November 2017
Made with MST-Tool ver. 2.17.10

Example 1, Use of the MST-Tool on a Fan system

Below is an example of use of the program. The example deals with optimizing a fan system that produces the same amount of air before and after.

The installation is a VAV system, i.e., Variable Air Volume. This example, however, only shows the optimization of the system in the one duty point where the fan is at its maximum.

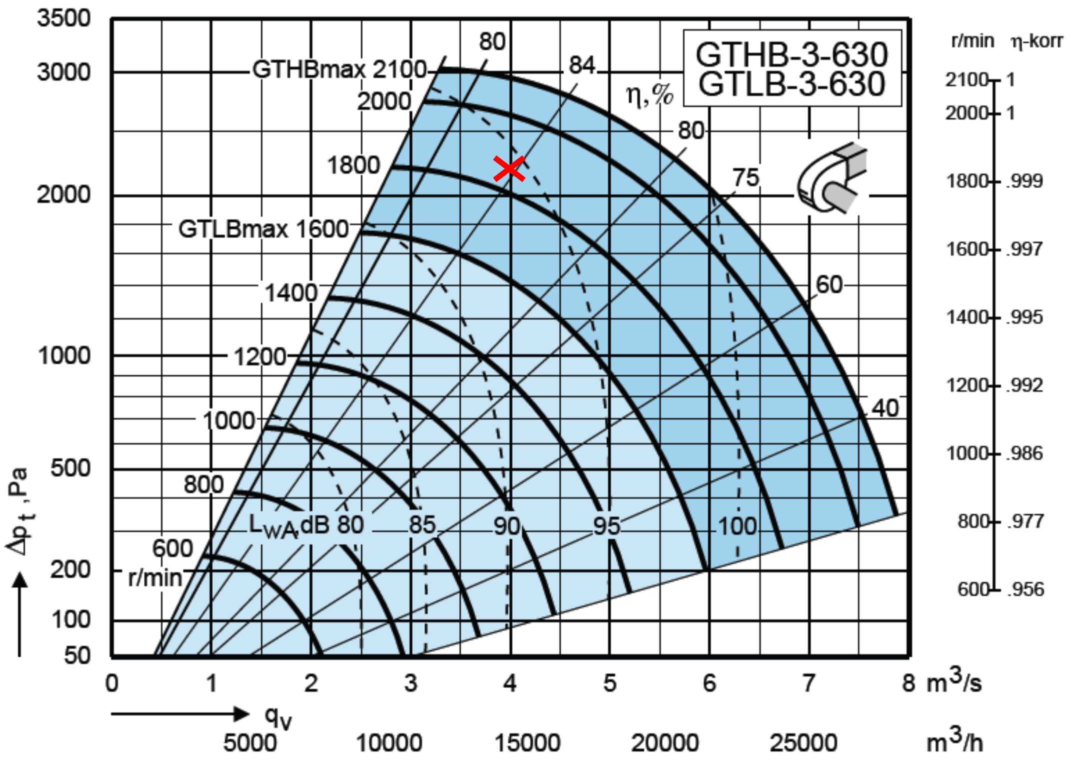
1.1 Data for the fan system

Below is a description of the components included in the fan system. In addition to the fan it includes a transmission, a motor and a control unit (frequency converter).

1.1.1 Fan

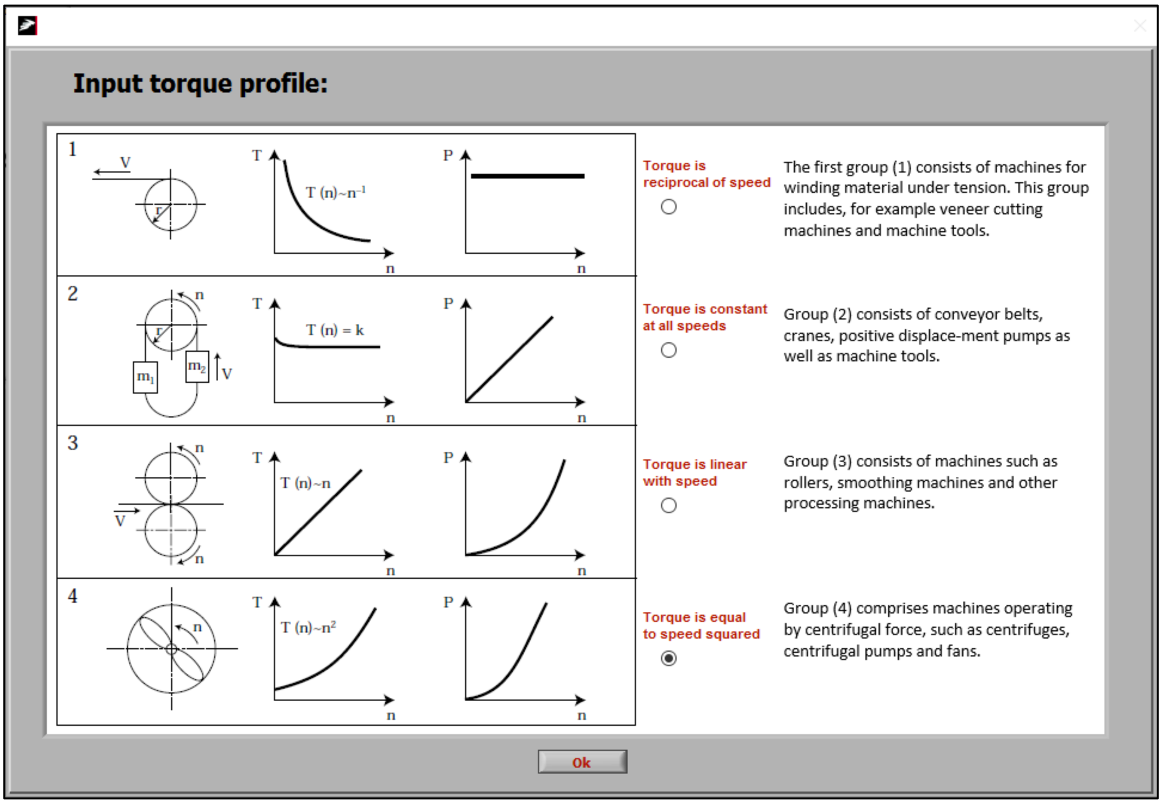
It is measured that the fan (with backward curved blades), is providing a flow rate q_v of 4.0 m^3/s (14.400 m^3/h) at a total pressure increase through the fan of Δp_t: 2200 Pa.
At this duty point, the fan, as shown in the figure below, has an efficiency of 84 %.

From this information, we deduct the hydraulic power (P4): $P4 = q_v \cdot \Delta p_t = 8.8$ kW.
This information must later be entered in the MST Tool.



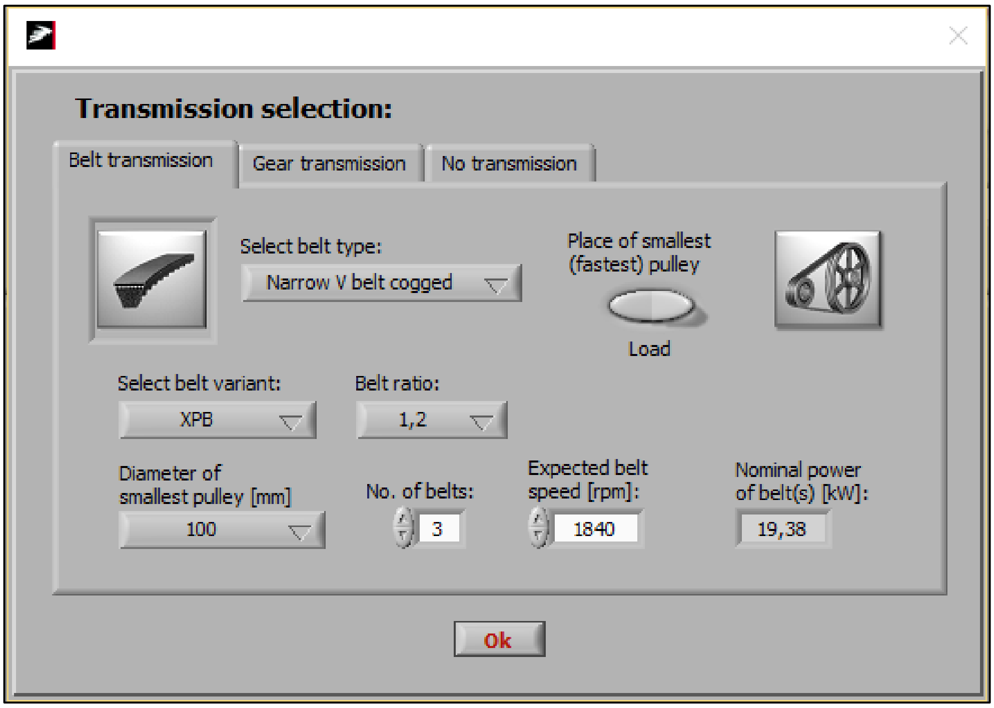
Curve for the fan in the system

Starting the tool, we must select type of torque profile:



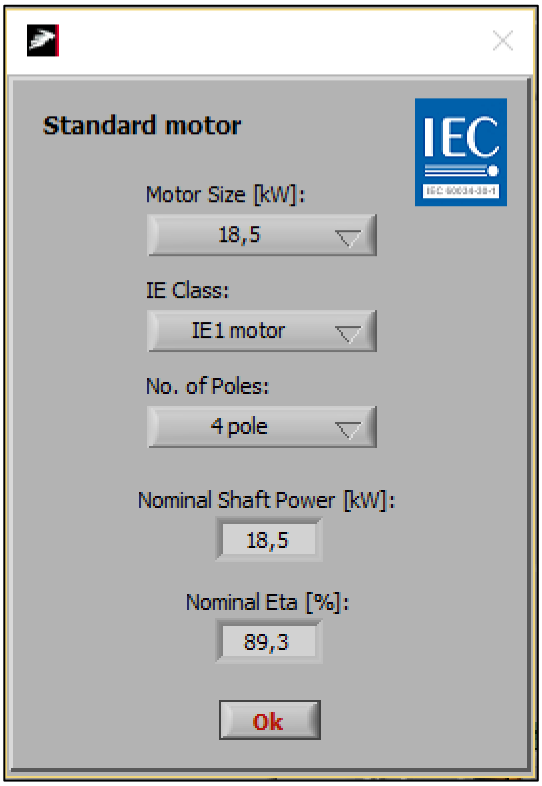
1.1.2 Belt transmission

Belt transmission consists of three pcs XPB belts (cogged narrow V-belts). The diameter of the small pulley is 100 mm and the exchange ratio is 1.2. The expected belt speed in this case corresponds approximately to the speed of the fan.
Estimated motor speed: 1533 x 1.2 = 1840 rpm.



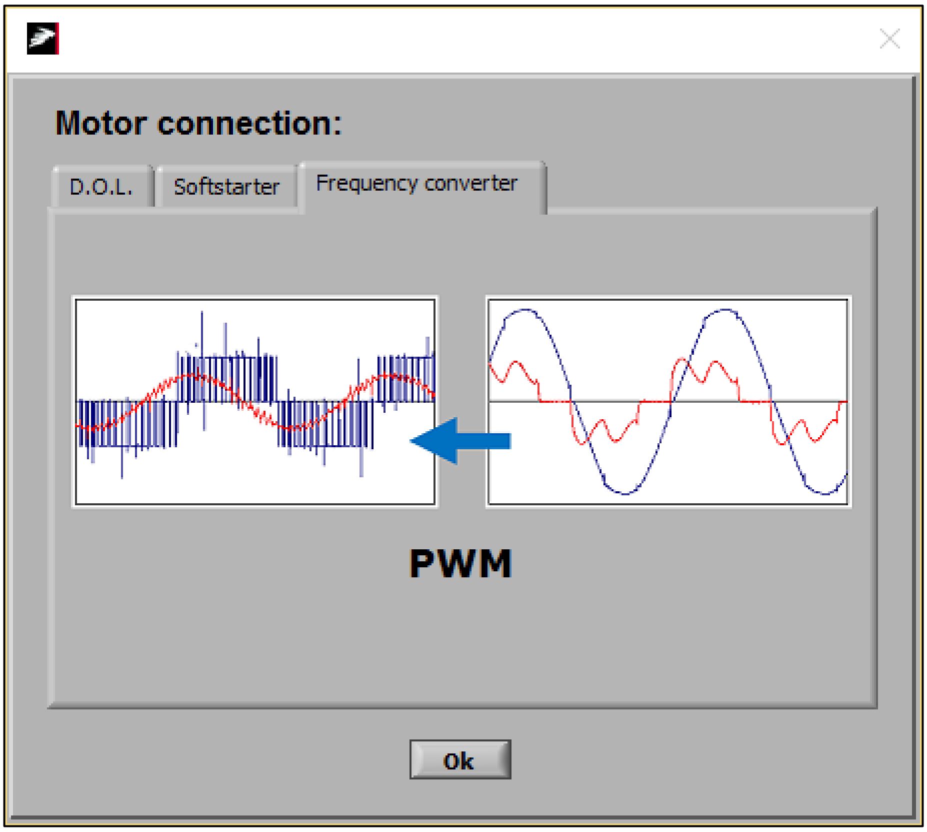
1.1.3 Motor

The Motor is a 4-polet 18,5 kW IE1 motor with "unknown" nameplate. Therefore, we select a standard IE1 motor in the tool:



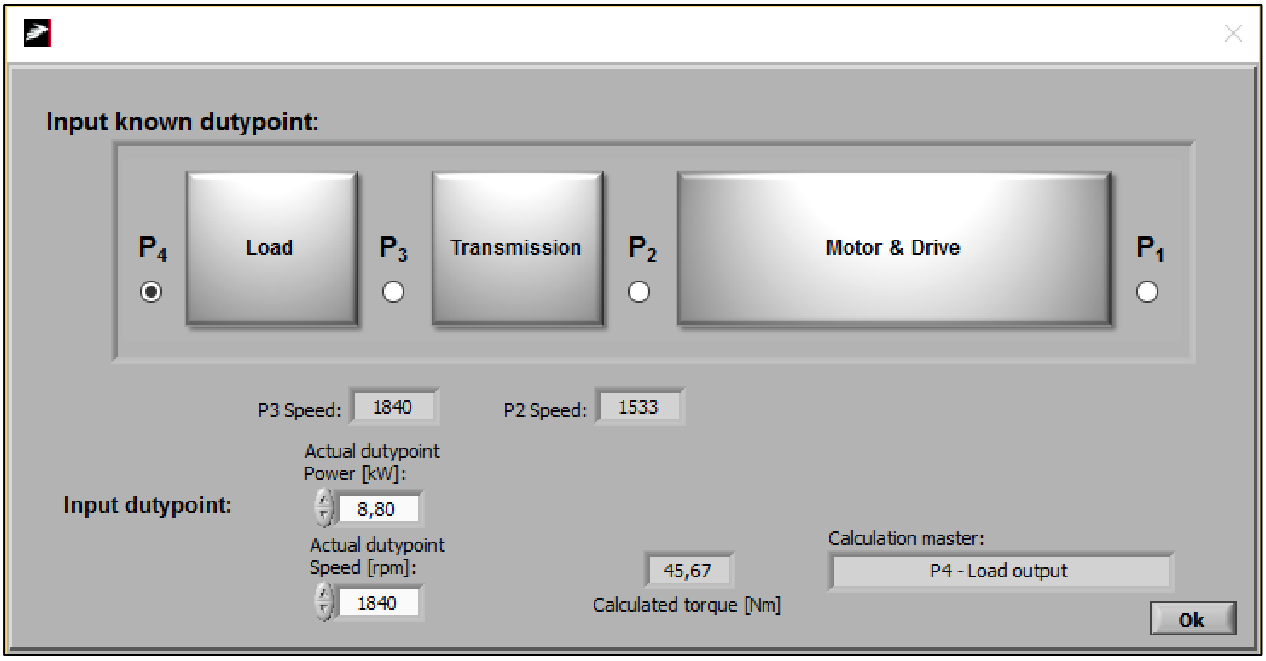
1.1.4 Speed Control

A frequency converter is sub-sequentially selected for speed control use:



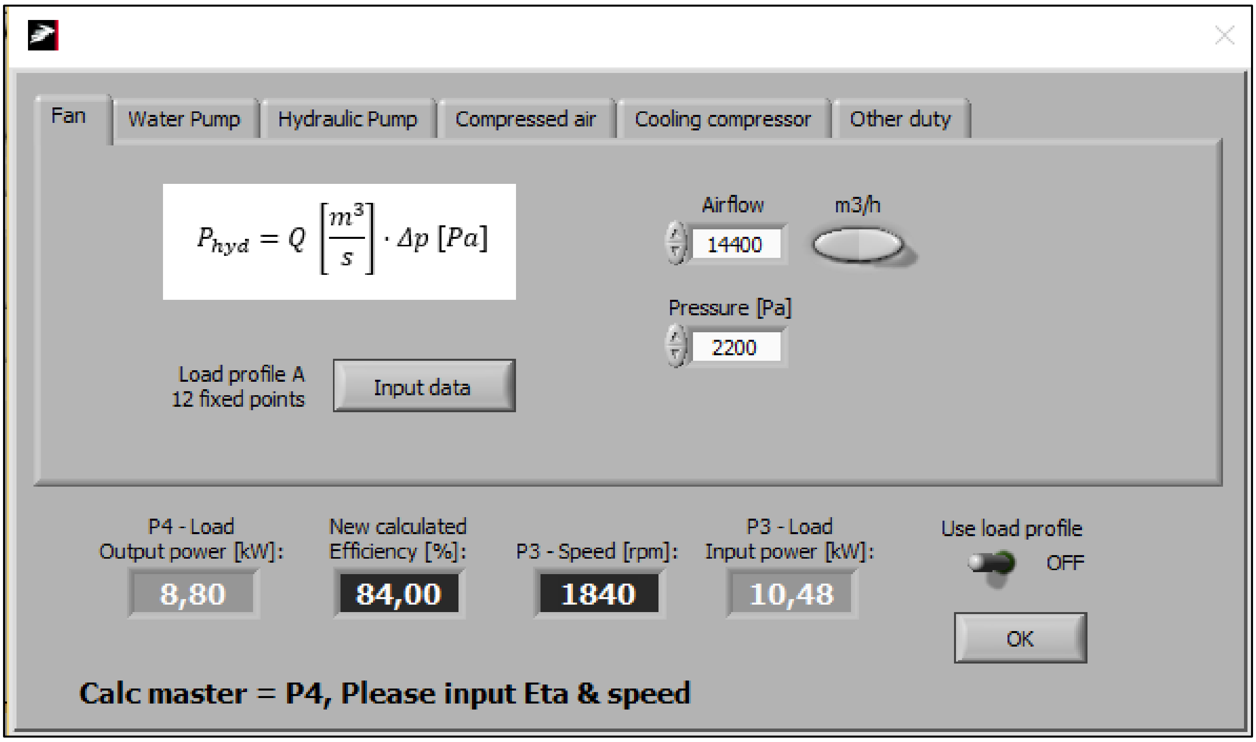
1.1.5 Known duty point calculation master

When the load, transmission and motor/drive all are selected, the program will ask for input of the one known duty point.
In the example above, we have information about P4 (8.8 kW):



1.1.6 Application input

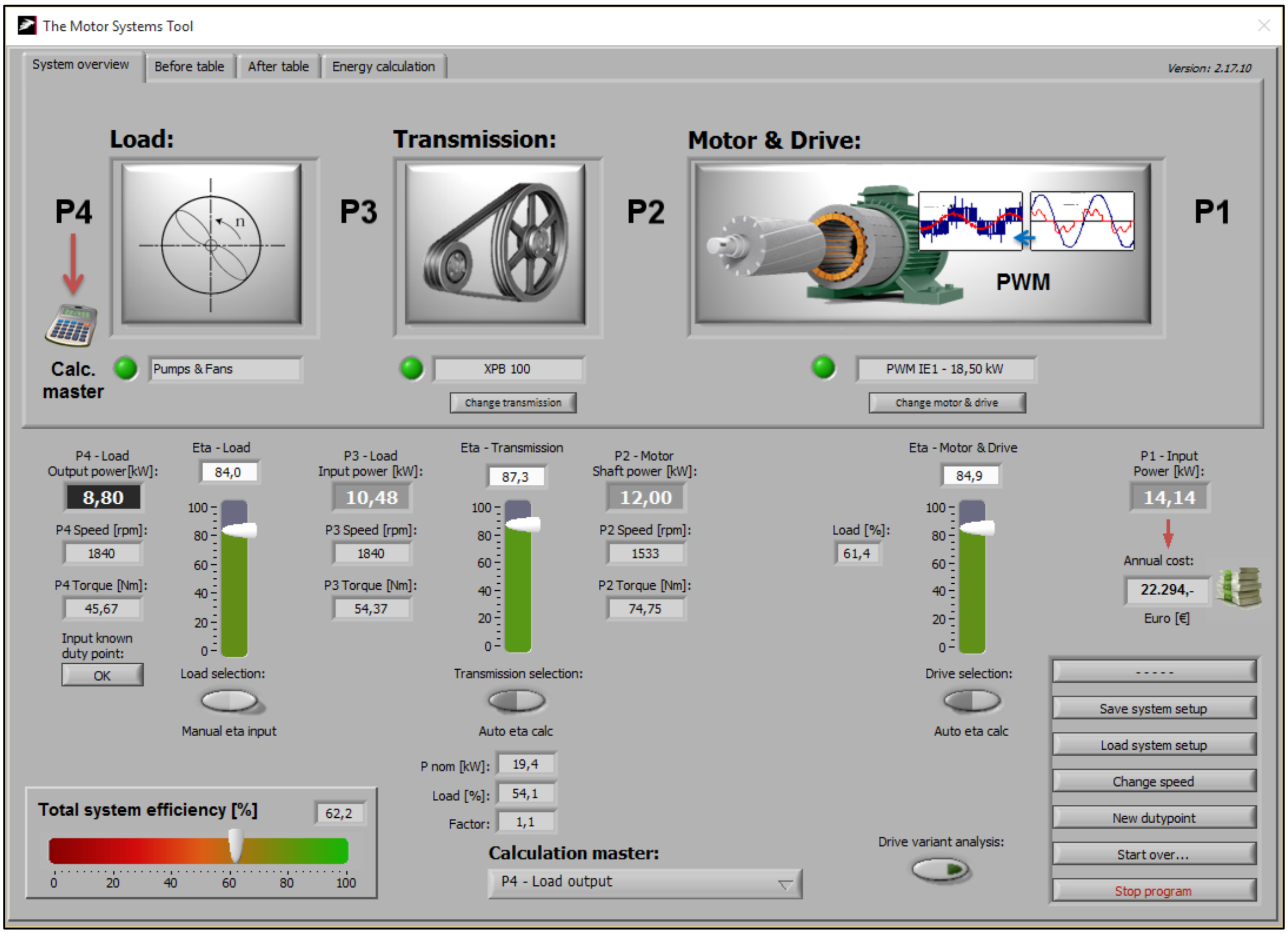
From the main page of the tool, a more detailed input of the application can be selected and put into the tool. In this case, we manually read the efficiency from the datasheet, but the MST-Tool provides numerous possibilities of putting in curves, load profiles & calculating in terms of the application driven by the motor system.



Application input of the MST-Tool – Fan input

1.2 Main page of the MST-Tool

Below is the main page of the MST-Tool. The efficiency of the fan at this duty point is known from the datasheet and entered manually at: 84%.



Main page of MST-Tool - before implementation of actions

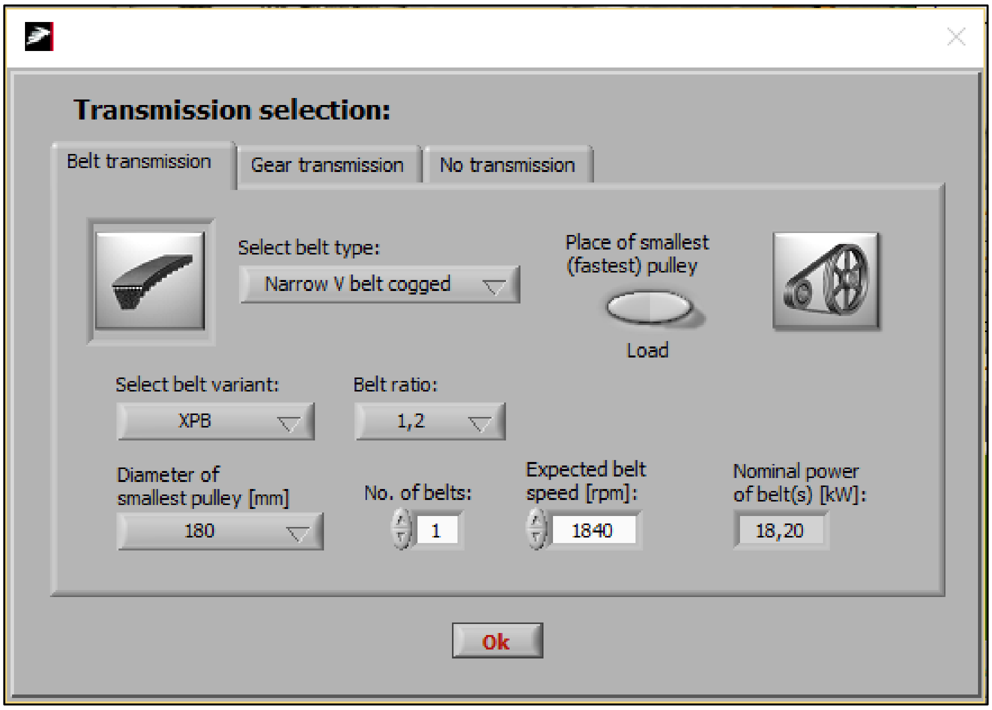
The total system efficiency is at this point calculated to 62.4%

From the main page, we see that the efficiency of the belt transmission is calculated to 87.3%, which is relatively low. This is due to the applied pulleys are small. As previously mentioned, the diameter of the small pulley is 100 mm, while the large is 120 mm. This results in a major loss (bending loss) of the belt transmission.

The efficiency of the drive (motor and inverter seen as one unit) is calculated to 84.9%, which again is relatively low. In this case, this can best be explained by the use of an IE1 motor and also that the load of the motor system is around 60%.

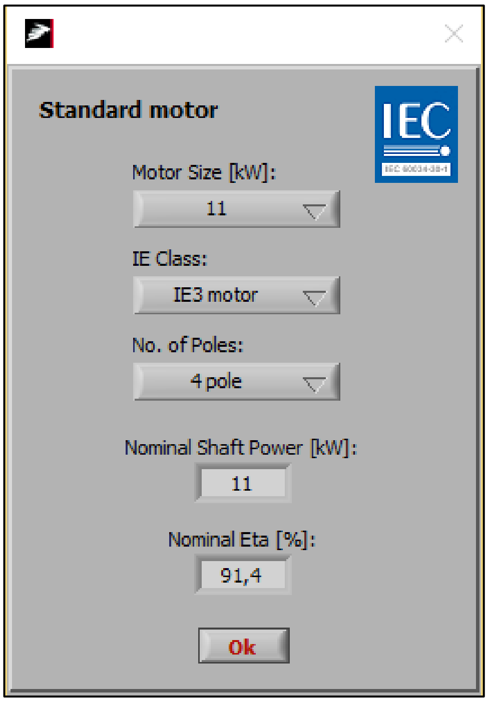
In order to improve the overall system efficiency two actions are carried out:

1. In one action pulleys are replaced. The new pulleys have larger diameters, 180 mm and 220 mm, and are “one-belt” pulleys. When using the splash screen for belt drives it can be seen, that the nominal power of one belt in a transmission with the smallest pulley of 180 mm is roughly the same as three belts with the smallest pulley of 100 mm.
   The new selection is chosen:



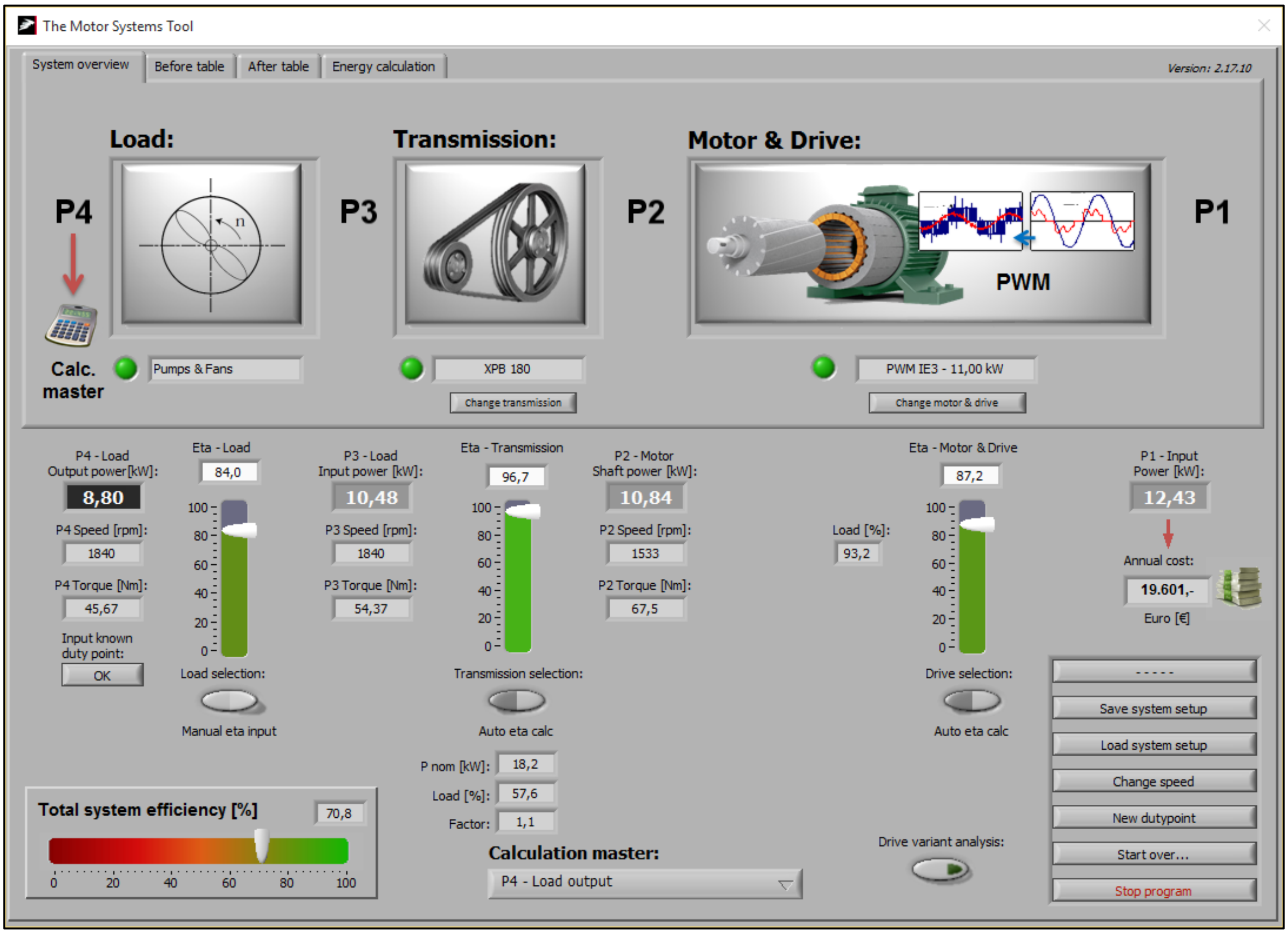
Selection of new transmission

2. In the second improvement, the 4-pole 18.5 kW IE1 motor is replaced with an 11 kW IE3 motor.



Selection of new IE3 motor

Main page after improvements:



Note that the same duty point P4 is maintained! (Calculation master)

The efficiency of the belt drive is now 96.7% (as opposed to 87.3% before). Best explained by the larger diameter of the pulleys. (One of MANY good advises on belt drive installations!)

The drive itself has improved from 84.9% to 87.2% in efficiency, but not only that, the actual power delivered by drive is now only 10.84 kW (used to be 12 kW) thanks to the better-chosen belt drive.

The total system efficiency has on these accounts improved from 62.2% to 70.8%, which corresponds to almost 10%

The total power consumption has dropped from 14.14 kW to now 12.43 kW, which is a reduction of approximately 12%.