Appendix 7. Cement

Sector Specific Annex to Audit Guideline under the EE Incentive Scheme for energy intensive industries in Vietnam

1 Introduction

The purpose of this annex is to secure that the most important opportunities for energy efficiency improvements in the cement sector are investigated.

The annex is prepared to provide more sector-specific guidance than what is presented in the general energy audit guideline prepared under the Danish/Vietnamese cooperation.

As such, the guideline describes the most important focus areas within the key technologies of:

1. **Storage** is the first part of the process on site where the raw materials are being gathered on site from the quarry and/or different suppliers. At the storage a pre-blending process can take place.

2. **Raw mill** is the process in which the raw materials are grinded and dried into homogeneous compositions of fine powder.

3. **Cyclone Preheater/calcinator** is a process where fine raw meal is partly calcined and preheated to approximately 850°C. Pre-heater chamber consists of series of vertical cyclones from where the raw meal passes before entering the kiln. Pre-heating chamber utilizes the emitting hot gases from kiln.

   The cyclone also acts as a dust collector.

4. **Rotary kiln** is a process where the pre-calcined raw meal (or raw meal slurry in the wet process) is dried, pre-heated, calcined and sintered to produce cement clinker.

5. **Cement mill** is a milling process where the clinker, gypsum and other additives are milled into the final cement.

6. **Fuel and combustion systems:** the primary fuels are used in the rotary kiln, which uses coal, petcoke, natural gas and waste. Coal and petcoke are crushed in a mill to get a fineness that secures an optimal combustion when used in the rotary kiln.

7. **Cooling systems** are used to cool the cement clinker after the rotary kiln. Cooling of the clinker heats up air which is often used for preheating purposes.

8. **Compressed air** is used to power the machinery of the facilities and is therefore applicable to all processes powered by heavy machinery.

9. **Generation of electricity** is often done in an ORC power plant utilizing the waste heat leaving the cyclones.

10. **Heat recovery systems** are applied to recover heat either at individual processes or to supply waste heat across several heat users.

Heat recovery is applicable to most of the key technologies individually, while overall systemic mapping of heat recovery is also important, as energy recovered from one technological process may be used in another.

2 Technology review compared with Best Current Practice

In the table below, best practice energy efficiency projects are listed for each of the technologies above. The energy audit should consider the possible viability of each of the measures in the specific context.

The energy audit report should document how these potential measures have been considered. For each measure it should be stated whether it is practically relevant for the specific enterprise. If it could be relevant, the report must make a pre-assessment of the technical and financial viability.

No.	Technology	Energy efficiency measures
1	Storage	• Optimizing the storage décor, to avoid any redundant handling of raw material. • Covering raw material, to avoid an increase of the moisture content, which must be removed afterwards.

No.	Technology	Energy efficiency measures
		• Optimizing transport systems e.g. using gravity conveyer, with the potential for electricity production. • Optimizing transports control to minimizing standby consumption and operating at optimal speed.
2	Raw mill	• Heat recovery on raw mill can be made by utilizing the hot exhaust air for preheating the raw material. See also item number 10 for heat recovery. • Milling should be controlled based on the content of the air and raw material. The energy performance can be optimized by adjusting the feed, grinding pressure, air flow, as well a rotary and table speed. • Is the drying control designed in a way making sure that over or under drying does not take place? The drying should be controlled by the moisture content in the raw material and by the moisture content of the drying air. • Several new emerging grinding mill technologies are under development, which all reduces the specific energy consumption: - Contact-free grinding systems. - Ultrasonic comminution. - High voltage power pulse fragmentation. - Low temperature comminution.
3	Cyclone preheater and calcinator	• The number of cyclones has a direct influence on the system efficiency. The financial optimal number is 4-6 cyclones. The moisture content also has an influence on the number of cyclones.

No.	Technology	Energy efficiency measures
		• Insulation of air ducts at the cyclones and calcinator (also in the Kiln) can reduce thermal losses and increase efficiency.
4	Rotary kiln	• Improving the brick insulation of the kiln. Better brick material will reduce thermal losses, need for cooling, and increase the production time. • Making sure the refractory lining is not allowing significant heat losses. To identify refractory issues, routine inspections should be conducted, checking for temperature hotspots. • Improving the combustion by controlling the oxygen, fuel and moisture content. • The heat from cooling the kiln should be recovered elsewhere in the system such as preheating air for combustion. • Optimizing process controls can reduce heat consumption, improve clinker quality, and increase the lifetime of the equipment. Relevant process parameters include homogenization of raw material, uniform coal dosing and optimal operation of the cooler. • Introducing a gas bypass can reduce the build-up of different substances originating from alternative fuels. The build-up reduces the performance of the kiln, calcinatory and preheater. A gas bypass that removes a part of the process gas can secure stable conditions.
5	Cement mill	• Reducing the clinker content by adding fillers like, sand, slag, limestone, fly ash and pozzolana will reduce the specific energy consumption.

No.	Technology	Energy efficiency measures
6	Fuel and combustion system	• The characteristic of the fuel has an influence of the specific consumption e.g. the moisture content of the lignite influences the energy efficiency of the combustion process. To improve the combustion process, the lignite could be pre-dried before use. • See Technology Catalogue for boiler and heating systems.
7	Cooling system	• Excess heat from the Clinker cooling can be recovered – see item number 10. • The air intake for the clinker cooling must be taken from a “cold” location and not from a hot environment to increase the efficiency of the clinker cooler. • The cooling air flow must be controlled according to the cooling demand and the control must not be done by dampers it should be done by a combination of on/off and frequency control. • Use cooler grate plates to provide a more uniform cooling distribution. • The cooling air must be controlled to the individual sections.
8	Compressed air	• See Technology Catalogue for compressed air systems.
9	Generation of electricity	• Electricity can be generated on the waste heat from the preheater by an ORC (Organic Rankine Cycle). The ORC has a power efficiency in the range of 10-20%. • Alternative methods of producing electricity locally should be considered by:

No.	Technology	Energy efficiency measures
		- Waste incineration. - Gas motors. - Combined heat and power. The methods must be evaluated against the electricity costs from the public grid.
10	Heat recovery	• Large quantities of waste heat are often available from the clinker cooler and preheater. • The hot air can be used for: - Combustion air both in the calcinatory and in the kiln. - Drying of raw material e.g. pozzolan. - Preheating for the raw mill. - Drying of fuel. - Electricity production by ORC. - Producing district heat for external usages.