TEST Step by Step - PLAN

	Step	Purpose
PLAN	1.1. Initial screening	Initial screening: go/no-go for TEST
	1.2 Scoping and Policy	Top management commitment to RECP and scope of the work
	1.3 TEST team	Plan, organize and train internal company team (as well as external team, if created).
	1.4 Identifying total cost of NPO and priority flows	**Starting the diagnosis: Identify the non-product output (NPO) costs and volumes at company system boundary.**
	1.5 Setting up focus areas	Continuing the diagnosis: identify focus areas at the level of production steps (e.g. cost centres).
	1.6 Revealing sources and causes of inefficiency	Concluding the diagnosis: identify sources and reveal root causes of inefficiency and pollution within focus areas.
	1.7 Option generation and feasibility analysis	Broadening the scope of possible improvement solutions and techno-economic analysis of a set of optimized feasible measures
	1.8 Action plan	Plan of actions for implementing and monitoring validated measures.

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P 1.4 – Identifying total cost of Non Product Outputs and priority flows

What are the material and energy inputs/outputs associated with the highest economic losses and/or to the most significant environmental impacts?

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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Overview of Step 1.4

Inputs	Activities	Outputs
Initial Screening report, flow charts, production inputs and outputs of the previous fiscal year (annual volumes and costs) and estimates of losses (percentages) Sector benchmarks (energy, water, raw materials), if available List of the company's environmental aspects and impacts	Calculate total non-product output (NPO) costs Identify significant flows: - High NPOs compared to benchmarks with significant associated costs (potential for RECP improvements) - Major environmental aspects/impacts (e.g., water scarcity) Set up RECP objectives , KPIs for priority flows, baseline	Total economic losses (NPO) and their break down Priority flows highest NPOs Baselines, objectives and targets, KPIs Recommendations for improving information system

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Resource efficiency Pays, but Accounting Systems hardly show it!

- in order to be able to show savings generated by resource efficiency, data must be available!

- Many companies do not have the accounting and management systems in place that allow monitoring of material flows and related costs.

- Companies (and environmental managers) thus find it difficult to analyze the benefits of RECP and EMS/EnMS properly and to mobilize funding for their projects.

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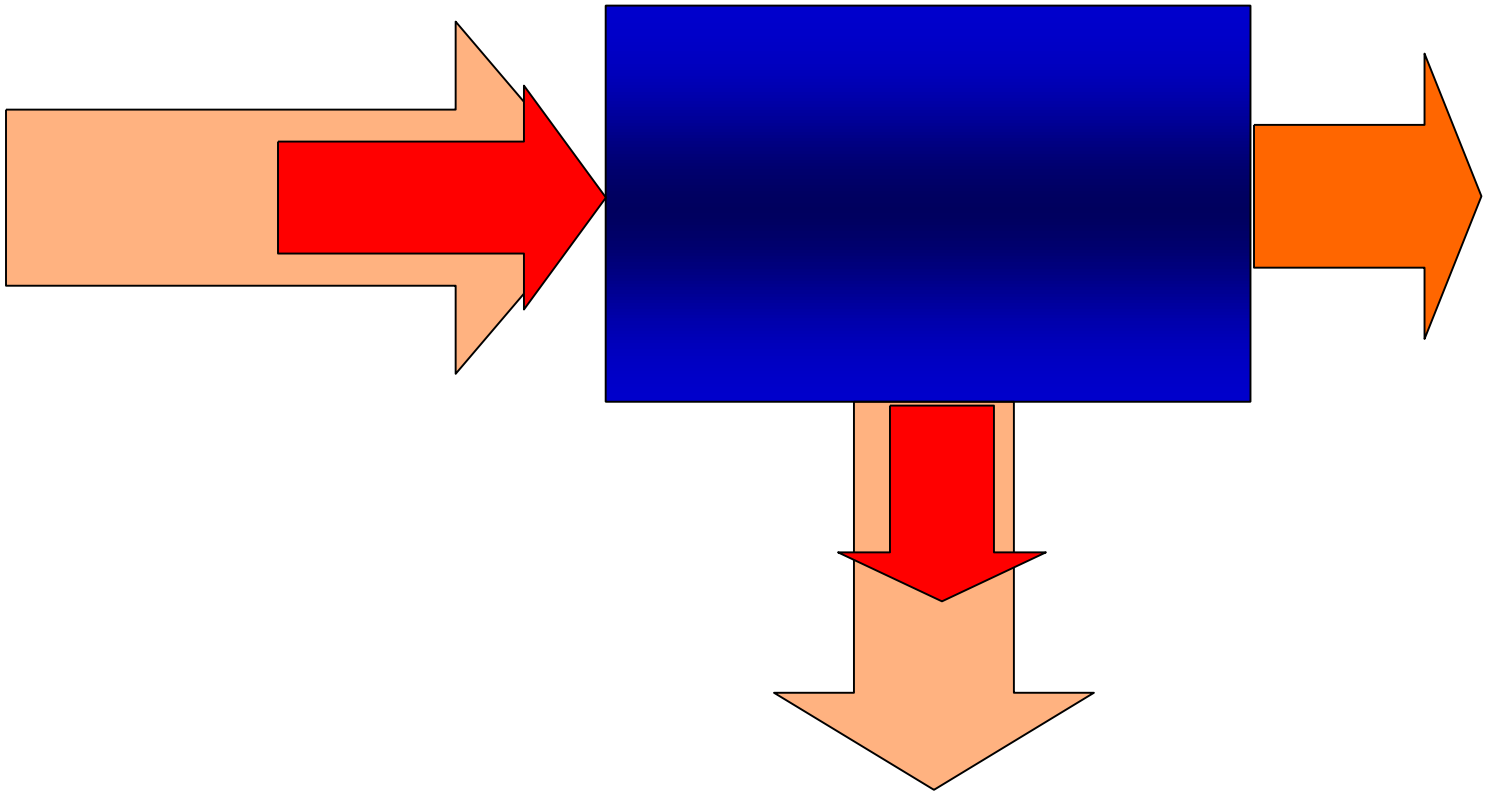
Why potentials for effective use of material and energy flows are not always visible within production process?



Focusing on waste disposal fees and misleading recycling revenues companies overlook the real cost for producing waste (labor, energy, expensive cost of materials that become WASTE!!)

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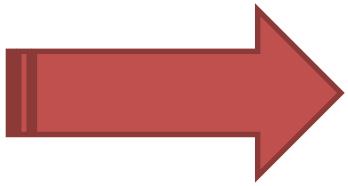
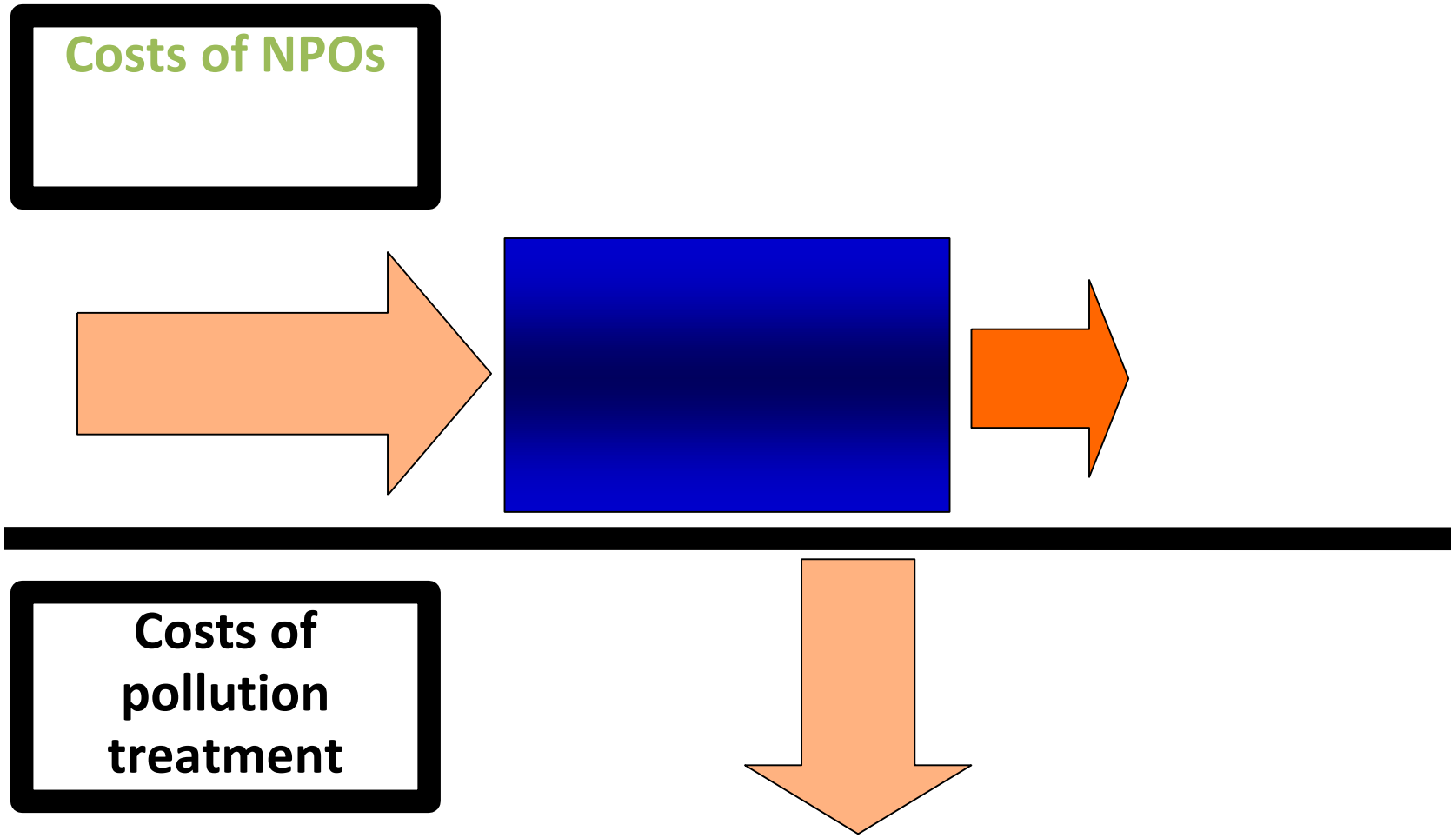


NPO COST CATEGORIES	% share of NPO
1. NPO COSTS OF MATERIAL AND ENERGY INPUTS	
➢ Raw and Auxiliary Materials	e.g. 2- 20 %
➢ Packaging Materials	e.g. 2- 10 %
➢ Operating Materials	100 %
➢ Water	1-100 %
➢ Energy	100 %
2. WASTE MANAGEMENT/END OF PIPE COSTS	
➢ Equipment Depreciation of EoP Equipment	
➢ Internal Personnel	
➢ External Services	
➢ Fees, Taxes and Permits	
➢ Fines, Remediation and Compensation	
3. MFCA SYSTEM COSTS	
➢ Equipment Depreciation	
➢ Internal Personnel	
➢ External Services	
➢ Other Costs	
TOTAL COSTS	
4. ENVIRONMENT RELATED EARNINGS	
➢ Other Earnings	
➢ Subsidies for RECP/EMS Projects	
TOTAL NPO COSTS (minus TOTAL ENVIRONMENT-RELATED EARNINGS)	

What is the ratio of costs between non-product output costs and costs for treating pollution?



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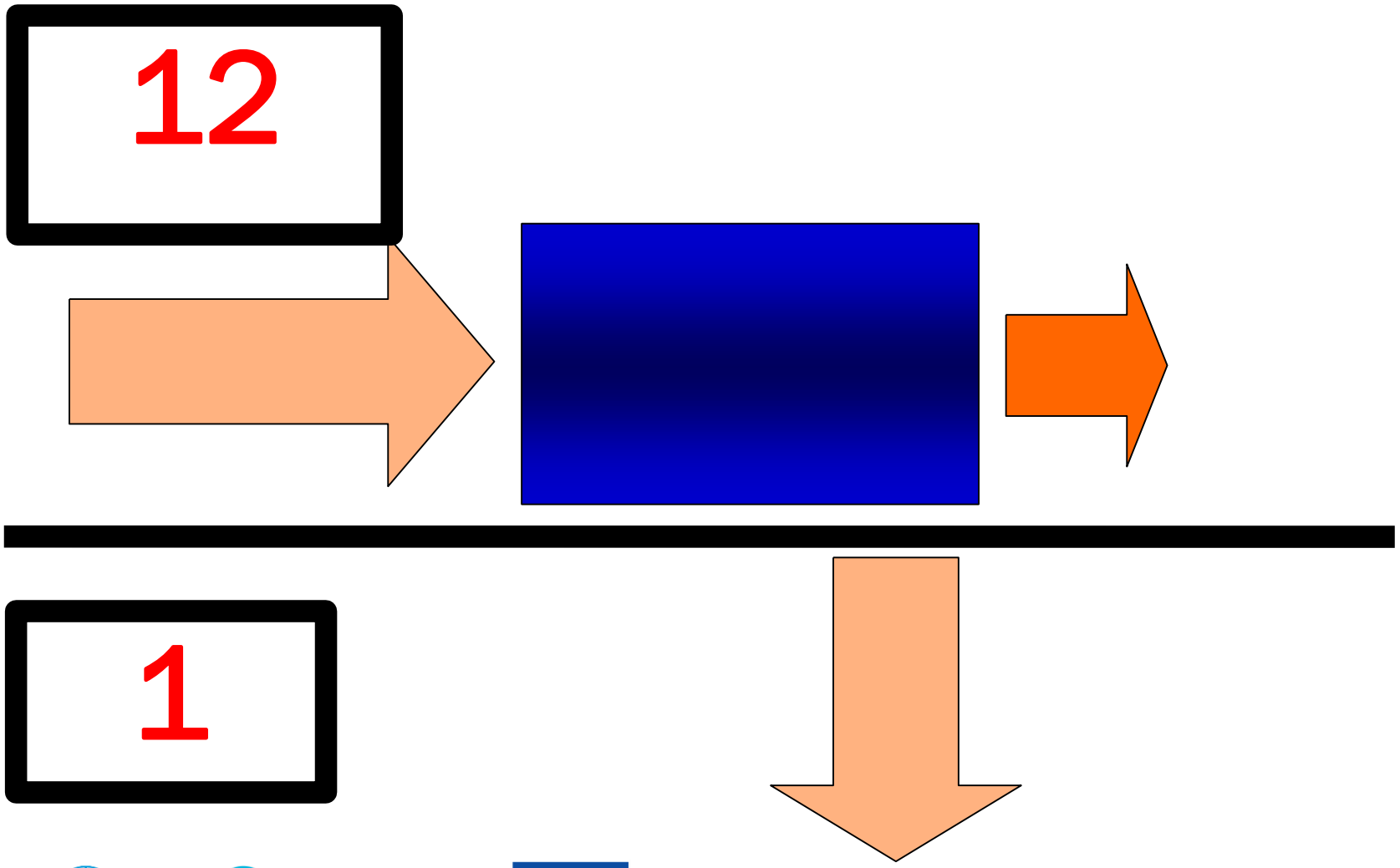
Following analysis of 50 CP projects implemented in industrial enterprises in the Czech Republic this ratio was:



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INPUT-OUTPUT ANALYSIS AND IDENTIFICATION OF NPO COSTS

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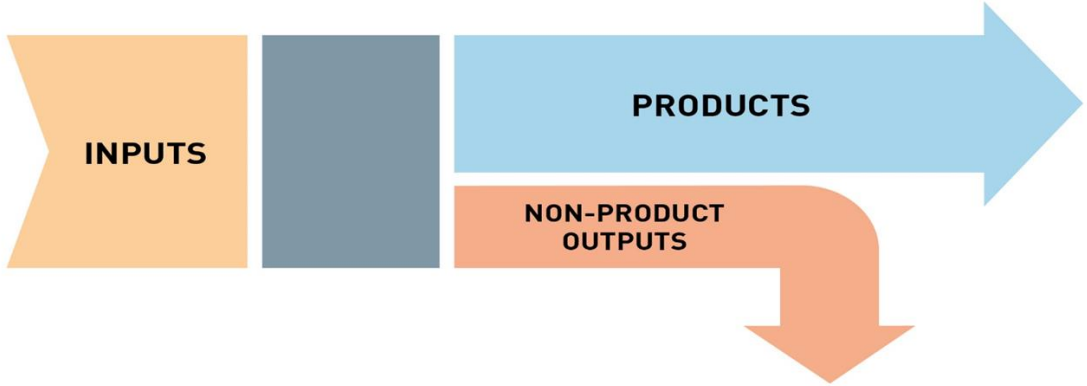
INPUT - OUTPUT Balance
Separating product from non product output

INPUTS
MATERIALS
Raw materials
Auxiliary materials
Packaging
Operating materials
WATER
Different sources
ENERGY
Electricity
Thermal energy

Company system boundary

OUTPUTS	Breakdown of outputs by input category
PRODUCTS	
Products	% of raw, auxiliary and packaging materials in the product
By Products	% of raw, auxiliary and packaging materials in valorized in secondary products
NON PRODUCT OUTPUTS	
Raw and auxiliary material	% of raw and auxiliary materials in waste (solid/liquid/emissions)
Packaging	% of packaging in waste
Operating Materials	100% operating materials is waste
Energy	100% energy used in the process (responsible for air emissions)*
Water	% of water not in the final product that is lost / become wastewater

* Unless company does not sell energy as product



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Energy as NPO

1. **Energy is considered as 100 % NPO** (unless the company is in the utility sector and is selling energy as a product):
   - 100% of fossil energy used is causing 100% air pollution and CO2 emissions (direct or indirect)
   - It does not go into the product

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Calculating the NPOs costs with the MFCA Excel Sheet

The MFCA Excel sheet is composed of 4 sheets:

1. Input Output Mass Balance
2. Process Flow Chart
3. NPOs Costs Breakdown
4. NPOs Cost Summary

MFCA excel tool

The best way to work with the template is to have an internal company workshop with production and accounting departments

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1. Input output mass balance

- Start by filling out the worksheet 1 of MFCA tool with the list of items from your Inputs, POs, and NPOs, based on the list of accounts of the previous business year, **if companies do not have more detailed cost accounting system in place (stock management, cost accounting and eventually production planning).**
- Record the total amounts and costs for each item for an entire financial year. Also record the source of information, i.e. each account's number in the Chart of Accounts as well as the source of information for the weight of the used input.
- Also record recommendations for improvement of the data availability.

1. Input	USD	Tons	Account number	Tonnage source
1.1 Raw and Auxiliary Materials				
Subtotal				
1.2 Packaging Materials				
Subtotal				
1.3 Operating Materials				

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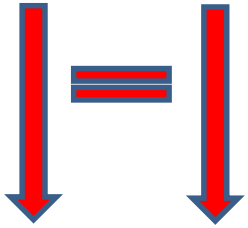
Mass Balance - NPO Cost

- Estimate NPO percentages in %, once this is done the MFCA calculator automatically calculate for each item the NPO costs.



1. Input	USD	Tons	Account number	Tonnage source	NPO %	NPO cost
1.1 Raw and Auxiliary Materials						
Subtotal						
1.2 Packaging Materials						
Subtotal						

- We are now able to see how much we are paying for inputs that are not found in the final product! i.e. NPO Cost
- *EMA – MFCA*

Breakdown of NPOs costs - Examples

NPO Raw materials and Product	NPO Packaging	NPO Operating materials	NPO Water	NPO Energy	EoP costs and earnings	Total NPO %
10%	4%	30%	5%	50%	1%	100%
26%	4%	14%	1%	54%	0%	100%
47%	12%	22%	2%	22%	4%	100%
72%	6%	6%	0%	15%	0%	100%
80%	2%	3%	1%	12%	2%	100%

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Priority setting using MFCA

- Nearly all companies participating in Med TEST II initially wanted to focus only on energy, as they considered this to be their main priority. Yet after the MFCA assessment companies realized that raw material losses also constituted a significant loss in monetary value, corresponding to 40-80% of NPOs

Significant flow ≠ Priority Flow

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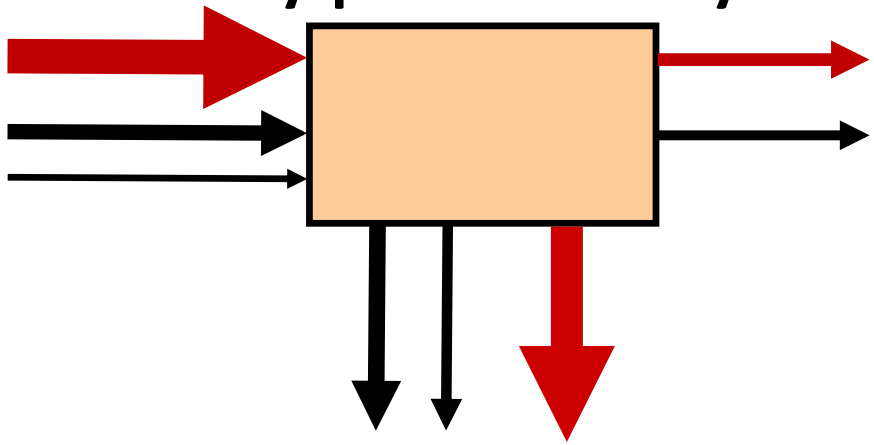
Identifying significant flows

Identification of significant flows is based on their:

- **Total non product output costs**
- **Environmental risks** (toxicity) & significant pollution
- Total amount (bulky materials could be significant due to logistical requirements)

BEWARE !!!: Volumes/costs of by-products may indicate hidden priority flows



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Be aware: Byproducts may still be costly!

- Byproducts are all nonproduct outputs that have been turned into a source of income! They are not the main product, but a good way of making use of NPO, e..g. sale of heat to municipal heat systems, sale of scrap
- BUT! Even though you get money for them, it may still be much more economical to reduce the amount of input material wasted.

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Selecting priority flows

- A flow with a very large NPO may not be selected as **priority flow**!

- **What is the potential for reduction of NPO?**

The **potential for improvement should be estimated, using benchmarking or regression analysis,** before taking the decision whether a flow should be selected as **priority flows for more detailed analysis in the following steps of TEST**.

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IDENTIFYING PRIORITY FLOWS AND SETTING UP BASELINES, OBJECTIVES AND TARGETS

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Benchmarking

Sources

- **EU BREFs - Best Available Techniques Reference Documents**
  http://eippcb.jrc.ec.europa.eu/reference/
- **IFC Industry Sector Guidelines**
  http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines
- **Case studies from the Mediterranean Region:** factsheets of industries participating in the SwitchMed (TEST II) project
  https://www.switchmed.eu/en/corners/service-providers/pages/cases
- **IFC Food Sector benchmark Tool**
  https://www.ifc.org/wps/wcm/connect/region__ext_content/ifc_external_corporate_site/europe+and+central+asia/resources/ifc+food+benchmark+tool

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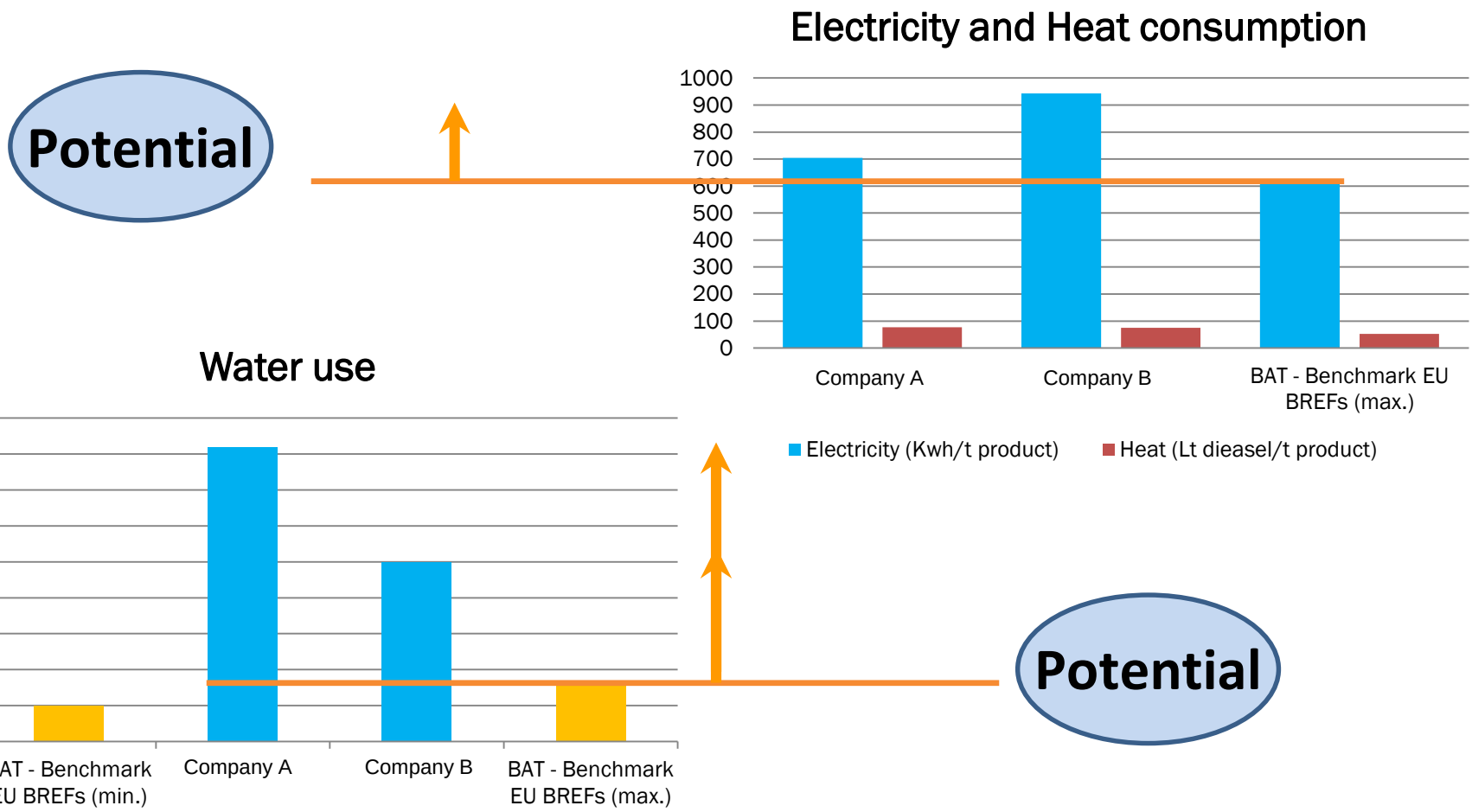
Benchmarking – Importance of Baseline

Two companies producing frozen vegetables in Egypt	Water consumption m3/t of product		Electricity consumption KWh/t of product		Fuel consumption Litre/ t of product (Diesel)	
	BAT	Baseline I	BAT	Baseline I	BAT	Baseline I
Company A	5 – 8.5	41.67	616.7	704.3	52.045	77.5
Company B		25.15		943.6		75.8

Benchmarking – Importance of Baseline



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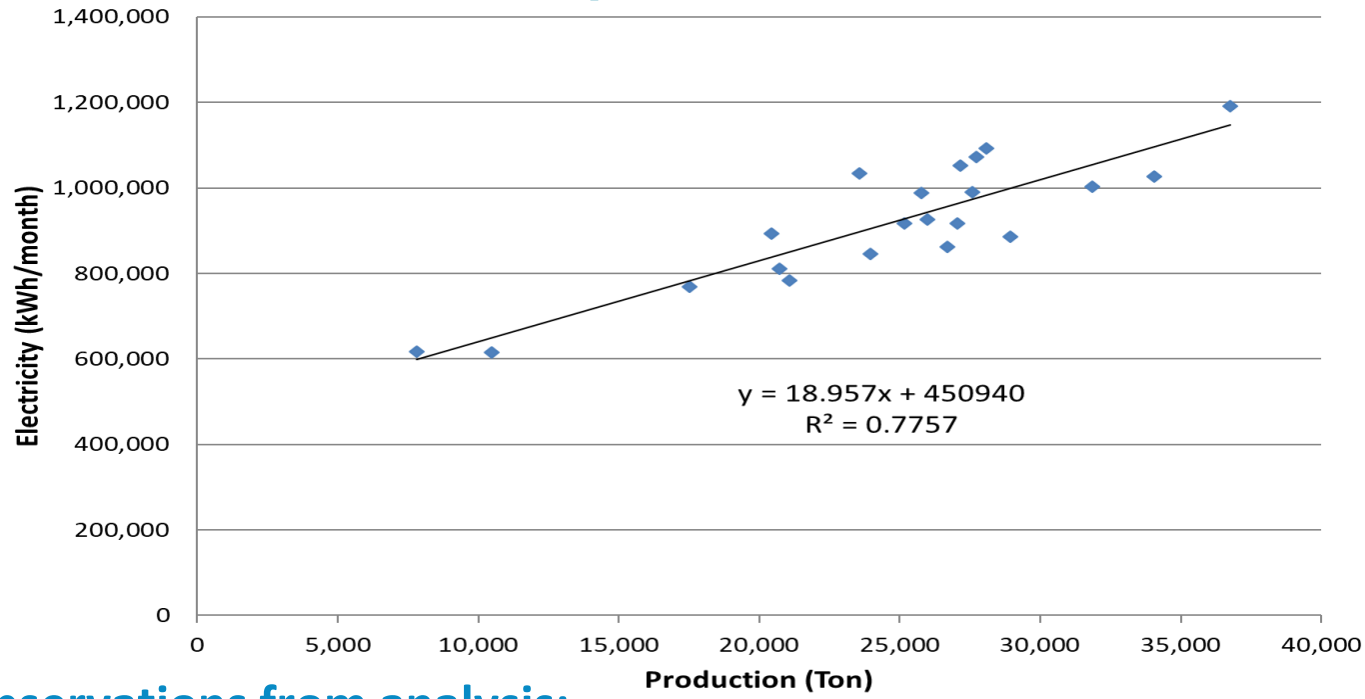
Company level Regression analysis in a beverage producer



Observations from analysis:

- Strong correlation between consumption and production levels
- Baseload of appr. 450 MWh is on the high side, most probably due to equipment running continuously also when there is no production
- All points above the baseline represent theoretical potential for improvement through better operation of existing technology

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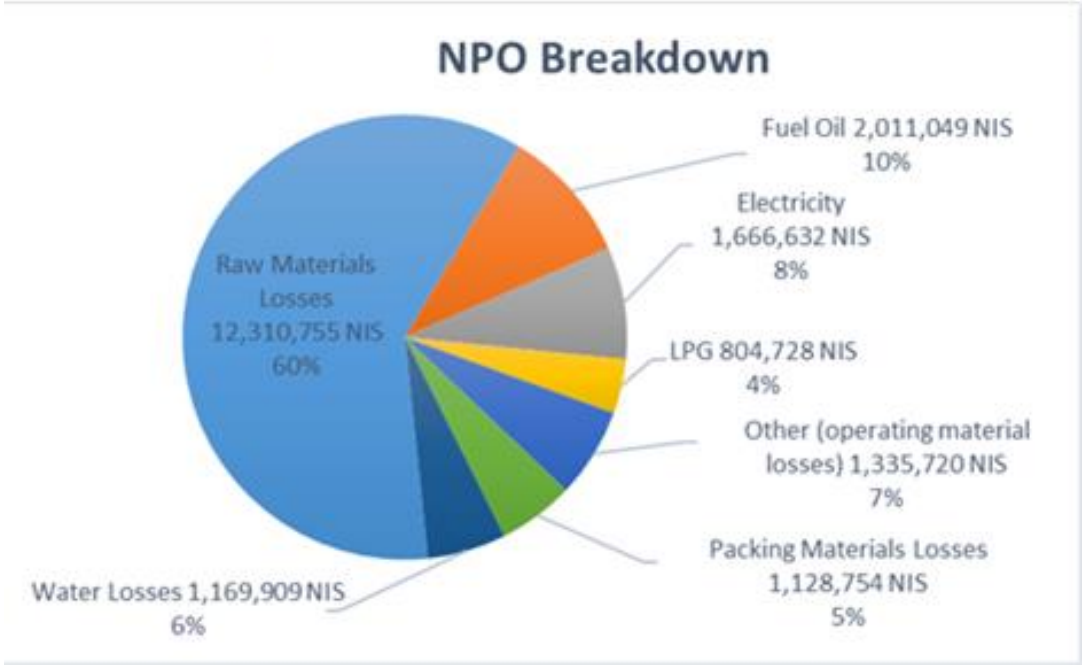
Identifying Priority flows



NPOs cost analysis:
Raw materials – sesame seeds
Energy: fuel and electricity

Environmental consideration
Water (WW compliance, water scarcity)

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Tahini and Halva manufacturing

- 11% sesame losses
- Fixed production losses:
  - 2% coarse dirt in sesame sacks at screening phase
  - 4-5% seeds natural moisture evaporating during roasting phase as well as removal of sesame seed shells (Tahini industry benchmark)
  - Remaining 5-6% of sesame seeds losses above benchmark!

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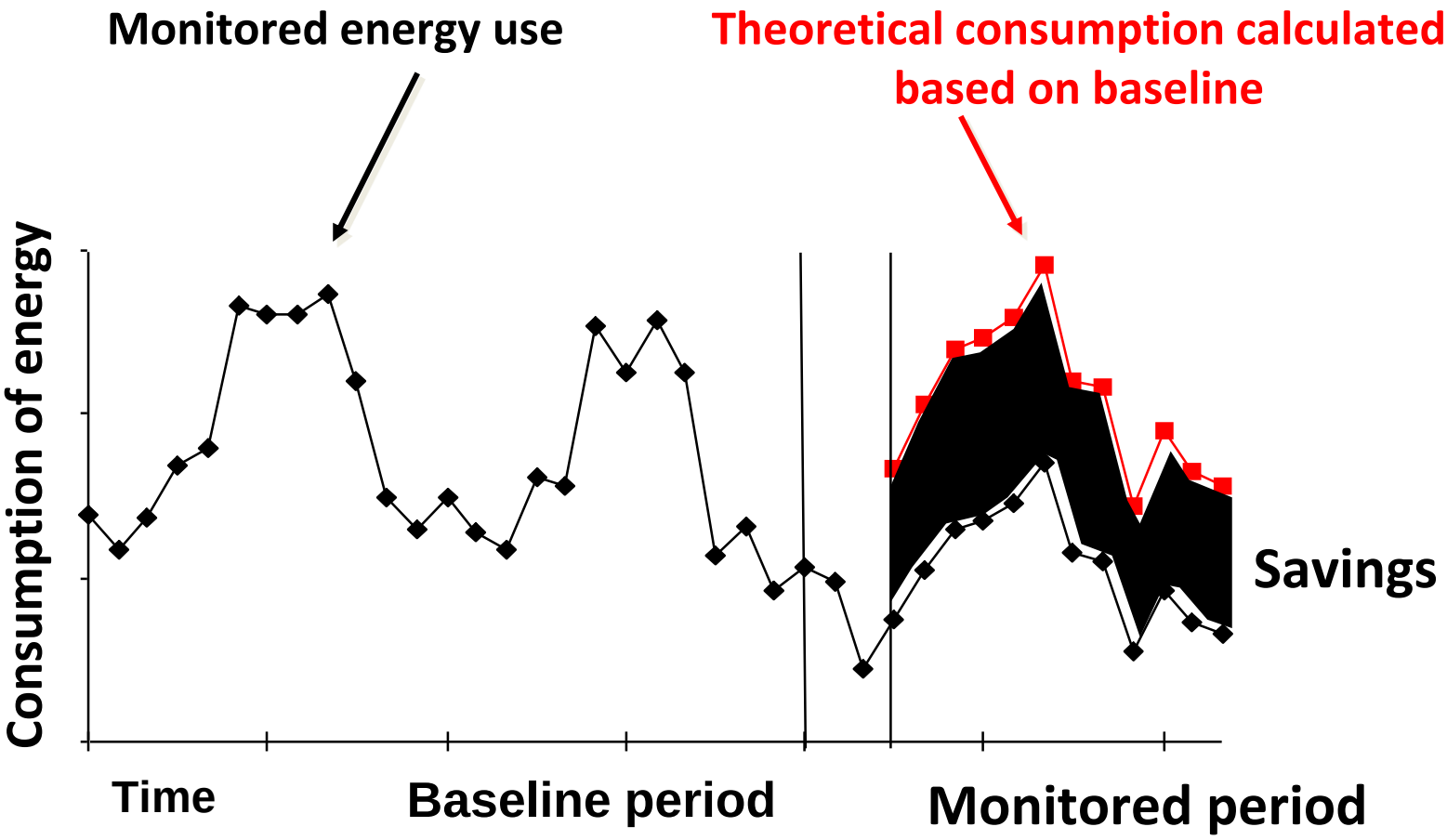
TOTAL Environmental Costs

0	NIS/unless otherwise specified	Percentage distribution %
1. NON-PRODUCT OUTPUTS (NPO) COSTS	**20,427,548**	**97.4%**
1.1. Raw and Auxiliary Materials (9.9% loss)	12,310,755	58.7%
1.2. Packaging Materials (10% loss)	1,128,755	5.4%
1.4. Operating Materials	1,335,720	6.4%
1.5. Water	1,169,909	5.6%
1.6. Energy	4,482,409	21.4%
2. WASTE MANAGEMENT /EoP	**538,906**	**2.6%**
2.1. Equipment Depreciation	6,000	0.0%
2.2. Operating Materials		
2.3. Water and Energy		
2.4. Internal Personnel		
2.5. External Services		
2.6. Fees, Taxes and Permits	532,906	2.5%
2.7. Fines, Remediation and Compensation		

Importance of Baseline



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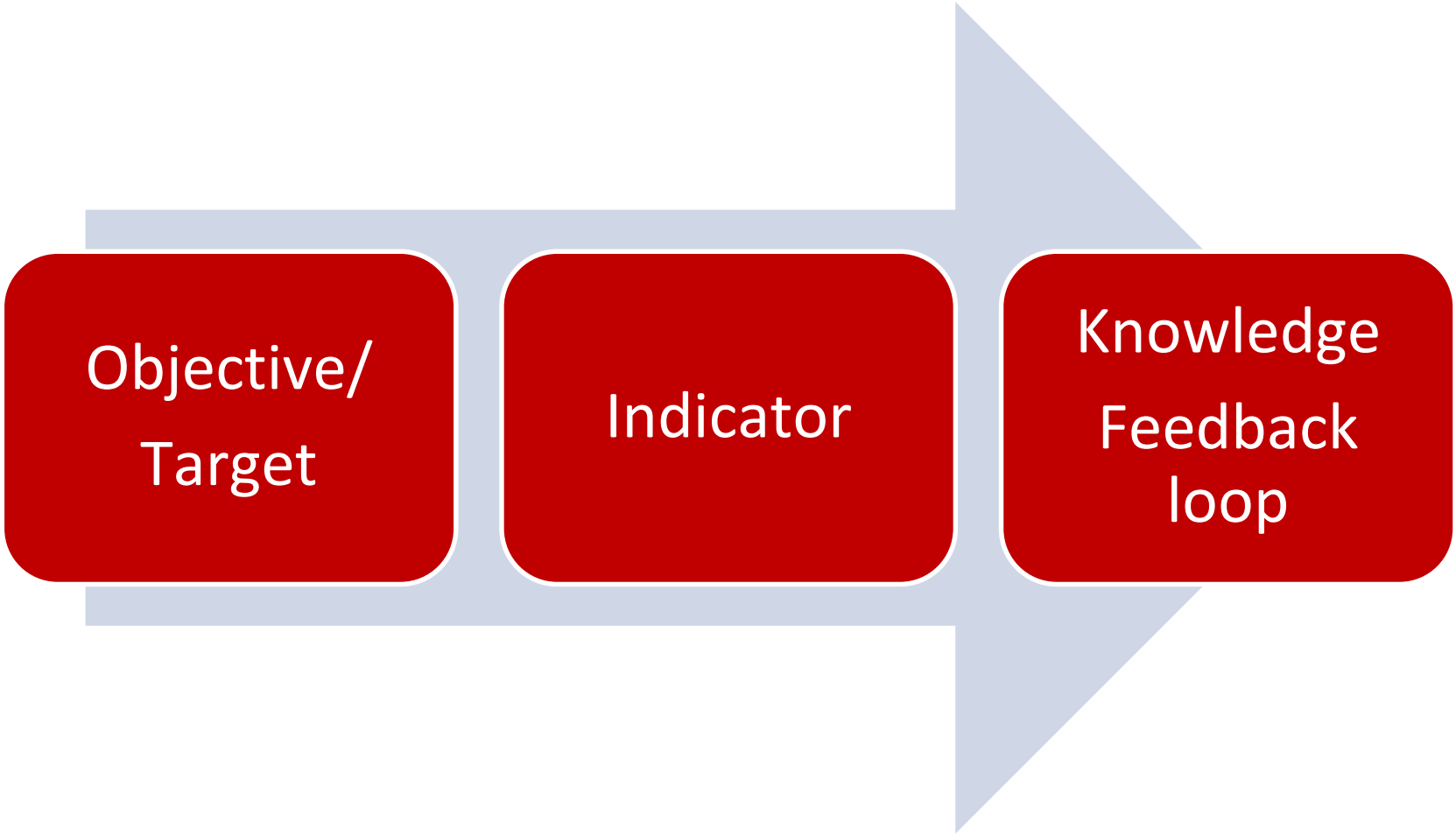
Indicator as an intermediary



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KPIs and OPIs

Absolute and Relative indicators are within TEST distinguished at two basic levels as:

KEY PERFORMANCE INDICATORS (KPIs) at the overall organizational level - based on financial or non-financial metrics used to reflect the critical success factors of an organization and measure progress towards its goals

OPERATIONAL PERFORMANCE INDICATORS (OPIs) to measure a system's internal performance in supporting company-wide KPI and enabling an understanding of performance of specific company areas or units

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Baselines, objectives, targets for priority flows – example from pulp and paper company

Flow	Benchmark Unit	Actual specific consumption - BASELINE	International benchmarks (EU-BREFs)	Company targets and KPIs
Raw material losses	t raw mat. / t product	9.3%	<7-9%	10 % in 5 years
Water	m^3/t of product	410	100	100 m^3/t in 3 years
Electricity	kWh/t of product	1409	600-1200	900 kWh/t in 3 years*
Wastewater	m^3/ADt	365	50	80 m^3/ADt in 2 years
BOD_5	kg/ADt	54.8	1	10 m^3/ADt in 2 years
COD	kg/ADt	299	20	50 kg /ADt in 2 years
TSS	kg/ADt	77.4	1.5	8 kg /ADt in 2 years

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Purpose of an information system on flows and monitoring plan

1. **Monitor overall enterprise performance** at the level of selected priority flows utilizing KPIs, recording MFCA recommendations

2. **Measure the performance of key consumers** through OPIs, for:
   - understanding causes of inefficiency and implementing corrective measures
   - planning and setting up new targets

3. **Verify improvements in performance and savings compared to** expected benefits deriving from the implemented resource efficiency measures (TEST action plan)

4. **Make people** who influence resource efficiency and pollution generation **accountable** at all levels

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Monitoring financial and physical flows

The EMA-MFCA tool can be used to complement the financial information system for effective monitoring of material and energy flows:

- An MFCA information system should start at the company system boundary (top down) and make best use of the existing information systems, such as financial and cost accounting, stock management and production planning.
- The input-output balance at the corporate level should be calculated regularly on an annual or monthly basis using the EMA-MFCA tool and be linked to bookkeeping, cost accounting, storage and purchase as well as production planning systems.
- The values and volumes in tons or kilograms of all material flows should be listed simultaneously when the related invoices are recorded.
- Main hindrance to applying MFCA is that raw and auxiliary materials as well as packaging are typically recorded in stock management and production planning systems (PPS), but not in cost centres. Only financial accounting records all the data on material inputs (though most often only in monetary terms and with no clear disaggregation rules or consistency checks with other information systems)

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Improving information systems

Typical recommendations:

- Data recording of material purchase by material groups in financial accounting
- Separate accounts for material groups
- Estimation and recalculation of scrap percentages
- Recording of material volumes in inventory management
- Posting of inventory losses
- Separate cost category “environmental management”
- New Cost Centers / New Accounts
- Purchase of a scale for the incoming store, to allow calculating actual consumption, to recalculate units in to kilograms

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Company example

- It is recommended to monitor and record the sesame seeds purchase volumes under accounts 70001 and 70002
- The account number 72001 contains Halva raw materials purchase (salt & additives). It is recommended to record under this account also the volumes (Tonnes) of the raw materials.
- The account number 71002 and 71004 contain Tahini packaging materials. It is recommended to record under this account also the volumes (Tonnes) of the Tahini packaging materials
- 82002 includes fresh water and municipal sewage fees. Should split account to two separate accounts

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Linkages with EMS

EMS Not in place

- The MFCA tool can be used for identifying the environmental aspects of an organization. The priority material, water, and energy flows identified at this step are related to environmental and energy aspects of the company as defined by ISO standards. Indeed, the evaluation process for identifying and prioritizing significant aspects may include eco-efficiency criteria (e.g., cost of material/energy losses) in line with the MFCA principles and tools.

EMS In place

- Data on waste and emissions is typically better recorded if an EMS is in place and thus calculation of the mass balance is supported. The MFCA tool can be used by the company to collect data for the identification of environmental aspects related to priority flows. Eco-efficient criteria (e.g. cost of material/energy losses) used within the MFCA analysis can be integrated into existing evaluation process for prioritizing significant environmental aspects.

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Highlights

- Start at company boundary
- Focus on inputs and outputs (company as „black box“)
- Focus on money values of I/O and existing information systems
- Record volumes of I/O to the degree available
- Quantify/Estimate NPOs
- Record options to improve the information systems
- Identify the significant flows characterized by the highest NPOs
- For the significant flows estimate potential for improvement (e.g. benchmarks)
- Select the priority flows (significant flows with potential for improvement) and set up targets
- Set up objectives, KPIs and Baseline

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Thank YOU for your Attention

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EXERCISE - MFCA

Input-Output balance on the company level

- Step 1:

Think about your favourite cake! Do you know the recipe? List the inputs and outputs (no values, just the types of inputs and outputs) of a company that produces your favourite cake, e.g. Guglhupf for Austria.

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TIPs

- Remember that auxiliary materials become part of the product, but by definition operating materials are not part of the product
- For packaging, it is necessary to distinguish between the packaging of the input materials and the packaging materials used for the product.
- Materials which are used several times in a loop system, e.g. refilled glass bottles or pallets, the amounts purchased to replace discarded amounts are recorded
- In general, cake bakeries do not produce by-products. However, potential by-products include selling any excess waste heat from the baking room. Use of the eggshells in gardening, or of the cake crumbs as bird feed are instead examples of recycling because the company is not able to sell them. The borderline between a by-product and a waste for recycling is vague and depends on market prices. By definition, by-products generate earnings, while waste goes to a recycling or disposal or free of charge.

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EXERCISE - MFCA

Input-Output balance on the company level

- Step 2:

Estimate the percentages for product output (PO) and non-product output (NPO) for all the inputs to the bakery

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TIPs

INPUT	Non-product output in percentage
Raw materials	
	If no data is available, it may be reasonable to estimate a total NPO percentage for all raw materials together, e.g. at 5%. Data recording, information systems and quality management for the main inputs and processes should then be gradually improved.
Auxiliary materials	The people responsible for production often have good estimates. For auxiliary materials, the loss percentage normally is lower than for raw materials, e.g. 1% for the bakery, and perhaps 2% for the rum, as a lot remains in the glass bowl together with the raisins.
Packaging	Experience says 1-5% as long as you do not have better data.
Operating materials	Per defininition 100% NPO
Energy	Per defininition 100% NPO
Water	Depending on product and processes, 100% NPO for the bakery

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- Excel MFCA – EXERCISE Bakery

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