

## Energy-Using Product Group Analysis

### **Lot 5: Machine tools and related machinery**

#### Executive Summary – Version 1

Sustainable Industrial Policy - Building on the Ecodesign Directive - Energy-using Product Group Analysis/2

Contact:

Fraunhofer Institute for Reliability and Microintegration, IZM

Department Environmental Engineering

**Dipl.-Ing. Karsten Schischke**

Gustav-Meyer-Allee 25, 13355 Berlin, Germany

Tel: +49 (0)30 46403-156

Fax: +49 (0)30 46403-131

Email: [schischke@ecomachinetools.eu](mailto:schischke@ecomachinetools.eu)

URL: <http://www.ecomachinetools.eu>

Project Team

Karsten Schischke, Eckhard Hohwieler, Roberto Feitscher, Jens König, Bernd Duchstein, Nils F. Nissen

Berlin, June 18, 2010

---

## Executive Summary

### Introduction

This executive summary of the EuP product group study “Machine tools and related machinery” will be updated regularly as the study is progressing, summarising the latest status of findings and giving an outlook on next steps in the study. Tentatively, there will be 3 revisions of the initial executive summary: A revision each in preparation of the 2<sup>nd</sup> and 3<sup>rd</sup> stakeholder meeting and a final executive summary once the study is completed.

This first version summarises the initial findings of the following tasks as of June 2010:

TASK 1 – DEFINITION

TASK 2 – ECONOMIC AND MARKET ANALYSIS

TASK 3 – USER REQUIREMENTS

Task reports are published at [www.ecomachinetools.eu](http://www.ecomachinetools.eu) .

### Main Findings

As there is a limited common understanding of what is a machine tool and as also standards and legislation do not provide an unambiguous definition of “machine tools” this study has to come up with a “machine tools” definition. This definition, based on engineering considerations that typically cutting, shaping and joining technologies are those employed by machine tools, economic classifications (NACE Rev. 2, and industry statistics), standards on process technologies (such as DIN 8580), and the existing legal framework (machinery directive) is as follows:

*A machine tool is a stationary assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application, which is the geometric shaping of workpieces made of arbitrary materials using appropriate tools and forming, cutting or joining technologies.*

Exemplarily machine tools comprise those for separating / cutting and forming of metals, including those using a laser beam, ultrasonic waves, plasma arc, magnetic pulse,

electrolytic etching, etc., for turning, drilling, milling, shaping, planing, boring, grinding etc., for soldering, brazing, or welding. For further examples see the Task 1 report.

Explicitly, machine tools for processing a variety of materials are covered, not only metal working machine tools, i.e. also wood working ones and those for other rigid materials such as stones, plastics, glass etc.

As there are similarities between machine tools and other kinds of machinery and equipment, the scope of this study covers explicitly equipment related to machine tools as far as the operation and design of the machine tool could have an effect on this related equipment and components and modules of other machinery, which are similar to those used in machine tools.

Therefore, the title of this study is changed to **Machine tools and related machinery**. The meaning and definition of “related machinery” will be subject to further investigations throughout this study. This broader scope is meant to identify potentially a broader environmental improvement potential in industrial production than only with a focus on machine tools as such.

It is intended to follow a modular approach (i.e. machine modules) in the following environmental analysis, taking the machine tools as the starting point, but covering through this modular approach also other (“related”) machinery.

A first screening of environmental parameters unveils, that despite major doubts about the parameter setting of the EPTA Work Plan Study a **total annual power consumption of machine tools in the range of several hundreds of TWh** in the EU-27 can be confirmed. There is only a limited number of Life Cycle Assessments available in the public domain, those of CECIMO presented in preparation of their SRI proposal being the most recent and comprehensive one: Their findings indicate, that the life cycle impacts are dominated by the use phase, and here electrical energy consumption is of much higher importance than cooling lubricants or hydraulic oil. Also the screening by Fraunhofer of machine tools properties against environmental parameters as listed in Annex I of the ErP directive indicates **highest relevancy of energy consumption in operational and non-operational modes**, and a **moderate relevancy of lubricants’ consumption, ease for reuse and recycling, extension of lifetime, waste generation related to the use phase (production waste), emissions to air (saw dust, welding fume...)**.

As PRODCOM / NACE Rev. 2 lists roughly 100 product categories of machine tools it was deemed necessary to identify those machine tools categories with presumably highest environmental relevancy. This is explicitly not meant to shrink down the scope

of the study to these “Top 20” machine tools categories, but to allow for a more focused discussion, with a priority on most relevant types of machinery. Among these “Top 20” categories are inter alia sawing machines for working wood, cutting machines for paper and paperboard, soldering and welding equipment, machine tools to work mineral materials, way-type unit heads for working metal by drilling, boring, milling, threading or tapping, non-numerically controlled drilling machines for working metal (excluding way-type unit head machines), riveting machines, swaging machines and spinning lathes for working metal, horizontal machining centres for working metal.

There are numerous standards existing for machine tools covering safety aspects. In Europe a huge number of these standards is implemented through the machinery directive. With respect to environmental aspects of machine tools there are only very few relevant standards yet such as ISO 5170 on lubrication systems and ISO 11204 on noise test methods. The first standard tackling specifically machine tools with regard to environmental aspect is the planned ISO/NP 14955 - Environmental evaluation of machine tools. Taking the current status of approved and published standards as a basis, there are **gaps in standardisation** of machine tools specifically regarding the **eco-design process, marking / labelling of materials / components (e.g. identification of hazardous substances), power consumption measurements (machines and modules), power modes, power management, consumption of lubricants (measurements, assessment), consumption of compressed air (measurements), process waste generation measurement including yield losses.**

Most relevant legislation on the European level regarding EHS issues are

- Directive 2006/42/EC on machinery
- Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)
- Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
- Commission Regulation (EC) No 640/2009 on ecodesign requirements for electric motors

Within the industry there is no voluntary agreement yet, but CECIMO initiated a Self-Regulation Initiative (SRI) in 2009.

The machine tools market is subject to huge fluctuations, depending on economic cycles. Average lifetime of machine tools is between 10 and 20 years, depending among other factors on the technical level (NC or non-NC). There is a huge market for used

machine tools, indicating machine tool lifetimes frequently in the range of several decades. Due to this long lifetime the stock (installed base) of machine tools shows much less fluctuation than the sales figures. Based on PRODCOM the installed stock of the “Top 20” machine tools categories is estimated at 100 million machine tools back in 1995, now (2008) being in the range of 160 million machine tools and reaching 200 million machine tools in 2025.

The main producers of machine tools in Europe are **Germany** (with a share of almost 50%) and **Italy** (26%). Similarly, main consumers of metal processing machine tools in Europe are **Germany** and **Italy**, followed by **France**. In terms of numbers of enterprises using (potentially) machine tools the target market is much more diverse as machine tools constitute an important part of the production processes in numerous other industrial sectors. The number of **machine tools using companies** in EU-27 can be estimated at roughly **800,000 – 1,200,000 enterprises**. Major target markets for metal working machine tools are tool and mould construction, machine tools building itself, automotive suppliers and automotive manufacturers.

The Life Cycle Cost model for machine tools is subject to the broad variety of machine tools and the fact, that many more factors than only purchase price, consumables and spare parts play a role. Actually, running costs over the lifetime in almost all cases seem to be higher than initial investment, costs for electricity and (where applicable) consumables are very relevant, but even more maintenance costs.

Reflecting the regions where machine tools are most prominently used, size of companies using them and regional electricity costs, roughly the “typical” electricity price for use of metal working machine tools is 0,11 Euro/kWh, for wood working machine tools 0,14 Euro/kWh, but which a broad spread across EU-27. Based on PRODCOM data calculated purchase prices range from below 100 Euro for e.g. band saws to approximately 20,000 Euros for horizontal machining centres and NC tool-milling machines for working metal and nearly 500,000 Euros for multi-transfer machines. Taking into account all machine tools of NACE 28.41 and 28.49 (parts and components excluded), the average calculated purchase price for machine tools is 5,000 Euro.

Total sales volume for EU-27 for mineral oil based non-water miscible and water miscible cooling lubricants was roughly 800 million Euro in 2008, indicating the high economic relevancy of coolants.

The **value of tools, work holders and spare parts** in total for EU 27 production in 2008 was **7,6 billion Euros**, compared to a sales volume (sold production) of 26,4 billion Euros for machine tools in the same year.

Machine tools are **business-to-business products**. Recent survey results show, that “energy efficiency” – despite some outstanding initiatives - is not very important in the marketing of the machine tool manufacturers. The important facts are price, cutting speed and innovative equipment.

Although occasionally there is a mentioned interest in life cycle costing (Total-Cost-of-Ownership) by machine tools operating companies, a standardised calculation the running costs specifically is still lacking and usually not provided by machine tools manufacturers.

Retrofitting and refurbishment of machine tools after a certain time in use is very common and reported to happen a couple of times throughout the lifetime of a machine tool. Due to the B2B nature of the machine tools market and the material value of scrapped machine tools a high recycling quota can be anticipated also statistical data on this aspect are not available at all.

## **Outlook**

It is intended to follow a modular approach for the following environmental and technical analysis, focussing on the modules typically found in machine tools, which are: frame, guides and bearings, main drives, feed drives, control device, hydraulic unit, cooling lubricant unit, and potentially others if used in machine tools and related machinery.

The Base Case assessments will take into account these modules when assessing 4-5 exemplary machine tools configurations.