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The Final Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase II -Cemnet Sector Replication Projects for Energy Efficiency(1)

Request for Proposal No: P. 2005/020

Project No: EG/CPR/99/G31

Submitted By:

Tianjin Cement Industry Design and Research Institute (TCDRI)

June 3, 2007

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The Final Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ--Cemnet Sector Replication Projects for Energy Efficiency(1)

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Contents

INTRODUCTION AND ACKNOWLEDGMENT

Introduction

This final report submitted to the United Nations Industrial Development Organization (UNIDO) prepared by the Tianjin Cement Industry Design and Research Institute (TCDRI) as the contractor according to the requirements of contract of "Energy Conservation and GHG Emissions Reduction in Chinese TVEs—Phase II -Cement Sector Replication Projects for Energy Efficiency(1)" between UNIDO and TCDRI. This final report is a summary of works and activities in the above-mentioned projects.

Acknowledgement:

The accomplishment of the contractor is a joint effort of TCDRI and ten pilot plants. Here, we would like to thank all the participants for their hard work and contribution during the accomplishment of the work. Many of the thanks will be sent to all the PMO and UNIDO's chief technical advisor (CTA), Ms. Mounira Latrech and other UNIDO staff. With the support of them, the hard work of the cement Sector Replication Projects for Energy Efficiency becomes a challenge and interesting task.

SUMMARY

Overview

TCDRI Qualification

Tianjin Cement Industry Design and Research Institute (TCDRI) is one of the prospecting and designing institutes under the management of Central Enterprises Operating Committee (former under SABMI). As one of the earliest founded design institutes in China, TCDRI now became a first-class design institute with the strongest design capability in building materials industry of China since it was set up in 1953. Through years of development and expanding, TCDRI now has turned into a large comprehensive designing enterprise incorporated scientific research, engineering design, construction supervision, turnkey contract construction, consultative engineering technical service and machinery & electrical equipment manufacture. In 1992, TCDRI was granted "the Direct Business Right with Foreigners" by the Ministry of Economic and Trade, and in 2000 TCDRI was granted "Self-run Import Enterprise" by Tianjin Foreign Economic Relations and Trade Committee. In 1995, TCDRI was entitled by the Development and Research Center of the State Council as "the first institute for design and research on new dry process cement production line in China", and compiled in a book called "Honor Records of the Most in China" (1949~1995). In 1993 TCDRI was honored as one of "the Hundred Strongest Institute" (the sole design institute gain this title in building materials industry) and afterwards, was successively chosen as "the Hundred Strongest in Overall Strength in China Prospecting and Designing Institute". In 1996, TCDRI was the first one passing the conformity of quality system certification ISO9000.

China Cement Development Center (CCDC) created by Chinese government and UNIDO is a sole international institution in Asian and Pacific Area. From the founding of CCDC in 1983, entrusted by UNIDO, TCDRI successfully organized and sponsored three international mini-cement meetings and trained more than 100 cement professional staffs for Asian and pacific Area. TCDRI played an important role on training professionals, providing technical assistance and international technical exchange for Asian and Pacific Area.

At the present, TCDRI has obtained several qualifications on engineering and consultation including non-metallic mineral, construction engineering, environmental pollution prevention and control. The certificates which TCDRI commanded involves "Export Licence of Engineering Design", "Grade A Certificate on Cement and

Waste-heat Generation Engineering Design", "Grade A Certificate on Turnkey Contract Construction", "Grade A Certificate on Engineering Consultation" and "Special Qualification on Intelligent System of Construction Engineering" as well as the "Conformity of Quality System Certification ISO 9000".

The major business and service include: Cement engineering design, cement raw materials quarry engineering design, new process / technology and new materials development and application, waste heat power generation station design, raw materials testing and evaluation, pressure vessels design, environmental impact assessment and prevention, turnkey contract construction, construction supervision and operation management, construction costs and consultant service, equipment manufacture and completed installation supply, cement technical information and consultant service etc.

There are about 800 staffs and 300 other employees in TCDRI. Among 800 staffs, 700 are professionals in different sections including 2 design masters, 2 experts at national level and 4 experts at provincial and ministerial level, 220 professors and senior engineers, 300 engineers and 160 assistant engineers.

In order to meet market competition, TCDRI has established multiple economic structure and set up 24 divisions, 2 wholly-owned subsidiaries, 11 holding subsidiaries and 1 collectively-owned company.

There are advanced facilities for scientific research in TCDRI. There are 16 labs including laboratory test center, cold and hot model pilot plants, machinery and electric plants, cement technical training center and computer center etc. In TCDRI it is possible to carry out simulating test, research experiment, semi-industrial scale tests and auto-control development for cement manufacturing, industrial wastes utilization, raw materials grindability and burnability testing, as well as training programs for technicians. The results of these activities provide reliable technical guarantee for first-rate engineering design and scientific research in China cement industry.

The completion of the state "Torch Plan" project-new energy conservation cement installation manufacture base is a beneficial practice for industrial development on TCDRI technical achievements, this plant has a stronger ability on equipment manufacturing and sales and has become a new economic growth point of TCDRI.

As one of the demonstration units of CAD, various intelligent computer softwares are widely-applied in scientific research and engineering design in TCDRI, now, the level

for applying computer-integrated circuit keeps progressing, computer network and shared engineering database, as well as office automation has been realized. This makes TCDRI being in a leading position among design institutes in China.

Over 50 years, TCDRI has accomplished more than 400 cement plants and other engineering designs, over 200 turnkey contract construction, construction supervision and engineering consultation, has developed and designed more than 6000 sets cement equipment and fulfilled scientific research for 140 subjects. Since 1970s, Tianjin Cement Industry Design and Research Institute (TCDRI) has been engaged in the design, research and development for exhaust gas waste heat utilization in cement industry, and has worked out different waste heat power generation systems suitable for different types of kilns. Up to now more than thirty waste heat power generation systems have been put into normal operation, and economic benefits and social benefits have been achieved. And meanwhile TCDRI has accumulated practical experiences through site erection and commissioning of those power stations.

Especially during the past 5 years, the subject of the research and development of medium and low temperature waste heat power generation technology and related equipments has achieved great progress, TCDRI has established its leading position in the field of industrial waste heat utilization, and it has the ability to make the design and commissioning of waste heat power station and self-supporting station for different rotary kilns in cement plants and other industries.

By above achievements, TCDRI has made great contributions to the products adjustment and technical progress in China building materials industry and created notable social and economic returns both for state and clients.

Overview

With the world population increase and rapid economy development, the resources shortage is becoming more and more serious; seeking new resources and reasonable utilizing existing resources will be the key for the sustained development of economy in each country. So in all society fields including production, building, circulation and consumption, resources saving and reasonable utilizing should be put into agenda.

Comprehensive resources utilization will be a long-term major economy policy of all countries in the world; it will take an important part in resources saving, environment protection, economic effect improvement, optimum resources configuration and sustained development.

TCDRI recognizes that this sub-contract is a critically important part of the whole project. Our basic approach is to satisfy UNIDO's needs with a term of experts and designers who collectively represent senior level expertise in designing waste heat power plants or similar facilities, and familiarity with cement making processes is an advantage. Working interactively with UNIDO, and the Shenhe cement company, we have researched the existing information provided by Shenhe company, and our design has met the following requirements:

- The waste heat power plant is expected to operate smoothly and steadily, with no adverse effects on cement production. Operation of the power plants should reach 95% relatively to the cement production lines.
- In addition, the waste heat power plant is expected to emit no harmful emissions such as SO_2 and particulates, but to effectively reduce these emissions from the head and tail of the cement kiln.

Design principle

The design principle of waste heat power generation station is **"reliable production, advanced technology, saving investment and improved benefit"**.

Under this principle we are aiming to select reasonable running parameters which can not only make full use of waste heat in the cement plant, but also have no effects on the normal production, to make good selection of main equipments which shall be Chinese standard equipments with ripe technology; to save the investment as much as possible with the conditions to have safe and satisfactory production and to reduce the costs, as well as to increase the economical benefit of the enterprise.

Proposed work plan

TCDRI have identified this sub-contract as a five-month project (refer to the containing seven major tasks. A brief description of each task is as follows.

Task 1: Review experiences and outputs of the UNIDO pilot project, namely "Design of Waste Heat Power Plant for Zhejiang Shenhe Cement Company"

TCDRI has accomplished "Design of Waste Heat Power Plant for Zhejiang Shenhe Cement Company" successfully with the matured technique.

TCDRI has provided over-all technique services through commissioning and equipment purchasing assistance and so on.

TCDRI has investigated at site for design and service, a visit report has been worked out. In the report engineering problems have been analyzed and effective measures

have been put forward in order to avoid similar problems in other projects.
The Waste Heat Power Plant for Zhejiang Shenhe Cement Company has been put into operation now, as for the experiences and outputs of this project as follows.

Scale of construction

Regarding to the cement production line of 2500t/d and with the prerequisite of satisfying the production of the existing line. A waste heat power generation system of one turbine-generator set motivated by waste heat boilers (AQC & SP boiler) has been adopted. The proposed capacity is detailed as follows:

Installed capacity: 3MW
Yearly power generation amount: 2094×104 kWh
Yearly running hour: 7050h

Condition of construction

- **Sources of waste gas**

As a production line of 2500t/d, the waste heat sources to be used are:
waste gas at clinker cooler (normal): 57000 m^3/h, temperature: 350℃/90℃.
waste gas at kiln inlet (normal): 167000 m^3/h, temperature: 335℃/220℃.

- **Water supply**

The water supply for a 3 MW power station includes the cooling water for exhaust steam of a turbine-generator set, Washing water for reduction rinse in chemical water treatment and a small quantity of equipment cooling water, cooling water has been circulated. Therefore, the daily water consumption for the power station is 1004m^3 approximately.

- **Station site**

The waste heat generation station consists of an AQC boiler, a SP boiler, a turbine generator room, power distribution room, a chemical water treatment section, a circulated water pump station, cooling towers.

AQC boiler has arranged in the open space at the kiln outlet, it occupies an area of area of 12 m×10 m.

SP boiler has located on the building of exhaust fan of the kiln inlet, so no more space is needed.

A combined building has been hold the turbine generator, the power distribution

system, the power generation control system, it occupied an area of area of (21+7.5) m×18 m; the circulated water pump station and cooling towers occupied an area of 12 m × 6 m. the chemical water treatment section occupied an area of 21 m × 9 m.

An ideal arrangement for the power station is relatively concentrated one. But for an existing cement production line, expansion power generation station arrangement could not be so ideal, but a practical solution could be worked out.

Thermodynamic system introduction

The thermodynamic system is composed of waste heat boilers and a turbine-generator set.

- **Kiln outlet waste heat boiler -AQC boiler**

The heat-receiving surface of kiln outlet waste heat boiler i.e. AQC boiler has been divided into three stages:

Stage Ⅰ: steam stage, producing 1.6MPa-300℃ over-heat steam, which flows to the turbine directly as main feed steam for power generation.

Stage Ⅱ: steam stage, producing 0.25MPa-150℃ over-heat steam, which flows to the turbine directly as supplement feed steam for power generation.

Stage Ⅲ: hot water stage, for heating turbine condensing water so as to increase feed water temperature of the AQC boiler steam stage and the SP boiler.

Waste gas from the middle discharge outlet of the cooler has been introduced to the AQC boiler for heat exchanging, then returned to the existing kiln outlet exhaust treatment system, and discharged to the atmosphere trough a stack after EP dedusting.

- **Kiln inlet waste heat boiler-SP boiler**

Kiln inlet waste heat boiler i.e. SP boiler produces 1.6MPa-280℃ over-heat steam, which merges with the main steam of the AQC boiler, the merged steam has been fed to the turbine for power generator.

Waste gas from the kiln inlet has been introduced to the SP boiler for heat exchanging, then returned to the existing kiln inlet exhaust treatment system, and discharged to the atmosphere trough a stack after EP dedusting.

➢ **Steam turbine**

A 2-stage mixed-pressure steam turbine has been adopted, the rated capacity is 3MW. The parameter of main steam is 1.27MPa—290℃, the parameter of supplemental steam is 0.15MPa—125℃. The rotating speed is 3000r/min.

➢ **Cooling water system**

A circulation system has been adopted in the project. The system includes circulation cooling pumps, cooling tower, water pool and pipe network. When the system is in operation, the circulation cooling pumps extract water from the water pool and convey to each section for equipment cooling, the return water is conveyed to cooling tower by means of remaining pressure of the circulation pumps, after cooling the water returns to the water pool for circulation use.

The circulation cooling system could satisfy max. cooling water demand of the power station. The system includes 2 mechanical draft GFRP cooling towers capacity 600t/h each, 2 circulation pumps (flow rate 680t/h, lift 26m) for a turbine-generator set.

➢ **Chemical water treatment**

In order to satisfy power station boiler water quality standard and considering local water data, "two-stage sodium demineralizing system" process has been adopted in the project. Running flow sheet is described as follows.

The raw water from the plant supply network flows to mechanical filters, and then flow to raw water tanks after filtering, the raw water pumps pump the water to demineralizing device. After treatment water quality reaches: rigidity$\leqslant$0.03me/l.

For boiler drum water quality adjustment, direct chemical feed method has been adopted, Na_3PO_4 solution shall be pumped to waste heat boiler drums.

➢ **Control system**

A centralized and distributed computer control system (DCS) has been used for the power station process supervision and control. The process parameter collection, process control and production log print are all accomplished by the DCS system.

➢ **Main proposed technical indexes**

Yearly power generation amount: 2094×10^4 kWh

Yearly power supply amount: 1903×10^4 kWh

(with the reduction of the power consumption used by the station itself)

Power generation amount with waste heat per ton clinker:	28.51 kWh/t
Yearly working hour:	7050 h
Water consumption:	1004 m^3/d

Fixed labor: 15 persons (including 3 administration persons)

Electrical power system

- **Existing configuration of the electrical power system in the cement plant**

In the 2500 t/d cement plant there is a substation of 35kV/6kV and one 20000kVA transformers is installed. The incoming line of 35kV is from a local power station-Heshan substation. The distribution voltage of the substation is 6kV and a single busbar scheme is used.

- **System Connection of the Power Station**

For the proposed 3MW pure waste heat power station, all generated power has been used for the cement production line, a 6kV single bus-bar non-sectional connecting method is adopted, the 6kV bus-bar of the 3MW power generation set is connected to this section, The power station connects with the cement plant substation 6kV bus-bar by single cable circuits.

A connecting power circuit breaker cabinet, a bus-bar PT cabinet, a surge absorber cabinet, station service circuit breaker cabinets and generator circuit breaker cabinet will be equipped for the 6kV bas-bar of the power station.

Task 2: Conduct a comprehensive assessment of each of the10 potential replication cement plants identified (see Annex 1), including but not limited to the following aspects:

a) **Production processes**
b) **Technologies and equipment**
c) **Raw materials**
d) **Energy and electricity use**
e) **Products, output, and markets**
f) **Productions workers and technical personnel**
g) **Ownership, fixed assets, loans, and other financial information**

Key findings and outputs of the assessment shall be consolidated into the feasibility study report as mentioned in task 3 below.

We have conducted process parameter calibration for the ten potential replication cement plants in order to achieve production line operation status.

We have conducted investigation at site to achieve the knowledge of production

process, technologies and equipment, raw materials, energy and electricity use, products, output, marketing, production workers and technical personnel, ownership, fixed assets, loans and other financial information and work out a comprehensive assessment for each of every cement plant selected.

As requested by UNIDO, the feasibility study report has included but not limited to the following aspects:

- Summary Indexes of Financial Evaluation
- Plan of Funds Raising and Application
- Every Year Production Cost Estimation Table (value-added tax excluded)
- Statement of Profit & Loss
- Fund Resource and its Application
- Assets and liabilities Sheet
- Statement of Financial Cash-flow (Total Investment)

Task 3: Based on the above assessment and in consultation with plant management, propose a list of measures and investments to the plant 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 or power generation target for each replication project should be at least 8,200 tons of coal equivalent (tce), or 21,000,000 kWh per year on average. The contractor should draw on successful experiences of the pilot plants in terms of technology,, equipment, and management, but the proposed renovation measures and investments must suit the conditions of the potential replication plants.

At the present, TCDRI has obtained the qualification on designing of the power plant engineering. The certificates that TCDRI commanded involves "Grade B Certificate on Waste-heat Generation Engineering Design" and the "Conformity of Quality System Certification ISO 9000".

The technical proposal prepared by TCDRI has satisfied the national a long-term major economy policy. And the energy-saving or power generation target for each replication project should be at least 8,200 tons of coal equivalent (tce), or 21,000,000 kWh per year on average.

Base on above certifications and ripe experience, TCDRI has drawn on successful experiences of the pilot plants in terms of technology, equipment, and management, and the proposed renovation measures and investments must suit the conditions of the potential replication plants.

Task 4:Conduct a feasibility study of the proposed measures, investments and energy savings. The feasibility study must abide by the applicable regulations in China as well as other requirements for technical renovation projects. The feasibility study should include, but is not limited to, the following elements:

1) **Justification of the basis and principles of the feasibility study and design**
2) **Description of the local power grid network and the internal power supply and consumption systems**
3) **Description of key production process and equipment parameters**
4) **Justification of site selection of the key construction and structural components of the power plant**
5) **Discussion of labor protection, fire control, safety in production, and industrial hygiene issues**
6) ***Measures to meet relevant environmental standards and requirements***
7) **Measures for energy conservation and rational utilization of resources, and energy saving potentials**
8) **Description of plant operation and management staffing requirements**
9) **Project implementation schedule**
10) **Investment estimates and economic and financial analysis.**

TCDRI has worked out a feasibility study of the proposed measures, investment and energy saving for each of every cement plant selected according technical calibration and comprehensive assessment.

In reports following elements has been included:

- General description
- The Existing power system of the company
- Technical solution
- Water supply and drainage
- Fire-fighting
- Ventilation and air conditioning
- Environment protection
- Profession safety and sanitation
- Resources saving and reasonable utilization
- Organization mechanism and fixed labor
- Proposed project schedule
- Investment estimation
- Financial evaluation
- Appendix
- Attached drawings

Task5: Assist each plant management to set up a system (or strengthen the existing system if one already exists) and an energy efficiency baseline, and

devise projected energy savings and emissions reduction in each of the replication plants (detail requirements see Annex 1), so as to improve the current practices of production management, energy management, quality inspection, personnel training, and other areas that may require attention.

TCDRI has found out management mechanism of each cement plant through investigation.

TCDRI has assisted each plant to set up a management system (or strength the existing system) according to specific plant conditions and experiences achieved in TCDRI established waste heat utilization power stations, so as to improve the current practices of production management, energy management, quality inspection, personnel training, and so on.

TCDRI has conducted tracing services to promote plant management level.

Task6: Facilitate plate management participation in training and workshops organized by stakeholders of the projects, and provide them with necessary support when and where required.

TCDRI has facilitated and provided technical support for plant management participation in trainings and workshops organized by stakeholders of the project with its administration and technique experiences.

Task7: The contractor should be responsible for following up the project progress of each of the plants, and marking reports when required by stakeholders of the project after the completion of the contract.

TCDRI has responsible for following up project progress of each of the plants;

TCDRI has effected to promote feasibility study report approving;

TCDRI has submitted related reports according to UNIDO's requirements.

The Decrease Amount of CO_2 Exhaust of Cement Sector Replication Project 1

No.	Name of Cement Plant	Cement Production Capacity	Installed Capacity of Power Station	Annual Power Supply	Annual Amount of Equals to Normal Coal Saving	Annual Decrease Amount of Equals to CO_2 Exhaust
1	Baoding Taihang Heyi Cement Co.,Ltd.	3000t/d	6MW	3478×10^4kWh	19129t	$2.920\times10^7m^3$
2	Guangxin Qingzhou Cement Co., Ltd.	2300~2400t/d	3MW	1815×10^4kWh	6237t	$9.52\times10^6m^3$
3	Jiaozuo Jiangu Cement Co., Ltd	1500t/d	3MW	1728.95×10^4kWh	5987t	$9.14\times10^6m^3$
4	Zhejiang Zhongkaiyuan Cement Co., Ltd	1500t/d	2.5MW	1623.6×10^4kWh	5680t	$8.67\times10^6m^3$
5	Deqing Zhongxinyuan Cement Co., Ltd	2500t/d	4.5MW	3478×10^4kWh	9625.55t	$1.4696\times10^7m^3$
6	Changxing Zhongsheng Building Material Cement Co., Ltd	5000t/d	6MW	3478×10^4kWh	12408t	$1.8944\times10^7m^3$
7	Lianshi Cement Plant Fujian Cement Co., Ltd	2300t/d	4.5MW	2934.6×10^4kWh	8980t	$1.3710\times10^7m^3$
8	Henan Tongli Cement Co., Ltd	5000t/d	6MW	3478×10^4kWh	13532t	$2.066\times10^7m^3$
9	Xinging Jingdingzi Building Material Cement Co., Ltd	5000t/d	6MW	3478×10^4kWh	12587t	$1.9217\times10^7m^3$
10	Wutong Building Material Cement Co., Ltd	2500t/d	3MW	1742.2×10^4kWh	5987 t	$9.14\times10^6m^3$

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Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase II -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Baoding Taihang Heyi Cement Co. Ltd., Yi City, Hebei Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Dec.25,2005

Wang lishun

PRESIDENT
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Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase II -Cement Sector Replication Projects for Energy Efficiency(1)
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Jiaozuo Jiangu Cement Co. Ltd., Jiaozuo City, Henan Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Dec.25,2005

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Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Zhejiang Sanshi Jindingzi Building Material Co. Ltd. Meishan Town, Zhejiang Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Nov.25,2005

Chen changcheng

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Zhejiang Changxin Meishan Building Material Co. Ltd. Meishan Town, Zhejiang Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Dec.25,2005

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Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1)
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Fujian Cement Co. Ltd. Lianshi Cement Plant, Shunchang Town, Fujian Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Dec.15,2005

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Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1)
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Zhejiang Zhongxinyuan Cement Co. Ltd. Deqing Town, Zhejiang Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Nov.25,2005

Xu zhihuang

PRESIDENT
Zhejiang Zhongxinyuan Cement Co. Ltd.
Deqing Town, Zhejiang Province, P.R.China

CERTIFICATE for RECEIVED THE FEASIBILITY STUDY REPORT

Nov. 25, 2005

TIANJIN CEMENT INDUSTRY DESIGN AND RESEARCH INSTITUTE (TCDRI)
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Attention: Mr. Zhang Fu, General Manager, Waste Heat Generation Engineering Dept.

Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase II -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Zhejiang Sanshi Wutong Building Material Co. Ltd. Meishan Town, Zhejiang Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Nov.25,2005

Chen changcheng

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Attention: Mr. Zhang Fu, General Manager, Waste Heat Generation Engineering Dept.

Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Guangdong GITIC Green island Cement Co. Ltd. Yunfu Town, Guangdong Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Nov.25,2005

Cai peiwei

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Nov. 25, 2005

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Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase II -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Zhejiang Zhongkaiyuan Cement Co. Ltd. Deqing Town, Zhejiang Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Nov.25,2005

Xu Zhihuang

PRESIDENT
Zhejiang Zhongkaiyuan Cement Co. Ltd.
Deqing Town, Zhejiang Province, P.R.China

CERTIFICATE for RECEIVED THE FEASIBILITY STUDY REPORT

Dec. 25, 2005

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Attention: Mr. Zhang Fu, General Manager, Waste Heat Generation Engineering Dept.

Energy Conservation and GHG Emissions Reduction in Chinese TVEs
Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1)
Project No: EG/CPR/99/G31

Henan Tongli Cement Co. Ltd., Zhumadian City, Henan Province(hereinafter called Company) certifies that the RECEIVED THE FEASIBILITY STUDY REPORT of the Waste Heat Power Plant for the Company has been accepted as per the applicable Chinese laws and regulations a well as relevant requirements for technical renovation projects on Dec.25,2005

Yang xu

VICE-PRESIDENT
Henan Tongli Cement Co. Ltd., Zhumadian City
Zhumadian City, Henan Province, P.R.China

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (6MW) of Baoding Taihang Heyi Cement Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:

Tianjin Cement Industry Design and Research Institute(TCDRI)

December 20, 2005

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1. General description

Baoding Taihang Heyi Cement Co., Ltd. is one of the biggest building material companies of China, controlled by Hebei Taihang Cement Corporation. One new-type dry process clinker production line and cement miller system with output capacity of 2000t/d is put into construction in 2003, through the technical reformation, the clinker output has achieved 3400t/d and the cement output achieved 15 million ton.

The company owns advanced process, equipments and technology, its parents company has forty years experience of cement production and management.

Located in the Yi County Hebei Province, 120km north to Baoding Municipal, 190km east to Tianjin Municipal, 87km to Peking, 112 national highway and Jingguang west highway cross in the county, the company enjoys convenient communication and superior geographical advantage.

In order to fully utilize the waste heat discharged from the cement production process, to save fuel and protect environment, and to make economic and social efficiency, according to the detail conditions of the company, the company purpose to utilize the waste gas exhausted from the kiln outlet cooler and kiln inlet preheater of the 3400t/d cement production line to erect a waste heat power station, the installed capacity of which will be 6MW.

2. Construction necessity

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement

industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure

medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature.. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

3. The project title is: Pure-low Temperature Waste Heat Power Station (6MW) of Baoding Taihang Heyi Cement Co., Ltd.

4. Project conditions

4.1 Power station location

The power station will be arranged in the field of the company, site had been planned before. Refer to the attached drawing "Power Station General Layout".

4.2 Geological conditions

The existing geological condition can meet the requirement of power station construction.

4.3 Nature conditions

4.3.1 Metrological conditions

Monthly average temperature: 12.2℃

Extreme highest temperature: 40.8℃

Extreme lowest temperature: -17.7℃

Hottest month average temperature: 26.4℃

Coldest month average temperature: -4.6℃

Day max. Rainfall: 1868mm

One hour max. Rainfall: 854mm

Monthly average relative moisture: 63.3%

Monthly max. relative moisture: 75.1%

Monthly min. relative moisture: 56.7%

Monthly average atmosphere: 1010.82hpa

Hottest month average atmosphere: 998.17hpa

Coldest month average atmosphere: 1021.90hpa

4.3.2 Earthquake intensity

According to ***Code for Architecture Earthquake Resistance*** (GB5011-2001), the basic earthquake intensity of the planned power station construction area is grade VII.

4.4 Chemical agents supply

The main chemical agents including NaCl and Na_3PO_4 can be purchased in the market and transported by trucks.

4.5 Water source

Since the total domestic and production water demand will be 66.2t/h (1589t/d), the water source capacity should be 1800t/d; a new well should be drilled for water supply.

4.6 Fund raising

The estimation of project investment will be 34.79 million RMB, which will be raised by owner.

5. Main design principal and guideline

The general technical scheme requires the power station design should follow the principal of "stability & reliability, advanced technology, saving energy and investment", the detailed guideline is as follows:

1) The precondition should be stability, adopt mature and reliable process and equipments and overcome problems in similar projects;

2) Advocate advanced process and adopt advanced technical scheme of thermodynamic system to decrease the operation cost and capital cost.

3) Domestic equipments and parts shall be adopted in principal and advanced equipments and parts can be imported for key parts.

4) Carry out related state and local stipulations, standard and laws concerning environment protection, labor safety, fire fighting and metering.

6. Working scope

The working scope is as follows:

Sub-item No.	Sub-item Name	Remarks
700	Power Station General Layout	
712	Turbine & Generator Room	
715a	AQC Boiler	
715c	SP Boiler	
729	Outdoor Pipeline	Including steam, water,compressed air
751	Chemical Water Treatment	
752	Water Circulating Pump Station	
753	Circulating water Cooling Tower	
754	Domestic and Fire-fighting water pipeline	

755	Production & Domestic Water Pipeline	
756	Circulating Water Pipeline	
761	Connection System	
762	Generator & Power Station High-voltage system	
763	Power Station Low-voltage Room	
764	Power Station Distribution Line	
765	Power Station Lighting Protection & Grounding	
766	Power Station Computer Control System	
767	Power Station Dispatching & communication system	
768	Power Station Telephone Line	
769	Power Station Central Control Room	

7. Technical scheme and main equipments model determination

7.1 Technical scheme

There will be a integral building, including turbine & generator room, chemical treatment room, deaerating room, central control room, high & low voltage distribution room. The supplementing & condensing turbine will be selected, the installed capacity will be 6MW, working steam parameter will be, first stage steam inlet 1.27MPa-290℃, the second steam inlet 0.15MPa-145℃.

10.5kV air cooling generator will be selected.

One centralized electrical room will be set up in the power station, the power will be supply by the outside network when the power station is in starting-up, when in normal operation, the power supply can be get either from outside network or generator directly.

A separate dispatching communication system will be installed in the power station; the related station post should be equipped with direct dispatching telephone. Dispatching communication facilities will be equipped between power station and outside network.

Turbine circulating water system adopts mechanical ventilation cooling tower;

Boiler water adopts combined demineralized water system;

DCS computer control system will be adopted.

7.2 Main equipments model determination

No	Equipment name and model	Quantity	Main technical parameter
1	6MW supplementing & condensing turbine	1	model: BN6-1.25/0.15 rated power: 6MW rated rotation speed: 3000r/min main steam pressure: 1.27MPa main steam temperature: 290℃ Supplement steam pressure: 0.15MPa Supplement steam temperature: 145℃ exhaust pressure: 0.007MPa
2	6MW generator	1	model: QF2-6 rated power: 6MW rated rotation speed: 3000r/min outgoing voltage: 10500V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 260000m^3/h (N) Inlet gas temperature: 360℃ Inlet gas dust concentration: <89g/m^3 (N) Outlet gas temperature: more than 220℃ Steam amount: 21t/h—1.6MPa—300℃ Water supply parameter:21t/h—2.5MPa—135℃ Total leakage: ≤10% Arrangement : outdoor
4	Kiln outlet waste heat	1	Inlet gas amount: 130000m^3/h (N)

No	Equipment name and model	Quantity	Main technical parameter
	boiler		Inlet gas temperature: 360℃ Inlet gas dust concentration: <11.4g/m^3 (N) Outlet gas temperature: 100℃ Stage I (steam) Steam parameter: 10t/h－1.6MPa－300℃ Stage I water temperature :10.5t/h－2.5MPa －135℃ Stage II (steam) Steam parameter: 4t/h－0.25MPa－150℃ Stage II water temperature:4.2t/h－2.5MPa －135℃ Stage III (steam) Water supply temperature: 36t/h－2.5MPa －135℃ Water supply temperature: 36t/h－2.5MPa
			－40℃ Total leakage: ≤5% Arrangement : outdoor
5	Deaerator	1	Capacity:40t/h Working pressure: 0.02MPa Working temperature: 104℃ Water tank capacity: 25m^3
6	Boiler water supply pump	2	Flow rate: 35~45t/h lift: 250~350m
7	Water circulating pump	3	Flow:1000m^3/h Lift:26m
8	Glass mechanical	3	Capacity:1000t/h

No	Equipment name and model	Quantity	Main technical parameter
	ventilation cooling tower		
9	Transformer	2	Model: SCB9-630/10 Capacity:630kVA
10	Chemical water implements	1	Capacity:10t/h
11	Computer control system	1	DCS system

8 Main technical economy index

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	6	
2	Average power generation	MW	5.4	
3	Annual operation rate	h	7000	
4	Annual power generation	10^4kWh	3780	
5	Annual power supply	10^4kWh	3478	
6	Power self-consumption rate	%	8	
7	Clinker output amount	t/h	142	
8	Per ton clinker waste heat power generation amount	KWh/t	38	
9	Labor quota of the station	person	18	
10	Investment estimation			
	Total estimation	10^4Yuan	3479.13	100%
	Among which: construction	10^4Yuan	489.98	14.08%
	Equipment expenses	10^4Yuan	2148.13	61.75%
	Installation	10^4Yuan	432.22	12.42%
	Other	10^4Yuan	408.80	11.75%
11	Economic benefits			

No	Technical designation	Unit	Indexes	Remarks
	Internal rate of return(before taxation)	%	32.69	
	Internal rate of return(after taxation)	%	22.88	
	Investment recovery period (before taxation)	Year	4.08	Including construction period
	Investment recovery period (after taxation)	Year	5.28	Including construction period
	Investment profit ratio	%	28.76	
	Investment taxation ratio	%	35.72	
	Repayment period	year	5.32	Including construction period
12	Annual average power generation cost	Yuan/kWh	0.089	
13	Annual average power supply cost	Yuan/kWh	0.097	

9. Conclusion

1) The project has the following construction conditions

- Utilizing the original field, it is unnecessary to purchase land.
- Chemical agents, power supply and water source are necessary for production can be guaranteed.
- The project funds are available
- Baoding Taihang Heyi Cement Co., Ltd. owns a staff team with

abundant construction, production and management experience.

2) The project design will rigidly follow the principal of "Stability & reliability, advanced technology, low energy consumption and investment". The waste heat power station design is the masterpiece base on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

3) The project is to recover large amount of waste heat discharged from the cement production process, it will achieve not only fuel saving but also environment protection, and it will contribute to the sustaining development.

4) The project implementation will rigidly carry out related national and local stipulations, standards and laws concerning environmental protection, labor safety, industrial sanitary, metering and fire fighting.

5) Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment one. While satisfying the state policy, the resources are comprehensively utilized, environment is improved and the construction predictions are satisfied. So we hope the related authorities will approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (3MW) of Jiaozuo Jiangu Cement Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:
Tianjin Cement Industry Design and Research Institute(TCDRI)

December 20, 2005

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1. General instruction

Located in the northwest of the Henan Province, bordering on Shanxi in the north and Yellow River on the south, Jiaozuo Municipal has two towns, four counties, four districts and one high technology industrial development area, floor area 4071 square kilometers, population is 3,400,000, and population of city is 800,000.

Jiaozuo has long history and civilization. Many famous history persons such as Simayi, Lishangyin, Hanyu, Xuheng, Zhuzaiyu is burn here, and Jiaozuo is also the origin of Chen shadowboxing. Mineral resource is very large here, such as coal, bauxite, limestone, pyrites and marble.

Has favorable agriculture production condition, Jiaozuo is one of three grain heavy-producing area, and famous for its Chinese traditional medicine (including rehmannia, hyssop, chrysanthemum and yam). Since Jiaozuo has been an important base of Henan province in energy, chemical industry, aluminum industry and auto's parts manufacture. Two famous projects will pass through the Jiaozuo, one is the water control works which will deliver the water from south to north and the other is nature gas pipeline which will deliver the gas from the west to east. Both of the above mentioned projects will provide many new opportunities for economic and social development.

Four railways passing through, two large freight marshalling yard located, Jiaozheng express highway, Jiaojin express highway and Jiaozuo Yellow River bridge direct linked with 107,301 national highways and Kailuo express highway, the transportation is surely very convenient to the rest parts of country. There are three express highways in construction, including Wenjiao express highway, Jijiao express highway and Taiao express highway, aim to realize the express highway will achieve each county by the end of "Tenth Five-year Plan".

In recent years, in order to realize the aims of agriculture making people

rich, industry making city strong and tourism making city famous, many measures have been put into practice.

In 2003, the total output of the city was 33.42 billion RMB, growing 15.1%; social fixed assets investment achieved 10.62 billion RMB, growing 47.5%; local financial revenue is 1.69 billion RMB, growing 30.9%; townsman disposable per capita income is 6605 RMB, growing 19.7%; farmers income per capita is 2905 RMB, growing 4.4%; every social work developing healthily; science and technology, education, civilization, sanitation and sports are good in Henan Province.

Henan Jiaozuo Jiangu Cement Co., Ltd. (the old name is Henan Jiaozuo Cement Plant), which is the biggest cement plant and the backbone of the Henan cement industry, belongs to Henan Tyre Group- controlled by nation. The company located in No.5, Gongzi Road, Jiaozuo Municipal, floor area 820 yields, has 1360 employees. The total asset of the company is 302.84 million RMB, total debt is 263.41 million RMB, and the fixed assets net worth is 148.27 million RMB. In 2003, the company produced cement 0.64 million tons, sold 0.66 million ton, gross income from the sales is about 0.112 billion RMB.

Jiaozuo Jiangu cement Co., Ltd. clinker production base located in Xicun Village, Xiuwu County, Jiaozuo Municipal. The company owns a four-stage pre-calcining clinker production line, the main equipments of which are imported from Roumania and the design capacity is 1000t/d. Since the production line was put into production in April, 1993, the company has been engaged in developing the manufacturing technique, the output of the production line has achieved great progress. Nowadays, the actual output has achieved 1450t/d.

Since Henan province has been in express way of the economic development, the power shortage is serious, and limiting power supply has occurred in many districts, power supply has been in heavy shortage

in Jiaozuo. In order to realize the sustaining development and resource comprehensive utilization, and to make the cement production in normal operation, according to the existing production capacity, technical condition, the waste heat condition exhausted from the 1450t/d clinker production line, and the general layout, the company purposes to utilize the waste heat of the clinker production line to build a waste heat power station with 3MW installed capacity.

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In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in

Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable

economic and social benefits, which results in cement production cost decreasing and energy saving.

Jiaozuo Jiangu cement Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 3000kW pure low temperature waste heat power station utilizing waste heat of a 2500t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (3MW) of Jiaozuo Jiangu Cement Co., Ltd

2. Feasibility study report bases

- "Technical consult contract" between Jiaozuo Jiangu Cemenet Co., Ltd and Tianjin Cement Industry Design & Research Institute;
- Feasibility study report basic information provided by Jiaozuo Jiangu Cemenet Co., Ltd;
- Related national laws, stipulations, technical standards.

3. Main design principal and guideline

The feasibility study report should reflect national macroscopic economic and sustaining development policies, insist on the principal of "objective, faring, scientific and reliable", analyse both favorable and unfavorable factors, put forward suggestions for the owner to make decision, and provide reliable basis for project approval.

A feasibility study report is a part of important content of earlier stage for a project, and an important basis for investment. A feasibility study report must satisfy national laws, regulations, industry policies, and its content and quality should be in accordance with related stipulations.

The general technical scheme shall guarantee that power station construction and production and shall not affect the normal operation of cement production. In that case, the design of power station shall follow the principal of "reliable operation, advanced technology, low energy

consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and avoid failures exposed in similar projects.

(2)Advocate advanced technology and adopt advanced technical scheme to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

1000t/d cement kiln outlet cooler waste gas boiler (AQC boiler);

1000t/d cement kiln inlet preheater waste gas boiler (SP boiler);

Boiler water treatment system;

Turbine generator system;

Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

4.2 Working procedure

According to the institute ***Quality Manual***, a project manager should

prepare a project kick-off report to state the study bases, scope, principle and requirements, and hold a kick-off meeting with all specialties as participants; all specialties should carry out design and study on main technical scheme in their own field.

5 Project condition

5.1 Project station location

The planned station is arranged within the area of the existing 1000t/d cement production line, See attached drawing 1 "Power station general layout".

5.2 Natural condition

5.2.1 Meteorological condition

Annual average temperature: 15.9℃

Extreme highest temperature: 40.5℃

Extreme lowest temperature: -12.4℃

Basic wind pressure: 0.45kN/m^2

Basic snow pressure: 0.45kN/m^2

Max. frozen depth: 0.15m

The others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6, and basic earthquake acceleration is 0.05g.

5.2.3 Geological condition

According to the ***Engineering Geological Reconnaissance Report*** submitted by Henan Building Material Industry Design Institute, the engineering geological of the project is common, the foundation stability is good, and the existing geological condition can meet the requirement of power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3Po_4 \cdot 12H_2O$, which can be purchased locally and transported to the plant by truck.

5.2.5 Water source requirement

The total water demand will be 35.61t/h (max. 49.81t/h), excluding the fire demand. Taking the unforeseen water demand into consideration, the total water supply capacity will be 35.61t/h (max. 49.81t/h)×1.2=42.7 t/h (max. 59.8t/h).

There is a purifying department of capacity 100m^3/h is built in the plant area. The source water is pump to the purifying department for treatment, and the treated water will be as power station production water. Domestic and auxiliary production will be supplied by plant domestic water system, which is supply by the municipal water supply network, the supply is guaranteed. The fire-fighting water will be supplied by the existing plant fire-fighting network, which is to be extended for power station.

5.2.6 Power supply

There is an existing general substation of 35kV/6kV, located in the field of the cement plant, one main transformer of 35kV/6.3kV of 20MW is installed in the substation. The incoming 35kV power supply is through single overhead line, the power supply is from the nearby substation.

Both 35kV and 6kV adopt single busbar connection system in the general substation.

The devices of the general substation are in normal operation.

5.2.8 Investment estimation and fund raising

The total investment estimation of the project will be 0.1776 billion RMB, Which is raised by owner.

6. Technical scheme and main equipments model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration

when working out the thermodynamic system and installed solution:

1) Making the best of the waste heat exhausted from the cooler and preheater;

In order to fully utilize the waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it to produce the same parameter boilers as kiln inlet boiler, reformation on the kiln outlet cooler shall be made, and the waste gas will be exhausted from the middle stage of the cooler.

According to the data submitted by the company, the waste heat source of the cement line can be utilized are as follows:

Practical 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 60000m^3/h（normal）— 350℃↘100℃ which contents about 1532×10^4kJ/h heat.

Kiln inlet preheater waster heat condition: 180000m^3/h（normal）— 320℃↘225℃（Exhaust gas is planned for raw meal drying, the temperature is determined by cement process）, which contents about 2542×10^4kJ/h heat.

2) When in normal operation, the power station will not feed power to outside network.

3) The pure-low temperature waste heat power station construction and operation will not affect the cement production.

4) The principal of "mature & reliable operation, advanced technology, low investment and high efficiency" will be followed in the power station system and equipments selection. At the same time, the actual technical level of domestic waste heat power equipments will be taken into consideration.

5) Kiln ash precipitated in the waste heat boilers will be recollected and reused in the cement production, in order to realize the resource comprehensive utilization and environment protection.

6) DCS computer central control system shall be adopted for the process control and management.

7) A centralized electrical room will be set up in the power station, when the power station is in start-up, the power station get the power from outside network. When in normal operation, the power supply can be get either from the outside network or the generator directly.

8) The power station will connect with the outside network at the 6kV side of plant substation, the operation mode is connecting with the outside network but not feeding power to it.

9) The power station will equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities will be arranged between the power station and outside network.

10) Kiln inlet boiler will be arranged between the kiln inlet exhaust outlet and stack, a bypass pipeline is designed to ensure the cement production in normal operation in case of the power station or boiler failure.

6.2 Thermodynamic system solution and installed capacity

According to the pure waste heat power generation technology, and equipments development status in China domestic and the cement production waste heat source conditions, pure low temperature waste heat power station will be adopted in the project.

Taking into the consideration of the cement production line inlet and outlet waste heat resource distribution conditions, following the principal of "stability, reliability, advanced technology and not affecting cement production", the thermodynamic system and installed capacity are as follows:

The main equipments includes two waste heat boilers and one set condensing turbine and generator set, the installed capacity of which is 3MW.

A waste heat boiler called AQC boiler was arranged between the kiln outlet cooler middle stage and kiln outlet EP. The original kiln outlet cooler exhausted pipeline is remained as AQC boiler lower temperature exhausted pipe. When AQC boiler is in maintenance or failure, the cement burning system can conduct normal operation, the cement production will not be affected. The first stage of the AQC boiler produces over-heated steam with 1.25MPa-330℃, the second stage will produce 2.1MPa-110℃ high temperature water.

A waste heat boiler will be arranged between the kiln inlet preheater and kiln inlet high temperature fan. The original pipeline will be remained as the bypass pipeline, when SP boiler is in failure or maintenance, the burning system can conduct normal operation and the cement production will not be affected. SP boiler will produce over-heated steam with 1.25MPa-300℃.

One N3-12 condensing turbine and generator set will be selected to match the two waste heat boilers.

6.3 Main equipments

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	3MW condensing turbine	1	model: N3－12 rated power: 3MW rated rotation speed: 5600r/min main steam pressure: 1.2MPa main steam temperature: 290℃ exhaust pressure: 0.008MPa
2	3MW generator	1	model: QF3－2

No	Equipment name and model	Quantity	Main technical parameter
			rated power: 3MW rated rotation speed: 3000r/min outgoing voltage: 6300V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 180000m^3/h (N) Inlet gas temperature: 320℃ Inlet gas dust concentration: <65g/m^3 (N) Outlet gas temperature: 225℃ Steam amount: 14.2t/h—1.25MPa—300℃ Water supply parameter: 14.6t/h—110℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 60000m^3/h (N) Inlet gas temperature: 360℃ Inlet gas dust concentration: <30g/m^3 (N) Outlet gas temperature: 100℃
			Stage I (steam) Steam parameter: 4.98t/h—1.25MPa—300℃ Water supply temperature: 5.13t/h—110℃ Stage I water temperature :19.73t/h—110℃ Water supply temperature40℃ Total leakage: ≤5% Arrangement : outdoor
5	Deaerator and water tank	1	Model : SCY20 Working pressure: 0.0926MPa Work temperature: 45℃ Deaerating water amount: 20m^3

No	Equipment name and model	Quantity	Main technical parameter
6	Boiler water supply pump	2	Model: DG25－30×9 Flow rate: 15～30t/h lift: 297～220m

7. Main technical economy index:

No	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	3	
2	Average generation power	MW	2.97	
3	Annual operation rate	h	7050	
4	Annual power generation	10^4kWh	2094	
5	Annual power supply	10^4kWh	1843	
6	Annual power purchase reduction	10^4kWh	1935	
7	Per ton clinker waste heat power generation amount	KWh/t	28.5	
8	Mechanical equipment	t	~1000	~120 set
9	Electrical equipment	t	~102	~80 set
10	Total occupied area	m^2	~4200	
11	Total construction area	m^2	~1090	
12	Labor quota of the station	person	21	
	Among which: worker	person	17	
	Management personnel	person	4	
13	Labor productivity			
	Total	10^4kWh /person	99.7	

No.	Technical designation	Unit	Indexes	Remarks
		• a		
	Worker	10^4kWh /person • a	123.2	
14	Investment estimation			
	Total estimation of fixed assets investment	10^4Yuan	1776	
	Among which: construction	10^4Yuan	234.33	
	Equipment expenses	10^4Yuan	1097.76	
	Installation	10^4Yuan	252.25	
	Other expenses	10^4Yuan	191.18	
15	Economic benefits			
	Investment recovery period (before taxation)	Year	3.63	Including construction period
	Investment recovery period (after taxation)	Year	4.71	Including construction period
	Investment profit ratio	%	34.71	
	Cost of power generation	Yuan/kWh	0.130	Excluding tax

1.8 Conclusion

1) The project has the following construction conditions

- Utilizing the original field, it is unnecessary to purchase land.
- Chemical agents, power supply and water source are necessary for production can be guaranteed.
- The project funds are available
- Jiaozuo Jiangu Cement Co., Ltd. owns a staff team with abundant construction, production and management experience.

2) The project design will rigidly follow the principal of "Stability & reliability, advanced technology, low energy consumption and investment". The waste heat power station design is the masterpiece base on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

3) The project is to recover large amount of waste heat discharged from the cement production process, it will achieve not only fuel saving but also environment protection, and it will contribute to the sustaining development.

4) The project implementation will rigidly carry out related national and local stipulations, standards and laws concerning environmental protection, labor safety, industrial sanitary, metering and fire fighting.

5) Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment one. While satisfying the state policy, the resources are comprehensively utilized, environment is improved and the construction predictions are satisfied. So we hope the related authorities will approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (2×7.5MW) of Henan Tongli Cement Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:

Tianjin Cement Industry Design and Research Institute(TCDRI)

December 20, 2005

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1. General description

Henan Tongli cement Co., Ltd. was found in Sep. 1995, registered capital is 0.21 billion RMB. The company owns two new-type dry process cement production lines, one is 2500t/d and the other is 2000t/d, the total production capacity is 1.6 million ton Portland cement per year.

The first pre-calcining cement production line of 2000t/d was put into production in Dec.1998, which is being reformed; the actual output will be 2500t/d after reformation. The other 2500t/d cement production was put into production in Dec. 2003. The third cement production of 5000t/d production capacity has been in construction in Dec, 2003.

In order to fully utilize the waste heat discharged from the cement production process, to save fuel and protect environment, and to make much more economic and social efficiency, the company purposes to utilize the waste heat discharged from the kiln outlet cooler and kiln inlet preheater of the three cement production line to erect a pure low temperature waste heat power station, the installed capacity of which will be 2×7.5MW.

2 Construction necessity

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing

energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power

generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

3. The project title is: Pure-low Temperature Waste Heat Power Station (2×7.5MW) of Henan Tongli Cement Co., Ltd.

4. Project conditions

4.1 Power station location

Main building (including turbine & generator room, high & low voltage distribution room, central control room and chemical treatment room) is arranged on the southeast of the 5000t/d cement production line; SP boilers are arranged upon the kiln inlet high temperature fans of each lines; AQC boilers are arranged between the kiln outlet coolers and coal millers of each lines; water circulating pump and circulation cooling tower is separately arranged near the main building.

4.2 Geological conditions

The existing geological conditions can meet the requirement of the power station construction.

4.3 Nature conditions

4.3.1 Meteorological conditions

Extreme highest temperature: 42.3℃

Extreme lowest temperature: -15.5℃

Annual max. rainfall: 1394.1mm

Annual min. rainfall: 266.6mm

Max. frozen depth: 340mm

Day max. snow thickness: 140mm

Max. wind speed: 23m/s

Dominating wind of the year: SN

4.3.2 Earthquake intensity

According to the ***Code for Architecture Earthquake Resistance*** (GB5011-2001), the basic earthquake intensity of the planned power station construction area is grade VIII.

4.4 Chemical agents supply

The main chemical agents including NaCl and Na_3PO_4 can be purchased locally and transported to the plant by trucks.

4.5 Water source

The total domestic and production water demand will be 160t/h (3840t/d), the water source capacity should be 4608t/d, and the existing water source capacity can satisfy.

4.6 Fund raising

The estimation of project investment will be 120.15 million RMB, which is owner raise 35% and 65% loaned by bank.

5. Main design principal and guideline

The general technical scheme requires the power station design should follow the principal of "stability & reliability, advanced technology, saving energy and investment", the detailed guideline is as follows:

1) The precondition should be stability, adopt mature and reliable process and equipments and overcome problems in similar projects;
2) Advocate advanced process and adopt advanced technical scheme of

thermodynamic system to decrease the operation cost and capital cost.

3) Domestic equipments and parts shall be adopted in principal and advanced equipments and parts can be imported for key parts.

4) Carry out related state and local stipulations, standard and laws concerning environment protection, labor safety, fire fighting and metering.

6. Working scope

The working scope is as follows:

Sub-item No.	Sub-item Name	Remarks
700	Power Station General Layout	
712	Turbine & Generator Room	
715a	AQC Boiler	
715c	SP Boiler	
729	Outdoor Pipeline	Including steam, water,compressed air
751	Chemical Water Treatment	
752	Water Circulating Pump Station	
753	Circulating water Cooling Tower	
754	Domestic and Fire-fighting water pipeline	
755	Production & Domestic Water Pipeline	
756	Circulating Water Pipeline	
761	Connection System	
762	Generator & Power Station High-voltage system	
763	Power Station Low-voltage Room	
764	Power Station Distribution Line	
765	Power Station Lighting Protection & Grounding	

766	Power Station Computer Control System	
767	Power Station Dispatching & communication system	
768	Power Station Telephone Line	
769	Power Station Central Control Room	

7. Technical scheme and main equipments model determination

7.1 Technical scheme

There will be a integral building, including turbine & generator room, chemical treatment room, deaerating room, central control room, high & low voltage distribution room. The supplementing and condensing turbines will be selected, the installed capacity will be 2×7.5MW, working steam parameter will be; first stage steam inlet 1.25MPa-290℃, the second steam inlet 0.15MPa-135℃.

10.5kV air cooling generator will be selected.

One centralized electrical room will be set up in the power station, the power will be supply by the outside network when the power station is in starting-up, when in normal operation, the power supply can be get either from outside network or generator directly.

A separate dispatching communication system will be installed in the power station; the related station post should be equipped with direct dispatching telephone. Dispatching communication facilities will be equipped between power station and outside network.

Turbine circulating water system adopts mechanical ventilation cooling tower;

Boiler water adopts combined demineralized water system;

DCS computer control system will be adopted.

7.2 Main equipments model determination

No	Equipment name and model	Quantity	Main technical parameter
1	7.5MW supplementing & condensing turbine	2	model: BN7.5-1.25/0.15 rated power: 7.5MW rated rotation speed: 3000r/min main steam pressure: 1.25MPa main steam temperature: 290℃ Supplement steam pressure: 0.15MPa Supplement steam temperature: 130℃ exhaust pressure: 0.007MPa
2	7.5MW generator	2	model: QF7.5－2 rated power: 7.5MW rated rotation speed: 3000r/min outgoing voltage: 10500V
3	Kiln inlet waste heat boiler for 2500t/d clinker production lines	2	Inlet gas amount: 201800m^3/h (N) Inlet gas temperature: 360℃ Inlet gas dust concentration: <100g/m^3 (N) Outlet gas temperature: more than 250℃ Steam amount: 12.1t/h－1.6MPa－300℃ Water supply parameter:12.7t/h－2.5MPa－120℃ Total leakage: ≤0% Arrangement : outdoor
4	Kiln outlet waste heat boiler for 2500t/d clinker production lines	2	Inlet gas amount: 98100m^3/h (N) Inlet gas temperature: 390℃ Inlet gas dust concentration: <30g/m^3 (N) Outlet gas temperature: 100℃ Stage I (steam) Steam parameter: 7.75t/h－1.6MPa－300

No	Equipment name and model	Quantity	Main technical parameter
			℃ Stage I water temperature :8.14t/h－2.5MPa－120℃ Stage II (steam) Steam parameter: 5.0t/h－0.25MPa－150℃ Stage II water temperature:5.25t/h－2.5MPa －120℃ Stage III (steam) Water supply temperature: 26.09t/h－2.5MPa －120℃ Water supply temperature: 26.09t/h－2.5MPa －40℃ Total leakage: ≤10% Arrangement : outdoor
5	Kiln-inlet-waste-heat-boiler for 5000t/d clinker production line	1	Inlet gas amount: 358000m^3/h（N） Inlet gas temperature: 360℃ Inlet gas dust concentration: <100g/m^3（N） Outlet gas temperature: more than 250℃ Steam amount: 22.5t/h－1.6MPa－300℃ Water supply parameter:23.6t/h－2.5MPa－120℃ Total leakage: ≤10% Arrangement : outdoor
6	Kiln outlet waste heat boiler for 5000t/d clinker production line	1	Inlet gas amount: 116070m^3/h（N） Inlet gas temperature: 390℃ Inlet gas dust concentration: <30g/m^3（N） Outlet gas temperature: 100℃

No	Equipment name and model	Quantity	Main technical parameter
			Stage I (steam) Steam parameter: 9.16t/h－1.6MPa－300℃ Stage I water temperature :9.62t/h－2.5MPa－120℃ Stage II (steam) Steam parameter: 5.9t/h－0.25MPa－150℃ Stage II water temperature:6.2t/h－2.5MPa－120℃ Stage III (steam) Water supply temperature: 39.42t/h－2.5MPa －120℃ Water supply temperature: 39.42t/h－2.5MPa －40℃ Total leakage: ≤0% Arrangement : outdoor
7	Deaerator and water tank	1	Working pressure: 0.008MPa Work temperature: 45℃ Deaerating water amount: 100m^3
8	Boiler water supply pump	3	Model: DG46－50×6 Flow rate: 46t/h lift: 300m
9	Water circulating pump	3	Flow:3240m^3/h Lift:32m
10	Transformer	2	Model: SCB9-1600/10 Capacity:1600kVA
11	Chemical water	1	Capacity:15t/h

No	Equipment name and model	Quantity	Main technical parameter
	implements		
12	Computer control system	1	DCS system

8. Main technical economy indexs

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	2×7.5	
2	Average power generation	MW	2×6.49	
3	Annual operation rate	h	7200	
4	Annual power generation	10^4kWh	9346	
5	Annual power supply	10^4kWh	8514	
6	Annual power purchase reduction	10^4kWh	8759.2	
7	Power self-consumption rate	%	8.9	
8	Clinker output amount	t/h	416	
9	Per-ton-clinker-waste-heat-power generation amount	KWh/t	22.4	
10	Labor quota of the station	person	30	
11	Investment estimation			
	Total estimation	10^4Yuan	12015	
	Among which: construction	10^4Yuan	1249.47	
	Equipment expenses	10^4Yuan	8416.4	
	Installation	10^4Yuan	1010.83	
12	Economic benefits			
	Internal rate of return(before taxation)	%	24.38	
	Internal rate of return(after	%	17.82	

No	Technical designation	Unit	Indexes	Remarks
	taxation)			
	Investment recovery period (before taxation)	Year	5.07	Including construction period
	Investment recovery period (after taxation)	Year	6.31	Including construction period
	Investment profit ratio	%	19.27	
	Investment taxation ratio	%	24.25	
	Repayment period	year	5.32	Including construction period
	Annual average power generation cost	Yuan/kWh	0.122	
	Annual average power supply cost	Yuan/kWh	0.134	

9. Conclusion

1) The project has the following construction conditions

- Utilizing the original field, it is unnecessary to purchase land.
- Chemical agents, power supply and water source are necessary for production can be guaranteed.
- The project funds are available
- Henan Tongli Cement Co., Ltd. owns a staff team with abundant construction, production and management experience.

2) The project design will rigidly follow the principal of "Stability &

reliability, advanced technology, low energy consumption and investment". The waste heat power station design is the masterpiece base on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

3) The project is to recover large amount of waste heat discharged from the cement production process, it will achieve not only fuel saving but also environment protection, and it will contribute to the sustaining development.

4) The project implementation will rigidly carry out related national and local stipulations, standards and laws concerning environmental protection, labor safety, industrial sanitary, metering and fire fighting.

5) Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment one. While satisfying the state policy, the resources are comprehensively utilized, environment is improved and the construction predictions are satisfied. So we hope the related authorities will approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase II -Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Fujian Cement Co., Ltd. Lianshi cement plant

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:
Tianjin Cement Industry Design and Research Institute(TCDRI)

December 1, 2005

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1. Brief Introduction

Fujian cement Co., Ltd. is one of the key enterprises in Fujian province, the group are honored as "China 500 Optimum Economic Benefit Enterprise", its cement products has gained the ISO certification. Now it has 5 cement production lines are under running, and one in under construction (2500t/d). By the end of Mar. 2003, the industry asset is 1.435 billion Yuan RMB, form January to August in 2003, the cement output is 2.0022 million ton.

Fujian Cement Co., Ltd. Lianshi cement plant located in the Sunchang county Fujian province, it owns 2 cement production lines, which are the No.4 and No.5 cement production lines of Fujian Cement Co., Ltd. The advanced technology and equipments of No.5 cement production line is imported from Australia, it's a key project in "seven-five" plan invested by central and local government, it was under commissioning in Aug. 1988, by the end of 1990 it was under production with rated capacity of 2000t/d; The design of No.4 cement production line was undertaken by China, it began to construct in Jan. 2000, and it was under commissioning with rated capacity of 2300t/d in Sep. 2001. now the No.4 and No.5 cement production lines are running smoothly.

In order to farther develop, according to the existing capacity and technology condition, combining with the waste heat and plot area of No.4 and No.5 cement production lines, Fujian Cement Co., Ltd. Lianshi cement plant has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 4500kW pure low temperature waste heat power station utilizing waste heat of No.4 and No.5 cement production lines.

2.Construction necessity

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No.

1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process; in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development,

the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

3.The project title is: Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Fujian Cement Co., Ltd Lianshi cement plant.

4. Project conditions

4.1 Power station location

The planned main building of power station will be arranged in the north spare area of inlet building of No.4 cement production line, within the

main building are turbine and generator building, electrical room, central control room and water treating section.

4.2 Geological conditions

The existing geological conditions can meet the requirement of the power station construction.

4.3Meteorological conditions

Annual average temperature: 18.7℃

Absolute highest temperature: 40.3℃

Absolute lowest temperature: -6.8℃

Annual average relative humidity: 81~84%

Annual average rainfall: 1699.5mm

Dominating wind of the year: NW

Others are according to national meteorological information summary.

Earthquake proof intensity is degree 6.

4.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

4.5 Water source

The total project water demand is 56.0t/h, firefighting water is not excluded, accounting unpredicted water, the total water supply capacity is 56.0t/h×1.2=67.2t/h (about 1600t/d).

4.6 Investment estimation and fund raising

The estimation of project investment is 29.62 million Yuan, which is the owner raise 50% and 50% loaned by bank.

5.Main design principal and guideline

The general technical scheme shall guarantee that the normal production and construction shall not affect the normal operation of cement production. In that case, the design of power station shall follow the

principal of "reliable operation, advanced technology, low energy consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and overcome problems exposed in similar projects

(2)Advocate advanced technology and adopt advanced technical scheme of thermal system and burning system to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipment and parts shall be adopted in principal, and advanced equipment and parts can be imported for key parts.

(5)For technical scheme, the recovery of waste heat from waste gas from clinker cooler and preheater shall be considered.

(6)DCS computer control system shall be adopted for the process control of main and auxiliary unit of the power station to ensure the reliability.

(7)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(8)Considering the comprehensive utilization of resources, the furnace slag produced in the project can be used for cement production.

6. Working scope

- No.4 cement kiln outlet cooler waste gas boiler (AQC1 boiler);
- No.4 cement kiln inlet preheater waste gas boiler (SP1boiler);
- No.5 cement kiln outlet cooler waste gas boiler (AQC2 boiler);
- No.5 cement kiln inlet preheater waste gas boiler (SP2 boiler);
- Boiler water treatment system;
- Turbine generator system;
- Power station water circulation system;
- Power station electrical system;

- Power station auto control system;
- Power station outdoor steam & water pipeline system;
- Power station outdoor water supply & drain system and other matched communication, lighting, etc

7. Technical scheme and main equipment model determination

7.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

The main building contains turbine-generator room, water treating section, control room, low and high tension distribution room. Taking into consideration of the expansion of waste heat power station for No.8 cement production line, a 4.5MW condensing turbine will be adopted, the steam inlet parameter will be 1.25MPa—290℃.

Air-cooling generator will be adopted.

DCS computer control system shall be adopted for the process control and management.

A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.

The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

7.2 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	4.5MW condensing turbine	1	model: N4.5－1.25 rated power: 4.5MW rated rotation speed: 3000r/min main steam pressure: 1.25MPa main steam temperature: 290℃ exhaust pressure: 0.005MPa
2	4.5MW generator	1	model: QF2－4.5 rated power: 4.5MW rated rotation speed: 3000r/min outgoing voltage: 6300V
3	Kiln inlet waste heat boiler (SP1)	1	Inlet gas amount: 166520m^3/h（N） Inlet gas temperature: 350℃ Inlet gas dust concentration: <60g/m^3（N） Outlet gas temperature: 235℃ Steam amount: 8.4t/h－1.6MPa－300℃ Water supply parameter: 8.8t/h－40℃ Total leakage: ≤10% Arrangement : open
4	Kiln outlet waste heat boiler (AQC1)	1	Inlet gas amount: 100080m^3/h（N） Inlet gas temperature: 350℃ Inlet gas dust concentration: <30g/m^3（N） Outlet gas temperature: 210℃ Steam parameter: 6.3t/h－1.6MPa－300℃ Water supply parameter: 6.6t/h－40℃ Total leakage: ≤10% Arrangement : open

No	Equipment name and model	Quantity	Main technical parameter
5	Kiln inlet waste heat boiler (SP2)	1	Inlet gas amount: 170625m^3/h（N） Inlet gas temperature: 335℃ Inlet gas dust concentration: <100g/m^3（N） Outlet gas temperature: 235℃ Steam amount: 7.4t/h－1.6MPa－300℃ Water supply parameter: 7.8t/h－40℃ Total leakage: ≤10% Arrangement : open
6	Kiln outlet waste heat boiler (AQC2)	1	Inlet gas amount: 105960m^3/h（N） Inlet gas temperature: 350℃ Inlet gas dust concentration: <30g/m^3（N） Outlet gas temperature: 210℃ Steam parameter: 6.7t/h－1.6MPa－300℃ Water supply parameter: 7t/h－40℃ Total leakage: ≤10% Arrangement : open
7	Deaerator and water tank	1	Deaerating capacity: 35t/h Working pressure: 0.008MPa Work temperature: 45℃ Deaerating water amount: 25m^3
8	Fead water pump	1	Model : DG25-50×7 Flow: 31t/h Lift: 350m

8. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	4.5	
2	Average generation power	MW	4.44	
3	Annual operation rate	h	7200	
4	Annual power generation	10^4kWh	3196.8	
5	Annual power supply	10^4kWh	2934.6	
6	Annual power purchase reduction	10^4kWh	3071	
7	Per ton clinker waste heat power generation amount	KWh/t	24.78	
8	Mechanical equipment	t	~1200	
9	Electrical equipment	t	~89	
10	Total occupied area	m^2	~4500	
11	Total construction area	m^2	~1280	
12	Labor quota of the station	person	25	
	Among which: worker	person	21	
	Management personnel	person	4	
13	Labor productivity			
	Total	10^4kWh/person • a	128	
	Worker	10^4kWh/person • a	152	
14	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	2962	
	Among which: construction	10^4 Yuan	468.12	
	Equipment expenses	10^4 Yuan	1627.25	
	Installation	10^4 Yuan	444.2	
	Other expenses	10^4 Yuan	422.51	

No.	Technical designation	Unit	Indexes	Remarks
15	Economic benefits			
	Investment recovery period (before taxation)	Year	3.75	Including construction period
	Investment recovery period (after taxation)	Year	4.81	Including construction period
	Investment profit ratio	%	32.18	
	Cost of power generation	Yuan/kWh	0.118	Excluding tax

1.8 Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Fujian Cement Co., Ltd. Lianshi cement plant has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied. So we hope the related authorities would approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase II -Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (3MW) of Guangdong GITIC Green Island Cement Co., Ltd

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:
Tianjin Cement Industry Design and Research Institute(TCDRI)

November 16, 2005

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1. Description

Guangdong GITIC Green Island Cement Co., Ltd previously known as "Guangdong Yunfu Cement Plant" was acquired by "Green Island Cement Group" in 1998, a member of Hong Kong "Cheung Kong Infrastructure Holdings Group " and now the yearly cement production capacity is one million tons. Green Island Cement (Group) also owns a cement grinding plant in Shantou, and bulk cement terminals at Guangzhou, Shenzhen and Zhuhai .

Geographically, the company' s production base is located 5 kilometers north suburb of Yunfu city, Guangdong with an area of 350,000 square meters. In virtue of local supporting infrastructure including the Xijiang River Liudu Port along with direct national highways and railway linked, the transportation is surely very convenient to the rest parts of country.

The company possesses a high-grade limestone quarry, with a floor area of 1.35 million square meters and a reserve of 99 million tons. The limestone is transported via a 7.2-kilometer long ropeway from the quarry to the plant.

The company' s main production equipment is fully imported from FCB Corporation in France. The equipment is of modern design, such as limestone pre-homogenizing silo, Loesche LM 32.4 vertical mill, raw material homogenizing silo, air beam clinker cooler supplied by Satarem Corporation in France, 5 stage pre-calcining system, first stage low pressure cyclone by adopting PMT technology, high efficient separator cement mill with roller press system and ARL9800 Oasis X-ray fluorescence spectrometer from Switzerland . The storage and packing equipment for finished cement product is of advanced design and supplied by the German company Haver Boecker, such as rotary packer. Also, the company has two bulk cement lines, of which the

loading capacity attains 900tph.

Under the company' s management, the company attaches great importance to protecting environment ,improving both the equipment running efficiency and the cement quality. Such improvements include independent design of G3SP calcinator system, modification of vertical mill, cement mill air separator and dust collector and adoption of advanced monitoring system for equipment operation status. The newly installed cement cooler and roller press have further improved the production capacity and the cement performance. The company took the lead in using the cement cooler in China that could cool the outgoing cement down to below 60℃, good for both storage and use of large-volume concrete. In addition, the central process control system has been enhanced by introducing the latest DCS technology from Yokogawa in Japan, featuring excellent performance, higher volume of feedback information, high operating stability and reliability. The management of Green Island Cement Group in Hong Kong has also joined in the routine management of the plant to offer operative and technical support.

Along with population increase and economy development, resources shortage contradiction is sticking out, reasonable resources comprehensive utilization becomes the key factor to maintain sustained economy development. So early in 1996 the State Council has issued a series policies on resources comprehensive utilization, which initiate both resources development and saving, and stress reasonable utilization on existing resources and decrease resources consumption.

Resources including petroleum, coal, water and etc. are all essential necessaries for people existence and society development. The State Economy & Trade Committee issued a file of 《Resources Comprehensive Utilization Power Plant Stipulation》 in July 2000, in the file it is clearly stated that resources comprehensive utilization power

plants mean the enterprises which adopt low heat value fuels such as waste heat, exhaust pressure, city rubbish, gangue, coal marl, etc. to produce power or heat. The file indicates that resources comprehensive utilization power plant application must satisfy the following conditions:

Single unit capacity equal to or more than 500kW;

Generated power quality satisfies national standard, fuel source is nearby;

Discard treatment and utilization measures are adopted, exhaust pollution is limited to related standards.

For the resources comprehensive utilization power plants using gangue and coal marl as fuel, gangue must be main fuel, and heat value should be not more than 12560kJ/kg, circulating fluidized bed boilers should be adopted, when sulfur content in fuel is more than 1%, de-sulfur measure should be adopted; for the resources comprehensive utilization power plants using waste heat or exhaust pressure as medium, installed capacity should be determined according to waste heat and exhaust pressure parameters and amount.

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of

total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process; in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power

stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

Guangdong GITIC Green Island Cement Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 3000kW pure low temperature waste heat power station utilizing waste heat of a 2500t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (6MW) of Guangdong GITIC Green Island Cement Co., Ltd

2. Feasibility study report bases

- "Technical consult contract" between Guangdong GITIC Green Island Cement Co., Ltd and Tianjin Cement Industry Design & Research Institute;
- 《Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (6MW) of Guangdong GITIC Green Island Cement Co., Ltd》 prepared by TCDRI;
- 《Reply to Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (6MW) of Guangdong GITIC Green Island Cement Co., Ltd》 (No. 2004-129) issued by Guangdong Economy & Trade Commission;

- 《Opinion on request of Guangdong GITIC Green Island Cement Co., Ltd captive power station connecting to local power network》 (No. 2004-21) issued by Guangdong Yunfu Power Bureau;
- Feasibility study report basic information provided by Guangdong GITIC Green Island Cement Co., Ltd;
- Related national laws, stipulations and technical standards.

3. Main design principal and guideline

The feasibility study report should reflect national macroscopic economic and sustaining development policies, insist on the principal of "objective, faring, scientific and reliable", analyse both favorable and unfavorable factors, put forward suggestions for the owner to make decision, and provide reliable basis for project approval.

A feasibility study report is a part of important content of earlier stage for a project, and an important basis for investment. A feasibility study report must satisfy national laws, regulations, industry policies, and its content and quality should be in accordance with related stipulations.

The general technical scheme shall guarantee that power station construction and production and shall not affect the normal operation of cement production. In that case, the design of power station shall follow the principal of "reliable operation, advanced technology, low energy consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and avoid failures exposed in similar projects.

(2)Advocate advanced technology and adopt advanced technical scheme to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

5000t/d cement kiln outlet cooler waste gas boiler (AQC boiler);

5000t/d cement kiln inlet preheater waste gas boiler (SP boiler);

Boiler water treatment system;

Turbine generator system;

Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

4.2 Working procedure

According to the institute《Quality Manual》, a project manager should prepare a project kick-off report to state the study bases, scope, principle and requirements, and hold a kick-off meeting with all specialties as participants; all specialties should carry out design and study on main technical scheme in their own field.

5. Project conditions

5.1 Power station location

The planned power station is arranged within the area of the existing 2000t/d cement line.

5.2 Natural conditions

5.2.1 Meteorological conditions

Annual average temperature: 15.9℃

Extreme highest temperature: 40.5℃

Extreme lowest temperature: -12.4℃

Basic wind pressure: 0.45kN/m^2

Basic snow pressure: 0.45kN/m^2

Max. frozen depth: 0.15m

Others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6, and basic earthquake acceleration is 0.05g.

5.2.3 Geological conditions

Since the waste heat power generation station is located within the scope of geological survey of the cement plant, the existing geological conditions can meet the requirement of the power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

5.2.5 Water source

The total project water demand is 35.61t/h (max. 49.81t/h), firefighting water excluded, accounting unpredicted water, the total water supply capacity is 35.61t/h (49.81t/h)×1.2=42.7t/h (59.8t/h).

There is a purifying department of capacity 100m^3/h is built in the plant area. The source water is pumped to the purifying department for treatment, the treated water is as power station production water. Domestic and auxiliary water is supplied by plant domestic water system, which is supplied by municipal water supply network, the supply is

guaranteed. Fire-fighting water is supplied by the existing plant fire-fighting network, the network is to be extended for the power station.

5.2.6 Power supply

There is an existing general substation (Suihe substation) of 35 kV/6kV located in the field of the cement production area, one main transformer of 35 kV/6kV of capacity of 20 MVA is installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

Both 35kV and 6kV buses adopt single busbar connection.

The devices of the general substation are in normal operation presently.

5.2.7 Investment estimation and fund raising

The estimation of project investment is 17.76 million yuan, which is raised by the owner.

6. Technical scheme and main equipment model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. Practical 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 60000m^3/h（normal）— 350℃↘100℃ which contents about 1532×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: 180000m^3/h (normal) — 320℃↘225℃ (Exhaust gas is planned for raw meal drying, the temperature is determined by cement process), which contents about 2542×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;

3) The pure waste heat power station construction and operation shall not affect cement production.

4) The pure waste heat power station system and equipment selection should follow "mature & reliable operation, advanced technology, low investment and high efficiency".

5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.

6) DCS computer control system shall be adopted for the process control and management.

7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.

8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.

9) The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to

insure cement production continuing in case of waste heat boiler or power station failure.

6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of "stability, reliability, advanced technology and not affecting cement production", the thermodynamic system and installed solution are determined as follows:

The main equipment includes two waste heat boilers and one set condensing turbine & generator set, the installed capacity is 3MW.

One waste heat boiler called AQC boiler is arranged between kiln outlet cooler middle stage and kiln outlet EP. The original cooler exhaust pipeline is remained as AQC boiler low temperature exhaust pipe, when AQC boiler in failure or maintenance, cement burning process can conduct normal operation. The first stage of AQC boiler produces 1.25MPa-300℃ over-heat steam, the second stage produces 2.1MPa-110 ℃ high temperature hot water.

One waste heat boiler called SP boiler is arranged between kiln inlet preheater and kiln inlet high temperature fan. A bypass exhaust pipeline is designed, when SP boiler in failure or maintenance, cement burning process can conduct normal operation. The SP boiler produces 1.25MPa-300℃ over-heat steam.

One N3-12 condensing turbine generator set is selected to match the two waste heat boilers.

6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	3MW condensing turbine	1	model: N3－12 rated power: 3MW rated rotation speed: 5600r/min main steam pressure: 1.2MPa main steam temperature: 290℃ exhaust pressure: 0.008MPa
2	3MW generator	1	model: QF3－2 rated power: 3MW rated rotation speed: 3000r/min outgoing-voltage: 6300V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 180000m^3/h（N） Inlet gas temperature: 320℃ Inlet gas dust concentration: <65g/m^3（N） Outlet gas temperature: 225℃ Steam amount: 14.2t/h－1.25MPa －300℃ Water supply parameter: 14.6t/h－110℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 60000m^3/h（N） Inlet gas temperature: 360℃ Inlet gas dust concentration: <30g/m^3（N）

No	Equipment name and model	Quantity	Main technical parameter
			Outlet gas temperature: 100℃ Stage I（steam） Steam parameter: 4.98t/h--1.25MPa—300℃ Water supply temperature: 5.13t/h—110℃ Stage Ii water temperature : 19.73t/h—110℃ Water supply temperature: 40℃ Total leakage: ≤5% Arrangement : open
5	Deaerator and water tank	1	Model : SCY20 Working pressure: 0.0926MPa Work temperature: 45℃ Deaerating water amount: 20m^3
6	Boiler water supply pump (two set for each system)	2	Model: DG25—30×9 Flow rate: 15～30t/h lift: 297～220m

7. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	3	
2	Average generation power	MW	2.97	
3	Annual operation rate	h	7050	
4	Annual power generation	10^4kWh	2094	
5	Annual power supply	10^4kWh	1843	
6	Annual power purchase reduction	10^4kWh	1935	
7	Per ton clinker waste heat power generation amount	KWh/t	28.5	
8	Mechanical equipment	t	~1000	~120 set
9	Electrical equipment	t	~102	~80 set
10	Total occupied area	m^2	~4200	
11	Total construction area	m^2	~1090	
12	Labor quota of the station	person	21	
	Among which: worker	person	17	
	Management personnel	person	4	
13	Labor productivity			
	Total	10^4kWh/person • a	99.7	
	Worker	10^4kWh/person • a	123.2	
14	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	1776	
	Among which: construction	10^4 Yuan	234.33	
	Equipment expenses	10^4 Yuan	1097.76	
	Installation	10^4 Yuan	252.25	
	Other expenses	10^4 Yuan	191.18	

No.	Technical designation	Unit	Indexes	Remarks
15	Economic benefits			
	Investment recovery period (before taxation)	Year	3.63	Including construction period
	Investment recovery period (after taxation)	Year	4.71	Including construction period
	Investment profit ratio	%	34.71	
	Cost of power generation	Yuan/kWh	0.130	Excluding tax

8. Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Guangdong GITIC Green Island Cement Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ -Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Sanshi Jindingzi Building Material Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:

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November 20, 2005

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1. Description

Located in the south-east coastal area and the Yangtze River Delta, bordering on Shanghai in the north, Zhejiang Province enjoys superior geographical advantage. Since China's reformation and open policy implementing, Zhejiang economy has achieved rapid development, both industrial increase rate and economic indexes are among the best places of all provinces. Especially during the "Tenth Five year Plan" period, Zhejiang speeds up its modernization process, which creates favourable conditions for cement industry development, total cement output in 2002 amounted to 57.93 million ton, increased by 18% comparing to last year, it takes the fourth palaces in all China provinces; in which 7.5 million ton cement selling to Shanghai and Jiangsu markets, which takes 13% of the total.

In the last three years of the "Tenth Five-year Plan" period, China will continue its positive financial policy and maintain high development speed. Zhenjiang Province will speed up infrastructure building, enhance foreign investment introduction, and strengthen technical reformation; and along with Ningbo bridge project establishment and successful application of Shanghai International Fair, Zhejiang cement industry meets a great development chance. It is estimated that Zhejiang cement demand will amount to 77 million ton in the later period of "Tenth Five-year Plan".

Since Zhejiang Economy & Trade Commission issued《Zhejiang Cement Industry Structure Adjustment and Development Instruction Opinion》 in 2000, new dry process cement production has achieved rapid development, up to now, in Zhejiang 27 new dry process cement lines have been put into operation, more than 30 in building, among cement output in 2002, 7 million ton is dry process produced cement, which takes 12% of total amount, the ratio of large scale and small scale is improving.

But in the market high grade cement (P.O42.5 above) can not meet the demand. Along with the market demand change, low grade cement may excess, high grade cement shortage contradiction sticks out.

Zhejiang Sanshi Building Material Co., Ltd, is located in Wutong village Meshan Town, Changxin Municipal, Zhejiang Province.

The company owns more than 1300 staff, and occupied 3.311×10^4 square meters. The No 1~5 cement production lines are wet-process rotary cement production lines, the company owns two new dry-process production lines of 2500t/d and 5000t/d. Annual output is more than 2 million ton P.O32.5, P.L32.5 and P.c32.5 ordinary portland cement.

Along with population increase and economy development, resources shortage contradiction is sticking out, reasonable resources comprehensive utilization becomes the key factor to maintain sustained economy development. So early in 1996 the State Council has issued a series policies on resources comprehensive utilization, which initiate both resources development and saving, and stress reasonable utilization on existing resources and decrease resources consumption.

Resources including petroleum, coal, water and etc. are all essential necessaries for people existence and society development. The State Economy & Trade Committee issued a file of 《Resources Comprehensive Utilization Power Plant Stipulation》 in July 2000, in the file it is clearly stated that resources comprehensive utilization power plants mean the enterprises which adopt low heat value fuels such as waste heat, exhaust pressure, city rubbish, gangue, coal marl, etc. to produce power or heat. The file indicates that resources comprehensive utilization power plant application must satisfy the following conditions:

Single unit capacity equal to or more than 500kW;

Generated power quality satisfies national standard, fuel source is nearby;

Discard treatment and utilization measures are adopted, exhaust pollution

is limited to related standards.

For the resources comprehensive utilization power plants using gangue and coal marl as fuel, gangue must be main fuel, and heat value should be not more than 12560kJ/kg, circulating fluidized bed boilers should be adopted, when sulfur content in fuel is more than 1%, de-sulfur measure should be adopted; for the resources comprehensive utilization power plants using waste heat or exhaust pressure as medium, installed capacity should be determined according to waste heat and exhaust pressure parameters and amount.

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle

of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation

technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

Zhejiang Sanshi Jindingzi building material Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 6000kW pure low temperature waste heat power station utilizing waste heat of a 5000t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Sanshi Jindingzi building material Co., Ltd

2. Feasibility study report bases

- "Technical consult contract" between Zhejiang Sanshi Jindingzi building material Co., Ltd and Tianjin Cement Industry Design & Research Institute;
- 《Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Sanshi Jindingzi building material Co., Ltd》 prepared by TCDRI;
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- Feasibility study report basic information provided by Zhejiang Sanshi Jindingzi building material Co., Ltd;
- Related national laws, stipulations and technical standards.

3. Main design principal and guideline

The feasibility study report should reflect national macroscopic economic and sustaining development policies, insist on the principal of "objective, faring, scientific and reliable", analyse both favorable and unfavorable factors, put forward suggestions for the owner to make decision, and provide reliable basis for project approval.

A feasibility study report is a part of important content of earlier stage for a project, and an important basis for investment. A feasibility study report must satisfy national laws, regulations, industry policies, and its content and quality should be in accordance with related stipulations.

The general technical scheme shall guarantee that power station construction and production and shall not affect the normal operation of cement production. In that case, the design of power station shall follow the principal of "reliable operation, advanced technology, low energy consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and avoid failures exposed in similar projects.

(2)Advocate advanced technology and adopt advanced technical scheme to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

5000t/d cement kiln outlet cooler waste gas boiler (AQC boiler);

5000t/d cement kiln inlet preheater waste gas boiler (SP boiler);

Boiler water treatment system;

Turbine generator system;

Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

4.2 Working procedure

According to the institute《Quality Manual》, a project manager should prepare a project kick-off report to state the study bases, scope, principle and requirements, and hold a kick-off meeting with all specialties as participants; all specialties should carry out design and study on main technical scheme in their own field.

5. Project conditions

5.1 Power station location

The planned power station is arranged within the area of the existing 5000t/d cement line, which is located in Heshan Town, Tongxiang City, 20km east from Tongxiang City, 50km south from Hangzhou City, 150km northeast from Shanghai, 20km away from 320 high road and Jinghang high way.

5.2 Natural conditions

5.2.1 Meteorological conditions

Annual average temperature: 15.9℃

Extreme highest temperature: 40.5℃

Extreme lowest temperature: -12.4℃

Basic wind pressure: 0.45kN/m^2

Basic snow pressure: 0.45kN/m^2

Max. frozen depth: 0.15m

Others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6, and basic earthquake acceleration is 0.05g.

5.2.3 Geological conditions

Since the waste heat power generation station is located within the scope of geological survey of the cement plant, the existing geological conditions can meet the requirement of the power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

5.2.5 Water source

The source water is pumped to the purifying department for treatment, the treated water is as power station production water. Domestic and auxiliary water is supplied by plant domestic water system, which is supplied by municipal water supply network, the supply is guaranteed. Fire-fighting water is supplied by the existing plant fire-fighting network, the network is to be extended for the power station.

5.2.6 Power supply

There is an existing general substation of 35 kV/6kV located in the field of the cement production area, one main transformer of 35 kV/6kV of capacity of 22.5MVA is installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

Both 35kV and 6kV buses adopt single busbar connection.

The devices of the general substation are in normal operation presently.

5.2.7 Investment estimation and fund raising

The estimation of project investment is 34.38 million yuan, which is raised by the owner.

6. Technical scheme and main equipment model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. Practical 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 60000m^3/h（normal）— 350℃↘100℃ which contents about 1532×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: 180000m^3/h（normal）— 320℃↘225℃（Exhaust gas is planned for raw meal drying, the temperature is determined by cement process）, which contents about 2542×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;

3) The pure waste heat power station construction and operation shall not affect cement production.

4) The pure waste heat power station system and equipment selection

should follow "mature & reliable operation, advanced technology, low investment and high efficiency".

5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.
6) DCS computer control system shall be adopted for the process control and management.
7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.
8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.
9) The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.
10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to insure cement production continuing in case of waste heat boiler or power station failure.

6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of

"stability, reliability, advanced technology and not affecting cement production", the thermodynamic system and installed solution are determined as follows:

The main equipment includes two waste heat boilers and one set condensing turbine & generator set, the installed capacity is 6MW.

One waste heat boiler called AQC boiler is arranged between kiln outlet cooler middle stage and kiln outlet EP. The original cooler exhaust pipeline is remained as AQC boiler low temperature exhaust pipe, when AQC boiler in failure or maintenance, cement burning process can conduct normal operation. The first stage of AQC boiler produces 1.60MPa-300℃ over-heat steam, the second stage produces 135℃ high temperature hot water.

One waste heat boiler called SP boiler is arranged between kiln inlet preheater and kiln inlet high temperature fan. A bypass exhaust pipeline is designed, when SP boiler in failure or maintenance, cement burning process can conduct normal operation. The SP boiler produces 1.60MPa-300℃ over-heat steam.

One N6-1.25 condensing turbine generator set is selected to match the two waste heat boilers.

6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	6MW condensing turbine	1	model: N6－1.25 rated power: 6MW rated rotation speed: 3000r/min

No	Equipment name and model	Quantity	Main technical parameter
			main steam pressure: 1.25MPa main steam temperature: 290℃ exhaust pressure: 0.008MPa
2	6MW generator	1	model: QF6－2 rated power: 6MW rated rotation speed: 3000r/min outgoing voltage: 6300V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 260000m^3/h（N） Inlet gas temperature: 360℃ Inlet gas dust concentration: <89g/m^3（N） Outlet gas temperature: 220℃ Steam amount: 22t/h－1.6MPa－300℃ Water supply parameter: 135℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 130000m^3/h（N） Inlet gas temperature: 360℃ Inlet gas dust concentration: <11.4g/m^3（N） Outlet gas temperature: 100℃ Stage I（steam） Steam parameter: 11t/h－1.6MPa－300℃ Water supply temperature: 34t/h－135℃ Stage II water temperature : 34t/h－135℃ Water supply temperature: 40℃ Total leakage: ≤5% Arrangement : open

No	Equipment name and model	Quantity	Main technical parameter
5	Deaerator and water tank	1	Working pressure: 0.008MPa Capacity: 40t/h Work temperature: 40℃ Deaerating water amount: 25m^3
6	Boiler water supply pump	2	Flow rate: 35～45t/h lift: 250～350m

7. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	6	

No.	Technical designation	Unit	Indexes	Remarks
2	Average generation power	MW	5.4	
3	Annual operation rate	h	7000	
4	Annual power generation	10^4kWh	3780	
5	Annual power supply	10^4kWh	3478	
6	Annual power purchase reduction	10^4kWh	3652	
7	Per ton clinker waste heat power generation amount	KWh/t	26	
8	Total occupied area	m^2	~4200	
9	Total construction area	m^2	~1090	
10	Labor quota of the station	person	18	
11	Among which: worker	person	16	
12	Management personnel	person	2	
	Labor productivity			
	Total	10^4kWh/person • a	210	
13	Worker	10^4kWh/person • a	236	
	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	3438	
14	Economic benefits			
	Investment recovery period (before taxation)	Year	3.39	Including construction period
	Investment recovery period (after taxation)	Year	4.28	Including construction period
	Investment profit ratio	%	38.99	

No.	Technical designation	Unit	Indexes	Remarks
	Cost of power generation	Yuan/kWh	0.116	Excluding tax

8. Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Zhejiang Sanshi Jindingzi building material Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (3MW) of Zhejiang Sanshi Wutong Building Material Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:
Tianjin Cement Industry Design and Research Institute(TCDRI)

November 18, 2005

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1.General description

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Zhejiang Sanshi Building Material Co., Ltd is the key enterprise of Zhejiang Sanshi group, established in 1978, is the state-owned large-scale enterprise, and also is the largest cement enterprise in Zhejiang province, is located in Meshan Town, Changxin Municipal, Zhejiang Province.

The company owns more than 1300 staff, and occupied 3.311×10^4 square meters. The No 1~5 cement production lines are wet-process rotary cement production lines, the company owns two new dry-process production lines of 2500t/d and 5000t/d. Annual output is more than 2 million ton P.O32.5, P.L32.5 and P.c32.5 ordinary portland cement.

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1.4 Working scope and procedure

1.4.1 The working scope is as following:

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Power station outdoor steam & water pipeline system;

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1.5 Project conditions

1.5.1 Power station location

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1.5.2 Natural conditions

1.5.2.1 Meteorological conditions

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1.5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

1.5.2.5 Water source

The total project water demand is 35.61t/h (max. 49.81t/h), firefighting water excluded, accounting unpredicted water, the total water supply capacity is 35.61t/h (49.81t/h)×1.2=42.7t/h (59.8t/h).

There is a purifying department of capacity 100m^3/h is built in the plant area. The source water is pumped to the purifying department for treatment, the treated water is as power station production water. Domestic and auxiliary water is supplied by plant domestic water system, which is supplied by municipal water supply network, the supply is

guaranteed. Fire-fighting water is supplied by the existing plant fire-fighting network, the network is to be extended for the power station.

1.5.2.6 Power supply

There is an existing general substation (Suihe substation) of 35 kV/6kV located in the field of the cement production area, one main transformer of 35 kV/6kV of capacity of 20 MVA is installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

Both 35kV and 6kV buses adopt single busbar connection.

The devices of the general substation are in normal operation presently.

1.5.2.8 Investment estimation and fund raising

The estimation of project investment is 17.76 million yuan, which is raised by the owner.

1.6 Technical scheme and main equipment model determination

1.6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. Practical 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 60000m^3/h (normal) — 350℃～100℃ which contents about 1532×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: $180000m^3/h$ (normal) —320℃↘225℃ (Exhaust gas is planned for raw meal drying, the temperature is determined by cement process), which contents about 2542×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;

3) The pure waste heat power station construction and operation shall not affect cement production.

4) The pure waste heat power station system and equipment selection should follow "mature & reliable operation, advanced technology, low investment and high efficiency".

5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.

6) DCS computer control system shall be adopted for the process control and management.

7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.

8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.

9) The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to

insure cement production continuing in case of waste heat boiler or power station failure.

1.6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of "stability, reliability, advanced technology and not affecting cement production", the thermodynamic system and installed solution are determined as follows:

The main equipment includes two waste heat boilers and one set condensing turbine & generator set, the installed capacity is 3MW.

One waste heat boiler called AQC boiler is arranged between kiln outlet cooler middle stage and kiln outlet EP. The original cooler exhaust pipeline is remained as AQC boiler low temperature exhaust pipe, when AQC boiler in failure or maintenance, cement burning process can conduct normal operation. The first stage of AQC boiler produces 1.25MPa-300℃ over-heat steam, the second stage produces 2.1MPa-110 ℃ high temperature hot water.

One waste heat boiler called SP boiler is arranged between kiln inlet preheater and kiln inlet high temperature fan. A bypass exhaust pipeline is designed, when SP boiler in failure or maintenance, cement burning process can conduct normal operation. The SP boiler produces 1.25MPa-300℃ over-heat steam.

One N3-12 condensing turbine generator set is selected to match the two waste heat boilers.

1.6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	3MW condensing turbine	1	model: N3—12 rated power: 3MW rated rotation speed: 5600r/min main steam pressure: 1.2MPa main steam temperature: 290℃ exhaust pressure: 0.008MPa
2	3MW generator	1	model: QF3—2 rated power: 3MW rated rotation speed: 3000r/min outgoing voltage: 6300V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 180000m^3/h（N） Inlet gas temperature: 320℃ Inlet gas dust concentration: <65g/m^3（N） Outlet gas temperature: 225℃ Steam amount: 14.2t/h—1.25MPa—300℃ Water supply parameter: 14.6t/h—110℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 60000m^3/h（N） Inlet gas temperature: 360℃ Inlet gas dust concentration: <30g/m^3（N）

No	Equipment name and model	Quantity	Main technical parameter
			Outlet gas temperature: 100℃ Stage I（steam） Steam parameter: 4.98t/h－1.25MPa－300℃ Water supply temperature: 5.13t/h－110℃ Stage Ii water temperature : 19.73t/h－110℃ Water supply temperature: 40℃ Total leakage: ≤5% Arrangement : open
5	Deaerator and water tank	1	Model : SCY20 Working pressure: 0.0926MPa Work temperature: 45℃ Deaerating water amount: 20m^3
6	Boiler water supply pump (two set for each system)	2	Model: DG25－30×9 Flow rate: 15～30t/h lift: 297～220m

1.7 Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	3	
2	Average generation power	MW	2.97	
3	Annual operation rate	h	7050	
4	Annual power generation	10^4kWh	2094	
5	Annual power supply	10^4kWh	1843	
6	Annual power purchase reduction	10^4kWh	1935	
7	Per ton clinker waste heat power generation amount	KWh/t	28.5	
8	Mechanical equipment	t	~1000	~120 set
9	Electrical equipment	t	~102	~80 set
10	Total occupied area	m^2	~4200	
11	Total construction area	m^2	~1090	
12	Labor quota of the station	person	21	
	Among which: worker	person	17	
	Management personnel	person	4	
13	Labor productivity			
	Total	10^4kWh/person • a	99.7	
	Worker	10^4kWh/person • a	123.2	
14	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	1776	
	Among which: construction	10^4 Yuan	234.33	
	Equipment expenses	10^4 Yuan	1097.76	
	Installation	10^4 Yuan	252.25	
	Other expenses	10^4 Yuan	191.18	

No.	Technical designation	Unit	Indexes	Remarks
15	Economic benefits			
	Investment recovery period (before taxation)	Year	3.63	Including construction period
	Investment recovery period (after taxation)	Year	4.71	Including construction period
	Investment profit ratio	%	34.71	
	Cost of power generation	Yuan/kWh	0.130	Excluding tax

1.8 Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Zhejiang Sanshi Wutong building material Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied. So we hope the related authorities would approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase II -Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (2.5MW) of Zhejiang Zhongkaiyuan Cement Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:
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November 12, 2005

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1. Description

Located in the south-east coastal area and the Yangtze River Delta, bordering on Shanghai in the north, Zhejiang Province enjoys superior geographical advantage. Since China's reformation and open policy implementing, Zhejiang economy has achieved rapid development, both industrial increase rate and economic indexes are among the best places of all provinces. Especially during the "Tenth Five year Plan" period, Zhejiang speeds up its modernization process, which creates favourable conditions for cement industry development, total cement output in 2002 amounted to 57.93 million ton, increased by 18% comparing to last year, it takes the fourth palaces in all China provinces; in which 7.5 million ton cement selling to Shanghai and Jiangsu markets, which takes 13% of the total.

In the last three years of the "Tenth Five-year Plan" period, China will continue its positive financial policy and maintain high development speed. Zhenjiang Province will speed up infrastructure building, enhance foreign investment introduction, and strengthen technical reformation; and along with Ningbo bridge project establishment and successful application of Shanghai International Fair, Zhejiang cement industry meets a great development chance. It is estimated that Zhejiang cement demand will amount to 77 million ton in the later period of "Tenth Five-year Plan".

Since Zhejiang Economy & Trade Commission issued《Zhejiang Cement Industry Structure Adjustment and Development Instruction Opinion》 in 2000, new dry process cement production has achieved rapid development, up to now, in Zhejiang 27 new dry process cement lines have been put into operation, more than 30 in building, among cement output in 2002, 7 million ton is dry process produced cement, which takes 12% of total amount, the ratio of large scale and small scale is improving.

But in the market high grade cement (P.O42.5 above) can not meet the demand. Along with the market demand change, low grade cement may excess, high grade cement shortage contradiction sticks out.

Along with population increase and economy development, resources shortage contradiction is sticking out, reasonable resources comprehensive utilization becomes the key factor to maintain sustained economy development. So early in 1996 the State Council has issued a series policies on resources comprehensive utilization, which initiate both resources development and saving, and stress reasonable utilization on existing resources and decrease resources consumption.

Resources including petroleum, coal, water and etc. are all essential necessaries for people existence and society development. The State Economy & Trade Committee issued a file of 《Resources Comprehensive Utilization Power Plant Stipulation》 in July 2000, in the file it is clearly stated that resources comprehensive utilization power plants mean the enterprises which adopt low heat value fuels such as waste heat, exhaust pressure, city rubbish, gangue, coal marl, etc. to produce power or heat. The file indicates that resources comprehensive utilization power plant application must satisfy the following conditions:

Single unit capacity equal to or more than 500kW;

Generated power quality satisfies national standard, fuel source is nearby;

Discard treatment and utilization measures are adopted, exhaust pollution is limited to related standards.

For the resources comprehensive utilization power plants using gangue and coal marl as fuel, gangue must be main fuel, and heat value should be not more than 12560kJ/kg, circulating fluidized bed boilers should be adopted, when sulfur content in fuel is more than 1%, de-sulfur measure should be adopted; for the resources comprehensive utilization power plants using waste heat or exhaust pressure as medium, installed capacity

should be determined according to waste heat and exhaust pressure parameters and amount.

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO

presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

Zhejiang Sanshi Wutong building material Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 3000kW pure low temperature

waste heat power station utilizing waste heat of a 2500t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (2.5MW) of Zhejiang Zhongkaiyuan Cement Co., Ltd.

2. Feasibility study report bases

- "Technical consult contract" between Zhejiang Zhongkaiyuan Cement Co., Ltd and Tianjin Cement Industry Design & Research Institute;
- 《Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (2.5MW) of Zhejiang Zhongkaiyuan Cement Co., Ltd》 prepared by TCDRI;
- 《Reply to Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (2.5MW) of Zhejiang Zhongkaiyuan Cement Co., Ltd》issued by Zhejiang Economy & Trade Commission;
- Feasibility study report basic information provided by Zhejiang Zhongkaiyuan Cement Co., Ltd;
- Related national laws, stipulations, technical standards.

3. Main design principal and guideline

The feasibility study report should reflect national macroscopic economic and sustaining development policies, insist on the principal of "objective, faring, scientific and reliable", analyse both favorable and unfavorable factors, put forward suggestions for the owner to make decision, and provide reliable basis for project approval.

A feasibility study report is a part of important content of earlier stage for a project, and an important basis for investment. A feasibility study report must satisfy national laws, regulations, industry policies, and its content and quality should be in accordance with related stipulations.

The general technical scheme shall guarantee that power station construction and production and shall not affect the normal operation of

cement production. In that case, the design of power station shall follow the principal of "reliable operation, advanced technology, low energy consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and avoid failures exposed in similar projects.

(2)Advocate advanced technology and adopt advanced technical scheme to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

1200t/d cement kiln outlet cooler waste gas boiler (AQC boiler);

1200t/d cement kiln inlet preheater waste gas boiler (SP boiler);

Boiler water treatment system;

Turbine generator system;

Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

4.2 Working procedure

According to the institute《Quality Manual》, a project manager should prepare a project kick-off report to state the study bases, scope, principle and requirements, and hold a kick-off meeting with all specialties as participants; All specialties should carry out design and study on main technical scheme in their own field.

5. Project conditions

5.1 Power station location

The planned power station is arranged within the area of the existing 1200t/d cement line.

5.2 Natural conditions

5.2.1 Meteorological conditions

Annual average temperature: 16.0℃

Monthly average absolute highest temperature: 16.0℃

Monthly average absolute lowest temperature: -11℃

Annual average relative humidity: 80%

Annual average rainfall: 1383.4mm

Annual largest rainfall: 2120mm

Dominating wind of the year: SE(summer) NW(winter)

Ground annual average wind speed: 17m/s

Others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6.

5.2.3 Geological conditions

Since the waste heat power generation station is located within the scope of geological survey of the cement plant, the existing geological conditions can meet the requirement of the power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

5.2.5 Water source

The total project water demand is 30.0t/h, firefighting water is not excluded, accounting unpredicted water, the total water supply capacity is 30.0t/h×1.2=36.0t/h (about 864.0t/d).

5.2.6 Power supply

There is an existing general substation (Suihe substation) of 35 kV/6kV located in the field of the cement production area, two main transformer of 35kV/6kV of capacity of 5MVA and one main transformer of 35kV/0.4kV of capacity of 2MVA are installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

The devices of the general substation are in normal operation presently.

5.2.8 Investment estimation and fund raising

The estimation of project investment is 15.78 million Yuan, which is the owner raise 50% and 50% loaned by bank.

6. Technical scheme and main equipment model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 1200t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. After reformation 1200t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 50000m^3/h（normal）—435℃↘90℃ which contents about 2230.45×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: 90000m^3/h（normal）—37℃↘250℃（Exhaust gas is planned for raw meal drying, the temperature is determined by cement process）, which contents about 1678×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;
3) The pure waste heat power station construction and operation shall not affect cement production.
4) The pure waste heat power station system and equipment selection should follow "mature & reliable operation, advanced technology, low investment and high efficiency".
5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.
6) DCS computer control system shall be adopted for the process control and management.
7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.
8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.
9) The power station shall equip a separate dispatching communication

system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to insure cement production continuing in case of waste heat boiler or power station failure.

6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of "stability, reliability, advanced technology and not affecting cement production", and the following conditions also should be considered.

- 1200t/d cement production line

AQC boiler steam stage produced 5.91t/h—1.6MPa—300℃ over-heat steam;

- 2.5MW Turbine

According to the main steam parameter, the main steam parameter should be as 1.25MPa—290℃

So the installed capacity should be one 2.5MW turbine and 2 sets waste heat boilers.

In order to fully utilizing waste heat from the 1200t/d cement production line kiln outlet cooler and inlet preheater, the working out the thermodynamic system and installed solution:

After working exhaust steam condensates to water through a condenser, the condensation water is pumped to a deaerator for deaerating, then to

stage II of the AQC boiler as boiler feed water, SP boiler produced steam merges with AQC produced steam, the mixed steam is introduced to turbine for power generation. in this way a complete thermodynamic circulation system forms.

The strong points of this Thermodynamic system solution are as follows:

- The AQC boiler has two stages: the first stage of AQC boiler produces 1.6MPa—300℃over-heat steam, the second stage produces 130℃ high temperature hot water is used as feed water for AQC boiler steam stages and others is for SP boilers.
- The SP boiler has only one stage, SP boiler produced steam merges with AQC produced steam, the mixed steam is introduced to turbine for power generation.
- A bypass exhaust pipeline is designed in order to insure cement production continuing in case of waste heat boiler or power station failure.
- Since the waste gas is with higher dust concentration, in order to alleviate boiler abrasion, a sedimentation chamber is set up in the front of the AQC boiler.
- The vacuum deaerating method is adopted for the deaerator.
- The vertical waste heat boiler shall be adopted, in order to solve waste heat boiler leakage, ash-blocking, ash-purging and anti-abrasion problems.

Above-mentioned methods have been applied in many projects, the favorable results have been achieved, the technology is matured and reliable.

6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter
1	2.5MW condensing turbine	1	model: N2.5－1.25 rated power: 2.5MW rated rotation speed: 5600r/min/3000r/min main steam pressure: 1.25MPa main steam temperature: 290℃ exhaust pressure: 0.005MPa
2	2.5MW generator	1	model: QF2－2.5 rated power: 2.5MW rated rotation speed: 3000r/min outgoing voltage: 6300V
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 90000m^3/h（N） Inlet gas temperature: 370℃ Inlet gas dust concentration: <100g/m^3（N）
			Outlet gas temperature: 250℃ Steam amount: 5.91t/h－1.25MPa－300℃ Water supply parameter: 6.2t/h－130℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 50000m^3/h（N） Inlet gas temperature: 435℃ Inlet gas dust concentration: <10g/m^3（N） Outlet gas temperature: 95℃ Stage I（steam） Steam parameter: 7t/h－1.25MPa－300℃ Water supply temperature: 130℃

No	Equipment name and model	Quantity	Main technical parameter
			Stage Ii water temperature : 13.55t/h—130℃ Water supply temperature: 40℃ Total leakage: ≤% Arrangement : open
5	Deaerator and water tank	1	Model : SZD Working pressure: 0.008MPa Work temperature: 45℃ Deaerating water amount: 10m^3

7. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	2.5	
2	Average generation power	MW	2.05	
3	Annual operation rate	h	7920	
4	Annual power generation	10^4kWh	1623.6	
5	Annual power supply	10^4kWh	1475.9	
6	Annual power purchase reduction	10^4kWh	1483.3	

No.	Technical designation	Unit	Indexes	Remarks
7	Per ton clinker waste heat power generation amount	KWh/t	37.68	
8	Mechanical equipment	t	~1200	
9	Electrical equipment	t	~89	
10	Total occupied area	m^2	~4200	
11	Total construction area	m^2	~1090	
12	Labor quota of the station	person	14	
	Among which: worker	person	11	
	Management personnel	person	3	
13	Labor productivity			
	Total	10^4kWh/person • a	115.9	
	Worker	10^4kWh/person • a	147.6	
14	Investment estimation			
	Total estimation of fixed	10^4 Yuan	1578.21	
	assets investment			
	Among which: construction	10^4 Yuan	271.37	
	Equipment expenses	10^4 Yuan	805.71	
	Installation	10^4 Yuan	283.02	
	Other expenses	10^4 Yuan	218.11	
15	Economic benefits			
	Investment recovery period (before taxation)	Year	4.29	Including construction period
	Investment recovery period (after taxation)	Year	5.45	Including construction period
	Investment profit ratio	%	25.9	

No.	Technical designation	Unit	Indexes	Remarks
	Cost of power generation	Yuan/kWh	0.129	Excluding tax

1.8 Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Zhejiang Zhongkaiyuan Cement Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied. So we hope

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Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase II -Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Zhejiang Zhongxinyuan Cement Co., Ltd.

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1. Description

Located in the south-east coastal area and the Yangtze River Delta, bordering on Shanghai in the north, Zhejiang Province enjoys superior geographical advantage. Since China's reformation and open policy implementing, Zhejiang economy has achieved rapid development, both industrial increase rate and economic indexes are among the best places of all provinces. Especially during the "Tenth Five year Plan" period, Zhejiang speeds up its modernization process, which creates favourable conditions for cement industry development, total cement output in 2002 amounted to 57.93 million ton, increased by 18% comparing to last year, it takes the fourth palaces in all China provinces; in which 7.5 million ton cement selling to Shanghai and Jiangsu markets, which takes 13% of the total.

In the last three years of the "Tenth Five-year Plan" period, China will continue its positive financial policy and maintain high development speed. Zhenjiang Province will speed up infrastructure building, enhance foreign investment introduction, and strengthen technical reformation; and along with Ningbo bridge project establishment and successful application of Shanghai International Fair, Zhejiang cement industry meets a great development chance. It is estimated that Zhejiang cement demand will amount to 77 million ton in the later period of "Tenth Five-year Plan".

Since Zhejiang Economy & Trade Commission issued《Zhejiang Cement Industry Structure Adjustment and Development Instruction Opinion》 in 2000, new dry process cement production has achieved rapid development, up to now, in Zhejiang 27 new dry process cement lines have been put into operation, more than 30 in building, among cement output in 2002, 7 million ton is dry process produced cement, which takes 12% of total amount, the ratio of large scale and small scale is improving.

But in the market high grade cement (P.O42.5 above) can not meet the demand. Along with the market demand change, low grade cement may excess, high grade cement shortage contradiction sticks out.

Zhonglida Group is located in the developed center of Jiahu Plain of the Yangtse Rive, 160km east from Shanghai, 40km south from Hanzhou and 150km north from Suzhou, the group enjoys favorable location; and moreover water and road communications are available by Jinghang Canal, Huhang Highway, Hangyong Highway, Hangning Highway and some national highways.

Zhejiang Zhongxinyuan Cement Co. Ltd. is a share-holding sub-company of Zhonglida Group.

Zhonglida Group is a sharing enterprise with multi-business including cement, brick, real estate, education, culture products, touring, quarry mining and so on. In which cement industry asset is 550 million Yuan RMB, annual output is 3.5 million ton. Cement sales income is 330 million Yuan RMB in 2003 with profit and tax 60.38 Yuan RMB, economical benefit indexes are listed in the former in the Province. The group is honoured as "Optimum Economic Benefit Enterprise of Zhejiang Province" in consecutive eight years.

Through exploring and summarizing Zhonglida Group forms its characterized management pattern, the efficient management assures cement product quality. Along with population increase and economy development, resources shortage contradiction is sticking out, reasonable resources comprehensive utilization becomes the key factor to maintain sustained economy development. So early in 1996 the State Council has issued a series policies on resources comprehensive utilization, which initiate both resources development and saving, and stress reasonable utilization on existing resources and decrease resources consumption.

Resources including petroleum, coal, water and etc. are all essential

necessaries for people existence and society development. The State Economy & Trade Committee issued a file of 《Resources Comprehensive Utilization Power Plant Stipulation》 in July 2000, in the file it is clearly stated that resources comprehensive utilization power plants mean the enterprises which adopt low heat value fuels such as waste heat, exhaust pressure, city rubbish, gangue, coal marl, etc. to produce power or heat. The file indicates that resources comprehensive utilization power plant application must satisfy the following conditions:

Single unit capacity equal to or more than 500kW;

Generated power quality satisfies national standard, fuel source is nearby;

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For the resources comprehensive utilization power plants using gangue and coal marl as fuel, gangue must be main fuel, and heat value should be not more than 12560kJ/kg, circulating fluidized bed boilers should be adopted, when sulfur content in fuel is more than 1%, de-sulfur measure should be adopted; for the resources comprehensive utilization power plants using waste heat or exhaust pressure as medium, installed capacity should be determined according to waste heat and exhaust pressure parameters and amount.

Tianjin Cement Industry Design and Research Institute (TCDRI) under the jurisdiction of the State Property Management Commission is the No. 1 cement design institute in China of qualification A. TCDRI has been engaged in cement equipment and process development and research for many years, through several generation unremitting efforts, our cement industry has achieved great progress in both output scale and energy saving. Production line capacity has enlarged from 1000t/d and 2500t/d to 5000t/d, 8000t/d and 10000t/d, clinker heat consumption has increased to 3000~3300kJ/kg from original 4600~6700kJ/kg, but still large amount

medium and low temperature waste heat of 350℃ produced in cement production process can not been recovered, which results in amazing energy waste. Heat contented in exhaust gas of temperature 350℃ below discharged from kiln outlet cooler and kiln inlet preheater takes 35% of total clinker burning heat consumption. With resources comprehensive utilization putting into practical application, large amount medium and low temperature waste heat can be recovered for power generation, heating, and cooling. The resources comprehensive utilization technique has become effective energy saving method in China cement industry.

In the late 1960s, foreign countries started the research on pure medium and low temperature waste heat power generation process, in the middle of 1970s, both thermodynamic system and equipment have been applied to practical use. In the early 1980s the application burst, especially in Japan the technique has been not only applied in domestic 20-odd pre-calcining cement production lines but also exported to Taiwan, Korea and so on. It is proved that Japanese-developed waste heat boiler and medium and low quality steam turbine are mature and reliable through operation experiences in several ten plants. In 1996 Japan NEDO presented a set of 6480kW pure medium and low temperature waste heat power station equipment to Anhui Ningguo Cement Plant, which matches with the plant 4000t/d precalcining kiln, TCDRI has undertaken technical transformation and cooperated to accomplish design and development, the station is in normal operation now.

With the successful development of low parameter and multi-inlet turbine (TCDRI cooperating with turbine manufactures for the work), pure medium and low temperature waste heat power station adopting Chinese-made equipment becomes mature. Pure low temperature waste heat power station all adopting Chinese-made equipment designed by TCDRI has been put into normal operation in April 2003 in Shanghai

Wanan Group Jinshan Cement Plant (1200t/d cement clinker production line), the power station installed capacity is 2500kW, normal power generation 1900~2100kW, power generation amount per ton clinker attains 34~42kW, which meets the advanced level of the same type power stations.

In recent years TCDRI has accomplished design of more than twenty medium and low temperature waste heat power stations of supplement type and pure waste heat power stations, these power stations have been put into operation successfully, especially the operation of Shanghai Wanan 2500kW pure low temperature waste heat power station marks Chinese medium and low temperature waste heat power generation technique has become mature and started practical use. These resources comprehensive utilization power stations have achieved favorable economic and social benefits, which results in cement production cost decreasing and energy saving.

Zhejiang Sanshi Wutong building material Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 4500kW pure low temperature waste heat power station utilizing waste heat of a 2500t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Zhejiang Zhongxinyuan Cement Co., Ltd.

2. Feasibility study report bases

- "Technical consult contract" between Zhejiang Zhongxinyuan Cement Co., Ltd and Tianjin Cement Industry Design & Research Institute;
- 《Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Zhejiang Zhongxinyuan Cement Co., Ltd》 prepared by TCDRI;

- 《Reply to Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (4.5MW) of Zhejiang Zhongxinyuan Cement Co., Ltd》issued by Zhejiang Economy & Trade Commission;
- Feasibility study report basic information provided by Zhejiang Zhongxinyuan Cement Co., Ltd;
- Related national laws, stipulations, technical standards.

3. Main design principal and guideline

The feasibility study report should reflect national macroscopic economic and sustaining development policies, insist on the principal of "objective, faring, scientific and reliable", analyse both favorable and unfavorable factors, put forward suggestions for the owner to make decision, and provide reliable basis for project approval.

A feasibility study report is a part of important content of earlier stage for a project, and an important basis for investment. A feasibility study report must satisfy national laws, regulations, industry policies, and its content and quality should be in accordance with related stipulations.

The general technical scheme shall guarantee that power station construction and production and shall not affect the normal operation of cement production. In that case, the design of power station shall follow the principal of "reliable operation, advanced technology, low energy consumption and investment", the detailed guideline is as follows:

(1)Adopt mature and reliable process and equipment and avoid failures exposed in similar projects.

(2)Advocate advanced technology and adopt advanced technical scheme to decrease the operation cost and renovation investment.

(3)Make full use of the existing public facilities and administrative organizations.

(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

2520Ot/d cement kiln outlet cooler waste gas boiler (AQC boiler);

2500t/d cement kiln inlet preheater waste gas boiler (SP boiler);

Boiler water treatment system;

Turbine generator system;

Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

4.2 Working procedure

According to the institute《Quality Manual》, a project manager should prepare a project kick-off report to state the study bases, scope, principle and requirements, and hold a kick-off meeting with all specialties as participants; All specialties should carry out design and study on main technical scheme in their own field.

5. Project conditions

5.1 Power station location

The planned power station is arranged within the area of the existing 2500t/d cement line.

5.2 Natural conditions

5.2.1 Meteorological conditions

Annual average temperature: 16.0℃

Monthly average absolute highest temperature: 16.0℃

Monthly average absolute lowest temperature: -11℃

Annual average relative humidity: 80%

Annual average rainfall: 1383.4mm

Annual largest rainfall: 2120mm

Dominating wind of the year: SE(summer) NW(winter)

Ground annual average wind speed: 17m/s

Others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6.

5.2.3 Geological conditions

Since the waste heat power generation station is located within the scope of geological survey of the cement plant, the existing geological conditions can meet the requirement of the power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

5.2.5 Water source

The total project water demand is 56.0t/h, firefighting water is not excluded, accounting unpredicted water, the total water supply capacity is 56.0t/h×1.2=67.2t/h (about 1612.8t/d).

5.2.6 Power supply

There is an existing general substation (Suihe substation) of 35 kV/6kV located in the field of the cement production area, two main transformer of 35kV/6kV of capacity of 1.6MVA are installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

The devices of the general substation are in normal operation presently.

5.2.8 Investment estimation and fund raising

The estimation of project investment is 28.01 million Yuan, which is the owner raise 50% and 50% loaned by bank.

6. Technical scheme and main equipment model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. After reformation 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 90000m^3/h (normal) —415℃↘90℃ which contents about 4269×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: 180000m^3/h (normal) — 380℃↘250℃ (Exhaust gas is planned for raw meal drying, the temperature is determined by cement process), which contents about 3756×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;

3) The pure waste heat power station construction and operation shall not affect cement production.

4) The pure waste heat power station system and equipment selection

should follow "mature & reliable operation, advanced technology, low investment and high efficiency".

5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.

6) DCS computer control system shall be adopted for the process control and management.

7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.

8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.

9) The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to insure cement production continuing in case of waste heat boiler or power station failure.

6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of

"stability, reliability, advanced technology and not affecting cement production", and the following conditions also should be considered.

- 2500t/d cement production line

AQC boiler steam stage produced 1.3t/h－1.6MPa－300℃ over-heat steam; and the water stage produced 25.5t/h－123℃ hot water.

SP boiler produced 13t/h－1.6MPa－300℃ over-heat steam.

- 4.5MW Turbine

According to the main steam parameter, the main steam parameter should be as 1.25MPa－290℃

So the installed capacity should be one 4.5MW turbine and 2 sets waste heat boilers.

In order to fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater, the working out the thermodynamic system and installed solution:

After working exhaust steam condensates to water through a condenser, the condensation water is pumped to a deaerator for deaerating, then to stage II of the AQC boiler as boiler feed water, SP boiler produced steam merges with AQC produced steam, the mixed steam is introduced to turbine for power generation. in this way a complete thermodynamic circulation system forms.

The strong points of this Thermodynamic system solution are as follows:

- The AQC boiler has two stages: the first stage of AQC boiler produces 1.6MPa－300℃over-heat steam, the second stage produces 130℃ high temperature hot water is used as feed water for AQC boiler steam stages and others is for SP boilers.
- The SP boiler has only one stage, SP boiler produced steam merges with AQC produced steam, the mixed steam is introduced to turbine for power generation.
- A bypass exhaust pipeline is designed in order to insure cement

production continuing in case of waste heat boiler or power station failure.

- Since the waste gas is with higher dust concentration, in order to alleviate boiler abrasion, a sedimentation chamber is set up in the front of the AQC boiler.
- The vacuum deaerating method is adopted for the deaerator.
- The vertical waste heat boiler shall be adopted, in order to solve waste heat boiler leakage, ash-blocking, ash-purging and anti-abrasion problems.

Above-mentioned methods have been applied in many projects, the favorable results have been achieved, the technology is matured and reliable.

6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter	
1	4.5MW condensing turbine	1	model:	N4.5－1.25
			rated power:	4.5MW
			rated rotation speed:	3000r/min
			main steam pressure:	1.25MPa
			main steam temperature:	290℃
			exhaust pressure:	0.005MPa
2	2.5MW generator	1	model:	QF2－4.5
			rated power:	4.5MW
			rated rotation speed:	3000r/min
			outgoing voltage:	10500V

No	Equipment name and model	Quantity	Main technical parameter
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 180000m³/h (N) Inlet gas temperature: 380℃ Inlet gas dust concentration: <100g/m³ (N) Outlet gas temperature: 250℃ Steam amount: 13t/h—1.6MPa—300℃ Water supply parameter: 13.65t/h—123℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 90000m³/h (N) Inlet gas temperature: 415℃ Inlet gas dust concentration: <10g/m³ (N) Outlet gas temperature: 90℃ Stage I (steam) Steam parameter: 11.3t/h—1.6MPa—300℃ Water supply temperature: 123℃ Stage Ii water temperature : 25.5t/h—123℃ Water supply temperature: 40℃ Total leakage: ≤5% Arrangement : open
5	Deaerator and water tank	1	Model : SZD Working pressure: 0.008MPa Work temperature: 45℃ Deaerating water amount: 20m³
6	Fead water pump	1	Model : DG25-30×9 Flow: 12~30t/h Lift: 297~220m

7. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	4.5	
2	Average generation power	MW	3.76	
3	Annual operation rate	h	7920	
4	Annual power generation	10^4kWh	2977.9	
5	Annual power supply	10^4kWh	2712.9	
6	Annual power purchase reduction	10^4kWh	2726.5	
7	Per ton clinker waste heat power generation amount	KWh/t	37.68	
8	Mechanical equipment	t	~1200	
9	Electrical equipment	t	~89	
10	Total occupied area	m^2	~4500	
11	Total construction area	m^2	~1280	
12	Labor quota of the station	person	28	
	Among which: worker	person	22	
	Management personnel	person	6	
13	Labor productivity			
	Total	10^4kWh/person • a	212.7	
	Worker	10^4kWh/person • a	270.7	
14	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	2801.51	
	Among which: construction	10^4 Yuan	488.33	
	Equipment expenses	10^4 Yuan	1450.27	
	Installation	10^4 Yuan	451.25	
	Other expenses	10^4 Yuan	411.66	

No.	Technical designation	Unit	Indexes	Remarks
15	Economic benefits			
	Investment recovery period (before taxation)	Year	4.16	Including construction period
	Investment recovery period (after taxation)	Year	5.29	Including construction period
	Investment-profit ratio	%	27.22	
	Cost of power generation	Yuan/kWh	0.126	Excluding tax

1.8 Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Zhejiang Zhongxinyuan Cement Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied. So we hope the related authorities would approve the feasibility study report as soon as possible.

A Feasibility Study Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cement Sector Replication Projects for Energy Efficiency(1) Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Changxing Meishan Building Material Co., Ltd.

Contract No: 05/034

Project No: EG/CPR/99/G31

Submitted By:

Tianjin Cement Industry Design and Research Institute(TCDRI)

December 20, 2005

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Zhejiang Changxin Meishan building material Co., Ltd has investigated the resources comprehensive policy and waste heat power station technique and market, they are planning to build a 6000kW pure low

temperature waste heat power station utilizing waste heat of a 5000t/d new dry process cement line.

The project title is: Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Changxin Meishan building material Co., Ltd

2. Feasibility study report bases

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- 《Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Changxin Meishan building material Co., Ltd》 prepared by TCDRI;
- 《Reply to Technical proposal for the Pure-low Temperature Waste Heat Power Station Project (6MW) of Zhejiang Changxin Meishan building material Co., Ltd》 (No. 2004-129) issued by Zhejiang Jiaxing Economy & Trade Commission;
- 《Opinion on request of Zhejiang Changxin Meishan building material Co., Ltd captive power station connecting to local power network》 (No. 2004-21) issued by Zhejiang Jiaxing Power Bureau;
- Feasibility study report basic information provided by Zhejiang Changxin Meishan building material Co., Ltd;
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(4)Domestic equipments and parts shall be adopted in principal, and key parts can be imported.

(5)DCS computer control system shall be adopted for the process control of main and auxiliary equipment of the power station to ensure the reliability.

(6)Carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

4. Working scope and procedure

4.1 The working scope is as following:

5000t/d cement kiln outlet cooler waste gas boiler (AQC boiler);

5000t/d cement kiln inlet preheater waste gas boiler (SP boiler);

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Power station water circulation system;

Power station electrical system;

Power station auto control system;

Power station outdoor steam & water pipeline system;

Power station outdoor water supply & drain system and other matched communication, lighting, etc

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5. Project conditions

5.1 Power station location

The planned power station is arranged within the area of the existing 5000t/d cement line, which is located in Heshan Town, Tongxiang City, 20km east from Tongxiang City, 50km south from Hangzhou City, 150km northeast from Shanghai, 20km away from 320 high road and Jinghang high way.

5.2 Natural conditions

5.2.1 Meteorological conditions

Annual average temperature: 15.9℃

Extreme highest temperature: 40.5℃

Extreme lowest temperature: -12.4℃

Basic wind pressure: 0.45kN/m^2

Basic snow pressure: 0.45kN/m^2

Max. frozen depth: 0.15m

Others are according to national meteorological information summary.

5.2.2 Earthquake intensity

Earthquake proof intensity is degree 6, and basic earthquake acceleration is 0.05g.

5.2.3 Geological conditions

Since the waste heat power generation station is located within the scope of geological survey of the cement plant, the existing geological conditions can meet the requirement of the power station construction.

5.2.4 Chemical agents supply

The main chemical agents are industrial HCl and $Na_3PO_4 \cdot 12H_2O$ which can be purchased locally and transported to the plant by trucks.

5.2.5 Water source

The source water is pumped to the purifying department for treatment, the treated water is as power station production water. Domestic and auxiliary water is supplied by plant domestic water system, which is supplied by municipal water supply network, the supply is guaranteed. Fire-fighting water is supplied by the existing plant fire-fighting network, the network is to be extended for the power station.

5.2.6 Power supply

There is an existing general substation of 35 kV/6kV located in the field of the cement production area, one main transformer of 35 kV/6kV of capacity of 22.5MVA is installed in the substation. The incoming 35kV power supply is through single overhead line, the supply is from nearby area substation.

Both 35kV and 6kV buses adopt single busbar connection.

The devices of the general substation are in normal operation presently.

5.2.7 Investment estimation and fund raising

The estimation of project investment is 34.38 million yuan, which is raised by the owner.

6. Technical scheme and main equipment model determination

6.1 Technical scheme

According to the design principals determined in the project proposal approval, following preconditions should be taken into consideration when working out the thermodynamic system and installed solution:

1) Fully utilizing waste heat from the 2500t/d cement production line kiln outlet cooler and inlet preheater.

In order to fully utilize waste heat discharged from the kiln outlet cooler, increase the waste gas temperature, and make it produce same parameter over-heat steam as the kiln inlet boiler, reformation on the cooler shall be made, the exhaust heat shall be extracted from the middle stage.

According to the information supplied by the company, waste heat sources of the cement line can be utilized are as follows:

a. Practical 2500t/d cement production line kiln outlet cooler middle stage waste heat condition after reformation: 60000m^3/h（normal）— 350℃↘100℃ which contents about 1532×10^4kJ/h heat.

b. Kiln inlet preheater waste heat condition: 180000m^3/h（normal）— 320℃↘225℃（Exhaust gas is planned for raw meal drying, the temperature is determined by cement process）, which contents about 2542×10^4kJ/h heat.

2) When in normal operation the power station should not feed power to outside network;

3) The pure waste heat power station construction and operation shall not affect cement production.

4) The pure waste heat power station system and equipment selection should follow "mature & reliable operation, advanced technology, low investment and high efficiency".

5) Kiln ash precipitated in waste heat boilers should be collected and reused in cement production in order to achieve resources comprehensive utilization and environment protection.

6) DCS computer control system shall be adopted for the process control

and management.

7) A centralized electrical room is set up in the power station, when the power station in start-up, the power supply gets from outside network, when in normal operation, the power supply can get either from outside network or generator directly.

8) The power station connects with an outside network at the 6kV side of the plant substation, the operation mode is connecting with outside network but not feeding power to it.

9) The power station shall equip a separate dispatching communication system, the related station posts should be equipped with direct dispatching telephones, communication facilities between the power station and outside network should be arranged.

10) A waste heat boiler should be arranged between kiln inlet exhaust outlet and stack, a bypass exhaust pipeline is designed in order to insure cement production continuing in case of waste heat boiler or power station failure.

6.2 Thermodynamic system solution and installed capacity

According to pure waste heat power generation technology and equipment development status in China and the cement production line waste heat conditions, pure low temperature waste heat power generation process is to be adopted in the project.

Taking into consideration of cement production kiln outlet and inlet waste heat resources distribution conditions, and satisfying the precondition of "stability, reliability, advanced technology and not affecting cement production", the thermodynamic system and installed solution are determined as follows:

The main equipment includes two waste heat boilers and one set condensing turbine & generator set, the installed capacity is 6MW.

One waste heat boiler called AQC boiler is arranged between kiln outlet

cooler middle stage and kiln outlet EP. The original cooler exhaust pipeline is remained as AQC boiler low temperature exhaust pipe, when AQC boiler in failure or maintenance, cement burning process can conduct normal operation. The first stage of AQC boiler produces 1.60MPa-300℃ over-heat steam, the second stage produces 135℃ high temperature hot water.

One waste heat boiler called SP boiler is arranged between kiln inlet preheater and kiln inlet high temperature fan. A bypass exhaust pipeline is designed, when SP boiler in failure or maintenance, cement burning process can conduct normal operation. The SP boiler produces 1.60MPa-300℃ over-heat steam.

One N6-1.25 condensing turbine generator set is selected to match the two waste heat boilers.

6.3 Main equipment

According to the determined thermodynamic system and low parameter turbine production and application conditions, the main and auxiliary equipments are as follows:

No	Equipment name and model	Quantity	Main technical parameter	
1	6MW condensing turbine	1	model:	N6－1.25
			rated power:	6MW
			rated rotation speed:	3000r/min
			main steam pressure:	1.25MPa
			main steam temperature:	290℃
			exhaust pressure:	0.008MPa
2	6MW generator	1	model:	QF6－2
			rated power:	6MW
			rated rotation speed:	3000r/min
			outgoing voltage:	6300V

No	Equipment name and model	Quantity	Main technical parameter
3	Kiln inlet waste heat boiler	1	Inlet gas amount: 260000m³/h (N) Inlet gas temperature: 360℃ Inlet gas dust concentration: <89g/m³ (N) Outlet gas temperature: 220℃ Steam amount: 22t/h—1.6MPa—300℃ Water supply parameter: 135℃ Total leakage: ≤5% Arrangement : open
4	Kiln outlet waste heat boiler	1	Inlet gas amount: 130000m³/h (N) Inlet gas temperature: 360℃ Inlet gas dust concentration: <11.4g/m³ (N) Outlet gas temperature: 100℃ Stage I (steam) Steam parameter: 11t/h—1.6MPa—300℃ Water supply temperature: 34t/h—135℃ Stage II water temperature : 34t/h—135℃ Water supply temperature: 40℃ Total leakage: ≤5% Arrangement : open
5	Deaerator and water tank	1	Working pressure: 0.008MPa Capacity: 40t/h Work temperature: 40℃ Deaerating water amount: 25m³
6	Boiler water supply pump	2	Flow rate: 35～45t/h lift: 250～350m

7. Main technical economy indexes

No.	Technical designation	Unit	Indexes	Remarks
1	Installed capacity	MW	6	
2	Average generation power	MW	5.4	
3	Annual operation rate	h	7000	
4	Annual power generation	10^4kWh	3780	
5	Annual power supply	10^4kWh	3478	
6	Annual power purchase reduction	10^4kWh	3652	
7	Per ton clinker waste heat power generation amount	KWh/t	26	
8	Total occupied area	m^2	~4200	
9	Total construction area	m^2	~1090	
10	Labor quota of the station	person	18	
11	Among which: worker	person	16	
12	Management personnel	person	2	
	Labor productivity			
	Total	10^4kWh/person • a	210	
13	Worker	10^4kWh/person • a	236	
	Investment estimation			
	Total estimation of fixed assets investment	10^4 Yuan	3438	
14	Economic benefits			
	Investment recovery period (before taxation)	Year	3.39	Including construction period
	Investment recovery period (after taxation)	Year	4.28	Including construction

No.	Technical designation	Unit	Indexes	Remarks
				period
	Investment profit ratio	%	38.99	
	Cost of power generation	Yuan/kWh	0.116	Excluding tax

8. Conclusion

(1)The project has the following construction conditions:

- With utilization of the existing field, it is unnecessary to purchase land.
- Chemical agents, power supply and water sources necessary for production can be guaranteed.
- The Project funds are available.
- Zhejiang Changxin Meishan building material Co., Ltd has a staff team with abundant project construction, production and management experiences.

(2)The project design will follow the principal of "reliable production, advanced technology, low energy consumption and investment". The power waste heat power design is the masterpiece based on the achievements of TCDRI, it lays solid foundation for the implementation of the project.

(3) The project is to recover large amount waste heat discharged from cement production process, it will achieve not only fuel saving but also environment protection, it will contribute to sustained development.

(4) The project implementation will carry out relevant state and local stipulations, standards and laws concerning environmental protection, labor safety, metering and fire fighting.

(5)Financial evaluation indicating the profitability of the project

To sum up, the project is an ideal investment project. While satisfying the state policy, the resources are comprehensively utilized and environment is improved, and the construction preconditions are satisfied.

The M & E Form of the Final Report for:

United Nations Industrial Development Organization

Energy Conservation and GHG Emissions Reduction in Chinese TVEs Phase Ⅱ-Cemnet Sector Replication Projects for Energy Efficiency(1)

Request for Proposal No: P. 2005/020

Project No: EG/CPR/99/G31

Submitted By:

Tianjin Cement Industry Design and Research Institute (TCDRI)

June 3, 2007

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M & E Form: Cement Sebsector Replication Project

No.	TVEs	Business Profile (1)	Technical Process and Major Energy-use Equipments (2)	E E Baseline										Proposed Technical Renovation (3)	Project Investment					Project Status	Anticipated Results											Remarks (4)
				Energy Type	Energy consumption (physical quantity)	Conversion Factor	Energy use (tce)	Energy Use/Unit Product			Output Before Renovation		Total energy use (tce)	CO2 Coefficient	CO2 Emissions (t/a.)		Total (RMB¥10,000)	GEF support (US$)	Others (RMB¥10,000)			Start-end date	Financial Evaluation			Production After Renovation		Energy Use/Unit Product			Capacity Added (KW)	Operation Hours/a.	Energy(5) Savings (tce/a.)	Energy Recovered (tce/a.)	Total (tce/a.)	CO2 emission Reduction (t/a.)	
1	Zhongliduan Group Zhejiang Zhongxinyuan Cement Co., Ltd.	Accessory	installed Capacity 2400t/d	Coal(t)	874,084.00	1.000	874,084	coal-use (clinker)	1.020	tce/t clinker	848025.600	t clinker/a.	918,814.00	2.493	2,290,613.27	Accessory 2	2.802	0	Commercial loans	1,401		No	No	Payback period	5.29	year	848,625	t clinker/a.	coal-use (clinker)	0.103	t clinker/a.	4.5	7920	31,584.00	13,650.12	25,234.12	62,908.68	
				Electricity (MWh)	116,890.00	0.385	44,734	c c energy consumption (5)	0.910	tce/t cement	1800000.000	t cement/a.							Entrustment Loan	0				IRR	22.70	%	1,000,000	t cement/a.	c c energy-use (5)	0.905	t cement/a.							
																			Self-Funding	789				NPV	7251.00	¥10,000											
				Sum Total			918,818												Financial Assistance					Cost of energy saving	0.096	¥1/tce											
Total																	2802	0														4.50	7920.00		

Note:

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4. Cost of energy savings: a) Energy saved after the renovation; a) "Energy Recovered": energy recovered by the waste heat power plant. a) + b) = total energy savings.

5. c c energy-consumption: cement comprehensive energy-consumption

6. Remarks: Please state and explain the source of baseline data.

7. Formula for calculating cost of energy savings:

(1) for Waste Heat Power Generation:

$$CE = \frac{Invest \dfrac{i(1+i)^n}{(1+i)^n - 1} + Cost}{EF}$$

Legend:

CE—cost of energy savings, ¥/kWh

Invest— Initial cost (¥)

i—Discount rate;

n— Project lifecycle (a.)

Cost— Annually operational increment cost

EF— Energy savings (kWh/a.)

M & E Form: Cement Sebsector Replication Project

No.	TVEs	Business Profile (1)	Technical Process and Major Energy-use Equipments (2)	E E Baseline										Proposed Technical Renovation (3)	Project Investment				Project Status	Anticipated Results													Remarks (4)
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1	Zhejiang Sanshi Group Nutong Building Material Co., Ltd.	Accessory 1	Installed Capacity 11000kT	Coal(t)	84,471	1.000	84,471	coal-use (clinker)	0.103	tce/t clinker	821250	t clinker/a.	107,643	2.493	268,353	Accessory 11	1,776	0	Commercial loan		Running	2004.9~2005.7	Payback period	4.71	year	1,642,500	t clinker/a.	coal-use (clinker)	0.103	t clinker/a.	3	7050	17,480	8,100	25,580	65,772	
				Electricity (MWh)	60,500	0.383	23,172	c e energy consumption (3)	0.100	tce/t cement	1000000	t cement/a.							Entrustment Loan				IRR	26.68	%	2,000,000	t cement/a.	c e energy-use (3)	0.097	t cement/a.							
																			Self-Funding	1,776			NPV	4393.00	¥10,000												
				Sum Total			107,643												Financial Assistance				Cost of energy saving[4]	0.093	¥1/tce												
Total																	1776	0													3.00	7050.00	

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i—Discount rate;

n— Project lifecycle (a.)

Cost— Annually operational incremental cost

EF— Energy savings (kWh/a.)

M & E Form: Cement Sebsector Replication Project

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				Energy Type	Energy consumption (physical quantity)	Conversion Factor	Energy use (tce)	Energy Use/Unit Product			Output Before Renovation		Total energy use (tce)	CO2 Coefficient	CO2 Emissions (t/a.)		Total (RMB¥10,000)	GEF support (US$)	Others (RMB¥10,000)		Start-end date	Financial Evaluation			Production After Renovation		Energy Use/Unit Product			Capacity Added (MW)	Operation Hours/a.	Energy[5] Savings (tce/a.)	Energy Recovered(tce/a.)	Total (tce/a.)	CO_2 emission Reduction(t/a.)	
1	Changxing Beishan Zhongsheng Building Material Co.,Ltd.	Accessory 1	Installed Capacity 1800t/d	Coal(t)	168,943	1.000	168,943	coal-use (clinker)	0.125	tce/t clinker	1314000	t clinker/a.	211,073	2.493	526,205	Accessory 1	5,944	0	Commercial loan	2,927	2004.11~2005.10	Payback period	4.28	year	1,314,000	t clinker/a.	coal-use (clinker)	0.129	t clinker/a.	6	7000	13,211	16,086	29,297	73,037	
				Electricity (MWh)	110,000	0.385	42,130	c e energy consumption[5]	0.132	tce/t cement	1600000	t cement/a.							Entrustment Loan	2,927		IRR	30.28	%	1,600,000	t cement/a.	c e energy-use[5]	0.122	t cement/a.							
																			Self-Fubding			NPV	9731.00	¥10,000										
				Sum Total			211,073												Financial Assistance			Cost of energy saving[6]	0.093	¥/tce										
Total																	5944	0													6.00	7000.00	

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i—Discount rate;

n— Project lifecycle (a.)

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M & E Form: Cement Sebsector Replication Project

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1	Zhejiang Sanshi Group Jindingzi Building Material Co., Ltd.	Accessory I	Installed Capacity 18000kW	Coal(t)	168,843	1.000	168,943	coal-use (clinker)	0.103	tce/t clinker	821250t clinker/a.	211,073	2.493	526,205	Accessory II	1,776	0	Commercial loan		Running	2004.9~2005.7	Payback period	4.71	year	1,642,500	t clinker/a.	coal-use (clinker)	0.103	t clinker/a.	3	7000	17,480	8,100	25,580	63,772	
				Electricity (kWh)	110,000	0.383	42,130	c c energy consumption[5]	0.106	tce/t cement	1000000t cement/a.							Entrustment Loan				IRR	26.68	%	2,000,000	t cement/a.	c c energy use[5]	0.097	t cement/a.							
																		Self-Funding	1,776			NPV	4393.00	¥10,000											
				Sub Total			211,073											Financial Assistance				Cost of energy saving[6]	0.093	¥1/tce											
Total																1776	0	1													3.00	7050.00		

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1	Guangdong Guangzhu Guizhou Cement Co.,Ltd.	Accessory 1	Installed Capacity 8400kW	Coal(t)	84,471.00	1.000	84,471	coal-use (clinker)	0.20	tce/t clinker	821250.000	t clinker/a.	107,642.50	2.493	268,352.75	Accessory 2	1,776	0	Commercial loan	0	No	No	Payback period	4.71	year	821,250	t clinker/a.	coal-use (clinker)	0.103	t clinker/a.	1	7050	6,226.40	8,100.45	14,376.85	35,841.49	
				Electricity (MWh)	60,500.00	0.383	23,172	c c energy consumption[5]	0.11	tce/t cement	1000000.000	t cement/a.							Entrustment Loan	1,776			IRR	16.68	%	1,000,000	t cement/a.	c c energy use[5]	0.100	t cement/a.							
																			Self-Funding				NPV	4393.00	¥10,000											
				Sum Total			107,643												Financial Assistance				Cost of energy saving[4]	0.09	¥1/tce											
Total																	1776	0	0													3.00	7050.00		

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EF— Energy savings (kWh/a.)

M & E Form: Cement Sebsector Replication Project

No.	TVEs	Business Profile (1)	Technical Process and Major Energy-use Equipments (2)	B E Baseline										Proposed Technical Renovation (3)	Project Investment				Project Status	Anticipated Results												Remarks (4)
				Energy Type	Energy consumption (physical quantity)	Conversion Factor	Energy use (tce)	Energy Use/Unit Product			Output Before Renovation		Total energy use (tce)	CO2 Coefficient	CO2 Emissions (t/a.)		Total (RMB¥10,000)	GEF support (US$)	Others (RMB¥10,000)			Start-end date	Financial Evaluation			Production After Renovation	Energy Use/Unit Product			Capacity Added (MW)	Operation Hours/a.	Energy[1] Savings (tce/a.)	Energy Recovered(tce/a.)	Total (tce/a.)	CO_2 emission Reduction(t/a.)	
1	Jiangsu Jiangu Cement Co., Ltd.	Accessory 1	Installed Capacity 8800kW	Coal(t)	84,471	1.000	84,471	coal-use (clinker)	0.10	tce/t clinker	821250	t clinker/a.	107,642.50	2.493	288,362.75	Accessory 2	1,776	0	Commercial Loan	0	No	No	Payback period	4.71	year	821,250	t clinker/a.	coal-use (clinker)	0.103	t clinker/a.	3	7050	6,652.00	8,100.45	14,752.45	36,777.86	
				Electricity (MWh)	60,500	0.383	23,172	c e energy consumption[3]	0.108	tce/t cement	1000000	t cement/a.							Entrustment Loan	1,776			IRR	26.68	%	1,000,000	t cement/a.	c e energy-consumption[3]	0.100	t cement/a.							
																			Self-Funding				XPV	4393.00	¥10,000											
				Sum Total			107,643												Financial Assistance				Cost of energy saving[4]	0.013	¥1/tce											
Total																	1776	0													3.00	7050.00		

Note:

1. Plant Business Profile shall cover general information of the plant before the renovation, e.g. date of establishment, ownership, fixed assets, production, employment and salary, raw materials and accessories used, type of products, description and qualification rate of products, product market (e.g. key market, sales volume, prices, etc.). A 800 - 1000 word description shall be attached to the main form, while putting key points into the form.

2. Technical process and major energy-use equipments: This shall include production processes flow diagram (e.g. types of kilns and drying chambers), total installation capacity with descriptions of each individual equipment, descriptions of major coal-use equipments(e.g. cement kilns). A 800 - 1000 word description shall be attached to the main form, while putting key points into the form.

3. Proposed Technical Renovation: This shall include briefly major energy conservation measures and the anticipated effects, as well as impacts on the employment and their salary 800 - 1000 word description shall be attached to the main form, while putting key points into the form.

4. Cost of energy savings: a) Energy saved after the renovation, b) "Energy Recovered": energy recovered by the waste heat power plant, a) + b) = total energy savings.

5. c e energy-consumption: cement comprehensive energy-consumption

6. Remarks: Please state and explain the source of baseline data.

7. Formula for calculating cost of energy savings :

(1) for Waste Heat Power Generation:

$$CE = \frac{Invest \dfrac{i(1+i)^n}{(1+i)^n - 1} + Cost}{EF}$$

Legend:

CE—cost of energy savings, ¥1/kWh

Invest— Initial cost (¥)

i—Discount rate;

n— Project lifecycle (a.)

Cost— Annually operational increment cost

EF— Energy savings (kWh/a.)

M & E Form: Cement Sebsector Replication Project .

No.	TYEs	Business Profile (1)	Technical Process and Major Energy-use Equipments (2)	EE Baseline										Proposed Technical Renovation (3)	Project Investment				Project Status	Anticipated Results											Regarks (6)
				Energy Type	Energy consumption (physical quantity)	Conversion Factor	Energy use (tce)	Energy Use/Unit Product			Output Before Renovation		Total energy use (tce)	CO2 Coefficient	CO2 Emissions (t/a.)		Total (RMB¥10,000)	GEF support (US$)	Others (RMB¥10,000)			Start-end date	Financial Evaluation			Production After Renovation		Energy Use/Unit Product			Capacity Added (MW)	Operation Hours/a.	Energy[4] Savings (tce/a.)	Energy Recovered(toe/a.)	Total (tcm/a.)	CO_2 emission Reduction(t/a.)	
1	Zhonglida Group Zhejiang Zhangjiayan Cement Co., Ltd.	Accessary 1	Installed Capacity 5800t/d	Coal(t)	41,868.00	1.000	41,898	coal-use (clinker)	1.030	tce/t clinker	848025.000	t clinker/a.	918,818.00	2.493	2,290,613.27	Accessory 2	1,578	0	Commercial loan	789	No	No	Payback period	5.45	year	848,025	t clinker/a.	coal-use (clinker)	1.030	t clinker/a.	2.5	7920	735,377.00	7,685.40	740,968.40	1,847,214.28	
				Electricity (MWh)	53,506.00	0.383	20,491	c c energy consumption[5]	0.915	tce/t cement	1000000.000	t cement/a.							Entrustment loan	0			IRR	21.84	%	1,000,000	t cement/a.	c c energy-consumption (t)	0.055	t cement/a.							
																			Self-Funding	789			NPV	4002.00	¥10,000												
				Sum Total			62,389												Financial Assistance				Cost of energy saving[6]	0.099	¥1/tce												
Total																	1578	0																2.30	7920.00	

Note:

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3. Proposed Technical Renovation: This shall include briefly major energy conservation measures and the anticipated effects, as well as impacts on the employment and their salary. 800 - 1000 word description shall be attached to the main form, while putting key points into the form.

4. Cost of energy savings: a) Energy saved after the renovation; b) "Energy Recovered": energy recovered by the waste heat power plant. a) + b) = total energy savings.

5. c c energy-consumption: cement comprehensive energy-consumption

6. Remarks: Please state and explain the source of baseline data.

7. Formula for calculating cost of energy savings:

(1) for Waste Heat Power Generation:

$$CE = \frac{Invest \frac{i(1+i)^n}{(1+i)^n - 1} + Cost}{EF}$$

Legend:

CE—cost of energy savings, ¥/kWh

Invest— Initial cost (¥)

i—Discount rate;

n— Project lifecycle (a)

Cost— Annually operational increment cost

EF— Energy savings (kWh/a.)

M & E Form: Cement Sebsector Replication Project

No.	TVEs	Business Profile [1]	Technical Process and Major Energy-use Equipments [2]	B E Baseline											Proposed Technical Renovation [3]	Project Investment				Project Status	Anticipated Results											Remarks [6]
				Energy Type	Energy consumption (physical quantity)	Conversion Factor	Energy use (tce)	Energy Use/Unit Product			Output Before Renovation		Total energy use (tce)	CO2 Coefficient	CO2 Emissions (t/a.)		Total (RMB￥10,000)	GEF support (US$)	Others (RMB￥10,000)			Start-end date	Financial Evaluation			Production After Renovation	Energy Use/Unit Product			Capacity Added (t/h)	Operation Hours/a.	Energy[4] Savings (tce/a.)	Energy Recovered(tce/a.)	Total (tce/a.)	CO_2 emission Reduction(t/a.)	
1	Baoding Taihang Heyi Cement Co.,Ltd.	Accessory 1	Installed Capacity 18744kW	Coal (t)	84,471.00	1.000	84,471	coal-use (clinker)	0.10	tce/t clinker	821250.000	t clinker/a.	107,642.50	2.493	268,352.75		3,479	0	Commercial loan	0		Xa	Xa	Payback period	5.28	year	1,116,900	t clinker/a.	coal-use (clinker)	0.100	t clinker/a.						
				Electricity (MWh)	60,500.00	0.383	23,172	c e energy consumption [5]	0.11	tce/t cement	1000000.900	t cement/a.							Entrustment Loan	0				IRR	22.88	%	1,360,000	t cement/a.	c e energy-use [5]	0.092	t cement/a.	5	7000	20,550.00	16,085.00	36,680.00	91,458.20	
																			Self-Finding	3,479				NPV	6845.00	￥10,000										
				Sum Total			107,643												Financial Assistance					Cost of energy saving [4]	0.09	￥1/tce										
Total																	3479	0														6.00	7000.00		

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Legend:

CE—cost of energy savings, ￥1/kWh

Invest— Initial cost (￥)

i—Discount rate;

n— Project lifecycle (a.)

Cost— Annually operational increment cost

EF— Energy savings (kWh/a.)