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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Proposal for a Commission Regulation

implementing Directive 2009/125/EC with regard to Ecodesign requirements for water pumps

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Lead DG: ENER

Associated DG: ENTR

Other involved services: SG, LS, ENV, COMP, ECFIN, INFSO, MARKT, SANCO, TRADE, RTD

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SECTION 1: PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1 Organisation and timing

This implementing measure is one of the priorities of the Action Plan on Energy Efficiency[1], and is part of the 2008 Catalogue of actions to be adopted by the Commission for the year 2008.[2] This proposal is part of the European Commission commitment announced in the European Economic Recovery Plan to draw up measures for products, which offer very high potential for energy savings.

The proposed implementing measure is based on the Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the Commission to set Ecodesign requirements for energy-related products[3], in the following abbreviated as "Ecodesign Directive". An energy-related product, or a group of energy-related products, shall be covered by Ecodesign implementing measures, or by self-regulation (cf. criteria in Article 19), if the Ecodesign represents significant sales volumes, while having a significant environmental impact and significant improvement potential (Article 15). The structure and content of an Ecodesign implementing measure shall follow the provisions of the Ecodesign Directive (Annex VII).

Article 16 provides the legal basis for the Commission to adopt implementing measures on this product category.

Consultation of stakeholders is based on the Ecodesign Consultation Forum as foreseen in Article 18 of the Directive (see next section for details), including the consultation of stakeholders during a preparatory technical study[4] from March 2006 till February 2008 in order to assist the Commission in analysing the likely impacts of the planned measures.

Article 19 of the Directive 2009/125/EC, amended by Directive 2008/28/EC[5] foresees a regulatory procedure with scrutiny for the adoption of implementing measures. Subject to qualified majority support in the regulatory committee and after scrutiny of the European Parliament, the adoption of the measure by the Commission is planned by the end of 2009.

The Commission carried out the above mentioned preparatory study on pumps in preparation of the implementing measure. On 29 May 2008 a meeting of the Ecodesign Consultation Forum established under Article 18 of the Ecodesign Directive was held (details are provided below). Article 19 of the Ecodesign Directive foresees a regulatory procedure with scrutiny for the adoption of ecodesign implementing measures. If both the Article 19 Committee and

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1. COM(2006)545 final.
2. COM(2008)11 final.
3. OJ L 285 of 31.10.2009, p. 10.
4. Technical/economic ecodesign study on electric motors, water pumps (in commercial buildings, drinking water pumping, food industry, and agriculture), pumps in buildings and on fans for ventilation in non residential buildings was conducted on 6 March 2006 – 6 February 2008 by an external consultant AEA Technology plc (UK) in partnership with ISR University of Coimbra (Italy) and Fraunhofer Institute for Systems and Innovation Research (Germany): http://www.ecomotors.org/.
5. Directive 2008/28/EC of the European Parliament and of the Council of 11 March 2008 amending Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products, as well as Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC, as regards the implementing powers conferred on the Commission, OJ L 81, 20.3.2008, p. 48

the European Parliament give a favourable opinion on the draft implementing measure and impact assessment, the adoption of the measure by the Commission is planned in 2009.

1.2 Impact Assessment Board

The Impact Assessment Board (Opinion 10.07.2009) gave its favourable opinion with comments and questions, which were answered and taken into account in the final IA report, in particular in further clarifying the scope of the measure and the link between the relevant existing EU legal measures and the foreseen pump Regulation. The implications of Article 15 of the Ecodesign Directive were explained in relation to the proposed regulation on water pumps and the objectives on promoting competitiveness and free movement were further clarified. The choice of lower-than-LLCC level for minimum efficiency requirements and the question on marginal improvement costs in relation to cut-off values was explained, including the explanation on objectives of the proposed information request (the 'non-labelling') of water pumps and on the discount rate used. The Board also sent technical questions (25.06.2009) to DG TREN and requested in its Opinion that the repliers provided by TREN be taken into account in the updated IA report. The IAB comments are fully taken into account in this report.

1.3 Transparency of the consultation process

External expertise was gathered in particular in the framework of a study providing a technical, environmental and economic analysis (in the following called "preparatory study") carried out by external consultants[6] on behalf of the Commission's Directorate General for Energy and Transport (DG TREN). The preparatory study followed the structure of the "MEEuP" ecodesign methodology[7] developed for the Commission's Directorate General for Enterprise and Industry (DG ENTR). MEEuP has been endorsed by stakeholders and is used by all ecodesign preparatory studies.

The water pump preparatory study has been developed in an open process, taking into account input from relevant stakeholders including manufacturers and their associations, environmental NGOs, consumer organizations, EU Member State experts, experts from third countries and international organizations as e.g. the International Energy Agency (IEA). The preparatory study provided a dedicated website[8] where interim results and further relevant materials were published regularly for timely stakeholder consultation and input. The study website was promoted on the Ecodesign-specific websites of DG TREN and DG ENTR.

Three open stakeholder meetings were organised on 29.06.2006, 21.11.2006, and 24.10.2007 in which the progress of the study was discussed in detail. The pump study was also discussed within the European umbrella organisation Europump in its Joint Working Group, which gathers the pump and pump industry around one table (cooperation of Europumps Technical and Standards Commissions). The Working Group provided industry input on technical and economic issues.

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[6] EuP preparatory studies "Lot 11: Motors, by A. de Almeida, final report of 28 Feb. 2008; documentation available on the ecodesign website of the Commission's Directorate General Energy and Transport http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm.

[7] "Methodology for the Ecodesign of Energy Using Products", Methodology Report, final of 28 November 2005, VHK, available on DG TREN and DG ENTR ecodesign websites: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm and http://ec.europa.eu/enterprise/eco_design/index_en.htm.

[8] http://www.ecomotors.org/.

On 29 May 2008 a meeting of the Ecodesign Consultation Forum (established under Article 18 of the Ecodesign Directive) was held (details are provided below). The Commission services presented a working document suggesting ecodesign requirements related to pumps. One month before the meeting the working document was sent to the members of the Consultation Forum and to the secretariat of the European Parliament for information of ENVI and ITRE committees. The working document was published on the TREN Ecodesign website, and it was included in the Commission's CIRCA system alongside the stakeholder comments received in writing before and after the meeting.

1.4 Preliminary results of stakeholder consultation

The main input from the stakeholder consultation was a wide variety of comments from all relevant stakeholders in Europe and beyond during the technical/economic study and the Consultation Forum meeting. It also provided additional detailed technical and market data.

The general approach to set mandatory minimum requirements in the framework of Ecodesign is largely supported by industry associations but the level of requirements and the timing were questioned. While industry preferred lower minimum energy efficiency levels with slower introduction, environmental NGOs and some Member States requested higher levels and faster implementation than proposed.

As to the efficiency calculation, the industry proposed not to concentrate just on the point of best efficiency of the pump but also on part load and overload conditions. With the proposed 'House of Efficiency' approach, the level of efficiency of a pump is defined by measuring it on three points (part load, best efficiency point and overload). This ensures more reliable and meaningful efficiency information than the definition of the best efficiency point only. The approach was approved by stakeholders and considered easy to implement for market surveillance authorities. The 'frozen image' in which the data was presented was criticized. A harmonised test standard would be necessary to complement the calculation method. The Commission would launch a mandate for these purposes.

As to the cost of the measure for industry Europump suggested an average cost to redevelop a pump model type up to be about € 200,000, which was queried by environmental NGO's and some Member States, as not every pump model will have to be redesigned from scratch and production and design are done in entire pump families. Europump agreed that investment differs but that this had been included in the estimate.

Environmental NGOs and some Member States queried whether it would be possible to limit the scope so that higher cut-off rates would be possible for some pump types but this was objected by the industry, as some manufactures could be looking for a way out through the excluded pump definitions to avoid the requirements. This would also reduce the total savings.

Environmental NGOs and some Member States would like to see information requests on pump efficiency related to the benchmark and on electronic controls, including possible inclusion of requirements on variable speed drives. The benchmark of C=80% was considered tough but acceptable.

SECTION 2: PROBLEM DEFINITION

Pumps are used for a variety of purposes, such as for irrigation, water supply, gasoline supply, refrigerant supply in air conditioning and refrigeration systems, to move chemicals or waste water (sewage), for flood control, marine services, etc. Because of the wide variety of applications, pumps have a plethora of shapes and sizes resulting in thousands of pump types from very large to very small, from handling gas to handling liquid, from high pressure to low pressure, and from high volume to low volume.

This impact assessment focuses on glanded water pumps on the basis of the ecodesign preparatory study on pumps. Glandless pumps (circulators) are currently being regulated within another Ecodesign process. This water pumps considered include single stage end suction, vertical multistage and submersible multistage pumps, as defined in the Ecodesign preparatory study on Lot 11.

Water pumps covered are run by motors and drives covered by the draft motor Regulation, except multistage submersible pumps. Integrated pump/motor/drive products must meet both sets of requirements, those on motors and on pumps. Transmission is not considered as pumps are normally directly attached to the motor and not like fans where belts and chains may be used. That is, energy consumption of water pumps is calculated as hydraulic energy and not electrical, as the electrical energy consumption depends on the actual motor installed on the water pump and covered by the motor measure.

In the impact assessment following parameters are used:

- Discount rate: Is a correction factor which reflects the fact that costs and benefits arises at different times. The discount rate takes this into account and by implementing makes it possible to directly compare costs and benefits.

- Natural price development regardless of discount rate: The impact assessment calculation model cover a range of natural price development, such as maintenance, energy prises and product price per change in efficiency.

The underlying problem can be summarized as follows: although energy efficient products and technical solutions exist on the market leading to lower power consumption of water integrated pumps without negatively affecting their functionality or cost, the market penetration of such pumps equipment remains limited.

As requested by Article 15 of the Ecodesign Directive, the preparatory study identified the environmental aspects in relation to pumps:

(1) they have a significant environmental impact within the Community;

(2) they present significant potential for improvement without entailing excessive costs;

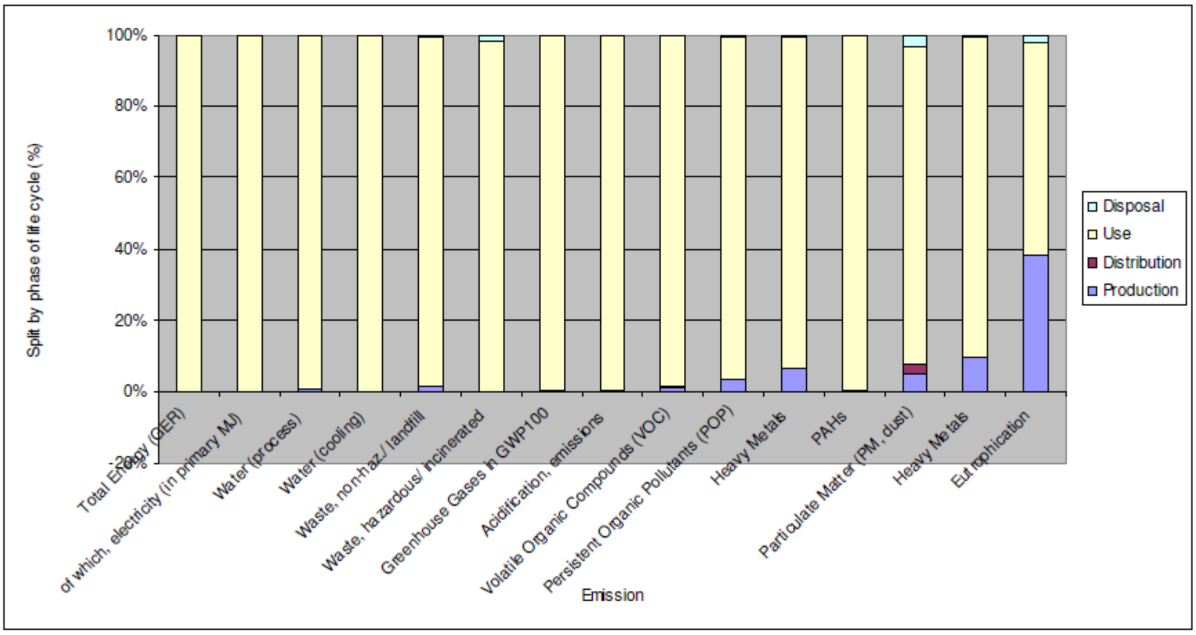
(3) they are not addressed properly by market forces (market failure);

(4) they are not sufficiently addressed by other relevant Community legislation (see part on existing legislation).

2.1 Environmental impact

According to the technical/economic study on water pumps[9], the dominating environmental impact of pumps is energy consumption in use, as show in figure 1. As other impacts, only minor aspects are related to hazardous substances and waste. Those aspects are already addressed by related Community legislation (see below). The below Figures show the typical picture of environmental impacts of pumps covered.

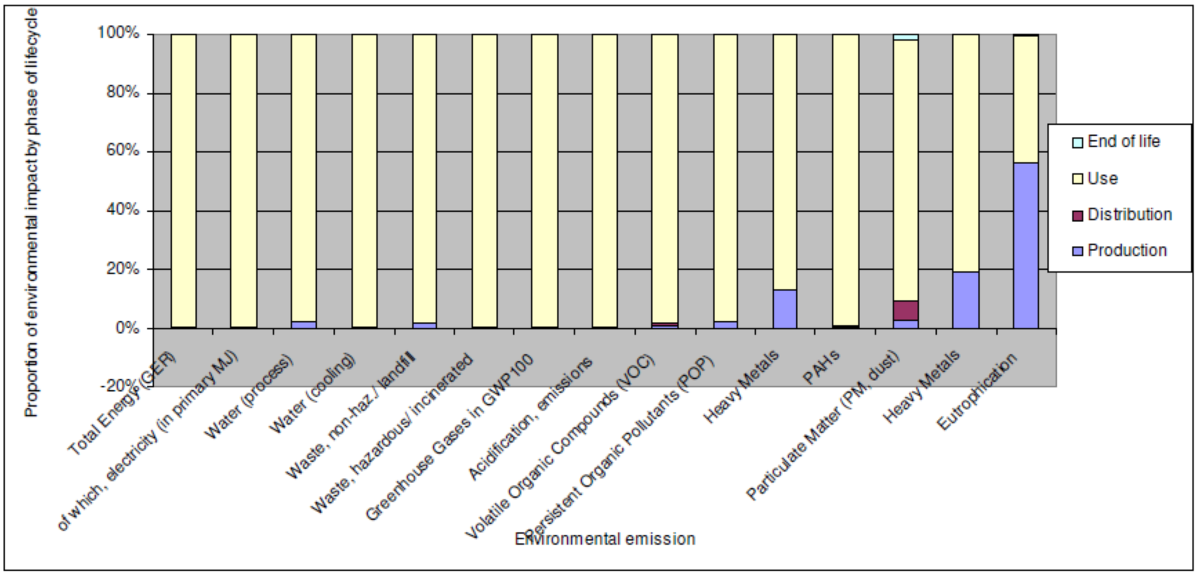
Figure 2.1.a: Environmental impact over the lifecycle - ESOB pump (small).



These particular base case pumps were selected as they were estimated to have the lowest ratio of emissions between the Use and other phases.

Figure 2.1.b: Environmental impact over the lifecycle - MSS pumps (small)

9 Technical/economic ecodesign study on electric motors, water pumps (in commercial buildings, drinking water pumping, food industry, and agriculture), pumps in buildings and on fans for ventilation in non residential buildings was conducted on 6 March 2006 – 6 February 2008 by an external consultant AEA Technology plc (UK) in partnership with ISR University of Coimbra (Italy) and Fraunhofer Institute for Systems and Innovation Research (Germany): http://www.ecomotors.org/.



2.2 Improvement potential

The following table 2.2 illustrates the savings potential of water pumps depending on the sub-option chosen (for details, see Annex V).

Table 2.2 Projected energy consumption and saving potential for water pumps.

	No-policy TWh	Policy TWh	Improvement potential TWh
2010	117.7	117.7	0
2020	136.2	131,6-133,7	2.5-4,6

In the preparatory study, the marginal cost was considered linear while calculating LLCC. That is, the marginal cost was the same e.g. at 20% and at 60% cut off rate. Additionally, the preparatory study assumes, agreed by stakeholders, that re-development cost for a low efficiency pump is the same whether it is developed only just up to comply with the 40% minimum requirement or directly up to 70% cut off level efficiency[10]. As to the efficiency variations between water pump of different technologies, the preparatory study confirms that identical cut-off levels are appropriate for all pump types considered.

2.3 Market failures

The main market barriers hampering a larger market penetration of energy efficient pumps were identified in the preparatory study and are as follows:

1. *Negative externality*

[10] As there is no guarantee of the manufacturer action, and to avoid overestimating savings, this impact has not been taken into account in the savings calculations. If it had, the calculations would have lead to about 1 TW additional savings by 2020 within the range of the sub-options considered.

Negative externality related to energy use: not all environmental costs are included in electricity prices. That is why end user (and producer) choices are made on the basis of lower electricity price not reflecting environmental costs for the society.

2. *Split incentives*

In the industry and tertiary sector, budget manager responsible for the purchase cost will not be inclined to have an interest in savings shown in budgets for running cost.

3. *Asymmetric information*

The purchase price is well visible and is typically modestly higher for energy efficient pumps. On the other hand, information on running costs/cost savings is not explicit and can be obtained only with difficulties**.** The pump market is almost entirely a market between manufacturers and installers. Installers tend to base their purchases on purchase cost instead on life cycle cost, since they will not pay the pump operating costs. As a result, manufacturers or installers have no incentive to reduce the energy consumption of pumps, even though this could be done at a low additional cost to the manufacturer and would bring significant savings to the end user and reduced CO_2 emissions.

There have been energy efficient pumps on the market for a long time, but their market share has so far been low. Due to the quality and type of the data the exact market share of high efficient pumps can only be estimated; there are discrepancies between data from Eurostat and from the industry (Europump)[11].

The below tables show examples of the impact of market failures to demonstrate the life-cycle cost of water pumps at C=30%, C=40%, C=50% and C=70% levels respectively.

Table 2.3: Life-cycle cost to consumer of an average water pump (base case, no inflation correction). The period is the water pumps life time from the base case year 2005.

	Purchase price incl. installation (EUR)	**Life-time running cost (EUR) ***	**Total life-time cost (EUR)**	**Savings over life-time (EUR)**
Average pump (2005) basecase	1431	7129	8560	-
Cut off 30 %	1434	6974	8408	152
Cut off 40 %	1435	6952	8387	173
Cut off 50 %	1437	6941	8378	182
Cut off 70 %	1477	6842	8319	241

** Including energy and maintenance.*

A high-efficient water pump is cheaper for the consumer over the life-cycle than an average water pump.

4. *Possible distortion of the internal market*

11 Additionally, the preparatory study assumes that the distribution of actual pumps per efficiency class is equal across all C=X% deciles

Alongside these market failures, there is a risk that in absence of an EU approach, Member states will introduce national measures to increase the efficiency of appliances in a given Member State, which might lead to hampering of the internal market.

2.4 Existing legislation and other relevant initiatives

There is no specific EU legislation or voluntary agreements on water pumps. Energy consumption of pumps is expected to remain high without the proposed policy.

Some initiatives have been launched in Member States to raise awareness for pump electricity consumption. For example, in Denmark the Danish Electricity saving Trust has in 2007 and 2008 carried out an information homepage for energy efficient pumps (both glanded and glandless), with a list of specific pumps and pumps with energy labels. While there is information on the results of the campaign on (glandless) pumps, no information is available on the development of sales of water (glanded) pumps in the scope of this measure.

The Energy Performance of Buildings Directive (EPBD) 2002/91/EC sets requirements on the regular inspection of boilers (Art. 8) and air-conditioning systems (Art. 9) in buildings. Water pumps are not in the scope of the EPBD, nor impacted indirectly. Water pumps have not been identified as a particular area within the EU CO2 or RES targets and no information has been received during the impact assessment that would indicate any particular impact on investment decisions or on increased concern of the energy demand by water pumps driven by electric motors.

2.5 Baseline scenario for electricity consumption of pumps

In order to carry out a technical, environmental and economic analysis the preparatory study provided a classification of pumps and their usage patterns with a detailed analysis of representative base case models of each category. In particular the study has, amongst others, provided the following key elements:

– definitions to differentiate between the pumps included in this implementing measure and those excluded from its scope;

– the installed base ("stock"), annual sales, and the typical lifetime. Since EUROSTAT does not provide separate statistics for this particular product group, the figures have been established based on data mainly from the industry;

– electricity consumption of pumps and usage patterns of these devices. The usage patterns are a key element for determining the gross electricity consumption of pumps. An assumption, with the agreement of all stakeholders, regarding the operating conditions of pumps was made to be 1000 – 4000 hours/a, depending on the type of the pump;

– technologies and efficiency levels yielding reduced electricity consumption and the additional costs for applying them compared to the current 'market average';

– potential trade-offs between electricity consumption and material related environmental impacts. (No trade offs were identified);

On the basis of the above mentioned elements and without taking further policy measures, the energy consumption of pumps will be 136.2 TWh in 2020.

2.5.1 Energy consumption of pumps in 2005

The preparatory study comes to the conclusion that the large penetration rate of pumps leads to very important overall electricity consumption.

For the year 2005 the preparatory study estimates the installed base of pumps to be 15.8 million and that the hydraulic energy consumption of the stock corresponds to 109.1 TWh in EU-25[12] and the electrical energy corresponding 126.6 TWh, based on an average motor efficiency of 86 %, which costs of 10.4 bln. EUR[13], and prompt 50 Mt of CO_2 emissions.

12 EU-27 figure is not available.

13 Average weighted electricity price for water pumps in the EU 2005: 0.082 €/kWh

Table 2.5: Energy consumption, expenditure and CO_2 emissions in 2005, 2010, 2020 and 2025 (BaU) of water pumps

	2005	2010	2020	2025
Energy [TWh]	109.1	117.7	136.2	146.4
Expenditure [Bln. EUR]	12.5	14.4	19.4	22.5
CO_2 emission [Mt CO_2]	50.0	53.9	62.4	67.1

2.5.2 Energy consumption of pumps in 2020

Building on the technical, environmental and economic analysis, the baseline scenario for estimating the future evolution of the electricity consumption related to pumps on 2020 has on one hand been developed under the following conditions:

– The market trend as developed in the preparatory study leads to a slight increasing penetration rate of pumps, and, assuming typical life/usage times, the installed base of equipment will increase to approx. 19.7 million units in 2020.

On the other hand:

– It is assumed that the aggregated pump electricity consumption of households and tertiary sector will not be reduced by any sporadic initiatives at Member State or European level.

Under these assumptions, it is expected that electricity consumption of pumps will rise to approx. 136.2 TWh in 2020.

2.6 Benchmarks and level of ambition

The preparatory study has shown that, depending on the functionality provided, existing cost effective technical solutions allow for pump electricity consumption levels lower than the current market average.

Benchmarks achievable by best available technology

The preparatory study and additional input from stakeholders in the Consultation Forum has shown that the highest achievable efficiency ("benchmark") with technology currently available on the market for pumps corresponds to 80% cut-off level.

Level of ambition

According to the Ecodesign Directive requirements on energy consumption in use should aim at the life-cycle cost minimum for the end-user. The preparatory study concludes that pump efficiency at 70% cut-off level can be achieved by all pumps with technologies, which reduce the life-cycle cost for the end-user. However, as this level would induce important cost for the industry the preparatory study proposes lower cut-off level as the target for minimum requirements. The impact assessment shows, taking into account the quality of the data and information on investment cost, that this is the case. However, still with lower level of ambition, sufficient time must be given for industry to adapt for the requirements.

- The technologies for achieving these efficiency levels are available, but the majority of products on the market do not meet them. In order to take into account the effects on manufacturers, the appropriate levels for ecodesign requirements will be argued in Section 5.

2.7 House of Efficiency scheme

In most real life applications, pumps will spend much of their time working some way from their design point, and so it is important to take account of this when classifying pump performance. The new "house of efficiency" scheme addresses this issue by setting efficiency criteria for not only 100% flow, but also sets slightly lower efficiency thresholds at 75% and 110% of rated flow that a pump must also exceed. This will avoid pumps passing the simple (rated flow) efficiency threshold, but actually performing very poorly when operated away from this point.

The methodology for setting the efficiency levels for different types of pumps has been devised based on a 3-D plane as explained in Annex IV. Although the derivation of this is technically complex, it is easy for manufacturers to use. The method has been developed in conjunction with the preparatory study, and approved by stakeholders, allowing the comparison of pumps on a scientifically rigorous basis.

2.8 Legal basis for EU action

The Ecodesign Directive[14] and, more specifically, its Article 16 provides the legal basis for the Commission to adopt an implementing measure addressing the environmental impact of pumps.

[14] Ecodesign Framework Directive 2009/125/EC

SECTION 3: OBJECTIVES

As laid out in Section 2, the preparatory study has confirmed that a large cost effective potential for reducing the electricity consumption of pumps exists but the potential is not tapped. The objective is to consider alternative policy options, and sub-options, if relevant, in order to correct the market failure, and which:

I) reduce energy consumption and related CO2 and pollutant emissions following Community environmental priorities, such as those set out in Decision 1600/2002/EC or in the Commissions European Climate Change Programme (ECCP) and;

II) promote energy efficiency and contribute to the security of supply in the framework of the Community objective of saving 20% of the EU's energy consumption by 2020.

While aiming at these objectives, the Ecodesign Directive, Article 15 (5), requires that Ecodesign implementing measures also meet the following criteria:

a) there shall be no significant negative impacts on the functionality of the product, from the perspective of the user;

b) health, safety and the environment shall not be adversely affected;

c) there shall be no significant negative impact on consumers in particular as regards affordability and life cycle cost of the product;

d) there shall be no significant negative impacts on industry's competitiveness, in particular as the level of ambition is set such that it allows the production of standard efficiency pumps, including a 'tool' to promote high-efficient pumps;

e) in principle, the setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers;

f) no excessive administrative burden shall be imposed on manufacturers.

SECTION 4: POLICY OPTIONS

This section considers four policy options.

4.1 Option 1: No EU action

This option is discarded for the following reasons:

– The market penetration of energy efficient pumps will remain limited despite the existence and cost-effectiveness of such products on the market;

– If no harmonized action is taken it could be expected that Member States would want to take individual, non-harmonized action on pumps (not yet expressed by Member States regarding glanded pumps). This would hamper the functioning of the internal market and add administrative burdens for manufacturers and costs for consumers, in contradiction to the goals of the Ecodesign Directive;

– There is a risk of competitive disadvantages for manufacturers designing their products to meet high-efficiency standards vis-à-vis competitors manufacturing cheaper low-efficient pumps is existent although low due to the small price difference between the low- and the high-efficiency pumps; installers have little interest in the electricity bill of the end-user.

– The specific mandate of the Legislator (Article 15.1) would not be respected despite the fact that all criteria of Article 15.2 setting the rationale for an implementing measure are met.

4.2 Option 2: Self-regulation

This option is discarded for the following reasons:

– No initiative for self-regulation has been brought forward by the manufacturers of pumps despite of several discussions within the Ecodesign preparatory study on Lot 11; industry prefers mandatory requirements due to their positive impact on level playing field;

– The specific mandate of the Legislator (Article 15.1) would not be respected despite the fact that all criteria of Article 15.2 setting the rationale for an implementing measure are met.

4.3 Option 3: Energy labelling of pumps

Energy labelling under the European energy labelling directive 2010/30/EU is discarded for the following reasons:

Pumps in the scope of this impact assessment are not household appliances, and are therefore not covered by the labelling requirements set under the Energy Labelling Framework Directive 2010/30/EU[15]. Furthermore, the actual operating point of a water pump is rarely at the specified "Best Efficiency Point" quoted in datasheets. Instead it will usually be at a reduced flow point, where the pump will have a reduced efficiency (compared to its BEP). The correct sizing of a pump is therefore critical for minimising energy costs. The use of a label to denote an "efficient" pump could lead the less educated specifier to select such an

[15] OJ L 153 of 18.6.2010, p. 1.

"efficient" pump in preference to a correctly sized pump. In many cases this "efficient" pump would actually use more energy than the correctly sized pump that had a lower headline efficiency indicated in a label. Labelling of pumps based on lower than BEP efficiency, does not make sense either, as the end-user should not be encouraged to use pumps beyond the BEP, when possible. Labelling for pumps is therefore potentially misleading and might encourage the selection of inappropriate pumps.

Also, after the implementation of the minimum efficiency requirements it would be difficult to distinguish seven energy efficiency classes above the proposed cut-off levels (only three realistic levels left).

4.4 Option 4: Ecodesign implementing measure on pumps

This option aims at improving the environmental impact of pumps, i.e., setting maximum levels for their power consumption. This sub-section contains details of the rationale for the elements of the corresponding regulation, as listed in Annex VII of the ecodesign framework directive.

The preparatory study and stakeholder comments lead to following 4 sub-options[16]:

1. Cut-off level[17] 10% by 2013 and 30% by 2014;
2. Cut-off level 10% by 2013 and 40% by 2014;
3. Cut-off level 20% by 2013 and 50% by 2014;
4. Cut-off level 40% by 2013 and 70% by 2015.

In the fourth sub-option, due to very demanding level of requirements, one more year is given for manufacturers to adapt for the proposed requirements compared with the other sub-options.

4.4.1 Definition of the types of energy-related products covered

The devises covered by the ecodesign measure on water pumps are in line with the scope of the preparatory study and the Commission Staff Working Document.

Pumps have the primary function of ensuring the pumping of clean water mainly in commercial, agricultural and food industry systems. Three specific type of pumps, divided in 10 different categories, are covered by this impact assessment; two types of centrifugal glanded pumps called *single stage end suction pumps* and *vertical multistage pumps* and one type of centrifugal glandless pumps called *submersible multistage pumps*.

4.4.2 Implementation of ecodesign requirements

According to the 2009/125/EC, the target levels for measures should be set at least life cycle cost (LLCC), which presumes that at some point the price of the product increases so much with extra design options to save energy that the life cycle costs (purchase price plus running costs) will start to rise again. The preparatory study has shown that the proposed level is cost-effective for the end user and can be achieved with current or expected state-of-the-art

16 Annex 3

17 'Cut-off level' refers to the percentage cut off from the market of pump types (not of actual pumps) by the given dates. For further details, see Annex IV.

technology. However, the cost of the measure for the industry must be taken in due consideration.

The Directive lists a set of criteria that need to be met when designing an implementing an implementing measure. However, the Article 15 of the Ecodesign Directive does not set the required criteria in any hierarchy[18].

The Impact Assessment on pumps shows that water pumps are placed on the market in great numbers (above 200.000), they have a significant environmental impact (117.7 TWh consumption by 2010) and environmental improvement potential (savings potential 2.5-4,6 TWh by 2020, if eco-design sub-options are considered) without excessive cost. The preparatory study and the impact assessment show that the cost issue is highly complex, partly due to the type of data and the nature of industry that is working on product design without having had much need to innovate or redesign existing products during the last decades.

One of the key questions in this impact assessment is the comparison of the cost for the industry and the benefit for the consumer; the least life cycle cost continues diminishing until BAT. However, this would generate very high cost for the industry and it would be unclear how much the product price would be increased. Currently, there is no method available to create a hierarchy between the cost to industry and the benefit to the consumers in terms of LLCC. This will have to be considered in Chapter 5 and 6 in the light of the results of the analysis.

Power levels

- The proposed requirements on pumps are based on the revised Europump house of efficiency calculation method with maximum power levels introduced in two stages in order to ensure that the requirements are dynamic in providing long-term perspective for the operators in the pump market.

Comments on the implementation of the Ecodesign requirements

The implementing measure is based on the Europump *house of efficiency* calculation method.

The energy consumption maximum limits are based on the function performed by a pump. The proposed minimum energy performance requirements and the timing for their introduction have been set taking into consideration:

– The least life-cycle cost of the product in accordance with Annex II of Directive 2009/125/EC.

– The expected market and technology developments. The requirements will be applicable two years after the measure has entered into force and will correspond to the available pump technology for decreased energy use.

– Time is needed for manufacturers to redesign and manufacture new more efficient pumps. As the low-efficient pump types must be re-design and the necessary production lines

[18] However, it can be assumed that the criteria for a significant environmental impact precedes the criteria on indicative volume of 200.000 (e.g. if 10.000 commercial refrigerators consume ten times more than 10 million chargers, then there might be enough reason to base an implementing Regulation on the Art. 15.b even if in apparent conflict with Art. 15.a, provided that the criteria listed in Art. 15.c and d are fulfilled.

established, it is necessary to give time for manufacturer to make the necessary investments. Since the necessary technology has already been on the market for many years, and as many pump manufacturers already produce high efficient pumps, the timeframe of two vs. four years is considered to be enough.

– It should also be considered that discussions with the affected industry started in 2006, so the coming of the measure has been know for several years by now.

Ecodesign parameters for which no Ecodesign requirements are necessary

In accordance with Directive 2009/125/EC and the methodology used in the preparatory studies, all environmental impacts of pumps have been considered. It has been concluded that the energy consumption in the use phase is, by far, the biggest environmental impact of these devices.

Other than energy-use, an environmental aspect of pumps which has to be considered is their recyclability. Pumps contain mainly cast iron and stainless steel. The impeller may be in bronze to avoid roughening by corrosion. The hydraulic components of small vertical multistage pumps and small submersible multistage well pumps are usually made from pressed sheet stainless steel or plastic materials. The metals have a positive scrap value. It is to the professional installer's advantage (in most cases, the replacement, repair and disposal or recycling of pumps is managed by the installer) to send old pumps to scrap and avoid a disposal cost. The preparatory study assumes, together with the stakeholders, that due to their high value all of the metallic components are recycled. The non-metallic components are considered as not recycled. Although pumps are not covered by WEEE or RoHS, existing pump designs appear to be compliant with these Directives.

At this moment the possibilities to enhance the recyclability of pumps through better design are very limited. The value of the materials used and the competition in the pump market makes manufacturers optimise material use and recyclability. In average a water pump consists of 90-95 % metal, mostly stainless steel and cast iron, while 5-10 % is plastic and card board for packing. The average energy consumption in the life cycle (11 years) is roughly 10,000 kWh/y*11 y = 110,000 kWh. The average weight of metal in a water pump is roughly 150 kg. Remelting of metal consumes approximately 3 kWh/kg i.e. 450 kWh = 0,4 % of the life cycle cost of energy. Hence the environmental impact of the disposal of pumps is negligible. This is also the conclusion from the preparatory report, e.g. p. 131.

4.4.3 *Measurement standard and method for estimation of the energy efficiency*

Performance testing of pumps can be done with one of two ISO grades, Grade 1 (most accurate) or Grade 2 (least accurate) to EN ISO 9906-1999 (currently being revised). The tolerance on efficiency for Grade 2, which is the norm for mass produced pumps of the type with which this study is most closely concerned, is 5% of the value.

The Europump method of classifying pump performance is defined in the so-called house of efficiency scheme as described in Annex IV.

4.4.4 *Information to be provided by manufacturers*

In order to facilitate compliance checks manufacturers are requested to provide information in the technical documentation referred to in Annexes IV and V of Directive 2009/125/EC in so far as they relate to the requirements laid down in this implementing measure.

Furthermore manufacturers are requested to declare the actual and the benchmark efficiency value of the pump on the name plate, or near the name plate, of the product, including in the product packaging and documentation in order to provide a tool for for-runner manufactures to market high-efficient pumps.

4.4.5 Date for evaluation and possible revision

The main issues for a possible revision of the Regulation are:

- appropriateness of the product scope;
- appropriateness of the levels for the ecodesign requirements for the efficiency of allowed pumps.

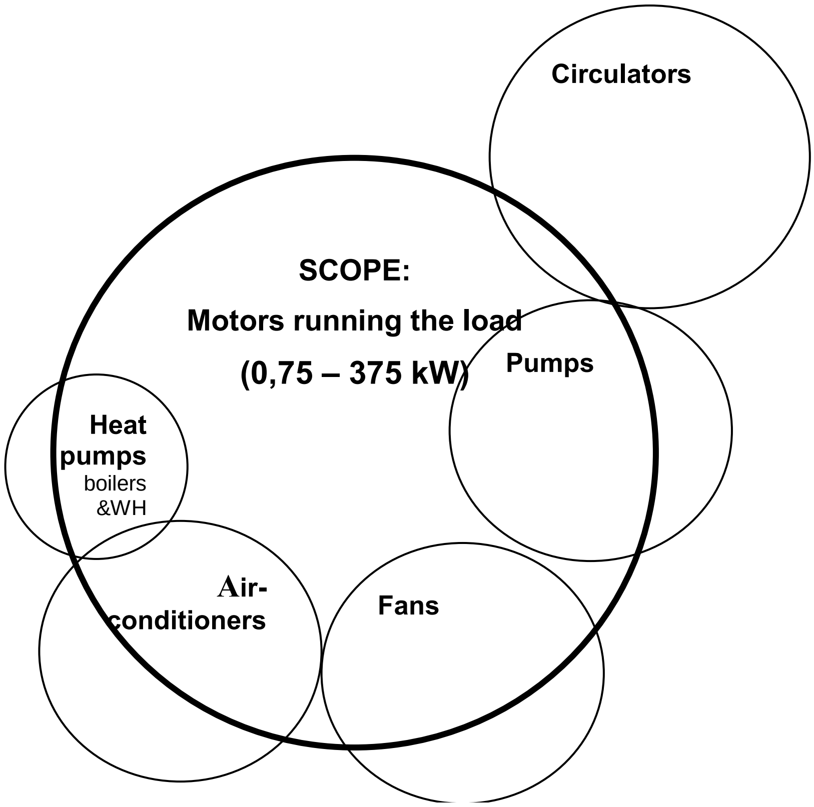
With a view to the level of requirements proposed, a review can be presented to the Consultation Forum five years after entry into force of the regulation.

4.4.6 Interrelation with other ecodesign implementing measures – implications on scope

Pumps are driven by motors that are covered by an implementing measure on motors. Thus, pump products that include a pump and a motor covered by these implementing measures must comply with both the motor and the pump measure for affixing the CE mark in the same way as these products must comply with any other relevant EU legislation, such as the Low Voltage Directive, for example.

From the systemic point of view, there is a potential overlap between the pump and the motor efficiency. The below figure provides an overview of products with potential overlaps in motor systems. The overlap between these groups is never complete.

Figure 4.4.6: Estimated potential overlap in energy consumption and saving potential of products in motor systems



To avoid the overlap (for more details, see Annex III), the pump study only considered the hydraulic efficiency of the pump, while the motor measure considered the efficiency of the motor transforming the electrical energy into mechanical energy for the needs of the pump (load). The disadvantage is that in this way the system efficiency (including the motor, drive, transmission and pump) can not be regulated. However, as most pumps are sold separately from the other parts of the system, this approach allows tackling the efficiency of both motor and the pump.

SECTION 5: IMPACT ANALYSIS

Given that options 1-3 have been discarded in Section 4, this section looks into the impacts of option 4 and its sub-options. An assessment of possible sub-options as regards the "intensity" of the measure - the combination of the levels of requirements and the timing for the levels pursuant to Article 15(4f) of the Ecodesign Directive - was carried out.

This assessment follows the criteria set out in Article 15(5) of the Ecodesign Directive, and includes impacts on manufacturers in particular SMEs and administrative costs. The aim is to find a balance between a quick implementation for achieving the appropriate level of ambition and the associated benefits and potential burdens related e.g. to an un-planned re-design of equipment for achieving compliance with ecodesign requirements, while avoiding negative impacts for the user, in particular as related to affordability and functionality. The methodology of the analysis is explained in Annex 2.

The sub-options and their technical feasibility were considered as discussed with stakeholders.

This chapter compares the impacts of the various scenarios per aspect, i.e. by

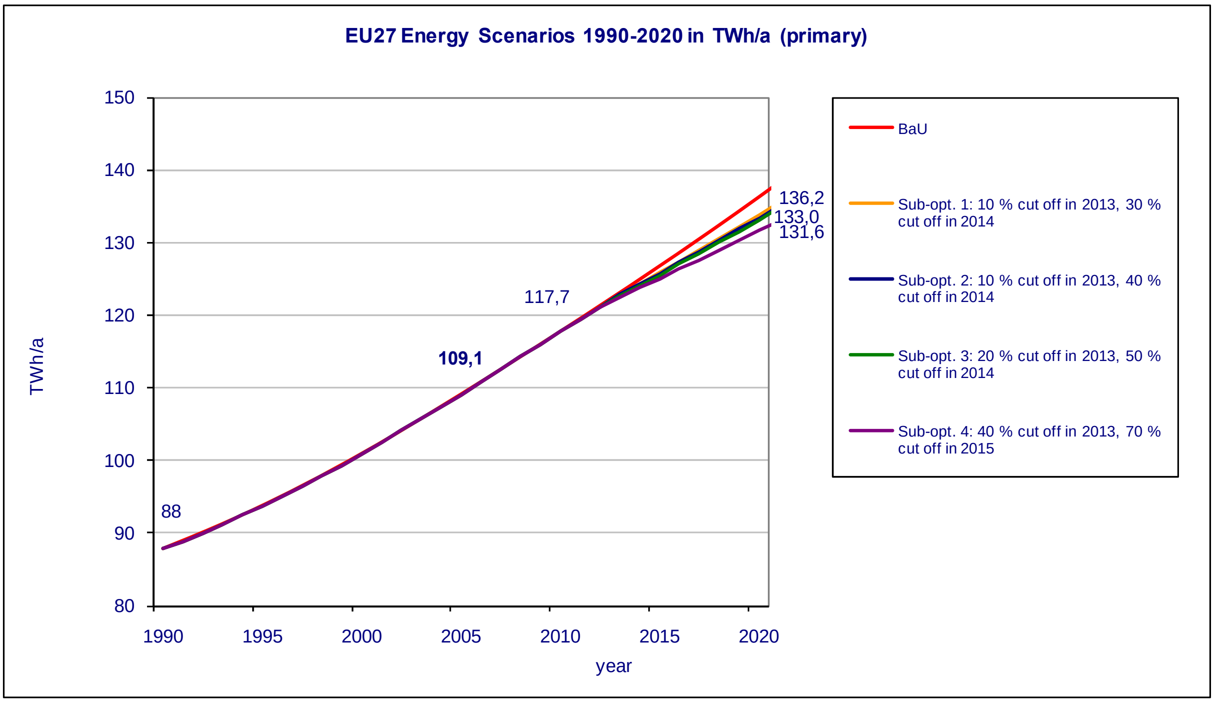
- Energy saving;
- Greenhouse gas emission reduction;
- Customer economics and affordability;
- Business economics and competitiveness;
- Employment;
- Technology, functionality and innovation;
- Health, safety and other environmental aspects;
- Administrative burden;
- Impact on trade.

5.1 Energy saving

The table and figure below shows the electricity consumption of the scenarios BaU and 4 sub-options. The BaU scenario is an expected natural development. It is assumed that efficiencies have remained the same since 1990 in the BaU scenario i.e. a development of 0 % p.a.[19]. The 4 sub-options are further explained in Annex III.

[19] "Preparatory studies for Requirements of Ecodesigns – Lot 11 on electric motors, water pumps, pumps in buildings and fans for ventilation in non-residential buildings. Appendix 6: Lot 11 - 'Water Pumps (in commercial buildings, drinking water pumping, food industry, agriculture)', April 2008, p. 56, available on Eco Motors website http://www.ecomotors.org/files/Lot11_pumps_1-8_%20issue6_110408_%20final.pdf

Figure 5.1: Energy consumption scenarios 1990-2020



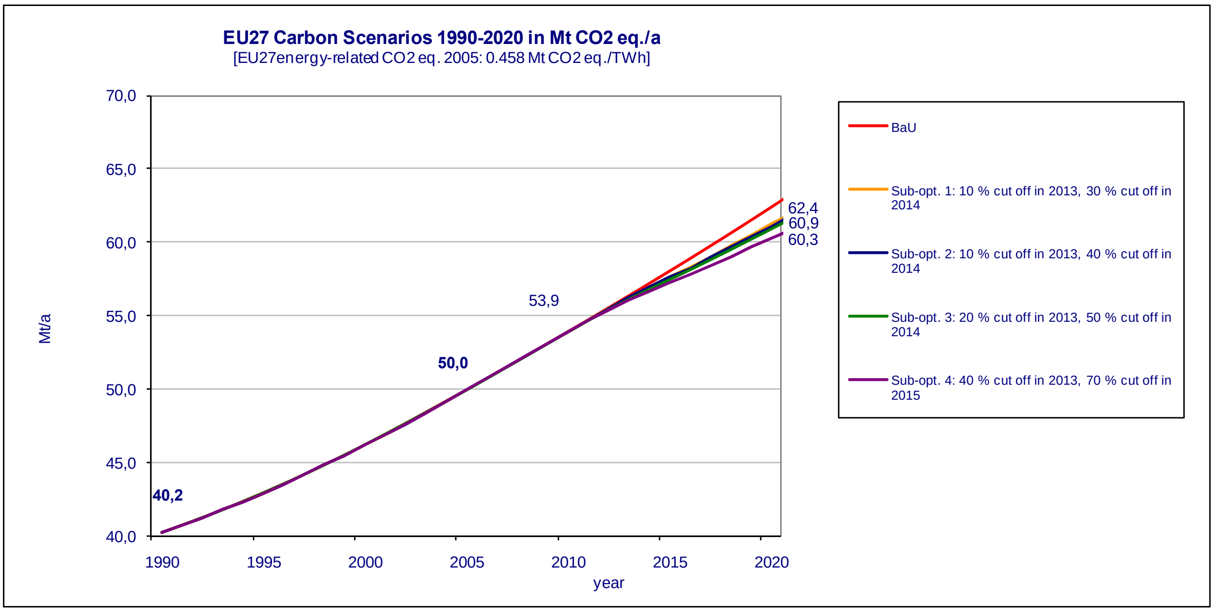
Stock electricity in TWh/a							
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
BaU	**87,8**	**93,7**	**100,9**	**109,1**	**117,7**	**126,7**	**136,2**
Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014	**87,8**	**93,7**	**100,9**	**109,1**	**117,7**	**125,8**	**133,7**
Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014	**87,8**	**93,7**	**100,9**	**109,1**	**117,7**	**125,7**	**133,4**
Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014	**87,8**	**93,7**	**100,9**	**109,1**	**117,7**	**125,5**	**133,0**
Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015	**87,8**	**93,7**	**100,9**	**109,1**	**117,7**	**125,0**	**131,6**

The largest energy saving is offered by the sub-option 4, which will give a saving of 4,6 (136.2-131.6) TWh/a in 2020 compared with the BaU scenario.

5.2 Greenhouse gas emission reduction

The tighter the requirements are and the sooner they become effective, the higher the accumulated electricity savings and hence the related CO2 emissions reductions. The accumulated CO2 savings for sub-options 1 - 4 by 2020 are shown in the figure below.

Figure 5.2: Greenhouse gas scenarios 1990-2020



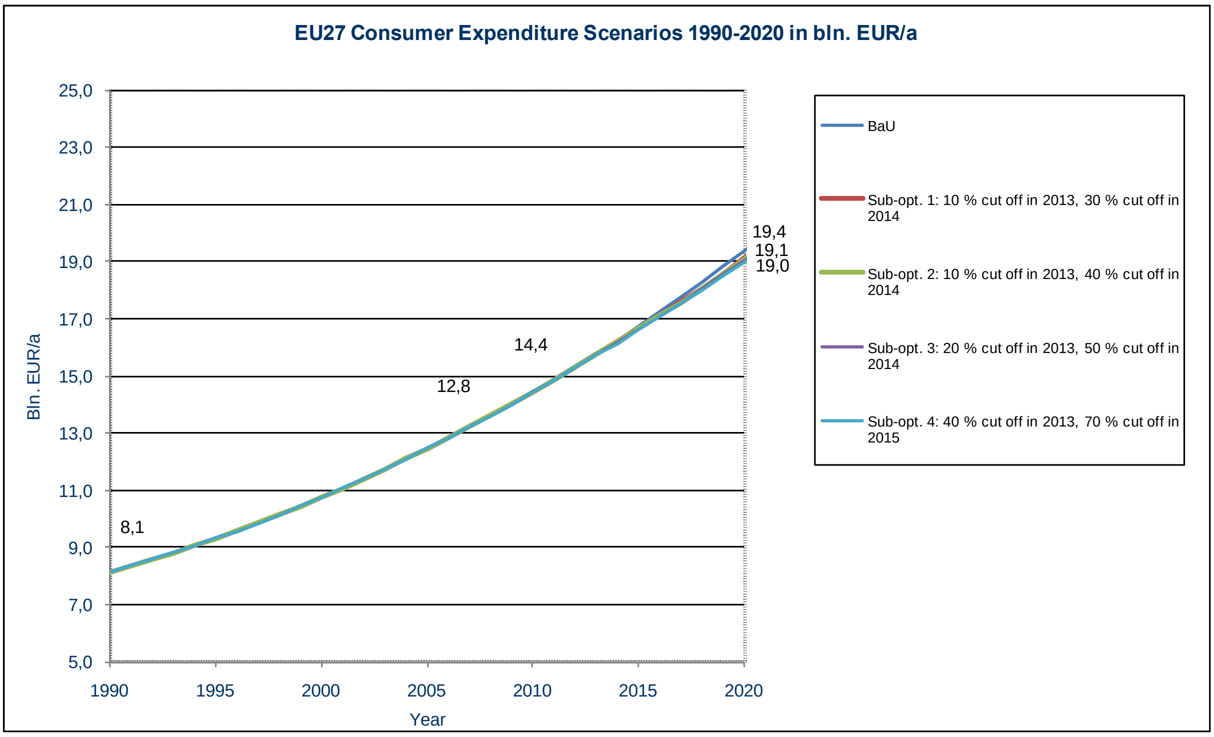
CO2-emission in total stock [Mt CO2-eq/a]							
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
BaU	**40,2**	**42,9**	**46,2**	**50,0**	**53,9**	**58,0**	**62,4**
Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014	**40,2**	**42,9**	**46,2**	**50,0**	**53,9**	**57,6**	**61,2**
Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014	**40,2**	**42,9**	**46,2**	**50,0**	**53,9**	**57,6**	**61,1**
Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014	**40,2**	**42,9**	**46,2**	**50,0**	**53,9**	**57,5**	**60,9**
Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015	**40,2**	**42,9**	**46,2**	**50,0**	**53,9**	**57,3**	**60,3**

The largest CO_2 reduction is offered by the sub-option 4, which will give a saving of 2.1 (62.4-60.3) Mt CO_2 eq. 2020 compared with the BaU scenario.

5.3 Consumer economics and affordability

The implementation of ambitious minimum cut-off requirements will not increase the consumer purchase costs significantly. The consumer expenditure is shown in below figure per sub-option.

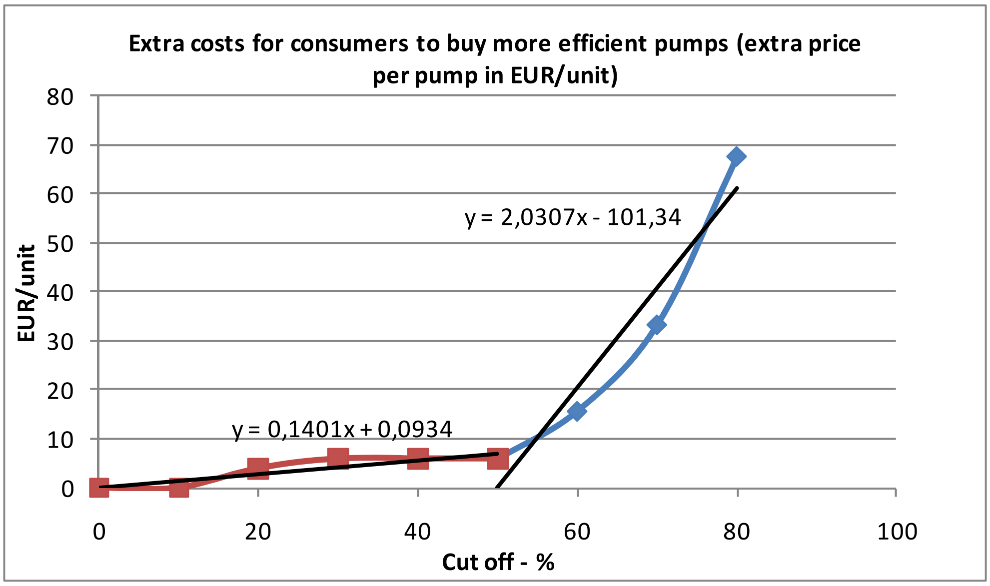
Figure 5.3: Consumer expenditure scenarios 1990-2020



Stock consumer expenditure [bln. EUR/a]							
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
BaU	**8,1**	**9,3**	**10,7**	**12,5**	**14,4**	**16,7**	**19,4**
Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014	**8,1**	**9,3**	**10,7**	**12,5**	**14,4**	**16,6**	**19,1**
Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014	**8,1**	**9,3**	**10,7**	**12,5**	**14,4**	**16,6**	**19,1**
Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014	**8,1**	**9,3**	**10,7**	**12,5**	**14,4**	**16,6**	**19,1**
Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015	**8,1**	**9,3**	**10,7**	**12,5**	**14,4**	**16,6**	**19,0**
Avg. Purchase cost (excl. install) for year of purchase [EUR/unit]							
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
BaU	**981**	**981**	**981**	**981**	**981**	**981**	**981**
	981	**981**	**981**	**981**	**981**	**984**	**984**
	981	**981**	**981**	**981**	**981**	**985**	**985**
	981	**981**	**981**	**981**	**981**	**987**	**987**
	981	**981**	**981**	**981**	**981**	**1,027**	**1,027**

The lowest consumer expenditure over the life cycle is offered by the sub-option 4 . The total saving in consumer expenditures are 0.4 (19.4-19.0) billion EUR in 2020 compared with the BaU scenario. The average costs per product (excluding installation costs) for the consumer is minimal, for example, in the sub-option 4, product price would increase by 46 EUR (from 981 to 1,027 EUR) in 2005-prices. The below figure shows that, at cut-off level 0%, the average price is 981 EUR, and at cut-off 40% level, the average price is 985 EUR vs. at cut off 70 % the average price is 1027 EUR.

Figure 5.4: Extra costs for consumers to buy more efficient water pumps.



The below table (preparatory study) and graph show extra cost for the consumer depending on the cut-off rate applied.

Table 5.1: Cost for the consumers to buy more efficient pumps

Cut off (%)	ESCC S	ESCC L	ESOB S	ESOB L	MSS S	MSS L	MS S	MS L	ESCCi S	ESCCi L	Total cost pa (Euros)
80	12,420	11,385	6,072	3,450	35,162	9,660	13,800	3,450	4,968	4,554	104,921,400
70	6,120	5,610	2,992	1,700	17,326	4,760	6,800	1,700	2,448	2,244	51,700,400
60	2,880	2,640	1,408	800	8,154	2,240	3,200	800	1,152	1,056	24,329,600
50	1,080	990	528	300	3,058	840	1,200	300	432	396	9,123,600
40	1,080	990	528	300	3,058	840	1,200	300	432	396	9,123,600
30	1,080	990	528	300	3,058	840	1,200	300	432	396	9,123,600
20	720	660	352	200	2,038	560	800	200	288	264	6,082,400
10	0	0	0	0	0	0	0	0	0	0	0

5.4 Business economics and competitiveness

The European pump market is very important in being twice the size of the US and triple of the Japanese pump market. Thus, Europe has a unique position in giving a boost for the development of minimum energy efficiency requirements in third countries. Today, minimum requirements only exist in China[20] at about, or slightly below, C=30% level.

The pump market is led by a number of middle-sized pump companies and a several multinational companies, who have worldwide manufacturing facilities, with a trend towards production in regions with a lower cost of labour. Production in Europe is cost effective in particular for higher-priced high-efficient pumps, engineered pumps which may be tailored in some way for end users, including low volume pumps. Companies that have invested heavily in automation are also able to make high volume pumps at competitive prices in Europe.

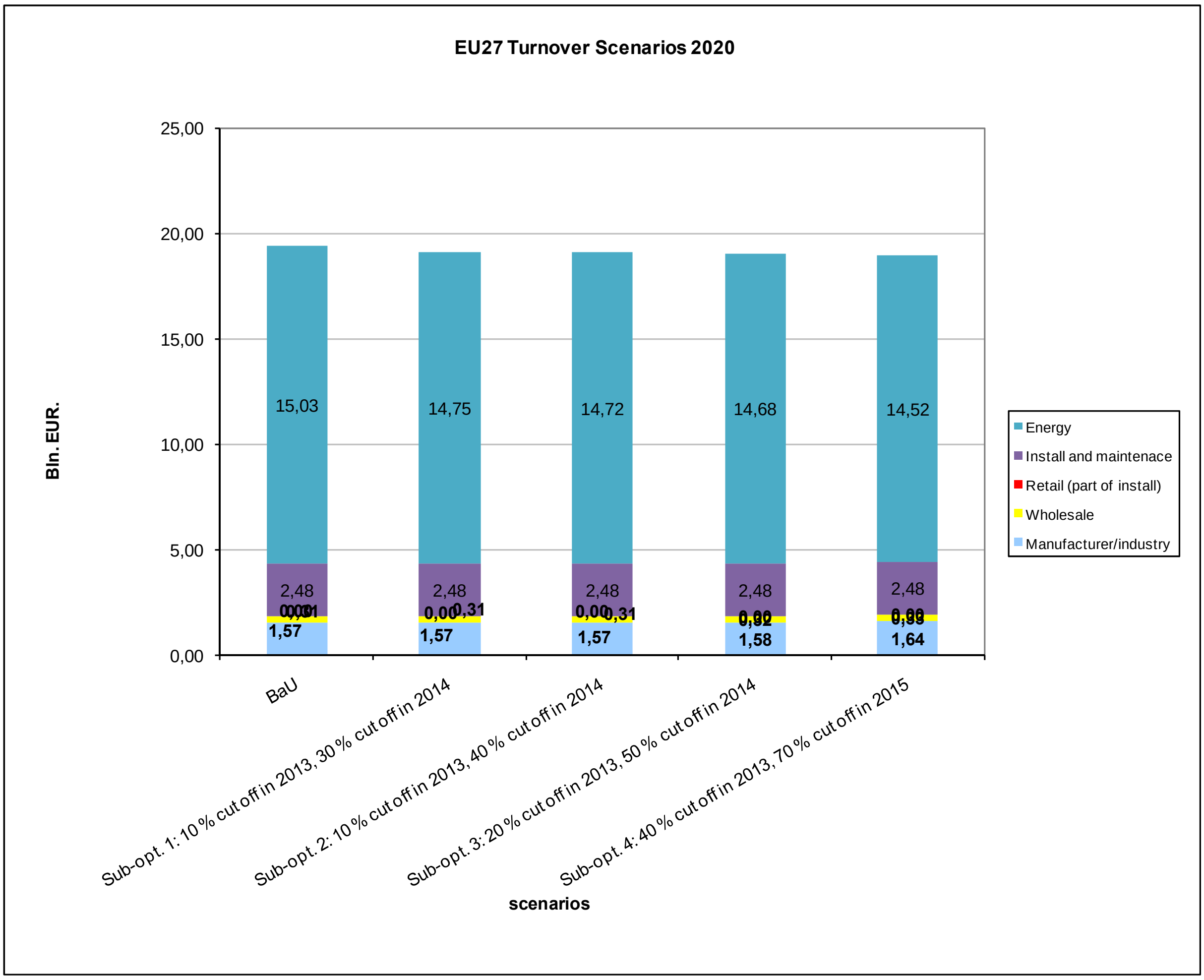
In the European Pump Association (Europump), there are 450 member companies. There is also a minor non-known number of pump manufactures outside the Association. Most pump manufacturers produce a wide range of pump, in some cases up to thousands of pump types, for a number of applications (not only water pumps). 15 European manufacturers are known to produce water pumps, half of them in Germany, others being from Italy, France, UK,

[20] Since 2005.

Denmark and Sweden. No precise information has been provided on the turnover and staff of these companies but the information on the web sites of these companies show that non of these companies can be considered SME[21]s; only one company employs less than 250 employees but has a turnover of some €100 M.

The diagram below represents the outcome of the stock model as regards business revenues.

Figure 5.5: Turnover scenarios 2020



Redesign and investment cost

The redesign and investment cost for manufacturers depends on the level of ambition of the proposed requirements (timing and cut-off values). The table below shows the Europump estimate for the total costs for the industry related to each cut off level (see also Annex V). This is due to the fact that manufacturers, especially the large ones, seek to have as many different pump types as possible in order to provide customers the pumps with best efficiency point (BEP) as close to the needs of the application as possible. Another issue is that many manufacturers produce by modulating existing pumps up and down in efficiencies, to meet the customers demand, this can work out to a certain level (i.e. to a certain cut-off) and after that it will cost extra money in development.

[21] Applying the minimum limits for large SMEs of €50 M annual turnover and staff of 250.

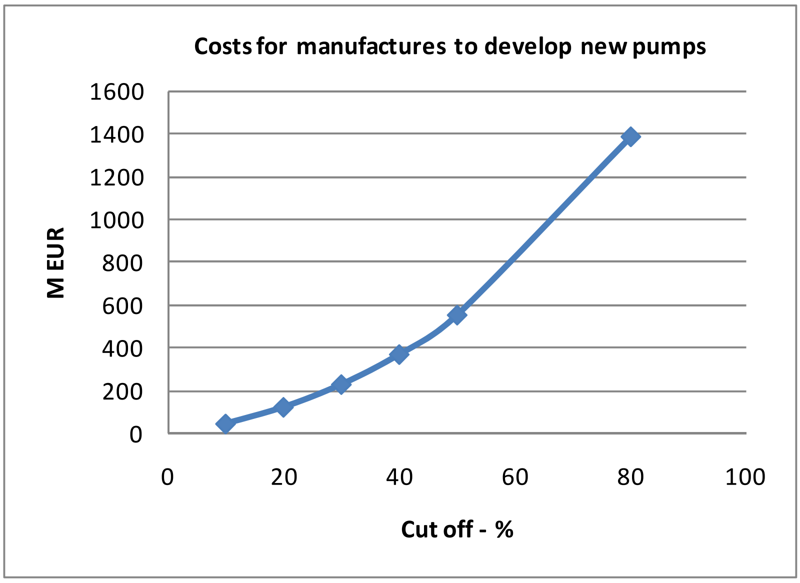
Table 5.2: Development cost per cut off level per pump by Europump

Cut off %	Development cost (M €)
10	43
20	120
40	400
50	550
70	1060
80	1380

The preparatory study shows the production cost as a function of cut-offs. Development costs were excluded. This makes it difficult to estimate cost provided by the industry as presented in table 5.2; estimating development costs are difficult even for the industry due to the new situation in which these development costs are born. However, it is known that only a small number of pump types (those below cut off rates) will have to be redesigned and that the technology is easily available on the market.

A main reason for the fact that development costs are not properly reflected in the prices of the pumps currently on the market seems to be that the pump industry is an established industry working with old patents; there has been very little incentive to produce more energy efficient hydraulic parts of these products, which makes the industry estimates on redesign costs difficult.

Figure 5.6. Cost for manufactures to develop new pumps.

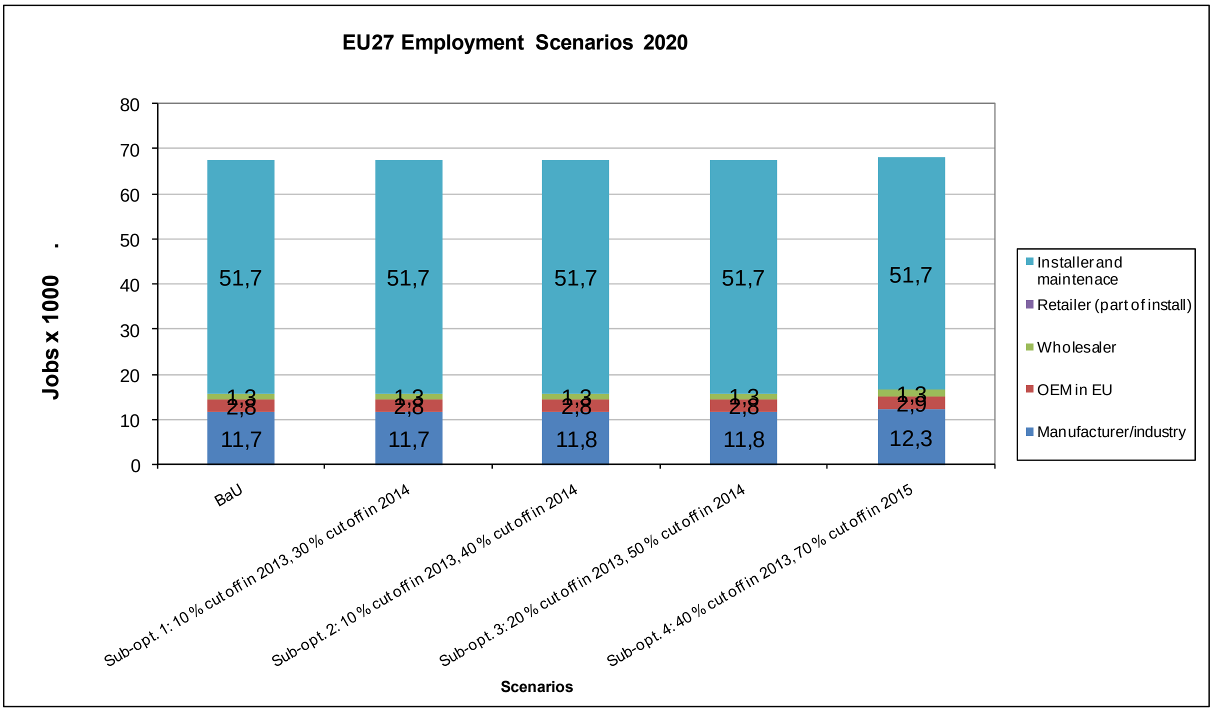


Currently, there is no method available to create a hierarchy between the cost to industry and the benefit to the consumers in terms of LLCC. In the case of water pumps, the claimed cost to industry increase by hundreds of millions from one cut off rate to another while the change in life cycle cost to consumer is within the range of 5% (variation between €23.5 and €22.9 billion/a). Due to the uncertainties related to the available data, cost to the industry in the present economic downturn and the minor increase in LLCC, a compromise level of C-40% was put forward by the preparatory study.

5.5 Social costs

Employment

Figure 5.7: Employment (excl. energy sector) scenarios 2020



All sectors personnel (excl. energy sector) (000)	1990	1995	2000	2005	2010	2015	2020
BaU				**51,9**	**55,9**	**60,1**	**64,6**
Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014				**51,9**	**55,9**	**60,2**	**64,7**
Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014				**51,9**	**55,9**	**60,2**	**64,7**
Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014				**51,9**	**55,9**	**60,2**	**64,7**
Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015				**51,9**	**55,9**	**60,7**	**65,3**

Table 5.3: Impact on employment.

EMPLOYMENT							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
Employment (jobs)	industry EU (incl OEM)	'000	14,5	14,6	14,6	14,6	15,2
	OEM non EU	'000	0,7	0,7	0,7	0,7	0,7
	w hole-sale	'000	1,3	1,3	1,3	1,3	1,3
	installers	'000	51,7	51,7	51,7	51,7	51,7
	TOTAL	'000	**68,2**	**68,2**	**68,2**	**68,2**	**68,9**
	of w hich EU	'000	67,4	67,5	67,5	67,5	68,2
	EXTRA EU jobs	'000	reference	**0,0**	**0,1**	**0,1**	**0,7**
	of w hich SME**		reference	0,0	0,0	0,0	0,2
** partitioning 30% industry & w holesale, 80% installers							

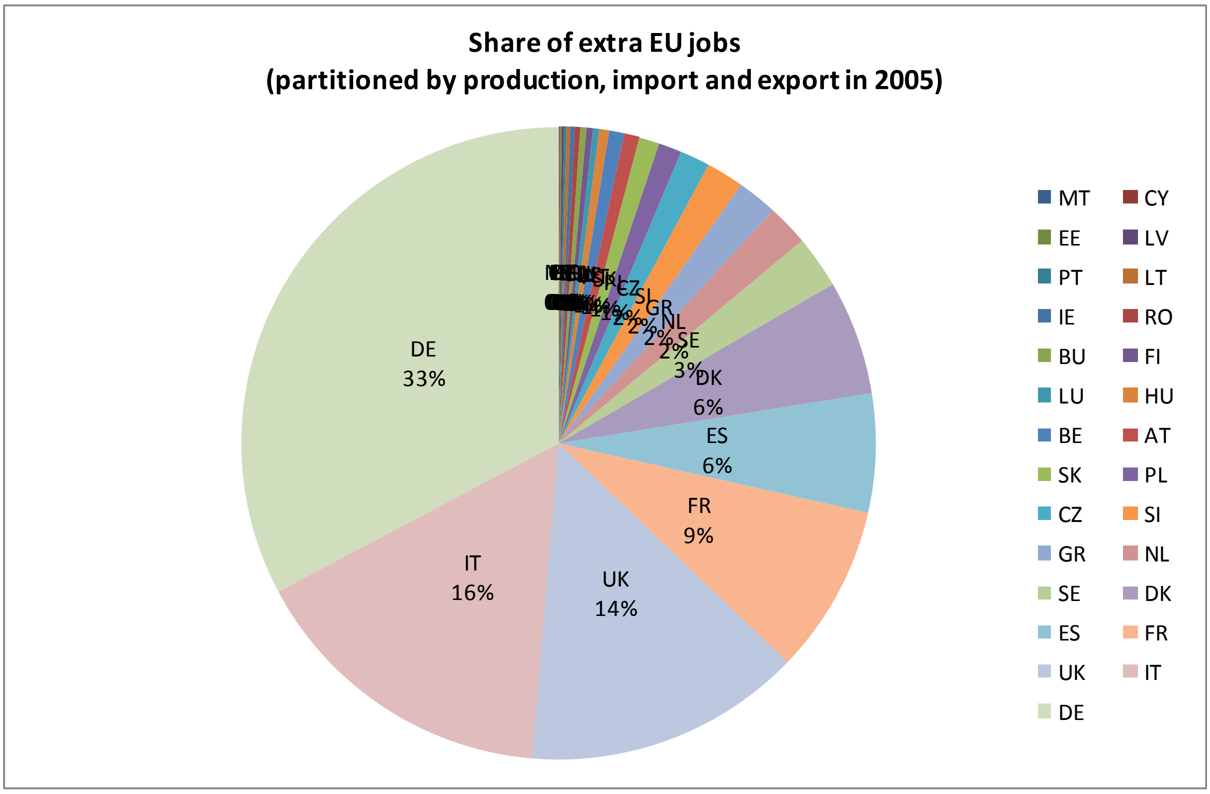
The total number of employed people with relation to water pumps estimated to be around 67.400 in Europe (2005). This number is increased to about 68.200 in sub-option 4 in 2020 with respect to the BaU-scenario due to an assumed increase of the pump sale by 1.5 % p.a.

The relative low job increase is primarily corresponding to an almost stable product selling price.

The risk for a loss of jobs is considered to be unchanged as the sales are expected to grow by 1.5 % per year. Results of the scenario analyses summarised in below figure show that the considered sub-options can only very slightly increase the number of jobs in manufacturing companies at installer and wholesale level.

The figure below shows the geographical distribution of jobs in several EU countries. The number of jobs is mainly dependent on the number of water pumps in the various countries and existence of manufacturing facilities.

Figure 5.8: EU jobs scenarios 2020 water pumps



Health, safety and environmental aspects not captured in measures

The analysis in the preparatory study has shown that the eco impacts from the production, distribution and end-of-life phases are very small or insignificant compared to the use phases.

5.6 Administrative cost

The form of the proposed legislation is a regulation, which is directly applicable in all Member States. This ensures that there are no costs for national administrations due to the transposition of the implementing legislation into national legislation. The use of a regulation also provides level playing field for the industry, as the measure comes into force simultaneously in an identical form across all the Member States.

With the entry into force of new requirements, manufacturers will need to adapt the design of products not complying with the new requirements. This in general implies the need for re-assessing the conformity of products with the legal requirements. The conformity assessment is usually part of the normal internal design control of the manufacturer (or management system as in Annex V of the Directive) to ensure that the product will meet the legal requirements. Only in exceptional case (to be justified as laid down in Annex VII of the Directive) can the implementing measure require third party testing. The cost of assessing conformity of pumps is very small as this is already done as a part of standard measurements for catalogue data and CE-marking. The Europump House of Efficiency scheme has been developed and approved by all manufactures. Moreover:

– all manufacturers are affected by the need for a conformity assessment, because the proposed regulation creates a level playing field;

– costs for assessing conformity as a consequence of redesign are occurring only once upon introduction of the regulation;

– manufacturers/importers of pumps already now have to assess conformity of pumps, compile technical documentation and affix "CE" marking, therefore this particular measure will only marginally increase the cost of conformity assessment;

– the cost of assessing conformity is not a direct function of the volume of production, as the cost is more related to the number of types of pumps produced. There being thousands of pump models in the market the proposed relatively low cut off levels will ensure that no manufacturer need to redesign the whole production, as most manufacturers produce pump types in various efficiency ranges. Also, apart from producing waater pumps in the scope of this impact assessment, most pump manufacturers produce other types of pumps and other products used in pumping systems, such as motors, drives, turbines, valvesn etc. Thus, the cost involved in conformity assessment for pumps cannot be considered as affecting the competitiveness of pump manufacturers, nor the SMEs vis-à-vis high volume producing manufacturers. Accordingly, due to the low impact of conformity assessment on manufacturers no EU standard cost model is necessary.

5.7 Impact on trade

The process for establishing Ecodesign requirements for water pumps has been transparent for both EU and non-EU manufacturers. Furthermore, before the proposed Regulation is adopted by the Commission a notification to the WTO-TBT[22] Agreement will be issued and WTO members will have the opportunity to submit their comments to the Commission on the draft proposal.

Competitive disadvantages for EU manufacturers exporting pumps to third countries or for non-EU manufacturers importing pumps are not expected; all manufacturers will have to comply with the Regulation on an equal basis. No such disadvantages are known to exist either due to the minimum requirements on pumps in China or due to the Korean certification scheme. Although the pump market is global in nature, most EU water pump manufacturers produce mainly for the EU market. This applies equally for non-EU manufacturers in their respective regions.

According to the preparatory study and the Darmstadt University data collection (see Annex IV) 15 European manufacturers are known to produce water pumps. In total, 450 pump manufacturers are identified as members of the European Association (Europump). The water pump production is only a small part of the total pump production and all water pump

22 The Technical Barriers to Trade Agreement under the World Trade Organisation aims at ensuring that regulations, standards, testing and certification procedures do not create unnecessary obstacles.

producers manufacture a large number of various types of pumps. About half of all known water pump producers are German, others being from Italy, France, UK, Denmark and Sweden. No precise information has been provided on the turnover and staff of these companies but the information on the web sites of these companies show that none of these companies can be considered SME[23]s; only one company employs less than 250 employees but has a turnover of some €100 M. No reliable information is available[24] on the exports and imports of individual manufacturers or 'Member States', nor for EU export and imports, despite of more than two years of serious attempts under the preparatory study and the impact assessment. This is also due to the reluctance of individual manufacturers to revel this information that is considered sensitive. It is known that pump sales, although being global in nature, are also 'regional' in the sense that the EU water pump sales are strongly dominated by European companies. The same applies to other major markets.

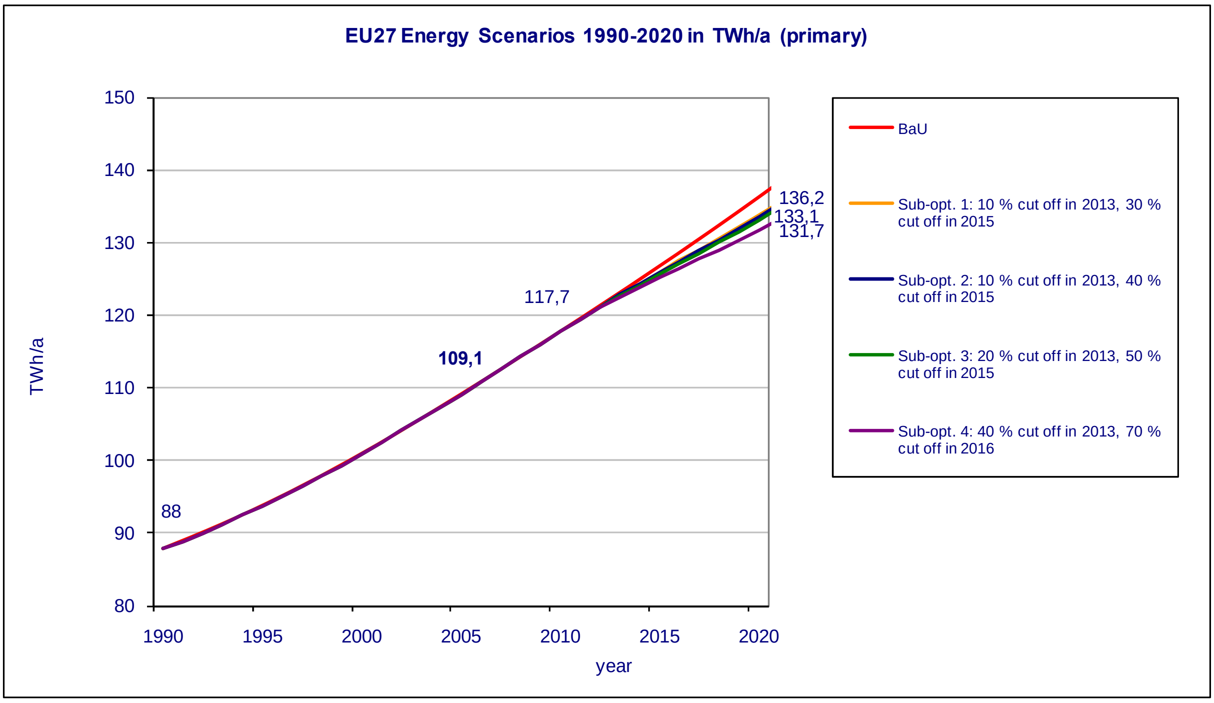
5.8 Comparison of sub-options for changed introductory dates

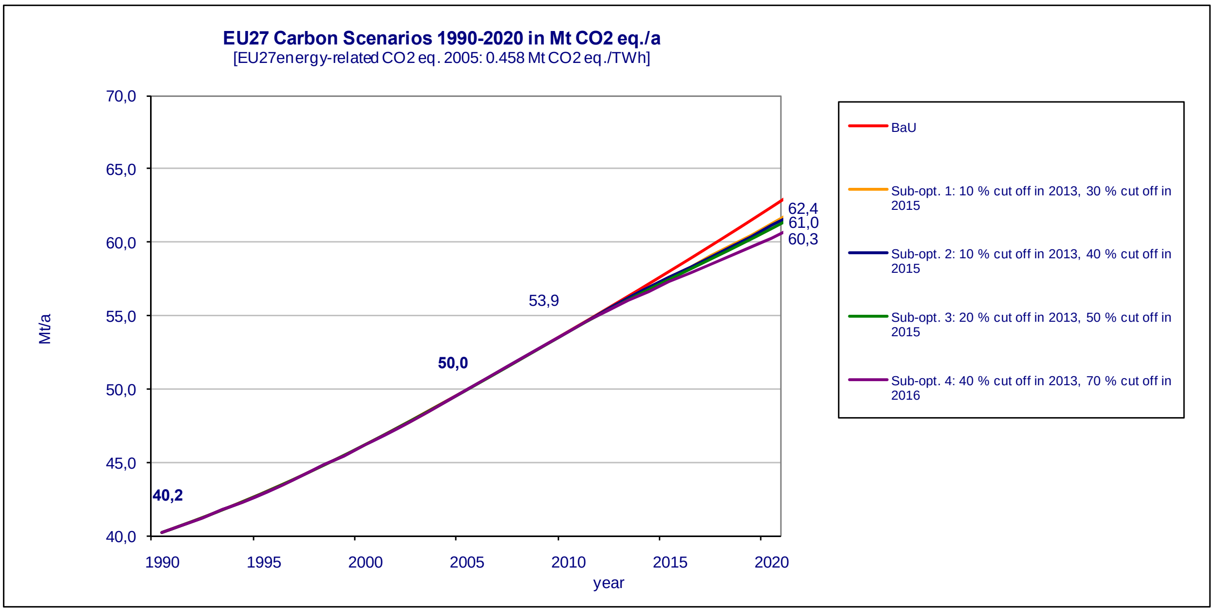
This chapter considers the impact, if the second tier requirement is postponed by one year for all sub-options. Considering the option of moving back the second tier requirement is not sensible, as it would be identical to the date of the first tier requirement. Below, the impacts are compared, if the second tier requirementsare postponed by one year for all sub-options.

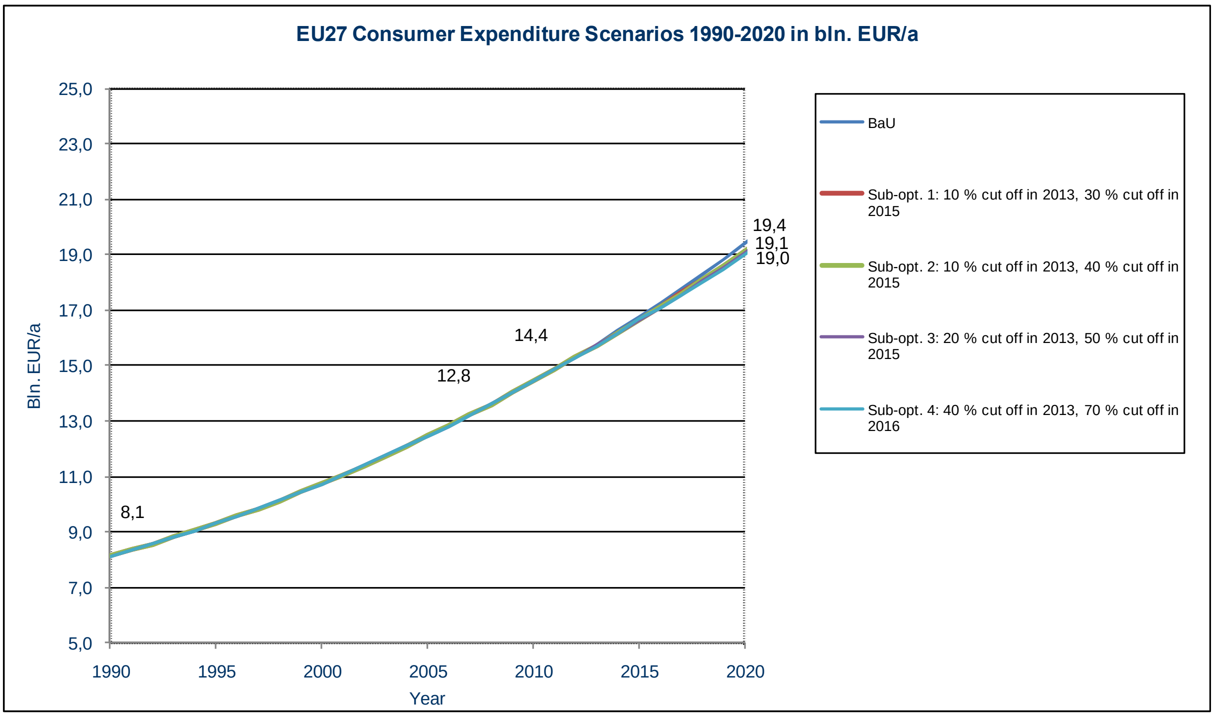
[23] Applying the minimum limits for large SMEs of €50 M annual turnover and staff of 250.

[24] As the preparatory study shows, Eurostat data is not useful as it is incomplete and does not distinguish data with sufficient detail on water pumps specifically.

Figures 5.10: Implementation of the second tier requirements one year later







The results of the graphs are summarized in the below tables.

Table 5.7: Impact on electricity consumption by 2020, if the second tier requirements are introduced one year later

Electricity consumption in 2020 [TWh/year]	**Sub-option 1**	**Sub-option 2**	**Sub-option 3**	**Sub-option 4**
As per proposed timing	133.7	133.4	133.0	131.6
One year later	133.8	133,5	133,1	131.7
Increase in 2020	0.1	0.1	0.1	0.1

Table 5.8: Impact on CO2 emissions by 2020, if the second tier requirements are introduced one year later

CO_2 emissions in 2020 [Mt CO_2]	**Sub-option 1**	**Sub-option 2**	**Sub-option 3**	**Sub-option 4**
AS per proposed timing	61.2	61.1	60.9	60.3
1 year later	61.3	61.1	61.0	60.3
Increase in	0.1	0	0.1	0

2020				

Table 5.9: Impact on consumer expenditure in 2020, if the second tier requirements are introduced one year later

Consumer expenditure in 2020 [Bln. EUR/year]	Sub-option 1	Sub-option 2	Sub-option 3	Sub-option 4
Proposed timing	19.1	19.1	19.1	19.0
1 year later	19.1	19.1	19.1	19.0
Increase in 2020	0	0	0	0

The analysis shows that later implementation leads to no additional decrease in electricity and CO2 emissions savings by 2020.

5.9 Sensitivities considered

Sensitivities are considered for two variables:

- an increased product price per cut off level;
- a decreased electricity price.

All analyses are performed for the year 2020.

The impact of ecodesign requirements on the affordability of products would in principle require an assessment of income structure of the users of water pumps. The purchase cost increases against the life cycle cost reduction of water pump in the light of the proposed policy measure, as shown in the below table. The tables below show also the impacts, if the electricity price is doubled.

In the reference situation the discount rate payback[25] is used as indicator in the following table. The payback times are adapted in accordance with a 4% discount rate.

[25] As described in Annexes to Impact Assessment Guidelines, 15 Januar 2009

Table 5.10: Main impacts in reference situation.

MAIN IMPACTS							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
ENVIRONMENT							
	Electricity	PJ/a	**1226**	**1203**	**1200**	**1197**	**1184**
	GHG	Mt CO2 eq./a	**62**	**61**	**61**	**61**	**60**
	Electricity	TWh/a	**136**	**134**	**133**	**133**	**132**
CONSUMER							
EU totals*	Expenditure	€ bln./a	**19,4**	**19,1**	**19,1**	**19,1**	**19,0**
	Purchase costs	€ bln./a	2,8	2,8	2,8	2,8	2,8
	Running costs	€ bln./a	16,6	16,4	16,3	16,3	16,1
per product*	Product price	€	981	984	985	987	1027
	Install cost	€	450	450	450	450	450
	Energy costs	€ /a	762	743	740	739	727
	Maintenance costs	€ /a	82	82	82	82	82
	Discount rate payback ***	years	reference	**0,2**	**0,2**	**0,3**	**1,7**
* all money are not inflation corrected							
*** payback is discount rate corrected							

Table 5.11: Simple payback period (SPP) when increased product price per cut off level by 50 %

MAIN IMPACTS							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
ENVIRONMENT							
	Electricity	PJ/a	**1226**	**1203**	**1200**	**1197**	**1184**
	GHG	Mt CO2 eq./a	**62**	**61**	**61**	**61**	**60**
	Electricity	TWh/a	**136**	**134**	**133**	**133**	**132**
CONSUMER							
EU totals*	Expenditure	€ bln./a	**19,4**	**19,1**	**19,1**	**19,1**	**19,0**
	Purchase costs	€ bln./a	2,8	2,8	2,8	2,8	2,9
	Running costs	€ bln./a	16,6	16,4	16,3	16,3	16,1
per product*	Product price	€	981	985	987	989	1050
	Install cost	€	450	450	450	450	450
	Energy costs	€ /a	762	743	740	739	727
	Maintenance costs	€ /a	82	82	82	82	82
	Discount rate payback ***	years	reference	**0,3**	**0,4**	**0,5**	**2,5**
* all money are not inflation corrected							
*** payback is discount rate corrected							

Figure 5.11: Increased product price per cut off level by 50%

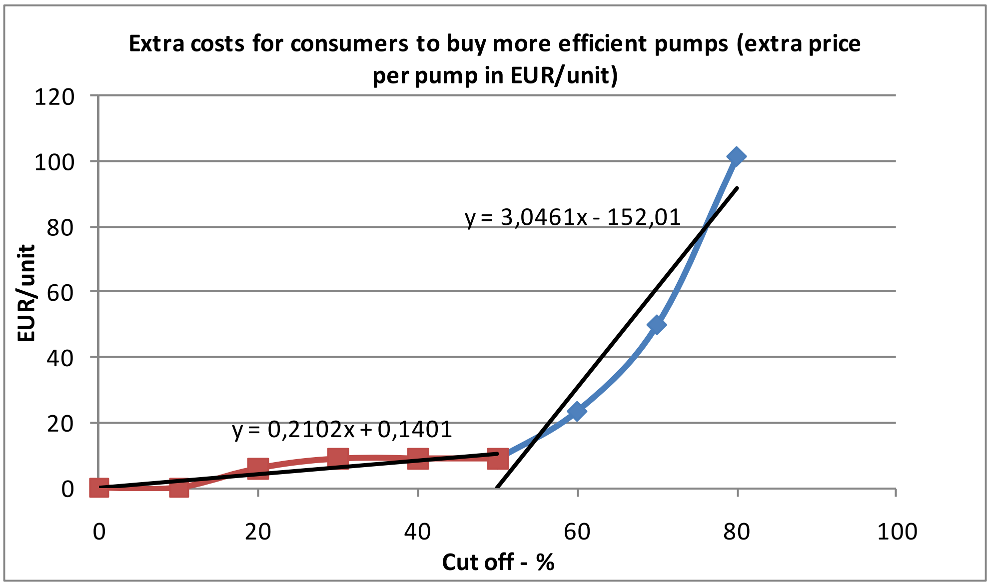


Table 5.12: Simple payback period (SPP) when decreased electricity price

MAIN IMPACTS							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
ENVIRONMENT							
	Electricity	PJ/a	**1226**	**1203**	**1200**	**1197**	**1184**
	GHG	Mt CO2 eq./a	**62**	**61**	**61**	**61**	**60**
	Electricity	TWh/a	**136**	**134**	**133**	**133**	**132**
CONSUMER							
EU totals*	Expenditure	€ bln./a	**13,6**	**13,4**	**13,4**	**13,4**	**13,4**
	Purchase costs	€ bln./a	2,8	2,8	2,8	2,8	2,8
	Running costs	€ bln./a	10,8	10,7	10,6	10,6	10,5
per product*	Product price	€	981	984	985	987	1027
	Install cost	€	450	450	450	450	450
	Energy costs	€ /a	467	455	454	453	446
	Maintenance costs	€ /a	82	82	82	82	82
	Discount rate payback ***	years	reference	**0,3**	**0,4**	**0,5**	**2,7**
* all money are not inflation corrected							
*** payback is discount rate corrected							

The electricity price used in this impact assessment is 0.082 EUR/kWh (2005) excl. tax and an annual increase on 2 %. The price derives from the preparatory study, further explained in Annex II. According to the European energy trends[26] the electricity price is assessed to be 0.063 EUR/kWh (2005) excl. tax and an annual increase on 0.48 %. This will somehow show the price sensibility in the impact assessment, and hence used as parameter.

[26] European Commission DG Energy and Transport 'European Energy and Transport – Trends to 2030 – Update 2007'

Table 5.13: Decreased CO_2 emission factor

MAIN IMPACTS							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
ENVIRONMENT							
	Electricity	PJ/a	**1226**	**1203**	**1200**	**1197**	**1184**
	GHG	Mt CO2 eq./a	**54**	**53**	**52**	**52**	**52**
	Electricity	TWh/a	**136**	**134**	**133**	**133**	**132**
CONSUMER							
EU totals*	Expenditure	€ bln./a	**19,4**	**19,1**	**19,1**	**19,1**	**19,0**
	Purchase costs	€ bln./a	2,8	2,8	2,8	2,8	2,8
	Running costs	€ bln./a	16,6	16,4	16,3	16,3	16,1
per product*	Product price	€	981	984	985	987	1027
	Install cost	€	450	450	450	450	450
	Energy costs	€ /a	762	743	740	739	727
	Maintenance costs	€ /a	82	82	82	82	82
	Discount rate payback ***	years	reference	**0,2**	**0,2**	**0,3**	**1,7**
* all money are not inflation corrected							
*** payback is discount rate corrected							

According to Annex II the CO_2 emission factor is changed to 0.393 kg CO_2 eq./kWh.

In summary, reducing electricity price shows a payback time between 0.3 and 2.7 years for the considered sub-options compared with 0.2 and 1.7 years for the reference situation. While strong increase in product price per cut off level leads to payback periods between 0.3 and 2.5 years compared with 0.2 and 1.7 years for the reference situation.

Reducing the CO_2 emission factor does only influence the CO_2 emission (GHG-emission). The reduction of CO_2 emission factor shows a total GHG-emission on 52 Mt CO_2 eq./a for the considered sub-options compared with 62 Mt CO_2 eq./a for the reference situation. However the saving will in both situations be 2 Mt CO_2 eq./a.

SECTION 6: CONCLUSIONS

The table below give an overview of impacts.

Table 6.1: Overview of main impacts.

MAIN IMPACTS							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
ENVIRONMENT							
	Electricity	PJ/a	**1226**	**1203**	**1200**	**1197**	**1184**
	GHG	Mt CO2 eq./a	**62**	**61**	**61**	**61**	**60**
	Electricity	TWh/a	**136**	**134**	**133**	**133**	**132**
CONSUMER							
EU totals*	Expenditure	€ bln./a	**19,4**	**19,1**	**19,1**	**19,1**	**19,0**
	Purchase costs	€ bln./a	2,8	2,8	2,8	2,8	2,8
	Running costs	€ bln./a	16,6	16,4	16,3	16,3	16,1
per product*	Product price	€	981	984	985	987	1027
	Install cost	€	450	450	450	450	450
	Energy costs	€ /a	762	743	740	739	727
	Maintenance costs	€ /a	82	82	82	82	82
	Discount rate payback ***	years	reference	**0,2**	**0,2**	**0,3**	**1,7**
* all money are not inflation corrected							
*** payback is discount rate corrected							
BUSINESS							
EU turnover	Manufacturers	€ bln./a	**1,6**	**1,6**	**1,6**	**1,6**	**1,6**
	Wholesalers	€ bln./a	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**
	Installers	€ bln./a	**2,5**	**2,5**	**2,5**	**2,5**	**2,5**
EMPLOYMENT							
			Scenario's 2020				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
Employment (jobs)	industry EU (incl OEM)	'000	14,5	14,6	14,6	14,6	15,2
	OEM non EU	'000	0,7	0,7	0,7	0,7	0,7
	w hole-sale	'000	1,3	1,3	1,3	1,3	1,3
	installers	'000	51,7	51,7	51,7	51,7	51,7
	TOTAL	'000	**68,2**	**68,2**	**68,2**	**68,2**	**68,9**
	of w hich EU	'000	67,4	67,5	67,5	67,5	68,2
	EXTRA EU jobs	'000	reference	**0,0**	**0,1**	**0,1**	**0,7**
	of w hich SME**		reference	0,0	0,0	0,0	0,2
** partitioning 30% industry & w holesale, 80% installers							

The below table summarizes the considerations on the impacts of the four main options and assesses them on a relative scale: +, ++, +++[27]. '0' means BAU level or no change against its level.

[27] Based on Article 15 of 2009/125/EC, there should be no 'negative' impacts.

Table 6.2: Boundary conditions.

BOUNDARY CONDITIONS ("should be no negative impacts")					
	Scenario's 2020				
IMPACTS "No negative impacts" following Art. 15, sub 5 of 2009/125/EC	**BAU**	**Sub-opt. 1: 10 % cut off in 2013, 30 % cut off in 2014**	**Sub-opt. 2: 10 % cut off in 2013, 40 % cut off in 2014**	**Sub-opt. 3: 20 % cut off in 2013, 50 % cut off in 2014**	**Sub-opt. 4: 40 % cut off in 2013, 70 % cut off in 2015**
Economics	0	+	+	+	+
Social	0	0	+	+	+
Environmental	0	+	+	+	++
Industrial	0	++	+	-	--

The sub-option 4 provides more savings than sub-options 1-3, which are rather close to each others in this respect. However, the redesign cost for the industry is manifold, depending on the way of calculating the cost, compared with other sub-options.

As stated in Chapter 5, there is no method available to create a hierarchy between the cost to industry and the benefit to the consumers in terms of LLCC. In the case of water pumps, the claimed cost to industry increase by hundreds of millions from one cut off rate to another while the change in life cycle cost to consumer is within the range of 5% (variation between €23.5 and €22.9 billion/a). Due to the uncertainties related to the available data, cost to the industry in the present economic downturn and the minor increase in LLCC, a compromise level of C-40% was put forward by the preparatory study.

This impact assessment has not been able to identify arguments to go against the stakeholder views and the proposals of the preparatory study. Consequently, the above table shows that an Ecodesign implementing measure on pumps (sub-option 2) should become effective on 2013 and 2014. This would lead to 40% cut off of pump types (currently on the market) from the market by 2014.[28]

This would provide the appropriate balance between an improved environmental impact of pumps, including technical feasibility, and cost benefits for the end user (due to reduced electricity consumption), on the one hand, and possible additional burdens for manufacturers (in particular due to unplanned re-design) on the other hand. In particular:

- cost-effective reduction of electricity losses of pumps;
- a payback time of less than 2 years ensures that the requirements are affordable to the consumers;
- correction of market failures and proper functioning of the internal market;
- no significant administrative burdens for manufacturers or retailers;

[28] Compare with e.g. glanded pumps of which 97% of actual pumps are cut off from the market by the Regulation on circulators, or with motors of which above 95% of actual motors be cut off from the market by 2017.

- a 'marketing tool' for the for-runner industry in form of an information request on the actual and benchmark efficiency of the product;

- very slightly increased purchase cost, which would be largely compensated by savings during the use-phase of the product;

- possibly decreased purchase cost medium-term, when the impact of economies of scale for effective technologies takes place;

- that the specific mandate of the Legislator is respected;

- reduction of the electricity consumption of about 2.8 TWh, corresponding to savings of 0.3 billion EUR and 1.3 Mt of CO_2 by 2020 compared to the "no action" option. The electricity consumption saved corresponds approximately to the annual electricity consumption of the Cyprus;

- a clear legal framework for product design which leaves flexibility for manufacturers to achieve the energy efficiency levels of the second tier already before the coming into force of the second requirement;

- costs for re-design and re-assessment upon introduction of the regulation, which are limited in absolute terms, and not significant in relative terms (per product);

- fair competition by creation of a level playing field;

- no significant impacts on the competitiveness of industry, and in particular for SMEs, in particular as there are very few small manufacturers in pump industry, and due to the fact that several manufacturers already manufacturer high-efficient pumps and a host of other products used in pumping systems;

- no negative impact on employment;

- no identified impact on trade.

SECTION 7: MONITORING AND EVALUATION

The main monitoring element will be the tests carried out for new product conformity. Products placed on the Community market have to comply with the requirements set by the proposed regulation, as expressed by the CE marking. Monitoring of the impacts is mainly done by market surveillance carried out by Member State authorities ensuring that the requirements are met.

The appropriateness of scope, definitions and concepts will be monitored by the ongoing dialogue with stakeholders and Member States. Input is also expected from work carried out in the context of upcoming Ecodesign activities on further product categories, and related activities.

The main issues for a possible revision of the proposed regulation are

– the appropriateness of the levels for the specific Ecodesign requirements;

– the appropriateness of the product scope.

Taking into account the time necessary for collecting, analysing and complementing the data and experiences in order to properly assess the technological progress, a review can be presented to the Consultation Forum no later than seven years after entry into force of the regulation.

ANNEX I: MINUTES OF CONSULTATION FORUM MEETING

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE D - New and Renewable Energy Sources, Energy Efficiency & Innovation
Energy efficiency of products & Intelligent Energy – Europe

Brussels, 22.09.2008

SUMMARY MINUTES

Possible Eco-design Implementing Measures on Pumps under the Directive on the Eco-design of Energy-Using Products (2005/32/EC)

Seventh meeting of the Eco-design Consultation Forum (29th May 2008)

Centre Albert Borschette (CCAB), Room OA, Rue Froissart 36, 1049 Brussels

EC Participants: André BRISAER (Chairman), Ismo GRÖNROOS-SAIKKALA (TREN/D3), Villo LELKES (TREN/D3), Kerstin LICHTENVORT (ENTR/B1)

Introduction

The Chairman welcomed the group and introduced Mr. Hugh Falkner who was responsible for the technical study.

The Commission Staff Working Document (CSWD) on possible Eco-design requirements for pumps was presented (see presentation circulated together with these draft minutes). The CSWD had been made available four weeks prior to the meeting on http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum.

The Commission explained the types of pumps covered by the envisaged measure. Pumps covered by the CSWD are run by motors covered by the motor sub-study, except multistage submersible pumps. Integrated pump/motor products must meet both sets of requirements, those on motors and on pumps. Transmission is not considered as pumps are normally directly attached to the motor and not like fans where belts and chains may be used. Wastewater pumps and pumps with special features are out of scope.

The requirement levels are based on the Lot 11 preparatory study keeping in mind the Article 15 of the Directive. With regard to the benchmark, the best performing product and technology can be identified based on the environmental aspects under consideration, but when determining the most cost-efficient pump it has to be done in the context of each application.

It would have been possible to add extra tiers into this measure but, based on comments received, but the technical study saw a review in the light of technological developments as most appropriate. It is proposed to review the measure after 5 years.

Europump Presentation on 'House of Efficiency'

Europump propose to concentrate not just on the point of best efficiency but also on part load and overload conditions. With the 'House of Efficiency' approach, the level of efficiency of a pump is defined by measuring it on three points (part load, best efficiency point and overload). This ensures more reliable and meaningful efficiency information than the definition of the best efficiency point only.

Stakeholder discussion:

Europump gave details of the cut-off percentages. If worst performing pumps are cut-off from the market, development costs can be expected when a manufacturer does not produce pumps above the cut-off level. These include the development of new types of pumps, the increased production costs of the same types and redesigning all production lines. Europump suggest an average cost to redevelop a pump model type up to be about € 200,000.

ECOS (representing environmental NGO's) queried the figure as every pump model will not be redesigned from scratch and production and design are done in entire pump families. Europump agreed that investment differs and they have included this element in the estimate.

The Netherlands wondered if these costs were taken into account in the life cycle cost analysis as the correct way of proceeding is to add the costs to the price of the product. The physical, non-monetary barriers for efficiency improvement should be the most important issues to be looked at, but these can also be related back to the life cycle cost analysis and products can be marked up to get these costs back.

ECOS supported the point that least life cycle cost should be kept as the major criteria for setting requirement levels as required by Annex II of the Directive. It is necessary to expand production capacity in order to achieve more ambitious requirements with introductory dates carefully considered.

Europump noted that the problem for industry is that the investment comes first before the costs can be recouped, and that there is a wide range of applications to be considered. Ultimately, the most efficient approach is to use the pump which fits best to the application.

A discussion followed on possibly weighting or limiting the **scope** of pump types, which would give the possibility for more ambitious requirements. Splitting the scope or limiting it slightly would mean that industry could accept higher cut-off points faster and, according to ECOS, the cut-off level could go to 70 - 80% rather than the current target of 40%, as this would still be below least life cost level.

Europump was concerned that splitting the scope could lead to manufacturers looking for a way out. It is in the interests of industry to have a measure applicable to all pump types which encourages the improvement of all products. Also, the scope had been discussed carefully during the preparatory study and the current scope ensures that manufacturers cannot simply produce bigger pumps (over-sizing) to avoid meeting requirements. Europump clarified that the cut-off is 40% of the type of pumps, and does not refer to energy consumption as such.

The Chairman summarised that there are two options – to include all products in the scope or just the most sold ones. Considering that sales figures will not be made available and that the LLCC supports the current approach, then it is best to avoid narrowing the scope.

ECOS agreed with the Chairman's conclusion but would like to see higher cut-off rates. He also suggested possibly limiting the scope by type of application, type of pump or pump size by looking at the pumps with the most volume or energy efficiency potential.

The Chairman asked if **market surveillance** authorities would be able check, without excessive cost, the proposed efficiency levels, and whether the SMEs could afford conformity assessment. Europump assured that efficiency can be easily measured; there is just a calculation factor to be implemented based on statistical data. Europump would like to see at least a CE assessment mark and a test assessment for series pumps. As soon as a standard is available, testing will be easy.

ECOS asked about the reliability and transparency of the Europump data. Europump clarified that the only way to get companies to share the data was to send it to an independent research institute that would publish the results anonymously. The methodology and the way companies deliver the data is transparent but it means that only the results and not the data are available. However, the data could be made available for viewing at Darmstadt University (where the work was carried out).

Belgium was concerned about implementation. If 1000 models of pumps will be off the market of a total of some 2000 models of pumps in a few years, how should market surveillance authorities check that they have been removed? Would it be up to the European companies to provide authorities with this information? And what about the products from outside of Europe which have a very different starting point for market surveillance?

The Chairman clarified the role of the CE mark. After the date of entering into effect of the measure, pumps that do not comply with the requirements are not allowed to bear the CE mark anymore and may not be put on the market.

The Chairman asked the floor for suggestions of any additional **information requirements** that might me necessary.

Germany would like to see the efficiency of the pump and the maximum head stated on the nameplate. As the market is mostly professional, there is no need for other information.

Europump commented that this information is already part of the standard marketing information but industry can provide any needed information to aid choice of the consumer.

ECOS would like to see information included about the use of electronic controls and how the pump efficiency is related to the benchmark.

Germany commented that maybe there should also be an information requirement to state the **benchmark** efficiency. This would make it easier for market surveillance to compare against the graph on slide 16 of Commission's presentation.

The Chairman asked stakeholders' views on the 80% cut-off level for the benchmark as suggested in the CSWD.

Europump commented that 80% would be a tough target but is acceptable and cautioned against pulling the customer away from the best pump for the particular application. Mr. Falkner added that the method is sufficiently transparent as the graph in the presentation would give a minimum efficiency level for each type of pump at every duty within the range considered. Concerning the selection of the best pump for the application, the purchaser should ideally consider the efficiency of a selected pump at its actual calculated working point, not select it on the basis of peak efficiency.

ECOS described the cut-off system as a frozen image of market surveillance from last year. However, every year appliances on the market change, leading to a different image of the situation. If an energy efficiency index was developed with every pump with its relative efficiency compared to the maximum on the graph, it would give a better result. The output of the graph could be made more transparent to be easily added to a piece of legislation. Europump will work on making this at the request of the Chairman.

ECOS stresses the need for more ambitious requirements. The current levels were set last year and the market will change in the next 8 years. ECOS wants the 2015 requirements to be set earlier and requires an assessment of the market before the new targets are set in 2015. The Chairman agreed that the market situation will be different in 2015 but noted that we need the situation from last year as a starting point.

Europump asked if the Commission might regulate controlled (**variable speed drive**) pumps in the future as considerable savings could be made there. Commission explained that in principle pumps with VSDs will easily meet the proposed requirements in part load. In the meantime, an information requirement for pumps without VSDs should be considered under the Annex I.2 of the EuP Directive explaining pumps without VSD are less efficient in given part load conditions. The Commission would welcome any proposals that industry has on this issue.

Europump would like to have an EN standard on motors and pumps with VSDs. Good pumps on the market are a must but the potential of VSDs should be addressed. The Chairman stated that the Commission would be happy to help industry and to put a mandate to the standardisation bodies to facilitate faster development of a standard.

ECOS and the UK supported further work on VSDs.

End of summary minutes

ANNEX II: IMPACT ASSESSMENT METHODOLOGY

The electricity consumptions and savings are calculated on the basis of the hydraulic performance of the pump only. The electricity consumption of the motor and the variable speed drives have been considered in a separate impact assessment on motors.

The impact analysis uses the scenario and variable **inputs** as defined in the following paragraphs.

The **calculation method** for the scenario analysis is a so-called **Stock Model,** which means that it is derived from accumulated annual sales and waste figures for water pumps over the period 1990-2020 (with a start-up period 1960-1990). The stock model sets the pace for the scenarios. The direction is determined by trends in terms of increase/decrease in:

- number of sales;
- number of stock;
- hydraulic energy consumption per unit, and
- hydraulic energy efficiency.

The trends are described in the preparatory study. The main variable in the various scenarios is energy and its derived parameters.

Outputs for each scenario are:

- Energy consumption in PJ/a (conversion 1 TWh= 3.6 PJ);
- Carbon emission in Mt CO2 equivalent/a;
- Consumer-related economical parameters: purchase price, energy expenditure, maintenance costs and total expenditure in bln. EUR/a. [2005 prices]];
- Business-related economical parameters: turnover per sector (industry, wholesale, retail, etc.);
- Employment: calculating job creation/loss using the sector-specific turnover per employee.

Final outcomes are presented at aggregation level (totals), but in the intermediate stages a distinction is made by the typology and by size.

Inputs for each scenario are:

Discount rate on 4 % p.a. is used.

The average EU25 electricity prices from the preparatory study are used and weighted between products sold to industry and products sold to domestic (same i.e. household electricity price). All prices are exclusive tax.

Table A.2.1. Total primary energy consumption in the stock (2005).

	Total primary energy **TWh**	**Weight**
Products (sold to industry)	97	89 %
Products (sold to domestic)	12	11 %

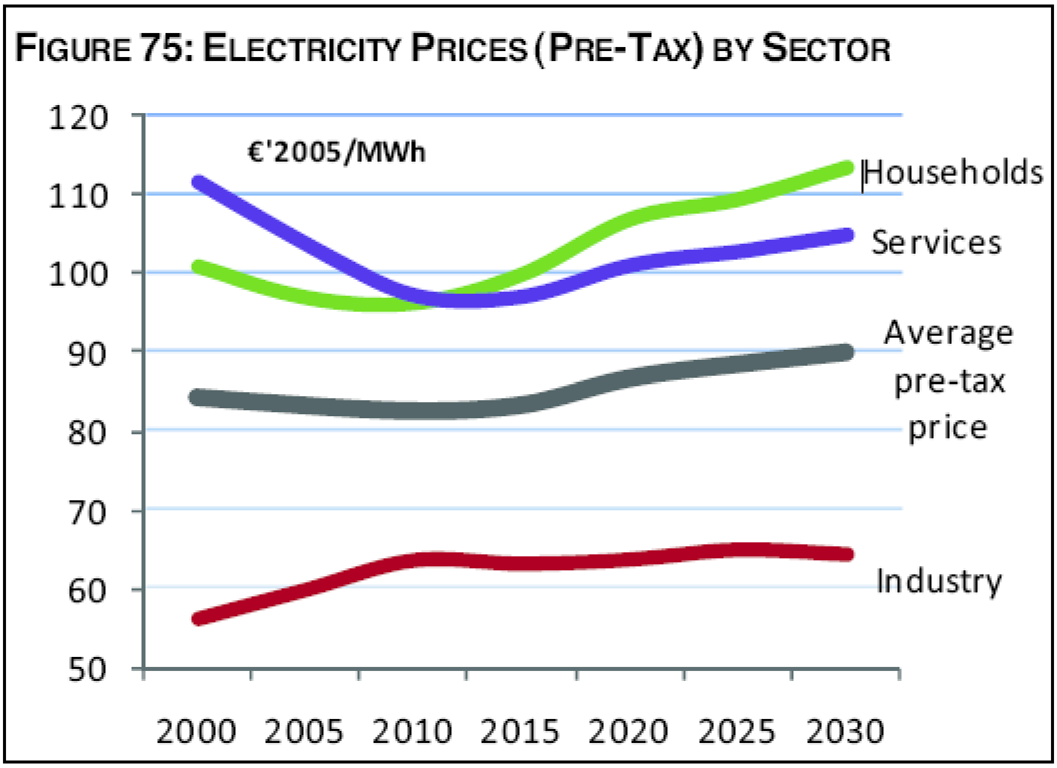
Table A.2.2. Electricity prices exclusive tax from the preparatory study.

	Average EU25 electricity prices (2005)
Industry	0,075 EUR/kWh
Domestic	0,135 EUR/kWh
Weighted	0,082 EUR/kWh

Annual electricity price rate increase of 2 %.

In the publication 'European Energy and Transport – Trends to 2030 – Update 2007' by DG for Energy and Transport the future energy prices by sector are assessed.

Figure A.2.1. Electricity prices exclusive tax by sector (2000-2030).



Summarised the data in Figure A.2.1. are shown in Table A.2.3.

Table A.2.3. Electricity prices exclusive tax from European Energy and Transport – Trends to 2030 – Update 2007.

	Trends 2005	Trends 2030	Annual electricity price rate increase
Industry	0.060	0.065	0.32 %
Domestic	0.085	0.115	1.22 %
Weighted (Table A.2.1.)	0.063	0.071	0.48 %

The preparatory study has found rather large discrepancy between Eurostat sales data for EU 27 and water pump sales data provided by Europump. The study chooses to use the Europump data. The Europump data are used also in this impact assessment. It must be noticed that there is a certain margin of uncertainty in the sale and stock data used in the analysis.

The preparatory study and thus the impact assessment follow the recommendations of the Methodology Study MEEUP 2005 (main report page 97), which says:

EU-15 electricity in 2001 (mix 25% solid fuel, 25% gas and oil and 50% non fossil fuel)[29] equals 0.400 kg CO_2/kWh. New EU-10 electricity (mix 65% coal and 35% non fossil fuel)[30] equals 0.580 kg CO_2/kWh. Weighted average (weighted by electricity production) equals 0.430 kg CO_2/kWh.

Adder for fossil fuel extraction and transport is 10% and subtract credit for waste heat use (CHP/ DH) is -10%[31]. This equals 0 % adder to 0.430 kg CO_2/kWh.

Adder for electricity distribution losses is 5%, this equal a CO_2 emission factor on 0.43 kg CO_2/kWh * 1.05 = 0.452 kg CO_2/kWh.

Adder for non-CO2 emissions: MEEUP takes into account non-CO_2 emissions. Explicitly SF_6 emissions (0.1 mg/kWh[32]), during electricity transmission is mentioned. According to IPPC the GWP-100 of SF_6 is 22,800, which means that 0.1 mg equals 2.28 g CO_2. In total 0,006 kg CO_2/kWh is partitioned for non-CO_2 GHG emissions.

Total: 0.452 + 0,006= 0.458 kg CO2 eq./kWh. This value is used in the impact assessment.

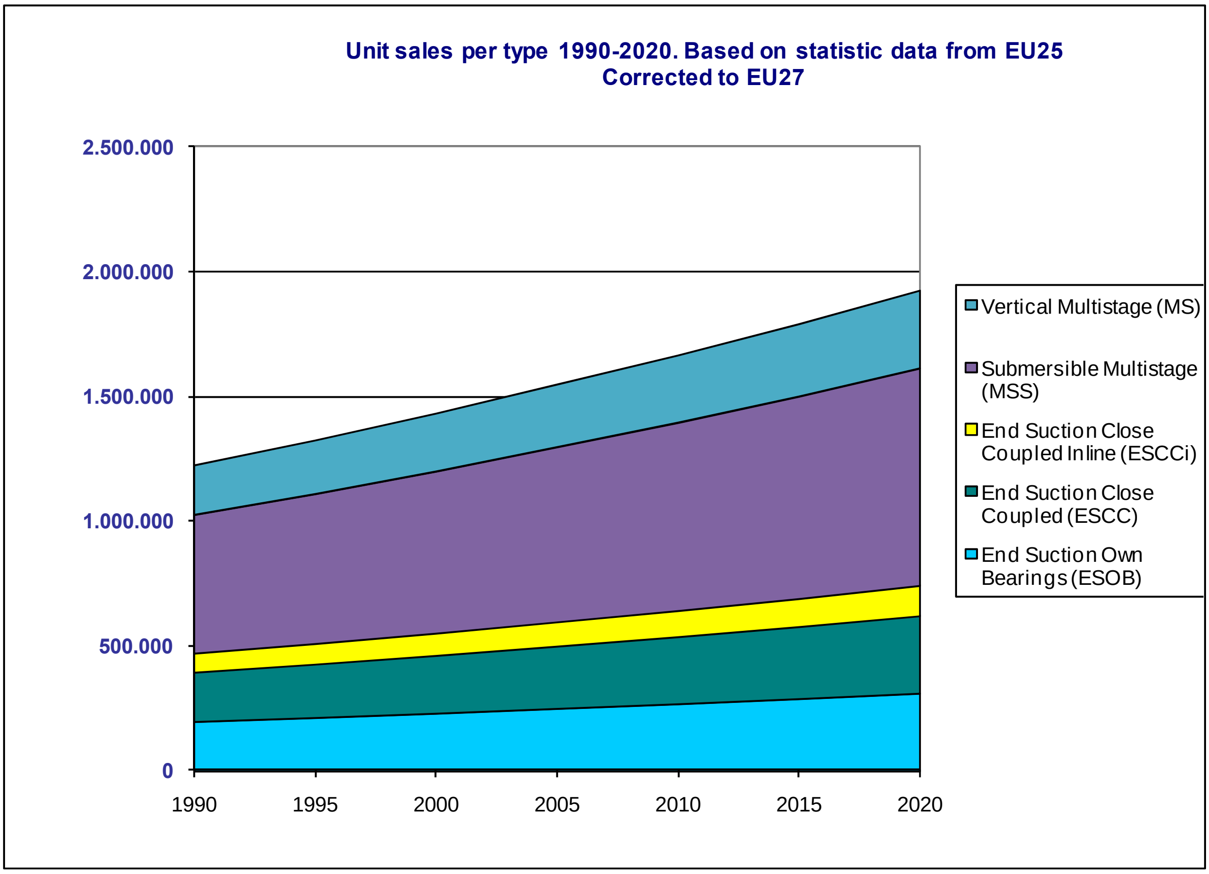
CO_2 emission on 0.430 kg CO_2/kWh in 2001 is roughly in line with the MEEUP Study, which calculate 0.410 kg CO_2/kWh in 2005. Projection for 2020 is 0.350 kg CO_2/kWh[33]. To make the result comparable with MEEUP: 0.350 kg CO_2/kWh * transmission loss (1.05) + SF_6 emissions (0.006) = 0.374 kg CO_2 eq./kWh in 2020.

29 Source: EPER 2001
30 Source: EU country statistics 2000-2004
31 Source: GEMIS database
32 Source: CIGRE
33 Source: DG Energy and Transport 'European Energy and Transport – Trends 2030 – Update 2007'

For projections of the effect of measures until 2020, the average over the 2010-2020 period (i.e. 2015) is probably most appropriate, which is 0.393 kg CO_2 eq./kWh in 2015.

In the sensibility analysis 0.393 kg CO_2 eq./kWh is compared with 0.458 kg CO2 eq./kWh used in this impact assessment.

Figure A.2.2. Annual water pumps sale in the period from 2005 to 2020 (x1000).



ANNEX III: BAU OPTION AND BASE CASE KEY INPUTS

Sales, stock and hydraulic energy consumption

The base case represents the average product sold in the reference year 2005. The 2005 water pump unit sales amount to about 1.55 million units.

The BAU scenario (and other scenarios) is carried out for five types of water pumps in two typical relative sizes (small and large), which are considered being the representative within the groups of water pumps. Data on water pump size, price and sales in 2005 is shown in table below.

The assumptions to the baseline scenario (tariffs for households and businesses, changes of electricity prices over time, CO2 price etc) are based on the MEEuP methodology[34] used uniformly for all ecodesign preparatory studies and impact assessments

The selection of base case and the price and sales data are based on the preparatory study building on the MEEuP methodology. According to the study there is a margin of uncertainty in the sales data, which causes a corresponding uncertainty in the stock data used in the analysis.

Table A.3.1. Main data for water pumps base cases (in 2005)[35]

Type of pump	Size	Typical rated flow m^3/h	Typical rated head m	Price EUR/unit	Estimted sales Units in 2005	Estimated stock Units in 2005
End Suction Own Bearings (ESOB)	Small	30	30	440	200,000	2,200,000
End Suction Own Bearings (ESOB)	Large	125	32	1,000	50,000	550,000
End Suction Close Coupled (ESCC)	Small	25	32	900	200,000	2,200,000
End Suction Close Coupled (ESCC)	Large	125	32	3,300	50,000	550,000
End Suction Close Coupled, Inline (ESCCi)	Small	25	32	900	80,000	880,000
End Suction Close Coupled, Inline (ESCCi)	Large	125	32	3,300	20,000	220,000
Submersible Multistage (MSS)	Small	8.5	59.2	910	560,000	6,160,000
Submersible Multistage (MSS)	Large	15	88	1,000	140,000	1,540,000
Vertical Multistage (MS)	Small	4	45	1,000	200,000	2,200,000
Vertical Multistage (MS)	Large	10	42	1,000	50,000	550,000
Sum					1,550,000	17,050,000

The aggregated scenario for all five types of water pumps is carried on the basis of average weighted energy consumption (average of small and large taking into account the number of sales of each water pump type). The average weighted energy consumption for a base case water pump is estimated to be 6,904 kWh/a and an average total hydraulic efficiency of 66.5 % in 2005.

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34 MEEUP Methodology Report to the European Commission, Methodology Study Eco-design of Energy-using Products, VHK, Delt, 28.11.2005.

35 Preparatory study p. 30

The annual unit sale and the estimated size of the stock in the period from 1990 until 2025 are shown in table below. The annual sale and the stock are assumed to be the same in all scenarios.

Table A.3.2. Total water pumps sales, stock, and average weighted energy consumption of pump stock (BAU scenario).

Energy, sales and stock							
	1990	1995	2000	2005	2010	2015	2020
Electricity consumption per unit (kWh/a UNIT)	6,904	6,904	6,904	6,904	6,904	6,904	6,904
Average efficiency in stock (hydraulic)	66.5%	66.5%	66.5%	66.5%	66.5%	66.5%	66.5%
Sales units	1,226,752	1,326,219	1,433,750	1,550,000	1,666,250	1,791,219	1,925,560
Stock units	12,526,410	13,522,114	14,612,601	15,797,406	17,050,000	18,354,906	19,731,524

According to the BaU scenario, the 2005 hydraulic energy consumption of all water pumps amounts to about 109.1 TWh/a.

The MEEUP model states that energy consumption should be calculated based on actual and test standard conditions. However, there is currently no test standard condition, and so in order to derive the base case model, an assumed flow profile was used, based on the experience of the study team[36].

Table A.3.3. BEP in the MEEUP model.

% of BEP flow	% of time at this flow
50	25
75	50
100	20
125*	5

The energy performance of each pump was then calculated using assumed efficiency in part load, average lifetime decrease in efficiency, and a standard annual running hours.

36 Preparatory study p. 79

Figure A.3.1. Distribution of water pumps

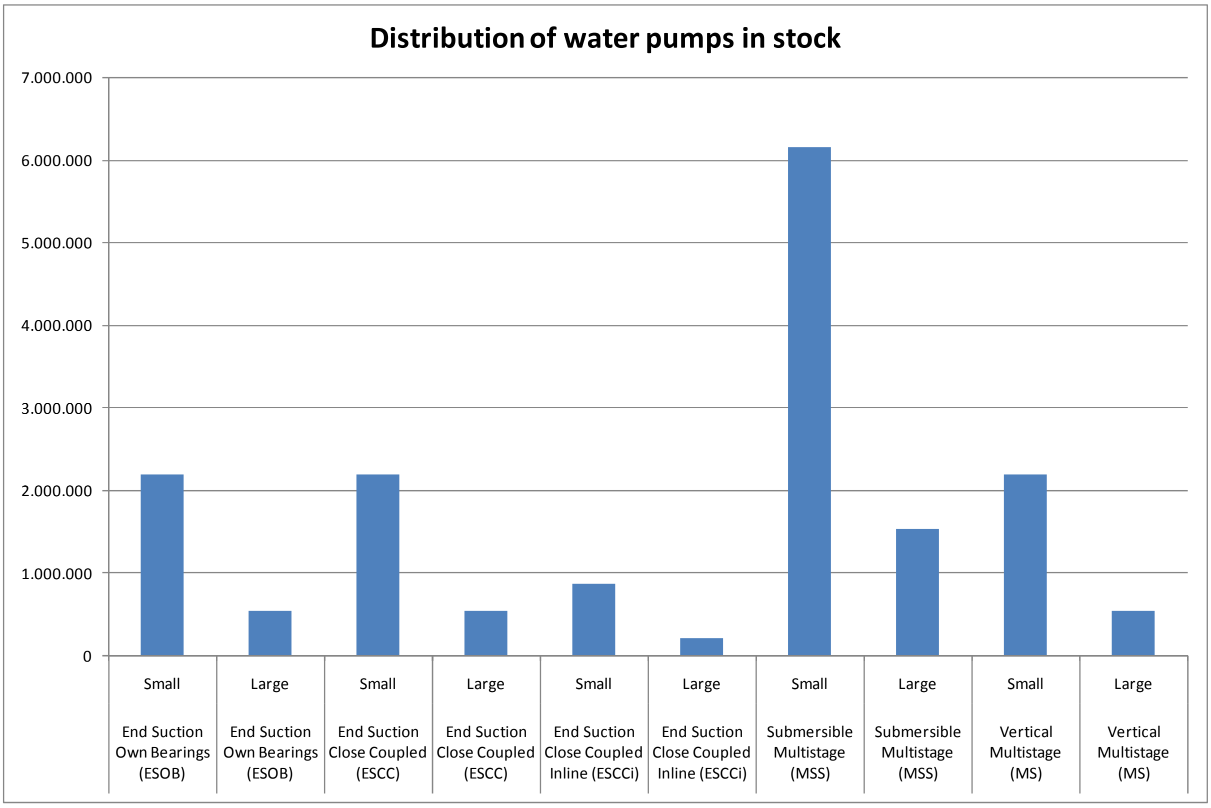
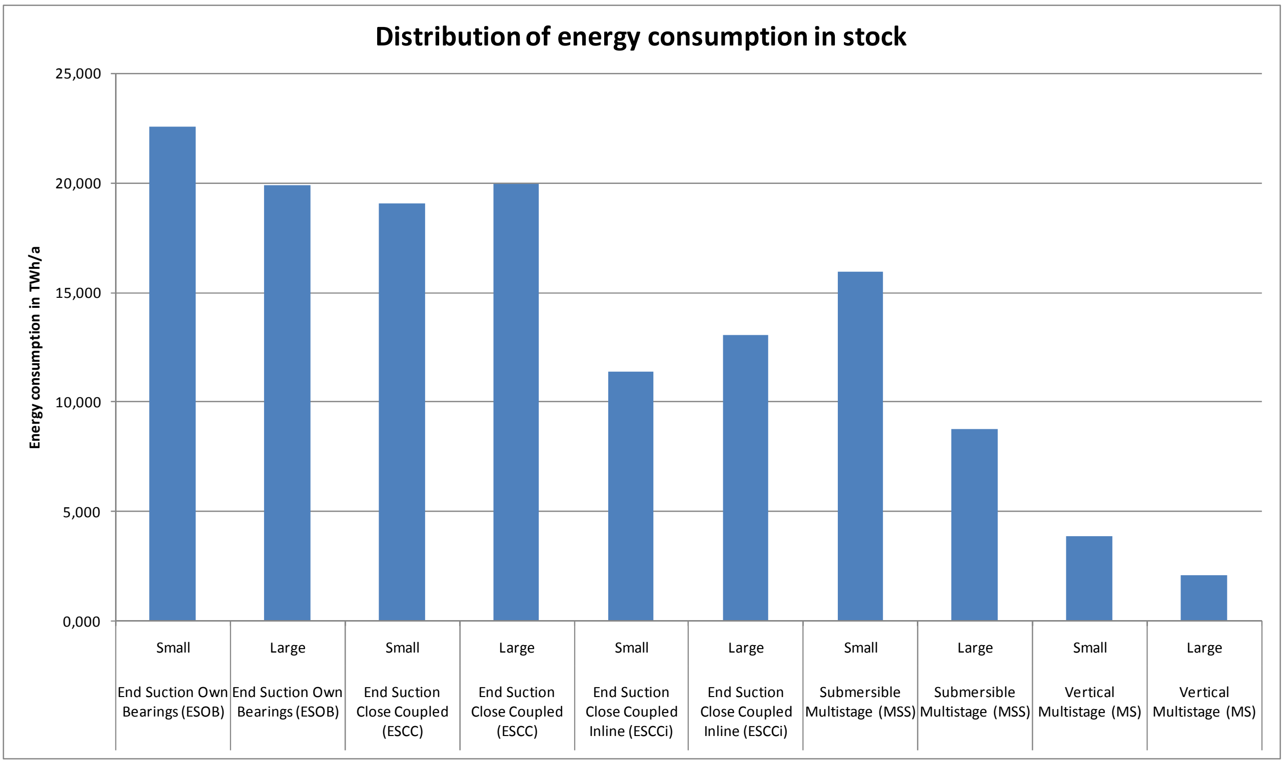
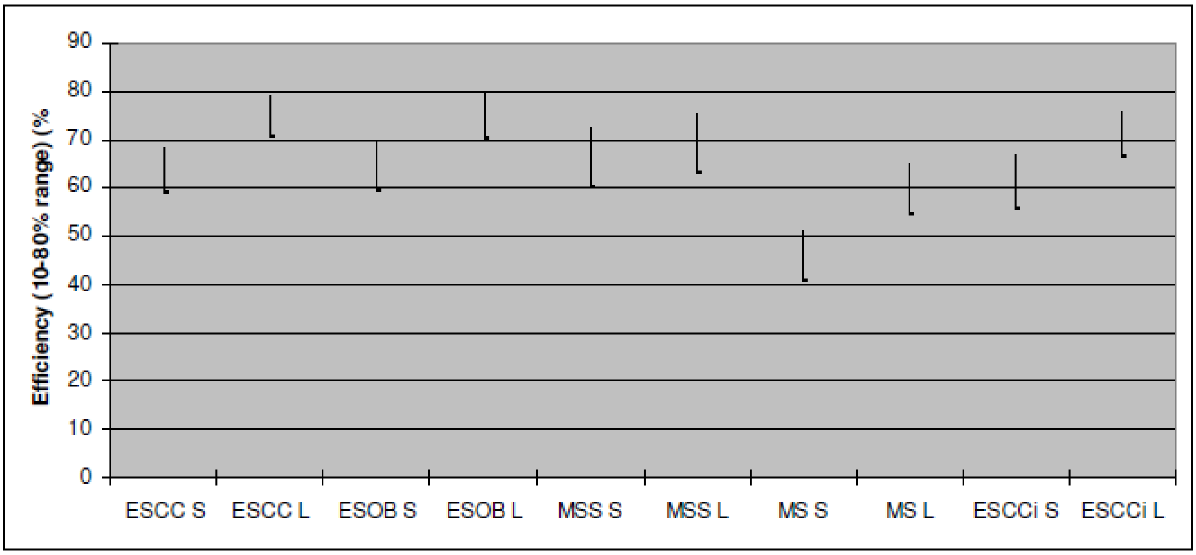


Figure A.3.2. Distribution of energy consumption of water pumps



The below figure on the range of actual efficiencies per pump type shows that the difference between the least and most efficient pump is only, as a rule, around 10 percentage points. This in its turn explains partly the low level of savings offered when moving from one decile to another[37].

Figure A.3.3. - Distribution of water pump spread of actual efficiencies in 2005.



Not only in terms of energy, but also in terms of emissions, the use phase is dominant, mainly because of the emissions from power generation. The carbon emissions are set at 0.458 kg CO_2 equivalent/kWh electricity[38]. Acidification emissions are set at 0.0027 kg/kWh electricity[39]. The production phase is the most relevant for the waste generation.

BAU scenario trends 1990-2020

Using base case 2005 as an anchor point, the projections 2005-2020 are based on the following assumptions and trend (for all types of pumps):

- Annual sales growth: 1.5 percent p.a.;
- Average product life: 11 years;
- Pump running hours per year: 1,000-4,000 (depending on the water pump type);
- Installation costs: 450 EUR and;
- Maintenance costs in life time: 900 EUR.

In the preparatory study, it is assumed that installation costs and maintenance costs are significantly higher but the impact assessment found the figures unrealistic and hence downgraded these costs on the basis of the assumption that installation will in average take 15

37 This becomes obvious when one divides the depicted spread of efficiency in ten deciles.

38 Compare EU-15 energy-related CO2 equivalent 2005 is 3357 Mt, so approximately 1.5 % (Kyoto-relevance). For EU-27 approximately 4000 Mt (1.3 %)

39 Compare EU-15 total in 2005: 10,945 kt SOx equivalent (2.6 %). Gothenburg-relevance (also NEC Directive)

hours and maintenance will in average require 30 hours during lifetime. The average EU time rate is set to 30 EUR/h[40].

In the BAU scenario without any new policy measures no increase in the energy efficiency is expected to happen until 2020. The energy efficiency trend assumed in the BAU scenario appears in table below.

Table A.3.4. Energy efficiency trends for water pumps (base case)

Type of pump	Size	Hydraulic efficiency
End Suction Own Bearings (ESOB)	Small	65.0%
End Suction Own Bearings (ESOB)	Large	72.0%
End Suction Close Coupled (ESCC)	Small	65.0%
End Suction Close Coupled (ESCC)	Large	73.0%
End Suction Close Coupled Inline (ESCCi)	Small	62.0%
End Suction Close Coupled Inline (ESCCi)	Large	70.0%
Submersible Multistage (MSS)	Small	63.0%
Submersible Multistage (MSS)	Large	73.4%
Vertical Multistage (MS)	Small	60.0%
Vertical Multistage (MS)	Large	65.0%
Weighted average		66.5 %

General considerations

Because labelling is not considered as an appropriate measure for pumps (mainly industrial and basically 100% installed by professional installers) only sub-options on eco-design requirements are carried out. The sub-options are based on the Ecodesign preparatory study on pumps and on the stakeholder requests. Two introductory dates are proposed under each sub-option. As a revision of the foreseen Regulation is proposed in five years after the coming into force of the Regulation (that is 2014/2015), no third introductory dates are proposed. This will ensure that possible subsequent requirements be based on the most accurate data available.

Sub-option 1 (Cut-off at 10 % + cut-off at 30 %)

Requirements are implemented in two stages at levels as follows:

In 2013: cut-off at 10 %;

In 2014: cut-off at 30 %.

This sub-option is proposed by the industry (Europump).

Sub-option 2 (Cut-off at 10 % + cut-off at 40 %)

Requirements are implemented in two stages at levels as follows:

40 "Preparatory studies for Requirements of Ecodesigns – Lot 11 on electric motors, water pumps, circulators in buildings and fans for ventilation in non-residential buildings. Appendix 7: Lot 11 - 'Circulators in building' 8 April 2008, available on Eco Motors website http://www.ecomotors.org/files/Lot11_CirculatorsInBuildings_DraftFinalReport.pdf

In 2013: cut-off at 10 %;

In 2014: cut-off at 40 %.

The second sub-option is based on the preparatory study and on the CSWD.

Sub-option 3 (cut-off at 20 % + cut-off at 50 %)

Requirements are implemented in two stages at levels as follows:

In 2013: cut-off at 20 %;

In 2014: cut-off at 50 %.

The third sub-option is an intermediate level, in terms of level of requirements, developed during the impact assessment due to the important difference between the sub-options 2 and 4.

Sub-option 4 (cut-off at 40 % + cut-off at 70 %)

Requirements are implemented in two stages at levels as follows:

In 2013: cut-off at 40 %;

In 2015: cut-off at 70 %.

The fourth sub-option is proposed by environmental NGOs and some Member States.

An overview of the sub-options is shown in the below figure.

Table A.3.5. Introduction of MEPS – policy options to be considered (cut-off method)

Sub-option	Organisation	2013	2014	2015	2016
1	Industry (Europump)	10 %		30 %	
2	CSWD backed by preparatory study	10 %	40 %		
3	Commission II	20 %	50 %		
4	ECOS, MSs	40 %			70 %

The below tables show the projected development of energy efficiency per sub-option.

Table A.3.6. Development in energy efficiency and unit energy consumption after implementation of ambitious minimum energy efficiency requirements

Average efficiency in stock (hydraulic) [%]							
	1990	1995	2000	2005	2010	2015	2
BaU	66,5%	66,5%	66,5%	66,5%	66,5%	66,5%	6
Sub-opt. 1: 10 % cut-off in 2013, 30 % cut-off in 2014	66,5%	66,5%	66,5%	66,5%	66,5%	68,3%	6
Sub-opt. 2: 10 % cut-off in 2013, 40 % cut-off in 2014	66,5%	66,5%	66,5%	66,5%	66,5%	68,5%	6
Sub-opt. 3: 20 % cut-off in 2013, 50 % cut-off in 2014	66,5%	66,5%	66,5%	66,5%	66,5%	68,6%	6
Sub-opt. 4: 40 % cut-off in 2013, 70 % cut-off in 2015	66,5%	66,5%	66,5%	66,5%	66,5%	69,7%	6

Energy consumption per unit [kWh/a/unit]							
	1990	1995	2000	2005	2010	2015	2
BaU	6.904	6.904	6.904	6.904	6.904	6.904	6
Sub-opt. 1: 10 % cut-off in 2013, 30 % cut-off in 2014	6.904	6.904	6.904	6.904	6.904	6.729	6
Sub-opt. 2: 10 % cut-off in 2013, 40 % cut-off in 2014	6.904	6.904	6.904	6.904	6.904	6.706	6
Sub-opt. 3: 20 % cut-off in 2013, 50 % cut-off in 2014	6.904	6.904	6.904	6.904	6.904	6.695	6
Sub-opt. 4: 40 % cut-off in 2013, 70 % cut-off in 2015	6.904	6.904	6.904	6.904	6.904	6.590	6

Manufacturers and global markets

Water pumps sold in Europe are primarily manufactured in Europe. The market is made of some 15 water pump manufactures of various sizes, without real SMEs or companies dominating the market. All manufacturers are producing also other types of pumps.

The only country in the world with mandatory minimum requirements is the People's Republic of China since December 2005. These requirements are based on a scheme with recommended efficiencies that were in place since 1991. There is also a voluntary efficiency certification scheme in Korea by the Korea Energy Management Corporation (KEMCO).

Original Equipment Manufacturers (OEM)

Water pump manufacturers produce most of the necessary components in house. Therefore, the OEM sector is relatively low. However, there are some OEM manufacturers producing specific materials used in components etc. An OEM factor of about 0.3 as a fraction of manufacturer personnel is considered being realistic. About 20 % of these OEM activities are estimated to take place outside EU.

Wholesale and retail

The wholesale margin on the manufacturer selling price is estimated to be 20 %. Most pumps are sold by installers and hence whole sale. A retail market does not really exist.

Installer

The installation and maintenance cost about equal to the purchase cost of a pump.

Table A.3.7. Variables used for the calculation of employment, turnover etc.

ECONOMICS		
Baseprice	981	Consumer product purchase price [€]
PriceInc	0%	Price increase per efficiency %-point [€/ %] (defined elsewhere, hence 0 % here)
Rmaint	82	Annual maintenance costs [€/ a]
Rmaintinc	0%	Annual cost increase maintenance [%/ a]
Install	450	Install costs [€/]
InstallDec	0.0%	Annual installation cost decrease [%/ a]
Rel	0.082	Weighted electricity rate industry and consumer [€/ kWh electric]
Rgas	0.047	Gas rate [€/ kWh primary GCV]
Roil	0.061	Oil rate [€/ kWh primary GCV]
CO2el	0.458	CO2 emission for electricity, EU27 average [Mt CO2/TWh]
Relinc	2.0%	Annual price increase electricity [%/ a]
Rgasinc	2.0%	Annual price increase gas [%/ a]
Roilinc	2.0%	Annual price increase oil [%/ a]
ManuFrac	83.0%	Manufacturer Selling Price as fraction of Product Purchase Price [%]
WholeMargin	20%	Margin Wholesaler [% of Manufacturer Selling Price]
RetailMargin	0%	Margin Retailer on product [% on wholesale price]
VAT	0%	Value Added Tax [in % on retail price]
ManuWages	0.134	Manufacturer turnover per employee [mln €/ a]
OEMfactor	0.3	OEM personnel as fraction of manufacturer personnel [-]
WholeWages	0.25	Wholeseller turnover per employee [mln €/ a]
RetailWages	0.1	Installer/Retailer turnover per employee [mln €/ a]
ExtraEUfrac	0.2	Fraction of OEM personnel outside EU [% of OEM jobs]
Inflation	0%	Inflation rate (counted possitive in the model) [%/ a]
DiscountRate	4%	Discount rate [%/ a]
ProductLife	11	Life time of the product [years]

Scope of measure and overlap with other products

The scope of the impact assessment report on water pumps follows the scope of the preparatory study, which is based on a common (MEEuP) methodology for Ecodesign preparatory studies. The scope of the study was defined in the terms of reference for a call for tender published by the Commission on the basis of the Article 16.2 of the Ecodesign Directive (pumps are part of electric motor systems). Water pumps were considered as an important first step to savings within the broader family of pump products due to the availability of measurement standards and requirements elsewhere in the world. Water pumps have also been identified as a priority pump type to be regulated due to recent minimum efficiency requirements imposed in China and such plans underway in several other countries; the EU remaining without such requirements would risk further flooding of the EU markets by low efficiency pumps from third countries, where they can not anymore be placed on the market.

Other pumps have special features that make energy efficiency considerations very complex. For example, waste water pumps have very large clearances to allow safe passage of large items, which reduces their efficiency. Reducing clearances will improve the efficiency, but will lead to more frequent clogging and so expensive emergency call-outs with the related financial and carbon costs. Pumps used in chemical industry must comply with strict material and safety requirements, swimming pool pumps must be seen in the context of the system in which they are used (e.g. filters used) etc. An additional EUP study is therefore needed in order to understand the performance requirements of different sorts of pumps.

The high variation of applications and technical parameters will make any technical study more complex than the preparatory study on water pumps. The pragmatic choice of first focusing on circulators and water pumps helps to build up the necessary technical knowledge to tackle the more demanding appliances in the near future (e.g. the preparatory study on water pumps and circulators has led to more vigorous standardisation work in the field of other pump types too).

In terms of scope of the proposed water pump measure, it will have no relation to the forthcoming Regulations on circulators due to different technology (glanded vs. glandless) and application areas (heating systems vs. clean water pumping).

The foreseen motor Regulation is related to the proposed water pump Regulation in the sense that the regulated motors are driving all other water pumps except submersible multistage water pumps', which have their own specific motor. However, as only the hydraulic efficiency of the pump is considered, there is no overlap in energy consumption or savings with the motor (the motor Regulation only regulates the efficiency of transforming electrical energy to mechanical energy without taking into account the energy consumption of the load = pump).

The savings from circulators and motors are related to reduction of losses in the product in different ways. The savings potential of the considered water pumps is related (apart from materials used) to the hydraulic performance of the appliance. Basically this relates to the physical design of the interior part of the pump and to its relation to pumping duty.

The savings from circulators are partly related to hydraulic performance of the product, but the main focus is in reducing the losses in turning the electrical energy into mechanical energy for the needs of the hydraulic part of the 'pump'; a circulator includes an inbuilt motor. Consequently, in the preparatory study for circulators the total efficiency (motor + 'pump') was considered, while for water pumps only the hydraulic performance was considered.

The savings from a motor are related to the reduction of losses in turning the electrical energy into mechanical energy, including the use of control technology in variable speed and load applications. The impact of the pump is not considered together with its motor due to an endless variation of applications (load and speed patterns).

ANNEX IV: CUT-OFF CALCULATION METHOD

This Annex describes the method to define a minimum level of pump efficiencies based on statistical evaluations by Technical University Darmstadt.

Chair of Fluid
Systems Technology

Prof. Dr.-Ing. Peter Pelz
Prof. Dr.-Ing. Bernd Stoffel

Final report of EUROPUMP Joing Working Group on EuP concerning activities on "A method to define a minimum level for pump efficiencies based on statistical evaluations"

Darmstadt, 17.09.2007

Execution of evaluation: Chairman of the institute:

Dr.-Ing. Miriam Roth

Dr.-Ing. Gerhard Ludwig

Dipl.-Ing. Valérie Bischof

Prof. Dr.-Ing. Peter Pelz

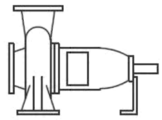
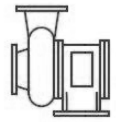
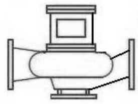
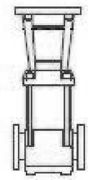
Objectives

The following report is the result of the EuP Joint Working Group (JWG) of EUROPUMP, the European Association of Pump Manufacturers. It takes into account aims of the study group for LOT11 (AEA – Future Energy Solutions) and concerns of the manufacturers participating in the JWG.

The purpose of this work was to propose a concept of a go/no-go scheme for pump efficiency evaluation. The pumps considered are water pumps in commercial buildings, for drinking water pumping, food industry and agriculture. A minimum level limit (bottom curve) for the efficiency values of several pump types was to be determined. Each pump is characterized by its type, its specific speed n_s and its size.

In order to obtain data which is representative for a customary pump selection, 16 manufacturers of 7 EU countries have given pump values of flow rate, head and efficiency at the best efficiency point (b.e.p.) as well as at part load ($0.75 \cdot Q_{b.e.p.}$) and overload ($1.10 \cdot Q_{b.e.p}$). 5 different pump types with 2-pole as well as 4-pole electric motors have been considered (see Table 1); the total amount of pump data processed was 2390.

Table A-4.1: Water pumps considered in the investigation

Pump Type		Number of Pumps	
		4-pole motor	2-pole motor
ESOB End Suction Own Bearings pump		532	412
ESCC End Suction Close Coupled pump		435	364
ESCCI Inline End Suction Close Coupled pump		187	165
MS Multistage pump		55	85
MSS Submersible Multistage pump		-	155
		∑ 2390	

Section 1: Efficiency considerations

<u>Data processing</u>

The specific speed n_s of each pump of the data was calculated

$$n_s = n \cdot \frac{Q^{\frac{1}{2}}}{\left(\frac{H}{i}\right)^{\frac{3}{4}}}$$

Specific speed n_s [min^{-1}]

Rotational speed n [min^{-1}]

Flow rate Q [m^3/s]

Pump head H [m]

Number of stages i [-]

The range of specific speed of all pumps is from n_s 6 to 110.5 min^{-1} (approximately 312 to 5746 rpm in US-units), and the range of flow rate is from 1.8 to 1200 m^3/h (approximately 8 to 5280 gpm). The below figures show the range of specific speed and of the flow rate for each pump type.

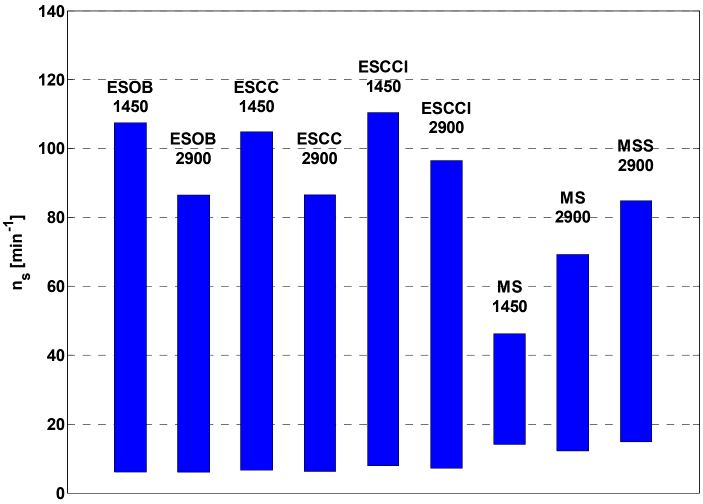


Figure A4-1: Range of specific speed of the data

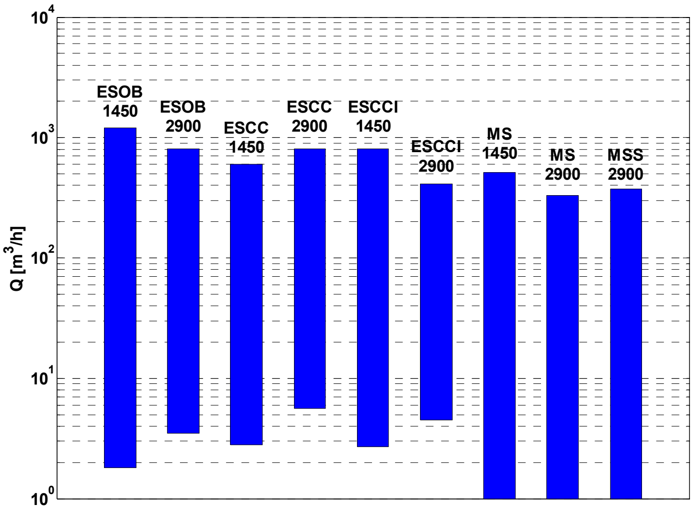


Figure A4-2: Range of flow rate of the data

Scope

It was agreed by the EuP-JWG that the scope of water pumps having to fulfil the minimum efficiency requirement is defined as follows (see Table 2 and Appendix 1):

Table A4-2: Hydraulic scope according to the pump type

Pump type	**Defined scope**				
ESOB ESCC ESCCI	n = 1450 min^{-1}	$Q_{b.e.p.}$ ≥ 6 m^3/h	$H_{b.e.p.}$ ≤ 90 m	6 min^{-1} ≤ n_s ≤ 80 min^{-1}	P_2 15 kV
ESOB ESCC ESCCI	n = 2900 min^{-1}	$Q_{b.e.p.}$ ≥ 6 m^3/h	$H_{b.e.p.}$ ≤ 140 m	6 min^{-1} ≤ n_s ≤ 80 min^{-1}	P_2 15 kV
MS	n = 2900 min^{-1}			$Q_{b.e.p.}$ ≤ 100 m^3/h	
MSS	3“ ≤ nominal size ≤ 6“				

Scheme: 'House of Efficiency'

The decision scheme 'House of Efficiency' [1] takes into account design and application purposes as well as the pump minimum efficiency dependence on flow. The minimum acceptable efficiency is therefore different for each pump type. The pass-or-fail scheme is based on two criteria A and B.

Criterion A is the pass-or-fail minimum efficiency requirement at the best efficiency point (b.e.p.) of the pump:

$$\text{(A)} \quad \eta_{Pump}(n_s, Q_{BEP}) \geq \eta_{BOTTOM}$$

Criterion B is the pass-or-fail minimum efficiency requirement at part load (PL) and at overload (OL) of the pump:

$$\text{(B)} \quad \eta_{BOTTOM-PL,OL} \geq x \cdot \eta_{BOTTOM}$$

That leads to bottom lines specific to each pump type at a certain flow (see fig. A4-3) which have to be defined, based on statistical data.

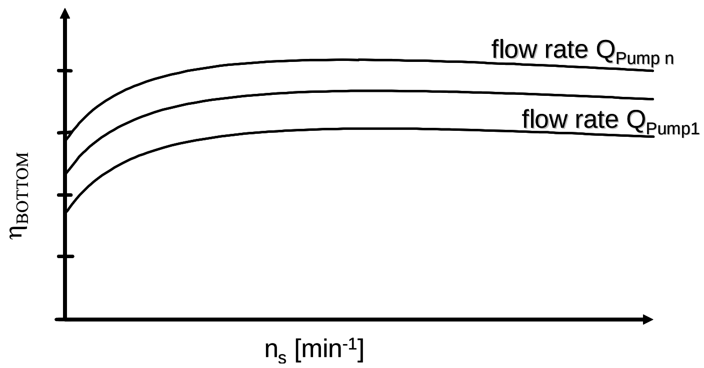


Figure A4-3 : Bottom lines for different geometrical pump sizes (defined for nominal flow rate Qn > Q1) within one pump type (e.g. ESCC) [1]

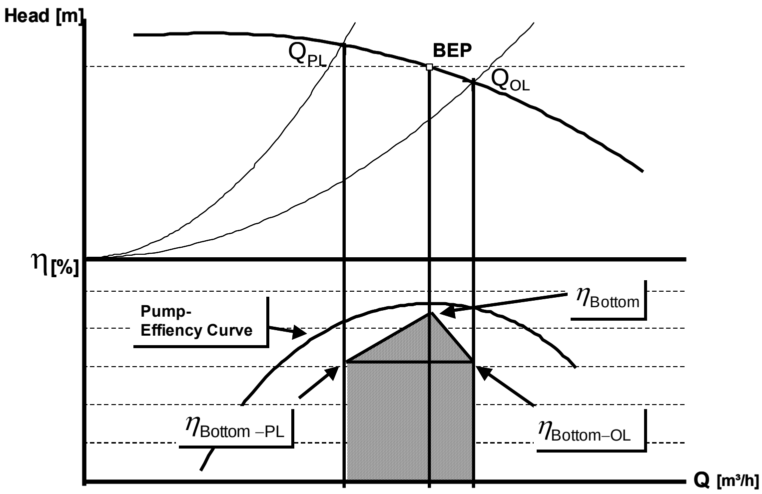


Figure A4-4: 'House of Efficiency' – explanatory representation of proposed scheme in a η(Q):flow-Plot [1]

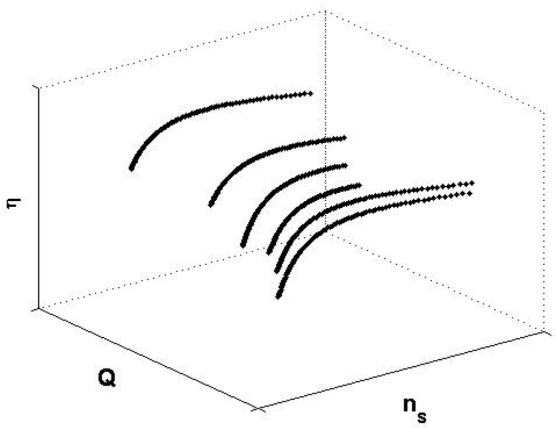
In figure A4-4 the representation of the two criteria is shown in an η(Q):flow-plot. The pump efficiency curve with its maximum at the best efficiency point does not cross the 'roof of the efficiency house'. The part and over load minimum acceptable efficiencies at $0.75 \cdot Q_{BEP}$ and $1.10 \cdot Q_{BEP}$ build the roof-triangle with the minimum acceptable efficiency at best efficiency point. As a result, the pump efficiency curve has to be broad and high to fulfil the criteria. The shown example is for a pump passing the agreed efficiency criteria (not yet set) and would therefore pass the energy efficiency check. Subsequently it would be eligible for CE-marking in accordance with the applicable Directive. Pumps with robust trade-off criteria like NPSH, noise, application for dirty water or other aspects should separately be considered with their own minimum acceptable efficiency and specific factor 'X' to be defined.

The application of this scheme requires the definition of pump specific bottom lines for different flows (see figure 3) as well as the factor *x* for part load and overload based on the statistical data provided by the manufacturers.

Minimum efficiency requirement and cut-off values

Since the efficiency bottom limit mainly depends on the specific speed and on the flow rate of a pump, it should be described by a three-dimensional plane. The shape of the plane was defined using data from a previous investigation carried out by the Technische Universität Darmstadt in 1998 [3]. A statistical evaluation of data collected from several questionnaires sent to European pump manufacturers was carried out and an envelope of the data of the efficiency values over n_s was created for 6 distinct flow rates under consideration of physical laws which determine dependence of pump internal losses on geometrical and operational pump data (as shown in figure A4-5).

The six curves were extrapolated (quadratic polynomial) to the limits of the scope considered in this investigation and a plane fitting the curves (linear interpolation) was created (as it is shown in figure A4-6).



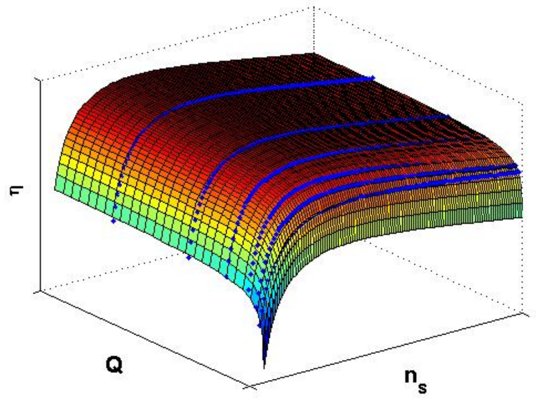

η
Q
n_s

Figure A4-5: Curves from previous investigations
Figure A4-6: Extrapolated curves

The mathematical description of the plane was obtained by means of a 3-d quadratic polynomial approximation. The equation[41] defining the efficiency plane is:

$$\eta_{BOT} = -11.48\,x^2 - 0.85\,y^2 - 0.38\,xy + 88.59\,x + 13.46\,y - C$$

with

$x = \ln(n_s)$ with n_s in [min^{-1}]

$y = \ln(Q)$ with Q in [m³/h]

The final plane is shown in figure A4-7. The numbers of pumps (in percentage of the total data of one pump type) that do not fulfil the minimum efficiency requirements imposed by the plane are lying below the surface and are therefore "cut-off" by the plane.

With C used as a variable for each pump type, it is possible to identify the pumps with the lowest efficiencies for the size and specific speed considered. The plane is shifted downwards vertically according to the value of C, until the chosen quantity cut-off criterion is fulfilled. The shape of the plane is valid for all defined pump types.

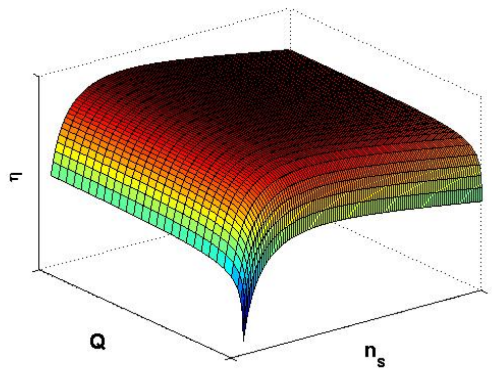


Figure A4-7: Final plane

Table A4-3 shows the values of C for the pump type considered and for different cut-off criteria.

Table A4-3: Values of the variable C for different quantity cut-offs

[41] The equation is valid for quantity cut-offs from 5% to 80%. The mathematical scope of the equation is $6 < n_s < 120$ [min^{-1}] and $2 < Q < 1000$ [m^3/h]. The plausibility has to be checked according to the cut-off criterion.

	Quantity cut-off									
	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%
C (ESOB 1450)	134.38	132.58	131.70	130.68	129.35	128.07	126.97	126.10	124.85	122.94
C (ESOB 2900)	137.28	135.60	134.54	133.43	131.61	130.27	129.18	128.12	127.06	125.34
C (ESCC 1450)	134.39	132.74	132.07	131.20	129.77	128.46	127.38	126.57	125.46	124.07
C (ESCC 2900)	137.32	135.93	134.86	133.82	132.23	130.77	129.86	128.80	127.75	126.54
C (ESCCI 1450)	138.13	136.67	135.40	134.60	133.44	132.30	131.00	130.32	128.98	127.30
C (ESCCI 2900)	141.71	139.45	137.73	136.53	134.91	133.69	132.65	131.34	129.83	128.14
C (MS 1450)	134.83	134.45	133.89	132.97	132.40	130.38	130.04	127.22	125.48	123.93
C (MS 2900)	139.52	138.19	136.95	135.41	134.89	133.95	133.43	131.87	130.37	127.75
C (MSS 2900)	137.08	134.31	132.89	132.43	130.94	128.79	127.27	125.22	123.84	122.05

The table values read horizontally (cut-off 5% to cut-off 80%) result from the efficiency scatter of each pump type. The comparison of different pump types has to be done in consideration of the head and flow rate at b.e.p. using the mathematical equation presented above.

An important advantage of using a three dimensional approach for the evaluation is that the scatter in efficiency values is properly showing the efficiency differences due to design and manufacturing of pumps of the same size and specific speed. If flow rate classes were used instead, the scatter would be broader due to the efficiency differences resulting from pumps of various sizes. Such an approach would not reflect the difference of the individual efficiency of each pump from the statistically mean value for the corresponding flow rate and therefore is not suitable to serve as an evaluation scheme. The data provided for the ESCC 1450 pump for example has an apparently too high efficiency scatter of 27.3 percentage points for a flow rate class of 70-100 m^3/h, the scatter is 21.3 percentage points for the smaller flow rate class of 80-100 m^3/h and 15.8 for 90-100 m^3/h. A correct efficiency scatter is only obtained by introducing a Q-dimension and thus using a three dimensional method.

Part load and overload

The pump data given by the manufacturers was evaluated at part load ($0.75 \cdot Q_{b.e.p.}$) and overload ($1.10 \cdot Q_{b.e.p}$).

A part load coefficient x was calculated with

$$x = \frac{\eta_{partial\ load}}{\eta_{b.e.p.}}$$

for each pump type and the standard deviation was determined. Figure 8 (left figure) shows the part load coefficient x and the double standard deviation, which includes 95.5% of all pumps of a type. The mean value of the part load coefficient for all pump types was calculated for part load to $x_m = 0.947$.

Using the same efficiency plane described in the previous sections, one can determine the minimum efficiency requirement for part load with:

$$\eta_{BOT,PL} = 0.947 \cdot \eta_{BOT,b.e.p.}$$

A mean overload coefficient of $x_m = 0.985$ was determined using the same method (figure 8 right figure). One can determine the minimum efficiency requirement for overload with:

$$\eta_{BOT,OL} = 0.985 \cdot \eta_{BOT,b.e.p.}$$

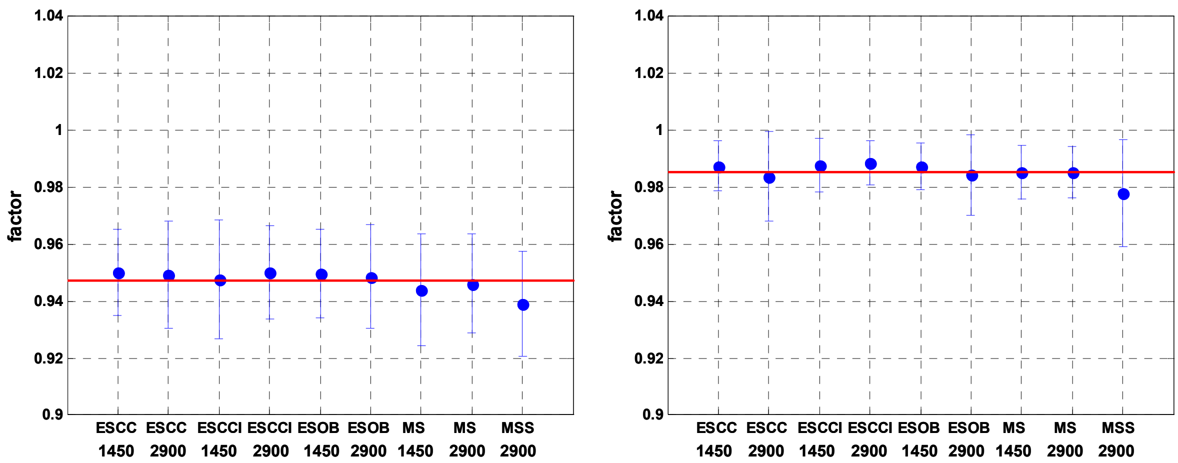


Figure A4-8: Coefficients for part load (left figure) and overload (right figure)

Example of application of the methodology (cut-off 10%)

A pump with the following characteristics is to be evaluated:

Pump type: ESOB

Rotational speed: 1450 min^{-1}

Flow at b.e.p.: 400 m^3/h

Head at b.e.p.: 10 m

Efficiency at b.e.p.: 85.7 %

Efficiency at part load $Q_{PL} = 0.75 \cdot Q_{b.e.p.} = 300\ m^3/h$: 80.5 %

1. Exact method (mathematical evaluation)

Step 1:

The specific speed is calculated to $n_s = 85.95\ min^{-1}$

Step 2:

The value of C is looked up in table 3 for the pump type and the cut-off criterion (ESOB, 4 pole motor, cut-off 10%):

C = 132.58

Step 3:

The minimum efficiency requirement for b.e.p. is calculated with the formula

$\eta_{BOT,b.e.p.} = -11.48\ x^2 - 0.85\ y^2 - 0.38\ xy + 88.59\ x + 13.46\ y - C$

$\eta_{BOT,b.e.p.} = 74.2535\ \%$

Step 4:

The obtained value is compared to the efficiency of the pump at b.e.p.

$\eta_{pump,b.e.p.} > \eta_{BOT,b.e.p.}$

Step 5:

The minimum efficiency requirement for part load is calculated with the formula

$\eta_{BOT,PL} = 0.947\ \eta_{BOT,b.e.p.}$

$\eta_{BOT,PL} = 70.32\ \%$

Step 6:

The obtained value is compared to the efficiency of the pump at part load.

$\eta_{pump,PL} > \eta_{BOT,PL}$

2. Graphical method

Step 1:

The specific speed is calculated to $n_s = 85.95\ min^{-1}$

Step 2:

The 2D graph for the pump type (ESOB, 4 pole motor, cut-off 10%) is looked up

Step 3:

The minimum efficiency requirement value is determined graphically.

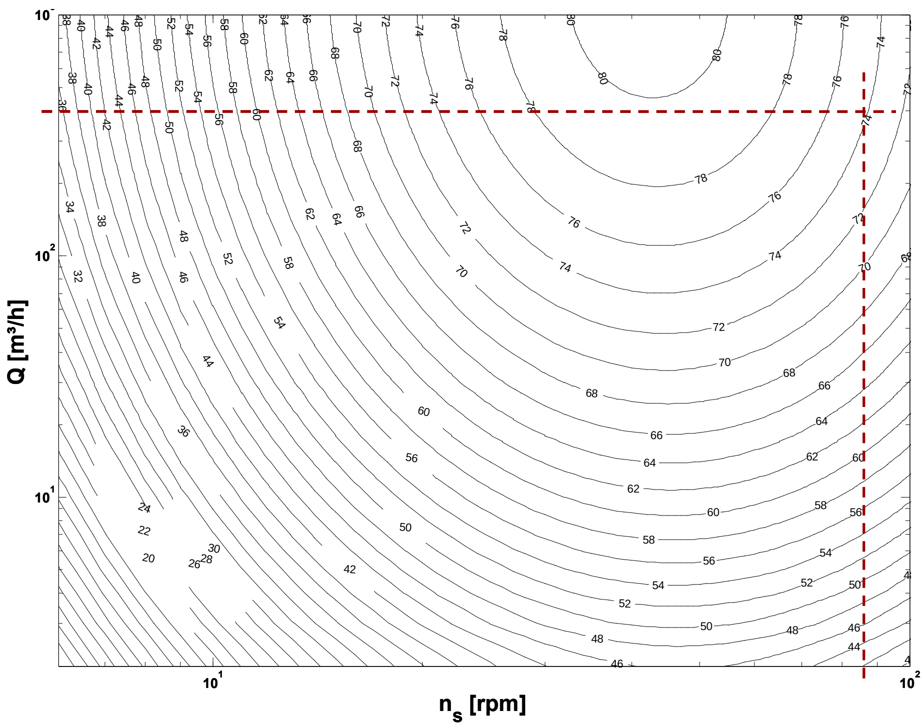


Figure A4-9: Example of efficiency lines for ESOB 1450, cut-off criterion 10%

$\eta_{BOT,b.e.p.} \approx 74.1$ %

Step 4:

The obtained value is compared to the efficiency of the pump at b.e.p.

$\eta_{pump,b.e.p.} > \eta_{BOT,b.e.p.}$

Step 5:

The minimum efficiency requirement for part load is calculated with the formula

$\eta_{BOT,PL} = 0.947\ \eta_{BOT,b.e.p.}$

$\eta_{BOT,PL} \approx 70.17$ %

Step 6:

The obtained value is compared to the efficiency of the pump at part load.

$\eta_{pump,PL} > \eta_{BOT,PL}$

Section 2: Energy savings

Scenario considerations

An estimation of the energy savings according to the selected cut-off criterion and pump type was carried out. The power consumption considered is the shaft power P2, excluding motor losses. The amount of energy savings depends strongly on what will be done with the pumps not fulfilling the minimum efficiency requirements. Different scenarios could be thought of; it is very likely that a combination of them will occur in reality.

One possible scenario is that the pumps not fulfilling the minimum acceptable efficiency limit are improved by design and manufacturing measures just to an extent to meet the requirements of efficiency imposed by the defined bottom efficiency plane. Another possible scenario would be that the pumps are improved to a level which is the average plane (old C mean) of the pump data. The last scenario and the one considered in this work is that the pumps failing the minimum acceptable efficiency are removed from the market and replaced by pumps of the same size and specific speed with an efficiency lying on the new average plane (new C mean) calculated from the data field excluding the removed pumps. Figure 10 illustrates this approach.

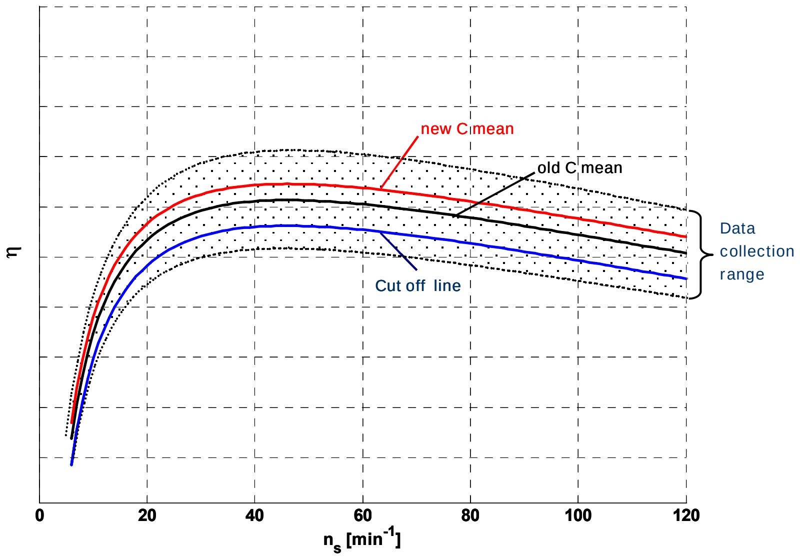


Figure A4-10: Cut-off and C-mean planes (for better visualisation the efficiency lines are shown for one flow rate only)

Estimation of the power savings

The annual energy consumption (AEC) of each pump type is the sum of the product of the numbers of pumps of one pump type (z), the running hours per year (t) and the average power consumption of this pump type per year (P_{avrg}). The power considered is P2, which is the shaft power input that does not include the motor losses.

Annual energy consumption [TWh]

$$AEC = \sum z \cdot t \cdot P_{avrg}$$

The energy consumption of the installed stock (STC) is the product of the pump's lifetime (n=10) and the annual energy consumption (AEC).

Stock energy consumption [TWh]

$$STC = n \cdot AEC$$

After removing the pumps with low efficiencies from the market and replacing them by better ones, the reduced energy consumption in ten years from now (REC) may be calculated by subtracting the power savings from the energy consumption of the installed stock.

Reduced energy consumption in 10 years from now [TWh]

$$REC = STC\,(1 - S)$$

S is the percentage of mean power reduction of all pumps of a pump type. It is calculated by summarizing the relative power improvement of each pump failing the minimum efficiency requirements and dividing the result by the total number of pumps of a pump type (N_{pumps}). The result is the mean relative power improvement in percent achieved by replacing the pumps failing the cut-off demands by better ones (see the scenario described above).

Power Savings [%]

$$S = \frac{\sum_{i}^{Nimpr} k_i \cdot \frac{(P_{b.e.p.,i} - P_{BOT,i})}{P_{b.e.p.,i}}}{N_{pumps}} \cdot 100$$

for each pump (index i) needing improvement:

$$(P_{b.e.p.} - P_{BOT}) = \frac{\rho\, g\, Q_{b.e.p.}\, H_{b.e.p.}}{\eta_{b.e.p.}} - \frac{\rho\, g\, Q_{b.e.p.}\, H_{b.e.p.}}{\eta_{BOT}} = \rho\, g\, Q_{b.e.p.}\, H_{b.e.p.} \frac{(\eta_{BOT} - \eta_{b.e.p.})}{\eta_{b.e.p.} \cdot \eta_{BOT}}$$

η_{BOT}: efficiency value imposed by the bottom efficiency plane [-]

P_{BOT}: reduced power consumption value on the bottom efficiency plane [W]

$\eta_{b.e.p.}$, $Q_{b.e.p.}$, $H_{b.e.p,}$ $P_{bep.}$: efficiency [-], flow rate [m^3/s], head [m], power consumption [W] of the pump at b.e.p.

ρ: water density [kg/m^3]

g: gravity constant [m/s^2]

k: weighting coefficient of the pump [-]

N_{pumps}: total number of pumps [-]

N_{impr}: number of pumps failing the efficiency requirements [-]

It should be pointed out that the percentage of power savings S applies to the scope of data given by the manufacturers (k =1); the running hours of each pump would be necessary in order to realize a weighting k_i and make an accurate estimation of the energy savings on the market.

Table A4-4 shows the results for the reduced energy consumption of each pump type for different cut-off criteria, as well as the total savings of energy in percentage and Terrawatthours in 10 years from now.

Table A4-4: Reduced energy consumption and energy savings for different quantity cut-offs

Pump type	Stock consumption [TWh]	Reduced energy consumption in [TWh] by cut-off [%]								
		5%	10%	15%	20%	30%	40%	50%	60%	80% [2]
ESOB 1450	27.00	26.79	26.66	26.55	26.44	26.23	26.03	25.80	25.49	25.35
ESOB 2900	27.00	26.82	26.66	26.52	26.40	26.18	25.99	25.76	25.46	25.33
ESCC 1450	20.25	20.09	19.99	19.90	19.82	19.68	19.53	19.38	19.21	19.13
ESCC 2900	20.25	20.12	20.00	19.90	19.82	19.66	19.51	19.36	19.21	19.13
ESCCI 1450	12.00	11.91	11.85	11.80	11.75	11.65	11.55	11.45	11.32	11.27
ESCCI 2900	12.00	11.90	11.82	11.76	11.69	11.56	11.46	11.34	11.21	11.14
MS 1450	4.50	4.48	4.46	4.44	4.41	4.36	4.30	4.26	4.20	4.17
MS 2900	4.50	4.46	4.44	4.42	4.40	4.36	4.32	4.28	4.19	4.15
MSS 2900	16.80	16.65	16.53	16.42	16.32	16.15	15.93	15.79	15.53	15.43
Total stock consumption [TWh]	144.30	143.22	142.40	141.71	141.05	139.85	138.63	137.41	135.82	135.12
energy savings in 10 years from now [%]		0.75%	1.31%	1.79%	2.25%	3.08%	3.93%	4.77%	5.87%	6.36%
energy savings P1 in 10 years from now [TWh]		1.08	1.90	2.59	3.25	4.45	5.67	6.89	8.48	9.18

A graphical representation of the results for all pumps is shown in figure A4-11. Figure A4-12 shows the energy savings in ten years from now for each pump type for different cut-off criteria.

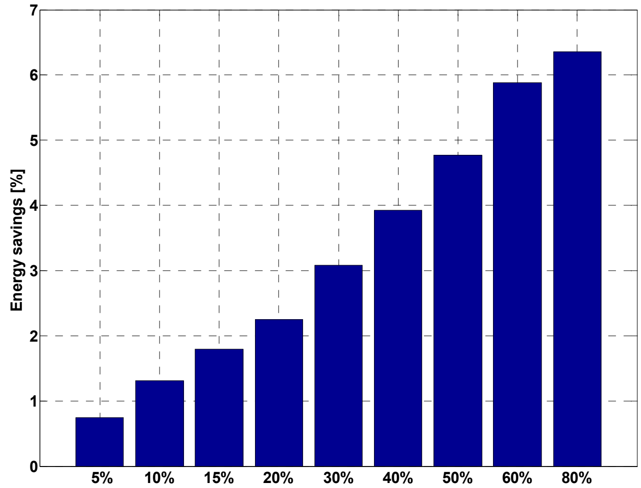


Figure A4-11: Total annual energy savings for different quantity cut-offs [%]

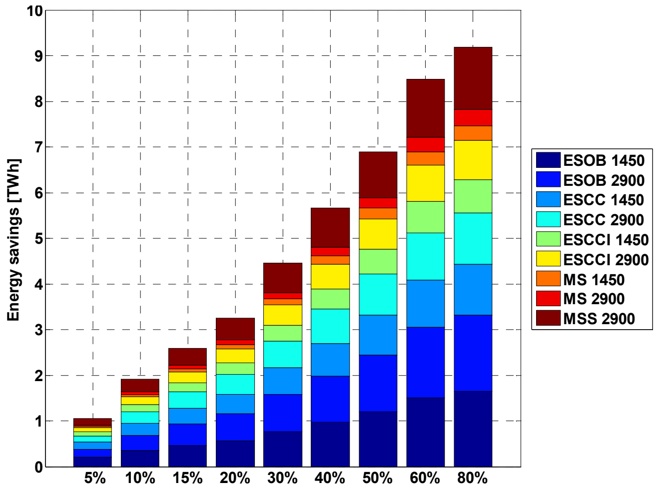


Figure A4-12: Energy savings of each pump type for different cut-offs [TWh]

List of the pump manufacturers who provided data for the evaluation

Allweiler, Radolfzell, Germany

Calpeda S.p.A., Montorso Vicentino, Italy

Caprari S.p.A., Modena, Italy

Cpma, Czech Pump Manufacturers Association, Lutin, Czech republic

Flowserve Pump Ltd., Newark, Great Britiain

Grundfos, Bjerringbro, Denmark

Johnson Pump, Örebro, Sweden

KSB AG, Frankenthal, Germany

LOWARA srl, Montecchio Maggiore Vicenza, Italy

Oddesse, Oschersleben, Germany

Osna Pumpen, Osnabrück, Germany

Peme Gourdin, Biot, France

Ritz, Schwäbisch Gmünd, Germany

SAER Elletropompe S.p.A., Guastalla, Italy

Sterling SIHI, Itzehoe, Germany

WILO, Dortmund, Germany

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Stoffel, B., Ludwig, G., and Meschkat, S., *'Evaluation of efficiency values considering the effect of pump size modularity'*, Technical University of Darmstadt, 2002.

ANNEX V: EUROPUMP COST ESTIMATE PER CUT-OFF LEVEL

This Annex explains the cost estimate provided by Europump[42] as to the redesign cost for the industry. Exact figures have not been made available by the industry or by individual manufacturers, as this information is considered sensitive. The feedback from Europump members indicated that the average development cost per pump type be € 200.000. This figure is based on the following assumptions:

- ½ yrear of man power **50.000€**
- Average tooling cost
- (impeller, pump housing, modification of technology) **100.000€**
- Modification of production machinery **20.000€**
- Testing, CE-Assessment, sales papers **30.000€**

==========

- Average development costs for one pump type **200.000€**

This total cost development cost (DC) for the industry is calculated as follows:

$$DC = f1 \cdot f2 \cdot f3 \cdot Z_{impr} \cdot fd \cdot 200\,000\ €$$

The application of the formula on each of the cut off rates gives total development cost as follows:

Cut-Off %	**Z_{impr}** [#]	**f1**	**f2**	**f3**	**fd**	**Development Cost (DC)** € Million
10	240	1,5	1,2	0,5	1	40
20	480	1,5	1,2	0,7	1	120
50	1200	1,5	1,2	0,85	1,5	550
70	1680	1,5	1,2	0,95	1,85	1.00
80	1920	1,5	1,2	1	2	1.400

The factors in the formula are as follows:

- Cut Off level (%)

'Cut Off' means the percentage of pump types that 'cut off' from the market, if minimum requirements are set at this given level. These values are not be confused with the level of the

[42] Europump represents 450 manufacturers in 15 EU Member States and in Switzerland, Russian and Turkey.

efficiency of a pump[43], nor with the cut off of actual pumps from the market[44]. As to the pump efficiency, the actual efficiency related to a Cut Off level depends on the particular pump type, e.g. the actual efficiency is very different for small and large pumps (see below for further explanation).

- Factor f1

All pump manufacturers are not member of a national manufacturers association and therefore could not respond to the data request. Also, pump performance data was not received from all Europump members (pump manufacturers). Thus, Europump assumes that about 50% of pump models are missing. Therefore, the factor f1 is specified as 1.5. This factor is raising the total cost for within the community. It has no impact of the development cost of a single manufacturer.

- Factor f2

Not all pumps were included in the data collection. Europump estimates that about 20% of models are missing. Therefore, factor f2 = 1.2. This factor has an impact on the development cost of the manufacturer.

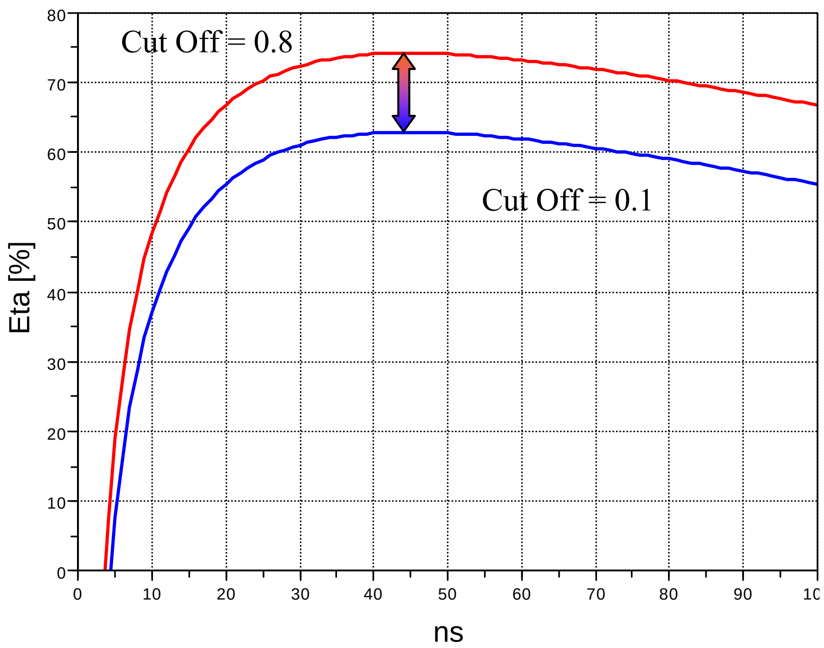
- Factor f3

When an engineer redesigns a pump type, he will learn and improve his knowledge. It will be possible to use some of the parts develop for one pump type when developing another pump type. The closer engineers get to the theoretically obtainable efficiency the less the learning can be used for other designs. Optimum performance requires optimum parts. This efficiency is covered by factor f3. It reduces the cost of the development. The reduction is higher at lower Cut Off level but it always stays well below 1.0.

- Factor Z_{impr}

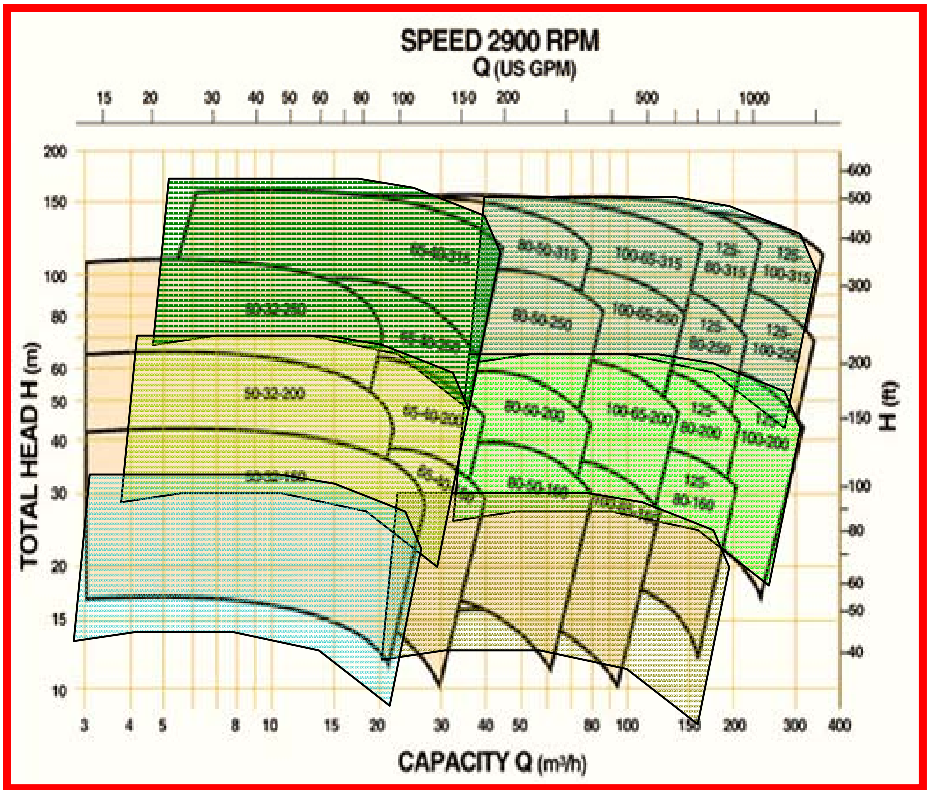
43 The efficiency difference between the least and the most efficient pump in any category is around 12 % (not 80 %).

44 1,55 million pumps are sold (2005) composed of some 2500-3000 pump models (types of pumps).



This factor refers to the number of pumps to be improved based on the data collection (cut off line).

Factor fd is critical for the application of the pump. In order to achieve the best efficiency, the pump must run close to its best efficiency point. If the number of pumps within a given performance field is too small, pumps in some applications will run further away from best efficiency point. This is illustrated in the chart below.



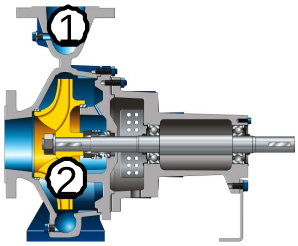
As shown on the chart, a given performance field (head and flow) can be covered by a large number of pumps (model numbers shown on the background) or by only a few models (colored area). With an increasing length of the curve, the application range of that particular pump increases well. Consequently, a pump is used further away from the best efficiency point. Thus, fewer pump types would lead to lower development cost but also to high power consumption in use phase. So, for increased energy savings, the density of each of the performance field would have to be rather increased than decreased. Hence, there is a trade off between the number of pump types per each performance field and the power consumption in use (closeness of the pump operation and its best efficiency point. Europump assumes that 50% more, respectively double the pump types, are needed to allow a sufficiently “close to BEP” -selection in order to achieve the best possible energy saving.

The tooling cost of the casing and the impeller is described below.

Tooling (= pattern) costs for water pumps

(example of a pump manufacturer)

ESOB Water Pump (example flow Q = 65 m³/h)



① Casing

② Impeller

Pattern set to cast casing ①

Pattern set to cast impeller ②

	Casing ①	Impeller ②
Average costs per set / material class (in €) :	14.000,-	12.000,-
Material classes [1] :	cast iron, stainless steel, ductile iron, cast steel	cast iron, bronce, stainless steel
Costs per part:	56.000,-	36.000,-

Total costs per size: 92.000,- €

1) Remark:
- Due to different shrinkage during casting every material class needs a specific pattern set.
- Because of various requirements different material classes are necessary