Ministry of Industry and Trade
General Directorate of Energy

LCEE LOW CARBON TRANSITION IN THE ENERGY EFFICIENCY
Vietnam-Denmark government cooperation in the energy sector

Embassy of Denmark

GREEN INVESTMENT FACILITY (GIF)

TSP Guideline

CHANGING FROM COAL FIRED CERAMIC KILN TO GAS FIRED CERAMIC KILN

Approved by The Project Director of LCEE

Approved Date: 25th April 2016

ENERGI STYRELSEN

VNEEP

Contents

Abbreviation

AMU	Administrative and Management Unit of GIF
EDK	Embassy of Denmark in Vietnam
EE	Energy Efficiency
ESA	Energy Saving Award
GIF	Green Investment Facility
LCEE	Low Carbon Transition in Energy Efficiency
LCTU	Low Carbon Transition Unit
LPG	Liquid Petroleum Gas
PMU	Project Management Unit
SEC	Specific Energy Consumption
SFC	Specific Fuel Consumption
SMEs	Small and Medium Enterprises
TSP	Technical Service Providers
VNEEP	Vietnam National Energy Efficiency Programme

1. Introduction

Green Investment Facility (GIF) is LCEE project's financial mechanism for promoting energy efficiency solutions for SMEs in brick, ceramic and food processing industries.

The guideline for EE solutions is mainly in technical point of view so that the TSP can use this guideline for their work in producing Pre check and Post check Reports following GIF requirements. In addition, the guideline sometimes provides information for SMEs to understand the specific requirements of the project in order to be eligible for support.

TSP should use Application, Pre-check and Post-check Forms when following this Guideline.

In order to apply for GIF, the following steps need to be done by involving stakeholders:

The First step: SMEs, independently or with support from consultants, propose project idea to AMU with explanation of the solutions for Energy saving or CO2 emission reduction and their expected investment plan. AMU will proceed to check the eligibility of the project idea with help from PMU (project management unit) if needed.

Result of this step: SMEs agree to prepare their applications and submit them to AMU. Standard Application Form will be provided to SMEs by AMU.

The Second step: SMEs submit their applications and required documents to AMU. AMU check and accept their applications and transfer them to TSP for pre-check of the EE project in SME.

Result of this step: SME application at TSP.

The Third step: TSP, as an independent inspector, goes to inspect in SME. The main duty of TSP is to foresee factors that can affect the success of project implementation; to check and estimate energy saving potentials of the proposed EE project, as well as check and revise investment items related to investment in proposed EE solutions and their total cost so that they are reasonable. After completion of the checking process, TSP completes Pre-check Report and sends it to AMU.

Result of this step: Pre-check Report at AMU office.

The Third step: AMU will send Pre-check report to PMU and PMU will evaluate them, and then inform Evaluation results to AMU- if all eligible criteria are met. AMU will inform SME to carry out borrowing procedures and invest in EE solutions. AMU will inform EDK for approval of loan guarantee and EDK will request Fund Holding Bank to issue Letter of Guarantee to lending banks for SMEs. In the most cases, the work can be done in parallel with pre-check work of TSP, and SME's application to lending bank and preparation for investment implementation.

Results of this step: SME invests in EE solutions, borrows loan and get loan guarantee from GIF.

The Fourth step: After EE solutions are implemented and in operation for at least 800 working hours, AMU will request TSP to go to the field to inspect the actual situation of the EE implemented solution check and calculate real percentage of energy savings of those EE

solutions. After checking, TSP will finalise their Post-check Report and submit to AMU. AMU will send it to PMU to get approval.

Result of this step: Satisfaction by AMU and PMU; Post Check Report written by TSP is at AMU Office.

The Final step: AMU, based on criteria, informs EDK about EE award level and amount of money, so EDK will request FHB to transfer money to the SMEs loan account at lending bank.

Result of this step: Eligible SME receive EE awards and money transferred to reduce SME's loan at lending bank.

The following standard forms are available at AMU office and on LCEE Website **http://www.lcee.vn:Application Form, Pre-check Form, and Post check Form.**

Based on some previously done solutions, the guideline has been prepared for known solutions. The above formats are only for general cases; there will be some difficulties in applying to each EE solution. In the future, the Guideline will be improved to cope with arising issues and Guideline for new upcoming EE solutions will be developed.

This Guideline describes the works that needed to be done by TSP when inspecting "solution of changing from coal fired ceramic kiln to gas fired ceramic kiln".

It is in effect from the date of approval for this revised Guideline and it is not applied for projects approved before the approval date of this Guideline.

2 Scope of standard solution

This measure applies

- when the new gas fired kiln replaces traditional coal fired kiln
- when the new gas fired kiln is constructed instead of traditional coal fired kiln in new setting ceramic enterprises

The measure includes the kiln itself as well as supporting installations such as thermocouple, burners, chimney, fans, drying system that uses exhaust gas for drying purpose, trolleys, supporting bars or plates necessary for arranging ceramic products in the kiln etc.

The measure does not include building construction material or works related to any building. It also does not include costs of upgrading of infrastructure

The portable guarantee may cover 50% of loan of the investment in the kiln including necessary auxiliaries such thermocouple, burners, chimney, fans, drying system that uses exhaust gas for drying purpose, trolleys, supporting bars or plates necessary for arranging ceramic products in the kiln etc. that are necessary for normal operation and fire control of the kiln.

3 Technical description of standard solution

(Application form 4.1 and 4.2,

Pre-check report part 2

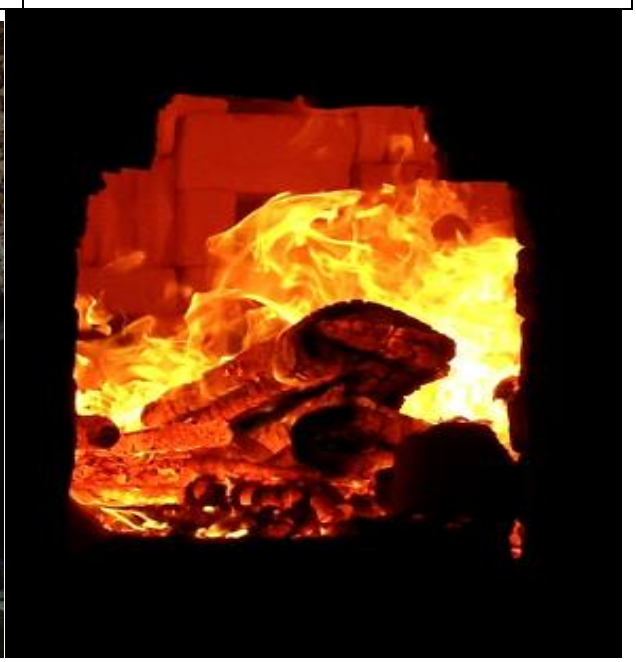
Post-check report par 1)

Principle of energy saving and greenhouse gasses emission reduction

In the traditional method, ceramic makers use coal fired box kiln, so ceramic products need to be settled inside the small box fitted for the products and arranged inside the kiln constructed traditionally by local refractory brick with very bad insulation. The kiln works intermittently with high pollution due to inefficient use of coal as a fuel. Energy consumption is high because it is used for heating the covering box before using for ceramic product. The bad structure of the kiln also results in high heat loss through walls especially the front wall that is only covered by a thin layer of brick when they finish arranging ceramic inside the kiln.

Figure 1 showing how traditional kilns works.

Box for keeping ceramic products inside	Box fired kiln



Arranging ceramic inside the kiln	Firing the kiln

By replacing the traditional ceramic kiln using coal as a fuel by a modern gas fired kiln, the following points can be explained for energy savings and CO_2 reduction of the solution

- The modern gas fired kiln uses modern insulation and refractory materials so that the heat loss through kiln surface could be minimized.
- Gas is clean fuel so ceramic could be contacted directly with the flame inside the kiln. Cover box is not necessary; therefore heat loss through heavy cover box does

not exist. A much smaller heat loss can occur in the supporting plate and frame bar for products.

- With the same amount of energy generation, LPG can have smaller CO2 emission since element Hydrogen in the fuel can react with Oxygen to create H2O during the combustion process. As a result, CO2 emission factor of LPG is much smaller compared to coal.
- LPG is burned in the form of gas in the burner, the combustion efficiency is much better compared to coal in the form of solid fuel, due the ability to mix fuel and Oxygen well during combustion process, as excess air could be kept much lower.

Request for description of Potential of energy savings and CO_2 reduction

- Describe the actual situation of enterprises including technical information of original coal fired kiln (Size, capacity, type of products that have been produced until now); proposed Gas fired kiln (Size, capacity, type of products that will be produced)
- Describe in more details the main structure of the proposed gas fired kiln with the design or other methods to show that the gas fired kiln is the modern and efficient choice.
- Describe the rearrangement of the working space that is suitable with the new gas fired kiln with suitable pictures to show original coal fired kiln, place for new kiln and if possible, with the plant view drawing of the factory before and after carrying out the project.
- Estimation of potential of Energy savings and CO2 reduction will be based on the Specific Energy Consumption (SEC) calculated in MJ/kg product or kg CO2 emission/kg product. Calculation methodology will be described below in article 6

4 Possible factors affecting the success of the project

The following factors may affect the success of the project.

- Market and Management of the enterprise: enterprise can have low profit and it takes a long time to finish 800 hours of operation if the product produce do not meet requirement of market or bad management in the production process. Possibility of this factor may be low. For this factor, TSP should prepare some questions for interviewing SME regarding the market, products to adapt to market orientation, and how they manage the process to identify the risk of loan return.
- Space for processing may be small for using gas-fired kiln efficiently since the space required for this kiln is bigger than a coal-fired kiln. For this factor, TSP should describe in more details the arrangement of the SME and SME's plan for rearranging space.
- Bad kiln structures can result in ineffective fire distribution. Consequence of this problem is low product quality as well as increased fuel consumption of the kiln. For these factors, the list of technology suppliers should be compiled and experience of the technology supplier should be recorded for evaluation in the future. The low quality technical supplier should be black listed. At the beginning, data of the number of successful technology transfers is valuable.

Since above-mentioned factors can affect the success of the project, it is suggested that the TSP should take them into considerations to identity any possibility of reducing original proposed energy saving.

5 Minimum Technical criteria

The new kiln investment should be constructed by experienced technology supplier who already have successfully transferred technology to at least five enterprises with a clear contract in which responsibility of technical supplier should be clarified in term of gas consumed to fire certain amount of products calculated by mass.

Arrangement of the working area should be planned for that the enterprise can have convenient work to supply input raw materials to the kiln.

The drying chamber using flue gas or LPG or other applied solution to eliminate the use of coal in drying molds and/or raw products is encouraged. In case it is necessary to use coal for this drying process, the GIF application form needs to describe detailed procedures of ceramic production to prove the necessity of coal use.

The design and construction of LPG fired ceramic kiln and drying chamber needs to be in details so that AMU/PMU can verify the quantity of materials to construct it.

Due to smaller heat inertia and larger energy savings to the LPG ceramic kiln, using ceramic fiberglass insulation material instead of thermal insulation bricks is encouraged. The insulation for surrounding wall, door and roof of the kiln must include the use of ceramic fiberglass with the thickness of at least 150mm.

The design and installation of the array of LPG cylinders, LPG supply pipeline system, enclosed safety devices and safety distance from the array of LPG cylinders to the household and production area must be complied with QCVN 10:2012/BCT - National technical regulation on safety for Collective Supply of Liquefied Petroleum Gas. The household, kiln designer and kiln contractor must be responsible for and declare their compliance of the standards for constructed LPG ceramic kiln and the entire system.

6 Economic assessment

(Referring to application form 4.4 - 4.6; Pre-check report 2.1 and 3; Post-check report par 3)

Investment costs

Investment of the gas fired kiln needs to be prepared for all necessary materials with cost estimation presented in a table. This table may be provided by SME or technical supplier. The duty of TSP is to evaluate the type, quantity, price of the materials, identify whether there are any unusual deviations from the normal, and ask for explanation and correction. All evaluations/verifications should be supported with sources of information based on a specific and detailed design used for the purpose of investment calculations. The final list of material

and costs, which shows total investment, should be upon agreement with AMU before finishing Pre check report.

7 Calculation of energy savings award

(Referring to post-check report par. 3)

(Referring to: Pre-check report 2.1)

The specific energy consumption (SEC) of the coal fired traditional kiln will not be measured. Instead it will be assumed, that the SEC of the traditional kiln is 18.744 MJ/kg of product. This number is based on a series of measurements of traditional kilns.

In case of gas-fired kiln, the following procedure could be used for Specific Energy Consumption calculation:

$$SEC = \frac{M_{LPG} Q_{LPG}}{\sum_1^p M_p N_p}$$

Where

- SEC: Specific Energy Consumption (MJ/kg product)
- MLPG: Mass of LPG for one batch (kg/batch)
- QLPG: calorific value of LPG (MJ/kg) (take value of 47.31 MJ/kg)
- Mp: mass of product p
- Np: number of product p in one batch.

The SEC will be determined by the TSP based on measurements of one batch.

The Energy Savings Award (ESA) will be calculated as follows:

If SEC is less than 9.4 MJ/kg, ESA is 30% of eligible loan amount.

If SEC is less than 11.2 MJ/kg, ESA is 23% of eligible loan amount

If SEC is less than 13.1 MJ/kg, ESA is 16% of eligible loan amount

If SEC is less than 15 MJ/kg, ESA is 10% of eligible loan amount

If SEC is more than 15MJ/kg, no Award given

8 TSP responsibility in Pre check and post check

Necessary activities of pre-check

- Guidelines for desk check (any necessary documents missing, preparation for on-site visit, the suitable time to visit …)
- Check for the methodology of rearranging production process that SME plans to do when converting the kiln, mainly to identify the preparation and SME's understanding of the new technology.

- Check and take photos of the location of new kiln and old kiln, give comment on the strong points and weak points of the location of gas kiln.
- Give questions on SME's plan after conversion of the kiln.
- Recalculate potential Energy savings, investment costs and payback period from application form and suggest revision if necessary.
- Identify factors affecting the success of project implementation.
- Prepare form of necessary information that SME needs to record for calculation of energy savings in post check report.

Necessary activities of post-check

- Recalculate energy savings from SME record (at least 5 batches). These will be used for reference only, not for the calculation of the energy savings award.
- Perform measurement and analysis of one batch of operation and recalculate energy savings;
- Compare results and comment for giving award level.
- Check the invested items clarified in pre check report after a certain time of working (800 Hours)
- Report on advantages and disadvantages of project implementation (specific comments to SME's situation are valuable).
- Report on the quality of the kiln after 800 hours of operation with necessary pictures.
- Submit the energy saving calculation table and the below summarized result table in excel format containing all calculation formula for monitoring and evaluation purpose.
- Calculate total annual energy savings and total annual CO_2 emission reduction as benefits obtained from the project. The below table needs to fulfill:

Energy savings and CO_2 reductions obtained from project				
	A	B	C	D
	Energy carrier or fuel	Annual Energy consumption before the project implementation	Annual savings	CO2 reduction (tons/year)
1	**Electricity**	MWh/year	MWh/year	
2	Coal	TOE/year	TOE/year	
3	Oil	TOE/year	TOE/year	
4	LPG	TOE/year	TOE/year	
5	Natural gas	TOE/year	TOE/year	
6	Biomass	TOE/year	TOE/year	
7	Solar	TOE/year	TOE/year	

8	Other	TOE/year	TOE/year	
9	**Total Fossil Energy** (∑ 2…5, 8)	TOE/year	TOE/year	
10	**Total Renewable Energy (RE)** (∑ 6…7, 8)	TOE/year	TOE/year	
11	**Total Energy Saving** (C1+C9+C10)	TOE/year		
12	**Conversion to RE**	*(C9 in conversion projects)* TOE/year		
13	**Total CO2 Reduction** (D1+D8+D9)	Ton/year		

If the output capacity of the new solution differs from the baseline situation, the baseline energy consumption must be reduced or increased to the equivalent of the output capacity of the new solution. For example, if a new ceramic kiln output capacity is two times higher than the old kiln, the baseline coal consumption should be adjusted to correspond to this new production capacity:
Specific energy consumption for baseline shall be multiplied by the number of production output units for the new solution.
The specific energy consumption for baseline must be defined in accordance with the specific guideline.

9 Annexes

Annex 1: Application Form

Annex 2: Pre-check Form

Annex 3: Post-check Form