# D4.2 - Draft LCA report

**Advanced Sensing Technologies for Paper Production (ASTEPP)**

**CIP Eco-innovation**
**Pilot and market replication projects**

**Call 2013**

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| | |
|---|---|
| **Client:** | **S.A. GIUSEPPE CRISTINI S.p.A.** |
| **Re:** | ASTEPP sensors application Life Cycle Assessment |
| **Description**: | Estimate of environmental loads while creating a paper product using innovative ASTEPP technology and comparing results with current production processes. |
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## CONTENTS

# 1. Introduction

The paper production phase is a high energy-consuming process; to transform the raw material, pulp and water into the semi-finished paper product, huge amounts of water and thermal, electrical and mechanical energy are required.

The ASTEPP sensors, offered by Cristini on the European market, allow some of the main operating parameters of the continuous machines to be monitored, thereby allowing the client companies to distinguish their production process according to the acquired parameters.

Thanks to the monitoring and evaluation of these data, the production process itself can be made efficient by setting the machines correctly. In fact, substantial energy and water savings can be obtained (heat, electricity).

This saving of energy flows and raw material, as highlighted in the analysis of this document, obviously also affects the environmental emissions of the production process itself in a positive way.

Starting with the analysis of the data acquired by Cristini during a series of tests carried out on a continuous paper production line of the OMISS plant, this document indicates the assessment of the improvements on the environmental impacts that occur in the production process of tissue type of paper, if properly monitored and set using the data read by the Cristini ASTEPP sensors.

In particular, as required in the "Project information sheet" guide, issued by Eco Innovation, this document analyses aspects related to:

- ✓ "Reduction on Green House effect Gas emissions (GHG)";
- ✓ "Reduction of water usage";
- ✓ "Reduction of energy consumption".

Note: the OMISS and OMISS companies, which may be cited in this document, form part of the OMISS group. Although some documents refer to one of the two companies, it should be noted that in any case, they form part of a single group.

## 2. Reference documentation

Below are the documents, applicable standards and guidelines that have been used as references when executing this analysis.

| Document code | Name | Issued by |
|---|---|---|
| UNI EN ISO 14040 | Environmental management - Life cycle assessment - Principles and reference framework | UNI |
| UNI EN ISO 14044 | Environmental management - Life cycle assessment - Requirements and guidelines | UNI |
| V2011-06-LCA | The Italian LCA network: Prospects and developments of the life cycle assessment in Italy | ENEA |
| Environmental Declaration Regulation EC 1221/2009 | OMISS OMISS OMISS Paper Mill - Emas - Environmental Declaration | OMISS OMISS OMISS |
| Environmental Declaration Regulation EC 1221/2009 | OMISS OMISS OMISS Paper Mill - Emas - Environmental Declaration - Attached | OMISS OMISS OMISS |
| OMISS OMISS trial#1 15&16.07.2015 | Optimisation study<br>OMISS OMISS TM03 14,15&16/07/2105 | Cristini S.P.A. |
| OMISS Preliminary analysis of process data PresscanFix _2.1 | PresScanFIX<br>Preliminary analysis of process data OMISS OMISS TM2 | Cristini S.P.A. |
| 212/2015 | CO2 atmospheric emission factor and development of renewable resources in the electrical sector | ISPRA |
| - | Present Consumption and Emission Levels of Paper Mills; | INERIS |
| - | An l.c.a methodology for the paper industry. | CAPS |

## 3. Acronyms

Following are the acronyms that may be found in this document.

| | |
|---|---|
| CML | Centrum Milekunde Leiden University |
| ENEL | Italian national authority for electricity |
| GHG | Reduction on Green House effect Gas emissions |
| GJ | GigaJoule |
| GWP | Global Warming Potential |
| KWh | kilowatt hour |
| L | Litre |
| LCA | Life Cycle Assessment |
| LCIA | Life Cycle Impact Assessment |
| LCI | Life Cycle Inventory |
| $m^3$ | Cubic metres |
| Min | Minute |
| t | Ton |

## 4. Brief Introduction of the LCA analysis

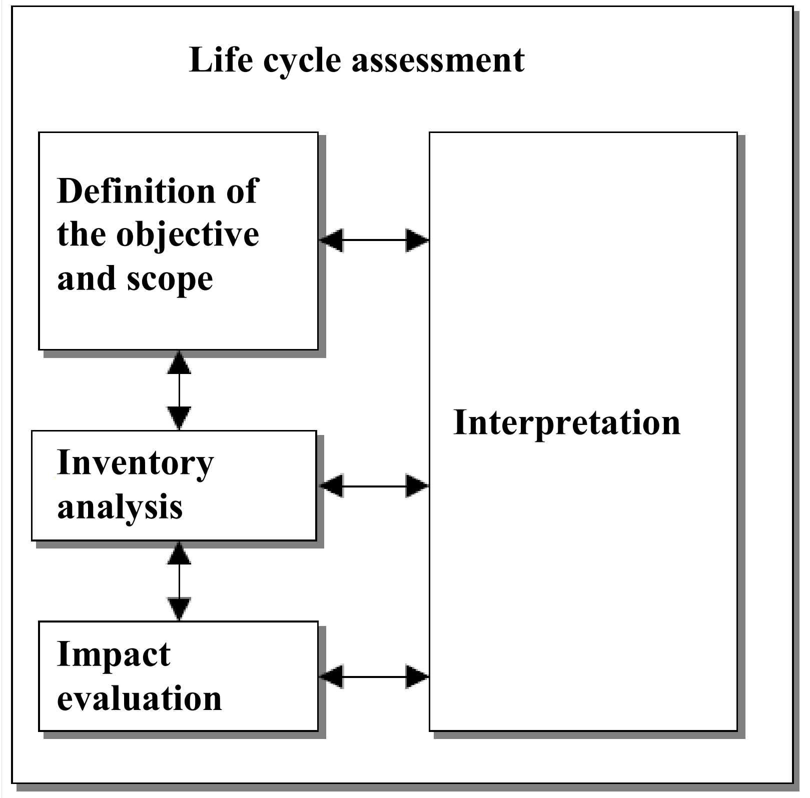
The Life Cycle Assessment is a technique of analysis, whose objective is to estimate the environmental loads of products and services through the evaluation of the life cycle of components or particular phases of use and application. The LCA technique in fact is recognised as one of the "official" methods for the environmental impact assessments. It was created and designed to provide scientific and quantitative information, thereby increasing awareness of the company with respect to the entire life cycle and the use of its devices. The LCA evaluates all the resources and the inputs required to "feed" the system being analysed, from an environmental aspect, and all the output flows from the system itself, that is to say the emissions in air, water and soil, etc. The applications and uses of a Life Cycle Assessment are very varied and can range from the entire life cycle of a product to a single process.

The data on the elementary flows of energy/resources, cover the extraction of raw materials to the disposal/recycling/final recovery of the product being studied.

This study refers to the principles and guidelines of an LCA, applying them to the specific field of analysis, as described in the following chapters.

The LCA analysis consists of 4 basic steps:

1. definition of the objective;
2. inventory analysis;
3. impact assessment (LICIA);
4. final interpretation of the results.

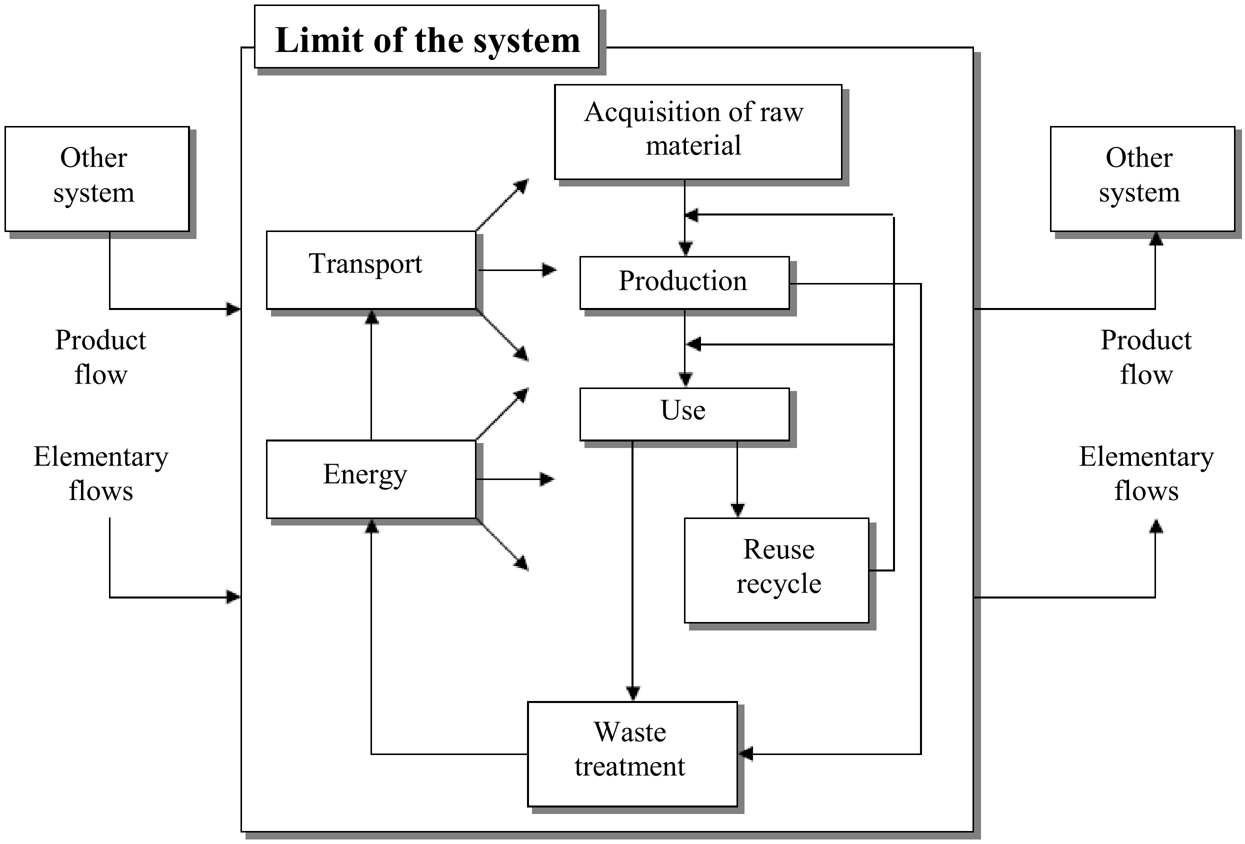


### 4.1. Definition of the objective

This is the first step of the LCA and requires the purposes of the study to be defined together with those of the functional unit, the system limits, recruitment, etc.
The following steps are carried out in this phase:

- Define the reasons and objectives of the analysis;
- Define the intended application;
- Define the limits of the system being studied;
- Define what can be considered as functional units and/or reference flows.

The choice of function and corresponding functional unit is significant on the entire study and the results obtained. The functions refer to the characteristic performance of the product, whereas the functional unit must quantify this performance, relating all the incoming and outgoing flows of material and energy. For example, in the study of a paper mill, the function is the production of paper and the functional unit is represented by a certain amount of paper produced (for example, a ton).
The product system is defined as an elementary set of process units that are interlinked by flows of material, energy and waste.
Under ideal conditions, the product system should be configured for the incoming and outgoing elementary flows (when materials and energy enter and leave the defined system without any prior transformation made by man).
The limits of the product system determine the process units to be included in the study and are determined by the assumptions used, the constraints due to the sources of the data and the scope of the analysis.




The system in turn is divided into process units, which are also interconnected by intermediate flows of material and energy and flows of waste to be treated. The product system can also be connected to another product system by flows of products and with the environment by elementary flows.

## 4.2. Inventory analysis

Data collection, their measurement and processing helps quantify inputs and outputs of each process unit. The most important categories in which data should be classified are:

- input of energy, raw materials, secondary support material, etc.;
- products;
- emissions in air, water, soil and other environmental aspects.

The data must have suitable quality requirements to support the LCA study. They are obviously inventory data that give accuracy and objectivity to the analysis. The following requirements should be considered during the data collection and sampling:

- temporal coverage, that is the age of the data and the duration of their collection;
- geographical coverage, that is the area where data will be collected;
- technological coverage, that is the technology to be applied in the data collection.

## 4.3. Evaluation of the impacts

The evaluation of the impacts in an LCA study is the phase in which the relevance of the environmental impacts is evaluated, associating inventory data with specific impacts and deepening the study. The level of detail, the impacts that are to be evaluated and the methods used, depend on the objective and the scope.
The evaluation generally consists of three steps:

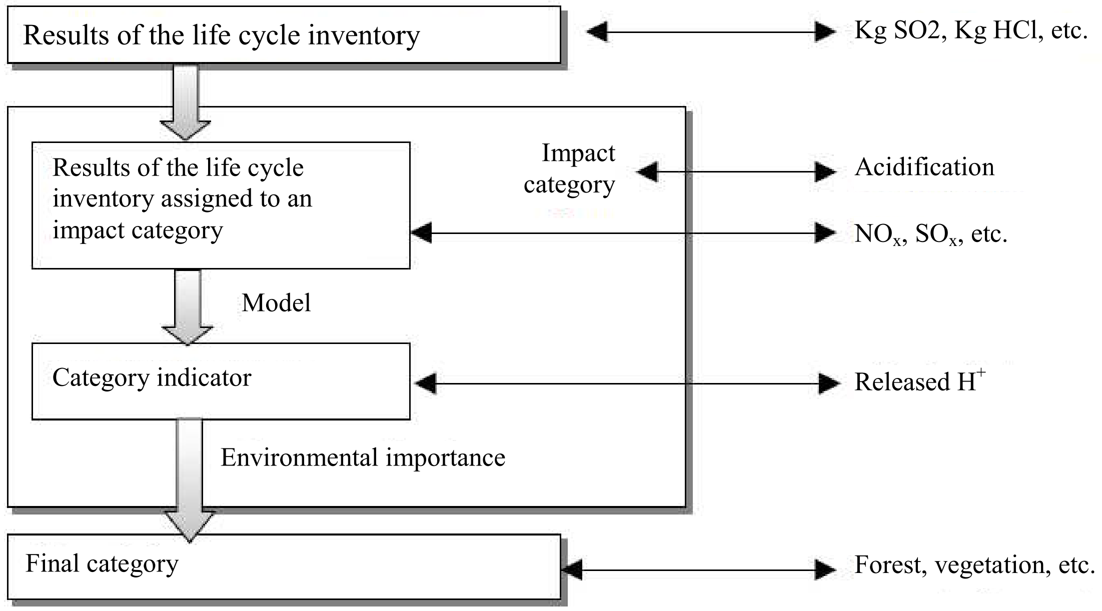
- classification, in which the inventory data are attributed to the individual impact categories;
- characterisation, in which the data within each category are weighed;
- normalisation, in which the impact categories are weighed.

It is important to consider that the evaluation is influenced by a certain amount of subjectivity in the choice of impact categories as well as, but especially, in the characterisation and weighting.

Classification is the phase in which the inventory data of the life cycle are distributed in the various impact categories. Each input and output can be included in one or more impact category and the choice depends on the objective of the study.

During characterisation, the environmental impact of the data obtained during the inventory phase is analysed and quantified, and aggregated in the impact categories with the classification. The result of the calculations is a numerical indicator, called a category indicator. The usefulness of the results of the indicators depends on the accuracy, validity and characteristics of the characterisation factors and models. The indicator results are calculated by using characterisation factors to convert the results of the inventory, assigned to the impact categories, in common units.

The results of the indicators are normalised by attributing a weight to the various data within the same impact category, in order to highlight the relevance of each result of the indicator, relative to a given reference flow.
In practice, the procedure transforms the result of the indicator by dividing it by a selected reference value.



Results of the life cycle inventory
Kg SO2, Kg HCl, etc.
Results of the life cycle inventory assigned to an impact category
Impact category
Acidification
NOx, SOx, etc.
Model
Category indicator
Released H+
Environmental importance
Final category
Forest, vegetation, etc.

## 4.4. Conclusions

The interpretation of the life cycle is the final phase of the LCA, which summarises and discusses the results of the inventory phase and assessment of the impacts. The aim is to draw conclusions and recommendations in order to make decisions in accordance with the objective and the scope of the study.
Significant aspects can be:

- the inventory parameters such as energy use, emissions, waste, etc.;
- the indicators of the impact categories such as use of resources, potential increase in temperature (GPW), etc.;
- the essential contributions so that the life cycle stages provide the results of the inventory or impact evaluation, either as an individual process unit or process groups, in terms of energy production and transport.

There are a variety of specific approaches, methods and tools to identify the environmental aspects and to determine their meaning.

# 5. ASTEPP sensors

## 5.1. Definition of the objective - ASTEPP Sensors

In this analysis, starting with the data obtained by Cristini and those published by OMISS (see Chapter 2 - Reference documents), the evaluation of possible improvements has been carried out in terms of environmental impact and the ASTEPP sensors could lead to the paper production process. In particular, the improvements that can be obtained by monitoring the construction process by means of the sensors being analysed have been evaluated and by optimising the operating parameters of the production line of a paper mill.

Considering that Cristini ASTEPP sensors do not alter the quality of the final product or the chemical-physical characteristics of the product itself and the waste products of the production line in any way, and do not either alter the paper production process (limited to allowing for the optimisation of some operating parameters, which are normally "set" according to the operator's decisions and therefore, are totally subjective), it has been decided to consider the environmental analysis of OMISS concerning its plant in OMISS as the starting data and in particular, the following documents have been used:

- OMISS OMISS Paper Mill - Emas - Environmental Declaration OMISS OMISS;
- OMISS OMISS Paper Mill - Emas - Environmental Declaration - OMISS OMISS Attached.

It is important to note that the analysis presented here is not intended to quantify all the individual contributions during the life of the "paper" product in terms of impacts on the environment, but in fact, only possible improvements are highlighted, which the ASTEPP sensors allow, limited to their operation and application, as detailed in the following chapters (Ref. 5.1.2 Limits of the system).

In order to quantify these improvements in terms of environmental impacts, it has been decided to analyse the process and to characterise the impacts through the typical CML model of the LCA analyses. In fact, the CML methodology provides results according to known impact categories measured in equivalent substance units.

### 5.1.1. Functional unit

This work considers the industrial production of tissue paper, that is paper produced to be normally used for sanitary purposes. The production of paper is defined as a function of the industrial system, whereas the functional unit is represented by a certain amount of paper produced, specifically a ton.

The composition and the main characteristics that define the paper relative to the functional unit in question are described below (a ton of paper produced).

| Characteristics | Values |
|---|---|
| Mixture | 50% short fibre<br>50% long fibre |
| Weight | 16.2 $g/m^2$ |
| Humidity | 5% |

**Table 5-1 - Features of the functional unit**

### 5.1.2. Limits of the system

The process of production of the tissue paper within a paper mill is performed by the manufacturing lines, commonly called continuous lines, which manage the step of complete realization, from the entrance of the pulp in the plant up to the exit of the finished product from the pope. Cristini ASTEPP sensors monitor a sub-step of the production process within the continuous line.

The limits of the system referred to in the study include a sub-step of the production system of the tissue paper. In particular, the productive sub-system is analysed from when the mixture of water and pulp, previously prepared and refined, is sprayed on the sheet, to the output phase of the finished product (pope roller area).

The analysis therefore, is gate to gate type and only considers that which remains within the gates of the company and the identified system, excluding the upstream and downstream stages of the process and the procurement and distribution of the product.

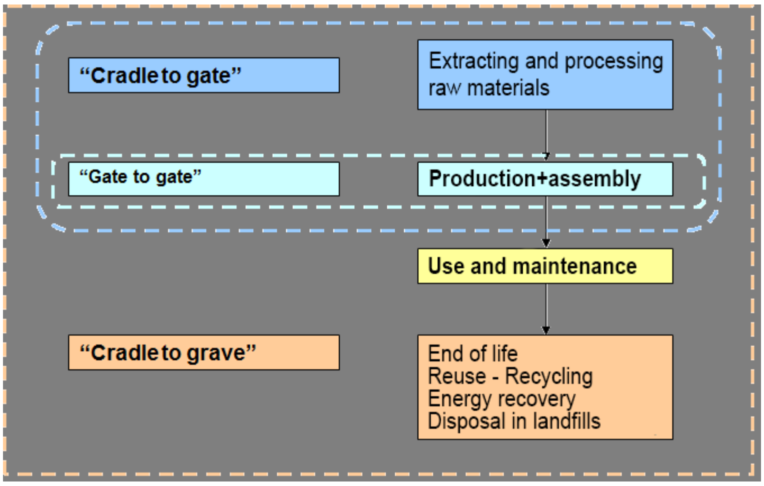



**Figure 5-1 – Settings of the limits of the system**

Energy/raw material/emission flows, relating to the auxiliary systems of the process in question are included in the product system, with reference to the data published by OMISS for the years 2011, 2012 and 2013 and relevant to the aspects on the "Reduction on Green House effect Gas emissions (GHG)", "Reduction of water usage" and "Reduction of energy consumption".

The limits of the system do not include:

- Production pulp, additives and fuels ancillary to the process;
- Production of packaging and transport;
- Use;
- Recycling/disposal of paper, of waste and of any residue in the production process of the continuous line;
- All the activities upstream and downstream of the process being examined.

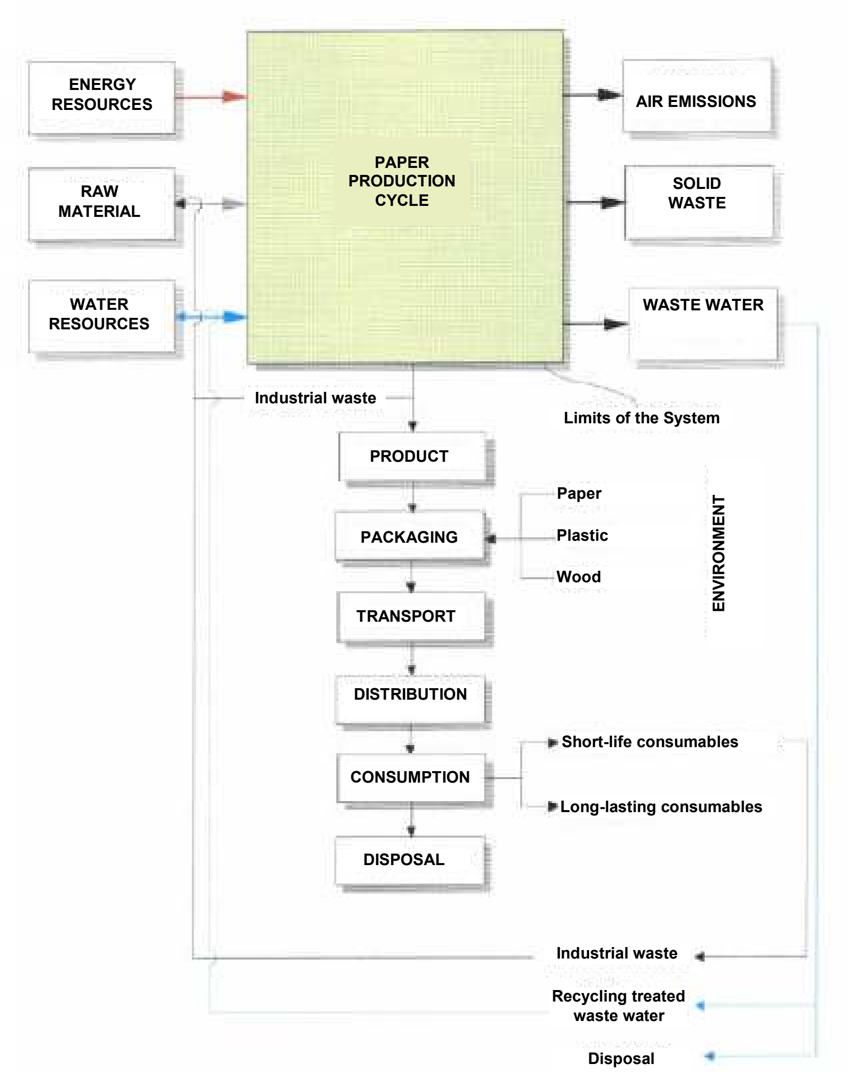



**Figure 5-2 –Paper production system**

## 5.2. Inventory analysis - ASTEPP Sensors

The data that are generally used in an LCA type of study can be divided into primary and secondary data.

The words "primary data" refer to all the data collected on site and which guarantee the best level of representativeness of the analysed system.
In this case, the primary data were taken directly on site by Cristini, at the STOFFAS plant in OMISS. In particular, these data relate to the operation of continuous machines called TM02 and TM03.
Primary data have time references to 2015.

"Secondary data" refers to data that are used to complete the analogue model of the system and that are retrieved from databases or from studies that have been carried out previously and published.
Specifically, secondary data are published by OMISS in the Environmental Declaration for the plant in OMISS and those related to the generation of electricity published by ISPRA (the Italian Institute for Environmental Protection and Research).

Note: secondary data used refer to the period 2011-2013. It was not possible to use more recent data as they are not yet available.

Refer also to chapter 2 Reference documentation of this document for a list of reference documents.

### 5.2.1. Input data

The flows of energy and materials within the product system have been reconstructed with reference to data published by OMISS OMISS on its own plants, for the years 2011, 2012 and 2013 (and part of 2014, which were not considered as they were partial).
In particular, the data related to water, electricity and methane consumption are basic.
With reference to OMISS publications, it is possible to identify that the paper production in the premises was equivalent to:

| Reference year | Production (t) | Average hourly production (t/h) |
|---|---|---|
| 2011 | 115361 | 13.1 |
| 2012 | 114819 | 13 |
| 2013 | 118917 | 13.5 |

**Table 5-2 - Average production of tons of paper**

The following documents were used as a reference to obtain the missing data on the emissions and flows:

- INERIS - Present Consumption and Emission Levels of Paper Mills;
- Caps - An l.c.a methodology for the paper industry.

The inventory data are also shown in the subsequent analysis sections where they are used to evaluate the impacts from the use of ASTEPP sensors and the subsequent optimisation of the production process.

## 5.3. Evaluation of the impacts - ASTEPP sensors

### 5.3.1. Energy Flow

Inside the plant, during the normal production process, the continuous line consumes large amounts of electricity and thermal energy (high energy-consuming process). The thermal energy, resulting from the use of methane, is basically used to dry the paper, whereas the electricity, in part purchased and in part self-produced, supports the various stages of the processing cycle.

#### 5.3.1.1. Methane

Please note that the secondary data published by OMISS indicates that the total consumption of methane was:

| Reference year | Methane consumption (GJ) | Specific consumption $(GJ/t)$ |
|---|---|---|
| 2011 | 1217285 | 10.55 |
| 2012 | 1162002 | 10.12 |
| 2013 | 1256439 | 10.57 |

**Table 5-3 – Average methane consumption**

This flow of methane is used to produce electricity via gas turbines and to produce heat via specific burners.

From the data acquired in the field by Cristini it is noted that, by monitoring the production process by means of the ASTEPP sensors and making the appropriate adjustments of the operating parameters of the continuous machine, the contribution of the methane flow to the auxiliary burners to the hoods can be reduced.

Specifically, savings of about 5 $m^3$ of burnt methane per ton of paper produced have been highlighted, equivalent to 0.175 $GJ/t$ (48.61 $KWh/t$)

These savings, correlated to the data published by OMISS, would have an impact of:

| Reference year | Methane savings |
|---|---|
| 2011 | 1.66% |
| 2012 | 1.72% |
| 2013 | 1.65% |

**Table 5-4 – Methane savings thanks to the use of ASTEPP sensors**

#### 5.3.1.2. Electricity

The analysis of the data published by OMISS shows that overall, the system has a specific consumption of 914.14 KWh/t (an almost constant data over the years), of which:

| KWh/t | Source |
|---|---|
| 576.9 | GAS TURBINES |
| 324.8 | ENEL |
| 12.4 | SOLAR PANEL |

**Table 5-5 – Source of electricity**

Note: The values of the electricity produced by the solar panels and gas turbines are considered self-producing directly in the plant.

The field data have shown that, using a suitable setting of the continuous machine, some utilities can be turned off so as to help the process, thereby saving about 400 KWh.

Presumably, and also logically, since energy can be saved, the manufacturer may decide to buy in smaller quantities, and these savings are to be deducted from the single value purchased externally, thereby reducing the ENEL share by about 31 Kwh/t, i.e. 9.45% and the total value of electricity required by 3.35%.

#### 5.3.1.3. Energy consumption

The plant data analysis published by the client company, OMISS, indicates total energy consumption shown in the selected functional unit (tons of paper) equivalent to:

| Reference year | Total methane consumption $(KWh/t)$ | Total Electricity consumption $(KWh/t)$ | Total Energy consumed $(KWh/t)$ |
|---|---|---|---|
| 2011 | 2930 | 914 | 3884 |
| 2012 | 2811 | 914 | 3725 |
| 2013 | 2936 | 914 | 3850 |

**Table 5-6 – Total energy consumption**

Energy savings via ASTEPP.

The following table shows the values of total energy consumption that can be achieved by using Cristini ASTEPP sensors. The values are obtained by subtracting the overall energy savings from the total consumption shown in the table on the previous page, as described in the previous paragraphs (both for the consumption of methane and electricity).

| Reference year | Total methane consumption (KWh/t) | Total Electricity consumption (KWh/t) | Total Energy consumed (KWh/t) |
|---|---|---|---|
| 2011 | 2881 | 883 | 3764 |
| 2012 | 2762 | 883 | 3645 |
| 2013 | 2887 | 883 | 3770 |

**Table 5-7 – Average consumption by means of optimisation with ASTEPP sensors**

As a percentage, therefore the following annual energy savings can be quantified:

| Reference year | Energy Savings |
|---|---|
| 2011 | **3%** |
| 2012 | **2.15%** |
| 2013 | **2%** |

**Table 5-8 – Energy savings thanks to the ASTEPP sensors**

### 5.3.2. Air emissions

The air emissions must be identified in order to evaluate the degree of reduction of the "Green House effect Gas emissions (GHG)" that ASTEPP system use has on the paper production process.

Part of the air emissions derive directly from the production process and partly from the use of electricity generated by non-renewable sources.

With reference to the data published by ISPRA for 2011-2013, the following values of $CO_2$ can be obtained, equivalent to:

| Reference year | $Kg(CO_2)/Wh$ |
|---|---|
| 2011 | 0.00039 |
| 2012 | 0.00038 |
| 2013 | 0.00033 |

**Table 5-9- $CO_2$ Emissions**

From which, in turn, one can derive the amount of $CO_2$ associated with each ton of paper produced (final reference unit of the analysis) considering only the energy acquired by the body (ENEL):

| Reference year | $Kg(CO_2)/t$ |
|---|---|
| 2011 | 135 |
| 2012 | 126 |
| 2013 | 108 |

**Table 5-10 – $CO_2$ emissions due to the electricity acquired**

These data, with reference to the electricity alone, which OMISS purchases from ENEL to produce one ton of paper, must be added to the equivalent $CO_2$ contributions produced directly by OMISS during its normal production cycle (due to the combustion of methane, in terms of the generation of electricity and the production of heat, as well as the powder of pulp produced).

The OMISS data lead to the following values by correlating the values to the reference unit (ton of paper produced):

| Reference year | $Kg(CO_2)/t$ | $Kg(CO)/t$ | $Kg(NO_X)/t$ |
|---|---|---|---|
| 2011 | 588 | 0.35 | 0.81 |
| 2012 | 564 | 0.43 | 0.60 |
| 2013 | 604 | 0.42 | 1.36 |

**Table 5-11 – Emissions in the environments of the OMISS premises**

#### 5.3.2.1. Impact category GPW100

As indicated in the reference documents, the Global Warming Potential is the impact category to be considered: Global warming potential calculated in 100 years (GPW100). GWP100 expresses the global warming caused by gas emission into the atmosphere. The index is based on a relative scale which compares each gas with the carbon dioxide, whose GWP is defined as value 1.

Therefore, correlating all the data reported in the previous paragraph is in $CO_2$, according to the above indexes, and summing the input contributions from electricity purchased by OMISS and its own input of the company production process will obtain the following total values (always correlated with the selected functional unit):

| **Reference year** | $Kg(CO_2)/t$ |
|---|---|
| 2011 | 727.4 |
| 2012 | 693.4 |
| 2013 | 719.2 |

**Table 5-12 – Emissions in a total environment**

Comparing these data with those obtained from optimisation of the process using ASTEPP sensors will result in this resource having generated an improvement in terms of global warming.

In particular, considering the noted energy savings result in a reduction of the emission of $CO_2$ equivalent to:

| Reference year | $Kg(CO_2)/t$ |
|---|---|
| 2011 | 12.1 |
| 2012 | 11.8 |
| 2013 | 10.4 |

**Table 5-13 – CO2 savings related to the electricity consumption**

Considering the noted savings in methane in the burner, a reduction of $CO_2$ approximately **10** $\mathbf{Kg(CO_2)/t}$ is obtained (in fact, 1 $m^3$ of burned methane gives rise to 1.95 kg of $CO_2$)

In brief, based on the above evaluation, one can assume that using Cristini ASTEPP sensors would have allowed for optimisation of the relevant production process, resulting in a reduction of $Kg\,(CO_2)/t$ emitted into the atmosphere equivalent to:

| Reference year | $Kg(CO_2)/t$ | % on the total |
|---|---|---|
| 2011 | 22.1 | 3 |
| 2012 | 21.8 | 3.1 |
| 2013 | 20.4 | 2.8 |

**Table 5-14 – Reduction of CO2 produced thanks to the use of ASTEPP sensors**

### 5.3.3. Water flows

The paper mill data published by OMISS show that the water drawn from wells and the industrial water system was 802863 $m^3$ in 2011, 731087 $m^3$ in 2012 and 701515 $m^3$in 2013. These data, correlated with production and therefore, the selected functional unit, indicate a specific consumption (l/t paper produced) equivalent to:

| Reference year | $l/t$ |
|---|---|
| 2011 | 6960 |
| 2012 | 6370 |
| 2013 | 5900 |

**Table 5-15- Specific water consumption**

The analysis of data published by OMISS determined that the water discharged from the plant was 458101 $m^3$in 2011, 414906 $m^3$in 2012 and 384684 $m^3$in 2013.
These data, always correlated with the functional unit of the ton of paper, indicate a specific consumption (l/t paper produced) equivalent to:

| Reference year | $l/t$ | % on the total |
|---|---|---|
| 2011 | 3970 | 57 |
| 2012 | 3610 | 56 |
| 2013 | 3230 | 54 |

**Table 5-16 – Discharged water**

From primary data obtained during the series of tests carried out on the plant equipped with the ASTEPP system, water savings of 300 l/min were established which, in terms of the functional unit, correspond to 1384 l/t.

In order to assess the actual water savings that the system would have on the cycle it is important to understand the water flow in the paper mill process in question (see image below).

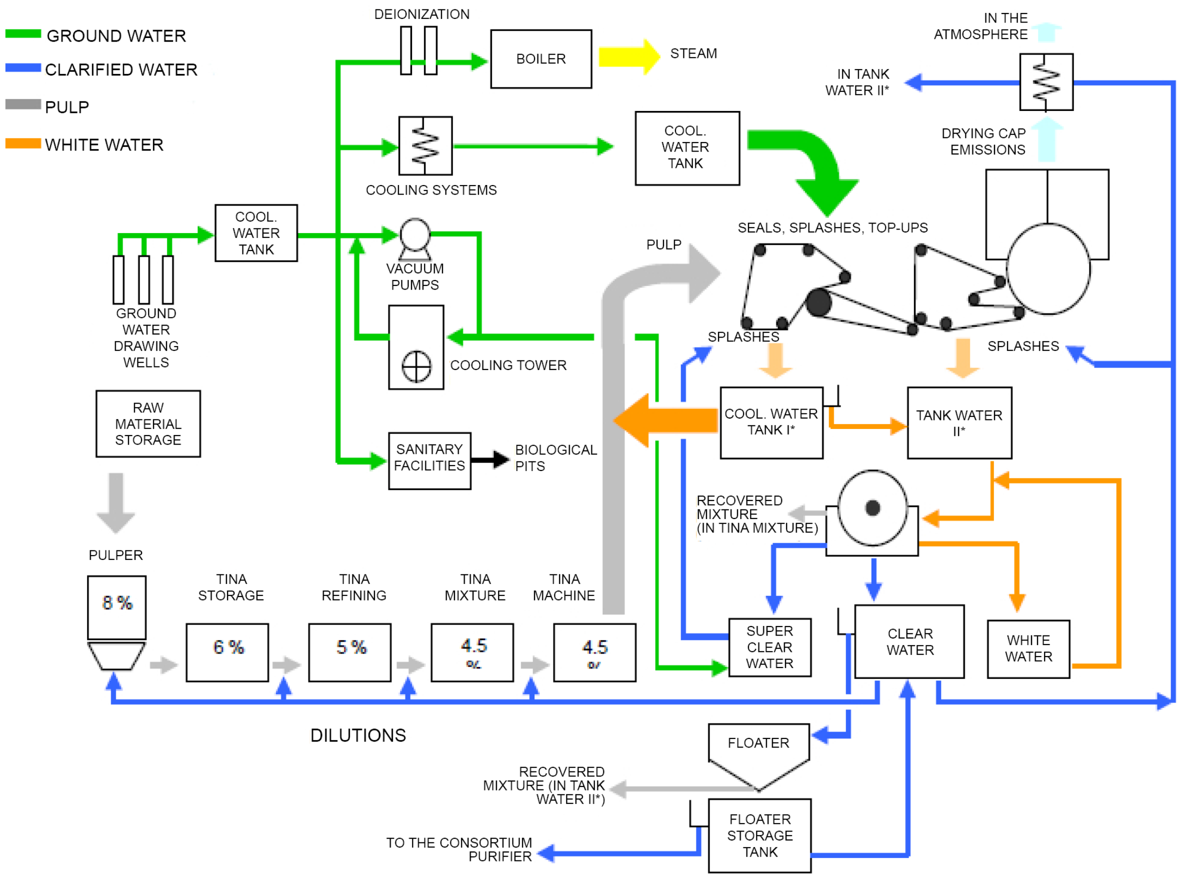



**Table 5-17 – Paper mill water flows**

In practice, the fresh water, drawn from wells/water supply is primarily used for the pump seals, for the production of steam, and for other services of various nature. While using the continuous machine, the water lost during the production process must be topped up, essentially for the following reasons

- evaporation while the paper is dried;
- residual moisture in the finished product;

- water not recoverable after the clarification treatments.

As the process water is removed from the paper, it is recovered and sent to the clarifier to then be used again in the mixture.

In view of the above, it is important to note that the water saved due to optimisation of the process using the ASTEPP system is fresh water. Therefore, considering the above listed values of saved water, and carefully assuming a recovery of this water in the process, following clarification, equivalent to 80%, it can be assumed that 60 l/m are the actual amount of water that can be saved by optimising the production process using ASTEPP sensors, equivalent to 277 l/t.

Therefore, the following results will be obtained by correlating the total water consumption indicated by OMISS with the values of saved water using ASTEPP sensors:

| Reference year | % of saved water |
|---|---|
| 2011 | 4% |
| 2012 | 4.3% |
| 2013 | 4.7% |

**Table 5-18- Reduction of water consumption thanks to the ASTEPP sensors**

## 5.4. Conclusions - ASTEPP sensors

Following the analysis, the monitoring of the paper production process, guaranteed by the sensors of Cristini S.p.A. called ASTEPP, allows the operators to better set the operating parameters of the paper production lines, thereby reducing the energy consumption and the environmental impacts.

It is evident that the operator, who operates without the support of the measurements and data provided by the ASTEPP sensors, has no guidelines and information on certain operating parameters of the production line. The company Cristini therefore, highlighted the impossibility of having a perfect setting of the machine and of the production process.

To date, the settings of the continuous machine, in particular those that modify these parameters, are set according to the sensibility and experience of the operator, according to sensation and knowledge. In fact, during the data collection and testing, the company Cristini could directly note how each operator set these values in a personal way and therefore, different from other operators.

In conclusion, the analysis showed that it is possible to use the production system by adjusting the operating parameters of the continuous line based on objective technical information provided by ASTEPP sensors and not on personal sensations or subjective parameters.

It is also important to emphasise that optimisation of the energy consumption of the continuous line using the ASTEPP sensors does not affect the quality and/or quantity of the final product in any way.

Below is a summary of the advantages in terms of energy savings and the environmental impact that Cristini ASTEPP sensors can achieve. In particular, as required in the "Project information sheet" guide, issued by Eco Innovation, this document highlighted aspects related to:

- ✓ "Reduction of energy consumption";

The results obtained have shown a reduction in energy consumption of 31Kwh per ton of paper produced, which correlated to the three years in question for the OMISS premises, would lead to a savings rate of:

| Reference year | Energy Reduction |
|---|---|
| 2011 | **3%** |
| 2012 | **2.15%** |
| 2013 | **2%** |

- ✓ "Reduction on Green House effect Gas emissions (GHG)";

The analysis results have shown a reduction in the amount of $CO_2$ produced equivalent to 10 kg per ton of paper produced which, correlated to the three years in question for the OMISS premises, would lead to a savings rate of:

| Reference year | GHG Reduction |
|---|---|
| 2011 | **3** |
| 2012 | **3.1** |
| 2013 | **2.8** |

✓ "Reduction of water usage".

The analysis results have shown a reduction in the amount of water used equivalent to 1384 l per ton of paper produced which, correlated to the three years in question for the OMISS premises, would lead to a savings rate of:

| Reference year | Water Usage |
|---|---|
| 2011 | 4% |
| 2012 | 4.3% |
| 2013 | 4.7% |