MATEC GmbH

MACHINING CENTRES WITH AN ECOLOGICAL EDGE

MACHINE BUILDING IN ACCORDANCE WITH MAN, NATURE AND ENVIRONMENT

ENERGY EFFICIENCY AND CO2-BALANCE

Our Economic Approach to Sustainability and Saving of Resources

Energy efficiency and CO2 Balance

Our Mission
Saving resources is a principle that we practice for decades at MATEC as a Swabian engineering company. This does not only apply to the processes in our company but to our whole range of products.

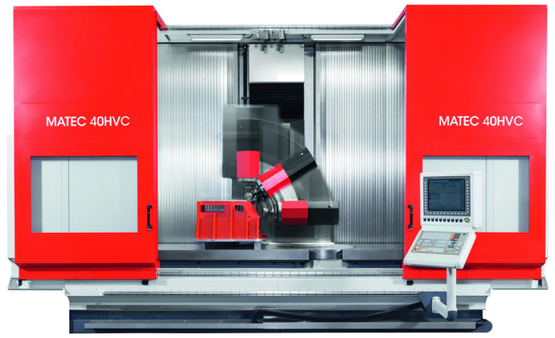
It is MATEC's mission to develop and manufacture eco-friendly machining centres. We do not manufacture our components by ourselves. Almost 99 % of our machine parts are being procured according to our guidelines from renowned manufacturers observing the highest standards in relation to quality, safety and environmental protection.

Therefore, hardly any significant waste or emissions occur in our premises during assembly and commissioning. We put our focus on reusable packaging. Additional energy is only needed during the short commissioning process of the machine. Power from renewable energies contributes to a positive ecological balance. MATEC is working on a CO^2 neutral level not only as a company but also for the machines we produce.

The MATEC modular system and our procurement strategy have another positive side effect apart from the lowest possible impact on the environment. New products available on the market, especially in the field of environmental protection and energy efficiency, can immediately be integrated into our machining centres – subject to their process capability. Thus, time consuming and energy intensive development and test stages are not needed which are normally required during in-house production.

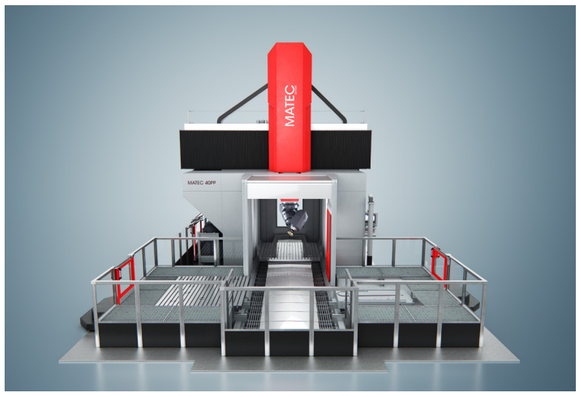
Machining centres from MATEC are being developed for the capital goods industry. They are the platform for mechanical machining tasks in almost every material. Different basic models in design, size and energy efficient technology cover a wide area of applications in industry.

Our customers, therefore, range from as much different industries as woodworking to aerospace technology. Hence, the requirements of the user in terms of design and equipment of the production machine are quite diversified.



Single-axis swivel head and integrated rotary table

2-Axis universal head and integrated rotary table



Gantry machining centre with 2-axis universal head and pallet changing system

MATEC is pursuing a completely different strategy in terms of energy efficiency and CO2 balance

For a positive energy balance, it is vital, that all people involved in the production processes are sensitive to the issue and receive adequate training.

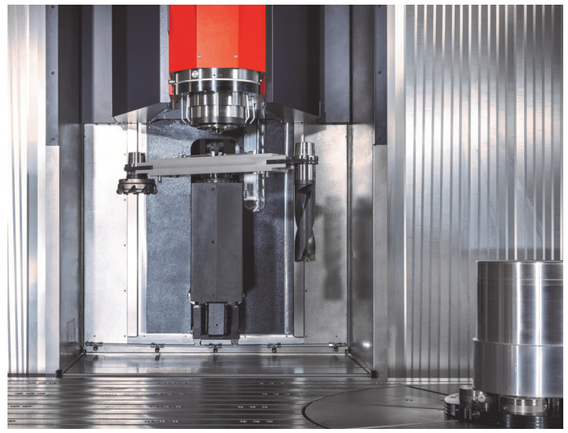
MATEC provides for a high level of energy efficiency by combining the right hardware in the machine with artificial intelligence in the software.

Our machine design features a moving tool magazine which allows to change tools in every axis position, in certain cases, even directly above the workpiece. In addition, the tool, which is needed next, can be picked while the machine is moving to the next machining position. Time saved per positioning cycle with tool change: between 3 to 6 seconds.

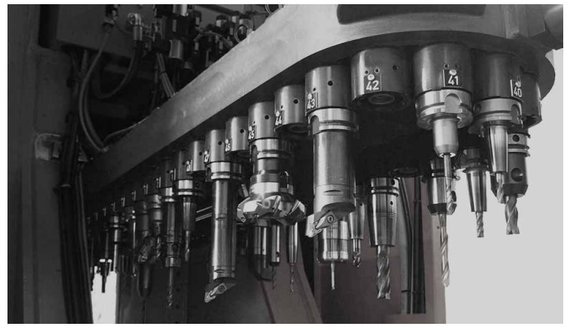
This principle does not consume any additional energy, avoids unnecessary travelling to the point of tool change, extends the lifetime of the machine, saves energy and improves the CO^2 balance. Moves that are not needed save most of the energy.

This unique feature saves a considerable amount of time while the workpieces are being machined. A higher output of workpieces in the predefined time results in a considerably reduced energy balance for each individual part. In practice, the production quantity is increased while the energy consumption is reduced.

Alternative drive technologies
Trying to reduce production time by using alternative drive technologies as e. g. linear drives and highly dynamic axis drives, normally only works for mass production or if the drive system has been applied for technical reasons.
A tremendously higher energy consumption and the extra cost for procurement and energy which goes along with it, could rarely justify the time saved under economical aspects.

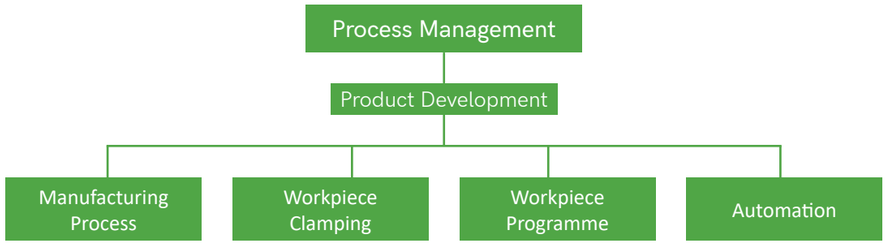

Tool change with shuttle integrated in the machine column


Tool magazine at the rear in a right angle to the column


Tool magazine integrated in the machine column

Process Management

The target is to economically produce workpieces under the aspect of reducing energy consumption. From its modular system, MATEC provides to its user exactly the right machines which guarantee an economical production under this particular aspect.



Production Process
Requirements of working in a more energy efficient way in metal-cutting go into the very last detail.
Processes which can be influenced by humans do have a tremendous impact. Already the slightest modifications in the production process can strongly improve the energy balance. Best possible conditions in process manage-

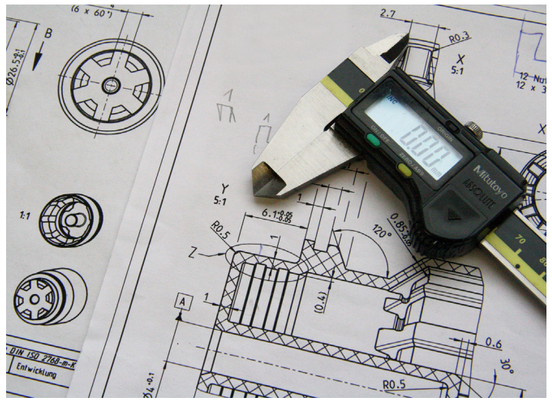
Basis of the Process Chain
Beside all other aspects, it is a good idea while designing a workpiece to already put the focus on avoiding unnecessary resources during the whole production process. Admittedly, an ambitious approach!

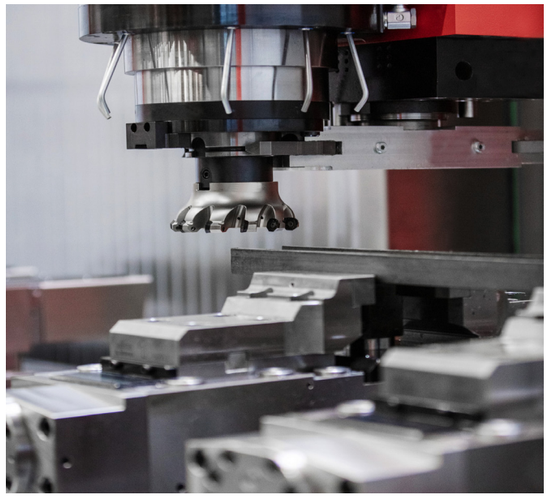
If deviations in form and position, depth gauge tolerances, surface qualities etc. are entered in an unmindful way, time consuming production processes, which are in contrast to cost and benefit, may be the consequence.

A particular example in this respect are tap holes in different diametres in the same workpiece. Each thread size requires at least 2 tools and also 2 tool changes (with a bevel cut, even 3 tools).

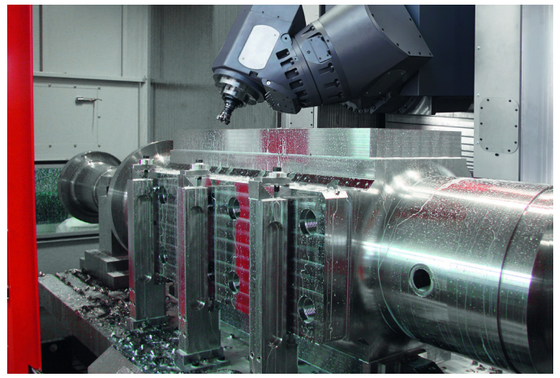
For a positive energy balance, it is vital to avoid unnecessary tool changes. For every tool change the main spindle has to be accelerated with maximum energy, in order to be slowed down again immediately after.

If all metal-cutting processes can be standardized while considering technically justifiable aspects the energy balance is significantly better.
Savings at this point have a positive influence on the energy balance of different departments involved, from stock-keeping over final assembly up to after-sales.





Workpiece Clamping
If clamping points and clamping method are already being defined while the workpiece is being developed, there are no more decisions required during the production process as of how the workpiece should be clamped.
The chosen fixture should also be predefined.
Reasonably priced, workpiece clamping fixtures off-the-shelf such as chuck, jaw chuck, zero point clamping systems etc. save resources and reduce non-productive time during loading and unloading to a minimum.

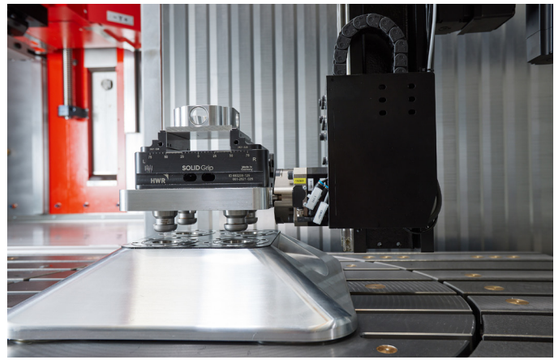


Workpiece Programming
CNC control units offer very convenient programming assistance on the machine as well as externally.
As experience has shown, many parametres have to be defined by the programmer, as they cannot be automated: sequence of process steps, choice of cutting tools, cutting data, travels, measuring cycles etc.

Normally, making up programmes is very time-consuming. However, it is always recommended to take more time for programming.
For series production, workpiece times on the machine can still be reduced by around 5 to 10 % by optimizing them subsequently - which experience has proven.

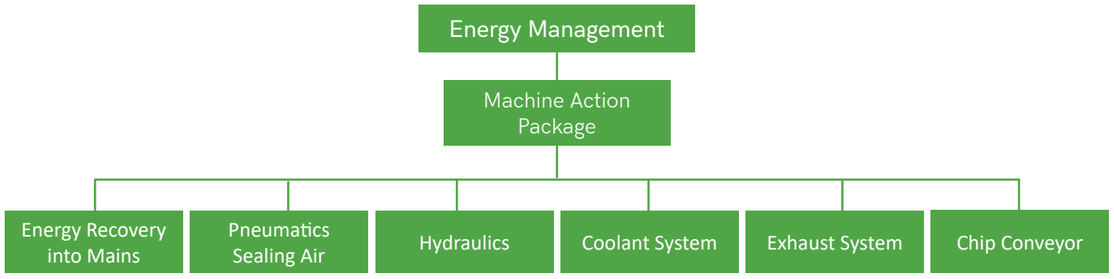
Automation
In many cases, automation is the best choice. Especially if, during standstill of the machine, the time-consuming process of clamping and aligning the workpiece plays an important role in the part production time.
When using automation, loading and unloading of the workpieces is done independently of the production machine. No energy is needed to this purpose.
However, the already mentioned definitions of production process and workpiece clamping are the basis of each automation.

But it is not only for series manufacturing that automation does provide a high level of energy efficiency.
Also for single part manufacturing, MATEC is offering intelligent automation processes.
Pallet handling with pallet changer, workpiece handling with robot or a mix of both do offer an excellent energy balance when considering non-productive times.



Energy Management

It is the target of an effective energy management to constantly adapt the energy consumption of the machine to the current production process. The primary target is to reduce the energy consumption in non-productive phases to a minimum by using the appropriate technologies.



Base Load Machining Centre
Machining centres also use energy in non-productive phases. However, with respect to control unit and drives, the amount is not significant. The base load is significantly influenced by the side units. The main energy consumers of the machine are side units such as hydraulics, pneumatics (sealing air), control cabinet and main spindle cooling and automation. Deactivating side units according to what is actually needed offers significant saving potentials.

The intelligent energy management by MATEC offers many variants to reduce the base load. To this purpose, units of consumption are being deactivated in non-productive phases in a targeted way via menu by the control unit. Choosing the side unit, moment of deactivation as well as period of deactivation are freely programmable.

When the process is finished or in case of an unintended standstill of the machine, the side units are automatically being deactivated in a given time frame after an advance warning. In a longer second phase, the machine is completely being switched off (control voltage off).

Energy Recovery into Mains
Basically, every accelerating process requires deceleration in return. To this purpose the energy from the moving loads of the drives is mostly being retransformed into electrical energy and recovered into the mains supply.

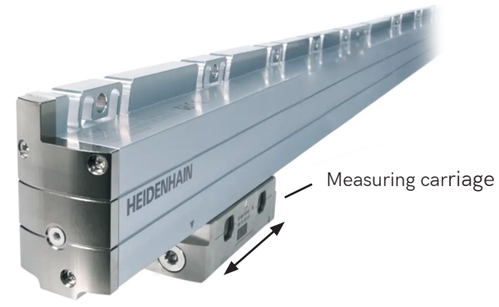
However, recovering energy back into the mains supply does not at all fulfil the expectations the actual term implies.
Regenerative supply modules and their components to smooth the mains voltage are wasting energy, even if the drives do not need any power.
Recovering energy into the mains supply is mainly used for drives with a high demand in energy and frequently changing cycles. In machining centres mainly for the main spindle with frequent tool changes.

If mainly contours are being machined with only a few tool changes, recovering energy is not the first choice.
The decision for a recovering or non-recovering supply module finally depends on the configuration of the machine and the chosen kinds of drives. MATEC is supporting you in finding an energy efficient as well as economical solution.

Pneumatics I Sealing Air
Sealing air (slight overpressure in components) prevents water and cooling liquid from penetrating into highly sensitive machine elements. Among them are mainly main spindle and swivel head as well as the linear encoders in the axes. Sealing air especially leaks through labyrinths or other sealings in components. Air belongs to the expensive media. Therefore, priority has to be given to reducing air consumption.

Main spindle and swivel head cannot do without sealing air. However, during non-productive phases sealing air is being deactivated after a short dwell time in a targeted way by the control unit.

Linear Encoders (Glass Scale)
Every linear axis is equipped with a direct measuring system. The measuring system is stationary and mounted directly near the linear guide. The measuring carriage of the measuring system is connected to the machine by means of a carrier and so it is precisely detecting the movements of the machine. The measuring carriage is sealed with a sealing tape. For technical reasons, the sealing tape cannot fully be insulated against vapours of cooling liquid or finest dirt particles. Therefore, sealing air is indispensable.



Hydraulics
Hydraulic pressure is being used in the machine to release the tools, to clamp rotary axes as well as to hydraulically clamp the workpiece.

The hydraulic unit of the machine is equipped with a frequency controlled drive motor and is working in interval mode with a variable pressure, based on the needs. Integrated pressure accumulators additionally support the reloading operation of consumption units, guarantee short action times and, beyond that, maintain the required hydraulic pressure during the rest intervals of the hydraulic pump.

During non-productive phases, the hydraulic system is specifically being deactivated by the machine control. The hydraulic system of the machine does not need an additional cooling system.
This is why the technology implemented by MATEC, achieves peak values in energy efficiency and CO_2 balance.


Hydraulic unit with drip pan for water pollution control

Energy Management

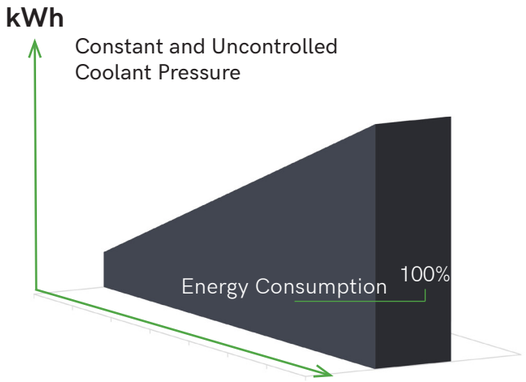
Coolant Unit (Wet Machining with Emulsion)
Lubrication and cooling are vital for machining. Almost every machining centre is equipped with a coolant unit.

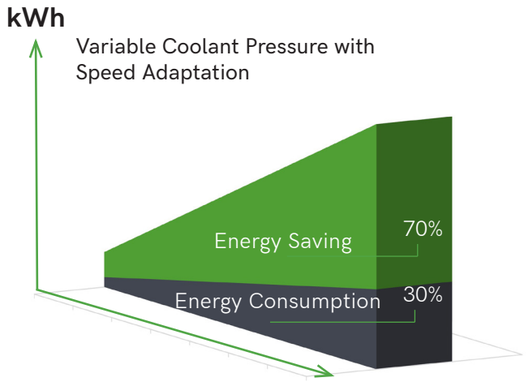
Modern economic production needs innovative technologies, also in the field of coolant units which are often considered rather negligently.
Especially, the coolant unit has a particular significance for automated machining centres due to its considerable influence on the availability of the machine.

The coolant unit is necessarily among the high consumers of energy. The quantity of cooling liquid, different pressures, flow rates, filtration, recirculation and, last but not least, a temperature control, if necessary, implicate a higher energy consumption.

Recirculating cooling liquid requires additional power, also during times of standstill, however, extends the expiry time of the emulsion by almost 100 % and prevents it from releasing odours at the workplace.

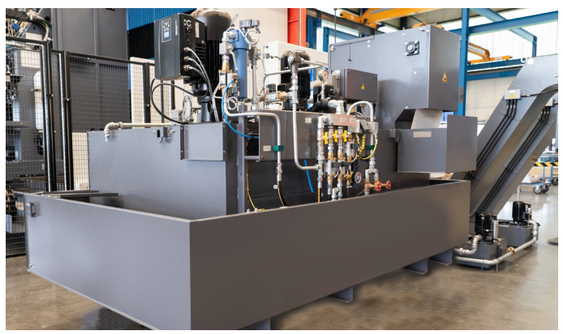
Frequency-controlled coolant pumps with variable pressure and speed adaptation contribute to a positive energy balance. They help to reduce energy consumption to the actual needs and are particularly efficient by saving energy of approx. 70 %.





First of all, numerous parametres call for a configuration of the coolant unit tailored to the job. This refers to normal applications on one hand, but also for special manufacturing processes such as the production of goods for the aircraft industry on the other hand.

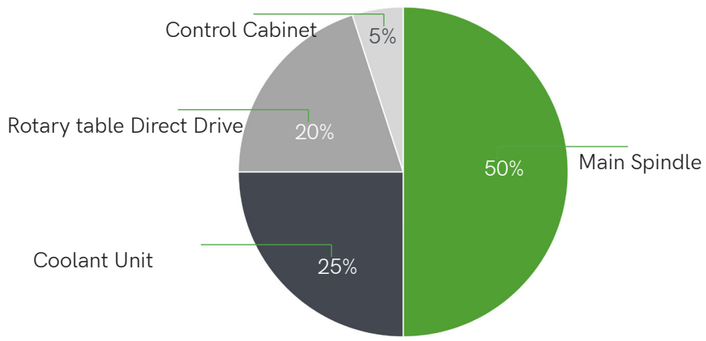
When planning the coolant unit, MATEC is cooperating with leading brands in the sector. Issues related to climate protection and energy efficiency are dealt with top priority by MATEC as well as by our suppliers.



Example of a Coolant Unit in the Field
- Frequency-controlled coolant pump
- Coolant pump for machine bed rinsing
- Recirculating pump tank
- Coolant tank 2,000 litres
- Metal-edge filter (primary chip filter)
- Paper band filter (fine filter)
- Drip pan for water pollution control

Energy Management

Machine Components
and their Ratio in Energy Consumption



Cooling Systems in the Machine
- Spindle
- Rotary tables
- Control cabinet
- Coolant unit
  with temperature control

Quality management with repeatable precision on the workpiece mainly depends on the thermal conduct of the machine. Thermal expansions on the machine and workpiece during production have a direct impact on the required precision.

Ideally, machine, workpiece, coolant and production area
should have the same temperature level.
It is the aim to get an even level, which is as close as possible to the temperature of the measuring room.

This target requires coolant systems with optimized consumption and these directly on the spots where unwanted warmth is being generated.
Primarily, these are the main spindle as well as directly driven rotary tables. In the field, each of these drive elements has different application conditions and, therefore, requires an independently regulated cooling circuit.
There are already efficient cooling systems available on the market, which allow independently regulated cooling circuits in one unit. Thus primary cooling circuits can precisely be regulated.

Secondary cooling circuits of coolant, control cabinet and other units of consumption are subject to different conditions and can normally be regulated in the same cooling circuit.

All cooling systems have one thing in common. In general, they directly release heat to the environment without using it for any further purpose. The energy balance is considerably improved, if waste heat can successfully be reused in a heat exchanger or similar system.
However, during planning and implementation of this idea, it is vital to closely cooperate in order to define the interface between machine and systems available at customer's end.

Projects of this kind have already been realized by MATEC several times.

Exhaust System I Filter (Coolant Vapour)
Exhaust systems filter the waste air from the working area and reduce environmental pollution by means of emissions of coolant vapour. They can directly be controlled and activated or deactivated at the right moment.

Chip Conveyors
The chip conveyor has two operation modes.
Permanent mode or interval mode with selectable interval cycles.

How to Calculate Energy Efficiency and CO2 Balance

The basis of comparison is a machining centre MATEC 30HV with swivel head and customary features. Total connected load: approx. 67 kVA. In process management, the production time of a sample workpiece is being compared according to the principle old I new. The machining process and the cutting data of the tools remain unchanged during comparison.

Process Management

Machine with Standard Features

Process Steps	Qty.	Time	Total
Unit	Pcs.	s	s
Loading of workpiece (manual clamping)	1	240	240
Touch probe (define zero points)	1	60	60
Processing time (without tool change)	1	720	720
Tool change (standard)	23	8	184
Unloading of workpiece	1	180	180
Total Part Production Time			**1,384**

Machine with Innovative Technical Features and Automation

Prozess Steps	Qty.	Time	Total
Unit	Pcs.	s	s
Loading of workpiece (with pallet changer)	1	120	120
Touch probe (define zero points)	1	60	60
Processing time (without tool change)	1	720	720
Tool change (above the workpiece)	23	5	115
Unloading of workpiece (with pallet changer)	1	120	120
Total Part Production Time			**1,135**

Difference between part production times 1,384 s - 1,135 s = 249 s per workpiece, equals 18% time saved

Energy Management

Machine without Energy Efficiency Mode

Consumer	Nominal Power	Workload	Consumption
Unit	kW/h	%	kW/h
Basic workload Control cabinet / control unit	6	100	6
Main spindle	30	60	18
Axis drives X I Y I Z Z-axis with weight counterbalance	14.4	60	8.64
Hydraulics	2.2	100	2.2
Coolant unit without temperature control	5.65	100	5.65
Exhaustion (cooling vapour)	0.55	100	0.55
Chip conveyor	1.47	100	1.47
Cooling unit Motor spindle, control cabinet	6.5	100	6.5
Total energy consumption	**66.77**		**49**

Machine with Energy Efficiency Mode

Consumer	Nominal Power	Workload	Consumption
Unit	kW/h	%	kW/h
Basic workload Control cabinet / control unit	4	100	4
Main spindle	30	60	18
Main spindle Energy recovery into mains			-4.5
Axis drives X I Y I Z Z-axis with weight counterbalance	14.4	60	8.64
Hydraulics	4.6	30	1.38
Coolant unit without temperature control	7.2	50	3.6
Exhaustion (cooling vapour)	0.55	50	0.275
Chip conveyor	1.47	60	0.882
Cooling unit Motor spindle, control cabinet	6.5	100	6.5
Total energy consumption	**68.72**		**39**

Difference energy consumption 49 kW/h - 39 kW/h = 10.23 kW/h saved, equals 21% energy saved

Calculation of Energy Saving

ENERGY BALANCE

Power Saved per Year

	Part production time	Theoretical production time in hours per year One-shift operation	Capacity utilization machine	Actual machine runtime per year based on utilized capacity	Quantity of produced workpieces per year	Production time per year	Power input machine	Energy consumption per year	Saving in hours per year
Unit	s	h/a	%	h/a	pcs.	h/a	kW/h	kWh/a	kWh/a
Part Production Time Standard machine	1,384	2,016	80	1,612	4,193	1,612	49	78,988*	
Part Production Time with innovative technology	1,135	2,016	80	1,612	4,193*	1,321	39	51,519*	**27,469***

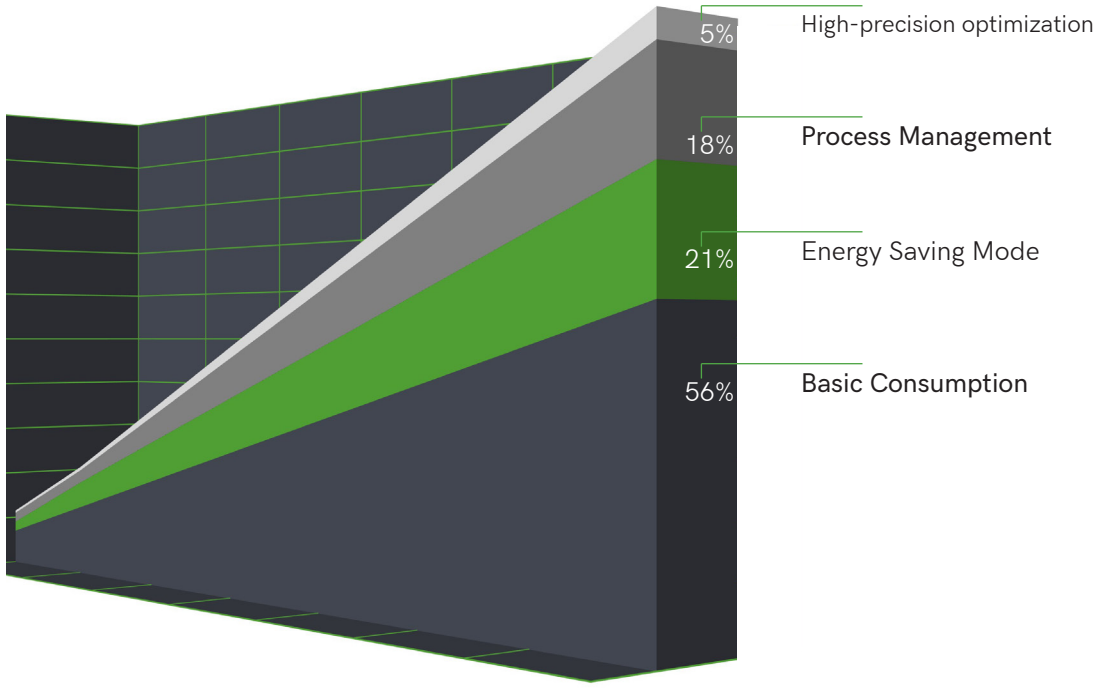
* The amount of energy saved is calculated by comparing the difference in energy consumption between standard machine and innovative technology by assuming an equal amount of parts produced per year. Result: 78,988 kW h/a less 51,519 kWh/a = 27,469 kWh/a

CO2 Balance

Calculated total energy saving: 27,469 kWh per year.
Producing one kWh needs approx. 0.575 kg CO2.
Thus 16 t CO2 are being saved per year.

Summary

Aforementioned parametres from process and energy management result in a realistic percentage of **approx. 35 %** in possible savings. However, it is vital to always keep track on the target set. Apart from the energy management automation in process management as well as the technical advantages of the MATEC machining centres have a considerable impact on the energy balance. Savings in labour cost when applying automation are not even considered in the study.



Saving cost and energy are only one side of the coin.
On the other side, additional cost for purchasing necessary system components have to be taken into account. If one assumes that energy will not become less costlier in future, an investment into environmental protection is worth being considered under economical aspects. In addition, subsidies can be drawn on governmental development schemes.

Realizing energy-saving side units on new machines or on existing MATEC machinery, step by step, is also an important way towards environmental protection.
It is MATEC who will do the planning and mounting and supply software updates.

MATEC GmbH