Lu'an Gas-fired Power Plant.

Task Members: Cheng Changye, Du Jie, Fan Zhong, and Han Yongkui

Completion Time: April 24 to April 25, 2006

Activity 6: Discuss and communicate waste heat power plant and its investment and construction experiences at Shanxi Gaoping Xinggao Coking Co. Ltd. and Taiyuan Taihang Grand Hotel.

Task Members: Cheng Changye, Du Jie, Fan Zhong, and Han Yongkui

Completed Time: April 23 to April 26, 2006

Through the above-mentioned dissemination activities, both the polit and the replication TVEs have deep feelings:

1) By the economic management course hold by senior engineer Mr. Fan Zhong, the electrical technology course hold by senior engineer Mr. Han Yongkui, the thermal system course hold by professorship senior engineer Mr. Cheng Changye, and the environment protection course hold by senior engineer Mr. Zhang Qi, the trainees have more understanding on problems about power plant design, unit operation, environment protection, discharge within the required standards, and CO_2 emission-reduction et al.

2) By the on-site visit to 2*50MW coal-fired unit of the Thermal Power Plant of the Taiyuan Xishan Coal & Power Group, 1*15MW waste heat unit of the Shanxi Gaoping Xinggao Coking Co. Ltd., and 1*6MW gas-fired unit of the Shanxi Lu'an Gas-fired Power Plant, the trainees get great confidence in waste heat power plant.

3) Technical problems, such as design key-points of waste heat boiler, waste heat recovery, design and operation problems caused by flue gas temperature variation, isolating door damage problems

due to over-burning, ash concentrating problems occurring in the rear of waste heat boiler, temperature drop in the steam pipe of waste heat boiler, and turbine vacuum leakage problem etc., have been discussed or solved in the on-site discussion and communion.

Task 2: Feasibility study on waste heat power generation technical renovation projects among the related replication TVEs. The main target is to propose a list of technical renovation measures and investment and to carry out feasibility study for the 4 potential replication TVEs that will introduce waste heat power generation onto their coke ovens.

As mentioned early, all of the 7 replication TVEs adopt the QRD-type coke ovens. After on-site survey and assessment, technical renovation suggestions have been submitted to the plant management according to their actual situations, respectively. The main idea is to recover the wasted thermal energy in the flue gas discharged form coke ovens by waste heat boiler and desulphurization & purification production process. Once the thermal energy has been recovered, power generation is possible. This is so-called waste heat power generation technique. Several advantages can be resulted form such technique. Firstly, the wasted thermal energy of flue gas can be recovered. Thus, flue gas can be discharged into atmosphere at a low temperature and heat pollution is reduced. Secondly, SO_2 contained in the flue gas can be removed more easily since temperature is lowered. Thirdly, dust contained in the flue gas can be collected by dust-collecting equipment, which can be easily attached to waste heat boiler. The waste heat accompanying with coking engineering can be transformed into electric energy. This facilitates to make up the deficit of power supply, which frequently has been encountered by enterprises themselves and local area in recent years. Since electricity is necessary to local economic development, such suggestions obtained supports from both enterprise and local government. Based on this idea, the contractor carried out feasibility study on waste heat power generation for Shanxi Jiexiu Luxin Coking Co. Ltd, Shanxi Gujiao Nanhai Coking Co. Ltd., Shanxi Fenyang Longquan Foundry Coking Co. Ltd., and Shanxi Fengyang Wenfeng Coking Co. Ltd., respectively.

Activity 7: On-site survey and assessment on the 4 replication TVEs, and collect raw material for feasibility study.

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, Fan Zhong

Completion Time: December 1, 2005 to February 10, 2006

Activity 8: Propose technical renovation measures and investment item list

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, and Fan Zhong

Completion Time: February 15 to April 10, 2006

Activity 9: Carry out Feasibility Study

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, and Fan Zhong

Completion Time: February 15, 2006

The Draft Feasibility Study Report for Shanxi Jiexiu Luxin Coking Co. Ltd was completed at the end of April 2006. Draft Feasibility Study Report for the remained 3 companies is still in progress by that time.

Activity 10: Review the Draft Feasibility Study Report

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, Fan Zhong, and specially invited experts.

Completion Time: May 12, 2006

In the review meeting, the invited experts gave their comments and suggestions on the Draft Feasibility Study Report for the 4 related companies

Activity 11: Perfect the Draft Feasibility Study Report, and finalize the formal Feasibility Study Report

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, and Fan Zhong

Completion Time: June 2006 to October 20, 2006

The Feasibility Study Report for the 4 related TVEs have been completed, accepted and confirmed by the companies, respectively. All of the 4 Feasibility Study Reports have been submitted to UNIDO and PMO according to provisions of the project contract.

Activity 12: Write the draft final report

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, Fan Zhong, and Zhang Jianwei

Completion Time: October 20, 2006 to Decmber 14, 2006

The Draft Final Report has been completed and accepted by UNIDO and PMO.

Activity 13: Improve and finalize the Final Report

Task Members: Cheng Changye, Du Jie, Wang Zengping, Meng Zhaoran, Xing Jie, Han Yongkui, Zhang Qi, Kang Jincai, Liu Yaoxiang, Zhang Shaocheng, Zhong Lei, Fan Zhong, and Zhang Jianwei

Completion Time: February 7, 2007

The Final Report has been completed.

As it can be seen from the Feasibility Study Report for Shanxi Jiexiu Luxin Coking Co. Ltd., Shanxi Gujiao Nanhai Coking Co. Ltd., Shanxi Fenyang Longquan Foundry Coking Co. Ltd., and Shanxi

Fengyang Wenfeng Coking Co. Ltd., the thermal energy contained in the flue gas with high temperature have been reused via waste heat power generation and CO_2-emission has been reduced. The target of the project has been reached successfully. The detailed expected indexes of energy-saving and emission-reduction are shown in Table 1.

Table 1 Expected energy-saving and emission-reduction indexes of the 4 replication TVEs that will introduce waste heat power generation onto their coke ovens

No.	Company Name	Coke Output (Million tons/y)	Technical Renovation Measures	Unit Rated Capacity (MW)	Total Investment (Ten thousands RMB Yuan)	Expected Index			
						Energy Consumption per Output	Recovered Energy (tce/y)	Power Generation (kWh)	CO_2 Emission Reduction (t/y)
1	Shanxi Jiexiu Luxin Coking Co. Ltd	1	waste heat power generation	24	9,257	1.41	73,536	1.92×10^8	183,325
2	Shanxi Gujiao Nanhai Coking Co. Ltd	0.4	waste heat power generation	18	6,092	1.36	55,152	1.44×10^8	137,494
3	Shanxi Fenyang Longquan Foundry Coking Co. Ltd.	0.4	waste heat power generation	12	4,622	1.51	36,768	9.6×10^7	91,663
4	Shanxi Fengyang Wenfeng Coking Co. Ltd.	0.5	waste heat power generation	18	6,606	1.34	51,705	1.35×10^8	128,901
Total				72	26,577		217,161		541,383

As shown in Table 1, once waste heat power generation technique has been adopted by the 4 companies, 217,161 tons of coal equivalent will be saved and 541,383 tons of CO_2-emission will be reduced per year, which is higher than the index stipulated by the TOR.

The waste heat power generation project of the other three replication TVEs, namely (1) Shanxi Lvliang Yaolong Coking Co. Ltd., (2) Shanxi Taiyuan Wanguang Coal & Coking co. Ltd., and (3) Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd., are now under construction. Despite this, they also attended training activities actively and built or improved their management systems required by the TOR under the fund of this project. On the basis of their feasibility study reports prior to this project, the installed power generation capacity reaches 2.34×10^8kWh, which saves 89,622 tons of coal equivalent and reduces 223,428 tons of CO_2-emission per year. The detailed indexes are shown in Table 2.

Table 2 Expected energy-saving and emission-reduction indexes of the other 3 replication TVEs that construct waste heat power generation onto their coke ovens currently

No.	Company Name	Coke Output (Million tons/y)	Technical Renovation Measures	Unit Rated Capacity (MW)	Total Investment (Ten thousands RMB Yuan)	Expected Index			
						Energy Consumption per Output	Recovered Energy (tce/y)	Power Generation (kWh)	CO_2 Emission Reduction (t/y)
1	Shanxi Lvliang Yaolong Coking Co. Ltd.	0.4	waste heat power generation	1.5	646	1.47	4,596	1.2×10^7	11,458
2	Shanxi Taiyuan Wanguang Coal & Coking co. Ltd	0.4	waste heat power generation	12	4703	1.57	36,768	9.6×10^7	91,663
3	Shanxi Lvliang Fuli Coking Co. Ltd.	0.4	waste heat power generation	18	6647	1.51	48,258	1.26×10^8	120,307
Total				31.5	11,996		89,622	2.34×10^8	223,428

3 Recommendations

The tasks specified in the TOR have been accomplished successfully by conducting a series activities mentioned above. To keep the objectives of the project sustainable, some meassures are recommended as follows:

1) By applying waste heat power generation, the heat contained in the flue gas discharged from the coke ovens are reused and converted into electricity. Not only the secondary energy is utilized reasonably, but also the atmosphere environment quality is improved effectively.
2) The practice of waste heat power generation is important for companies to improve their product quality, utilize resources efficiently, protect environment, alleviate power demand pressure, and raise company repute, market rate, and economic profit. Simultaneously, good social effect will also be reached. Therefore, there is a great potentiality to replicating waste heat power generation in companies that uses QRD-type coke ovens.
3) When applying waste heat power generation in coking sector, the enterprises' actual situation must be taken into consideration. Different product types and production technique, such as foundry coke and metallurgy coke, will result in different temperatures of flue gas, and thus limit the usage of waste heat resources. Also, main devices' selection will be influenced. More Important, the index of energy-saving and CO_2-emission varies greatly. For example, two of the replication TVEs of this project, Shanxi Fenyang Longquan Foundry Coking Co. Ltd. and Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd., have installed capacity of only 12MW due to the limited heat resource and plant spare area respectively, which is slightly lower than other companies in both installed capacity and the energy-saving and emission reduction indexes shown in the TOR. Another example is Shanxi Lvliang Yaolong Coking Co. Ltd, which produces foundry coke. Since the temperature of oven flue gas is only 620 centigrade due to its products type, the installed capacity is only 1.5MW, which is far lower than the indexes expected in the TOR. At present time, the company is suffering from the influence of international coking coal market, low coking coal's production can not supply enough waste heat to run its' waste heat power unit. Nevertheless, large-sized unit with high temperature, high pressure and high efficiency will still be recommended if conditions are suitable.
4) When constructing waste heat power plant, enterprises must cooperate with local electric power authority in advance and get their supports in both technique and policy. Now that waste heat generation has been encouraged by government environmental policy, it has a comparatively higher government regulated price. Enterprises should try their best to connect their units to power gird. In this way, the electricity generated by waste heat power plant can not only meet the needs of the enterprise, but also can send to other consumers at a high price. This will bring more benefits to the enterprises and reduce expenditure in operation and maintenance. Therefore, common understanding between enterprises and local power supply authorities must be reached. It is very important to get the Win-Win solution.
5) The waste heat boilers are generally arranged near coke ovens. Such arrangement needs long pipes to send steam from boiler outlet to turbine inlet. The distance of steam pipe will be 200 to 300 meters. Once the steam temperature lowers to a certain extent, not only the electricity output will decrease, but also turbine-generator's facilities will suffer from operation security problems in long-term. Therefore, enough attention should be paid to waste heat power plant area layout planning, steam pipes layout, isolating layer technique and isolating materials.

4 Social Impacts Generated by Project Replication

Shanxi Local Policy Instruction Council (LPIC) is a coordinating agency among government departments. One of the main tasks of LPIC is to replicate clean-type coke ovens and waste heat power generation technique in Shanxi TVEs, to facilitate energy-saving and lower energy consumption in coking sector, and to reduce greenhouse gas emission. The specific key-points should be noticed as follows:

1). Coordinate with government departments to formulate sector policies according to actual situations of the Shanxi rural and township coking industry, promote clean-type coke oven technique being suitable for environment protection and facilitating economic development. Based on the requirements of Shanxi Development and Reform Commission, more than thirty coking enterprises with clean-type coke ovens will gradually develop and apply waste heat power generation technique.

2). Give enough supports to the enterprises joining GEF projects in technical renovation and environment protection. So far, Shanxi Small and Medium Enterprise Bureau have provided low-interest loans of one million RMB to two polit enterprises and five replication enterprises.

3). Give introductions and reports to Shanxi Coking Coal Structure Adjusting Leader Group and Shanxi Coking Sector Cleaning and Rectification Leader Group. After coordinating with others respective, the clean-type coke ovens have been recognized by Shanxi Coking Coal Structure Adjusting Leader Group and get supports from sector policy to be listed as preferential developing furnace-type and technique. Shanxi Gaoping Xinggao Coking Co. Ltd. is appointed as Polit Coking Enterprise to inspect and evaluate typical oven. Such inspection and evaluation will be regarded as the base of formulating "Shanxi Clean Furnace Temporary Standard"

4). Cooperate with PMO to held Coking Enterprise On-site Meeting at Gaoping City for the purpose of replicating the polit enterprise's experience and technology of Shanxi Gaoping Xinggao Coking Co. Ltd. The leader of Shanxi Small and Medium Enterprise Bureau and other leaders from cities and counties presented the site meeting. More than 70 government officials and more than 200 enterprise representatives visited Shanxi Gaoping Xinggao Coking Co. Ltd. and promote these experience and technology to TVEs in Shanxi Province.

5). Learning advanced environmental ideas and experiences from GEF Project and finding out advanced technique of energy-saving and emission-reduction in other TVEs with high pollution (such as casting, cement), and then promoting these advanced technique for demonstration and promotion.

Finally, we can reach the target of realizing technical progress of all TVEs, strengthening environmental consciousness, reducing energy consumption and decreasing greenhouse gas emission.

Annex 1. Energy Efficiency Benchmark Table

Energy Efficiency Benchmark of the Replication Companies

No.	Company Name	Basic Condition	Main Energy-consumption Facility	Benchmark of Energy Efficiency								Technical Renovation Scheme	Total Investments (ten thousands RMB Yuan)
				Energy Type	Energy Consumption Amount	Conversion Factor	Energy Consumption (tons of tce)	Product Energy (tons of tce)	Output before Renovation (ten thousands tons of coke	Total Energy Consumption (tons of tce)	CO_2 Discharge Factor	CO_2 Emission (ton)	
1	Shanxi Jiexiu Luxin Coking Co. Ltd.	A private joint-stock company, established in 1995, located at Beixingwu Industrial Zone in Shanxi Jiexiu City. The plant occupies 100 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 1,000,000 tons of coke production capacity per year. Main products include Grade I metallurgy coke and small-size coke etc. The plant, with fixed asset RMB86,000,000 yuan, has 1200 staffs including 210 technical staffs. Main raw material is coking coal.	Heat recovery coking ovens and coal cleaning facility	fine coal	1,337,891t/y	1.028	1,375,352	1.41	100.00	1,405,321	2.493	3,503,465	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	9,257
				electric power	78,249,024kWh/y		29,969						
2	Shanxi Fengyang Wenfeng Coking Co. Ltd.	A private joint-stock company, established in 1993, located at Lujiazhuang Industry Zone in Shanxi Fenyang City. The plant occupies 56 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 500,000 tons of coke production capacity per year. Main products include Grade I metallurgy coke and Grade I foundry coke etc. The plant, with fixed asset RMB70,000,000 yuan, has 1000 staffs including 30 engineers and 40 technical staffs. Main raw material is coking coal.	Heat recovery coking ovens and coal cleaning facility	fine coal	655,417t/y	1.01	661,971	1.34	50.00	671,935	2.493	1,675,134	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	6,606
				electric power	26,016,000kWh/y		9,964						
3	Shanxi Fenyang Longquan Foundry Coking Co. Ltd.	A private joint-stock company, established in 1996, located at Sanquan Town in Shanxi Fenyang city. The plant occupies 36 hectare. The coking plant equips with QRD-2002 type Clean Heat Recovery Coke Ovens and has 400,000 tons of coking coal production capacity per year. Main products include Grade I metallurgy coke and Special Grade foundry coke etc. The plant, with fixed asset RMB54,160,000 yuan, has 392 staffs including 30 technical staffs. Main raw material is coking coal.	Heat recovery Coking Oven and Coal clean facility	raw coal	739,610t/y	0.8	591,688	1.51	40.00	602,424	2.493	1,501,843	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	4,622
				electric power	28,032,000kWh/y		10,736						
4	Shanxi Gujiao Nanhai Coking Co. Ltd.	A private joint-stock company, established in 1996, located at Dalinghe Coal Chemical Industry Zone in Shanxi Gujiao City. The plant occupies 200 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 400,000 tons of coking coal production capacity per year. Main products include Grade I metallurgy coke and Grade II metallurgy coke etc. The plant, with fixed asset RMB120,000,000 yuan, has 270 staffs including 56 technical staffs. Main raw material is coking coal.	Heat recovery coking ovens and coal cleaning facility	fine coal	525,600t/y	1.021	536,638	1.36	40.00	542,207	2.493	1,351,722	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	6,092
				electric power	14,541,600kWh/y		5,569						
5	Shanxi Lvliang Yaolong Coking Co. Ltd.	A private joint-stock company, established in 1996, located at Jinluo Town in Shanxi Lvliang District Zhongyang County. The plant occupies 16 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 400,000 tons of coking coal production capacity per year. Main products include Special Grade foundry coke, Grade I foundry coke and Grade I metallurgy coke etc. The Special Grade foundry coke is exported to Japan and USA.The plant, with fixed asset RMB60,000,000 yuan, has 280 staffs including 26 technical staffs. Main raw material is coking coal.	Heat recovery Coking Oven and Coal clean facility	fine coal	571,225t/y	1.014	579,222	1.47	40.00	588,414	2.493	1,466,916	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	646
				electric power	24,000,000kWh/y		9,192						
6	Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd.	A private joint-stock company, established in 1996, located at Loufan County in Shanxi Taiyuan City. The plant occupies 16 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 400,000 tons of coking coal production capacity per year. Main products include Grade I and Grade II metallurgy coke etc. The plant, with fixed asset RMB70,000,000 yuan, has 240 staffs including 40 technical staffs. Main raw material is coking coal.	Heat recovery coking ovens and coal cleaning facility	fine coal	613,321t/y	1.011	620,068	1.57	40.00	629,646	2.493	1,569,707	Waste heat power generation utilizing flue gas with high temperature from coking engineering, converting the heat energy into electric energy.	4,703
				electric power	25,008,000kWh/y		9,578						
7	Shanxi Lvliang Fuli Coking Co. Ltd.	A private joint-stock company, established in 1992, located at Lishi City in Shanxi Lvliang District. The plant occupies 16 hectare. The coking plant equips with QRD-2000 type Clean Heat Recovery Coke Ovens and has 400,000 tons of coking coal production capacity per year. Main products include Grade I foundry coke and Grade I metallurgy coke etc. The plant, with total output value RMB302,500,000 yuan, has more than 400 staffs including 56 technical staffs. Main raw material is coking coal.	Heat recovery coking ovens and coal cleaning facility	fine coal	592,273t/y	1.001	592,865	1.51	40.00	602,250	2.493	1,501,409	Waste heat power generation utilizing flue gas with high temperature from coking engineering , converting the heat energy into electric energy.	6,647
				electric power	24,504,000kWh/y		9,385						
Total													

-Coking Sector

Project Investment			Project Progress	Start and Finish Time	Finical Assessment			Expecting Effect							Notes
Project Support (US$)	Other (ten thousands RMB Yuan)							Output after Renovation (ten thousands RMB Yuan per	Product Energy Consumption (tons of tce per tons of coke)	New Added Unit (MW)	Annual Utilization (h)	Recovered Energy (tons of tce per year)	Total (tons of tce per year)	CO2 Emission reduction (tons per year)	
30,000	Commercial loan	6,480			Investment recovery period	5.84	year	100.00	1.41	24	8,000.00	73,536	73,536	183,325.25	
	Loan by mandate				IRR	21.92	%								
	Fund raised by enterprise	2,777			NPV	5746	ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving	0.0826	RMB Yuan/kWh								
30,000	Commercial loan	4,624			Investment recovery period	9.22	year	50.00	1.34	18	7,500.00	51,705	51,705	128,900.57	
	Loan by mandate				IRR	10.4	%								
	Fund raised by enterprise	1,982			NPV	1286	ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving	0.064	RMB Yuan/kWh								
30,000	Commercial loan	3,235			Investment recovery period	9.17	year	40.00	1.51	12	8,000.00	36,768	36,768	91,662.62	
	Loan by mandate				IRR	10.37	%								
	Fund raised by enterprise	1,387			NPV	889	ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving	0.067	RMB Yuan/kWh								
30,000	Commercial loan	4,264			Investment recovery period	9.22	year	40.00	1.36	18	8,000.00	55,152	55,152	137,493.94	U.S.$ and RMB is exchanged according to the rate of 1:7.8
	Loan by mandate				IRR	10.39	%								
	Fund raised by enterprise	1,828			NPV	1185	ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving	0.061	RMB Yuan/kWh								
30,000	Commercial loan				Investment recovery period		year	40.00	1.47	1.5	8,000.00	4,596	4,596	11,457.83	
	Loan by mandate				IRR		%								
	Fund raised by enterprise				NPV		ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving		RMB Yuan/kWh								
30,000	Commercial loan				Investment recovery period		year	40.00	1.57	12	8,000.00	36,768	36,768	91,662.62	
	Loan by mandate				IRR		%								
	Fund raised by enterprise				NPV		ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving		RMB Yuan/kWh								
30,000	Commercial loan				Investment recovery period		year	40.00	1.51	18	7,000.00	48,258	48,258	120,307.19	
	Loan by mandate				IRR		%								
	Fund raised by enterprise				NPV		ten thousands RMB Yuan								
	State subsidy				Cost of energy-saving		RMB Yuan/kWh								
												306,783	764810.02		

Annex 2. Acceptance Certificate

Shanxi Jiexiu Luxin Coking Co. Ltd.

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Jiexiu Luxin Coking Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

1. Waste Heat Power Plant Design

The waste-heat power generation plant will be built onto the "Clean Type" coking ovens with a production capability of 1,000,000 tons of coke per year. The contractor made a Feasibility Study Report on the Waste Heat Power Plant with an rated capacity of 24MW and consisting of 4*6MW condensing turbine-generators and 2*25t/h+4*20t/h waste-heat boilers. With the plant, it will retrieve and save energy, and reduce GHG emission to atmosphere considerably. After the operation of the power plant, it can generate 192,000,000 kWh, equivqalent to saving 72,000 tons of coal equivalent (tce), or reducing 183,000 tons of CO_2 emission annually.

2. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

3. Production/EE management system

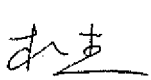
A production/EE management has been devised and provided to the plant.

Shanxi Jiexiu Luxin Coking Co. Ltd.

Responsible Person:  Vice General Manager of Shanxi Jiexiu Luxin Coking Co. Ltd.

Date: December 10, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person: 

Date: December 12, 2006

Shanxi Gujiao Nanhai Coking Co. Ltd

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Gujiao Nanhai Coking Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

1. Waste Heat Power Plant Design

The waste-heat power generation plant will be built onto the "Clean Type" coking ovens with a production capability of 400,000 tons of coke per year. The contractor made a Feasibility Study Report on the Waste Heat Power Plant with an rated capacity of 18MW and consisting of 3*6MW condensing turbine-generators and 4*25t/h waste-heat boilers. With the plant, it will retrieve and save energy, and reduce GHG emission to atmosphere considerably. After the operation of the power plant, it can generate 144,000,000 kWh, equivqalent to saving 55,000 tons of coal equivalent (tce), or reducing 137,000 tons of CO_2 emission annually.

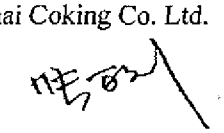
2. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

3. Production/EE management system

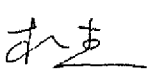
A production/EE management has been devised and provided to the plant.

Shanxi Gujiao Nanhai Coking Co. Ltd.

Responsible Person:  General Manager of Shanxi Gujiao Nanhai Coking Co. Ltd.

Date: December 3, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person: 

Date: December 12, 2006

Shanxi Fenyang Longquan Foundry Coking Co. Ltd.

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Fenyang Longquan Foundry Coking Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

1. Waste Heat Power Plant Design

The waste-heat power generation plant will be built onto the "Clean Type" coking ovens with a production capability of 400,000 tons of coke per year. The contractor made a Feasibility Study Report on the Waste Heat Power Plant with an rated capacity of 12MW and consisting of 2*6MW condensing turbine-generators and 4*20t/h waste-heat boilers. With the plant, it will retrieve and save energy, and reduce GHG emission to atmosphere considerably. After the operation of the power plant, it can generate 96,000,000 kWh, equivqalent to saving 36,700 tons of coal equivalent (tce), or reducing 92,000 tons of CO_2 emission annually.

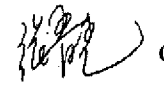
2. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

3. Production/EE management system

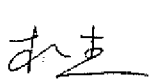
A production/EE management has been devised and provided to the plant.

Shanxi Fenyang Longquan Foundry Coking Co. Ltd.

Responsible Person:  General Manager of Shanxi Fenyang Longquan Foundry Coking Co. Ltd

Date: December 4, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person: 

Date: December 12, 2006

Shanxi Fengyang Wenfeng Coking Co. Ltd.

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Fengyang Wenfeng Coking Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

1. Waste Heat Power Plant Design

The waste-heat power generation plant will be built onto the "Clean Type" coking ovens with a production capability of 400,000 tons of coke per year. The contractor made a Feasibility Study Report on the Waste Heat Power Plant with an rated capacity of 18MW and consisting of 3*6MW condensing turbine-generators and 4*25t/h waste-heat boilers. With the plant, it will retrieve and save energy, and reduce GHG emission to atmosphere considerably. After the operation of the power plant, it can generate 135,000,000 kWh, equivqalent to saving 51,700 tons of coal equivalent (tce), or reducing 129,000 tons of CO_2 emission annually.

2. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

3. Production/EE management system

A production/EE management has been devised and provided to the plant.

Shanxi Fengyang Wenfeng Coking Co. Ltd.

Responsible Person: *Vice General Manager of Shanxi Fengyang Wenfeng Coking Co. Ltd*

Date: December 9, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person:

Date: December 12, 2006

Shanxi Lvliang Yaolong Coking Co. Ltd.

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Lvliang Yaolong Coking Co. Ltd.., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

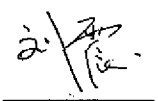
1. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

2. Production/EE management system

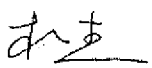
A production/EE management has been devised and provided to the plant.

Shanxi Lvliang Yaolong Coking Co. Ltd.

Responsible Person:  , General Manager of Shanxi Lvliang Yaolong Coking Co. Ltd.

Date: December 5, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person: 

Date: December 12, 2006

Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd.

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

1. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

2. Production/EE management system

A production/EE management has been devised and provided to the plant.

Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd.

Responsible Person: 刘 General Manager of Shanxi Taiyuan Wanguang Coal & Coking Co. Ltd.

Date: December 8, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person:

Date: December 12, 2006

Shanxi Lvliang Fuli Coking Co. Ltd

Acceptance Certificate

To whom it may concern:

This is to confirm, on behalf of the plant, Shanxi Lvliang Fuli Coking Co. Ltd, that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No. 05/072ML) for our technical renovation project for energy efficiency have been fully delivered by the contractor, Shanxi Century Central Test Electric Science & Technology Co. Ltd. in collaboration with Shanxi Taixiang Engineering Consulting Co. Ltd., and has been accepted by the plant. The project has been fully completed and operating smoothly. Thanks to the hardworking of the contractor.

Services delivered and accepted include the following:

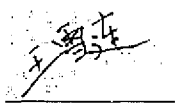
1. Technical Training and Management Knowledge Training of Related Positions

In project implementing, the technical training and management knowledge training of related positions were completed. Suitable management system was established according to our company actual situation. Full consulting and technical service is provided.

2. Production/EE management system

A production/EE management has been devised and provided to the plant.

Shanxi Lvliang Fuli Coking Co. Ltd

Responsible Person:  Manager of Shanxi Lvliang Fuli Coking Co. Ltd

Date: December 5, 2006

Shanxi Century Central Test Electric Science & Technology Co. Ltd.

Responsible Person: 

Date: December 12, 2006