Worksheets and Checklists for Cleaner Production Clubs

ASIE/2006/122-578
Improving the living and working conditions of people in and around industrial clusters and zones

IVAM

2008

List of worksheets and checklists

WORKSHEET 1A: PLANNING & ORGANISATION: LEADING TEAM MEMBERS (maximum 4 members)

1	Team leader	
	Name	
	Position	
	Justification	
2	Team member	
	Name	
	Position	
	Justification	
3	Team member	
	Name	
	Position	
	Justification	
4	Team member	
	Name	
	Position	
	Justification	

Justification: What are the main reasons to include the person in the team? Or in the case of a team leader: What are the main reasons to appoint the person as a team leader.

WORKSHEET 1B: PLANNING & ORGANISATION
CORE ASSESSMENT TEAM (maximum 5 members)

1	Team leader	
	Name	
	Position	
	Justification	
2	Team member	
	Name	
	Position	
	Justification	
3	Team member	
	Name	
	Position	
	Justification	
4	Team member	
	Name	
	Position	
	Justification	
5	Team member	
	Name	
	Position	
	Justification	

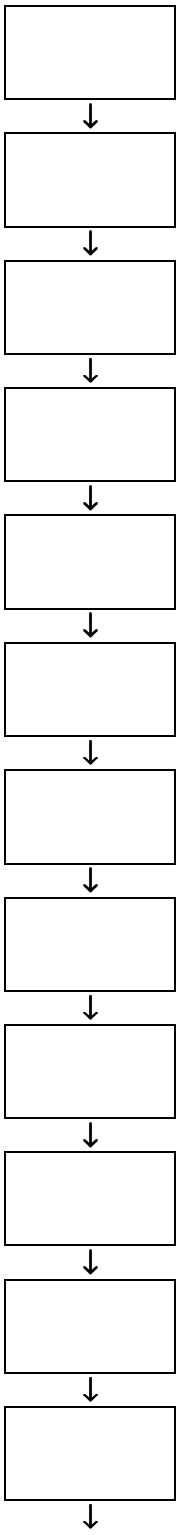
Justification: What are the main reasons to include the person in the team? Or in the case of a teamleader: What are the main reasons to appoint the person as a teamleader?

WORKSHEET 2: SIMPLE FLOWCHART

INPUT on this side **OUTPUT on this side**

(MATERIALS AND ENERGY)

(PRODUCTS, BYPRODUCTS, WASTES AND EMISSIONS



Use more worksheets for utilities (boilers, etc) and waste water treatment or in case the process is complicated.

Worksheet 3: Setting the CP-assessment focus

In this worksheet the CP-assessment focus setting is explained in three steps. The first step is to find and use benchmark to learn more about your process efficiencies. The next two steps will consequently lead to the CP-assessment focus. The focus setting can be done on a stream (like waste water) or a workshop or both. Also more than one stream can be selected in combination with one workshop. It is also possible that one stream will be focussed on for the entire facility or plant. However, it must be practical for the assessment team.

Step 1 Benchmarks

Use experience records and benchmarks for material and energy utilisation per unit of product to determine if your process can be improved and waste prevented.

Step 2 Stream selection

Give a rough estimation of quantities and costs per stream of raw materials, products and utilities (waste water, water, energy, auxiliaries - like aiding agents and catalysts).

Stream selection	Quantities per year	Costs per unit	Quantity of losses (in waste stream)	Costs of losses	Selection of focus
Raw materials					
(by)Products					
Utilities					

Step 3 Facility or unit selection

Give indication of importance for each facility or production unit (low/medium/high).

Criteria	Facility or unit selection		
	A	B	C
Importance of pollution			

Solid waste Air pollution Water pollution			
Quantity of utility consumption Steam Electricity Water Auxiliaries			
Costs of losses: Material losses Product losses Discharge/disposal Other			
Future developments Technology & management reform Regulations Other			
Other aspects Occupational health Use of hazardous materials and safety Quality of product & production rate Other			
Opportunities for CP			
Expectation for participation of leaders			
Selection of CP-assessment focus			

WORKSHEET 4: INPUT & OUTPUT TABLES

Input

Substance	Annual usage	Purchasing costs per unit	Costs of usage	Application
Raw materials and auxiliary materials				
Packaging materials				
Paper				
Wood				
Plastic				
Energy and utilities				
Steam				
Oil				
Water				
Electricity				
Compressed air				

Output

Waste/emission stream	Quantity per year	Internal costs	External costs	Total costs
Total				

WORKSHEET 5: ASSESSMENT OF UNIT INPUTS & OUPUTS

INPUTS | **OUTPUTS**

RAW MATERIALS	QUANTITY	COSTS

CATALYSTS	QUANTITY	COSTS

ENERGY	QUANTITY	COSTS

WATER	QUANTITY	COSTS

AIR	QUANTITY	COSTS

U N I T

O P E R A T I O N

GASEOUS EMISSIONS	QUANTITY	COSTS

DUST	QUANTITY	COSTS

(INTERMEDIATE) PRODUCTS	QUANTITY	COSTS

BY-PRODUCTS	QUANTITY	COSTS

RE-USE in other operations	QUANTITY	COSTS

WASTE WATER	QUANTITY	COSTS

RECYCLE

LIQUID WASTE	QUANTITY	COSTS

SOLID WASTE	QUANTITY	COSTS

WORKSHEET 6:CAUSE ANALYSIS OF WASTE AND EMISSIONS

Description of waste or emission	Quantity	Costs	Why is waste generated?	Detailed description of the cause of waste stream or emission
			❑ Composition raw materials ❑ Operating practices ❑ Production management ❑ Production technology ❑ Production equipment ❑ Product specifications	
Description of waste or emission	**Quantity**	**Costs**	**Why is waste generated?**	**Detailed description of the cause of waste stream or emission**
			❑ Composition raw materials ❑ Operating practices ❑ Production management ❑ Production technology ❑ Production equipment ❑ Product specifications	
Description of waste or emission	**Quantity**	**Costs**	**Why is waste generated?**	**Detailed description of the cause of waste stream or emission**
			❑ Composition raw materials ❑ Operating practices ❑ Production management ❑ Production technology ❑ Production equipment ❑ Product specifications	

Worksheet 7: Where – Why – How ?

		Where (waste stream &source)	Why (cause assessment)	How (option generation)
Input substitution				
Product modification				
Technology change	Technology change & Equipment			
Good operating practices	Good housekeeping & Better production			
On-site reuse and recycling				

Worksheet 8A: Description of options and benefits

Option Nr	Description of option	Benefits after implementation			Cost level
		Environmental	Economical	Other	
	Change of input materials				
	Technology change; improved equipment/process control				
	Good operation practices; good workers skills and good production management				
	Product modification				

Option Nr	Description of option	Benefits after implementation			Cost level
		Environmental	Economical	Other	
	On site re-use and recycling				

Cost level: A: Low/No cost options; B: Medium/high investment; C: complex/not enough information

Worksheet 8B: Results of option screening

Option Nr	Option	Results of screening			Cost level
		Implemented	To feasibility study	Not considered	

Option Nr	Option	Results of screening			Cost level
		Implemented	To feasibility study	Not considered	

Worksheet 9: Feasibility study

Investment costs

Equipment costs	Quantity	Unit price	Costs
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
……			Rp -
Pumps			Rp -
Piping			Rp -
Total			**Rp -**

Installation costs		Costs
Electrical		
Instrumentation		
Plumbing		
Mechanical		
Civil		
……		
……		
Total		**Rp -**

Engineering costs		Costs
Drawings		
Calculations		
……		
……		
……		
……		
Total		**Rp -**

Other costs		Costs
Import duties		
Permits		
Instruction		
……		
……		
……		
……		
Total		**Rp -**

Total cost of investment	**Rp -**

Worksheet 10 Feasibility study

Running costs after investment

Raw materials	Quantity	Unit price	Costs	
			Rp	-
			Rp	-
			Rp	-
			Rp	-
Total			**Rp**	**-**

Auxiliary materials	Quantity	Unit price	Costs	
			Rp	-
			Rp	-
Total			**Rp**	**-**

Energy cost	Quantity	Unit price	Costs	
Steam			Rp	-
Electricity			Rp	-
Oil			Rp	-
Gas			Rp	-
Total			**Rp**	**-**

Environmental costs	Quantity	Unit price	Costs	
Waste disposal			Rp	-
Water treatment			Rp	-
Air emission abatement			Rp	-
Total			**Rp**	**-**

Personnel costs	Person-years	Salary	Costs	
Operators			Rp	-
Supervisors			Rp	-
Total			**Rp**	**-**

Sales after investment			**Rp**	**-**

Total running costs after investment per year			**Rp**	**-**

Running cost before investment per year

Raw materials	Quantity	Unit price	Costs	
			Rp	-
			Rp	-
			Rp	-
			Rp	-
Total			**Rp**	**-**

Auxiliary materials	Quantity	Unit price	Costs	
			Rp	-
			Rp	-
Total			**Rp**	**-**

Energy cost	Quantity	Unit price	Costs	
Steam			Rp	-
Electricity			Rp	-
Oil			Rp	-
Gas			Rp	-
Total			**Rp**	**-**

Environmental costs	Quantity	Unit price	Costs	
Waste disposal			Rp	-
Water treatment			Rp	-
Air emission abatement			Rp	-
Total			**Rp**	**-**

Personnel costs	Person-years	Salary	Costs	
Operators			Rp	-
Supervisors			Rp	-
Total			**Rp**	**-**

Sales before investment			**Rp**	**-**

Total running costs before investment			**Rp**	**-**

Worksheet 11: Feasibility study

Pay back time

Fill in the data from the worksheet with the investment costs

Equipment costs		
Installation costs		
Engineering costs		
Other costs		
Total investment costs	$	-

Fill in the data from the worksheet with the old and new running costs

Total running costs before investment		
Total running costs after investment		
Annual savings (costs after investment minus costs before investment)	$	-

Divide the investment cost over the annual savings, this will give you the

PAY BACK TIME IN YEARS	#DIV/0!

Checklist 1: Planning and organization

Commitment of company management

		Yes	No
•	Is company management committed to the CP-assessment?		
•	Does company management agree with the CP-assessment planning?		
•	Does company management allow the assessment team members to spend enough time on the assessment?		
•	Is it clear what the goals of company management are?		
•	Do you have a clear arrangement for informing company management during the assessment?		
•	Is sufficient budget allocated to immediately implement obvious (housekeeping) CP-options?		

Establishing the leading team and the assessment team

		Yes	No
•	Has a leading team been established?		
•	Has the assessment team been established and approved by the leading team or company management?		
•	Have the team members agreed upon tasks and responsibilities?		
•	Do both team members support the facilitator (e.g. CP-consultant)?		

Gaining insight in possible barriers and opportunities

		Yes	No
•	Did the assessment team identify possible barriers that could negatively affect the CP-assessment?		
•	Has the assessment team discussed ways to overcome these barriers?		
•	Did the assessment team identify possible opportunities that could positively influence the CP-assessment?		

Informing company employees about CP

		Yes	No
•	Have you made a campaign to inform company staff about CP and the upcoming CP-assessment?		
•	Do you have a plan to keep company staff involved about the progress and results during the CP-assessment?		
•	Do you use different media (folders, announcement boards) to distribute the results op the CP-assessment?		

Planning the CP assessment

		Yes	No
•	Has the planning been discussed among the team members and the assessment team and leading team?		
•	Is it clear among all team members how much time is needed for each phase and specific activities?		
•	Are deadlines set?		
•	Have team meetings been arranged?		

Checklist 2: Pre-Assessment

Establishing a simple general flow chart

		Yes	No
•	Does the assessment team have a good overview of all facility and unit operations?		
•	Have the utilities and complementary facilities been included?		
•	Have the facility and unit operations been grouped in boxes that facilitate the collection of data and the decision making afterwards?		
•	Have the all inputs and outputs been considered, including cleaning activities, energy consumption, shutdown and start-up operations.		
•	Have input/output flows been analyzed in terms of quantity, environmental impact, efficiencies and costs?		
•	Is an overall energy (electricity and heat) balance made for a facility or the entire plant to permit prioritization of energy conservation opportunities?		

Establishing an assessment focus

		Yes	No
•	Can you make a short-list with those units with the highest impact in terms of environmental pollution, raw material and energy-efficiency and operational costs?		
•	Did you use trend analysis of energy consumption, vs. production rates in a distinct period to understand capacity utilization on energy use efficiency?		
•	Did you consider the tariff structure of electricity supply regarding maximum demand charge, and the energy demand profile over day cycle?		
•	Did you compare energy and raw material (incl. auxiliaries) consumption per kg of product with similar (inter)national industries (benchmarking)?		
•	Is the selection of each possible assessment focus, based on qualitative and limited quantitative information, justified (or is more information required)?		
•	In case more additional information is needed, did you include this unit as part of the assessment focus?		
•	Have you utilized in-house and external expertise for making the justification based on benchmarking?		
•	Do you know whether the company is in compliance with environmental and health & safety standards?		
•	Have you discussed the selection of focus(es) with leading team and do they give full support to the selection of the focus?		

Set plant-wide cleaner production targets

		Yes	No
•	Do you have reference material for raw material use, energy, waste and emissions for comparison?		
•	Did you consider the tariff structure of electricity supply regarding maximum demand charge, power factor?		
•	Are the short term (management) targets measurable?		
•	Are the short term targets also realistic (in terms of progress and investment needs)?		
•	Are the short term targets discussed with and supported by management?		
•	Have incentives been considered?		
•	Have you considered methods to regularly inform involved employees about the progress?		

Implement obvious improvements

		Yes	No
•	Have losses through leaks in pipes and valves, indications of insufficient maintenance, running taps and losses through improper handling been noted?		
•	Have the above noted losses been quantified in terms of environment and money (value of material, lost sales)?		
•	Are simple energy saving measures (timers, insulation) considered?		
•	Have solutions been proposed?		
•	Have solutions been implemented?		
•	Are the results being monitored?		

General points

		Yes	No
➢	Is a list with the focused and non-focused assessment items included in the report?		
➢	Concerning the obvious improvements, is the situation before and after the implementation described and quantified?		
➢	Did you include a simple general flow chart and are the targets described in the report?		
➢	Is everything going according to the planning? Is adjustment of the planning and division of tasks needed to allow for better results?		
➢	Have you re-evaluated the objectives of the assessment? Would refinement of the objectives serve the cleaner production assessment?		
➢	Have you informed management and employees about the progress of the cleaner production assessment?		
➢	Have you adjusted the composition of the assessment team in anticipation of the needs for the following steps?		

INVESTIGATION OF THE PRESENT STATUS ON-SITE INVESTIGATION

Description of the enterprise

- What is the current status of the enterprise, the main products, the production scale and the production output (real output and design output or capacity)?
- What is the organizational profile of the enterprise?
- How can the management of the enterprise be described?
- Are there any expansion plans?
- What is the actual market situation? Is there a stable demand site?
- How can the physical location, the environment the enterprise is situated in, be described?
- Geographic location, geological structure and hydro-geological, meteorological and ecological environment, etc?
- How the financial situation is: what is the value of assets, the product sale, the profits (after tax), etc?

Production data

- What are the different unit operations and main equipment?
- How is the product quality and are there variation in its quality?
- What are the major raw and subsidiary materials of production, the main products, the consumption of energy and water in each workshop and consumption of the energy and materials and utilities per unit product (can be annual figures)?
- What are the major material consuming operations and practices?
- What are the major energy consuming operations and practices?

Environmental status and issues

- What are the major pollution sources and the emission, including the status, quantity, toxicity and so on?
- Is there a treatment of the major pollution sources, what are the results (waste emissions characterized before and after treatment), what are the problems and the treatment costs of unit wastes?
- What are the environmental monitoring practices?
- Are waste and heat reused or recycled and if so in what way?
- Are there relevant regulations and requirements related to the enterprise, such as pollution discharge permits, regional total load limitation, and discharge standards of various sectors?
- Does the enterprise comply with those regulations?

Maintenance, Housekeeping, Motivation of the employees

- Are there signs of poor housekeeping, are floors swept, drums covered etc?
- Are there noticeable spills, leaking containers, is there water dripping and running?
- Are there smoke, flumes, dirt etc. that indicate material losses?
- Is there corrosion, dirt, discoloration on walls, floors and equipment that may indicate poor maintenance?
- Are there odors, experienced irritations, when entering the workplace that may indicate leaks?
- Are all containers labeled as to their content and hazard?
- Do employees have any comments about the sources of waste and emissions in the enterprise?
- How can the environmental awareness of the employees be described?

Accident prevention

- Are preventive measures such as the use of protective cloths, safety booths, helmets, dust caps, safety glasses, masks etc?
- Is emergency equipment available and visible to ensure rapid response to any incidents or spills?
- Is there a history off spills, leaks, accidents or fires in the enterprise?

Production layout

- How can de production layout be described, is it compact or are the related units located far from each other?
- Is there much transport of materials and products?
- Are the directly related unit operations close to each other?

Monitoring and control situation

- What is the level of monitoring of the operation, are data continuously collected and in what way?
- What is the level of process control, are the functions manual or are these (partly) automated?
- If the level of process control has been changed, is there information, for example historical data collection, on the influence of the improve process control on the environmental situation?

CHECKLIST 3: Assessment

Establishing the material balance

		Yes	No
•	Have you established a new more detailed flow diagram of the assessment focus?		
•	Have you included all activities including, handling, maintenance and cleaning?		
•	Have you considered all kinds of inputs and outputs? (for inputs: raw materials, catalysts, water & air, power) (for outputs: gaseous emissions, intermediate products, recycled and re-used streams, by-products, waste water, liquid wastes and solid waste)		
•	Have you put a cost to each input and/or waste stream?		
•	Have you checked if you have included all costs for waste streams (value for raw materials, handling, transport, fees, and waste treatment)?		
•	Have you used reliable data based on real data (and thus not based on design criteria, capacity calculations, etc but on on-site measurements, production and procurement/sales records)?		
•	Have you carefully checked all figures for inconsistency in unit (e.g. l/s, m3/h, GPM)?		
•	Most probably the inputs and outputs of your material balance will not equal exactly. Whether the deviation is of importance and/or needs to be investigated depends on the following considerations. Is the inconsistency significant? Relates the deviation to toxic, expensive materials or waste streams or to high risk of non-compliance? Do you have a fairly good idea why the deviation exists? Does the expected effort to correct the material balance weigh up against the gain of a better insight?		

Establishing the energy balance

		Yes	No
•	Has a heat balance been prepared for the relevant unit and facility operations?		
•	Is there excess heat or shortage?		
•	Did you set the box (battery limits) to prepare the heat balance of the unit operation according the location of the existing measuring devices (e.g. temp., pressure, flow)?		
•	Has the overall electricity demand and heat production been put in a history diagram to define the peak demands?		
•	Did you link the production rates per facility and unit operation to the heat and electricity demand?		
•	Have you put a cost to the energy consumption?		
•	Have you used reliable data based on real data (and thus not based on design criteria, capacity calculations, etc but on on-site measurements, production and procurement/sales records)?		
•	Have you carefully checked all figures for inconsistency in unit (e.g. psi, bar, barg)		

Finding and evaluating causes

		Yes	No
•	Have you seriously considered every cause category of waste & emissions? (Be careful; do not neglect certain causes and or waste & emission streams because you think that solutions may be difficult to find or implement)		
•	Did you 'translate' the energy-efficiency of facility operations to unit operations?		
•	Have you discussed the list of causes with the operators?		
•	Can you try to estimate the contribution of each cause to the total flow of a particular waste stream in the assessment focus? (try to measure, calculate and extrapolate)		
•	Have you analyzed the functions underlying the process?		
•	To which extent do basic assumptions influence the cause?		

Implement obvious improvements

		Yes	No
•	Some of the causes may be solved by simple solution (e.g. housekeeping or adjustment of equipment settings). Have you noted these options?		
•	Have solutions been implemented?		
•	Are the results being monitored?		

General points

		Yes	No
•	Is a list with all assessment items included in the report?		
•	Did you include the flow chart and the material and energy balance in the report?		
•	Is everything going according to the planning? Is adjustment of the planning and division of tasks needed to allow for better results?		
•	Have you re-evaluated the objectives of the assessment? Would refinement of the objectives serve the cleaner production assessment?		
•	Have you informed management and employees about the progress of the cleaner production assessment?		
•	Have you adjusted the composition of the assessment team in anticipation of the needs for the following steps?		

Checklist 4: Option Generation

Generating CP-options

		Yes	No
•	Have you thought of including ‘fresh’ people in the brainstorming session other than the assessment team members?		
•	Is the position of the facilitator clear to make sure the brainstorming session goes according to the fundamental rules?		
•	Have you thought of using one or more different brainstorming techniques, which might fit best to the situation and the group?		
•	Did you make a good 'problem definition' before starting the brainstorming (to make sure everyone tries to find solutions for the same problems)?		
•	Have you thought of the following fundamental rules for successful brainstorming? - postpone judgment and criticism - everything is allowed: 'wild' ideas lead to good solutions - build on other people's ideas - stick to the problem definition		
•	Did you look at the functionality of (parts of) unit operations?		
•	Have you thought of excessive design considerations operational misunderstandings, undue demands?		
•	Do you have someone to write down all ideas provided by the participants?		

Screening of options

		Yes	No
•	Have you involved experts from within the company or/and experts from outside the company in the screening of options?		
•	Have you arranged all options per unit of operation and investigated if some of the options interfere with or exclude each other?		
•	Have you made estimations for the change in inputs and outputs?		
•	Have you been aware of possible shift from material savings to increased energy demands and reverse effects?		
•	Have you looked at the technical, organizational, economic and environmental consequences?		
•	Have you divided them into the following three groups? - Options that can be implemented directly - Options that look promising but need extra investigation - Options that are clearly not (yet) feasible (next timers)		

Implement obvious improvements

		Yes	No
•	Have you started to implement those solutions that are categorized as 'go'ers'?		
•	Are the results being monitored?		

General points

		Yes	No
•	Is a list with all options included in the report?		
•	Did you include the modified flow chart and the modifications in the material and energy balance in the report?		
•	Is everything going according to the planning? Is adjustment of the planning and division of tasks needed to allow for better results?		
•	Have you re-evaluated the objectives of the assessment? Would refinement of the objectives serve the cleaner production assessment?		
•	Have you informed management and employees about the progress of the cleaner production assessment?		
•	Have you adjusted the composition of the assessment team in anticipation of the needs for the following steps?		

Possible energy saving potential

Structure of energy system	Measures to be taken	How to identify potential?
Management	Setting up a task force "Energy concerns"	Tasks and competence's are not clearly defined, there are no regulations, no monitoring of energy concerns (e.g. energy figures for newly bought machinery)
	Energy accounts	No continuous registration and updating of energy consumption and costs
	Respecting energy key figures	High specific consumption of existing machinery, out-of-date technology
Energy supply	Use of environmentally friendly fuels	High 502, dust or NOx emissions, no renewable energy sources
	Installation of solar. Collectors	Great demand for warm/hot water, even in summer
	Load management	High performance cost, low continuous performance
	Compensation for idle current	High cost for idle current
	Energy cost	High cost for electrical energy in comparison to similar plants
Conversion	Co-generation	Great parallel need (over 6000 h) of heat and electricity
	Boilers	Low combustion efficiency, high exhaust temperature, no flue gas register, badly adjusted burners
	Adjustment of burner performance (exchange nozzles)	Heat consumption drastically changed in recent years
	Control and maintenance refrigeration	No cleaning of heat exchangers; checking the temperature in the refrigerating chamber, insufficient aeration
	Compressed air	Great losses due to leakage's, compressor located at a warm spot, no maintenance of filters
Distribution	insulation of pipes, maintenance/exchange of steam traps	High energy consumption in spite of low production (e.g. at night, on weekends)
Consumer - Space heating Warm water	Better adjustment of heating	Adjustment, no thermostatic valves , no adaptation of room temperature to seasonal weather conditions, no lowering during the night, local overheating, radiators blocked or in niches
	Lowering transmission losses	no automatic gates, doors and windows in a bad state, air extraction not stopped when necessary
	Warm/hot water	High temperatures, no checking for water saving fittings and water stoppers, no insulation of pipes
Air conditioning	No adjustment of air input according to need, refrigeration, internal heat and humidity sources existent in the area, no sunblinds, no adjustment to specific needs (temperature and volume)	
Optimization of process	Volume stream of carrier (water,	Consumer -

heat installations	air) not checked, no or insufficient coverings and insulation, old processes process heat (e.g. convention dryers instead of infra red dryers)	process heat
Use of waste heat	Waste heat flows of different temperatures are not guided and used, waste heat from refrigeration unit or product refrigeration not used, waste water not used	
Maximum use of refrigeration points	Capacity badly used, temperature lower than necessary, blocking of cooling area, interruption of cold chain, heat sources placed near refrigeration points, no coverings	Consumer-refrigeration
Checking electrical drives	Suction grids and nozzles not regularly cleaned engines generally run with partial load	Consumer-electricity
Mounting of frequency converters	For air fans and pumps with high volumes which are not adjusted	
Optimization of lighting	Equipment more than 10 years old, bad lighting, no partial control	
Transport	No logistic concept, no control of the existing motor vehicle fleet and of routes, no transport by sea, rail, public transport	Consumpter-Transport

(Source: Ecoprofit, STENUM, 1995)