ANNEX A: More Detailed Information on Ecodesign Strategies and Overall Technical Options for All MT and Welding Equipment

- **Mass reduction of moving parts**

Taking into account the basic feature of all MT where the components are linked, and where at least one of them moves, it is possible to reduce the amount of energy consumed by light-weighting the moving parts to reduce the energy required in their acceleration and deceleration.

In order to achieve this, two strategies can be pursued: (1) Replacement of currently-used materials with lightweight alternatives; and (2) structured optimisation of machine components, allowing material reduction. In every case it is crucial to maintain the accuracy and productivity after the re-engineering to ensure the reliability of the product.

Aspects such as technological sophistication, material characteristics and specific costs are the main criteria to choose the optimal and more convenient replacement. Inherently, the further introduction of the chosen material requires a deep analysis of environmental, technical and cost effectiveness impacts.

If the optimisation of the structure is chosen, interrelated factors such as mechanical specifications, resistance, deflection and static stiffness must be adjusted to perform the activity as well as the original structure. An additional benefit is that lighter structures will inherently require less warm up time.

It is noted that it is difficult to set a baseline against which mass reduction can be measured, and so far no method of quantifying the energy savings from a particular mass reduction has been tabled. This is technically possible, but the impact is critically dependent on the operating profile.

Therefore, no definitive qualifying performance levels can be defined, and so not implementing measures are proposed.

- **Software-based energy management**

The implementation of energy monitoring where not already fitted, can decrease significantly the amount of energy used through giving end-users information on energy use. Whilst no additional specific energy savings are attributed to it, it represents best practice on all but the very simplest machinery. There are three ways of energy management that should be considered:

- Standby management, where many of the sub-system are switched off when not in use. It should be noted that some systems will require a “warming up” period when brought back on line and so care should be taken when setting up the standby operation of a MT. Good standby management allows the end-user to set up idle periods, pauses, cycles, etc. to optimise the process without compromising the functionality and performance of the machine. This is defined within ISO-DIS 14955-1.

- Recording and tracking of the energy consumption allows the end-user to have full control and identification of energy peaks and waste, informing what measures can be taken to make best use of energy saving operating modes such as standby and idle.
- Energy optimised motion control.

Regenerative drives

Super premium IE4 induction motors for the power drives minimise energy costs and reduce heat generated. However, there are currently only a few such motors available that do not require the use of a controller, and so they are not a universal solution. IE3 motors are currently BAT and are already mandated for use within existing motor regulations, so there is no place for any additional motor requirements. It is noted that for applications with frequent speed changes, the energy saving from a higher efficiency motor will be reduced, due to the longer time needed to accelerate the higher rotor mass commonly used.

The use of Regenerative Variable Speed Drives allows energy released during braking to be returned to the mains rather than dissipated in a power resistor. This is particularly cost-effective in drives with frequent accelerating and decelerating profiles. An alternative in multiple drive installations is the use of a common DC link to transfer recaptured power from one motor to another that is in positive torque mode.

There are many other opportunities for the use of more efficient controls or motors. However, there are not yet any definitions for these, and so ascribing required performance levels is not feasible. For example, Ecodesign ENER LOT 30 (draft Preparatory Study) does not consider that any measures for lower loss motor controls are practical.

Tool and work piece handling, clamping and upholding

This section explains that electro-mechanical, pneumatic and hydraulic systems can be optimised by greatly reducing or eliminating the energy consumption in idle conditions. Other aspects to consider are the reliability or durability reached by applying maintenance measures.

Manufacturers of electro-mechanical clamping devices claim that the advantages are a higher degree of adjustability, leaner machine design due to the omission of the hydraulic unit and reduced maintenance costs. On the other hand, hydraulic systems can provide high forces within limited space due to their physical characteristics.

An active vacuum clamping device based on piezo-stack actuators can reduce significantly the noise and vibrations of wood working MT during composite board manufacture. No definitive qualifying performance levels have been devised.

Hydraulic and Pneumatic optimised systems

In order to reduce the energy consumption in hydraulic and pneumatic systems, the control of the flow rate and pressure of the fluids is crucial. Energy saving options include on/off control, variable speed control or variable stroke pumps.

In the case of hydraulic systems, this type of control allows to achieve savings in raw material and also in waste fluid disposal. Hence, for oil-based machines, it is possible to use higher quality oils, obtaining larger replacement cycles because the consumption is lower. Moreover, significant improvements can be achieved by implementing energy consumption optimisation methods in the pump control system. Hydraulic system energy saving options include cooling of the motor, adaptable levels of pressure, use of hydraulic accumulators, optimised valves and prevention of nipple collapse.

In the case of pneumatic systems, proper sizing of piping components, avoidance of over-treatment, and operating at a minimum effective pressure can reduce the amount of compressed air consumed by the machine. The use of compressed air for cleaning MT is generally a poor practice, but where essential the use of high efficiency air concentrating nozzles should be considered. An example is the use of compressed air to protect seals and bearings during dry machining, such as on cast iron.

Maximum fluid speeds to limit friction can be established. The use of efficient controls that reduce hydraulic fluid flow (not primarily by the use of bypass or throttle) during times of low demand can be the defined measures.

- **Energy efficient cooling lubricant supply**

The friction of cutting tool on the workpiece causes heat, which must be removed in order to protect the properties of the workpiece and the lifetime of the cutting tool. For metal-working machine tools the consumption of cooling lubricant is vital to maintain effective performance, but for wood working machine tools it is not relevant. In this section options to reduce the energy linked to lubricant consumption are described.

The principle is to reach zero-lubricant level on machines, but technologies based on minimum quantity lubrication can also improve the functionality. However, the reduction of cooling will usually entail a reduction in speed of machining, and so the throughput will decrease. This is a major limitation to the widespread adoption of dry machining as a mean of energy saving.

As with compressed air supplies, cooling lubricant pipelines must be well adjusted to avoid leaks and pressure losses, because they are the source of extra energy consumption. The pump has to compensate the losses that are directly linked to the pipe diameter. In high volume cooling applications, such as grinding, by enlarging the pipe diameter the pressure loss can be reduced, and the pump will require less energy to operate. But in high pressure applications, such as assistance in chip removal, pipe friction is not such an energy loss. Other options are the use of cryogenic substances, vegetable oils, lubricants without mineral oil and the use of lubricants.

Note: Cooling lubricant should not be confused with the lubricants used to lubricate the moving parts themselves.

Simple controls can be used to ensure that the coolant pump is switched off during times between cutting operations and/or is varied to suit the varying demand on cooling.

Maximum fluid speeds can be established to limit frictions (3 m/s is suggested), although further work is needed to verify the practicality of a single limit for all types of MT.[1]

- **Cooling systems and use of cabinet heat**

The purpose is to control and extract the waste heat from both electrical and mechanical friction sources to the greatest possible extent. The cooling system may use either fan extractor or refrigeration equipment, which may be either integral or external. No definitive qualifying measures have been devised.

- **Energy efficient tempering (heating)**

The temperature of the workpiece under treatment has a major impact on product reliability and processing. This option studies alternative ways to reach the operating temperature in applications where the workpiece is heated. The reason for defined heating is the overall process temperature, e.g., steel has a temperature elongation coefficient of 11 microns per °C and m. Typical high-precision operations have a tolerance band of less than 5 microns. Therefore it is mandatory that the work piece, the process and the MT and the environment are compatible in terms of heat flow. Electromagnetic induction is a technology that ensures fast tempering and efficient production.

In the field of bander machines, glue rollers can be replaced by glue nozzles, a more reliable technology that reduces the heating-up stage using less energy than conventional technology, so large energy savings can be reached. No definitive qualifying measures have been devised.

- **Energy efficient welding**

In this section the recommended options are based on the idea that welding process is highly time-dependent, mass-dependant (gas, wire) and requires great accuracy to produce a consistent product.

The technology that provides the power to weld is the key factor, with a big movement of the market from transformer to inverter technology offering several big improvements:

- Significant energy savings due to shorter weld times,
- Improved and consistent power factor (99% achievable),
- Better weld quality, as the effect of electrical line disturbances in the welding process is minimised, and
- Higher productivity, as transformer cooling time between cycles is eliminated, which shortens weld times.

Efficiency improvements in this case can be in the range of 88% to 90%. Such efficiencies can be partly realised through better electronics circuitries, but much more significant efficiency improvements can be realised through the use of more material in coils, mainly copper for the windings.

[1] For example, this is the highest suggested speed at this popular website http://www.engineeringtoolbox.com/flow-velocity-water-pipes-d_385.html

Concerning the energy consumed during idle periods of the welding machine, the new options can consume as little as 7.5W, a substantial change from the conventional technology (163W).

As for other environmental concerns, improvements can come from the optimisation of gas consumption by leak prevention, implementation of adjustable flow devices for gas-fed welding machinery. Similarly, by increasing the deposition efficiency of the welding process, the maximum efficiency on welding wire consumption can be reached. The argon blends arc welding is an example, achieving 95% to 100% efficiency.