CHALMERS

Methodology for handling forest industry environmental data

Manual

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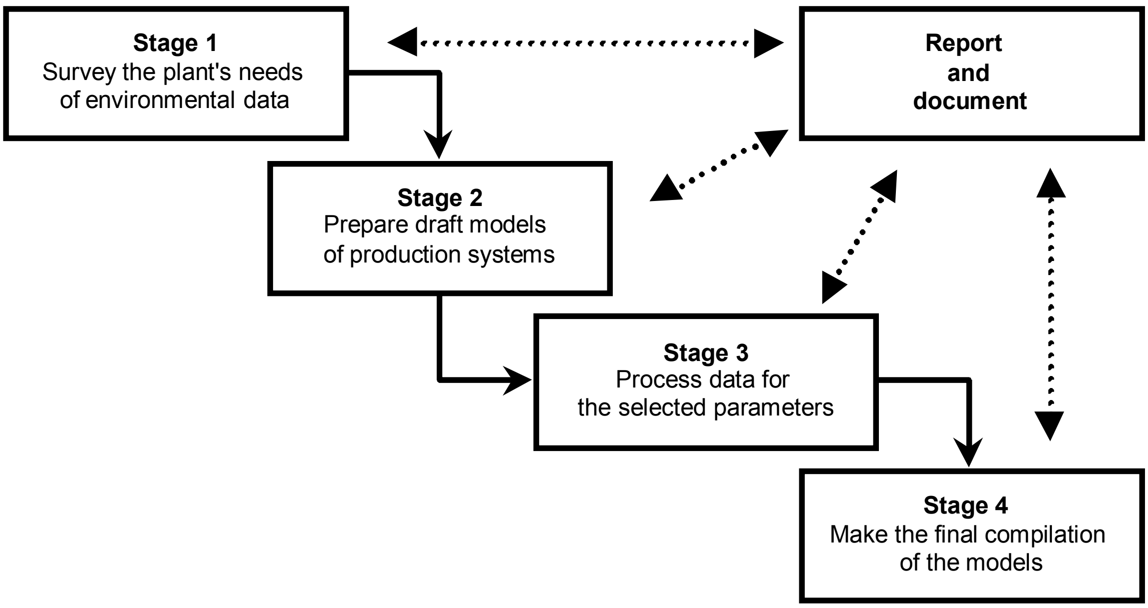

Prepared in collaboration between
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SSVL CPM CHALMERS

Foreword

This manual has been developed in the project " Methodology for handling forest industry environmental data", which was performed during the years 2000 to 2002. The project was financed by the Swedish forest industry through the Swedish Forest Industries Water and Air Pollution Research Foundation (SSVL). The participating companies financed their participation through their own internal funding and through in kind resources within CPM. The project was managed by CPM (Center for Environmental Assessment of Product and Material Systems) at Chalmers University of Technology in Gothenburg, Sweden.

The following material is available from the project:

- Pålsson A-C, et al. "*Methodology for handling forest industry environmental data – Method report"*, CPM-report 2005:1 (both Swedish and English version is available)
- Pålsson A-C, et al. *"Methodology for handling forest industry environmental data – Manual",* CPM-report 2005:2 (both Swedish and English version is available)
- Pålsson A-C, et al. *"An industry common methodology for environmental data management"*, Presented at SPCI 2002, 7th International Conference on New Available Technologies, June 4-6, 2002, Stockholm

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Content

Introduction

This manual describes a methodology for handling and reporting of environmental data at production plants in the forest industry.

The purpose of the methodology is to:

- allow for the compilation of a common database for the industry
- quality assure environmental data management
- simplify and co-ordinate the production plants' compilation of environmental data for different needs, such as basis for life cycle assessment, environmental labelling, environmental reporting and reporting to authorities.
- facilitate communication of environmental information to customers and other stakeholders
- set an industry standard for handling of environmental data

A full description of the methodology is found in the report entitled "Methodology for handling forest industry environmental data – Method report".

This manual and the method report is also available in Swedish.

Explanation of certain concepts used in the manual

Parameter

A measurable property of the technical system, which may cause environmental impact. Also referred to as an indicator (ISO 14031[1]). Please refer to appendix 2 for examples of relevant parameters.

Measurement system

Measurement equipment or calculation model/estimate for determination of one or several parameters in a production system.

Environmental data

Environmental data refers to data which describes the input and output flows of an activity. Examples of input and output flows that may cause environmental impact are the use of raw materials, emissions to air and water, waste and products which leave the system

Model of technical system

A model of a technical system in this context is a compilation of environmental data for a defined part of an activity, such as an individual process step, a department, a production line or an entire production plant

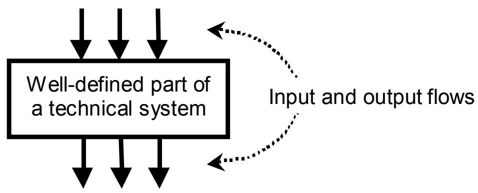


Figure 1. Model of a technical system

Different models are used for different purposes. Examples of models that are handled in a production plant are:

- *Activity and process related models*
  Reports the environmental impact of an activity or a process. This type of model is used as basis for annual environmental reporting, process optimisation etc..
- *Product related models*
  Reports the environmental impact for the production of a selected product. This type of model is used as basis for life cycle assessment, environmental labelling, product development etc.

[1] ISO 14031:1999 Environmental management - Environmental performance evaluation - Guidelines

This manual only describes how product related models are constructed.

Models of technical systems can be *simple* or *composite* (please refer to fig. 2). The difference between them is that a composite model consists of several simple models.

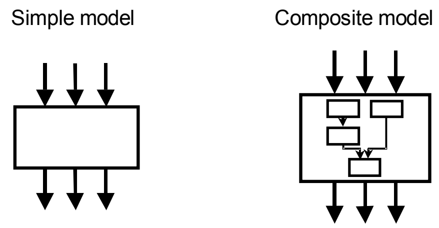


Figure 2. Simple and composite models of a technical system

Production system

Technical system (e.g. a production plant), that is required to produce a specified product or group of products. A production system can be constructed as a simple or a composite model.

Allocation

Allocation means partitioning the input or output flows of a unit process to the product system under study (defined as in ISO 14040[2]). Environmental impact sometimes has to be allocated between different processes or products. For example, it may be necessary to do an allocation if a measuring system only measures the total flow of steam which is then used in several processes, or where one process produces several products. Please also refer to appendix 7.

[2] ISO 14040:1997(E) Environmental management - Life cycle assessment - Principles and framework

Brief summary of procedures for introducing the methodology

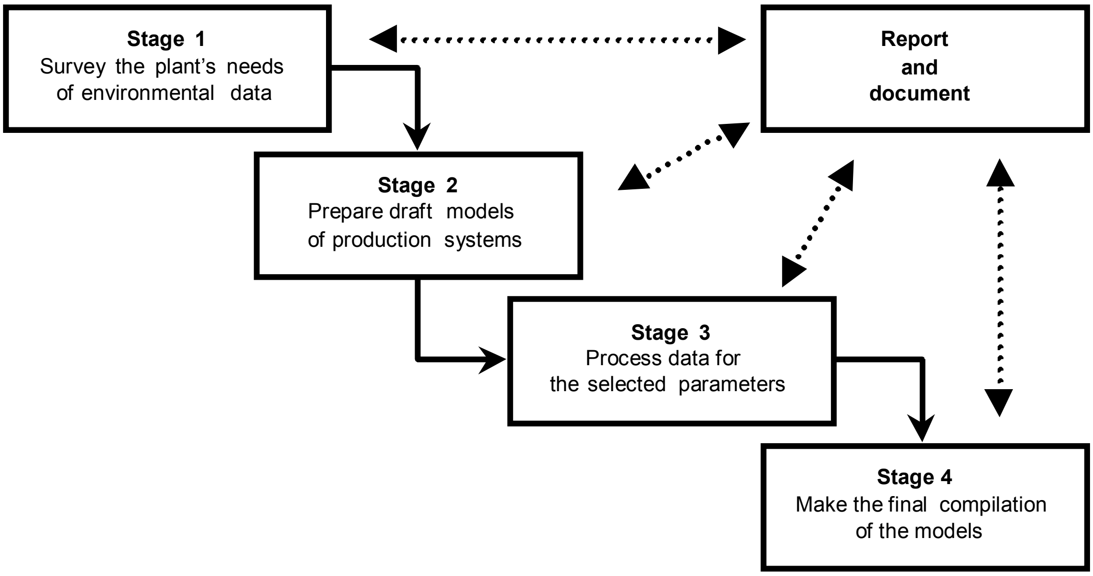


Figure 3. General outline of the implementation

Stage 1

Identify and survey the plants' needs of environmental data to satisfy different stakeholders.

Stage 2

Prepare first drafts of models describing the production system for selected products or product groups. In the work the production system is defined, i.e. the processes included in the production of the selected products/product groups are identified. Relevant parameters for the system are also selected here (raw material consumption, energy used, emissions to air and water etc.). Please refer to appendix 2 for examples of relevant parameters.

Stage 3

Process data for the parameters included in the models. This includes identification of measurement systems, acquisition and compilation of measurement values. Both physical measurements and calculation models can be used.

Stage 4

Do the final compilation of the models, including any final changes, using the information prepared in the previous stages.

Report and document

Documentation of how data has been collected is needed for *quality assurance of data*. The documentation facilitates the work of following up and updating. For this reason, the following questions must be addressed at each stage:

- What tasks are done in the activity (for example within ISO 14001 and ISO 9001 management systems)? What routines and instructions are established? How well is this documented? Does reporting of information and data function correctly?
- What functions (departments, personnel etc.) are affected at each stage?
- Are new routines and instructions needed for tasks, which are not done in the existing operations? Do new reporting paths need to be established?

Full description of implementation

Stage 1
Survey the plants' needs of environmental data

Work description

This stage surveys the needs for environmental data in the plant. This survey is used to prioritise and guide continued work.

The survey is intended to provide an overview of which compilations of environmental data that are needed, i.e. which models that need to be handled, and how the information is reported to the stakeholders. Appendix 1 contains an example of how the results of such a survey could look like.

Procedures

The reporting needs shall be identified and the following questions shall be answered:

- *Which stakeholders request environmental data?*
  Within the production plant, company group, industry associations, customers, public authorities, suppliers, environmental organisations etc.
- *What types of compilations of environmental data are requested?*
  What present and any future requirements are there for product related and/or process/activity related environmental data? Are historical data or forecasts asked for?
- *What information needs do the stakeholders have?*
  What specific requirements do stakeholders have on the information?

In this work, it is generally practical to systematically identify who the stakeholders are and what their specific needs of information are. A production site (a mill) may report environmental information to a number of stakeholders, e.g:

- *Authorities*
  E.g. local authorities, national EPAs and EU. What information is regulated by laws and other requirements?
- *Internal use at the mill*
  What information is used internally at the mill for environmentally sound product development, process survaillance, informing staff etc.
- *Within the company group*
  E.g. environmental and/or communication departments, that compiles internal benchmarkings and the group's environmental statement.
- *Customers*
  Who are the important customers requesting environmental information, and what is

that information used for, e.g. supplier evaluations, communication with their customers/stakeholders.

- *Bransch organizations*
  E.g. SSVL, the forest industries and ÅF-IPK and what is that information used for (averages, benchmarking etc.)?
- *Environmental Non-Governmental Organizations (ENGOs)*
  Is there any cooperation with ENGOs that calls for exchange of environmental information?
- *Suppliers*
  Is there any cooperation with suppliers of chemicla products, energy, wood etc. that calls for exchange of environmental information?

The different stakeholders generally have specific demands on content and format for how the environmental information shall be delivered, for example regarding system boundaries, parameters etc. The information is normally presented using one or more of the tools presented in table B1.2 in appendix 1. The table also shows some of the demands describing how the environmental information is presented. An overview of which environmental tools are used to meet the different stakeholders' information needs is given in figure B1.1 in appendix 1.

Stage 2
Prepare draft models of production systems

Job description

In this stage:

- The production system for selected products or product groups shall be delimited and relevant parameters shall be selected. The results will be the first draft for a model of the production system.
- routines shall be set up and documented for the work of compiling, updating and reporting the models

The models that are defined in this stage form the basis for the work in the following stages.

In the models that are constructed, *the activities that are controlled by the plant* should only be included in the first instance. At a later stage, the models can be enlarged to also include adjacent plants owned by another company, such as a combined heat power generation station on the factory site y or production of purchased raw material (such as chemicals, pulp and recycled paper) and energy.

Requirements on data for the selected parameters should also be specified here. *The actual compilation of data for input and output flows* for the models will however not be handled until the next stage of implementation.

At the time of writing (December 2001) an on-going project within the forest industry aims at compiling a guideline for how environmental data ought to be presented to achieve comparability between different production sites. In this project recommendations are developed on how product groups and system boundaries should be defined, which parameters should be presented, allocation procedures etc. For more information about the work, please contact Ola Svending at Stora Enso Environment (e-mail: Ola.Svending@StoraEnso.com).

Note:
The description in this manual is focused on *product related models*, but can also be used for preparation of process- and activity related models.

It can be necessary to define different models for different stakeholders, depending on different requirements for content, system boundaries etc.

Choice of approach when modelling a production system

The production system can either be described by a simple model or a composite model. The type of model chosen depends on what the model is to be used for, what the process looks like, number of functions/products etc.

A balance should be struck in the work, between the work needed to construct the models and what the models are to be used for. It is generally practical to construct models by making a first draft, testing whether it works, and then refine it as necessary.

- ***Simple models are suitable for:***
  - Finding an average of the total production.
  - Providing specific product information when it is practical to do an allocation.

  Advantages: Only one model to handle, small risk of calculation errors since total values for the plant are used.

  Disadvantages: Less flexible. The entire model has to be updated when minor process changes are made. Allocation problems can occur, when different products do not go through the same process stages or when they have large differences in resource consumption and environmental impact.

- ***Composite models are suitable for:***

  - Preparing information when several products or product groups are produced in the same plant.

  - Following up the proportion of different process steps in the total environmental impact.

  - Modelling how changes in e.g. the process affect the environmental profile of a product or a process.

  <u>Advantages:</u> Flexible, easy to create new composite models for different types of compilations, using models constructed for sections of the process. Some allocation problems can be avoided. When process changes are made, only the model that describes this process needs to be updated.

  <u>Disadvantages:</u> Can be difficult to define sub-systems/models and to determine the flows between the sections of the process of which the model is constructed. Risk of calculation errors since the result is calculated from data for input and output flows for the included models.

Procedure

A description of the procedure for constructing the production system as a simple model and as a composite model is given below.

Composite model

When the production system is described as a composite model, a flow chart is first constructed, using the included process components. Then simple models of the identified process components are constructed.

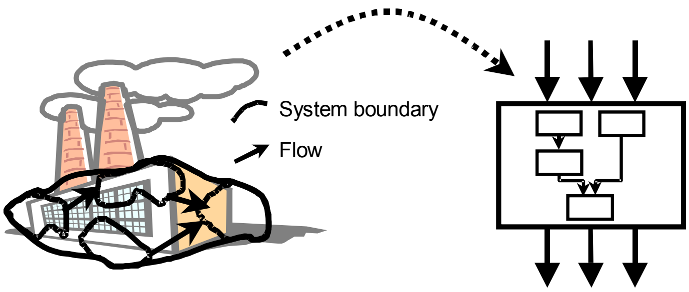


Figure 4. Compilation of a composite model of a technical system

<u>Describe and define the composite production system</u>

Break the production system down by following material flows through the plant. Try to identify internal products such as types of pulp, energy, chemicals etc. This identifies process components, which can suitably be described by defined simple models. During this task, requirements on the included models are specified, such as content, boundaries, relevant parameters etc. The level of detail (scope) depends on what the models are to be used for, and the possibility to obtain measurement values.

The definition also includes choosing relevant parameters for the models (Please refer to appendix 2).

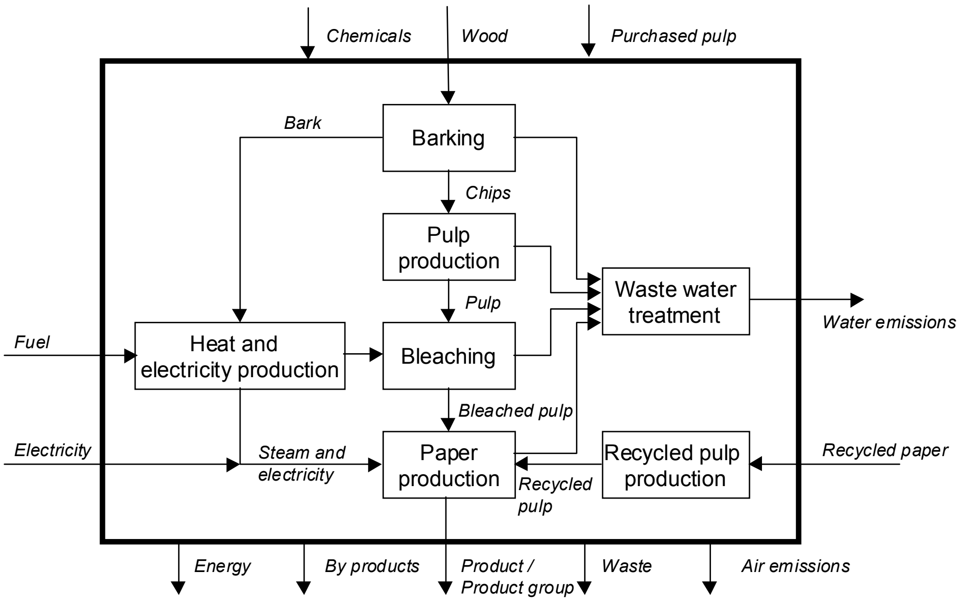


Figure 5. Example of a composite model of a production system. The included components are simple models of process sections in the production system.

Administration/office and support functions (maintenance etc.) are part of the plant, but are easy to neglect when only the material flows in production are tracked. However, these functions should also be considered, when models are constructed.

Define models included for process sections in the composite system

Models for the process sections included are compiled, based on the requirements specified for the composite system. The process sections should be defined so that each one of them delivers well-defined products or functions.

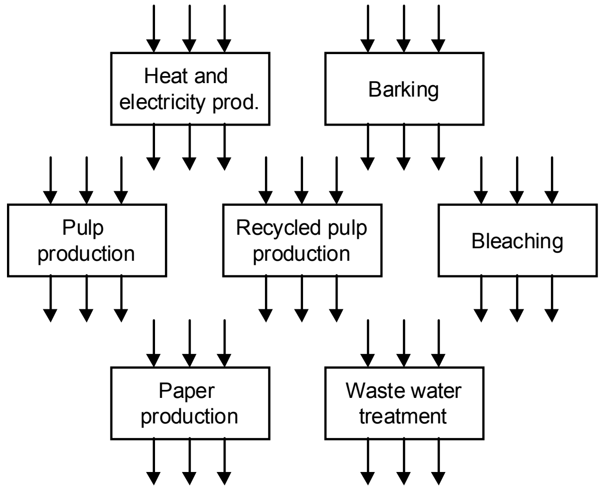


Figure 6. Examples of models of process sections, defined as simple models

For each model, it is important to be able to clearly define the boundaries of each model; the sections included and those that have been excluded. Relevant parameters for input and output flows for the model are selected, based on requirements of the composite system.

Simple model

If the production system is defined as a simple model, the entire production system is defined as one unit. The definition is done in the equivalent manner as for simple models in a composite system (see above). Energy and material flows are followed here, without defining process components.

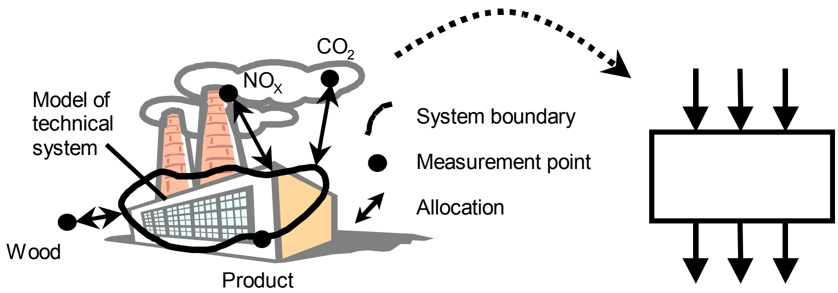


Figure 7. Compiling a simple model of a technical system

Documentation and reporting of the model(s)

The draft model(s) must be documented and justified. The documentation must contain a description of the purpose of the model(s), what is included (which process components etc.), the system boundaries and the parameters chosen. It is important to consider stakeholders' requirements and needs for reporting here (which were identified in the beginning).

For a composite model, both the composite model *and* each of the models included is documented.

The SPINE format should be used for documentation. Please refer to appendix 3 for a description of this format, and how the documentation should be drafted. The documentation can be done with SPINE based software or by using Word and Excel templates based on SPINE.

Appendix 5 contains examples of documented models.

Design of routines

Routines and instructions shall be designed to handle the models. It is best if the routines are inserted into the existing management system.

Stage 3
Process data for the selected parameters

Work description

This stage contains a description of how the numerical data for the chosen parameters (input and output flows) should be processed. This information is used to determine the magnitude of the input and output flows for the models defined in the previous stage.

The work consists of three phases:

- Specification of parameters and measurement systems
- Acquisition of measurement values
- Compilation of the acquired measurement values

Generally it is practical to carry out all three phases at one time for each parameter.

During this work, the *documentation of the models must be supplemented* by information describing how the processing is carried out, i.e. from where the information is taken and the procedures to be used in order to translate it to the values to be reported. Special emphasis must be given to ensuring that information is available and usable when the models are compiled. This documentation is then used as basis each time that data for the model is compiled. This ensures that the data is put together in the same way, each time that the model is updated with new values.

It is expected that the plant already have *well-established routines* for most of the selected parameters. Work at this stage then comprises the identification of the existing information, an investigation of whether it can be immediately used for the models that have been defined, as well as to make the relevant information available when the models are compiled. It is likely that the tasks handled in this stage are grouped in different ways within the existing routines and, that the same person/function is responsible for several of the phases to be investigated.

Procedures

Specification of parameters and measurement systems

In this phase, the existing measurement systems (measurement equipment and methods) must be identified for the parameters. This work also includes investigating, specifying and documenting the relationship between the measurement systems and the models; (location of the measurement system in the technical system, what sections of the process does the measurement system measure, for which parameters and process components will allocation be necessary etc.).

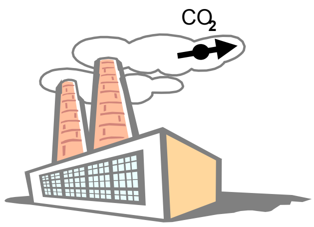


Figure 8. Specification of parameters and measurement systems

> ***NOTE:***
> Calculation models and estimations are in this context regarded as being measurement systems, in the same way as measurement equipment, and they should be documented in an equivalent manner. Thus, if physical measurements for the selected relevant parameters are not available, they can be calculated or estimated. See Appendix 6 for a description of some recommended models to be used for calculating selected emissions (CO_2, NO_x).

Procedure for identification and description of measurement systems

For each selected parameter, the associated measurement system shall be identified and described. This includes:

- *Specification of equipment and method;*
  Methods of measurement and measurement equipment used, performance and sensitivity, limitations, measurement conditions, measurement frequency etc.
- *Physical location in the technical system.*
  In what part of the technical system is the measurement system located? What measurement values can be used immediately to determine the magnitude of the input and output flows, and which ones need to be allocated between different defined process components and/or products or product groups?

- *Routines for the measurement system*

  Routines for maintaining the measurement system; maintenance, inspection, calibration, follow-up of deviations etc.
- *Dependencies between parameters*

  In cases where one parameter is dependent on the value of another parameter, these dependencies must be specified.

Reporting

The following information must be included:

- routines and specifications for measurement methods used
- location
- limitations of the measurement system, e.g. the measurement range
- specification of parameters that are dependent on other parameters
- follow-up of maintenance of measurement instruments

Acquisition of measurement values

In this phase, the routines and instructions for how the measurement values are acquired must be identified and evaluated. These must be available and observed, to obtain the relevant information.

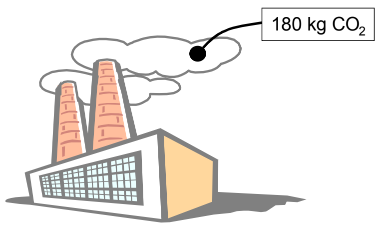


Figure 9. Acquisition of measurement values

Procedure for acquisition of measurement values

To be able to interpret and analyse the measurement values, the factors that have influenced the result must be documented and reported, together with the measured value,.

The following must be prepared during documentation of routines:

- procedure for acquiring measurement values
- follow-up of the way that routines are followed, non-conformance measures
- dealing with other circumstances that influence the result

Reporting

Reporting of result should comprise:

- numerical values for each parameter

- results from follow-up (any non-conformance that has influenced the registered measurement value)

Compilation of the acquired measurement values

In this phase, the routines and instructions for compiling measurement values are identified and evaluated.

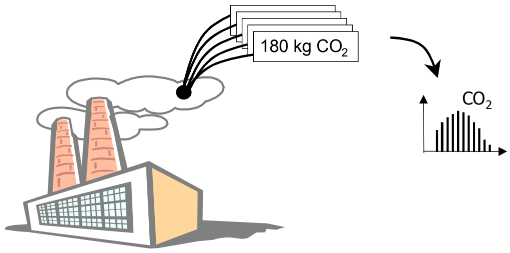


Figure 10. Compiling acquired measurement value

Procedure for documenting the compiling of measurement values

Routines for compiling measurement values must be evaluated and documented. This includes for example identifying:

- the interval for which the compilation is valid (period of time, a specific production volume etc.)
- statistical methods
- methods and routines for analysing measurement values; sorting of measurement values, deletion of extreme values, assumptions and simplifications etc.
- interpretation of the result; such as deviations during the studied interval, and any possible limitations

Reporting

The results reported are:

- a compilation of the measurement values
- interpretation of the result, such as deviations from the studied interval and any possible limitations

Stage 4
Make the final compilation of the models

Work description

The final compilation into a complete model is done based on the information prepared in the earlier stages. The result obtained is environmental data which describes the selected processes and products.

At this stage, it might be necessary to return to Stage 2 and make corrections to the models used in the beginning. Allocation is also done at this point. See Appendix 7 for a description of how this can be done.

It is a good idea to check that the final result is reasonable, by making an energy balance sheet and/or a material balance sheet of the final model, for example. The input flow must be equal to the output flow.

Routines and instructions for handling the models should include:

- administration work in the compilation of the models
- reporting to different stakeholders
- updating of the model when, for example, process changes and modifications are made, or when it is necessary to answer further inquiries that can not immediately be answered by the models that have been defined.

Appendix 1
Example of a survey of information requirements of a plant

In table B2.1 a simple example of the result of a survey of current and expected future requirements to satisfy different stakholders information needs.

Table B2.1

Stakeholder	***Type of compilation***	***Current requirements***	***Expected future requirements***
Environmental Protection Agency	Basis for annual compilation of forest industry discharge	Compiled for the plant	Product related data, divided per product groups
Supervisory authority	Annual environmental report	Data compiled according to control program	Stricter demands when updating the control program.
Customers	Mainly basis for life cycle assessment and environmental labelling	Requirements on data for production of specific products.	Increased demands
Board, shareholders	Basis for annual report/environmental report	Certain requirements in Companies Act	Key figures, linkage to environmental economy
Industry	Basis for the Forest Industry's Water and Air Pollution Research Foundation (SSVL) joint industry database	Models defined, based on specification that will be developed.	Data acquisition according to agreed methodology.

Figure B1.1 below presents tools (white ovals) used to communicate with different stakeholders (gray fields). Arrows indicate flows of information. The example is taken from a Stora Enso mill, 2000.

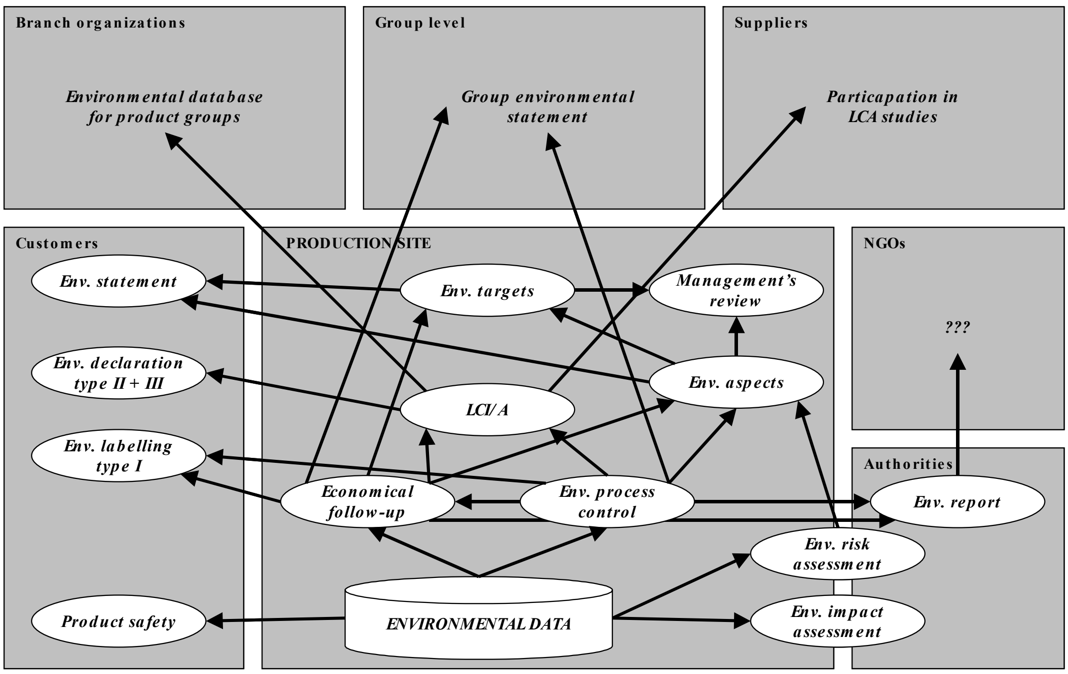


Figure B1.1 Example of stakeholders and environmental tools used at a production site

Table B1.2 below presents different environmental tools and some demands on their content. X denotes a strong demand, (X) denotes a possible demand and – denotes no demand.

Table B1.2

	Environmental aspects	Environmental objectives and targets	Management's review	Environmental process control	Environmental report	Life Cycle Inventory/ Assessment	Environmental statement	Environmental labels, type I	Environmental declarations, type II	Environmental declarations, type III	Environmental Risk Assessment	Environmental Impact Assessment	Product safety
Functional unit:													
Per ton product	-	X	X	-	-	X	(X)	X	X	X	-	-	(X)
Per year	X	(X)	(X)	-	X	-	X	-	-	-	-	-	-
Other functional unit	-	(X)	-	X	-	(X)	-	-	-	-	-	-	-
System boundary:													
Gate-to-gate	X	X	X	X	X	(X)	X	X	X	-	X	X	(X)
Cradle-to-gate	(X)	(X)	(X)	-	-	X	-	(X)	(X)	X	-	(X)	X
Cradle-to-grave	(X)	(X)	-	-	-	(X)	-	-	-	-	-	-	-
Retrospective view,	X	X	X	(X)	X	X	X	X	X	X	X	-	X
on-line, or	-	-	-	X	-	-	-	-	-	-	-	-	-
prospective view	-	(X)	(X)	-	-	(X)	-	-	-	-	(X)	X	-
Unit process distinction,	X	X	X	X	-	X	(X)	(X)	X	X	(X)	-	-
allocation, or	-	-	-	-	-	(X)	-	(X)	X	X	-	-	-
system expansion	-	(X)	(X)	-	-	(X)	-	-	-	-	-	-	-
Degree of aggregation of output:													
Binary (yes or no)	-	(X)	-	-	-	-	-	X	-	-	-	-	(X)
Selected parameters	X	X	X	X	X	X	X	-	X	X	X	X	X
Inventory list	-	-	-	-	-	(X)	-	-	-	-	-	-	-
Studied environmental effect:													
Emissions and use of resources	X	X	X	X	X	X	X	X	X	X	(X)	-	(X)
Effect on nature (e.g. acidification)	(X)	(X)	(X)	-	-	X	(X)	-	-	X	(X)	(X)	(X)
Impact on safeguard subjects (e.g. bio-diversity)	-	-	-	-	(X)	(X)	-	-	-	-	-	X	-

Figure B1.1 and table B1.2 are taken from Ola Svending *Environmental information supplied to the actors of the Swedish pulp and paper industry and the tools used to provide it.* CPM report 2001:6, Chalmers University of Technology, Göteborg.
The report is available at www.globalspine.com.

Appendix 2
Examples of relevant parameters

Input flows

Energy:

- Purchased fossil fuels
- Purchased bio fuels
- Purchased electricity

Raw material:

- Logs
- Chips
- Returned recycled paper
- Purchased pulp
- Chemicals (each chemical is reported separately)
- Fillers (each filler is reported separately)
- Packaging
- Raw water (ground water or surface water is specified)

Output flows

By products:

- Tall oil
- Crude turpentine
- Electricity
- Steam/district heating
- Bark

Emissions to air:

- Fossil CO2
- Biogene CO2
- CO
- SO2
- H2S
- Total-S
- NOx
- Particles

Emissions to water:

- Flow
- Process affected waste water
- COD
- BOD
- TOC
- Suspended particles
- AOX
- Chlorate
- ClO2
- Total-P
- Total-N
- Chelants
- Colour

Waste:
Waste to landfill

- Organic waste to landfill
- Inorganic waste to landfill
- Other waste to landfill

Waste to further processing/energy generation

- Waste to material recycling
- Waste to energy generation
- Other waste

Otherwise categories as in the Waste Disposal Regulations (1998:902) is used. Classification (codes) follows the European Waste Catalogue Web address (in Swedish): http://www.notisum.se/rnp/sls/lag/19980902.htm

Other relevant parameters

- Total use of energy for heating
- Total use of electricity

Note: The examples of relevant parameters are based on Swedish conditions. Other parameters may be relevant in other countries depending on local conditions.

Appendix 3
Documentation of models of technical systems in SPINE

Introduction

A description is given below, of the information, which should be documented in the SPINE-format[3] when preparing a model of a technical system. The documentation is used for reporting, storage, updating and follow-up of the model. The format can be used for documentation of both simple and composite systems. When composite models are documented, each one of the process components included is documented individually, together with documentation of the composite system. Please refer to appendix 5 for two examples of models that have been documented in SPINE.

The documentation can either be done in Word or Excel templates or in SPINE based software. See the chapter 'Tools when working with documentation' below for more information.

Documentation of models of technical systems in SPINE is sub-divided into five sections (please refer to figure B.1.).

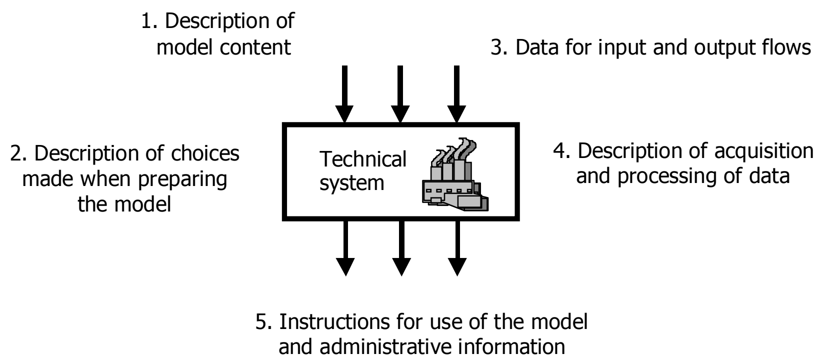


Figure B1. Documentation of models of technical systems in SPINE

The different sections of the documentation is handled in different stages of implementation:

- The draft models prepared in stage 2 are mainly documented in sections "1. Description of model content" and "2. Description of choices made in preparing the model".
- The processing of data made in stage 3 is mainly documented in sections"3. Data for input and output flows" and "4. Description of acquisition and processing of data"
- In the final compilation of the models, which is done in stage 4, all five sections are handled, i.e. any changes done to the models and in the processing of data are

incorporated in the documentation, and is supplemented by instructions for how the models can be used.

Documentation in the SPINE-format

A full description of the documentation in each section of the documentation process is given below. The different nomenclatures that is used in the documentation is found in appendix 4. The text in brackets is the name of the field in SPINE.

1. Description of model content

The description is sub-divided into the following fields:

Name (Name)

Name of the model. The name provides identification and an initial indication of what the model describes.

Scope/Type of system (Process Type)

A brief specification of the scope based on the studied technical system. For example, individual "Process step", "Gate to gate" etc. See nomenclature for ProcessType in appendix 4.

Address/geographical position (Site)

The address or the geographical position where the technical system described by the model is situated.

Description (Function)

Detailed description of the content and scope of the model, as regards included process stages, conversion processes and how these are linked, equipment used, process conditions etc.

Documentation advice

In general, it is practical to divide the description into two sections; a brief summary and a more detailed description.

When sections of the information can be found in other documents, (electronic or paper based media), references shall be made.

[3] SPINE – Sustainable Product Information Network for the Environment

Owner (Owner)

The owner of the technical system described by the model, specified with name and address. This is for example relevant if information from several production plants owned by the same owner is stored in a database, and you want to be able to identify the production plants owned by this owner in a simple manner.

Industry (Sector)

Specification of the industry to which the technical system belongs. See nomenclature Sector in appendix 4.

Flow chart (tables Componentship and FlowConnection)

Flow chart for the model.
Note: The flow chart is only used for composite models, where each of the included models has been documented separately.

2. Description of choices made when preparing the model

Background, purpose and field of application

The background, purpose and field of application for the model should be documented, so that the user will have an idea of what he can expect from the model, as well as what the basis were for the choices and boundaries reported in other sections of the documentation. The description in SPINE is sub-divided into the following sections:

Target group (Intended User)

Intended user or target group for the model.

Background/ general purpose (General Purpose)

The background of the model, for example circumstances that form the basis for why the model was prepared.

Specific purpose/field of application for the model (Detailed Purpose)

The specific purpose, and field of application for the model. For example, the specific question which the model was prepared to answer

Client (Commissioner)

The client for whom the model is prepared.

Persons who were responsible for preparing and reviewing the model

Persons responsible for preparing the model (Practitioner)

Name, organisation and address of the persons who were responsible for preparing the model.

Note: Many people are in general involved when preparing the model. Only the people who have done the practical work in the preparations should however be specified here. Other sources used in the preparations shall be references in the sections of the documentation where they were involved.

Reviewer of the model (Reviewer)

If the model has been reviewed, state the name, organisation and address of the persons who performed the review.

Note: Several different aspects of the model may have been reviewed. For example, the quality of documentation of the model (i.e. that the recipients can interpret the information), that the information is traceable, that the material used as a basis for the model has been correctly used and interpreted etc.

Functional unit

Chosen functional unit (Functional Unit)

The functional unit chosen for the model, i.e. the basis for calculation to which all input and output flows is related. For example 1 ton produced board.

Description and justification of the chosen functional unit (FU Explanation)

A description and justification of the chosen functional unit. For example, a description of the product properties, if the functional unit represents a product.

System boundaries

The description of system boundaries reports the choices made when the model was been delimited. The description is divided into the following sections:

Towards the nature system (Nature Boundary)

A description and justification of the delimitation's made in relation to the nature system. In this context, one should describe how input and output flows and other parameters presented in the model has been selected, which come from or reach the nature system, e.g. which resource extractions and emissions to air and water that have been chosen.

Towards other technical systems (Other Boundary)

A description and justification of the delimitation's made in relation to other technical systems. This includes a justification of the choice of parameters to and from other technical systems that is presented in the model; e.g. raw material flows, additives, waste material, products and by products. This also includes a justification of any excluded processes, i.e. processes that one has consciously chosen to exclude from the model.

Time system boundaries (Time Boundary)

A description and justification of the time horizon chosen for the model. For example 1 year, to 5 year, future scenarios etc.

Geographical system boundaries (Geography Boundary)

Geographical delimitations made for the system. This is mainly relevant for larger composite systems, such as when a flowchart in an LCA study is documented, where the included processes occur in several geographical areas.

Allocations and/or system expansions

Allocations made (Allocation)

A description of any allocations done, by specifying and justifying the principles, rules and procedures used.

Note: if allocations have been done for the described model, it is very important that these are clearly described and justified. Different methods of allocation give very different results, depending on the basis used for the allocation. See appendix 5 for a description of allocation. Allocation is done when the information delivered from the measurement system do not directly describe the flows that shall be quantified for the model, e.g. allocation of total measured electricity production on two production lines.

System expansions done (Lateral Expansion)

Justification and description of any expansions done in the system. In a system expansion an external technical system has been included in the model.

Note: A system expansion is sometimes done, in order to avoid allocation. System expansions can also be done to model the consequences of a change. In the same way as for allocations, system expansions must be clearly described and justified.

3. Data for input and output flows to the model

All input and output flows to the model are presented in relation to the chosen functional unit. The following information is stated in SPINE for each input and output flow:

Direction	**Type of flow**	**Name**	**Amount per functional unit**					**Origin or recipient**	
Direction	*Category*	*Substance*	*Quantity*	*QuantityMin*	*QuantityMax*	*SDev*	*Unit*	*ImpactMedia*	*ImpactRegion*

Direction (Direction)

Direction of the flow, i.e. input or output flow.

Type of flow(Category)

Category of the flow, such as raw material, additives, resource(s), products etc. See nomenclature *FlowType* in appendix 4.

Name (Substance)

Name of the flow. See nomenclature *Substance* in appendix 4.

Quantity per functional unit:

Value (Quantity)

Max value (QuantityMin)

Min value (QuantityMax)

Standard deviation (SDev)

Unit (Unit)

The quantity of the flow in relation, to the chosen functional unit.
Note: A description of how these values have been prepared is found in the next section of the documentation (section "Description of acquisition and processing of data").

Origin or recipient:

Type of environment (ImpactMedia)

Type of environment which the flow comes from or goes to when it leaves the studied technical system, e.g. air, water, ground, technosphere. Please refer to nomenclature *Environment* in appendix 4.

Geographical position (ImpactRegion)

Geographical position which the flow comes from or goes to when it leaves the studied technical system. Please refer to nomenclature *Geography* in appendix 4.

4. Description of acquisition and processing of data

A description of how the values reported for input and output flows have been processed. In practice, the values presented is a result of several phases of data processing:

- specification of parameters and measurement systems
- acquisition of individual measurement values
- compilation of the acquired measurement values into for example a mean value
- any further processing of the data to make it describe the studied model (allocation etc.)
- for composite models, the calculations done.

Ideally, processing of information in every phase of data processing should be described.

In SPINE, the description of the methods used to acquire and process the data can both be made on a general basis for the entire model (such as general assumptions made to convert the original data to the form that are reported), and on a specific basis for individual flows.

The description is divided into the following fields, for general and/or for specific flows:

Time period (Date Conceived)

Time period during which the data has been acquired and processed. For exampla; for a measured value, the time period during which the value has been measured and processed.

Type of method (Data Type)

A brief specification of the type of method used to acquire the reported value, such as by continuous measurement, single samples, assumptions etc. Please refer to nomenclature *QMetaDataType* in appendix 4.

Description of acquisition and processing of data (Method)

Description on how the data has been acquired and processed in order to obtain the data for input and output flows that are reported for the model (see section 'Data for input and output flows'). This includes a description of which measurement methods that have been used, the assumptions that have been made, any re-calculation that have been done etc.

Documentation advice

A recommendation is to structure the description into the different phases of data handling included in the acquisition and processing. This makes it easier for users of the documentation to see what has been done in each phase.

If the information is already documented, on paper based or electronic media, clear references should be made. The way that the information will be communicated should however be born in mind. If the information is to be communicated externally, outside the organisation, it is probable that references to internal documents will not be of any practical use to the recipient. In this case, an interpretation or extract from the referred information may need to be appended to make the information directly useful to the recipient.

References (Literature Ref)

Lists of references used in the description of the data acquisition and data processing above, for example internal reports, reference material, etc.

Other information (Notes)

Any other information, for example specification of supplier for a raw material.

5. Instructions for use of the model and administrative information

Recommendations for use of the model and assessment of data quality

The person(s) who has/have participated in preparing the model generally have a good knowledge of the strengths and weaknesses of the model, which may be difficult to discover by only reading the other documentation of the model. Documentation of advice and recommendations for application of the model and an assessment of the quality of the data are therefore very valuable for the user. In SPINE, this type of information can be documented in the following fields:

Advice and recommendations for application of the model (Applicability)

General description of advice and recommendations for how the model can and should be used. For example, the conditions under which the model is valid, and in what type of applications the model is suitable.

General assessment of data quality (AboutData)

A general assessment of the quality of the data presented.

Other information about the model (Notes)

Any other relevant information about the model.

Administrative information

In addition to documentation of the model, other administrative information for the model can be documented in SPINE, for example final report data, rules for how it may be distributed etc.

Final report date (DateConcieved)

The date when the model was finalised and reported.

Reference to publication (Publication)

A reference to where the information is published, either through a reference to the original documentation of the model (such as if it has been published on another medium or in another format) or by a reference to where the documentation is stored. This can for example be the internal information system where the documentation can be found, which is relevant when the information is communicated internally or externally.

Rules for distribution of the information (Availability)

Specification of rules for how the information about the model may be distributed, e.g. secrecy handling of the information.

Copyright (Copyright)

Specification by the holder of copyright for how the documentation.

Tools for working with documentation

The documentation in SPINE can be done using SPINE-based software or by using Word/Excel-templates with SPINE-format (an example of how a Word-template can be designed is found below).

SPINE-based software

Currently there are four different software based on SPINE available, which supports documentation of models of technical systems. These are: SPINE@CPM Data Tool (freely available software, developed at CPM), Ecolab (developed and marketed by Nordic Port), LCAit 4.0 (developed and marketed by Chalmers Industriteknik Ekologik), and World Wide LCA Workshop (a freely available web-based software, developed at CPM). When working with a SPINE-based software, the information is stored in a relational database with SPINE structure.

<u>Advantages with working in SPINE-based software</u>

All models that is handled, including the updates that is done, can be stored in the same place, in the same database. Handling of nomenclatures and addresses is facilitated since substance names, addresses etc. only needs to be entered once in the database. Composite models is physically linked in the database, which makes it easy to get an overview of the documentation. Different types of reports can be generated and different types of queries can be put to the database, to quickly find and retrieve documentation. Both calculations and documentation of composite models can be done in the same software.

Disadvantages

Available software generally requires education to be handled efficiently. The software available on the market today is mainly adapted for LCA.

Word-template

Advantages:

Well-known software that is already available on most computers. Do not generally require further education, except for interpretation of the format. Handling of documents can be made according to existing routines for document handling.

Disadvantages

Requires a separate document handling. Calculations of composite models needs to be done in a different tool.

Word-template for documentation in SPINE

Introduction

An example is given below on how a Word-template can be designed. Some recommendations for document handling when working with the template is to save each model in a separate document and name the files with the name of the model and a unique identity-number (for example the final reporting data can be used as an identity-number).

To keep track of all files; make a list of all documented models, with file-name and storage place. The files should be accessible for all concerned.

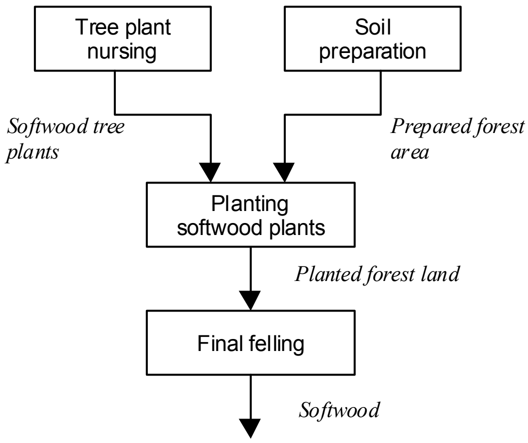
When up-dating:

- Make a copy of the file containing the model to be updated.
- Delete all numerical information and go through the documentation to see if the documentation is still relevant.

Example of Word-template:

1. Description of model content

<table>
<tr><td>Name
(Name)</td><td colspan="2"></td></tr>
<tr><td>Scope/Type of system
(Process Type)</td><td colspan="2">Use nomenclature: ProcessType</td></tr>
<tr><td rowspan="5">Address/ Geographical position
(Site)</td><td>Name:</td><td></td></tr>
<tr><td>Address:</td><td></td></tr>
<tr><td>Telephone:</td><td></td></tr>
<tr><td>Fax:</td><td></td></tr>
<tr><td>E-mail:</td><td></td></tr>
<tr><td>Description
(Function)</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Owner
(Owner)</td><td>Name:</td><td></td></tr>
<tr><td>Address:</td><td></td></tr>
<tr><td>Telephone:</td><td></td></tr>
<tr><td>Fax:</td><td></td></tr>
<tr><td>E-mail:</td><td></td></tr>
<tr><td>Industry
(Sector)</td><td colspan="2">Use nomenclature: Sector</td></tr>
<tr><td>Flow chart
(Tables Componentship and FlowConnection)</td><td colspan="2">A flow chart can in SPINE only be used for composite models, where each of the included systems has been documented in SPINE. Thus, only use the flow chart for composite production systems. The field can be deleted for simple models.

Use the same name in the flow chart of the included systems as is used in the documentation of them, and note which flow has been linked. An example of design of flow chart:


Each of the included systems has been documented separately. The flow that links the systems has been marked.</td></tr>
</table>

2. Description of choices made when preparing the model

Background, purpose and field of application

Target group *(Intended User)*		
Background/ general purpose *(General Purpose)*		
Specific purpose/ field of application for the model *(Detailed Purpose)*		
Client *(Commissioner)*	Name:	
	Address:	
	Telephone:	
	Fax:	
	E-mail:	

Persons who were responsible for preparing and reviewing the model

Persons respon-sible for preparing the model *(Practitioner)*	Name:	
	Address:	
	Telephone:	
	Fax:	
	E-mail:	
Reviewer of the model *(Reviewer)*	Name:	
	Address:	
	Telephone:	
	Fax:	
	E-mail:	

Functional unit

Chosen functional unit *(Functional Unit)*	
Description and justification *(FU Explanation)*	

System boundaries

Towards the nature system *(Nature Boundary)*	
Towards other technical systems *(Other Boundary)*	
Time system	

boundaries *(Time Boundary)*	
Geographical system boundaries *(GeographyBoundary)*	

Allocations and/or system expansions

Allocations made *(Allocation)*	
System expansions done *(Lateral Expansion)*	

3. Data for input and output flows to the model

Add as many rows in the table below that are needed to report all input and output flows.

Direction	**Type of flow**	**Name**	**Amount per functional unit**					**Origin or recipient**	
Direction	*Category*	*Substance*	*Quantity*	*Min*	*Max*	*SDev*	*Unit*	*ImpactMedia*	*ImpactRegion*
Input or Output	Nomenclature: FlowType	Nomenclature: Substance	Data	Data	Data	Data	Nom.: Unit	Nomenclature: Environment	Nomenclature: Geography

4. Description of acquisition and processing of data

General description

Time period *(Date Conceived)*	
Type of method *(Data Type)*	Use nomenclature: QMetaDataType
Description of acquisition and processing of data *(Method)*	
References *(Litterature Ref)*	
Other information *(Notes)*	

Description of specific flows

Copy the fields below for each flow that is described.

Flow:	Specify the flow that is described, with type of flow and name.
Time period *(Date Conceived)*	
Type of method *(Data Type)*	Use nomenclature: QMetaDataType
Description of acquisition and processing of data *(Method)*	
References *(Litterature Ref)*	
Other information *(Notes)*	

5. Instructions for use of the model and administrative information

Recommendations for use of the model and assessment of data quality

Advice and recommendations *(Applicability)*	
General assessment of data quality *(AboutData)*	
Other information about the model *(Notes)*	

Administrative information

Final report date *(DateConcieved)*	
Reference to publication *(Publication)*	
Rules for distribution of the information *(Availability)*	
Copyright *(Copyright)*	

Appendix 4
Nomenclatures to use in the documentation

This appendix contains the nomenclature that should be used in the documentation. They are based on the nomenclatures developed at CPM, which are presented in two reports[4, 5]. Additions have been made to the nomenclatures for branch affiliation (Sector), name of substances (Substance) and type of environment (Environment) to adapt to the forest industry's activities.

Table of content for the nomenclatures

[4] CPM-report 1997:6, Pålsson, A-C. *Handbok vid arbete med datakvalitet och SPINE*, Chalmers University of Technology (in Swedish only).
[5] CPM-report 2001:2, *Facilitating Data Exchange between LCA Software involving the Data Documentation System SPINE* Chalmers University of Technology.

Type of system – ProcessType

The nomenclature is in accordance with the different types of technical systems that may be studied in e.g. a life cycle assessment (LCA). For the models that are defined to describe a specific production site, the process types *Unit operation* and *Gate to gate* are used.

ProcessType	***Description***
Unit operation	Various types of a mill's sub-processes, e.g. boiler, evaporation, press section. The level of detail in the sub-processes depends on the scope of the model.
Gate to gate	Includes the activities that take place within a mill, i.e. at one location. An example can be a pulp mill. None of the activities producing or processing input or output flows is included. A Gate to gate system can be compiled of more than one Unit operation.
Cradle to gate	Technical system where "all" input flows have been followed to the nature system and that deliver a product or a function.
Cradle to grave	Technical system that describes e.g. a product's entire life cycle.
Gate to grave	Technical system that treats, uses and consumes a product or a function, and where "all" outflows reaches the natural system.
Other	Technical system of other type than those described above.

Branch affiliation – Sector

The nomenclature has been developed to identify product- and service suppliers. The basis of the structure and naming of sectors has been the UN's industrial classification of economic activities[6]. This structure has however been considerably modified and simplified to make it more easy to work with. The main structure of the sector nomenclature:

Sector
Biological
Forestry
Agriculture
Fishing
Mining and quarrying
Coal and lignite mining
Crude oil and natural gas extraction
Metal and mineral mining
Other mining

[6] *International Standard Industrial Classification of all Economic Activities, ISIC rev 3* Statistical Papers, series M, No 4, Rev 3 United Nations, New York 1990 ST/ESA/STAT/SER.M/4/REV. 3.

Construction
 	
Manufacturing
    Materials and components
    Machinery and equipment
    Consumer goods
 	
Energyware
    Fuel
    Grid electricity and district heat
 	
Transport
    Land transport
    Air transport
    Water transport
 	
Commercial, residential and institutional
 	
Waste handling and processing

Forest industry activities within the pulp and paper industry is categorised under *"Manufacturing – Material and components"*. There is however often a need for a refined structure.For this the SCB classification of business branches[7] is used. Se below for the sub-division that shall be used for the forest industry to *Manufacturing – Materials and components*:

Sub-division for "Manufacturing – Materials and components"

Pulp- paper and paper goods production
 	
    Pulp- paper and board production
        Pulp production
            Production of mechanical or semi-chemical pulp
            Sulphate pulp production
            Sulphite pulp production
        Paper and board production
            Production of newsprint and magazine paper
            Other printing paper production
            Production of kraft paper and kraft board
            Other production of paper and board
 	
    Production of paper and board goods
        Production of corrugated board and corrugated board boxes
        Other production of paper and board packaging
 	
    Production of tissue and hygiene paper
 	
    Production of writing paper, envelopes etc.
 	
    Wallpaper production
 	
    Production of other paper and board goods

[7] Standard for Swedish classification of business branches 1992, available in Swedish at http://www.scb.se/ekonomi/koder/kod.asp.

Flow types – FlowType

Nomenclature for different categories of flows entering or leaving a technical system.

FlowType	Explanation
Product	Output flows from a technical system that are categorised as products.
By-product	Other output flows from a technical system with an economical value.
Refined resource	Input flows to a technical system that comes from another technical systems.
Natural resource	Input flows to a technical system that comes from the nature system.
Emission	Output flows from a technical system to the nature system.
Residue	Output flows from a technical system that do not belong to Product or Emission, e.g. waste.

Name of substance – Substance

Generally, naming of a substance shall be as specific as possible and only the most common names of a substance. Below only a suggestion is given on how the nomenclature can be structured. Please also refer to appendix 2 for a suggestion to substance nomenclature to use in the documentation.

Substance	Explanation
Resources	Name of substance found in the nature system, e.g. crude oil.
Elements	Name of elements according to the periodic table of elements.
Supply Material	Name of substance that has been refined, and is commonly used as a raw material or additive in a technical system, e.g. caustic soda (NaOH).
Machinery and equipment	Name of composite machinery and equipment.
Consumer goods	Name of substances used as consumer goods.
Emissions	Name of substances commonly categorised as emissions from a technical system.
Waste	Name of substances commonly categorised as waste from a technical system.

Type of environment – Environment

Environment describes the surrounding from where a flow comes, or where a flow is heading. For example a flow may come from an external supplier of a certain substance, or it might be an internal flow of black liquor between the evaporation plant and the soda recovery unit. To simplify the connection of different sub-processes it may be practical to describe where a flow comes from or where it is heading.

Environment
Air
Agricultural air
Forestral air
High altitudes (>1000 m)
Indoor air
Rural air
Urban air
Water
Creek
Fossil water
Ground water
Lake
Marsh
Ocean
Pond
Rapid
River
Surface water
Swamp
Waterfall
Ground
Agricultural ground
Forestral ground
Grassland ground
Impediment ground
Industrial ground
Landfill ground
Rural ground
Urban ground
Other
Technosphere

An example of sub-structure to *Technosphere* is presented in the table below. Each production site may adapt this sub-structure further, e.g. through calling Paper machine for PM 2. Any internally developed (Technosphere) nomenclature must be documented, so that it can be understood by external parties. For the other nomenclatures, the sub-structures specified above shall be used.

Example of sub-structure to Technosphere
Wood yard
Wood room
Mechanical pulp production
CTMP production
Refining
Screening
Bleaching
TMP production
Refining
Screening
Bleaching
Groundwood production
Refining
Screening
Bleaching
Chemical pulp production
Sulfate pulp production
Digester
Screening
Washing
Delignification
Chemical recovery
Evaporation
Recovery boiler
White liquor clarification
Caustizising
Lime sludge reburning
Bleaching
Recycled paper pulp production (DIP)
Dissolver
Separation (of litter)
Deinking
Screening
Bleaching
Dispersion
Paper production
Wire part
Press section
Drying section
Coating
Glazing
Energy production
Solid fuel boiler
Fossil fuel boiler
Steam power station
Winding and packing
Raw water purification
Waste water treatment
Mechanical treatment
Chemical precipitation
Biological treatment
External supplier

Geography – Geography

The nomenclature and naming follows the current geographical division of continents and oceans, with sub-division in the countries that the continents consist of. The sub-division can, when necessary, be further refined in regions, municipalities etc.
The main structure of the geography nomenclature is:

Geography
Africa
Antarctic and Arctic Regions
America
Asia
Australia and Oceania
Europe
Sweden
Oceans

Note: The sub-division in countries is not presented here, due to its extensiveness. However, the countries are named according to current geographical nomenclature.

Type of method – QMetaDataType

The nomenclature contains names for different data types, i.e. different types of methods for data collection. This nomenclature is used to give a first guidance to how data has been collected, and is intended to supplement the documentation in the SPINE-field "Description of collection and processing of data". The nomenclature consists of *Derived data types, Monitored data types, Unspecified data types* and *Legislative and corporate limit data types.*

Derived data types:

QMetaDataType	***Explanation***
Derived, statistics	Result from calculation based only on statistically founded primary data that have been treated with statistical methods.
Derived, mixed	Result from calculation based on several data types, and where none of the input data is of the data type Unspecified.
Derived, unspecified	Result from calculation based on several data types, and where some of the input data is of the data types Unspecified, or Derived, unspecified.
Modeled data	Data based entirely or to the greater part on theoretical model reasoning.
Estimated from similarity	Data estimated using data from a similar process.

Monitored data types:

QMetaDataType	*Explanation*
Monitored data, continuous	Data monitored automatically with a high frequency (continuously). The frequency of measuring shall be documented in the field "Description of acquisition and processing of data (Method)" in the documentation format. Example: IR measuring of SO2 after a combustion chamber.
Monitored data, discrete	Data monitored automatically or manually with a lower frequency. The frequency of measuring shall be documented in the field "Description of acquisition and processing of data (Method)" in the documentation format. Example: Measuring of COD on a day collection sample.
Random samples	Automatic or manual measuring with a random frequency. The time for sampling shall be documented. Example: Measuring the moisture content of a waste fraction.
Single sample	Single automatic or manual measuring. Interval of measuring shall be documented. Example: Quarterly measuring of H2S after a combustion chamber.
Economical information	Data based on economical information, e.g. purchasing or sales statistics. Example: Annual consumption of a specific chemical product.

Unspecified data types:

QMetaDataType	*Explanation*
Unspecified	Unspecified method, i.e. information is missing on how data has been compiled.
Unspecified, expert outspoke	Data based on expert outspoke, but information is missing on what the outspoke is founded.
Unspecified, guesstimate	Data based on a very rough estimation.
Unspecified, panel judgement	Data based on an estimation made by a panel consisting of e.g. experts within the area.

Legislative or corporate limit data types:

QMetaDataType	*Explanation*
Legislated limit	Data estimated from legislated limit.
Corporate limit	Data estimated from internally set corporate limit, established e.g. to pass a Legislated limit.

Appendix 5
Examples of documented models

Two examples of models that have been documented in the SPINE-format are given in this appendix; a simple mode and a composite model. For the composite model only the overall description is given. Each of the processes included in this model have also been documented in an equivalent manner. More examples of documentation is given in the report ”Fabriksmodeller framtagna under etapp I – Dokumentation för AssiDomän Kraftliner, SCA Ortviken och Stora Enso Skoghall’. Please also refer to appendix 3 for a description of how the SPINE-format is interpreted and used.

Example of a simple model

An example of the documentation needed for a simple model is given below

Description of model content

Name

Ortviken Paper Mill

Scope/Type of system (Process Type)

Gate to gate

Address/geographical position (Site)

Ortviken Paper Mill
SCA Forest Products
Box 846
851 23 Sundsvall

Description (Function)

Activity description

<u>*Introduction*</u>

Ortviken Paper Mill is located in Sundsvall municipality. It manufactures and sells wood-based paper, newsprint, improved newsprint (greater brilliance) and light-weight coated (LWC) paper.

Ortviken Paper Mill has a capacity of up to 780 000 t/annum wood-based paper with its own production of pulp.

<u>Process description</u>

Log reception

The majority of the wood arrives by road as logs, and is unloaded by log-handling trucks in the factory site. A small amount of wood arrives by road as wood chips and is unloaded by the factory's buffer store for wood chips.

Barking

The wood trucks lift and carry the logs from the wood yard to the barking plant log input. The log input supplies the production line, which consists of the following stages with associated equipment.

Process stage barking

1. Thawing
2. Cutting
3. Bark drum
4. Chipping
5. Screening
6. Bark ripper
7. Bark presses

The screened chips and the pressed bark are transported on conveyors to buffer stores for onward transport to the pulp factory and the steam plant.

The chips are transported to the pulp factory via a conveyor from the barking plant or the chip buffer store and chip washers (3 in number). Washed wood chips from the chip washers are transported with their surplus water to the process water waste purification plant. The cleaned chips are then taken by a screw conveyor to the chip buffer line.

Pulp factory

All pulp produced within the plant is produced by the TMP process. This means that the chips are fragmented and the fibres are freed in a grinding machine, the refiner, containing either two counter-rotating, patterned disks or one rotating disk and a stationary disk. The grinding process is very energy-demanding.

The pulp is then transported for processing to LWC paper or newsprint.

For certain grades of paper, the brightness of the pulp must be improved by using bleaching processes. At Ortviken, reducing bleaching with dithionite and/or oxidising bleaching with peroxide is used. Both methods conserve the material (lignin) and thus only cause a mild discharge of wood material.

The paper mill

The finished, prepared TMP pulp is then pumped from the pulp factory buffer store to the paper mill beating material preparation stage. After this, it can be further refined if needed, and then mixed with disintegrated and ground sulphate pulp.
The dry paper is calendered and re-rolled at the same time as it is cut to the ordered roll widths and weights, and is packed in packaging before it is off-loaded.

Joint installations

Energy plant

The heating plant consists of 5 oil and/or biofuel fired furnaces for production of superheated steam (530°C, 64 bar). They have together a total rated power of 315 MW.
In addition, there is an electrically heated boiler for 20 bar steam and rated power of 20 MW and steam from three steam regenerators in the TMP re-cycling section, each with a rated power of 30 MW and steam pressure 2.5 bar.
There are 2 turbines for generation of backpressure power, with rated electrical power of 17 and 12 MW respectively. The factory also has a condensation generator with rated electrical power of 20 MW.
The flue gas from Ortviken’s five furnaces is directed, after ash separation, to two chimneys which are located in the middle of the factory site, separated by a distance of 22 m (from centre to centre). Each chimney has an outlet diameter of 3.0 m (inner diameter) and height 94 m above ground level.

Purification of raw water

The raw water which is used, mostly in the LWC mill, is purified by deflocculation with aluminium sulphate and filtration in a sand filter.

Waste water purification

Waste water purification consists of internal purification of the effluent from the slurry cooker and coating machine, using either ultra-filtration and re-cycling of concentrated waste slurry, or chemical precipitation and external purification, using mechanical, biological and chemical purification. Extracted sludge is pressed and burned.

Other matters

There is also a landfill with surrounding embankment on the factory site, for ash from wood burning (this has a separate control programme) and a buffer store for bark and wood waste on the east peninsula of Killingholmen island.

Owner

SCA Forest Products

Description of choices when preparing the model

Background, purpose and field of application

Target group (Intended User)

Swedish forestry industry

Background / general purpose (General Purpose)

Project CPM_SSVL 2000

Specific purpose/field of application for the model (Detailed Purpose)

Input data for production of a joint industry database

Client (Commissioner)

SSVL

People who were responsible for preparing and reviewing the model

Person responsible for preparing the model (Practitioner)

Name: Loviken, Görgen

Address: SCA Graphic Sundsvall AB,Östrand Pulp Factory, SE-861 81 Timrå

Phone: +46 60 - 16 41 67

Fax: +46 60 - 57 64 50

E-mail: gorgen.loviken@graphic.sca.se

Reviewer of the model (Reviewer)

Name: Pålsson, Ann-Christin

Address: CPM, Chalmers University of Technology, SE-412 96 Göteborg

Phone: +46 31-772 56 46

Fax: +46 31-772 56 49

E-mail: ann-christin.palsson@cpm.chalmers se

Functional Unit

Chosen functional unit

One tonne of newsprint

Description and justification of the chosen functional unit (FU Explanation)

The product described is mid-way between the standard and improved newsprint papers made Ortviken Paper Mill.

System boundaries

Towards the nature system (Nature Boundary)

Ortviken pulp factory and paper mill is currently concentrated to a clearly defined area of the former Killingholmen island in Sundsvall Municipality. There is a parking lot between the mill and the adjacent residential area. The distance from the factory site boundary to the closest building is 120 m and the distance from the factory buildings to the closest building is about 400 m.

The water recipient, the Sundsvall bay, allows the waste water to be well diluted. This is led from Ortviken through a 1.5 km long pipeline in an ENE direction to the Alnösund deep channel. The Sundsvall bay is a wide bay with a wide deep opening to the east (50-100 m), leading to the open Gulf of Bothnia. The bay is bounded on the east by a north-south line from Åstön to Brämön.

Allocations and/or system expansions

Allocations made (Allocation)

Primary fuel and internally generated electricity is allocated between Newsprint and LWC by the "Allocation of fuel and internally generated electricity, Ortviken Paper Mill" model.

Data for input and output flows to the model

Direction	**Type of flow**	**Name**	**Amount per functional unit**					**Origin or recipient**	
Direction	*Category*	*Substance*	*Quantity*	*Min*	*Max*	*SDev*	*Unit*	*Environment*	*Geography*
Input	Natural resource	Surface water	20				m3	Surface water	Sweden
Input	Refined resource	Bentonite	5				kg	Technosphere	Sweden
Input	Refined resource	Bio fuel	929				MJ	Technosphere	Sweden
Input	Refined resource	BSK	20				kg	Technosphere	Sweden
Input	Refined resource	Dithionite	10				m3	Technosphere	Sweden
Input	Refined resource	Electricity int	68				kWh	Technosphere	Sweden
Input	Refined resource	Electricity ext	2315				kWh	Technosphere	Sweden
Input	Refined resource	Heavy oil	420				MJ	Technosphere	Sweden
Input	Refined resource	Kaolin	25				kg	Technosphere	Sweden
Input	Refined resource	NaOH	10				kg	Technosphere	Sweden
Input	Refined resource	O2	10				kg	Technosphere	Sweden
Input	Refined resource	Spruce wood	2				m3 fub	Technosphere	Sweden
Input	Refined resource	Starch	2				kg	Technosphere	Sweden
Output	Emission	CO2 bio	200				kg	Air	Sweden
Output	Emission	CO2 fossil	30				kg	Air	Sweden
Output	Emission	NOx	0,5				kg	Air	Sweden
Output	Emission	SO2	0,1				kg	Air	Sweden
Output	Emission	COD	2				kg	Baltic sea	Sweden
Output	Emission	N-tot	0,1				kg	Baltic sea	Sweden
Output	Emission	P-tot	0,005				kg	Baltic sea	Sweden
Output	Emission	Susp. solids	0.5				kg	Baltic sea	Sweden
Output	Emission	Waste water	15				m3	Baltic sea	Sweden
Output	Product	Newsprint	1				ton	Technosphere	Europe
Output	Residue	Ashes	40				kg	Industrial ground	Sweden
Output	Residue	Industrial waste	1				kg	Landfill ground	Sweden

Description of acquisition and processing of data

General description

Time period (Date Conceived)

Calendar year 1999

Description of acquisition and processing of data(Method)

Fuel

External bio-fuel is reported via a report from the VMF, monthly summary. Internal bio-fuel is counted as a residual item, as the balance between total steam produced, minus purchased bio-fuel minus purchased oil and minus electricity for steam production. Electricity for wood handling, pulp production and pulp fragmenting is allocated by the weight (in tonnes) of pulp used. Electricity for water purification, maintenance and office use is allocated by number of tonnes produced.

Raw materials

Raw materials, except for logs and energy, are allocated in accordance with the formula and the volume produced for NEWS and LWC respectively.

Water sampling.

Flow controlled sampling with a vacuum sampler. Samples are collected every morning from Monday - Saturday, and on Monday morning a collective sample for Saturday and Sunday are taken. On public holidays, collective samples are taken every second day.
The outgoing waste water flow from the plant is constantly measured by a magnetic flow sensor.
Original copies of all method descriptions are stored in a binder by the laboratory manager. The outgoing water is allocated on the number of tonnes produced. Other water emissions are allocated by log/TMP consumption

Air emissions

Discharge of sulphur from fuel is calculated from information about the sulphur content of the fuel and the fuel consumption. The balance is calculated monthly and is based on volume measurement and sulphur analysis of oil, and calculation of steam production and the measured water content of bio-fuel. SOx discharge in the flue gas is also measured as the sulphur balance of the ingoing fuel and the outgoing ash, where the SOx in the flue gas is obtained as the balance item.

Instructions for measurement and sampling of emissions to air are available from the instrument department.
Air emissions are allocated according to the fuel mix as per "Allocation model, Ortviken Paper Mill"

Turpentine
Allocated by wood/TMP consumption.

Waste
Waste volumes are registered via dispatch notes/reception notes and are summarised annually in environmental report 060.53

Description of specific flows

-->Name: Waste water

Type of method (Data Type)
Monitored data, continuous
Descr. of acq. & processing of data (Method)
Mag, Krohne model M460/16 DN 600-T-HC.
Routines spec. in "Environmental report 060.35"
References (Literature Ref)
Environmental report 060.35
Other information (Notes)
The flow is common with LWC.

-->Name: Bentonite

Type of method (Data Type)
Financial information
Descr. of acq. & processing of data (Method)
Dispatch notes and monthly stocktaking.
References (Literature Ref)
Report from accounts department
Other information (Notes)
Common with LWC

-->Name: O2

Type of method (Data Type)
Financial information
Descr. of acq. & processing of data (Method)
Dispatch notes and monthly stock-taking
References (Literature Ref)
Report from accounts department
Other information (Notes)
Common with LWC

-->Name: Electricity ext

Type of method (Data Type)
Monitored data, discrete
Descr. of acq. & processing of data (Method)
Meters are read every month and summarised in elrappbygge1.xls, Sjölen. Internally generated electricity and externally purchased electricity is then allocated as per "Allocation model Ortviken Paper Mill"
References (Literature Ref)
Raw data in elrappbygge1.xls, Sjölen is summarised in JP2008OR.XLS

-->Name: Bio fuel

Type of method (Data Type)
Modelled data
Descr. of acq. & processing of data (Method)
Measurement by timber measurement society and monthly stock taking, is summarised in Fördel96c.xls, Sjölen.
Allocation between NEWS and LWC is done as per "Allocation model, Ortviken Paper Mill'. The result of the allocation is summarised in JP2008OR.XLS
References (Literature Ref)
Fördel96c.xls, Sjölen. Is summarised in JP2008OR.XLS

Other information (Notes)

The flow is measured together with LWC

-->Name: BSK

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Reception check and stock-taking, per month

References (Literature Ref)

Report from accounts department

Other information (Notes)

Common with LWC

-->Name: Dithionite

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Dispatch notes and monthly stock-taking

References (Literature Ref)

Report from accounts department

Other information (Notes)

Only used for manufacture of NEWS

-->Name: Heavy oil

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Oil level in tank is measured once a month and summarised in "fördel96c.xls, Sjölen". The total volume is then allocated between News and LWC as per "Allocation model, Ortviken Paper Mill". This allocation is done in "JP2008OR.XLS "

References (Literature Ref)

Raw data in fördel96c.xls, Sjölen
summarised in JP2008OR.XLS

Other information (Notes)

Common with LWC.

-->Name: Kaolin

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Dispatch notes and monthly stock-taking

References (Literature Ref)

Report from accounts department

Other information (Notes)

Only used for manufacture of NEWS

-->Name: NaOH

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Dispatch notes and monthly stock-taking

References (Literature Ref)

Report from accounts department

Other information (Notes)

Common with LWC

-->Name: Starch

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

Monthly stock taking

References (Literature Ref)

Report from accounts department

Other information (Notes)

Only used for manufacture of NEWS

-->Name: Spruce wood

Type of method (Data Type)

Financial information

Descr. of acq. & processing of data (Method)

VMF measurement and monthly stock taking. This is summarised in" JP2008OR.XLS".

References (Literature Ref)

Summarised in JP2008OR.XLS

Other information (Notes)

Common with LWC

-->Name: Surface water

Time period (Date Conceived)

calendar year 1999

Type of method (Data Type)

Monitored data, continuous

Descr. of acq. & processing of data (Method)

Input flow same as output flow

-->Name: CO_2 bio

Type of method (Data Type)

Modelled data

Descr. of acq. & processing of data (Method)

Calculated from fuel mix and emission factors in environmental facts. Fuel mix is prepared from "Environmental report 060.53" routines

References (Literature Ref)

Environmental report 060.53 and Environmental facts, Svensk Energiförsörjning

Other information (Notes)

Common with LWC

-->Name: SO_2

Type of method (Data Type)

Monitored data, discrete

Descr. of acq. & processing of data (Method)

Total quantity of SO_2 discharge is summarised with the following information and routines:
Analyses: Tot.S, Oil:D4294-90, Biofuel, sediment, bottom ash and fly ash: SCA-F 2691
The summary is specified in routine "Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC

-->Name: NOx

Type of method (Data Type)

Monitored data, continuous

Descr. of acq. & processing of data (Method)

Automatic, continual measurement with NDIR (NO) (H&B Radgas 1G) and converter registers NO_2 volumes. Summary acc. to "Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC

-->Name: COD

Type of method (Data Type)

Monitored data, discrete

Descr. of acq. & processing of data (Method)

Measurement method: SS028142. Routines specified in " Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC

-->Name: Susp solids

Type of method (Data Type)

Monitored data, discrete

Descr. of acq. & processing of data (Method)

Measurement method: SS028112. Routines specified in " Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC-->Name: P-tot

Type of method (Data Type)

Monitored data, discrete

Descr. of acq. & processing of data (Method)

Measurement method: SS028102. Routines specified in "Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC

-->Name: N-tot

Type of method (Data Type)

Monitored data, discrete

Descr. of acq. & processing of data (Method)

Measurement method: SS028101. Routines specified in " Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53

Other information (Notes)

Common with LWC

-->Name: CO2 fossil

Type of method (Data Type)

Modelled data

Descr. of acq. & processing of data (Method)

Calculated from fuel mix and emission factors in environmental facts. Fuel mix is prepared as per routines in "Environmental report 060.53"

References (Literature Ref)

Environmental report 060.53 and environmental facts, Svensk Energiförsörjning

Other information (Notes)

Common with LWC

-->Name: Electricity int

Time period (Date Conceived)

Calendar year 1999

Type of method (Data Type)

Monitored data, continuous

Descr. of acq. & processing of data (Method)

Meters are read every month and summarised in elrappbygge1.xls, Sjölen. Internally generated electricity and externally purchased electricity is then allocated as per "Allocation model Ortviken Paper Mill". The allocation is done in JP2008OR.XLS

References (Literature Ref)

Elrappbygge.xls, Sjölen Summarised in JP2008OR.XLS

-->Name: Ashes

Time period (Date Conceived)

Calendar year 1999

Type of method (Data Type)

Derived, mixed

Descr. of acq. & processing of data (Method)

Monthly weighing and summarising. Routines for summarising specified in "Environmental report, annual, reg. no. 060.53". Allocation between News and LWC is done as per "Allocation model, Ortviken Paper Mill"

References (Literature Ref)

Environmental report annual, reg. no. 060.53

Other information (Notes)

Common with LWC

-->Name: Industrial waste

Time period (Date Conceived)

Calendar year 1999

Type of method (Data Type)

Derived, mixed

Descr. of acq. & processing of data (Method)

Monthly weighing and summarising as per routines in "Environmental report annual, reg. no. 060.53"

References (Literature Ref)

Environmental report annual, reg. no. 060.53

Other information (Notes)

Common with LWC

Example of a composite model

An example of the overall documentation for a composite model is given below.

Description of model content

Name (Name)

Skoghall Mill, BM 8, Coated grades, for response to specific customer enquiries

Scope/Type of system (Process Type)

Gate to gate

Address/geographical position (Site)

Skoghall Mill, Box 501, SE-663 29 Skoghall

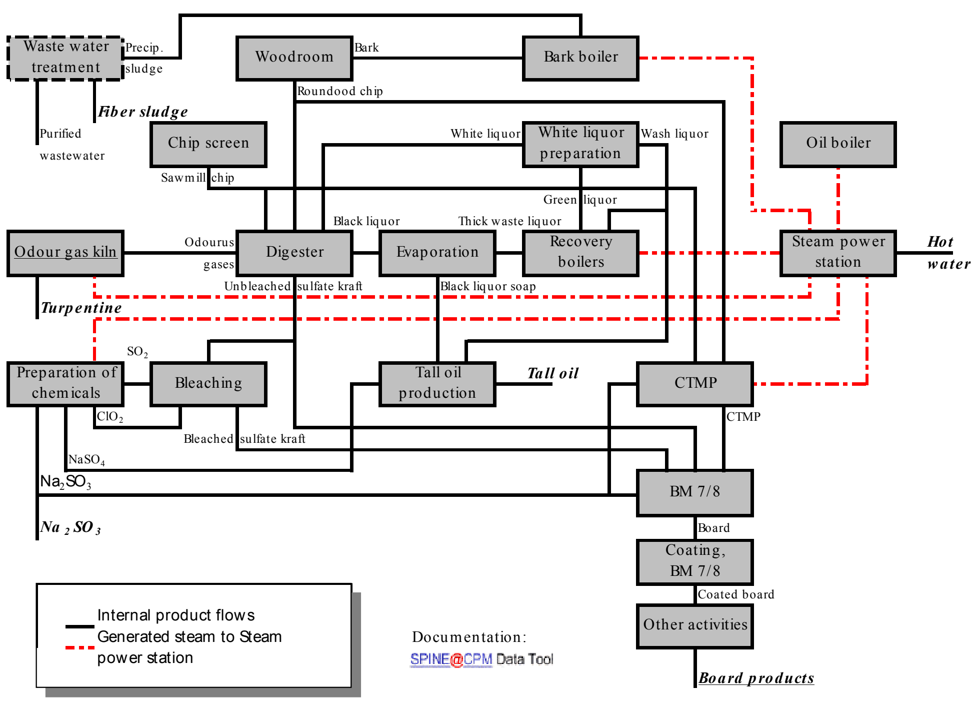
Description (Function)

The Skoghall Mill produces board for packaging of liquid and solid foodstuffs. Sulphate pulp is made for this (including a certain proportion of ECF bleached) and CTMP (mostly unbleached).

Owner

Stora Enso Packaging Boards

Flow chart



Description of choices made when preparing the model

Background, purpose and field of application

Target group (Intended User)

Environmental department at Skoghall Mill

Background/general purpose (General Purpose)

The model has been constructed with high resolution, to permit differences between various products with small variations in pulp composition, grammage etc. to be studied. The documentation of the included processes should form a reviewable basis for environmental calculations done on Skoghall Mill's products and processes.

Specific purpose/field of application for the model (Detailed Purpose)

This composite model provides a basis for environmental profiles for coated products produced at BM 8, as response to specific customer enquiries.

Commissioner (Commissioner)

Management group, Skoghall Mill

People who were responsible for preparing and reviewing the model

People responsible for preparing the model (Practitioner)

Ola Svending, Stora Enso Environment, Box 9090, 650 09 Karlstad. The material will be handed over to the Development Engineer, Environment at Skoghall Mill.

Functional unit

Chosen functional unit (Functional Unit)

1 ton coated board produced at Skoghall Mill's BM 8 (Board machine 8)

Description and justification of the chosen functional unit (FU Explanation)

The moisture content of the board is assumed to be 7%.

System boundaries

Towards the nature system (Nature Boundary)

-- Resources --

The model can be seen as a gate-to-gate system, where input flows of energy and materials to the included processes are not followed from the cradle. The parameter and its quantity, unit and supplier are reported instead, to permit system expansion.

-- Emissions to water --

The receiving water after purification is Kattfjorden in Lake Vänern.

-- Emissions to air --

Emissions to air are measured or estimated as they leave the technical system (after any purification) and reach the atmosphere.

-- Solid waste --

Solid waste to landfill is placed on Skoghall Mill's own landfills. For hazardous waste and other residual products, the means of processing each fraction is defined.

Towards other technical systems (Other Boundary)

Other boundaries are described for each resource or product flow by specifying the supplier or external customer.

Time system boundaries (Time Boundary)

Flow data apply to the year which is noted in conjunction with each flow data. The time frames for the environmental effects which might arise as a result of the flows can be considerably longer, for example climate changing effects should be seen over a 100 year period.

Geographical system boundaries (Geography Boundary)

The model described refers to Skoghall Mill, located about 10 km south of Karlstad.

Allocations and/or system expansions

Allocations made (Allocation)

No allocation of the environmental impact of by-products has been done. All steam which is consumed inside the mill is assumed to have been generated in the same way, i.e. the pulp mill is not assumed to be self-sufficient for steam. Internal electricity is assumed to have been generated by the same "average" steam.

Description of acquisition and processing of data

Time period (Date Conceived)

1 January 1999 – 31 December 1999

Description of acquisition and processing of data (Method)

The input and output flows for the composite model are calculated by means of the data for the input and output flows of each included process.

Most parameters for included processes are measured/analysed. Others are calculated (such as CO_2 calculated from the carbon content of the fuel) or are followed up from supplier invoices.

References (Literature Ref)

Most measurement values have been taken from Skoghall Mill's process monitoring system, WinMops. Other sources include the accounting follow-up system, MÄSK.

Instructions for use of the model and administrative information

Recommendations for use of the model and assessment of data quality

Advice and recommendations for application of the model (Applicability)

When the environmental profile shall be calculated, each included process is transferred from the SPINE@CPM Data Tool to the EcoLab environmental calculation software, using a so-called .xfr file. After that, the model is constructed using the flow schedule as above. If no changes are made to the included processes that need to be documented, it can then be re-used directly in EcoLab.

Appendix 6
Emission factors for CO_2 and other references for emission factors

Table B4:1 General CO_2 emission factors and energy values for different fuels.

Fuel	Unit	CO_2-emission factor [kg CO_2/GJ]	Energy value [GJ/unit]
Bio fuels			
Black liquor (70 % dry content)	1000 kg	126[8]	12,7[9]
Bark (50% dry content)	1000 kg	125[3]	8,4[4]
Waste wood	1000 kg	125[3]	19,2[4]
Sludge		110[3]	-
Tall oil soap (0,6% dry content)	1000 kg	-	20[10]
Tall oil (0,6% moisture content)	1000 kg	100[3]	37[5]
Methanol	1 m^3	-	15,6[11]
Tall oil pitch (0,06% moisture content)	1000 kg	70[5]	38[5]
Other bio fuels	1000 kg	100[12]	19,2[4]
Fossila bränslen			
Peat	1000 kg	106[7]	21[4]
Natural gas	1000 m^3	55[7]	38,9[6]
Heavy fuel oil (Eo 5)	1 m^3	77[7]	38,6[6]
Light fuel oil (Eo 1)	1 m^3	74[7]	35,9[6]
Coal	1000 kg	94[7]	27,2[6]

Other references

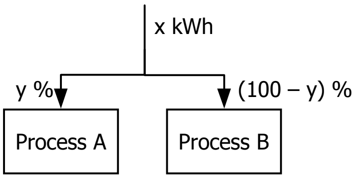
- *Emissions from combustion of various types of fuel*
  (sulphur, nitric oxides, carbon dioxide, particles and hydrocarbons)
  Miljöfakta, Svensk Energiförsörjning, Box 8324, 104 20 Stockholm (please refer to insert 5.5, page 5(12))
  Refers to Ny teknik 96:3, SCB
- *Emissions of nitric oxides during combustion of various types of fuel*
  Miljöfakta, Svensk Energiförsörjning, Box 8324, 104 20 Stockholm (please refer to insert 5.5, page 6 (12))
- *CO_2 content of various types of fuel*
  Nordic ecolabelling, Soft crêpe paper 005 Proposal for comment 1, 2 February 2000.
  Sources cited by this document include Statistics Sweden; Energy statistics 1995,
  SFT report 9513; Combustion installations. Guide for project planners,
  SFT: Discharge coefficients (Audrun Rosland, 1997)

[8] Emission factors based on mass balances and empirical experience, agreed upon by the Swedish pulp and paper industries. Source: Stora Enso Environmental Report 1999.
[9] MJ/kg dry substance
[10] Source: Statistics Finland, IPCC. (http://statfin.stat.fi)
[11] Source: Energifakta, Svensk Energiförsörjning, oktober 1998.
[12] Source: MiljöFakta, Svensk Energiförsörjning, januari 2001.

Appendix 7
Allocation

Whenever possible, allocation should be avoided by a more detailed model. When allocation is unavoidable, it should be done in accordance with the requirements set by the stakeholder.

Two different types of allocation are used at plant level:
1. A measured flow is allocated to two or more processes. The allocation can be done by means of physical relationships and assumptions. For example: an electricity meter measures the electricity consumption x kWh. This consumption is used by two included processes; Process A and Process B. To allocate the consumption of electricity on the two processes, the major electrical loads in the processes are charted and an assumption about the percentage balance between them is used.



2. Input and output flows for a process are allocated to two or more products. The allocation can be done by means of physical relationships or by means of economic value for the products. For example: a process produces two products; Product A and Product B. Product A costs 7500 kr/ton and Product B costs 2500 kr/ton. To assign the environmental impact of each product, an allocation by means of economic value is done. This distributes the total in- and output flows to each product. 75% of the environmental impact is allocated to Product A and 25% of the environmental impact is allocated to Product B.