BOY®

Spritzgiessautomaten

Innovative into the Future – BOY-Injectioneering

Saving energy and CO_2 whilst injection moulding

Saving resources

Origin of the BOY injection moulding machines

The resource-saving use of plastic and energy has always been a high priority at BOY. In fact, the company's foundation is based on this. In the 1960s, Max Schiffer, founder of BOY, was faced with the challenge that sprue systems accounted for a very large proportion of the shot weight in the production of smaller injection moulded articles. As today's hot runner systems were not yet available at that time, he developed a compact and small injection moulding machine himself, the BOY 15, in order to drastically reduce the energy and plastic requirements for unnecessarily large sprue systems from then on.

Energy efficiency, resource conservation and CO_2 savings - these topics have shaped the development of our injection moulding machines ever since. The servomotor pump drive was introduced at BOY (incidentally as the world's first injection moulding machine manufacturer) back in 2008. In many cases, this drive technology also outperforms its electromechanical counterparts from an energy perspective - particularly in the lower to medium clamping force range.

BOY is the only well-known manufacturer to rely on the proven two-plate clamping system. This not only has the advantage of taking up less space in the machine, but also reduces the amount of material used to manufacture the machine and only small amounts of oil are moved. The hydraulic locking of the pressure intensifier ensures that no drive energy is consumed at all in certain areas of the injection moulding process, as the servo motor switches off completely during these moments.

But BOY didn't stop there. The melting of the plastic granulate (heating and dosing) is the process step with the highest energy requirements for medium and high material throughputs. The development of the EconPlast plasticising unit has further reduced the required energy consumption. Thanks to improved heat input into the material and optimised insulation, a significant improvement could be achieved compared to the conventionally used plasticising units (heater bands + insulating sleeves).

Another logical step at BOY was the introduction of EconFluid, a specially developed hydraulic oil, which is optionally available for all machine types. By switching to this low-viscosity oil, significant savings can be achieved depending on the process.

However, it is not only mechanical engineering aspects that influence the energy consumption of an injection moulding machine. The energy consumption is significantly influenced by the application-oriented operation of the machine. A comprehensive training package is available for this purpose, which, in addition to the Procan ALPHA® control seminars, also includes further modules, such as the energy-saving seminar.

In addition, BOY offers comparative energy measurements, both on the existing „old“ machine and with the same tool on a new, energy-saving BOY machine of the E-series. In addition to energy savings, – which is often a sufficient incentive – you can also use these measurements to apply for subsidies (e.g. BAFA).

This brochure will give you an insight into the energy-saving world of BOY. We would be pleased to advise you individually on the modernisation of your machinery and the consumption optimisation of your existing BOY injection moulding machines.

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Picture 1: Photovoltaic system on the BOY factory halls

Advantages of servo-hydraulic drive concepts

It is wrongly assumed that fully electric machines are currently the most efficient machines available on the market. However, our experience shows that especially in the lower and middle clamping force range, the BOY servo hydraulics is usually more economical than their electromechanical counterparts. It always depends on the respective application (cycle time, material throughput, machine size, etc.). The following influencing variables (Table 1) play an important role here:

Time-dependent influencing variables:	Process-dependent influencing variables:
Standby consumption of the inverters	Driving / travel movements
Machine control system	Heating elements
	Dosing process
	Clamping force build-up
	Injection work
	Holding pressure

Table 1: Time- and process-dependent influencing variables

Time-dependent influencing variables

Regarding the time-dependent influencing variables, at a 1-K usage, it can be assumed that in both cases (servo-hydraulic or fully electric) that both machine types can manage with one control system. The first differences become apparent in the number of converters required, as each servo drive requires its own. This is illustrated in Figure 2.

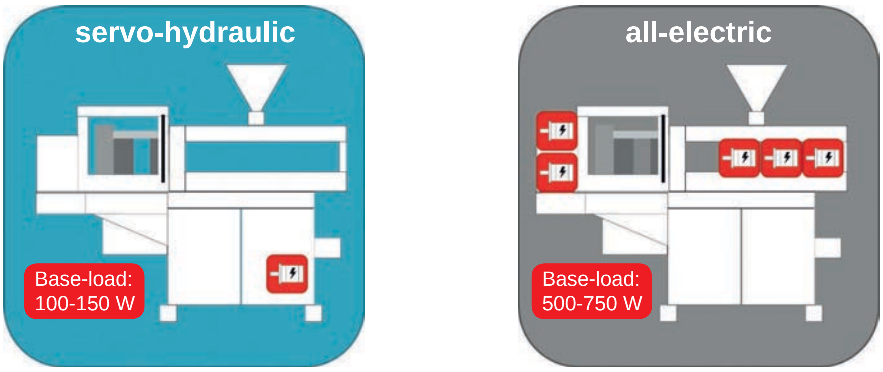


Figure 2: Minimum required number of converters for servo-hydraulic (left) or fully electric (right) injection moulding machines

Consequently, in a servo-hydraulic machine with typically one drive, only one inverter is required, as all travel movements (axial screw movement, rotary screw movement, movement of the injection unit, movement of the clamping plate, ejector stroke and, if necessary, core pulls) are realised with this inverter. Measurements have shown that such an inverter has a base load of about 100 - 150 W.

In the case of fully electric machines, however, each axis of movement requires its own drive and therefore its own inverter. This means that a standard machine (without options such as core pulls) requires five inverters for the basic functions mentioned above, which involve a base load of 500 - 750 W. If the machine is also equipped with core pulls, additional inverters are required.

Process-dependent influencing variables

In addition, of course, the process-dependent influencing factors / variables also have a considerable influence on the overall consumption. In both cases, energy is introduced into the plastic via heating elements (cylinder heater bands) and friction. This is basically independent of the drive concept.
In both cases, energy is required to build up the clamping force. If a toggle lever system of a fully electric injection moulding machine is compared with the BOY clamping system there is also no significant difference in terms of energy when maintaining the clamping force, as both systems maintain the clamping force without an active energy supply and are therefore passive.
There are energetic differences between the two drive concepts when it comes to the machine‘s travel movements (linear and rotary). Due to the higher conversion losses in servo-hydraulic machines, an electromechanical drive has an advantage here.

Assessment

Servo-hydraulic machines causes a lower base load compared to fully electric machines. Fully electric machines, on the other hand, are more efficient at converting electrical energy into kinetic energy. The latter is of secondary importance for low to medium material throughputs, but for very high material throughputs it results in energetic advantages.
For high material throughputs, BOY therefore offers an electric plasticising motor so that this energy-intensive process step is carried out with as little loss as possible. Figure 3 shows this relationship graphically for a servo-hydraulic machine, a fully electric machine and a hybrid model (servo-hydraulic machine with electric plasticising motor).

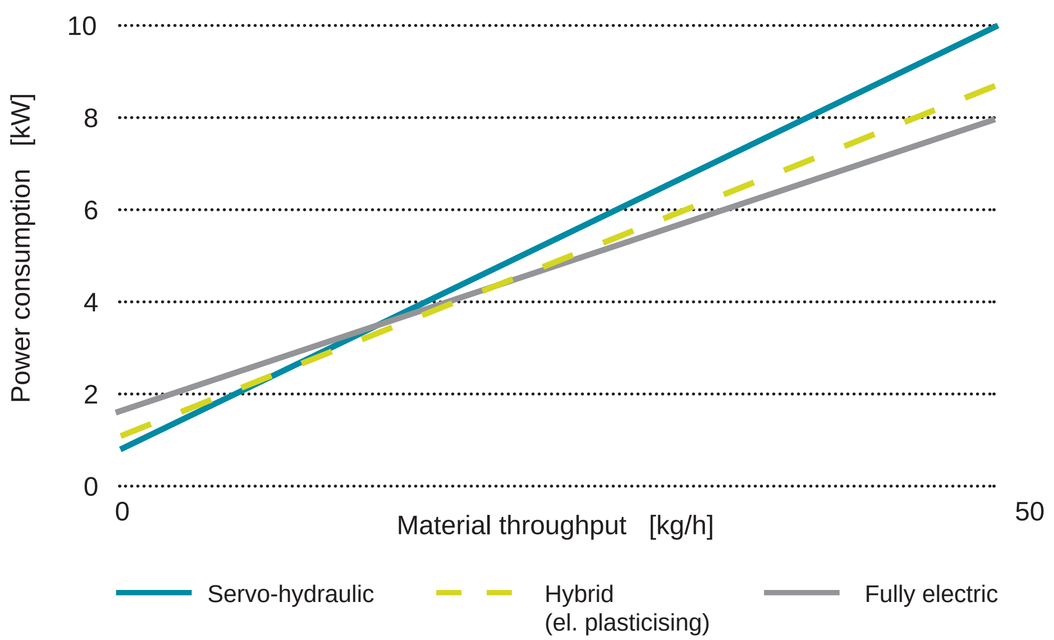


Figure 3: Exemplary representation of the energy consumption of different drive concepts depending on material throughput

EconPlast

Energy savings through

- Optimised heat transfer from heating element to cylinder.
- Reduction of the surface area due to smaller diameters in the conveying and compression zone.
- Less energy loss as a result of the feed zone cooling due to smaller cross-section (puncture, optimised feed zone control).
- Better insulation properties due to uniform surface compared to conventional heater bands.
- Low-friction plasticisation due to optimised screw geometry.
- Lower load on the drive train during dosing due to energy-optimised hydraulic equipment and the therewith associated lower system pressure (with EconPlast equipment from machine delivery).
- Optimised temperature detection by placing the temperature sensors close to the melt.

Improved temperature control

- Elimination of unheated areas between the heater bands.
- Better heat distribution over the perimeter (circumference) by eliminating unheated gaps between the half shells of the heater bands.
- Faster heating due to better heat transfer and less mass in the feed zone.
- More precise temperature control.

Other benefits

- Best possible protection against dirt and damage from the outside.
- Clean appearance due to polished steel jacket as outer shell.
- Longer service life due to lower temperature of the heating elements (due to better heat transfer) and shorter duty cycle due to the insulation.

Figure 4: The EconPlast units are available as an option for all BOY injection moulding machines in the E-series with a screw diameter of 24 mm or more

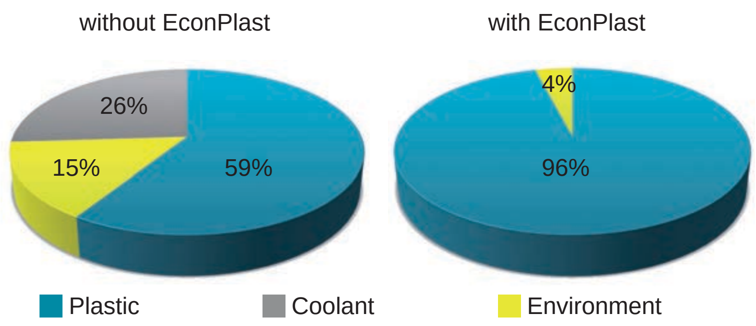


Figure 5: The energy losses to the environment and the cooling water are minimised. This significantly reduces energy consumption

EconFluid

Hydraulic oil tends to lose viscosity at high temperatures. In this state, it can transmit less hydraulic energy because it becomes thinner as the temperature increases. As a result, internal leakage in the hydraulic circuit increases and efficiency is reduced. At the lower end of the temperature spectrum, oils become more viscous, making them harder to pump through the entire hydraulic system, requiring more energy.

EconFluid is a hydraulic fluid with optimised viscometry and avoids the negative effects described above in the temperature range commonly used for injection moulding machines. Internal leakage at high temperatures is kept to a minimum and the increased energy requirements at low temperatures is avoided. The energy requirement of the drive of a BOY 35 E is reduced by 7-10 % when using EconFluid (compared to HLP 46).

Our findings show that too little attention has been paid to the hydraulic oil itself for a long time. Although there are alternatives to standard oils from various manufacturers, these usually only have a small percentage effect on energy consumption. EconFluid from BOY, on the other hand, significantly reduces the energy consumption of the drive side of hydraulic injection moulding machines.

Figure 6 shows the drive energy requirement of the BOY 35 E in a test cycle based on Euromap 60.1 using HLP 46 compared to EconFluid, in each case depending on the oil temperature. This is shown for a standard machine as well as the machine configuration with EconPlast. The energy advantages of EconPlast are immediately apparent.

In addition to the pure reduction in the drive energy requirement, the energy required for oil cooling is also reduced, as the oil heats up less due to the lower internal losses. At the same time, it has been proven that the machine becomes less sensitive to oil temperature fluctuations. In conjunction with the precise control technology, the BOY 35 E continues to operate with unchanged precision between 27 °C and 45 °C, and energy expenditure for heating or oil cooling can be minimised accordingly. Additional savings effect: EconFluid can be used for longer than monograde fluids, and with appropriate maintenance, for longer than five years. Furthermore, EconFluid can be mixed with HLP 46 without any problems, of course with the consequence that the advantages are reduced when increasing the proportion of HLP 46.

EconFluid can be retrofitted without any problems. You can therefore also optimise the energy efficiency of your existing machines. All you need to do is replace the hydraulic oil in the machine.

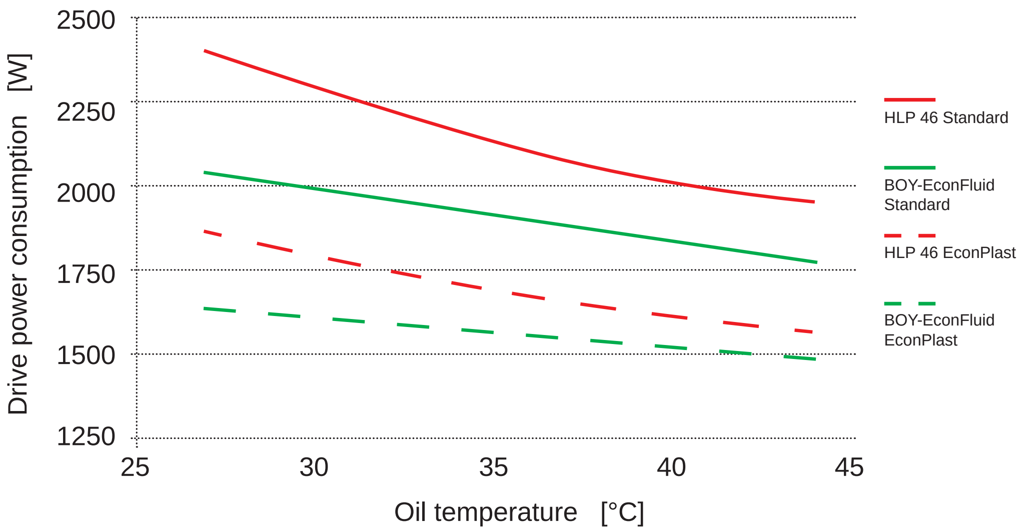
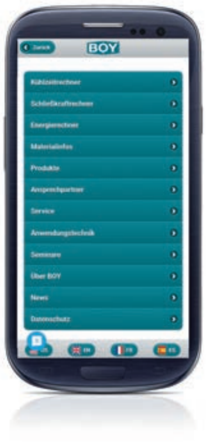


Figure 6: Oil temperature-dependent drive energy requirement of a BOY 35 E with EconFluid

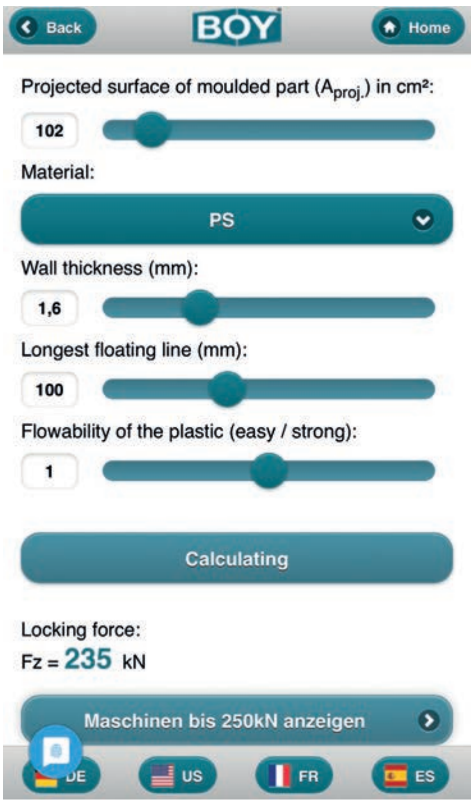
BOY App



Practical helper in everyday injection moulding
With any mobile device that has Internet access, the use of the practical helper is free of charge. In addition to cooling time and clamping force calculations, the app contains processing data for many plastics as well as dates and contact details and information on the product range.

With general information, the latest updates and easy access to all important functions, the BOY app offers everything you need. What makes our app special is its user-friendly interface that allows you to quickly and easily retrieve all relevant data. It‘s never been easier to stay up-to-date and never miss out on important information.

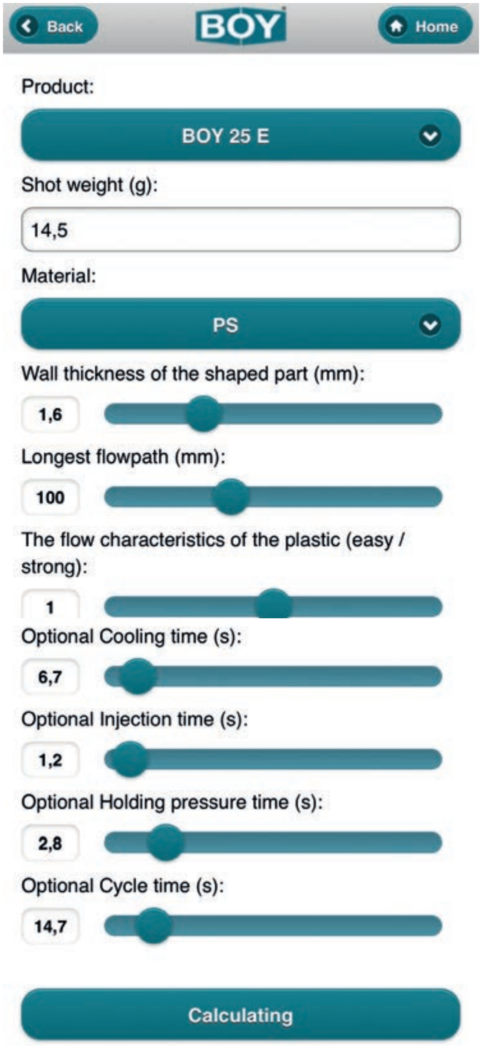
BOY App: Clamping force calculator



Among other things, our app offers the possibility of calculating the clamping force. This is done based on the moulded part data such as projected moulded part area [cm²], wall thickness of the moulded part [mm], longest flow path [mm] and flow behaviour of the plastic (light / heavy). This saves you time and you can be sure that you are always choosing the right machine.

Figure 6: Calculation example based on a delicatessen bowl.

BOY App: Energy Calculator

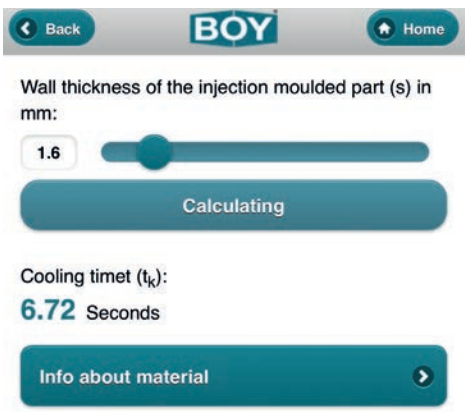


The energy calculator for injection moulding machines makes it possible to calculate the energy consumption of each individual injection moulding machine.

This gives you a guideline value that gives you an idea to which level of energy consumption the process can be reduced. By closely monitoring and analysing the energy consumption, measures can be taken to achieve lower consumption. This is not only economically sensible, but also important from an ecological point of view. A conscious use of energy is essential in times of climate change. Therefore, it is worthwhile to invest in new/ efficient injection moulding machines.

Result for BOY 25 E with PS	
Cycle time	14.7 s
Material throughput	3.55 kg/h
Power requirement	2.09 kW
Specific energy requirement	0.59 kWh/kg
Energy requirement with EconPlast	1.69 kW
Specific energy requirement with EconPlast	0.48 kWh/kg

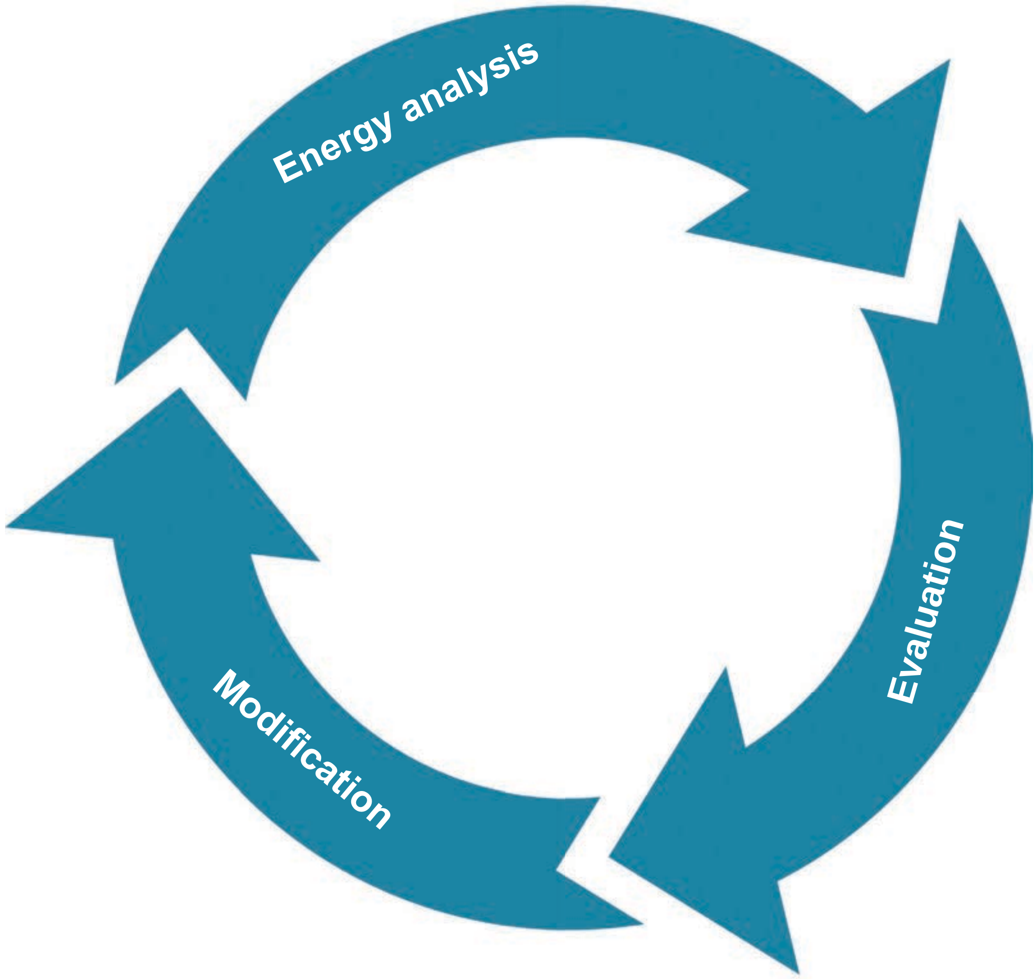
BOY App: Cooling Time Calculator



Our experience shows that the clamping force set for processes is often far too high. This not only places an excessive strain on the tool and the machine, it also directly leads to a higher energy requirement than is necessary to produce the article.

The clamping force calculator makes it possible to determine the actual clamping force requirement quickly and easily. Select the plastic being processed and estimate the projected area, wall thickness, longest flow path and the flow behaviour of the material as good as possible and you will receive a good approximation of the required clamping force.

Energy Saving Cycle



The environment must also be considered

However, the energy monitor is only part of the picture. It is also very important to look at the peripherals around the injection moulding machine – of course with a focus on energy consumption and the possibilities for reducing it. Because here, there is also a great potential for savings, which can often be used to your advantage simply by making specific settings.

Energy Monitor

Your standard energy-saving assistant for all machines of the E-series

Often there is not enough time to closely monitor the process. However, this “investment“ often pays off quickly, especially when energy prices are at a high level. Along with this, the CO_2 emissions are playing an increasingly important role, and it can be assumed that these emissions will be given more and more importance. These factors can be determined on the injection moulding machine itself with an energy analysis. At high material throughputs, you will usually find that the plasticising process accounts for a very large proportion of the energy consumption.

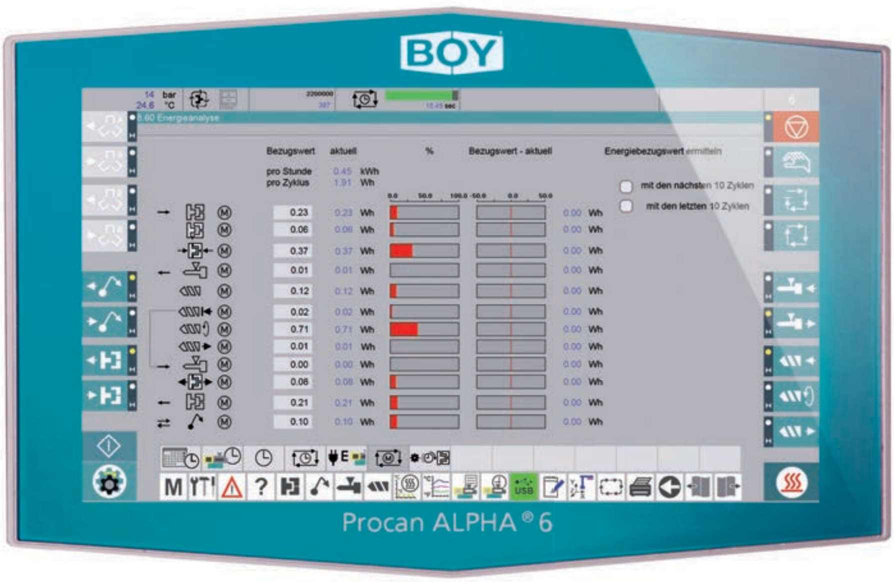
You can evaluate the energy consumption based on your experience with comparable applications or with the help of the integrated energy monitor. Here you will find the percentage weighting of consumption in relation to the total power consumption of the drive. With this insight, you can take appropriate actions and measures and modify the process. Question your process!

In the example of the plasticising process:

- Have I chosen the right screw speed for my process?
- Has the dynamic pressure (back pressure) been adjusted correctly?
- Have you set the temperature profile of the cylinder correctly?
- Has the temperature of the feed zone been adjusted?
- Am I not letting my dried material cool down before processing?
- Do I have the right plasticising unit for my process?

This is a small selection of questions you can ask yourself to understand and optimise the process.

Change only one factor at a time and wait for several cycles to be able to evaluate the change. Keep in mind that temperature changes in particular take time. The effect is then visualised with the help of the energy monitor. You can see exactly how the initiated measure affects the target variable (e.g. energy consumption during plasticising) – but also what positive or negative effect the measure has on other sub-process steps.



Construction and equipment are subject to change
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Low Energy = High Efficiency

Productivity

EconFluid

Avoid emissions

Circular Economy

EconPlast

Injection Unit

Servo-Drive

BOY

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