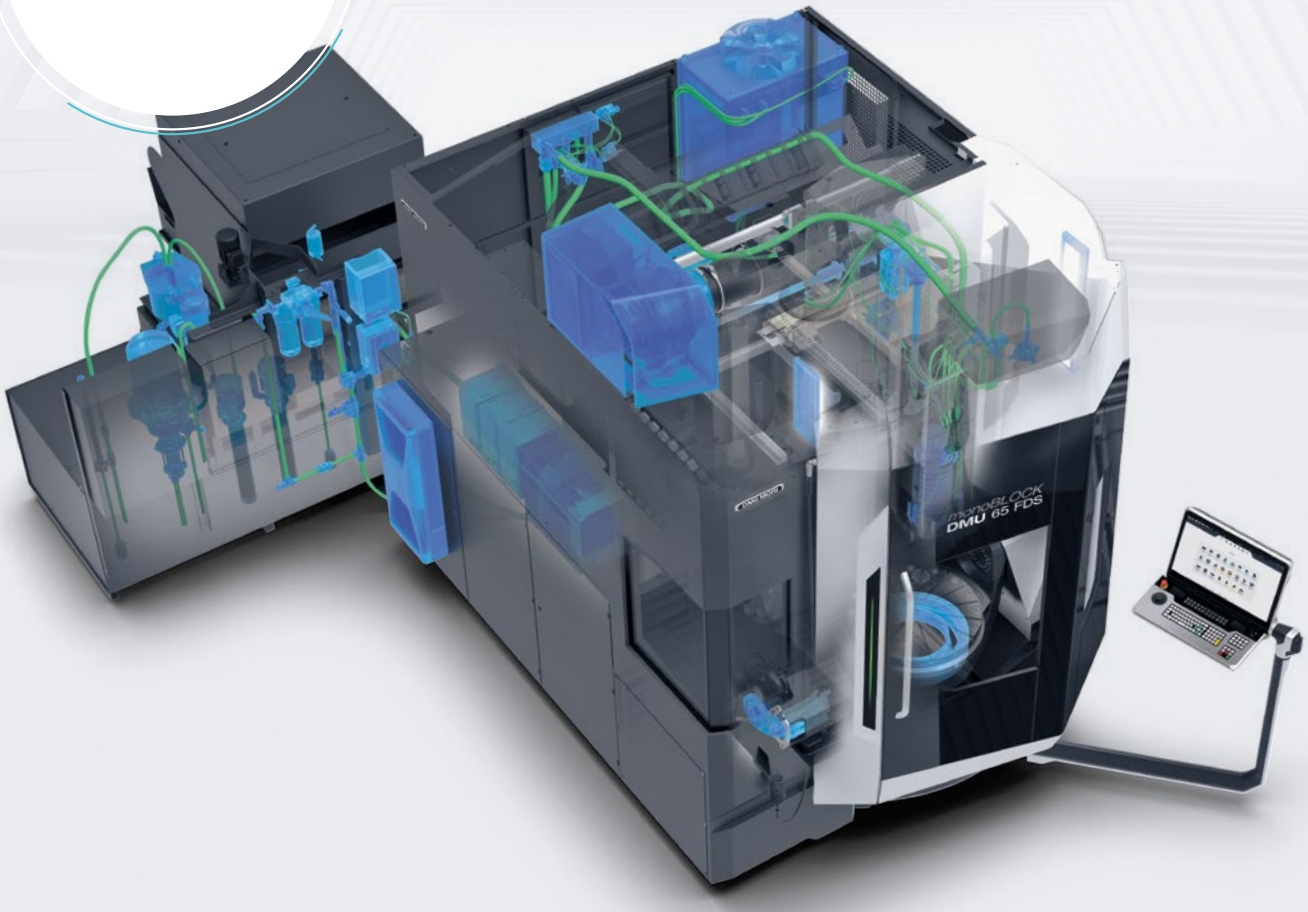
DMG MORI

DMG MORI **GREEN**MODE

ENERGY-EFFICIENT MACHINE TOOLS

GREENMODE

PURE
EFFICIENCY



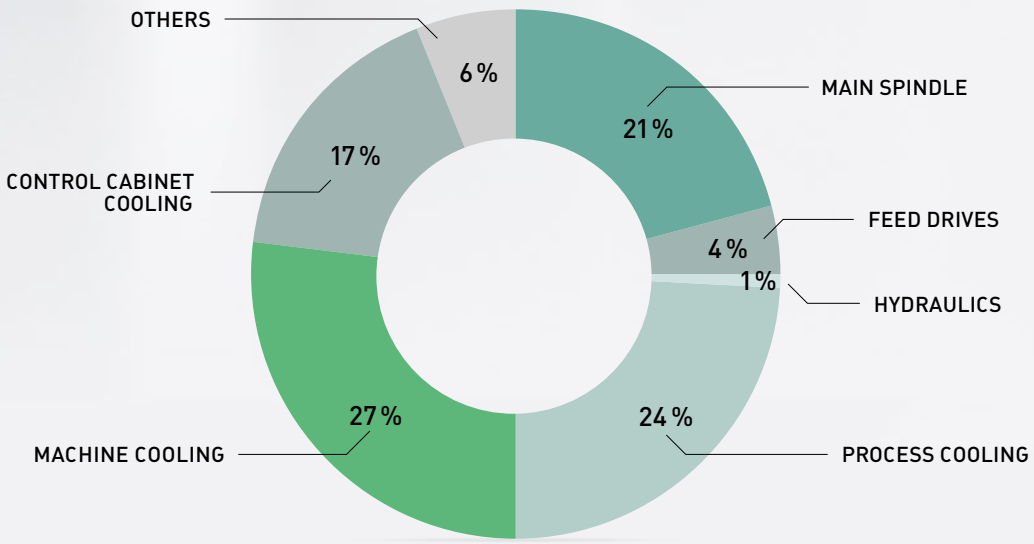
DMGMORI.COM

ENERGY-EFFICIENT MACHINE TOOLS

GREENMODE – Pure efficiency

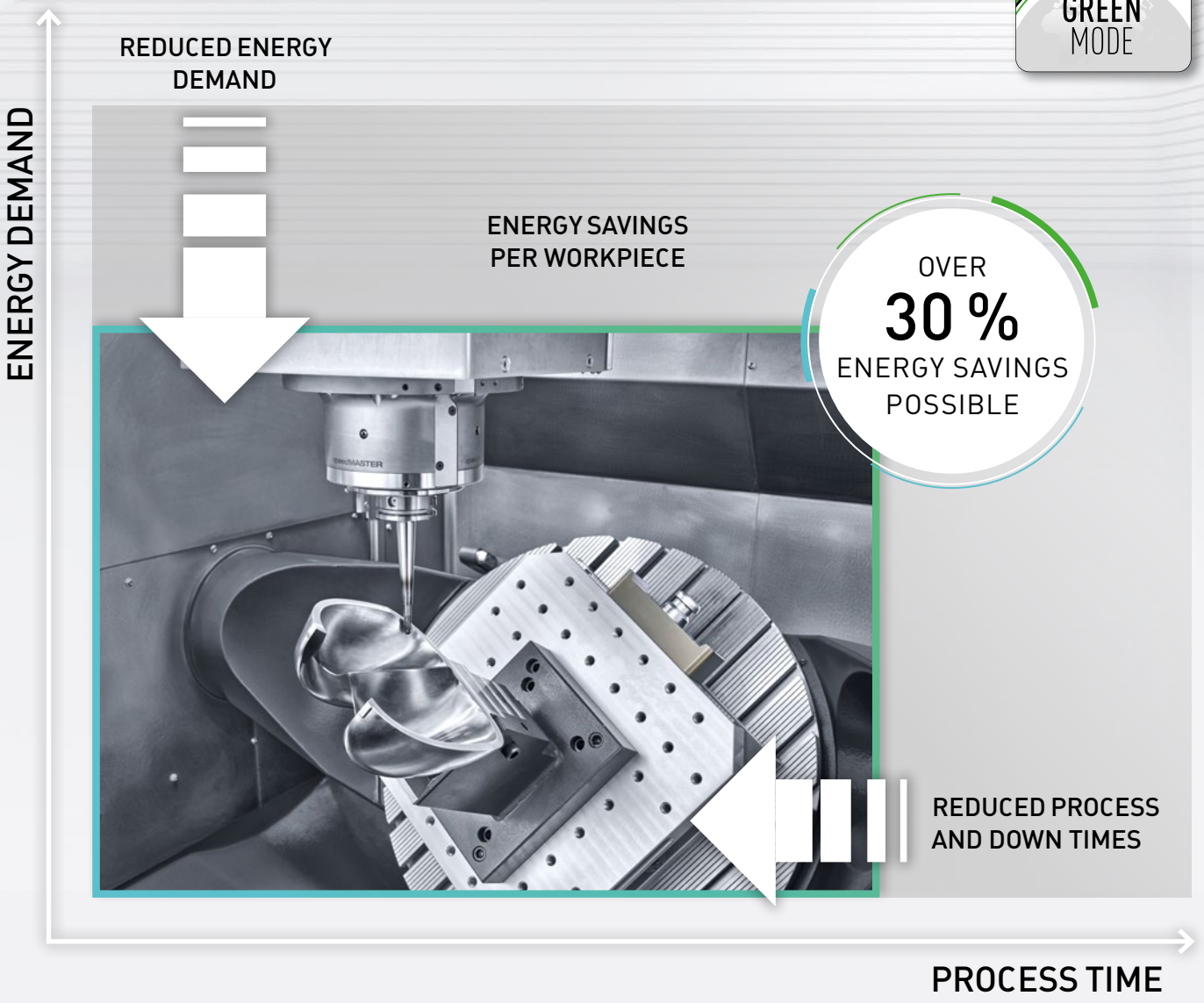
Increasing energy efficiency in industry is a key factor in achieving climate protection goals. In addition, low energy requirements are becoming increasingly important economically in view of rising energy prices. With **GREEN**MODE, DMG MORI is redefining energy efficiency in production. Significant savings are possible, especially in process and machine cooling, which often accounts for up to 70 % of the power consumption of a machine tool. Thanks to innovative hardware and software components, DMG MORI was able to reduce the energy requirement by more than 30 %. In this way, DMG MORI supports you on your way to energy-efficient production.

Typical shares of power demand in machine tools



13 measures for more energy efficiency and transparency

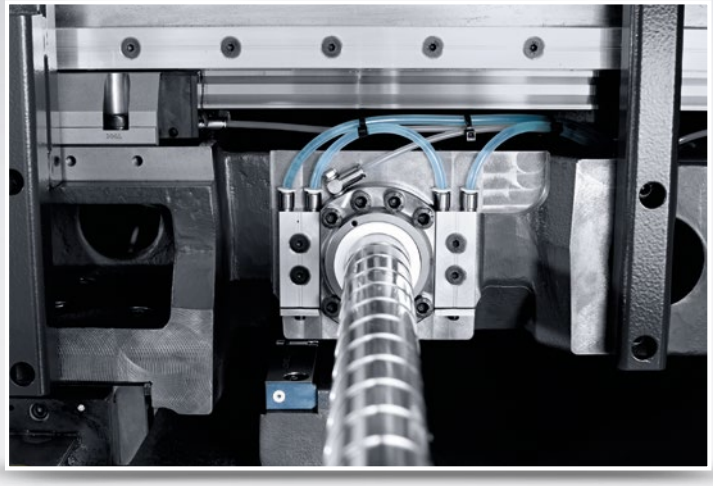
1. **Brake Energy Recovery**
2. **LED-Lights**
3. **Highly Efficient Chillers**
   Best-in-class machine & cabinet chillers
4. **Advanced Auto Shutdown**
   Automatic standby & wake-up
5. **Adaptive Feed Control**
   Shorter processing times
6. **Advanced Energy Monitoring**
   Workpiece-specific energy measurements
7. **Air Leakage Monitoring**
   Fast detection of leakages



8. **Frequency-Controlled Pumps**
   Efficient coolant supply
9. ***zero-sludge*COOLANT**
   Extended coolant lifetime
10. **Adaptive Coolant Flow**
    Smart pressure & flow control of coolant
11. ***zero*FOG**
    Compact & energy efficient unit
12. **AI Chip Removal**
    Shorter & efficient cleaning cycle
13. **Business Benefit Optimizer**
    Transparent comparison of power rating and emissions before investment

1. Brake Energy Recovery

Every acceleration movement is counteracted by a braking process. With the help of brake energy recovery, the energy of the moving masses can be converted back into electrical energy. This is then available for the next acceleration process. Brake energy recovery has a particularly positive effect in processes that require frequent acceleration of axes. This is the case, for example, in processes with frequent tool changes.



Gain something back with every move

+ Energy recovery with every deceleration
+ High-quality inverters
+ Standard in most DMG MORI machines

2. LED-Lights

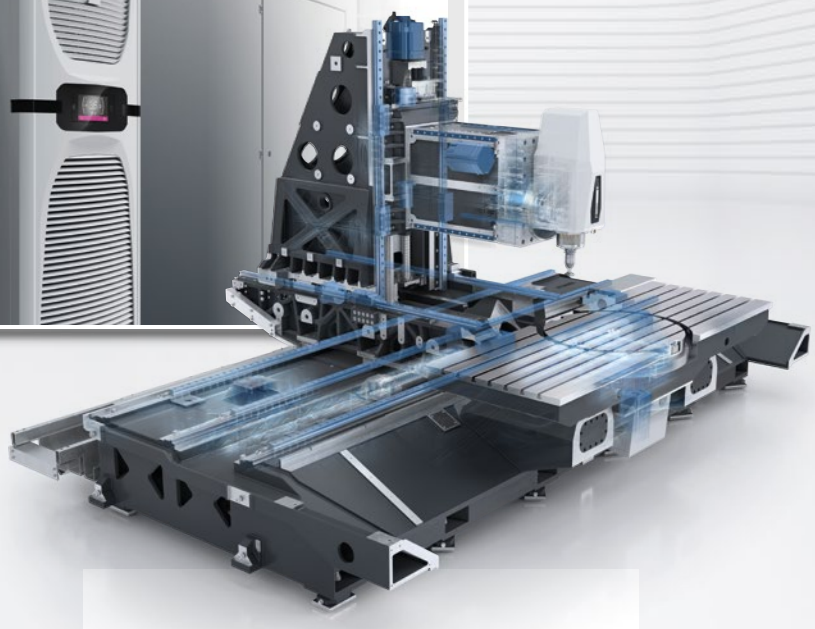
Light-emitting diodes – or LED (light-emitting diode) for short – have become an integral part of our everyday life and allow for highly efficient lighting solutions. For this reason, LEDs have also been standard at DMG MORI for several years in all machines for lighting the work area. Due to the required high luminosity in the work area and the long operating time, LEDs lead to considerable energy savings in the use phase of machine tools.

Bright and highly efficient

+ Consistent use of LED lamps
+ Up to 30 % less energy consumption compared to conventional light sources
+ Standard in all DMG MORI machines

Demand-based control cabinet cooling

+ Frequency-controlled cabinet cooler
+ High energy efficiency in partial load operation



3. Highly Efficient Chillers

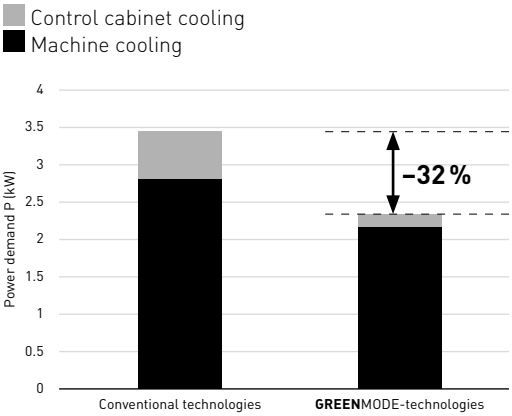
DMG MORI stands for precision and the highest machining accuracy. An important prerequisite for this is the thermal stability of the machine tool. In addition to design measures, active cooling systems are used. However, the active cooling of the machine and control cabinet can amount to up to 45 % of the total energy requirement of a machine. In order to reduce energy requirements while maintaining accuracy, DMG MORI relies on the most modern technologies.

Efficient machine cooling

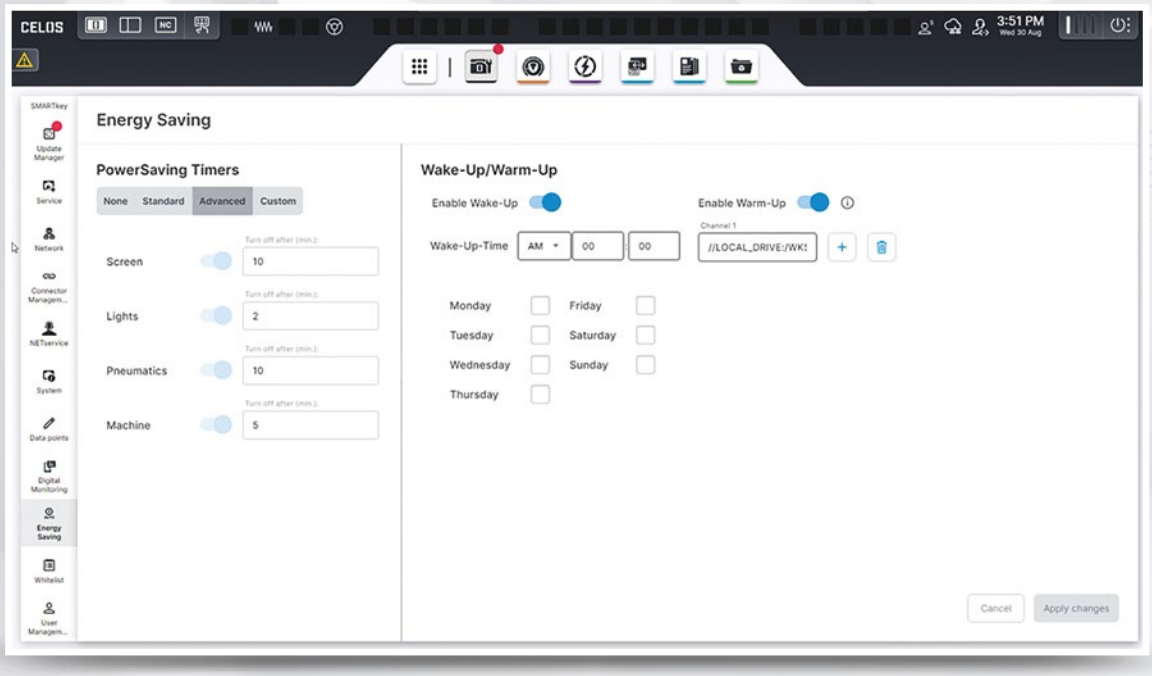
+ Use of water admixture technology or frequency-controlled aggregates
+ Particularly high efficiency in partial load operation
+ Use of refrigerants with reduced greenhouse gas potential

Energy savings with highly efficient chillers

Power demand DMU 40 eVo *linear*



*Mean power demand in machining at DMG MORI Energy Consumption Test Cycle



4. Advanced Auto Shutdown – Demand-oriented shutdown and wake-up of machine components

Machine tools already have a high power consumption in standby. By specifically switching off components that are not required at the time, energy requirements can be significantly reduced. With the DMG MORI Advanced Auto Shutdown, the machine automatically switches off unneeded units and restarts the machine precisely.

Intelligent shutdown of aggregates

+ Automatic shutdown of unnecessary aggregates in standby
+ Reduced electricity and compressed air requirements
+ Thermal stability monitoring for selected machine types

Easily configurable

+ Switching off aggregates individually configurable
+ Precisely ready for use thanks to time-based wake-up of the machine

5. Adaptive Feed Control – Less energy demand per workpiece because of higher productivity

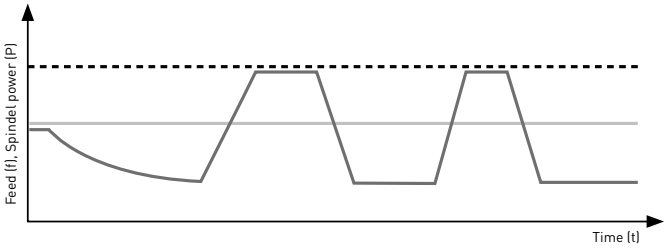
Due to the high fixed energy requirement of machine tools, increasing productivity has great potential to reduce the energy requirement per component.

An effective option for this is the Adaptive Feed Control, which is available for many machines from DMG MORI.

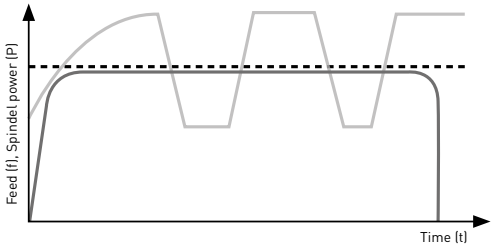
Benefits of Adaptive Feed Control

+ Automatic detection of process sections with low spindle power and adjustment of the feed
+ Freely programmable feed ranges
+ Lower energy requirement per component due to shorter processing time

Without Adaptive Feed Control:



With Adaptive Feed Control:



Optimized spindle power
Feed rate
Actual spindle power

EXAMPLE

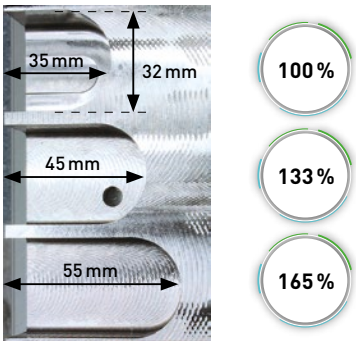
Process time: 80 s
Tool: 16 mm HPC end mill
Material: Ti-6Al-4V

open slot / depth: 32 mm

Conventional: 4× full groove cut + 4× partial cut
$Q = 24\ cm^3/min$

Trochoidal milling: $a_p = 32$ mm
$Q = 32\ cm^3/min$

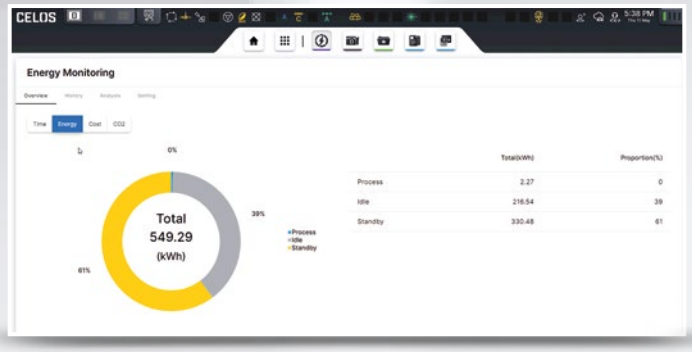
Trochoidal milling: $a_p = 32$ mm + AFC
$Q = 39.6\ cm^3/min$

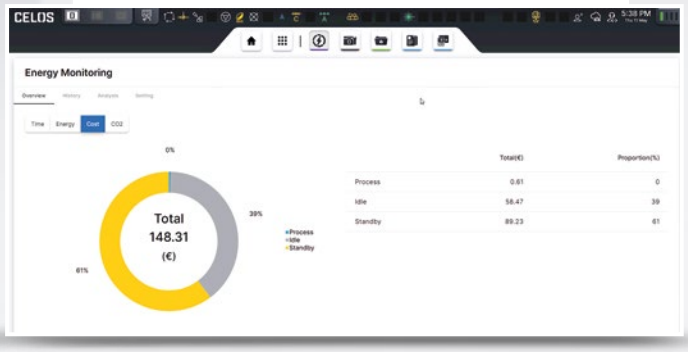


100 %
133 %
165 %

Full transparency in energy demand

+ Measurement of the electrical energy requirement
+ Measurement of compressed air demand
+ Machine and component-specific evaluation of the energy requirement
+ Automatic calculation of CO_2 emissions and energy costs





6. Advanced Energy Monitoring

How much energy did the process require? What are the energy costs for the component? How high were the CO_2 emissions for production? The Advanced Energy Monitoring from DMG MORI answers these questions reliably and transparently. In addition to the documentation, it is also possible to quickly evaluate process improvements.

7. Air Leakage Monitoring

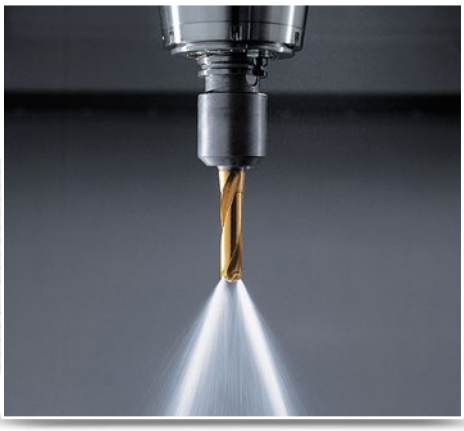
Compressed air is an expensive and energy-intensive medium. With the Air Leakage Monitoring from DMG MORI, leaks can be detected quickly, thus, energy and costs saved.

Detect compressed air leaks faster

+ Online comparison between target and actual compressed air requirements
+ System ready-to-use with machine delivery
+ Freely configurable monitoring limits

8. Frequency-Controlled Pumps

Conventional pumps always pump at maximum capacity. If the pressure in the system rises above a limit value (e.g. 80 bar) due to small cooling channels, part of the cooling lubricant is returned directly to the tank and the pressure is reduced. This is not energy efficient. In contrast, frequency-controlled coolant pumps allow an adjusted coolant supply.



Demand-based capacity through frequency control

+ The delivery rate of the pump is adjusted to the pressure specification via frequency-control
+ Reduced energy requirement in partial load operation

9. *zero-sludge*COOLANT – Coolant system without accumulation of sediments

The production and disposal of cooling lubricants are associated with high CO_2 emissions. With *zero-sludge*COOLANT, the operating time of cooling lubricants can be increased – especially in applications with the finest chips and particles.

Here is the video about *zero-sludge*COOLANT Technology:
youtu.be/1j5iHa2n6_8

Sediments in the coolant tank – A challenge

+ Finest chips and sediments can accumulate in the coolant tank
+ Accumulations can be observed particularly in machining of castings and during grinding
+ Cleaning the tank is time-consuming
+ The sediments degrade the quality of the cooling lubricant, so that it has to be replaced more frequently

UP TO
2 TONS
OF CO_2 SAVING
PER YEAR[2]

Operating principle

Several coolant nozzles are arranged in such a way that they whirl up the cooling lubricant and up to 99 %[1] of the sediment can be filtered.

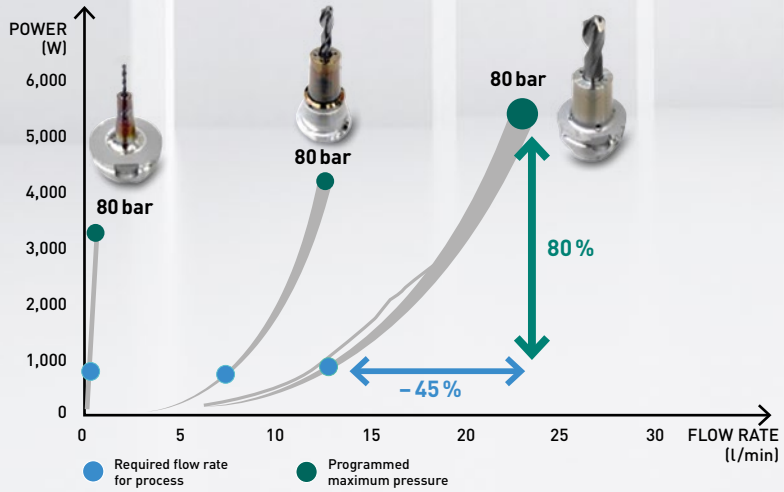
[1] Test result with test sediment sludge. The collection amount may vary depending on the type of material.
[2] Assuming that the entire tank volume (700 l) has to be replaced every four months instead of every three. Emission factor of 2.92 t CO_2/t for waste coolant incineration.

10. Adaptive Coolant Flow – Pure efficiency due to demand-based process cooling

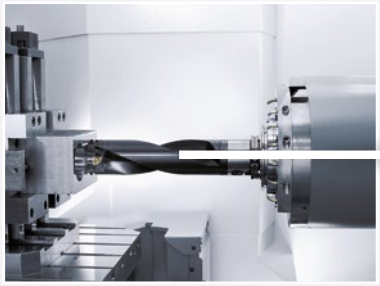
Process cooling with powerful pumps supports productive machining. However, up to 25 % of the energy consumption in the process is attributable to the coolant supply. With the innovative Adaptive Coolant Flow from DMG MORI, only as much coolant is added to the process as is actually required.

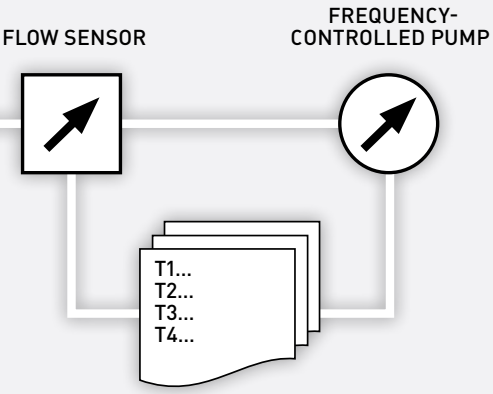
Approach of Adaptive Coolant Flow

+ Maximum pumping capacity not required for many processes
+ Exponential increase in pump power consumption with increasing flow rate
+ Slight reduction in flow rate can significantly reduce power consumption



Intelligent control and simple operation



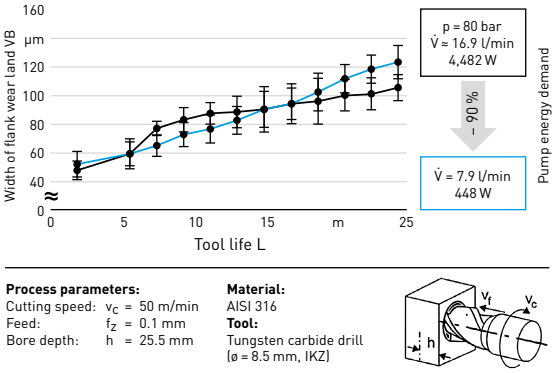


+ Tool-specific coolant supply
+ Integrated technology cycle to determine the appropriate volume flow
+ Values are automatically stored in the tool table
+ Control of the volume flow during the process
+ Pilot control allows rapid availability of the set volume flow and immediate switching off of the cooling lubricant supply

Same tool life with reduced flow rate

+ Power consumption of the coolant pump can be reduced by over 80 % in the process
+ Extensive studies show no increase in tool wear with reduced coolant flow*

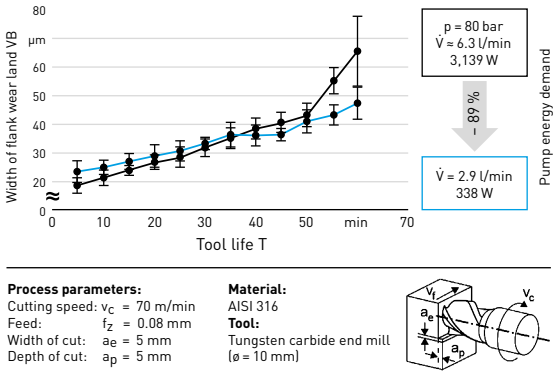
Effect on tool wear in drilling*



Process parameters:
Cutting speed: v_c = 50 m/min
Feed: f_z = 0.1 mm
Bore depth: h = 25.5 mm

Material:
AISI 316
Tool:
Tungsten carbide drill
(ø = 8.5 mm, IKZ)

Effect on tool wear in milling*



Process parameters:
Cutting speed: v_c = 70 m/min
Feed: f_z = 0.08 mm
Width of cut: a_e = 5 mm
Depth of cut: a_p = 5 mm

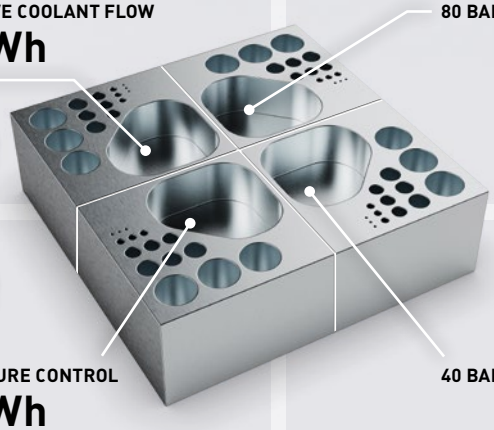
Material:
AISI 316
Tool:
Tungsten carbide end mill
(ø = 10 mm)

* Denkena, Berend, et al. "Energy efficient supply of cutting fluids in machining by utilizing flow rate control." CIRP Annals (2023).

Energy savings in machining

ACF – ADAPTIVE COOLANT FLOW
0.66 kWh
– 20 %*

80 BAR PRESSURE CONTROL
0.83 kWh



– 5 %*
60 BAR PRESSURE CONTROL
0.79 kWh

– 12 %*
40 BAR PRESSURE CONTROL
0.73 kWh

*Energy savings compared to 80 bar

Energy demand for machining the shown workpiece on a DMU 65 FDS monoBLOCK.

11. *zero*FOG – For clean working environment

Dangerous vapors cannot escape from the machine in an uncontrolled manner

+ Turbo fan powered by a high-efficiency motor for powerful suction
+ Stable and constant suction power
+ Degree of separation over 99.97 % for 0.3 µm particles

COMPACT DESIGN

+ Attached directly to the machine, no additional floor space required
+ Compact, built-in design
+ No on-site installation work necessary

Here is the video about *zero*FOG:
youtu.be/REnne6gEwa8

12. AI Chip Removal

Avoid accumulations of chips and downtimes

Accumulations of chips on the component or in the machine's working area lead to unwanted downtimes, especially in series production.

With the AI Chip Removal from DMG MORI, these downtimes can be avoided and non-productive times reduced compared to a conventional working space flushing.

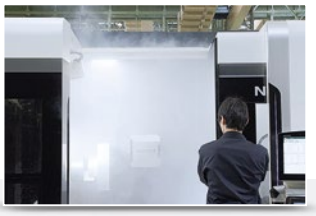
Here is the video about AI Chip Removal:
youtube.com/watch?v=mIEvH0ntDdw

LOW MAINTENANCE

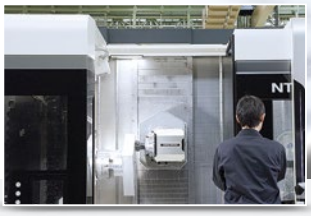
+ Automatic cleaning of the primary filter by high-pressure air, no manual cleaning required
+ Easy replacement of the secondary filter in just a few steps
+ Notification of the time of filter change

ENERGY SAVING

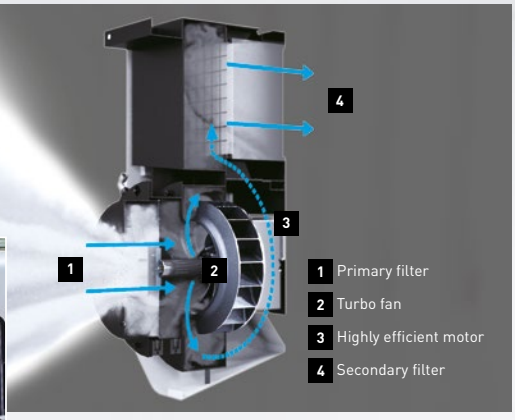
+ 35 % less CO_2 emissions and power consumption compared to conventional products



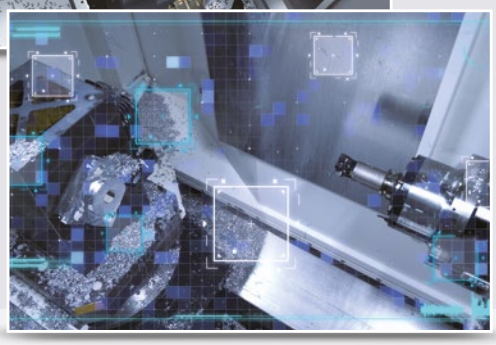
Comparison: Without *zero*FOG



With *zero*FOG



Turbo fan from DMG MORI with high suction power



Reduce non-productive times and use of coolant

+ Precise and efficient removal of chip accumulations
+ Up to 2 independently controllable coolant nozzles
+ Shorter non-productive times through targeted control of the flushing nozzles
+ Less coolant required

Automate with artificial intelligence

+ Optional extension with AI-based chip detection
+ Detection of chip accumulations using image recognition
+ Automatic programming of the working area flushing

The DMG MORI Energy Consumption Test Cycle

In order to evaluate the effects of new technologies on energy requirements, DMG MORI has established an internal standard for measuring the energy requirements of machine tools.

Features of the DMG MORI Energy Consumption Test Cycle

+ Standardized measurement of electrical energy and compressed air
+ Uniform measurement across all plants
+ Measurement of operating states according to ISO 14955-3

Machine tool: DMU 65 FDS monoBLOCK

-36%*

WITH **GREEN**MODE
32,190 kWh/a

-17,890 kWh/a

WITHOUT **GREEN**MODE
50,080 kWh/a

1. STANDBY	2. WARM UP	3. NC-READY	4. PROCESSING	5. EMERGENCY SHUTDOWN
Δ -45 %	Δ -16 %	Δ -11 %	Δ -38 %	Δ -81 %
Reference 7.7 kW **GREEN**MODE (ECO) 4.2 kW	Reference 9.0 kW **GREEN**MODE 7.6 kW	Reference 7.7 kW **GREEN**MODE 6.9 kW	Reference 17.3 kW **GREEN**MODE 10.8 kW	Reference 3.5 kW **GREEN**MODE (ECO+) 0.7 kW

Savings in operation – sample calculation

Machine running time: 4,000 hours/year (16 hours/day, 250 days/year)

Machine states	Standby	NC- ready	Machining
Ratio	30 %	20 %	50 %
Mean power demand without **GREEN**MODE	7.7 kW	7.7 kW	17.3 kW
Mean power demand with **GREEN**MODE	4.2 kW	6.9 kW	10.8 kW

CO_2-SAVING

6,548 kg/a

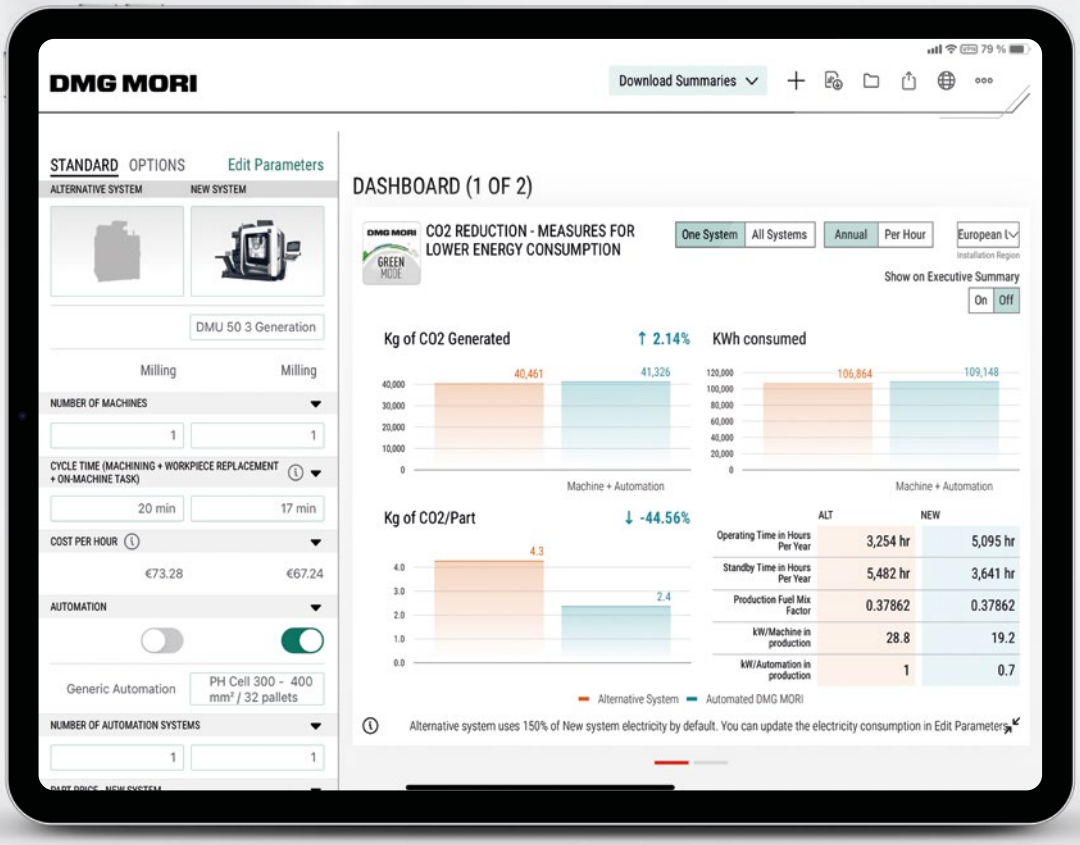
COST SAVING

5,725 €/a

*All values shown are based on internal investigations and experience from DMG MORI. Actual values may vary due to actual production conditions. Assumptions for annual energy demand: 250 working days/year, 2 shifts/day, 8 hours/shift, 30 % standby, 20 % NC ready, 50 % machining, CO_2 emission factor: 0.366 kg/kWh, electricity price: 0.32 €/kWh.

13. Full transparency in the investment phase – The Business Benefit Optimizer

With rising energy prices, it is becoming increasingly important to take these and the associated CO_2 emissions into account when making investment decisions. With the Business Benefit Optimizer, you can now analyze these effects with your contact person at DMG MORI.



+ Comparison of energy requirements and CO_2 emissions of individual machines and entire machine parks
+ Direct comparison of scenarios and the status quo
+ Consideration of individual CO_2 emission values possible
+ Talk to you contact person at DMG MORI today

Export Control: To prevent the illegal diversion of the equipment to individuals or nations that threaten international security, from 01/01/2023, every DMG MORI machine may be equipped with an RMS function (Relocation Machine Security). The RMS automatically deactivates the machine when the machine is moved or disassembled. Such deactivation does not take place during regular operation or maintenance.
If the equipment is so-disabled, it can only be re-activated by DMG MORI or some authorized representatives. Reactivation can be ordered via DMG MORI Service.
If the machine is deactivated due to a substantial repair activity, this service is free of charge.
DMG MORI may refuse to re-activate the machine if it determines that doing so would be an unauthorized export of technology or otherwise violate applicable export restrictions.
DMG MORI shall have no obligation to re-activate such machine and shall have no liability as a result thereof.

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