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

Solar heating for industrial processes

Approval 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 Prorgamme

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 GIF 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/and 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 checks and accepts their applications and transfers them to TSP for pre-check of the EE investment 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 Fourth 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 gets loan guarantee from GIF.

The Fifth 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 receives 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, 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 need to be done by TSP when inspecting "Solution of Solar Heating for Industrial Processes".

2 The standard solution

2.1 Scope of standard solution

(Referring to: Application Form parts 4.1 and 4.2; Pre-check Form parts 2 and 2.1).

The scope of the solution is an entire heat supply system including the heat generator (boiler) and heat distribution system.

This solution applies to renovation projects of existing cooling central systems. The measure applies:

- When SME invests to upgrade/renovate the existing process heating system(s).
- When SME invests in new process heat production capacity

The portable guarantee may cover 50% of the loan for the components replacement, necessary auxiliaries for normal operation mode of a solar heating system, such as pipes, pumps, metering thermal storage etc. In addition, investment costs in efficiency upgrade of an existing heat distribution system may be covered.

The guarantee covers possible investment in land acquired for the specific purpose of mounting solar collectors for the plant. The guarantee does not cover investment costs in buildings.

Total investments for the system improvement should be more than 400 million VND and at least 20% of electricity should be saved from the system. Limitation of the guarantee is 2 billion VND and limitation of the award is 1.2 billion when saving is 50% of electricity consumption of the system.

2.2 Technical description of standard solution

(Referring to Application form 4.1 and 4.2, Pre-check report par 2, Post-check report par 1).

Solar heating for industrial processes (SHIP) is applicable for processes up to temperatures around 250°C. It is most widely used for low-temperature purposes, up to about 100°C, where low-cost solar collectors can be applied, and where the conversion efficiency is higher.

SHIP is particularly viable for such purposes as pre-heating of process water, make-up water for steam production, but it may also be used for steam production, drying and other low-temperature purposes.

2.2.1 Design of SHIP systems

A SHIP system must be tailor-made for the specific purpose, which it should serve. The design should go through the following main steps:

- Calculate the thermal load (heat demand) hour by hour during a day / week / month / year, assess the temperature demand: Before designing the solar system it should be considered if the thermal load could be reduced, for example, through improved insulation of installations, through heat recovery or otherwise. In addition, the supply temperature may have a considerable impact on the costs of the solar energy system: higher temperature results in increasing heat losses from the solar panels, and high-temperature solar collectors tend to be more expensive.
- Perform a series of simulations of the solar heating system with various choices of solar panels, various heat storage capacities etc., in order to determine the most optimal system design.

A practical guide to design of SHIP systems is "Solar Process Heat Generation: Guide to Solar Thermal System Design for Selected Industrial Processes ".[1]

Another useful guide is the US Army "Central Solar Hot Water Systems Design Guide"[2]. This guide is mainly intended for central hot water preparation.

For simulation of the SHIP system the RETSCREEN software can be recommended for an initial assessment of the system dimensions and costs.[3] The software includes solar radiation data for a number of sites in Vietnam as well as a solar panel database. The main limitation is that it works only with a pre-defined load profile.

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[1] http://www.solar-process-heat.eu/fileadmin/redakteure/So-Pro/Work_Packages/WP3/Planning_Guideline/Techn_Bro_SoPro_en-fin.pdf

[2] https://www.wbdg.org/pdfs/solar_hotwater_dg.pdf

[3] http://www.retscreen.net/ang/download.php

For more complex industrial processes such as breweries, dairies and others, it may be worth the effort to do a more comprehensive analysis of the optimal way of integrating the SHIP. A comprehensive approach to SHIP integration into complex systems is given in the "Solar Process heat for Production and Advanced Applications"[4]

2.3 Possible factors affecting the success of the project

SHIP is particularly relevant when

- The heat supply temperature is low;
- The annual solar radiation is high;
- The demand for heat coincides well with the availability of solar energy;
- There is a sufficiently large area of space available for installation of the panels, for example on roof tops, on the ground, on top of a car park etc;
- The production costs of an existing heat supply are high (electricity, fossil fuel).

Although the technology is fairly simple, the success depends on a careful selection of components. First, solar panels should have a verified efficiency curve and a guaranteed minimum lifetime. The design should be based on careful analysis of the system in order to secure the most optimal integration and to find the right balance between the heating demand, the choice and size of solar collector area and the size of the heat storage tank.

2.4 Technical minimum criteria

(*Referring to: Pre-check report part 2 and Post-check report part 1)*

The following technical minimum criteria apply:

- The system design must be based on a simulation or design and calculation of the SHIP system proving the concept chosen;
- The solar panel efficiency must have been verified in a certified test (of manufacture);
- The SHIP system must be equipped with a heat supply meter.
- Any obvious measures for reduction of heat load (energy consumption) or reduction in supply temperature must be included into the project (clarification)

In addition to the technical minimum criteria, the supplier of the system must provide a performance guarantee for the solar panel array. The guarantee must be either based on an instantaneous performance at specific conditions (solar radiation, temperature, load), or a total annual output. In

[4] http://task49.iea-shc.org/Data/Sites/7/150218_iea-task-49_d_b2_integration_guideline-final.pdf

case of an instantaneous performance based guarantee, the guidelines of the "Solar District Heating Guidelines, Performance guarantees"[5] could be applied.

2.4.1 Economic assessment

(Referring to Application Form parts 4.4 - 4.6. Pre-check report parts 2.1 and 3. Post-check report part 3)

Investment costs

The following types of costs are eligible for support from the GIF:

- System design costs;
- All SHIP installations including panels and supporting structures, piping, heat storage tanks etc.;
- Measures to reduce heat load or supply temperatures;
- Monitoring and metering equipment;
- Connection to heating distribution system.

Valuation of benefits

The valuation of benefits will be performed as follows:

Fuel cost savings from possible EE measures

If the project includes measures to reduce heat consumption (insulation or other), the heat consumption reduction will be analyzed using conventional methods (heat reduction for transfer because of better insulation etc.). The fuel savings will be calculated as follows:

i) $S_f = S_e / Eta_{boiler}$,

Where

S_f is primary thermal energy fuel savings,

S_e is secondary thermal energy savings

Eta_{boiler} is the thermal efficiency of the boiler

Eta_{boiler} could by default be set to 0.75 for liquid and gas fuel oil boilers and 0.7 for solid fuel boilers (coal; biomass), unless more specific data is available for the boiler in question (average values according to [6]).

[5] http://solar-district-heating.eu/Portals/0/Factsheets/SDH-WP3_FS-3-3_Guarantees_version4.pdf

[6] http://www.thegef.org/gef/sites/thegef.org/files/gef_prj_docs/GEFProjectDocuments/Climate%20Change/Vietnam%20-%20(5412)%20-

ii) $M_f = S_f / Q_f$,

Where

M_f is fuel savings,

Q_f is calorific value of fuel

Fuel cost savings from solar heat supplied

The annual energy output from the SHIP system will be determined on the basis of the output guarantee.

If the guarantee is provided in the form of an instantaneous performance guarantee, the solar heating output will be determined on the basis of a simulation in RETSCREEN software using the guarantee values given and verified by the supplier after installation.

The fuel savings resulting from the SHIP heat supply will be calculated as above, using the boiler efficiency parameter.

2.4.2 Calculation of energy savings award

(*Referring to Post-check Report part 3)*

The energy savings award calculation is based on the calculated annual reduction in fuel consumption in the heat supply system following the measures taken, including possible energy efficiency measures as well as the SHIP heat production output.

Determination of the base case fuel consumption

The base case fuel consumption (F_{base}) will be calculated on the basis of actual fuel consumption during the previous year. If there is specific reason to expect a change in fuel demand (for example as a result of changes in production output or in processes or if the boiler has been replaced by a more efficient boiler), the base case fuel consumption assumption must be adjusted accordingly.

Determination of the post-project fuel consumption

Step 1: Calculate the annual heat output (Q_{tot}) from the central boiler corresponding to the base case fuel consumption using a formula similar to the formula i).

%20Promotion%20of%20Energy%20Efficient%20Industrial%20Boiler%20Ad/GEF5_UNIDO_CEO_Endorsement_Vietnam_5412_resubmission_signed.pdf

Step 2: Using the RETSCREEN software, calculate the solar heating output (Q_{solar}), using the total heat output of step 1, as well as guarantee parameters of the solar panel as well as the relevant temperature and other parameters.

Step 3: If energy efficiency measures are applied, add the annual energy savings to the Q_{solar} in order to obtain the total reduced heat supply from the boiler ($Q_{reduced}$).

Calculate the corresponding fuel consumption ($F_{reduced}$) using a formula similar to the formula i).

Step 4: Calculate the fuel savings percentage as follows:

Percentage fuel reduction = (F_{base}- $F_{reduced}$)/ F_{base}

2.4.3 TSP responsibility in Pre-check and post-check

Necessary activities of pre-check:

- Verify the analysis of the annual fuel and heat demand and the temperature level(s) of the demand.
- Verify the projected heat output of the SHIP system using Retscreen.
- Verify analysis of energy savings to be obtained from possible energy savings measures.
- Verify the quality of the system design.
- Verify the cost budget.
- Verify investment costs and payback period from application form and suggest revision if necessary
- Submit the estimated energy saving calculation and total annual CO2 emission reduction beneficent from the project in the below table and summarized result table in excel file containing all calculation formula for monitor and evaluation purpose.

Energy savings and CO_2 reductions obtained from project				
	A	B	C	D
	Energy carrier or fuel	Annual Energy consumption before 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		

Necessary activities of the post-check

- Check the measures made (EE and SHIP) and compare with the proposed measures. Check the quality of the installations.
- Verify the test of the solar panel array to check that it meets the performance guarantee.
- Verify that the output temperature of the solar array is no more than 2°C higher than the set point temperature.
- Verify that the system has been in uninterrupted operation for at least 800 hours with no major operational faults.
- Verify investment costs and payback period from application form and suggest revision if necessary
- Submit the energy saving calculation table and below summarized result table in excel format containing all calculation formula for monitor and evaluation purpose.
- Calculate total annual energy savings and total annual CO2 emission reduction beneficent from the project in the below table:

Energy savings and CO_2 reductions obtained from project				
	A	B	C	D
	Energy carrier or fuel	Annual Energy consumption before 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		

3 Annex

Application Form

Energy Audit Report or Refrigeration system audit report if possible.

TSP Pre-check Form

TSP Post-check Form