EFORWOOD
Tools for Sustainability Impact Assessment

ToSIA Handbook documenting ToSIA functionality and use

Tim Green, Wendelin Werhahn-Mees and Tommi Suominen

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Preface

This report is a deliverable from the EU FP6 Integrated Project EFORWOOD – Tools for Sustainability Impact Assessment of the Forestry-Wood Chain. The main objective of EFORWOOD was to develop a tool for Sustainability Impact Assessment (SIA) of Forestry-Wood Chains (FWC) at various scales of geographic area and time perspective. A FWC is determined by economic, ecological, technical, political and social factors, and consists of a number of interconnected processes, from forest regeneration to the end-of-life scenarios of wood-based products. EFORWOOD produced, as an output, a tool, which allows for analysis of sustainability impacts of existing and future FWCs.

The European Forest Institute (EFI) kindly offered the EFORWOOD project consortium to publish relevant deliverables from the project in EFI Technical Reports. The reports published here are project deliverables/results produced over time during the fifty-two months (2005–2010) project period. The reports have not always been subject to a thorough review process and many of them are in the process of, or will be reworked into journal articles, etc. for publication elsewhere. Some of them are just published as a "front-page", the reason being that they might contain restricted information. In case you are interested in one of these reports you may contact the corresponding organisation highlighted on the cover page.

Uppsala in November 2010

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EFORWOOD

Tools for Sustainability Impact Assessment

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ToSIA Handbook documenting ToSIA functionality and use

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I. Acronyms

BWC	Baden-Württemberg Case Study
C	Carbon
CBA	Cost-Benefit Analysis
cf	Conversion factor
DBC	Database Client
EU FWC	European Forestry-Wood Chain
FWC	Forestry-Wood Chain
GUI	Graphical User Interface
ha	Hectare
ICS	Iberian Case Study
m3	cubic meter
M2	Forest resource Module
M3	Forest to industry interaction Module
M4	Manufacturing, ind. processing and converting Module
M5	Industry to consumer interaction Module
MCA	Multi-criteria Analysis
PA	Policy Analysis
SCS	Scandinavian Case Study
SIA	Sustainability Impact Assessment
ToSIA	Tool for Sustainability Impact Assessment
WP	Work Package

II. Terminology

Case study	Case Studies in EFORWOOD refer to the application of ToSIA in the second phase of EFORWOOD to ensembles of FWCs, which are regionally specified. Depending on the specification of the regional FWC, either the forest resources, the industrial production capacity, the product consumption, or the entire FWC are restricted to a geographical region (see Specification of a FWC). There are three regional case studies in the EFORWOOD project: (i) Scandinavian production Case study, (ii) Baden-Württemberg Case study, and (iii) Iberian Peninsula consumption Case study. In addition there was a European case study.
Conversion factor	Mass in tons of Carbon is used as the information carrier for FWCs in ToSIA. The information carrier is the base unit (reference unit), which is used internal to the application, to ensure that all information is comparable, and consistent. The material flows between forest resource management and consecutive processes along the FWC are products which contain a percentage of Carbon. Each individual product needs a conversion factor from original mass to mass of contained pure Carbon. Additional conversion factors were established to enable the ToSIA output using different units such as m^3 of roundwood or tons of marketable end-products. Within M2, forest growth will be reported on a per hectare basis, thus need arises to convert from area-based figures to mass based figures. All conversion factors were supplied by module experts.

Forestry-Wood Chain	A FWC represents a set of Processes by which resources from forests are converted into services and products. In EFORWOOD, FWCs are dealt with at various levels. The highest level is the European FWC which is defined as EU 25 plus Norway and Switzerland (EFTA countries). There are many kinds of FWCs at the more detailed levels. They can be geographically defined or linked to the main processing chains (paper, wood-products, bio-energy etc.).
Indicator	Indicators show something or point to something. An indicator can thus be defined as: "A parameter, or a value derived from parameters, which points to / provides information about / describes the state of a phenomenon / environment / area with a significance extending beyond that directly associated with a parameter value (OECD, 1993)." "An indicator is a means devised to reduce the large quantity of data down to its simplest form retaining essential meaning for the questions that are being asked of the data". The term indicator should be differentiated from other terms that are sometimes used similarly or confused with this: Criteria / Impact Issue/ Sustainability Theme. Within the EFORWOOD project, indicator values per material flow are taken from the database client, where the set of indicator are introduced. In ToSIA, the calculated process indicator values are determined based on the material flow through the process and the indicator values per material flow from the database. Calculated module and FWC indicator values are then determined by aggregating the calculated process indicator values along the chain taking into account the system boundaries selected by the user.
Links	As soon as two processes with its input and output product are defined the processes are linked with each other. A link symbolizes where the output material flow of one process is going to.
Module	Modules are the subprojects of EFORWOOD. Modules combine processes together in logical groups (see also Processes and Stages of the FWC). Modules present the highest hierarchical level of a FWC. Modules are handled by different groups of institutions and so data and understanding of processes may differ from module to module. However, from the ToSIA database point of view, the module is just one of the classifiers for the processes. There is no difference in database structure between the modules.
Process (in a FWC); production process	The most important element of a FWC is a Process. Transformation of energy and materials takes place in a Process. In a process wood material will change its appearance and/or move to another location. Every process requires inputs and produces outputs. Inputs for each Process in a chain are supplied by outputs of previous Processes. Therefore in case of the FWC we call inputs and outputs simply Products. Processes include planting trees, stand treatments, harvesting, transport, sawing, pulping, papermaking, printing, packaging, recycling, and energy production – or when needed subsets thereof.

Product	Products are the mass-based inputs and outputs of processes, such as spruce logs or finished wood furniture. The functional purpose of products is to link together processes to form chain structures. Products are expressed in mass units and for each product the conversion factor, for converting it to different units (e.g. tons of C, m3, ha) should be known. Processes can also receive input products from outside of the FWC system boundaries (e.g. non-wood material used in furniture manufacturing).
Product share (input/output)	A product share is used to divide the material flow (in carbon) of each process into the input or output products.
Reference future	Reference futures were calculated and modeled as possible prolongations over time from 2005 to 20025 as A1 and B2 for 2015 and 2025 and are based on IPCC scenarios. In short, A1 describes a future based on globalization, high economic growth, low environmental awareness; whereas B2 incorporates regionalization, moderate economic growth, more oriented towards environment. These futures differ in wood demand from European forests. A1 less domestic demand, more import, B2 more domestic demand.
Scenario	A scenario in the context of EFORWOOD is a combination of internal or external drivers and their impacts to the FWC. Different classes of drivers were studied: • Drivers external from EU and European FWC (e.g. market demand for forest products in China; climate change) • Drivers external from European FWC, but EU internal (e.g. EU subsidies for renewable energies) • Drivers internal of the FWC (technical development) The scenarios result in alternative FWCs with different sustainability impacts compared to the current FWCs. Scenarios impacts can be evaluated with MCA and CBA evaluation methods.
Split ratio	A split ratio is used to divide one product to many (output) or merge many products to one (input).
Stage of a FWC	A module consists of several Stages. Stages define natural steps in the FWC. One stage can be characterized by alternative processes, which means that scenarios can be produced by switching to different processes within the same stage. There are no consecutive processes within one Stage (i.e. process of harvesting and the process of wood transportation should be placed in two separate Stages).
Variant/ Alternative	A variant is an alternative FWC in terms of indicator values, volume flow and/or slight changes in topology, and only exist in connection to a baseline case study (= basic FWC). Variants exist in reference futures and scenarios.

1. Introduction

One of the main objectives of EFORWOOD was to develop a decision support tool for Sustainability Impact Assessment (SIA), which could be used for the European Forestry Wood Chain (FWC) and subsets thereof (i.e. selected Single FWCs and Case Studies with multiple regional and national FWCs). The tool was designed to help decision makers (e.g. politicians) as well as scientists to assess the impacts of changes in a FWC (e.g. a policy change or technological development) on sustainability. ToSIA aims to provide answers to so-called 'what if' questions, e.g.

What would be the impact on the sustainability of European FWC (forest sector) if the protection of forests in Europe was increased by 10% of the total forest area.

A FWC is structured in the following four parts: Forest resources management, Forest to industry interactions, Processing and manufacturing and Industry to consumer interactions. Each part of a FWC is made up of a set of processes. Every production process in the chain is characterized by a set of indicators covering environmental, economic and social aspects of sustainable development.

Within EFORWOOD significant resources have been used to collect the data on the FWCs for the European forestry-wood chain (EU FWC), the Baden-Württemberg Case Study (BWC), the Scandinavian Case Study (SCS) and the Iberian Case Study (ICS).

The basic steps of a sustainability assessment with ToSIA are: development of the FWC and entering of data into the database, loading of data into ToSIA, calculation of material flow and indicator results per process. The results can be viewed and assessed in ToSIA, further processed with the decision support tools integrated into ToSIA or exported for further analysis elsewhere.

The development of a FWC and entering of the data is done with the EFORWOOD Database Client (DBC). From there the data is exported and loaded into ToSIA.

Integral parts of ToSIA are the decision support tools: Multi Criteria Analysis (MCA) and Cost Benefit Analysis (CBA). Both programs were developed separately from ToSIA. Users are referred to the relevant deliverables describing the tools (see § 6.5).

This user manual explains in brief the background of the project and the methodology of ToSIA. However, the main emphasis of this document lies in the explanation of the functionalities of ToSIA (version 1.0) at the end of the EFORWOOD project (2010). A more detailed description of the ToSIA method can be found in the EFORWOOD Deliverable D1.4.6.

Two types of ToSIA users are distinguished: (i) the non-expert user and (ii) the expert user. The non-expert user uses the specific chains and processes as defined in the EFORWOOD project. The expert user can use the EFORWOOD database client (DBC) to define the chains and processes files.

2. Basic concept of ToSIA

The SIA of the forest-based sector in EFORWOOD builds on the conceptual representation of FWCs as chains of value-adding production processes (Päivinen and Lindner 2008) (Lindner, Suominen et al. 2009). In Figure 1 the chain of production processes (shaded boxes) connected by an arrow line represent one simple FWC starting with forest resource management and ending with the end-of-life of a wood product. The basic concept of the representation of a FWC in ToSIA includes (i) the basic chain structure, and (ii) the wood flows through the chain of production processes. Sustainability impacts are measured in terms of environmental, economic and social indicators which are linked to the production processes of the FWC.
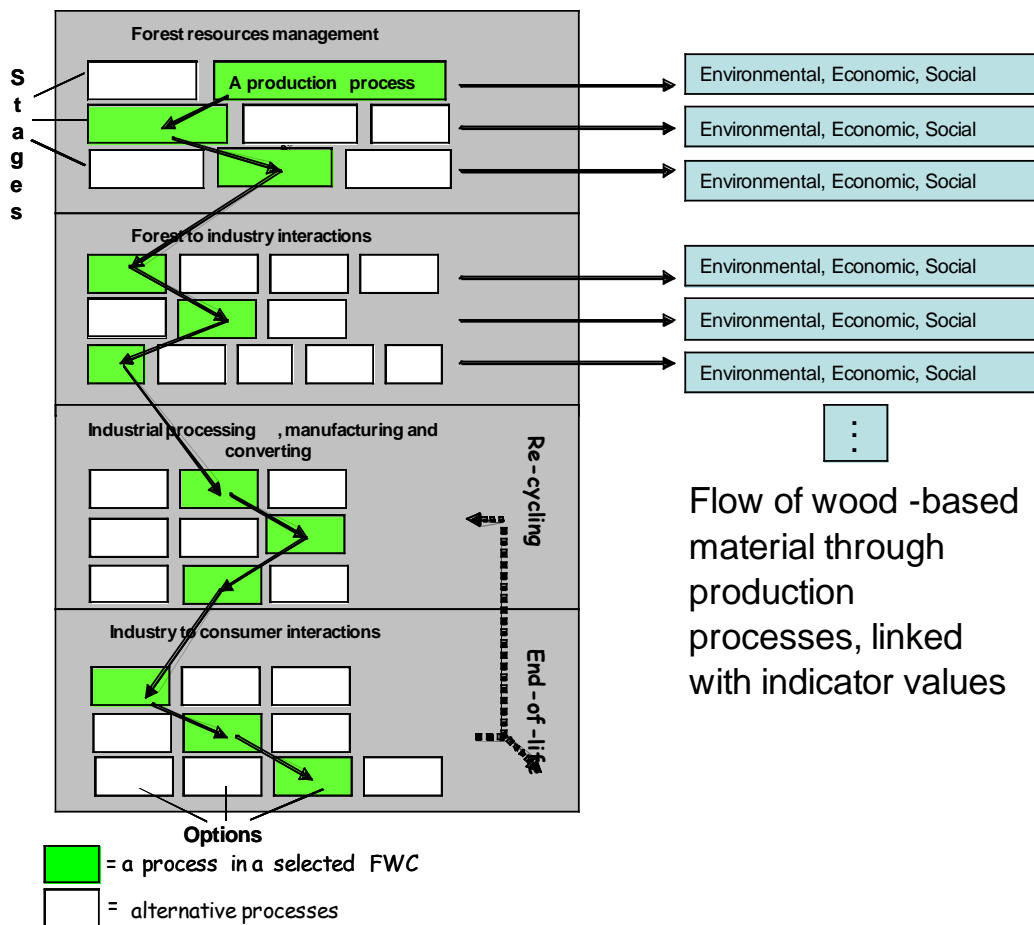

Figure 1. This is the methodological framework to assess the sustainability impacts of FWCs. The boxes (white, green) represent processes in one FWC, each process is linked with a set of environmental, economic and social indicators.

EFORWOOD is focusing on the assessment of sustainability impacts by comparing alternative FWCs in terms of their indicator performance. The work flow of conducting sustainability impact assessments with ToSIA is depicted in Figure 2.
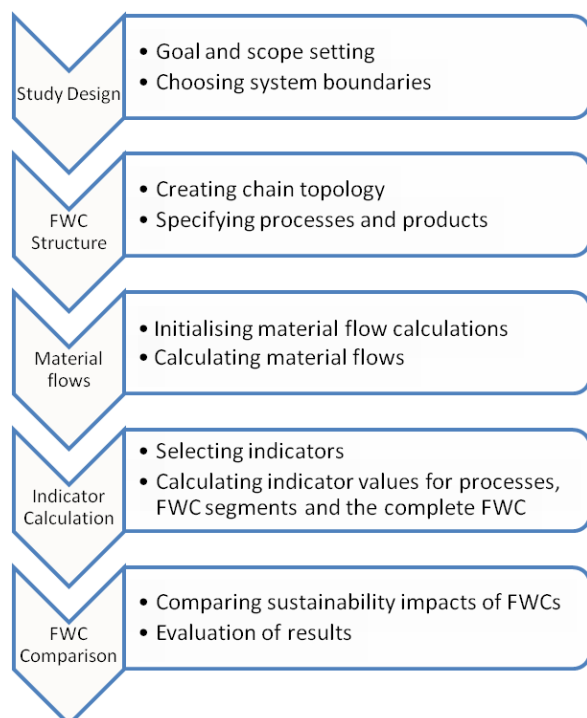
Figure 2. Work flow indicating steps in conducting a sustainability impact assessment for the FWC using ToSIA

A crucial concept of ToSIA is that all processes at different stages of the chain are calculated as if they were occurring simultaneously because the impact assessment is calculated for the whole FWC for one specific year. The dynamic evolution of forests over time is excluded in the assessment of a baseline year (2005 in EFORWOOD).

For more detailed information on the methodology of ToSIA and the EFORWOOD applications (Case Studies, EU FWC) please consults the following deliverables and journal publications:

-   D1.4.6/D1.4.5 (update) Documentation of ToSIA developments up to month 52 – Case Study applications / ToSIA version 1.0
-   Lindner M, Suominen T, Palosuo T, Garcia-Gonzales J, Verweij P, Zudin S, Päivinen R (in press) ToSIA – A Tool for Sustainability Impact Assessment of Forest-Wood-Chains. Ecological Modelling doi:10.1016/j.ecolmodel.2009.08.006
-   Päivinen R, Lindner M, Rosén K, Lexer MJ (submitted) A concept for assessing sustainability impacts of forestry-wood chains. European Journal of Forest Research.
-   Lindner M, Werhahn-Mees W, Suominen T, Vötter D, Zudin S, Roubalova M, Kneblik P, Brüchert F, Valinger E, Guinard L, Pizzirani S, Päivinen R (manuscript submitted) Conducting sustainability impact assessments of forestry-wood chains – examples of ToSIA applications. European Journal of Forest Research

3. Installation of ToSIA

ToSIA can be run on computers running any operating systems, which support Java. However, the MCA part of ToSIA can only be run under MS Windows operating systems.

ToSIA requires Java version 6 (or later). The latest version of Java can be downloaded at http://www.java.com/

Download. The zip file for the installation of ToSIA can be downloaded by EFORWOOD partners from the EFORWOOD portal at http://www.EFORWOOD.org. Other users wishing to get access to ToSIA can send an email to ToSIA@efi.int. In the future, the ToSIA management and user group (TMUG) will manage such requests.

Some of the data files needed to run ToSIA for the EU Forest Wood Chain (EU-FWC) are very large (around 100 MB). Therefore computer memory may be an issue for some ToSIA users. It is recommended that 1GB is available when running ToSIA to make the calculations for the EU-FWC.

If you experience problems running ToSIA, please contact the development team at "ToSIA@efi.int" and provide details of the used operating system, Java version, and how much computer memory is available. Text captured from the Command Prompt (a black text-only screen) is often very helpful, but in case of failed loading this can be copied also from the data loading -tab.

4. Users

Two types of ToSIA users are distinguished: (i) the non-expert user and (ii) the expert user. The non-expert user uses the specific chains and processes as defined in the EFORWOOD project. The expert user can use the EFORWOOD Database Client (DBC) to define the chains and processes files.

4.1.   Non-expert user

'Non-expert users' are those users who want to run ToSIA using predefined chain and process files. These files have been defined by the groups within the EFORWOOD project. These users can use ToSIA to make comparisons of variants of the predefined chains.

The relevant sections of this manual for non-expert users are from chapter 6.2 onwards.

4.2.   Expert user

'Expert users' are those users who have knowledge of the EFORWOOD Database, and want to use the Database Client to define the chain and process files to be loaded into ToSIA. As this document covers exclusively the using of ToSIA, expert users should refer to the respective deliverables.

For more detailed information on the EFORWOOD database and Database Client please consult the deliverables:
- D1.2.1 Analysis of data flow, data availability and level of harmonization of data collection methods (Database structure)
- D1.2.5 Database of case studies and EU-FWC and summary report of database development
- Database Client – User Manual version January 2010 – download from EFORWOOD portal[1]
- D1.2.7 Database of case studies and summary report of database development
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For more detailed information on the decision support tools developed in the EFORWOOD project and integrated into ToSIA please consult the deliverables:
- PD1.5.2 A protocol for the evaluation of MCA-models for use within EFORWOOD, including the outcome of stakeholder consultations within EFORWOOD and the software development framework (with wp1.4)
- PD1.5.3 A protocol for performing CBA and CEA within EFORWOOD, taking into account the software development framework and data availability
- D1.5.7 A report on MCA and CBA evaluation of the EU FWC

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[1] www.EFORWOOD.com

5. Data Preparation – EFORWOOD Database Client

The FWC is understood in ToSIA as a flexible structure linking production processes with input and output products. This structure is flexible due to the fact that it can be altered in shape (i.e. the arrangement and amount of processes) while still using the same static information on processes and products. Figure 3 shows a screen shot of the EFORWOOD Database Client (DBC).

Figure 3. Screen shot of the EFORWOOD Database Client. On the left hand side a visualisation of the Baden-Württemberg Case Study. The coloured boxed represent single processes; the black lines are the linkages between the processes/products of a process. On the right hand side information on the selected process is displayed. In the up left corner the functionality to download the ToSIA input data (red box)

The basic components needed to build up the topology of a FWC are (Table 1):
   a) Processes (in a FWC)
   b) Products
   c) Links

The topology is built in in the DBC using the Chain editor. New processes and products can be created or the stock of already existing processes and products can be used. New processes have to classified after predefined attributes e.g.: process country, process region, process unit. Links are drawn between the output and input products of two processes.

Next, the required data related to the processes, products and links have to be inserted (Table 1).

Table 1. The three core components of the topology of a FWC and its attributes. For each attribute comments and/or examples are given

Components	Attributes	Definition/example
Process	- Name, time, description, assumptions, geo-information, contact person	Basic information on the process and the year/scenario the data is applicable for
	- Process unit	All indicator data and conversion factors refer to the unit stated here, e.g. m^3 or t
	- Shares of input and output products	Needed to calculate the distribution of the material flow amongst the products. The shares always refer to the total carbon flow
	- Indicator data	Data is process specific, the basis is always the total input material flow, given per process unit; e.g. Labour costs - $€/m^3$
	- Conversion factor to EURO	Data process specific, monetary value of the product at the production stage
Product	- Conversion factors (cf): • product unit to ha • product unit to m3 • product unit to t • product unit to t of C	Needed to convert material flow into different units, cf to ha only required in the forest management part of FWC, the cf to carbon always required
	- Product assumptions	Basic information on product, e.g. tree species, moisture content
Link	- Split ratios • one to many • many to one	Defines how the material flow is divided, if one product is linked to many products/processes or vice-versa

Last but not least the ToSIA calculation need to be initialized. Depending on the set up of the application the initialization takes place in different sections of the FWC.

After the topology of the FWC is set and all required data is inserted, the data is downloaded from the DBC (see figure 3). The downloaded data consists out of two files: process XML and chain XML.

6. Use of ToSIA – Overview

6.1.   Flow initialization

How/where to initialize the flow calculation?

The initialization is the starting point of the material flow calculation and can happen in different places. The place of initialization depends on the perspective of the case study. ToSIA is designed in such a way that different perspectives for the sustainability impact assessment are possible. Figure 4 illustrates alternative ways of defining FWCs. The idea is to make it possible to analyze sustainability impacts of for example:

- the total use of a specific forest type or the entire forest in a particular region;
- an industry process where input products come from different sources and the products are later further refined;
- the composition of processes resulting in a single end-product (consumer-defined Iberian Case Study) or the consumption of wood-based products in a target region (in a regional case study).
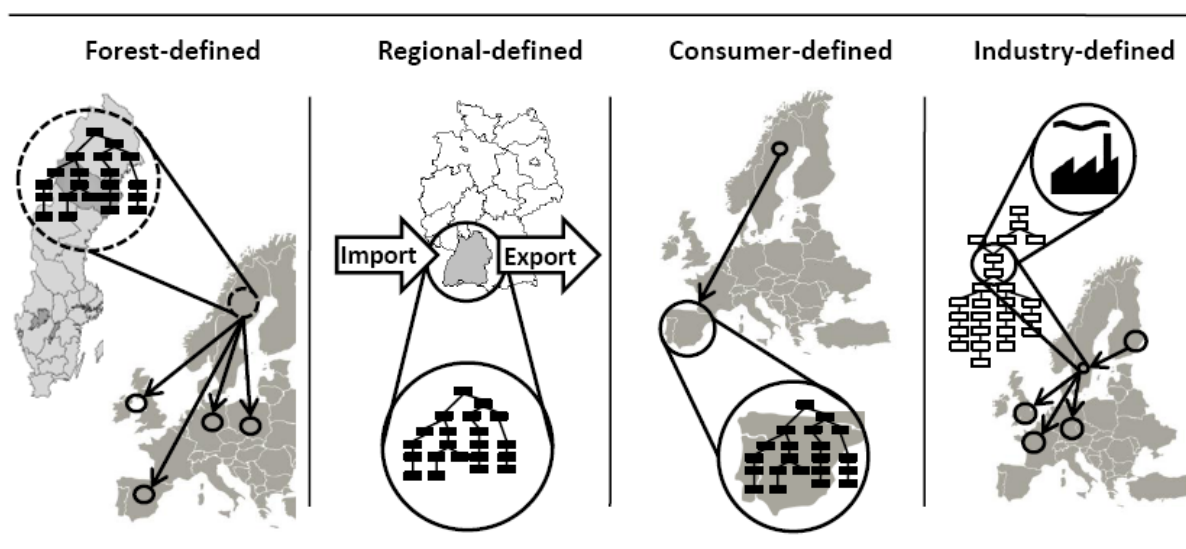

Figure 4. Examples of alternative ways of defining FWCs from the EFORWOOD project

The forest-defined FWC is initialized in the forest management part of the chain. The forest area and the annual harvesting amounts of the defined region (e.g. province, region or continent) are used to initialize the flow calculation.

The system boundaries of the analysis vary depending on the specification of the FWC. In a forest-defined FWC, the forest resource is specified (e.g. Scots pine forests in Northern Sweden) and only this resource is followed throughout the FWC. In a consumption-defined regional case study, the consumed wood-based products of a target region are specified and the FWCs needed for their production are followed backwards to the forest resources. In the case of a regionally-defined FWC, only the forest resources, production processes and consumption that occur within the selected region are analysed. The industry defined case study is focusing on one or several production facility/ies with specific production capacity, infrastructure etc. Only the processes related to the production facility are analysed.

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Depending on the perspective, the initialization takes place as follows:
- Forest resource (forest and region-defined), the material flow is given by the indicator 22.1 *Forest and Other Wooded Land Area* (units ha).
- Import initialization (Import processes), the material flow is given by the indicator 3.1.1 *Imports of wood and products derived from wood – Volume* (units tons or m^3).
- Export initialization (Export processes), the material flow is given by the indicator 3.2.1 *Exports of wood and products derived from wood – Volume* (units tons or m^3).
- In-chain initialization, the material amount is given by the indicator 99.0 Process initialization value. This is used when initialization does not happen by using the Forest Area indicator, but e.g. somewhere in the middle, or end of the chain.

The material flow and the place where the calculation was initialized will be documented on the graphical interface of ToSIA. For more detailed information on this topic please consult the deliverable D1.4.6 chapter 2.3.

6.2.   Preparation/Loading of data

Open ToSIA by double clicking on the "run_ToSIA" shortcut. Two windows will open: (1) a command line window; and (2) a graphical user interface (GUI).

In the GUI window, click on "Data preparation" (Figure 5). Click on the Browse buttons and find the Chains file and the Process file which you prepared and downloaded from the DBC. Click "Load chains" (blue arrow) if both chains are selected. The button "Load default chains" will load a FWC already stored in the ToSIA data package.
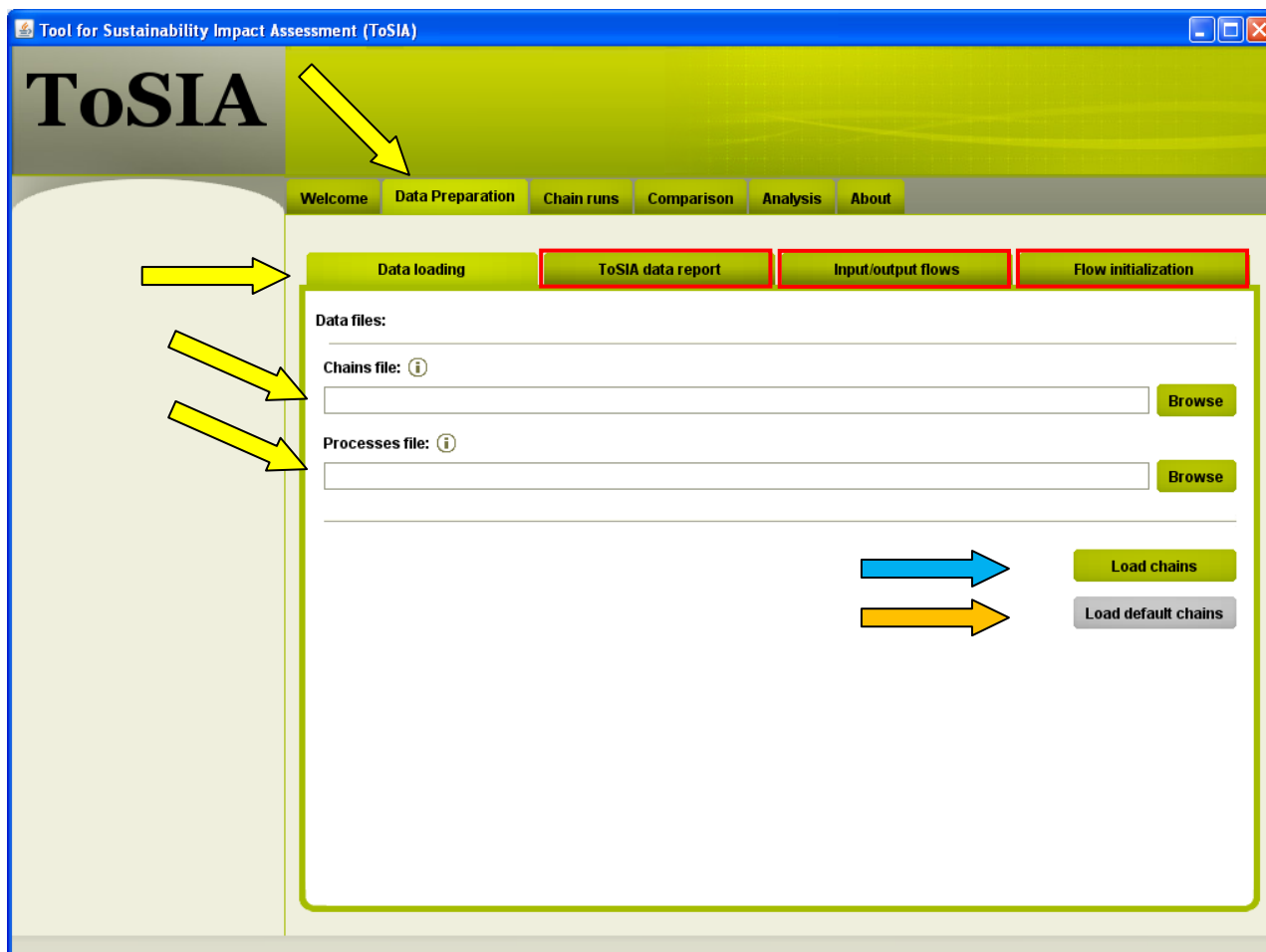

Figure 5. Loading the data in ToSIA, the default chains can be loaded pressing the button marked with the orange arrow, after the loading is completed the ToSIA data report, the Input/output flows and the Flow initialization can be view (red boxes)

ToSIA will load the data; depending on the complexity of the chains and processes this may take some seconds or minutes. You will get a message as soon as the loading of the data is complete.

If the chains or processes files contained errors, then you will get an error message and will not be able to continue running ToSIA. Read the error message and fix the problem in the data using the DBC. Close ToSIA and try reloading the chain and process files.

If the loading was successful the tab ToSIA data report, Input/output flows and Flow initialization can be select (red boxes in figure 5):

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- *ToSIA data report*
  This report gives the user information on the consistency of the data related to the material flow calculations i.e. split ratios, conversion factor and product shares. More details in chapter 6.6.
- *Input/output flows*
  All material flows in carbon are listed, entering and leaving a process. For more detail see chapter 6.6.
- *Flow initialization*
  This report indicates where and with what amounts (material flow in carbon) the ToSIA calculations were initialized. See also chapter 6.1.

6.3.   Chain Runs

The loading of the chain and process data is now complete and you can continue with the selection of the chain (Figure 6). Click on the tab "Chain runs" (yellow arrow) and select the chain and the variants of the chain from the dropdown list – year, reference future and scenario (blue arrow). Then press the "Calculate" button (orange arrow). The results will be now shown in the pane on the right hand side of the window. You have the choice between different ways of how the results are presented (orange arrow): table, chart and flow. The table and chart show the calculated indicator results, where as the flow shows the calculated material flow per process.

Figure 6. Switch to the tab "Chain runs" (yellow arrow), click on "New run" (green arrow), select the chain (blue arrow) and calculate the FWC by clicking on "Calculate" (orange arrow), next save the ToSIA run (click "Save run"). Different runs can be view when select the chain in the pane on the left (green box), when moving the mouse over a calculated result in the table view, a tooltip shows additional data (red box)

Next you can save the ToSIA runs by pressing the save button (orange arrow). You will be asked to give the ToSIA run a name. Then press save and the ToSIA run appears in the up left column under the "New run" button (green arrow). If additional runs shall be calculated press "New run" (green arrow) and follow the same procedure as already explained.

With the "Clear Session" button in the left bottom corner all saved ToSIA runs will be deleted from the ToSIA memory. If only one ToSIA run shall be removed pres1s the "X" sign on the left side on the ToSIA run (green box).

Select visualization

- *Table*

In the table view, you can also choose whether to display the calculated indicator results per process or aggregated by module or chain (figure 6, black arrow). Furthermore you can choose whether to show all indicators, only economic, social or environmental indicators are shown, or to select subset of the indicators (figure 7, 8).
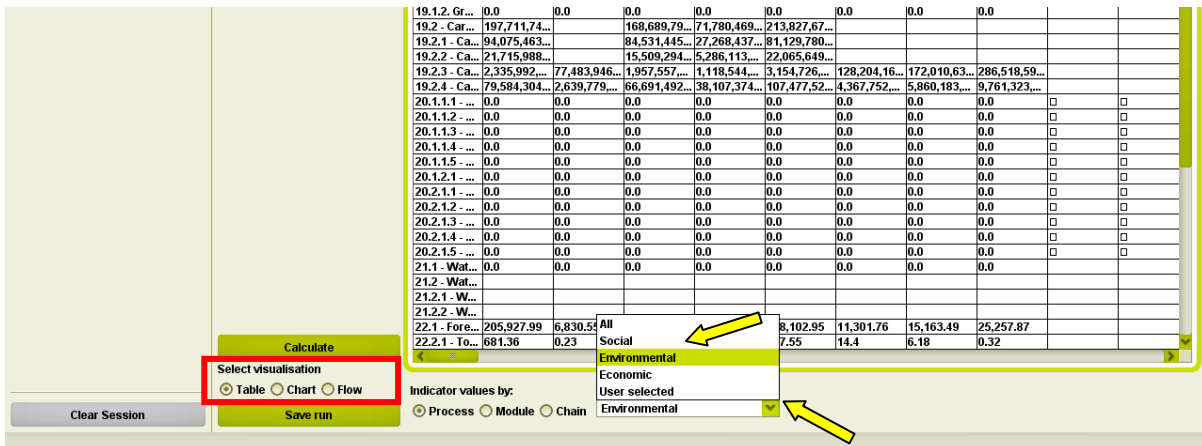

Figure 7. The table is selected as visualization, shown indicator: selecting only Social, Environmental or Economic indicator or User selected
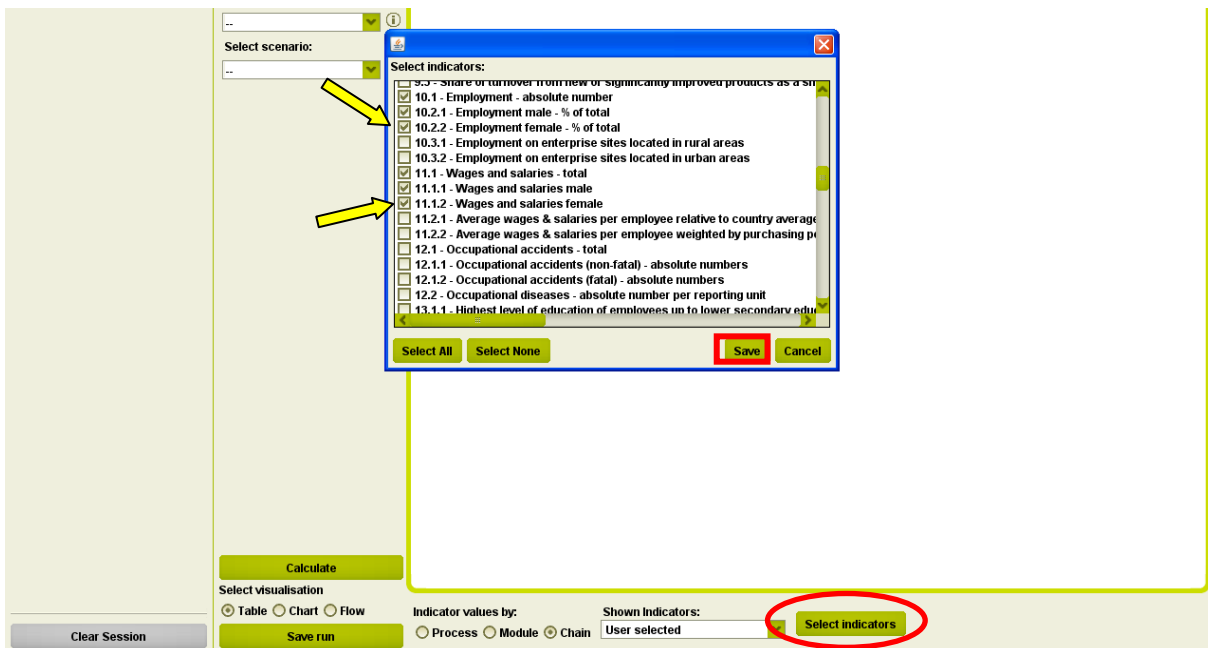

Figure 8. User selected indicators, after you made your selection (yellow arrow) click on "Save". The results will be immediately displayed in the main pane

- *Charts*

When selecting the chart visualization, the aggregated indicator results by module are shown (Figure 9). The charts/images can be exported from ToSIA.
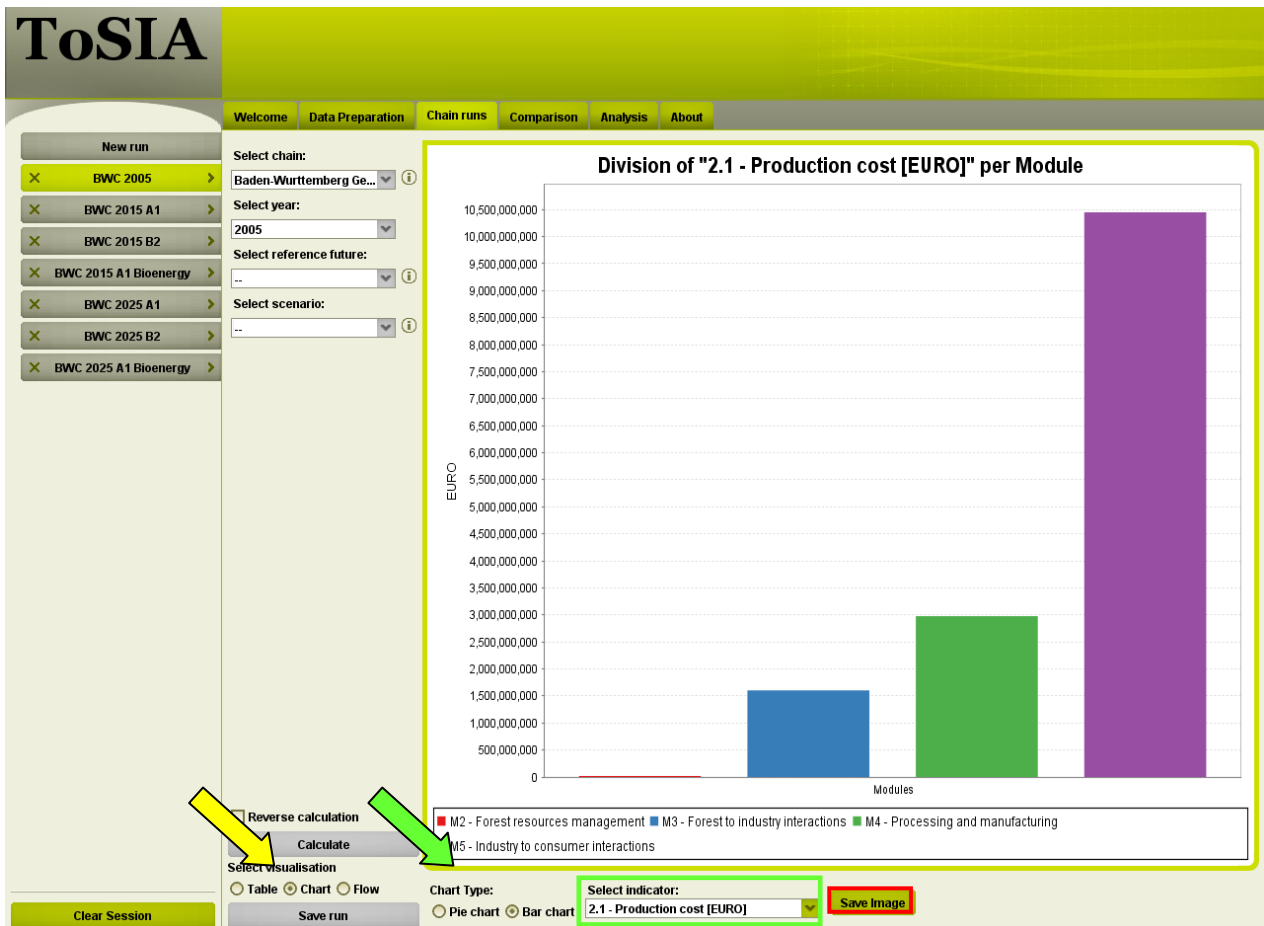
Figure 9. Selected visualization "Chart" (yellow arrow), then choose the chart type (green arrow); Pie chart or Bar chart, in this example the Bar chart was selected, next select a indicator (green box), the chart can be saved on the computer when pressing the Save Image button (red box)

The indicator results presented in charts are always aggregated by module. You can choose between two types of charts: pie and bar chart. The indicator results are shown singly and are selected from the dropdown list "Select indicator" (Figure 10). If you wish to use a chart outside ToSIA you select "Save image". A window will appear where you can browse the folder in which you want to save the image.

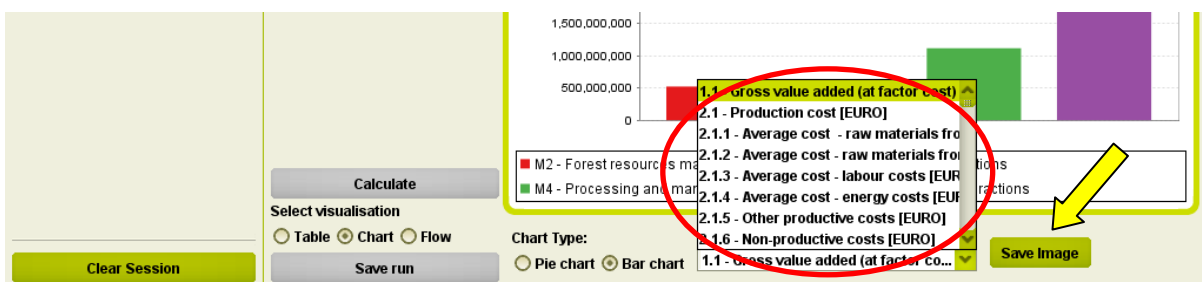**Figure 10.** Selecting an indicator from the dropdown list (red circle) and saving the image (yellow arrow)

- *Flow*

When selecting the flow visualization the calculated material flow is shown (Figure 11). The user has the option to view the material flow per process (in process units) or aggregated per module in tons of carbon (sum of material flow in carbon over every process in a module).
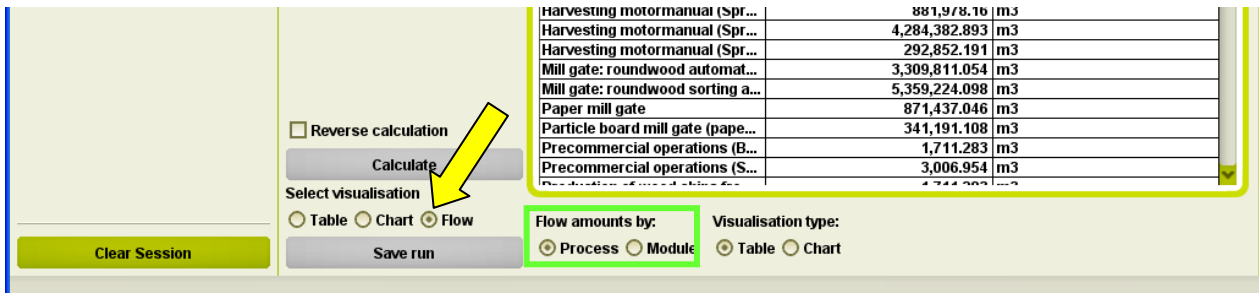
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Figure 11. Visualization of the material flow (yellow arrow), the flow amounts can viewed by process or module (green box)

6.4.   Comparison

Runs created in the chains tab can be compared in ToSIA, when selecting the "Comparison" tab (Figure 12). The difference between the runs can be viewed in a table or bar chart. To compare runs, add the runs to the comparison sections by clicking the arrow on the right side of each saved run in the panel on the left. Then click the "Compare" button. To remove a run from the "Run to compare" list, click the "X" next to the run.
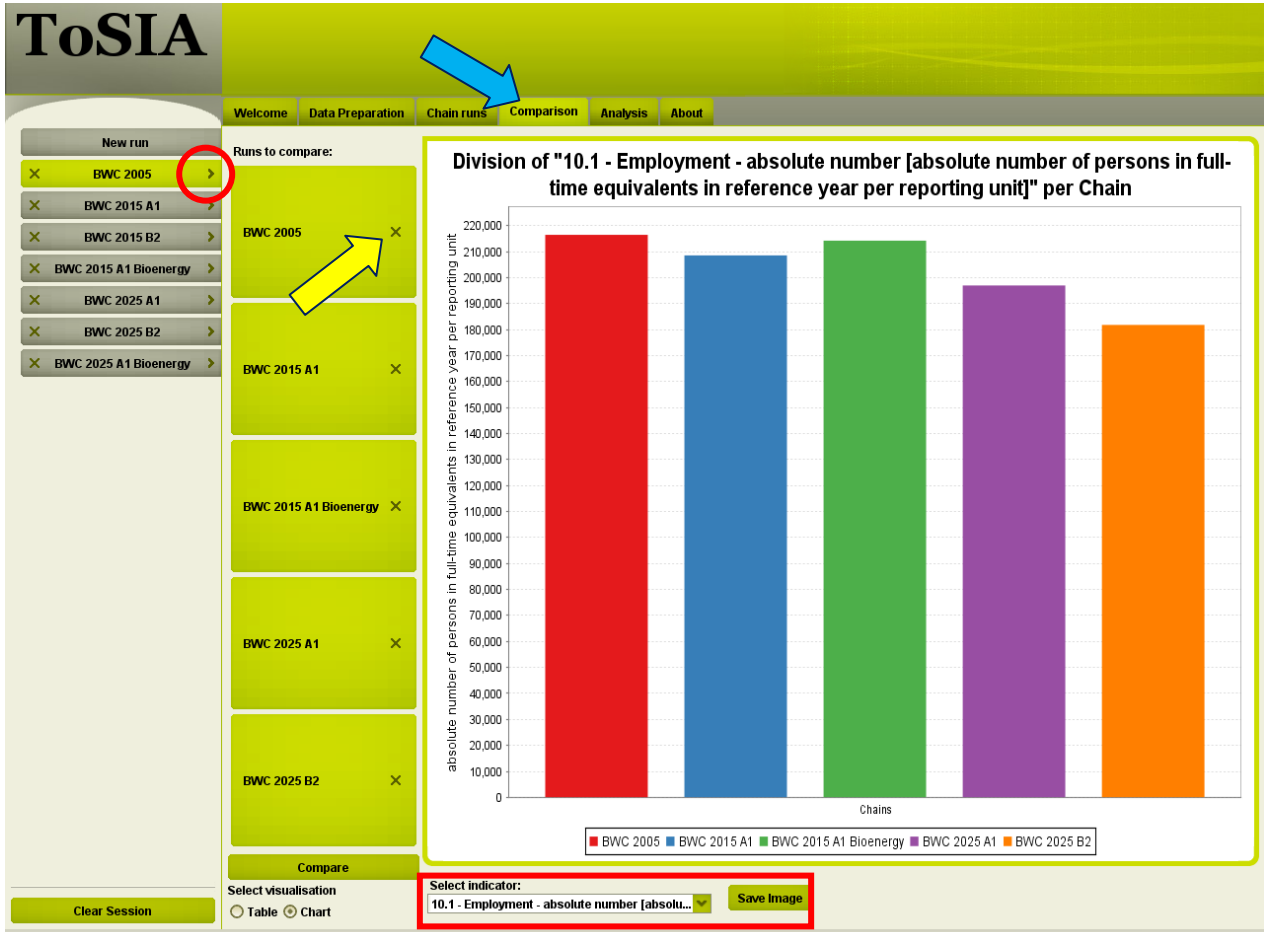

Figure 12. Comparing (blue arrow) different runs with each other, in this example five runs have been selected from the panel on the left side by clicking the ">" sign (red circle), to remove a run from the comparison click the "X" sign of the run (yellow arrow), the indicator can be selected and the chart saved (red box)

6.5.   Analysis

In the analysis section of the tool, the user can choose between the Cost-Benefit Analysis (CBA), the Multi-Criteria Analysis (MCA) and the Policy Analysis (PA) (Figure 13). The results of the ToSIA runs will be automatically imported into the decision support tools (DST).
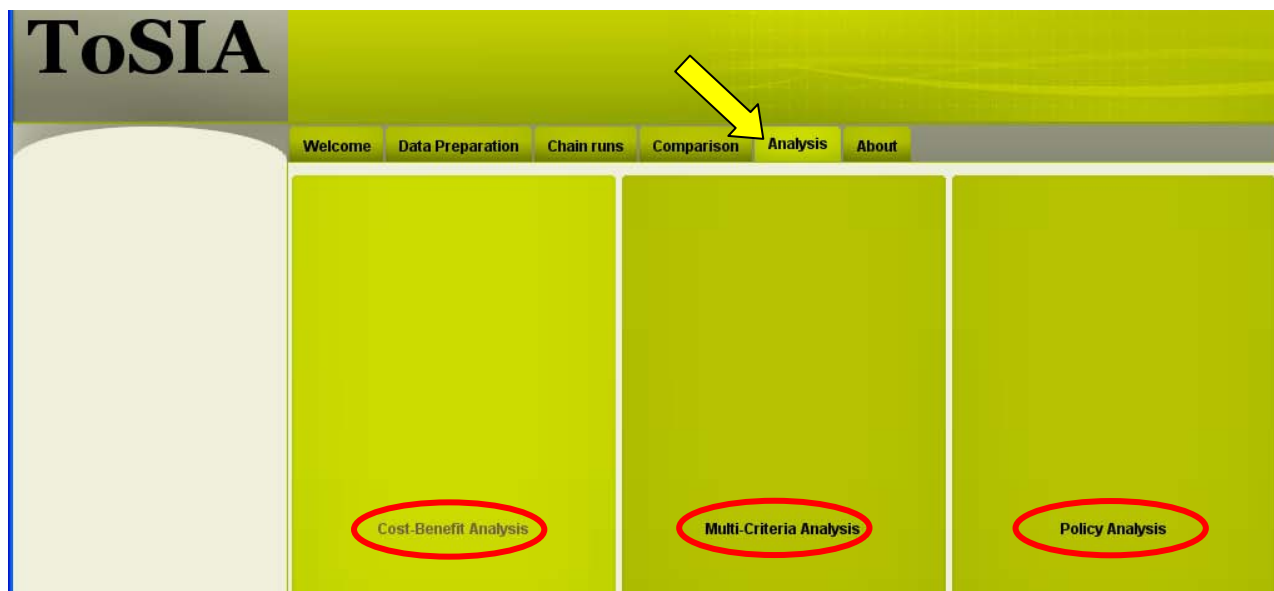

Figure 13. The Analysis section of ToSIA

The decision support tools integrated into ToSIA will not be explained in this deliverable. For more information see:

- MCA   - see deliverable D1.5.6.
- CBA   - see deliverable D1.5.7.
- PA   - see deliverable D1.1.5.

6.6.   ToSIA outputs

After the ToSIA runs are calculated and saved ToSIA automatically exports different result and data validation files. All files are saved in the same directory as the tool. Depending on the file type they carry the name of the FWC or the name given by the user, when saving a run in ToSIA. Find more details in Table 2.

Table 2. Files exported from ToSIA

File	Automatic naming	Explanation
Output product share	(name of FWC)_tosia_output_shares.csv	Listing of output shares used in calculation
Split ratios	(name of FWC) _tosia_output_split_ratios.csv	Listing of many to one split ratios used in calculation
ToSIA data report	(name of FWC) _tosia_data_report.csv	Reporting of data inconsistencies
Indicator results	(name of saved run)_tosia_indicator_results.csv	Calculated indicator results
Process flows	(name of saved run)_tosia_calculated_flows.csv	Input material flow per process
Product flows	(name of saved run)_tosia_calculated_product_flows.csv	Material flow of in-/output products
Calclog file	(name of saved run)_tosia_calclog.csv	Information on initialization of calculation
Postlog file	(name of saved run)_tosia_postlog.csv	Listing of in-/output flows in carbon
Indicator results XML	(name of saved run)_tosia_aggregated_results.xml	Calculated indicator results in XML format

Except of the Indicator results XML (xml file), all file are in a CSV format and can be imported into Excel from text. Each file will be explained in the following section:

Output product share

In this file all (all possible variants of a FWC) output product shares used in the ToSIA calculation are shown. Furthermore, the sum of output shares is shown. The delimiter is the "#" sign.

Split ratios

All one-to-many split ratios for each possible variant used in the ToSIA calculations are show. The delimiter of the CSV file is the "#" sign.

ToSIA data report

The validation of the figures needed for the flow calculations was done with the help of ToSIA. Several testing routines were implemented. All errors or deviations of the established routines are reported in the so called "ToSIA data report". This report has three different testing routines:

- Missing conversion factors
  Whenever a needed conversion factor is missing it will be reported. This accounts for the conversion factor from product unit to tonnes of carbon and from product unit to reporting unit if the unit differ. In order to make ToSIA at least load faulty data sets, the missing values are filled by a one.
- Missing split ratios and/or sum of split ratios ≠ 1
  If a split ratio (one to many) has not been entered, the sum of the default value exceeds always one (see also 2.3) and hence will be reported. Whenever the sum of the split ratios ≠ 1 it is reported.
- The sum of the product shares ≠ 1
  Whenever the sum of the product shares of a process is ≠ 1 a report is written. Smaller numbers are possible if some process waste is unaccounted for (e.g. dust emissions).

Furthermore another report in this file, which is a combination of the testing above, indicates whenever the relative output flow of a process differs from one. This could be the case if e.g. one output product (waste) is not continuing in the chain, or if one product is tripled because the product is distributed amongst several succeeding processes and the split ratios were not correctly entered. Hence these special reports must not always be seen as an error message, however, as additional information on the material flow calculations.

The delimiter of the CSV-file is again the hash sign (#). The report is structured after the process name and ID, the name of the contact person (data provider) and last but not least the report itself. This information proved to be sufficient to find the error in the data set. A more detailed presentation of the analysis of data quality can be found in Deliverable Report D1.2.6.

Indicator results
The Indicator results file lists all calculate ToSIA results by process and aggregated by module and chain. The delimiter is again the hash sign (#).

Process flows
This file states the material flow of each process (sum of material flow of input products) in process units. The delimiter is again the hash sign (#).

Product flows
This file states the material flow of each linked input or output product flow. If a product is not linked to a successor product (process), it will not be listed in the file. Furthermore, if one product is linked with many more than one product, each material flow (link) will be reported. The delimiter is again the hash sign (#).

Calclog file
The file lists the point and the amount where the calculation was initialized. No delimiter is needed.

Postlog file

The Postlog file gives the user a picture on the input and output material flow of each process. This information can be used to validate the material flow calculation and spot inconsistencies in the data. The delimiter of the file is again the hash sign (#).

Indicator results XML

This file contains the same information as the Indicator results, however, the file format is different.

7. References

D1.1.5 D 1.1.5 (update) An updated and further elaborated policy database. (EFORWOOD Deliverable).

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D1.5.6 Monetary values of environmental and social externalities for the purpose of cost-benefit analysis in the EFORWOOD project. (EFORWOOD Deliverable).

D1.5.7 Documentation of concept, implementation and use of the Multi-Criteria Analysis Software component (ToSIA-MCA) in EFORWOOD. (EFORWOOD Deliverable).

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