

# Appendix 9. Paper

## 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 pulp and paper 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. **Raw material** for paper making varies depending on the type of paper produced. However, the main component in paper is cellulose fibers. The prime source of cellulose is trees, especially pine, spruce, birch, and eucalyptus. Modern papermaking uses both virgin and recycled fibers, depending on the requirements of the final products.
2. **Transport of raw material** covers in principle both internal and external transport of raw material, depending on the origin of the material and boundary of the specific site. External transport covers transport from where the raw material is collected/made to the site, and the internal transport covers the transportation from the onsite storages to the pretreatment.
3. **Storage** is the process steps in between the incoming raw material, pretreatment, pulping, drying and final product. The storages are binding each process steps together and therefore the efficiency of the storages have a direct effect on the capacity and efficiency of each process steps.
4. **Pretreatment** of the raw material depends on the type of material. The pretreatment can consist of sorting, washing, debarking, chousing, drying of virgin and fibers.

5. **Pulping** is a process where the fiber structure of the raw material is broken down into a liquid solution. There are several pulping methods, but the most common are chemical and mechanical pulping. Chemical pulping separates the fibers into the raw material by dissolving the lignin bonds that hold these fibers together, often at elevated temperatures and pressures. Mechanical pulp is made by subjecting the raw material to an abrading action, either by pressing the wood against a revolving grinding stone or by passing the raw material through a mill.

The pulping can also involve a bleaching process to make with paper.

Some factories have their own pulping process while others source in pulp from pulping factories and then only re-pulp as a part of the paper making process.

6. **Papermaking** process can be divided into the following areas: wet end, wet press, drying section end and operational finishing and coating. The purpose of the papermaking process is to remove water by pressing, draining and evaporation. The dewatering is done by various gravity, vacuum, pressing, steam, and ventilation systems. This part of the paper process is the most energy intensive part of the process, being most energy intensive towards the dry end of the paper process.
7. **Steam boilers and distribution systems** are used to deliver heat for heat requiring processes across the facilities. An integrated part of the steam systems, co-generation and waste incineration systems are integrated to produce electricity and contribute to waste disposal respectively.
8. **Compressed air** is used to power the machinery of the facilities and is therefore applicable to all processes powered by heavy machinery.
9. **Reuse of raw material:** there are several options for reusing raw material in the process. The reuse of raw material will have a positive effect on the use of new raw material, plant efficiency and load on the waste treatment systems and plants.
10. **Heat recovery systems** are applied to recover heat either at individual processes or to supply waste heat across several heat users.
11. **Water treatment systems:** A large part of the paper making process involves water as a solvent, homogenization, and transportation agent. To support the water systems, fresh water, wastewater and water recovery systems are an integrated part of the paper making process.

12. **Electrical systems:** Electrical systems serve to support the paper making process. The main components of the electrical systems are motors, pumps, air compressors, vacuum systems, hydraulic systems and lighting systems.

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	Raw material	<ul style="list-style-type: none"> <li>Balancing the input of raw material to the production capacity (this goes both for virgin and recycled) to reduce bottlenecks that have a negative influence on the production KPIs.</li> <li>Are there efficient cleaning and screening procedures, to ensure high quality and to avoid losses?</li> </ul>
2	Transport systems	<ul style="list-style-type: none"> <li>Are high-efficient transport systems used e.g. belts or gravity conveyers as an alternative to pneumatic systems?</li> </ul>
3	Storage	<ul style="list-style-type: none"> <li>Balancing the input of raw material to the production capacity (this goes both for virgin and recycled) to reduce bottlenecks that have a negative influence on the production KPIs.</li> <li>Are the storages facilities organized to avoid any unnecessary handling procedures?</li> </ul>

No.	Technology	Energy efficiency measures
4	Pretreatment	<ul style="list-style-type: none"> <li>• Is the water recycled from the washing process?</li> <li>• Are efficient debarking and crushing methods used?</li> <li>• Are the chips being conditioned for improving the pulping process?</li> </ul>
5	Pulping	<ul style="list-style-type: none"> <li>• Are pulping aids used in the pulping process to increase liquor penetration and promote more even cooking?</li> <li>• Are raw materials, water, chemicals and energy recovered in all steps of the process?</li> <li>• Are efficient mixing methods applied?</li> </ul>
6	Papermaking	<ul style="list-style-type: none"> <li>• Is the water removal process optimized with the focus of removing water upstream in the process?</li> <li>• Are the process steps monitored to ensure that each step continuously performs optimally?</li> <li>• Is a steam box used for unifying the paper humidity and draining?</li> <li>• Is the hood of the dryer tight?</li> <li>• Is the dew point that levels in paper drying hoods measured and controlled to optimize the drying process?</li> <li>• Is heat recovered internally from the high-pressure dryers to the low-pressure dryers (cascade system)?</li> <li>• Is the drying controlled to make sure that under and over drying is prevented?</li> </ul>

No.	Technology	Energy efficiency measures
		<ul style="list-style-type: none"> <li>• Are all precautions taken to prevent downtime? Downtime on the paper machine increases the specific energy consumption and reduces the throughput.</li> </ul>
7	Steam boilers and distribution	<ul style="list-style-type: none"> <li>• See Technology Catalogue for boiler and heating systems.</li> <li>• Is solid waste being used as an energy source for producing steam?</li> </ul>
8	Compressed air	<ul style="list-style-type: none"> <li>• See Technology Catalogue for compressed air systems.</li> </ul>
9	Reuse of raw material	<ul style="list-style-type: none"> <li>• Is water (and temperature) reused from the vacuum system, or does it end up in the wastewater treatment?</li> <li>• Treated wastewater can be used for seals and water hose instead of fresh water.</li> <li>• Is the retention share high enough? Higher retention will have a positive impact on the raw material cost and wastewater treatment?</li> <li>• Are the steam and process condensate being recovered and reused?</li> <li>• Are the fibers and fines captured (e.g., using a DAF unit), to prevent ending up in the wastewater treatment?</li> </ul>
10	Heat recovery	<ul style="list-style-type: none"> <li>• Heat can be recovered from various parts of the process and reused on the process itself or in a recovery system serving other processes.</li> <li>• In the papermaking process there are a number of heat recovery solutions that can be or are applied to the processes. When optimizing the heat</li> </ul>

No.	Technology	Energy efficiency measures
		<p>recovery systems some of the following questions can be asked:</p> <ul style="list-style-type: none"> <li>- Is the recovery system in balance?</li> <li>- Does the heat recovery design and control support the full recovery potential?</li> <li>- Can the surplus heat be recovered for other purposes?</li> </ul> <ul style="list-style-type: none"> <li>• Some of the most common heat recovery solutions in the paper making process are: <ul style="list-style-type: none"> <li>- Reuse of flash steam.</li> <li>- Reuse of exhaust air for the process itself or for other heat demands e.g. pulp water heating.</li> </ul> </li> </ul>
11	Water treatment	<ul style="list-style-type: none"> <li>• In the water and wastewater treatment processes a long range of electrical components are used – i.e., electrical systems.</li> <li>• The maintenance level of filters, blowers, agitators etc. has a significant effect on energy consumption.</li> <li>• Speed, time and frequency of the operation of the different parts of the systems also have a significant impact on energy consumption, e.g. is the air blower adjusted to the actual demand or is it running at full speed?</li> <li>• In the wastewater treatment process the sludge contains biological material which can be utilized to produce bio methane. Bio methane can be used as a contribution to the thermal energy supply system.</li> </ul>

No.	Technology	Energy efficiency measures
12	Electrical systems	<ul style="list-style-type: none"> <li>• The paper making process involves several electrical components and systems, which can be optimized, considering:               <ul style="list-style-type: none"> <li>- Are motors controlled by inverters instead of gears and belts?</li> <li>- Are systems operating without products or activities? e.g. conveyers without products, lighting without human activities.</li> <li>- Is highly efficient equipment used? e.g. motors, pumps, light, etc.</li> <li>- Is internal transport minimized?</li> <li>- Are switchboards maintained? Maintenance minimizes thermal losses and the risk of failure.</li> </ul> </li> </ul>