RERAM

HANDBOOK FOR

RESOURCE AND ENERGY EFFICIENCY IN FOREST-BASED INDUSTRIES

OF EASTERN EUROPE

RERAM
HANDBOOK

A practical guide on how to improve cleaner production and efficiency in small and medium-sized enterprises in the forest-based sector

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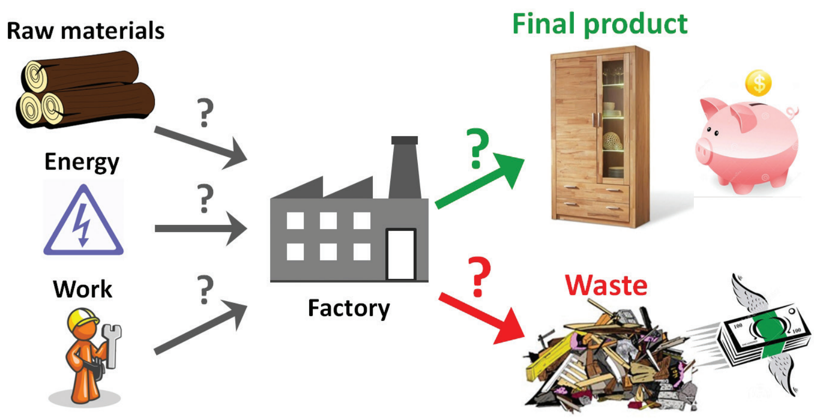
RESOURCE AND ENERGY EFFICIENCY:
WHY SHOULD THE WOOD INDUSTRY INVEST IN IT?

This Handbook is a practical guide for managers and technical personnel on how to improve production efficiency with the goal to save input costs and reduce environmental impacts at the same time.

Most woodworking companies are not aware that inefficient production generates large losses of material and energy and sum up to considerable costs. Wastes and emissions once were input materials, which were bought for money, but have not been converted into products to be sold for money.

This handbook introduces you to Cleaner Production principles, tools and improvement options that can leverage a variety of saving potentials in SMEs. The solutions can easily be applied in any company.

Efficiency: How much input is converted into the final product, how much is wasted?



Purchased raw materials and energy are main cost drivers in the woodworking industries. Purchase costs for this input cannot easily be reduced, however a company can influence the way this input is converted into products. Worldwide, many companies have proven that it pays back to implement dedicated measures for improvement while saving costs and resources.

Improving efficiency means to implement Cleaner Production into your business model. The goal is to reduce the amount of wasted material and energy, so that more of the input resources will be valorised into the final product, making your company as a whole more efficient and competitive.

THE HIDDEN COSTS OF WASTE

This handbook points to the most common issues of lacking efficiency, which companies usually do not pay attention to. Often considered as "minor problems", most managers are not aware that they generate large losses of material and energy and sum up considerable costs. In fact the "visible" costs for waste are those for treatment and disposal - but below the surface there is an "iceberg of hidden costs"!

The most common reasons for inefficiency in smaller woodworking companies include:

- Inefficient storage, handling and processing of raw materials
- Improper use and lacking maintenance of equipment
- Inefficient work flows, transport and logistics
- High losses of energy in all forms
- Improper handling and disposal of wastes
- Workers' safety issues

Underestimated costs of waste treatment

SELF-CHECK OF YOUR COMPANY

By means of a first self-check of the current situation in your company, many saving potentials and improvement options can easily be identified.

In general, about 50% of the identified options can be realised directly with little or no investment and will pay back in less than 6 months ("good housekeeping"). Another 25% of the options can be realised with a minor investment and will pay back in a medium term (usually less than 2 years). The last 25% of options require major investments that pay back only in a long term.

Making your production more efficient will save costs, but can also result in additional benefits that sustain your company's performance and growth:

- Higher quality of your end products
- Stronger position in your marketing
- Better working conditions for and motivation of your personnel
- Reduced impacts on the environment

SUSTAINABILITY

GLOBAL NEEDS FOR RESOURCES AND ENERGY

The world we live in is faced with tremendous environmental problems:

- The population grows by circa 250,000 per day.
- 795 million people suffer from hunger.
- 80,000 hectares of forests are cleared per day.
- Biodiversity loss: Between 10,000 and 100,000 animal and plant species go extinct per year.
- Global carbon emissions from fossil fuel use were about 9.795 gigatonnes in 2014.

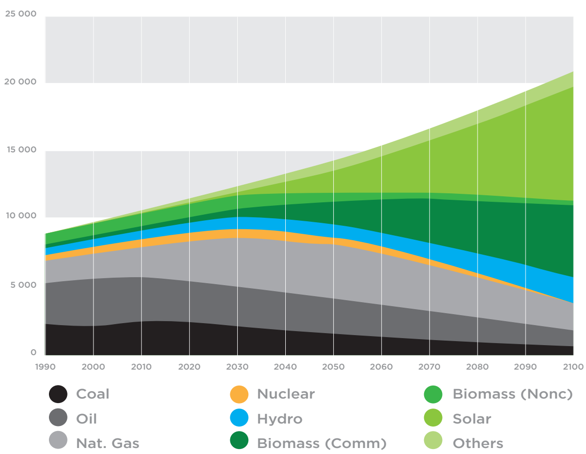
Resource needs: production of one Personal Computer (PC)

- Manufacturing one average PC uses at least 240 kg of fossil fuels, 22 kg of chemicals and 1,500 kg of water = in total 1.8 tonnes of materials. It is much more materials intensive than a car or a refrigerator)

- The life time of individual parts is up to 20 years, a PC however is replaced after ca. 2-4 years.

Global change of energy supply: 40% renewables until 2050

World primary Energy Consumption: Biomass & Solar Scenario 1990-2100



The global demand for energy is growing rapidly. Fossil fuels make up more than 80% of the total energy supply today.

Wood biomass is the main energy carrier in renewable energies today (more than 50%) and it will contribute even more to the reduction of fossil fuels in the future.

Sustainability is the global goal of a balanced, fair economic development without depleting the world's resources and ecological balance for future generations. Sustainability integrates economic, ecological and social criteria to create competitive advantages → Economic success with values.

PROTECTING THE WORLD'S CLIMATE: THE ROLE OF FORESTS AND WOOD

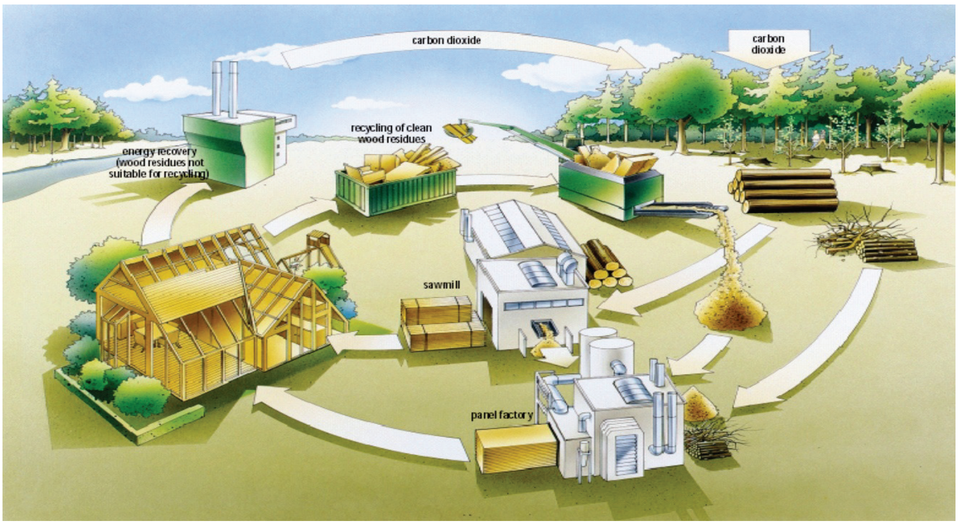
Using wood efficiently is an active contribution to climate protection, because it substitutes fossil fuels and other energy-intensive materials.

Trees are natural factories: A beech tree of circa 70 years and 15 m crown diameter filters approx. 2 CO_2 net kg/hour, 12 hours per day.

Forests are the green lungs of our earth. They protect natural carbon cycles and the climate. Through photosynthesis trees take up CO_2 from the atmosphere and bind it in wood.

Managed forests provide wood raw materials for various forest-based products, for example construction, furniture, paper, bioenergy or biochemicals. It is a save way to reduce the CO_2 emissions that are the main cause of Climate Change. The main functions are:

- the carbon sink effect of the forests
- the carbon storage effect of wood products
- substitution of carbon-intensive materials.



Carbon cycle of forests, forest-based products and bioenergy. Source: CEI-Bois 2011

Cascading Use of wood (see graphic) is the optimal way to use wood. Raw wood material from forests should first be converted into solid wood products and recycled as long as possible to maximize the carbon storage. Only if it cannot be recycled any more, it is finally used for energy production.

CLEANER PRODUCTION

THINKING WASTE AS A RESOURCE

Wastes and emissions once were input materials, which were bought for money, but have not been converted into products to be sold for money. Improving efficiency means to implement Cleaner Production as part of your business model. The goal is to minimize the amount of wasted material and energy and valorise more input resources in the final product.

The most common understanding of waste management in companies is: How can we get rid of the waste (End-of-pipe thinking)? However, the Cleaner Production idea of waste is: Where does it come from? What can be done to avoid it? The Cleaner Production benefits are:

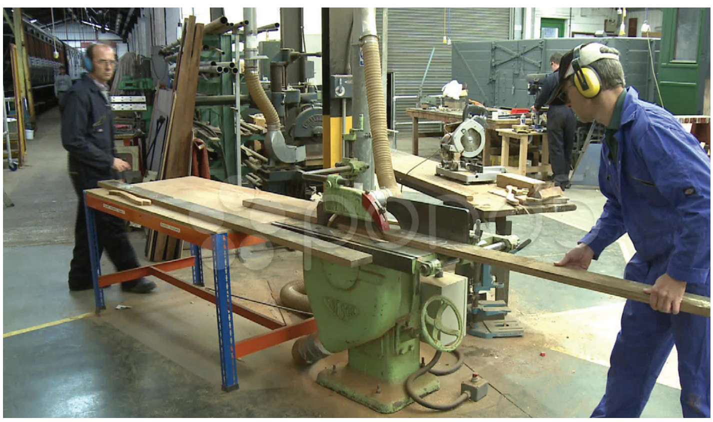
- CP pays back
- CP motivates the employees
- CP improves legal compliance
- CP creates innovation
- CP protects the environment
- CP increases quality

The CP Solution:
a consistent analysis of the materials from input to output, with:

- Input-output analysis
- Material flow analysis
- Energy analysis

Cleaner Production can consider your company's whole production cycle:

- technologies
- employees
- raw materials
- processes
- emissions
- suppliers and
- products



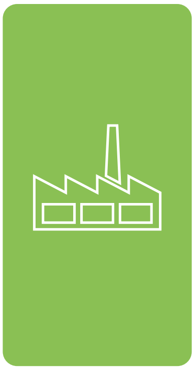
Cleaner Production considers all inputs and outputs of a company

INPUT

Material
raw materials, auxiliary materials, further materials

Energy
fuels with mass like LPG, oil, CNG, diesel

Energy
without mass like electricity



OUTPUT

Products
products, by-products

Material-related Emissions
waste, exhaust, waste water

Energy-related Emissions
waste heat, noise

Why are raw materials being converted to waste and emissions?

- Unused raw materials
- Impurities of raw materials
- Spent auxiliary materials
- Undesired side products
- Rejected products
- Residues from maintenance
- Losses in start-up and shutdown of machines
- Handling, storage, transport, samples, analysis
- Leakages, materials from damages
- Evaporation losses

Possible barriers and “idea killers” for implementation of CP options

- We have always worked like this
- We are too big/too small for this
- Do not forget we have to earn money
- This does not affect my department
- Nobody told me what to do
- I am still waiting for the O.K.
- It is not my business
- I have to wait for the boss
- I forgot
- I am very busy
- Let John do this
- I did not understand
- It is too early for this
- Now it is too late

Optimizing the efficiency of a production process

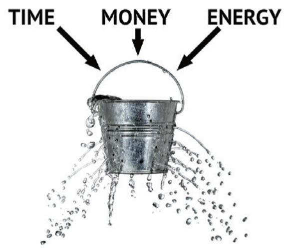
- A comparison with the best available technology shows the weak points.
- Material flow analysis evaluates the “production costs” of wastes.
- Eco-efficiency: the best use of materials reduces waste and emissions.

CLEANER PRODUCTION STRATEGIES

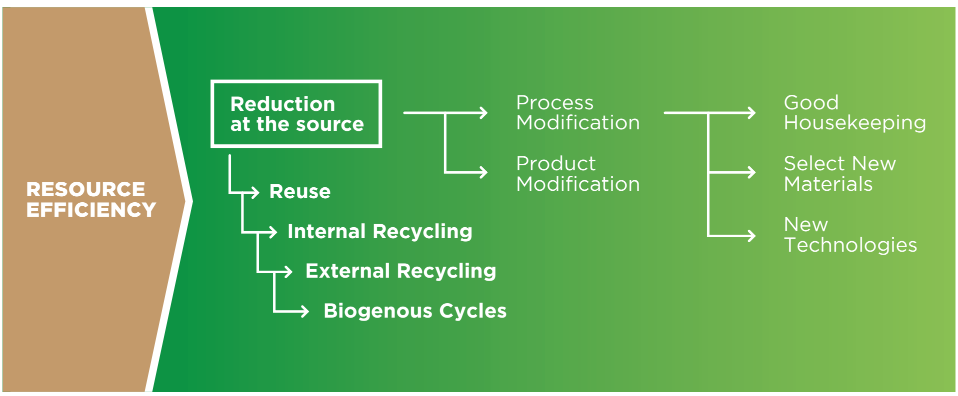
Avoiding Waste – Hierarchy of Cleaner Production Options

The first priority of resource efficiency is to identify waste minimization options, which allow to eliminate or to reduce waste at the source. Only when these options have been exploited sufficiently, other options like external recycling or waste disposal should be considered for remaining output materials.

Product modifications can cause important ecological improvements. These can include replacing the product, increasing its lifetime, changing the materials or even changing the product design ("eco-design"). However, most companies are reluctant to change their products.



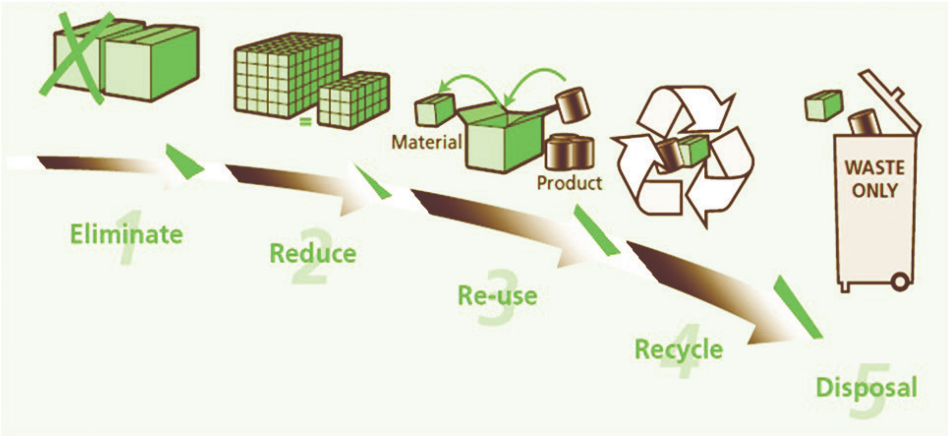
Process Modifications can reduce waste considerably and may relate to the entire work process in the company. These changes can comprise a full package of different measures.



Strategies for CP Options (based on the ÖKOPROFIT approach)

A) Good Housekeeping / Careful use of raw and process materials, including also organizational changes: These are the best and most economical measures to implement. Examples: training and motivation of staff; change of handling sequence; employment directives for materials and packing units; material flow tracking; measuring material consumption; dosage of chemicals, etc.

B) Select new raw and process material: Raw and process materials which are difficult to recover, or even toxic, can often be replaced by less risky materials, allowing to reduce waste and costs. Examples: use of waste as raw material; replacement of organic solvents by aqueous solvents; materials in reusable packaging; bigger bags or containers, etc.



The Waste Hierarchy. Source: Envirowise 2001

C) New technology, ranging from simple reconstructions to far-reaching process changes, including a lot of energy saving measures. Examples: change to LED technology in lighting; change to more efficient spray painting technologies; installation of heat recovery units; installation of variable speed drives at compressor and pumps or blowers, etc.

If the resource use cannot be reduced at the source, further resource efficiency strategies offer more possible options:

D) Reuse means using a substance or product for the same purpose as before. Example: Recovery of solvents for the same use, reusable packaging, etc.

E) Internal recycling includes 1. **Further use:** using a material or article for another purpose. Example: Using the solvent acetone only for cleaning purposes; use of second grade wood or wood waste for invisible parts (e.g. underbody).
2. **Reclamation (down-cycling):** using a material for another, usually inferior, purpose. Example: Plastic or paper waste as filling material for packaging; sawdust for particle boards or landscaping mulch. 3. **Resource recovery:** recovery and use of only part of the waste material.

F) External recycling: Only after all waste minimization steps have been taken into consideration, measures outside the company should be considered. It is also important to know whether the external waste handler is doing recycling or down-cycling, which means that the time of dumping is shifted. We can also distinguish between: 1. **Re-use of entire structures,** example: packaging material again as packaging material. 2. **Material use,** example: waste paper, scrap as raw material for production. 3. **Energy use,** example: Pallet used as heating material

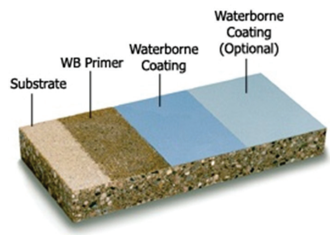
G) Biogenous Cycles: In addition to the actual recycling of material, waste recovery may also include the feeding of waste into biogenic cycles, as for example by composting of organic waste.

CP OPTIONS: EXAMPLES FROM WOOD INDUSTRIES

CP Option 'Good Housekeeping'

- Better storage and handling of raw materials and usable rest pieces allows to obtain circa +15% more saleable output from raw materials.
- Better recovery of wood dust and shavings increases amount of wood as usable energy fuel.
- Regular maintenance of sawmilling equipment improves output and quality of wood products.
- Drying chambers: optimised control of recirculation pump > switch them off when not required. Savings per year circa 20.000 kWh
- Compressor system: optimisation > reduce pressure to the correct level, fix leaks and shift the compressor to a less dusty place (to avoid clogging of filters). Savings per year circa 35.000 kWh.

CP Option 'Select New Materials'



- Furniture producer - Use of waterborne coatings: Company completely converted its finishing line to water based acrylic clear sealers and topcoats. Results include a high quality finish with excellent performance and a reduction of VOC emission rates by 80% and insurance costs by 25%.

CP Option 'Select New Technologies'

- Saw mill - Energy saving in drying chambers: Installation of frequency converters or VFD that control the speed of the fans based on temperature and moisture of air. Savings of 60-70% of electricity.
- Furniture company - Change from conventional spray guns to High Volume, Low Pressure (HVLP) spray equipment. Savings of 13-15% of coating usage and 90.000 €/year.

CP Options for 'Reuse', 'Recycling', 'Biogenous cycles'

- Finger Jointing Technique
- Sawdust for particle boards or landscaping mulch
- Sawdust for energy production
- Composting

EFFICIENCY IN PRACTICE: COMPARE FOR YOURSELF!

STORAGE AND HANDLING OF RAW MATERIALS

Raw materials are a major input cost factor in woodworking industries. Careful treatment, handling and sorting of materials during all steps of the production ensures a good quality of the final product and is a major cost saving option!

Bad practice: Destructive storage and inefficient use of expensive raw materials!

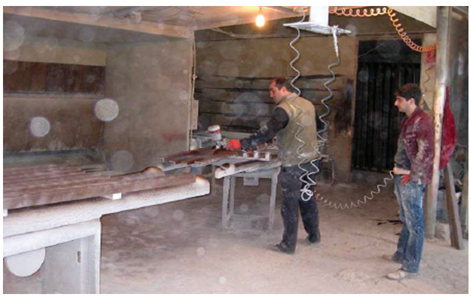
Good practice:
Proper storage of wood - vertically stored, well sorted, inventoried

WORKING ENVIRONMENT

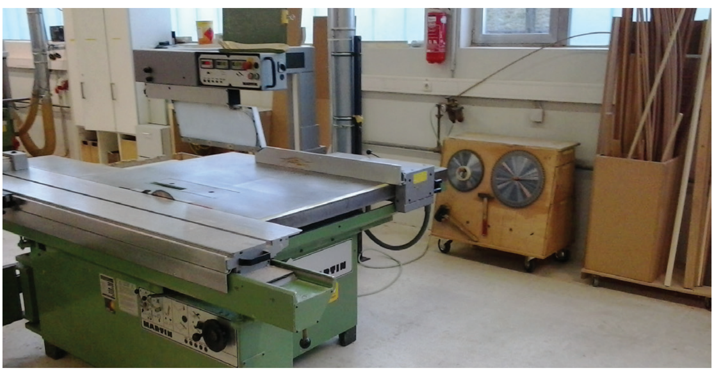
Dusty, difficult working conditions are a problem. A well functioning, proper working environment increases workers' efficiency and quality of the product!

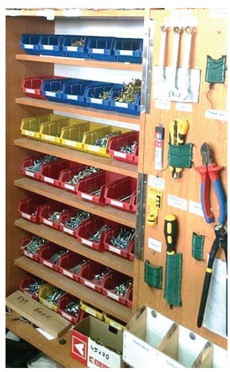
Bad practice:
Dirty, chaotic workshops and improper handling of valuable raw material

Bad practice:
Defect, non-maintained exhaustion system, quasi-inexistent dust collection



Good practice:
Clean, well organized workshop and properly ordered tools

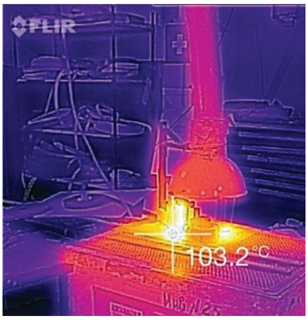


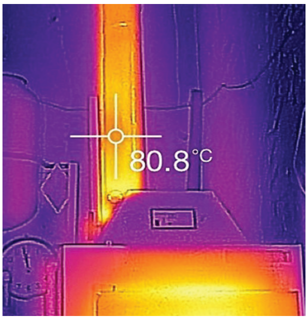


ENERGY EFFICIENCY

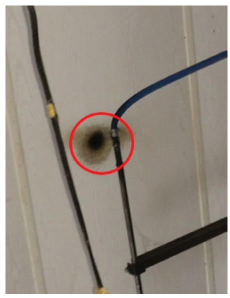
Lack of control over your company’s energy use in its many forms sums up to huge financial losses! Good housekeeping and maintenance pays back!

Bad practice:
Unused machines running, inefficient heating systems with huge losses





Bad practice:
Non-maintained, inefficient compressed air systems with many leaks

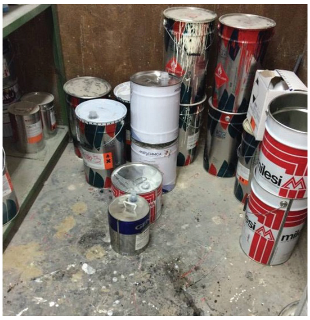


Good practice:
Well maintained, efficient modern compressed air and exhaust system

CHEMICALS, PAINTING, WORKERS' SAFETY

Safe storage and careful handling of chemicals reduce risk of accidents for your workers and costly material losses!

Bad practice:
Open containers with hazardous, dangerous chemicals



Bad practice:
Unprotected workers, inefficient painting techniques


Good practice:
Well isolated, modern painting booth / proper chemical storage room

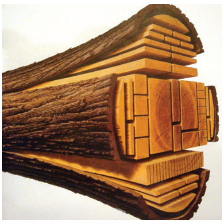

MOST COMMON IMPROVEMENT OPTIONS

The following issues are very frequent in wood industries of Eastern Europe, as documented in the enterprise checks performed during the RERAM projects.

- Awareness rising activities: trainings for employees regarding efficiency. First step: motivate employees to switch off machines not in use
- Waste management: clean up scrap, storage of empty drums, waste segregation according to law, repeated trainings of employees
- Dust collection: empty dust collector sacks, link collector with motor switch, maintenance of exhaust system
- Wood drying equipment: change gaskets, install VFD, heat recuperation system, insulation of hot pipes
- Recovery rate of wood: implement indicators, improve cut-to-length, install crosscutting line, yield improvements
- Handling of raw materials and usable rest pieces, improve storage of wood material and saw dust (for example protection against rain/humidity)
- Compressed air system: leak testing and fixing, red-tag system, correct pressure adjustment
- Spray painting: new technologies, training of employees, proper usage of booth, sufficient lighting, no sanding close to painting
- Maintenance of machines to ensure quality and avoid considerable losses
- Implement an indicator system to monitor environmental performance
- Lighting: change to electronic ballast and LED lamps, use natural light, place in optimal height, motivate to switch off lights and clean lamps
- Heating system and thermal insulation: insulation of boiler and pipelines, seal gaps between doors and door frames, transparent sheets at doors, reflector behind radiator, insulation of pipes and valves
- Storage of hazardous materials: train employees in the classification and labelling of chemicals, seal ground in storage areas, close containers, implement secondary catchment, check the storage of hazardous materials regularly and dispose old/outdated paints
- Risk management: clear guidance, motivation of employees to wear Personal Protective Equipment (PPE)
- Energy management: frequent checks of the energy load profile to avoid expensive energy demand peaks; implement waste heat recovery solutions to save costs

GUIDE FOR ENTERPRISE EFFICIENCY

IMPROVING WOOD RAW MATERIAL EFFICIENCY



This chapter on resource efficiency provides company owners and production managers with **benchmark data** for specific production steps, based on best available techniques in Central Europe, and it suggests a number of instruments to measure and improve recovery rates in companies in Eastern Europe.

- Basic raw material costs (mainly round wood) constitute a major part in the total production costs of primary wood products. For instance, in Central Europe round wood costs amount to approx. 70% of the total costs of sawn wood. For downstream wood products like Glulam or solid wood panels the share of raw material cost decreases in favour of other costs (labour costs, other auxiliary materials), but still remain at 50% and above.
- Low resource efficiency levels have a direct negative impact on the profit ability and competitiveness of companies not only due to supply shortages, high raw material costs, but also increased costs for waste handling and disposal. In addition, societal pressure calls for measures increasing the efficiency of wood processing companies in order to reduce the resource drain on the eco-system forest.
- An increased awareness of company owners and their staff on the impact of high timber recovery rates on production efficiency and wood waste reduction provides not only opportunities for better profitability and market position, but also tackles major societal challenges on the sustainable use of forest resources in the European Union and neighbouring countries.

The following benchmark data can be used to identify where your company's efficiency rates are lower than the industry average. The compiled data is based on literature study, company surveys, company checks and expert interviews. The data relies on circular sawing technologies. For band saw technologies efficiency rates can be slightly higher.

Solid wood products – material efficiency

Processing		Products, residues	Softwoods (Spruce)	Hardwoods (Beech)
Roundwood (fresh, after debarking) to sawn wood	→	Main yield	48%	38%
		Side boards	15%	15%
		Residues[1]	30%	40%
		Shrinkage	7%	7%
		Waste disposal[2]	0%	0%
		TOTAL	100%	100%
Sawn wood to Glue-laminated timber (Glulam)	→	Lamellas	72%	65%
		Residues[1]	28%	35%
		TOTAL	100%	100%
Sawn wood to solid wood panels	→	Lamellas	65%	57%
		Residues[1]	35%	43%
		TOTAL	100%	100%
Roundwood to Glulam	→	Overall efficiency	45%	35%
Roundwood to wood panel	→	Overall efficiency	41%	30%

Notes: 1. Shavings, sawdust, cuttings. Slabs and cuttings are chipped and used for drying processes and the workshop heating. The chip surplus is either directly sold or converted into added value product briquettes, pellets etc. In case of softwood the chipping is part of the sawmilling process (chipper canter/profiling equipment). 2. No waste, only main and by-products

Wood-based panels – material efficiency

Processing		Step	Output	Waste
Chipboard, MDF, hardboard	→	Primary cutting	90-92%	8-10%
		Secondary cutting	88-90%	10-12%

Other materials – material efficiency

Processing	Waste rates
Fabric/Foam (upholstery industry)	20-25%
Coatings/Paint	55-60%
Fittings (Metal, plastic)	2% of all components
Packaging material	2-5%
Return rate of goods (from customer)	5-15%

ENERGY I: ELECTRICITY & FUELS

Do you know your energy bills and your specific consumption (kWh/kg product)? Energy costs in a company usually account for 2 - 4 % of the turnover. The potential for savings with favourable payback typically is ca. 20 - 30 %!

Energy analysis

1. Start with annual energy consumption

- Document all energy carriers: quantity, cost, reference quantities, definition of indicators
- Analyse: Distribution of quantities and costs, variation of indicators
- Compare your data with other companies or literature

2. Proceed with analysis of energy input

- Annual and monthly consumption: bills
- Weekly and daily consumption: meters

3. Document and analyse your load curves

- Per year: show winter-summer relation, combined use of heat and power
- Per week: show decreased loads on weekends
- Per day: loads as bottlenecks, energy demand after production
- Think about Peak Load Control: Single peaks can be responsible for your power costs

4. Documentation of power consuming equipment

- Identification and documentation of equipment (power, running hours, load)
- Allocation of consumption (= motivation for investment into power saving measures)
- Setting of priorities by showing the structure of consumption

Continuous energy management

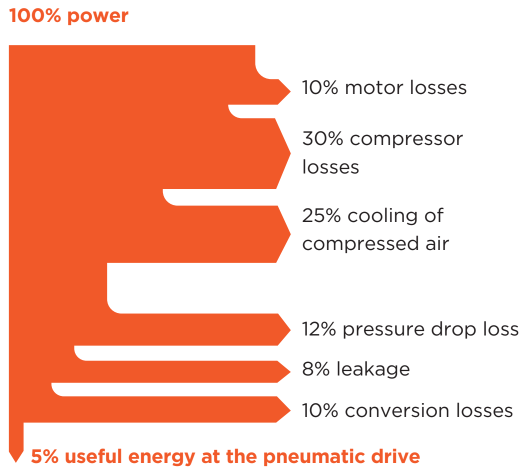
- Organization: set up an organizational unit, clarify the responsibilities and financial budget for its tasks
- Analyse and plan your energy situation, search for energy saving options
- Control of the energy plants, work out energy indicators
- Consulting: energy reports, internal consulting and market analysis
- Implement energy saving options, maintenance of energy plants

ENERGY II: COMPRESSED AIR

Compressed air is the most expensive form of energy: Be aware that an increase by +1 bar = +6% electricity! However, air systems are often poorly maintained - so don't blow your money in the air!

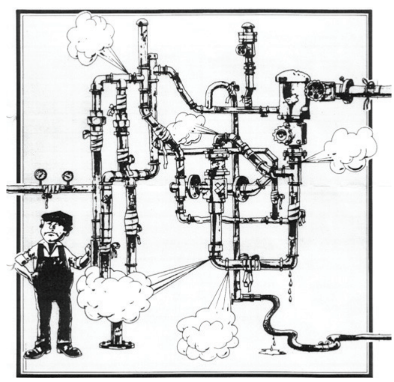
Features of a compressed air system

- High complexity with many parts
- Significant maintenance effort
- 10% of leakage is the rule
- Tendency to „grow"



Good practice in compressed air

- Switch off compressor, dryer and also the grid, when it is not needed
- Reduce pressure to minimum level
- Check for and repair leaks
- Use cold air as input for compressors
- Proper maintenance and cleaning
- Use electric tools



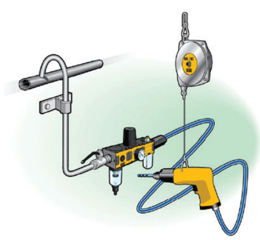
Main recommendations

- Install a ring system
- Keep pipeline length to a minimum
- Pressure difference between compressor –consumer: 0.5 bar
- Control and adjust the right pressure level

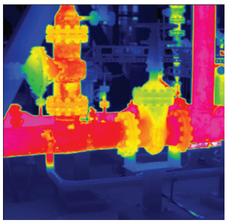
Costs of air leaks per size of leak hole

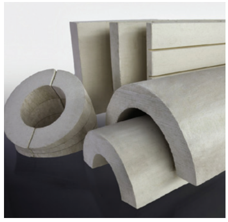
- 1 mm = 0,9 €/day = 317 € /year
- 3 mm = 8,7 €/day = 3.145 € / year
- 5 mm = 23,3 €/day = 8.515 € / year
- 10 mm = 93 €/day = 33.900 € / year

** based on electricity price of 0,09 €/ kWh*
** running 24/7, 365 days per year*



ENERGY III: FURTHER ENERGY EFFICIENCY OPTIONS





class	energy efficiency index
A	EEI < 0,4
B	0,4 ≤ EEI < 0,6
C	0,6 ≤ EEI < 0,8
D	0,8 ≤ EEI < 1,0
E	1,0 ≤ EEI < 1,2
F	1,2 ≤ EEI < 1,4
G	1,4 ≤ EEI

Recover heat from cooling

- Off-heat at 45 °C
- Economical for cooling machines > 10 kW cooling power
- 45 % of power can be reused as heat
- Favourable: good integration to existing heating system

Hot water

- Reduce temperature
- Reduce circulation during night
- Supply small users decentralized
- Remove unused taps
- Check sealing
- Check insulation

Ventilation and air conditioning

- Check temperatures
- Check clothing
- Switch on equipment only if needed
- Reduce air flow
- Increase recycling of air
- Check sealing
- Minimize (re)moistening
- Check valves and flaps

Heating

- Check temperature
- Lower temperature at night and weekends
- Seal doors and windows
- Use storage capacity of building
- Check insulation
- Check boiler, control, burners
- Switch off circulation pumps
- Free convection from radiators

Lights

- Use daylight wherever possible
- Switch off unneeded bulbs
- Use time controlled switches
- Clean windows/lamps
- Use energy efficient bulbs (LED) and electronic ballast

Machines in production lines

- Organize production flow
- Optimize use of machines
- Switch off unused machines
- Frequency/speed control: use Variable Speed Drives where feasible

WASTE MANAGEMENT

Managing waste is more than simply arranging a few containers in the enterprise! Good waste management helps you to improve the use of raw materials in your company and become more efficient.

Benefits: Why optimise your waste management?

- Transparency of quantity and costs of the waste streams
- Targeted minimisation and recycling measures
- Correct waste separation - disposal security
- Essential reductions of residual waste - cost reduction
- Waste handling as a part of a complete waste management plan
- Part of environmental management systems such as EMAS-regulation (EU), ISO 14001 (global)
- Visible example for a „living“ environmental protection
- Motivation of employees

Steps to implement your waste management system

- Check and correct legal compliance with the waste management act
- Assess the waste streams according to type, quantity and cost of waste
- Check of the weak points of the waste logistics
- Determine the minimisation and cost reduction potentials
- Definition, implementation and controlling of measures

Engage all staff for the set up of waste logistics

- Involve all staff in their working areas
- Inform about the correct waste separation
- Adapted container systems
- Re-design of the waste collection points
- Involve the cleaning personnel
- Motivation of all involved persons

WORKERS SAFETY




The woodworking industry has one of the highest accident rates in industrial manufacturing, mostly caused by contact with moving machinery! Protecting your personnel from accidents is your duty!

Simple steps to prevent accidents at woodworking machines

- Train employees before they are allowed to carry out unsupervised work
- Check that guards, brakes and safety devices are installed and used!
- Feed machines by hand only using well-designed push-sticks or jigs
- Check that machine controls are well positioned, labelled and maintained
- Switch off unused machines and disconnect them before maintenance
- Keep working area and floors free from loose materials or waste
- Ensure good lighting and heating
- Encourage employees to report any faults to their supervisor

Other important safety measures

Noise: Woodworking is one of the noisiest working environments, which can seriously damage the hearing. Dedicate measures to manage noise levels!

Painting & spraying: Many paints, varnishes, stains, thinners and glues give off vapours that are easily ignited and also hazardous to health. Spray only in suitable ventilated booths. Ensure that employees wear appropriate personal protective equipment, such as breathing masks, gloves, eye protection and overalls.

Hazardous materials: Store highly flammable liquids in a fire-resistant store or room that is well-ventilated, secure and leak-proof. Train staff in handling, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Wood dust: Concentrations of tiny wood particles can cause serious risks, such as fires, explosions, dangerous slippery floors, and health risks (skin irritations, asthma, nasal cancer). Maintain a functional dust-extraction system.

Handling & stacking: Many fatal accidents involve knock down by vehicles, falls from timber stacks or collapsing stacks. Stack materials on steady ground, arrange yard with good visibility, train staff in safe handling techniques, use secure supports.

HOW TO ASSESS EFFICIENCY?

ENTERPRISE REALITY CHECK

A reality check is a systematic examination of the current quality of your business, its processes and its impacts on the environment.

A company can either hire an external consultant to carry out the check or set up an internal team of competent people to perform the check using guidelines from handbooks and additional toolkits.

An audit is not a fault-finding exercise. The aim is to identify opportunities for improvements. Good practices will be noted and appreciated.

Objectives

- Convince the company owner and motivate the staff
- Collect initial data for project planning
- Identify “low hanging fruits” that can generate immediate cost savings and motivating the team
- Set a priority list for recommended improvements
- Benchmark the company’s situation

Benefits

- Improve and interchange of information between operations or plants
- Increase employee awareness of environmental policies and responsibilities
- Identify cost-savings including those resulting from waste minimization
- Evaluate training programs and providing data to assist in training personnel
- Provide an information base for use in emergency response arrangements

Steps of an initial audit

Step 1 PREPARATION	Step 2 CARRY OUT	Step 3 EVALUATION & FOLLOW UP
• Decide who does what • Define scope • Develop time plan • Prepare checklist and inform staff	• Carry out audit • Evaluation • Recommend CP options • Meeting with manager	• Follow up on implementation • Corrective plan • Environmental report • Setup regular monitoring

Schedule for an initial environmental audit

1. Meeting with director to discuss company policy, products, plans
2. General technical introduction (introduction, responsibilities, layout, flow sheet)
3. Site visit / workshops visit (in operation)
4. Take notes (preliminary data, flowsheet, pictures)
5. Feedback session

Interviews with staff

- Conduct interviews at the workplace during normal hours
- Explain your purpose
- Ask question and then actively listen
- Verify responses (confirm understanding)
- Check the facts (use other sources)
- Take notes, pictures and use checklists
- Make tentative conclusions (no secrets)
- Give opportunity to discuss other topics
- Keep neutral; don’t disagree or interrupt
- Learn from remarks of nearby people
- Thank for their time and cooperation

Interview your staff members, because they know the most details about your production!

Where auditors should look at

- Check machinery and workshops, especially dirty and chaotic places
- Check waste containers, and the ways they are handled
- Look for containers and items that are not labelled
- Examine contents to find items that don´t belong into this container
- Look for things that are not supposed to be thrown away
- Look out for old and/or unused equipment
- Look for leaking valves, tanks and discharge pipes, broken trays
- Check whether chemicals are properly stored in designated locations

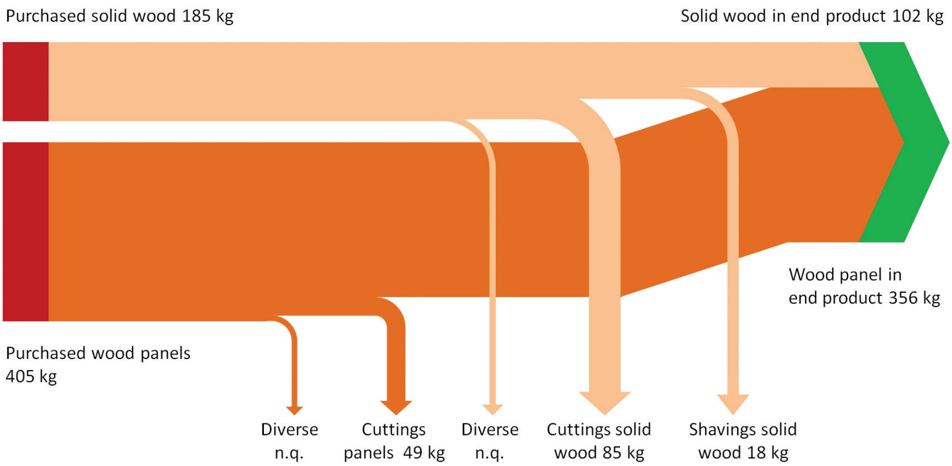
What auditors should ask

- Who empties the containers?
- Where does the waste go?
- How are hazardous chemicals dispensed?
- How is their use controlled?
- Ask what you would do if a hazardous chemical was spilled on the floor!

MATERIAL FLOW ANALYSIS

Why should you analyse your mass flows?

Within each production you find many places with losses of materials and energy, which are ecological and economical weak points at the same time! A mass flow chart shows the amounts of material per each production step. The material flow analysis gives answers about places and amount of losses.



Material flow chart 1: Wood material in furniture production

Inputs are solid timber (light brown stream) and wood-based panels (dark brown stream). During different processing steps, small shares of material waste (cuttings) are extracted from the total material flow. The final furniture product (orange) comprises approximately only 75% of the total combined inputs of wood material.

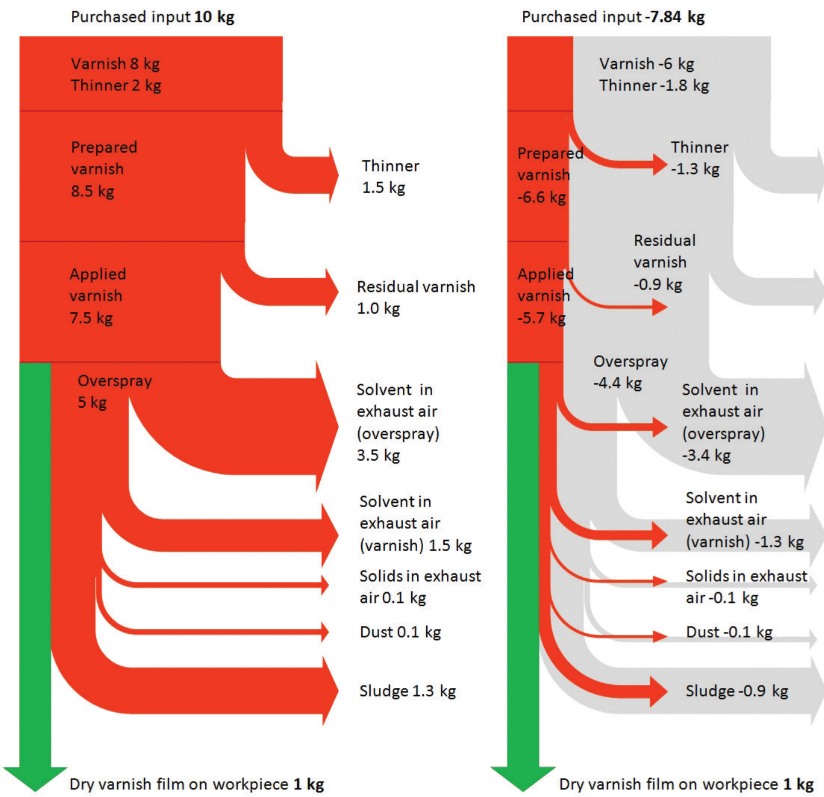
Questions to be asked:

- Which waste streams are generated?
- Which raw materials are lost?
- Where and why does this happen?
- Where are the weak points?
- Where are potentials for improvement?
- Which materials can be reused?

Wood raw material waste

Purpose of a material flow analysis

- Observe raw material flows through the company
- Identify and demonstrate linkages in the process
- Trace waste and emissions back to the place where they were produced
- Identify and demonstrate weak points (inefficiencies)
- Elaborate the material flow basis for evaluation and optimization
- Present data in view of decision making
- Give priority to sensible measures for waste and emission minimization



Material flow chart 2: Improved, efficient painting process

The example shows a painting process with losses (red) to obtain a final varnish film on the product (green). The original situation (left chart) shows large losses with a low efficiency rate of the process (approx. 10 kg of inputs are required per 1kg output = 10%). In the improved process (right chart), only 2.12 kg are required to obtain the same 1kg of output. The figures in the right chart indicate the savings.

How to conduct a material analysis on site?

The basic idea is simple: everything that goes into a production unit must go out again (although in converted forms). A balance traces flows of material within a defined time frame: input mass = output mass + storage (it is assumed that no chemical reaction happens).

The input materials must be quantified, monitored throughout the process and connected to the various produced outputs, e.g. the final products and wastes in solid, liquid or gaseous form. It is recommended to set up a visual material flow chart including all production steps.

Data from various sources has to be cross-checked and validated:

- Accounting department
- Material register of the production unit (on-site register, if available)
- Existing waste units
- Other information sources at hand (on-site or off-site, books, documents)

However, usually the available data is not sufficient or detailed enough for the analysis and additional own measurements need to be set-up temporarily:

- Material boxes at defined measure points
- Weight scales (standalone or integrated in fork lifters)
- Volume measurements (usually manual measurements)

Although discrepancies between measured and registered data are the rule rather the exception, a justification has to be provided and documented for each deviation.

Steps of a material flow analysis

1. Definition of goals
2. Parameters: What do you want to measure, e.g. efficiency rate
3. Limit the balance-frame: Where to measure the parameter e.g. efficiency rate of your whole unit or only a certain production step within the unit?
4. Limit the balance-period: For which time period respectively when and how often to repeat the analysis?
5. Identify the metering system (common unit & conversion factors)
6. Record and define the production steps (data collection, own measurements)
7. Drafting the flow sheet: material flows – qualitative, logical linkages
8. Balancing: material flows – quantitative, with measurements
9. Interpretation (comparison to the state of the art) and conclusions

LITERATURE

The RERAM Handbook and training manuals are partly based on: Stadt Graz Umweltamt, Austria. ÖKOPROFIT Schriftenreihe 2004. Reprinted with kind permission. Further references used for the handbook are noted below.

RERAM reports and toolkit

The following RERAM reports provide more guidance and practical knowhow on resource efficiency. The RERAM Toolkit includes various useful worksheets and training material to learn more about Cleaner production options. All are accessible via the project website www.reram.eu.

- Angerbauer et al. 2016. Reality check and benchmarking of raw material performance. RERAM project report D3.3. HCS, ACECon, IIWH.
- Kiyko et al. 2016. Resource efficiency of the forest-based sector in Eastern Europe (ENP-EaP countries). RERAM project report D2.3. UNFU, IIWH.
- Oberwimmer et al. 2016. Wood Innovation Toolkit. RERAM project report D4.3. HCS, ACECon, IIWH, AITT.
- Kolck et al. 2015. Resource and energy efficiency in woodworking industries. Meta-study on benchmarks and saving potentials. RERAM project report D3.1. HCS, ACECon, UNFU, IIWH.

Handbooks on Resource Efficiency

- European Commission DG Growth, 2016. European Resource Efficiency Self-Assessment Tool (RESAT). https://ec.europa.eu/growth/tools-databases/resat/
- JRC Joint Research Centre, 2016. Best Available Techniques reference documents (BREFs). http://eippcb.jrc.ec.europa.eu/reference/
- UNEP RECP 2010. Pre SME Toolkit Industrial Handbook. www.unep.org/pdf/PRE-SME_handbook_2010.pdf
- UNIDO 2008. Cleaner Production Toolkit http://www.unido.org/resources/publications/safeguarding-the-environment/industrial-energy-efficiency/cp-toolkit-english.html

Handbooks on Waste Reduction, Waste Management

- EEPA & TVA, 2004. Waste Reduction Guide for Wood Furniture Industries. Workbook. US Environmental Protection Agency, Center for Environmental

Research Information & Tennessee Valley Authority, Waste Management. Cincinnati, Ohio & Knoxville, Tennessee, US. http://infohouse.p2ric.org/ref/01/00418.pdf

- Envirowise, 2001. Furniture essentials: environmental information for furniture manufacturers. Good Practice Guide GG 289. Harwell International Business Centre, UK. www.wrap.org.uk/sites/files/wrap/GG289.pdf
- Envirowise, 2001. Savings from waste minimization in furniture manufacturing. Good Practice Guide GG 290. Harwell International Business Centre, UK. www.wrap.org.uk/sites/files/wrap/GG290.pdf
- WRAP Waste and Resources Action Programme, 2003. Wood waste recycling in furniture manufacturing: a good practice guide. Banbury, UK. www.wrap.org.uk

Handbooks on Energy Efficiency, Energy Management

- ECOINFLOW, 2015. Energy management in the European sawmill industry. SawEnMS handbook. http://www.ecoinflow.com/en-gb/industry/sawenmshandbook.aspx
- ECOINFLOW, 2015. Energy management in the European sawmill industry. Final project report. http://www.ecoinflow.com/Portals/0/PROR_final_26_06_final-compressed_web.pdf
- EERE, 2003. Improving compressed air system performance. A sourcebook for industry. US Department of Energy, Energy Efficiency and Renewable Energy. http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/compressed_air_sourcebook.pdf
- IHK Nürnberg, 2015. EUREM European Energy Manager. Guides & manuals in English for the wood furniture industry, carpentry and related businesses. Nürnberg. www.ihk-eforen.de/display/eurem/Furniture+English

Handbooks on Workers Safety

HSE Health and Safety Executive, UK

- HSE 1994. Supervising for safety in woodworking. www.geoffswoodwork.co.uk/hsesupersafe.pdf
- HSE 2012. Wood dust: controlling the risks. Woodworking information sheet WIS 23 (rev.1). www.hse.gov.uk/pubns/wis23.pdf
- HSE 2014. Stacking round timber, sawn timber and board materials. Safe working practices. Woodworking information sheet WIS 2 (rev.2). www.hse.gov.uk/pubns/wis2.pdf
- HSE 2014. Reducing noise at woodworking machines.

Woodworking information sheet WIS 13. www.hse.gov.uk/pubns/wis13.pdf

- HSE 2014. Retrofitting woodworking machines brakes. Woodworking information sheet WIS 38. www.hse.gov.uk/pubns/wis38.pdf
- HSE 2014. Tooling for use with hand-fed woodworking machines. Woodworking information sheet WIS 37. www.hse.gov.uk/pubns/wis37.pdf
- HSE 2014. Welfare at work. Guidance for employers on welfare provisions. INDG 293. www.hse.gov.uk/pubns/indg293.pdf
- LANSAWOOD, 2009. The Language of Safety and Health Signs and Signals in Wood Industry. Hazardous and harmful factors in the wood industry. http://www.adam-europe.eu/prj/3746/prj/Lansawood_Hazardous%20and%20Harmful%20%20Factors.ppt
- MAPFRE 2008. Safety guide woodworking facilities. Madrid. https://www.mapfrere.com/reaseguro/es/images/safety-guide-woodworking_tcm636-80884.pdf
- OSHA, 1999. A guide for protecting workers from woodworking hazards. U.S. Department of Labor Occupational Safety and Health Administration. Report 3157. www.osha.gov/Publications/osha3157.pdf

Pictures and graphics acknowledgements

- RERAM Enterprise checks in Ukraine, Moldova, Georgia, 2015-2016.
- ÖKOPROFIT Schriftenreihe, Umweltamt Stadt Graz, 2004.
- Bierma, TJ., F.L. Waterstaraat, and J. Ostrosky. 1998. The Green Bottom Line. Ch. 13: Shared savings and environmental management accounting. Greenleaf Publishing, UK, in: Institute of Environmental Engineering (APINI), www.financingcp.org/docs/CP1_Slides.ppt
- CEI-Bois, 2011. Tackle climate change: use wood. Brussels. www.cei-bois.org/files/b03500-p01-84-ENG.pdf
- Envirowise, 2001. Savings from waste minimization in furniture manufacturing. Good Practice Guide GG 290. Harwell International Business Centre, UK. www.wrap.org.uk/sites/files/wrap/GG290.pdf

Adpic.de.de / Alibaba.com / Boge.com / Cliparthut.com / Dreamstime.com / Endel-dietze.de / Freepik.com / Infratec.eu / K’Len 2016, http://klen.ua/ / Lespil.com / Lubetech, UK. / Openclipart.org / Quelle.de / Shutterstock.com / Vecteezy.com / VDMA 2003, druckluft-effizient.de

RERAM

Resource Efficiency and Raw Materials in the Forest-based Sector of Eastern Europe

The renaissance of wood as a renewable resource leads to a globally increasing demand and more and more non-sustainable exploitation of forests, especially in the Eastern European countries (ENP-EaP) Ukraine, Moldova and Georgia. Preserving natural forests and fostering sustainable use of wood is one of today's grand societal challenges.

Wood is an astonishingly versatile raw material: it is at the same time renewable, recyclable, reusable and refineable, offering many environmentally friendly products to society, such as construction, furniture, flooring, interior, paper products, bioenergy and innovative bio-chemical products. Using wood efficiently is good to substitute fossil fuels or energy-intensive materials and is therefore an active contribution to climate protection.

RERAM's goal is to improve raw material consumption in the forest-based sector through adapted solutions for resource efficiency. Saving resources is important for the SMEs to become competitive and reduce environmental impacts. In general managers are not aware that inefficient processing and low maintenance generate high material and energy losses, which in fact sum up high, hidden costs. The project developed an instructive training programme and hands-on reality checks for efficiency coaching of SMEs, which was tested in 19 woodworking companies.

RERAM demonstrated that resource efficiency represents a smart win-win solution for business and the environment and offers a real opportunity for SMEs in Eastern Europe.

RERAM was funded by the European Commission's FP7-INCO programme from 06/2014 until 05/2016 under grant no. 609573. It included 11 organisations from the EU and ENP-EaP countries: IIWH International Institute of Forestry and Wood-based Industries e.V., Germany | HCS Wood Cluster Styria, Austria | ITD Wood Technology Institute, Poland | UNFU National Forestry University of Ukraine | FORZA Agency for Sustainable Development of the Carpathian Region, Ukraine | WPFC Wood Processing and Furniture Cluster, Ukraine | AITT Agency for Innovation and Technology Transfer, Moldova | RECC Regional Environmental Centre for the Caucausus, Georgia / Armenia / Azerbaijan | AUG Agrarian University of Georgia, Georgia | InnovaWood, Belgium| PROKO Projektkompetenz.eu GmbH, Austria.

For further info please visit: www.reram.eu

This Handbook is a practical guide for managers and technical personnel how to perform a tangible self-check. It introduces cleaner production principles, effective tools and improvement options that can leverage a variety of common saving potentials in woodworking SMEs.

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