

Annex 13. Single EEI value for all pumps in scope

The extended product approach presented in this review study differentiates between variable and constant flow demand of pumping systems. Therefore, an EEI threshold for constant flow systems and an EEI for variable flow systems was developed. The decisive factor is the pumping system in which the pump unit is installed. Market surveillance authorities (MSA) stated that checking on site if a pump system is variable or constant flow would be beyond their mandate given in the eco-design directive and would face several severe practical challenges. It is therefore questionable whether Policy Option 1 (PO1) described in this report is enforceable via the ecodesign directive. This resulted in the development of alternative options PO2 and PO3 presented in this report, that achieve only a share of the prospected savings from this report in PO1.

After finalizing this report, some rethinking of Policy Option 1 (PO1) took place, with a view of achieving a larger share of the PO1 prospected savings.

The outcome of this rethinking is to have a single EEI value for all pump units in scope, independent of whether they are put into service in a variable or in a constant flow system. The implication of this is that all pumps in scope would be required to be fitted with a VSD. The general perception is that adding a VSD to constant flow system would add losses without getting the benefits of the VSD. As shown in this annex, this is not necessarily the case.

Advantage of using VSD's on pumps also in constant flow systems

Hydraulic design of pumps is limited by physical, technical and to a lesser degree, market constraints. The duty point required by a customer in Head and Flow (Pressure and volume moved per second) is the starting point for an offer by a pump manufacturer to fulfill the needs of the customer.

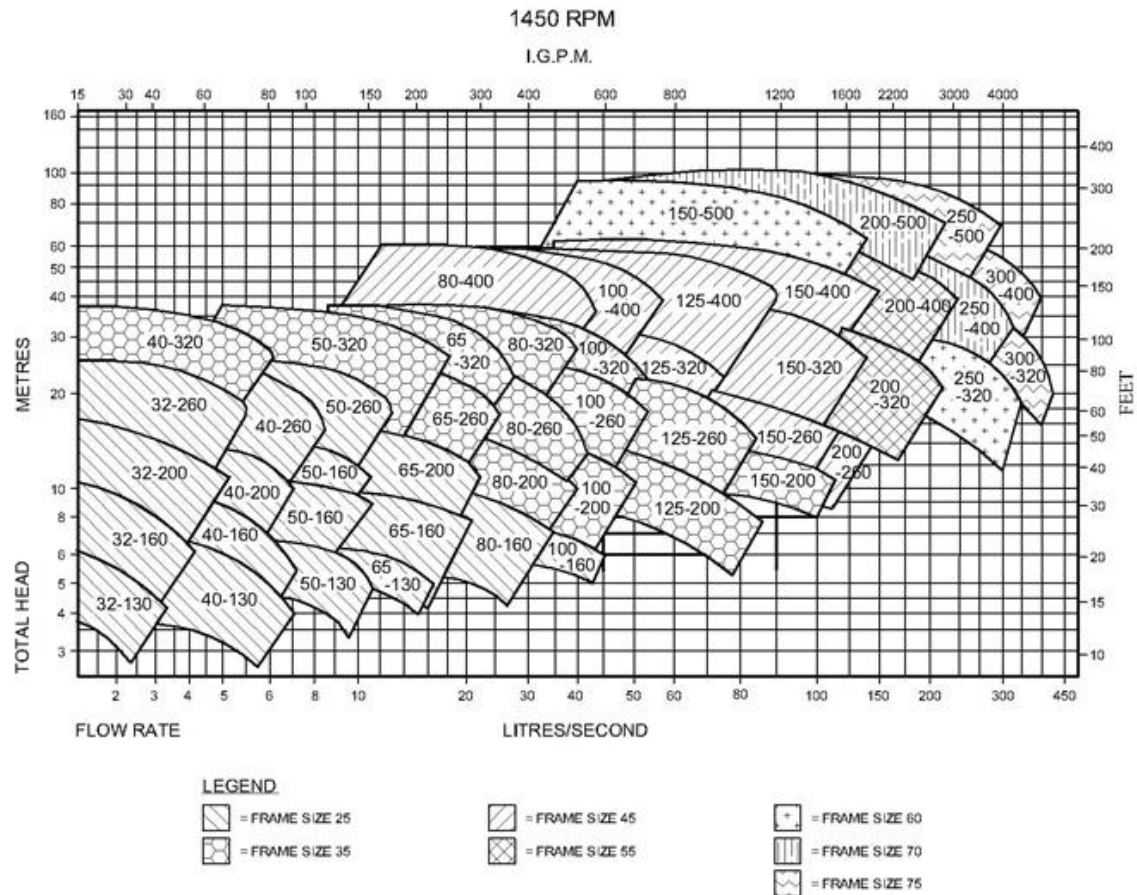
Primary limiting technical parameters that must be considered in hydraulic design of pumps are NPSH (Net positive suction head), noise, temperature, rotational speed of the motor, efficiency, reliability etc. In Chapter 3.2.2 is a list of functional parameters for pump design.

Electrical motors usually run with a certain defined speed (revolutions per minute) dependent on the design of the motor. With the given speed of the motor, the requested duty point needs to be achieved by the pump. Therefore, speed of the motor is a design parameter, which dictates specific hydraulic designs.

As a consequence, there is an infinite number of potential duty points that would require an infinite number of pumps exactly matching the duty point requested. This is not realistic.

To avoid this individual pump design requirement, which would result in a dramatic cost increase, every pump manufacturer offers pump families with a certain number of pumps each delivering a small range of duty points by trimming the impeller of the pump to the requested duty point.

Picture 1 shows a typical single stage pump family and the duty points offered per pump unit.

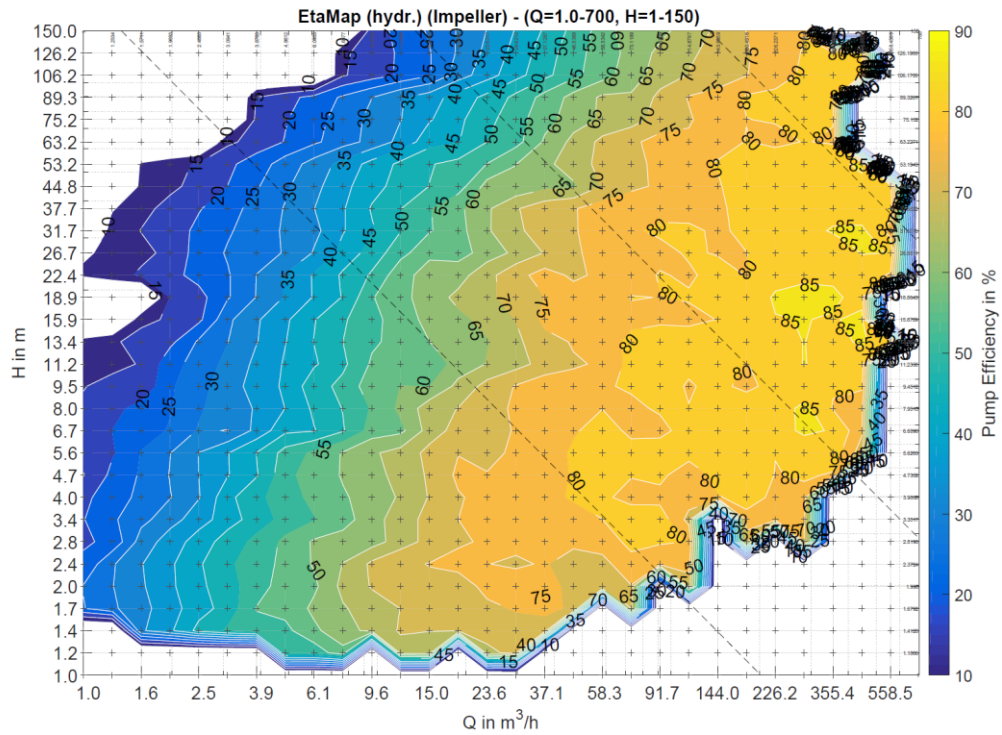


Picture 1: Typical Tombstone Diagram for Single Stage Pump Sizes and Duty Points for 1450 rpm

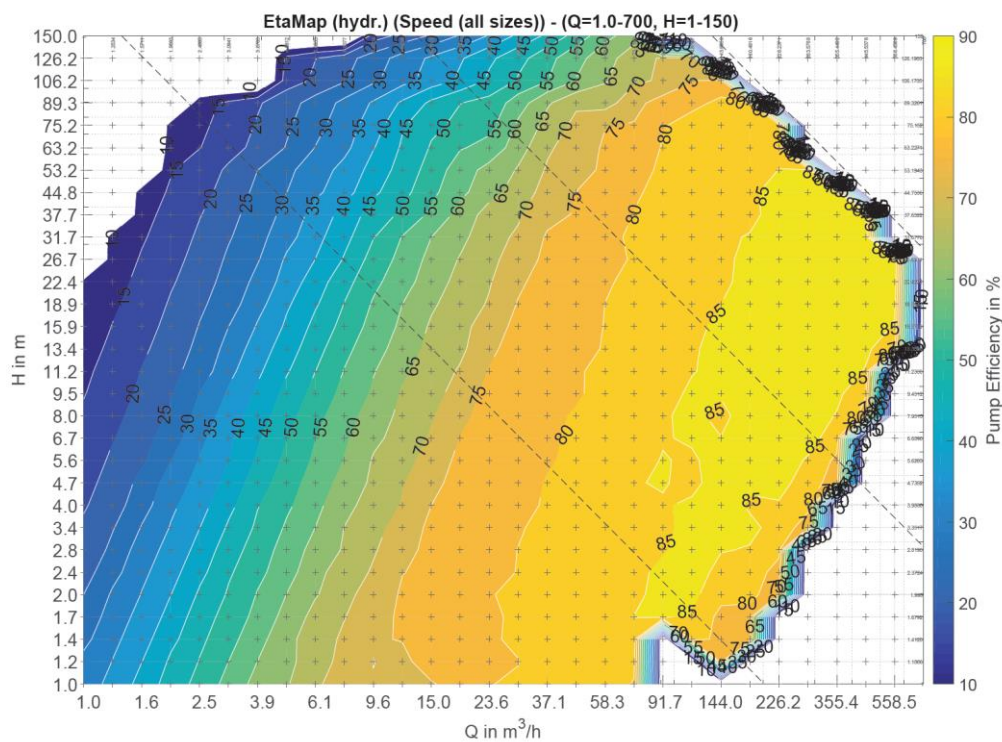
All pump designs shown in Picture 1 are based on the constraint that there is a defined nominal motor speed (4-pole with 1450rpm here, or 2-pole motors with 2900rpm etc.). If the constant nominal speed of the motor would not be a (limiting) design factor the number of trimmed impellers (and loss in efficiency) will be reduced dramatically. Instead of trimming the same duty point can be reached by reducing the speed.

In addition, if rotational speed is an open design parameter, this enables new optimized hydraulic pump designs.

Considering the above-mentioned limiting factors, pumps could even be designed for higher speeds than what is usual today. This can lead to pumps with higher efficiency and/or smaller raw material usage due to smaller needed sizes etc.



Picture 2: Best efficiency-selection of a pump hydraulic for a complete single stage pump family in Flow vs. Head region (provided by KSB)



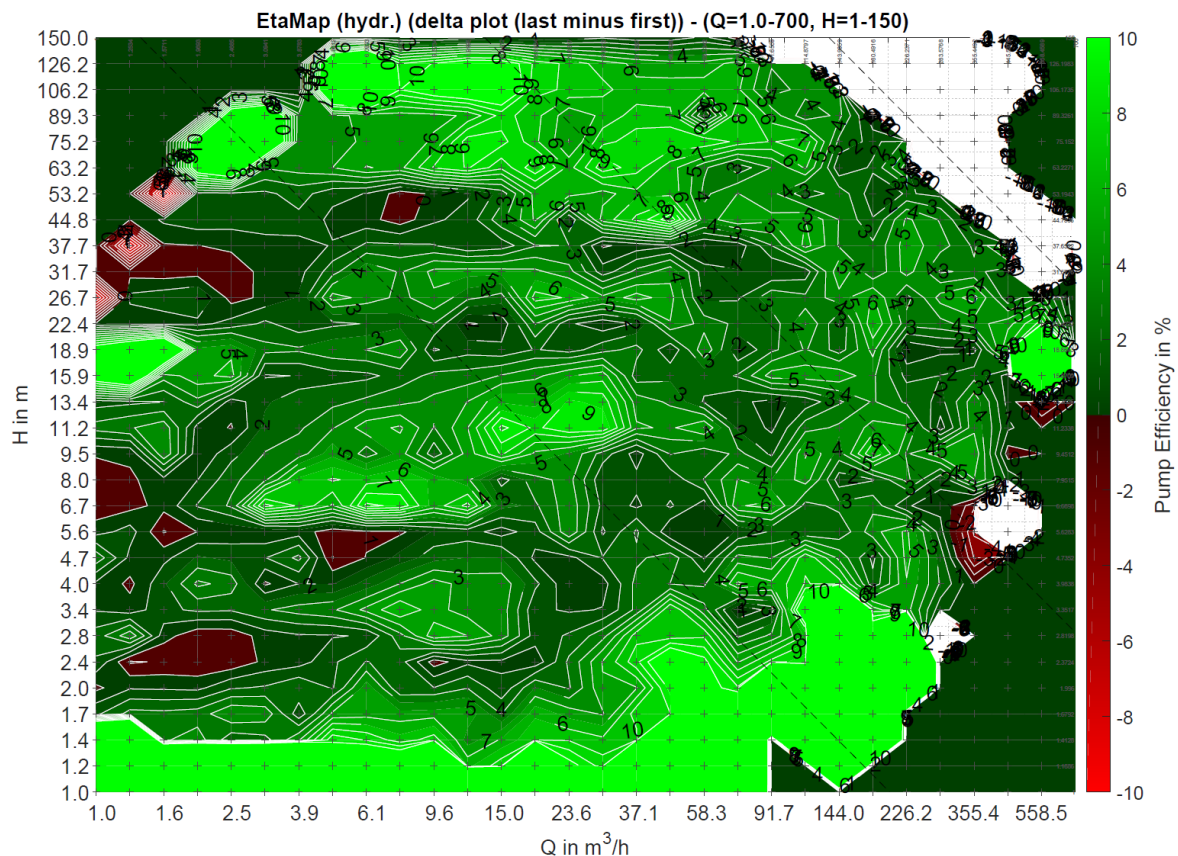
Picture 3: Best efficiency-selection of a pump hydraulic for a complete single stage pump family with speed control in Flow vs. Head region (provided by KSB)

The picture 2 and 3 show an existing ESOB single stage pump range and its corresponding efficiencies (blue = worst, yellow = best) delivered to the customer when ordered for a specific duty point. Picture 2 represents fixed speed pumps with trimming to the requested duty point. Picture 3 shows the best selection for pump hydraulics with full impeller diameter, but rotational speed adjusted to the Duty Point (Flow/Head).

Picture 4 shows the difference between Picture 2 and 3. Obviously, there are little red regions where a pump would not benefit from reduction of speed instead of trimming.

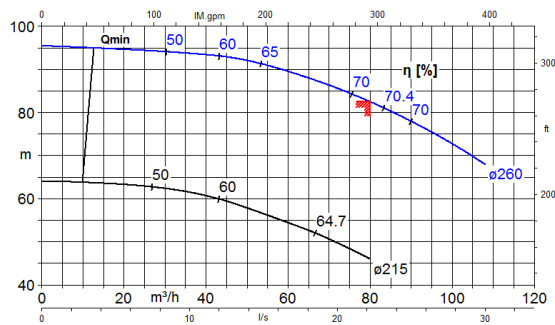
The majority of the achievable duty points show a positive benefit (green). Throughout the complete fleet consumption at constant speed, the gain in efficiency results in around 4%.

In average, this compensates the losses introduced by a frequency converter or other speed adjustments, which are required to change the rotational speed.

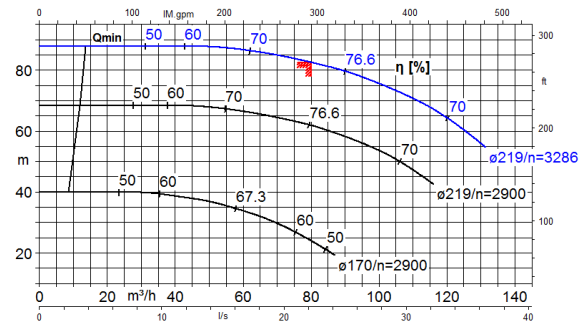


Picture 4: Efficiency difference between Picture 3 and Picture 2

Picture 5b shows an example for a pump, which is not hydraulically designed for the requested duty point (BEP is not exactly at requested duty point). By running the pump slightly faster than the normal pump speed by using a VSD it reaches the requested duty point with a higher efficiency (+5.3%points or 7,5%) than the next size of a fixed speed pump, which would normally be chosen for the identical duty point (picture 5a).



Picture 5a: duty point 82,5 m @ 80 m³/h
Pump size 50-250



Picture 5b: duty point 82,5 m @ 80 m³/h
Pump Size 50-200

Considering the above, it seems that, for certain pump types and sizes, it would be reasonable to impose a speed control on all pump-units. Some issues need further investigation e.g. through impact assessment, for instance:

- Scope of pump types suitable for an approach as described. Single Stage Pump units (ESOB, ESCC, ESCCi) are looking very promising (see above).
- Multistage Pump units, especially submersible borehole pumps are, due to their high number of stages, much more variable in pump design. An adjustable speed might not be beneficial for these pump types. This should be subject for further investigations ¹
- Other physical parameters such as NPSH (especially for over-speed pumps) needs further investigation. There are definitely physical and technical constraints in which such a regulation would make sense.
- Environmental impacts must be considered
- End-user life-cycle-cost needs to be investigated further during the Impact Assessment (e.g. single-phase drives for pump units, VSD filters in specific installations, pump unit size ...)

Energy efficiency requirement and enforcement

A single EEI value (instead of a constant and a variable flow EEI-value) chosen wisely for pump units in scope would indirectly imply a speed control to comply with to the requested EEI threshold. A similar legal approach is already in use for circulators under the Eco-Design-Directive since 2009.

Market surveillance authorities can check compliance of the product placed on the market or put into service by paper work based on the documented efficiency for the pump, motor and VSD by using the standards and the associated calculation program available from CEN.

Physical testing of the complete product (the Extended Product) can also be done. MSA's could do an inspection without the need to determine whether the installation is a variable or constant flow pumping system. In most cases it is obvious if the extended product, namely the pump unit, is equipped with a VSD or not.

¹ Cost-benefit analysis of VSD use in constant flow conditions, CeSMA, Naples, August 4th 2018, Prof. Ing. Armando Carravetta. <http://wpage.unina.it/arcarrav/>

Energy Savings

The majority of energy savings achievable from PO1 (80% of Savings/ 36,2 TWh per year – see table 31, Chapter 9) are realized with this option. An impact assessment analyzing the LLC for the end user still need to be performed.

A single EEI-value requires further investigation for the appropriate scope of the revision of EU No. 547/2012.

The relating standard series EN 17038 are from a technical point of view finished. An Annex ZA for harmonization needs to be done in a revision as soon as the legal text for the revision of EU No. 547/2012 is available.

The proposed modification to PO1 would remove the problem for MSAs when determining if the installation of a pump unit is correct within a certain pumping system. Market Surveillance inspection can be done through checking the product (Extended Product) itself.

This proposal will overcome the obstacles for market surveillance and will obtain the vast majority of possible energy savings from PO1.