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COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 22.7.2009
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COMMISSION STAFF WORKING DOCUMENT

Accompanying document to the

PROPOSAL FOR A COMMISSION REGULATION
implementing Directive 2005/32/EC with regard to Ecodesign requirements for circulators

FULL IMPACT ASSESSMENT – PART 2

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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 Ecodesign Implementing Measures on Circulators under the Directive on the Ecodesign of Energy-Using Products (2005/32/EC)

Seventh meeting of the Ecodesign Consultation Forum (27th 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),

Introduction

The Chairman welcomed the group and introduced Hugh Falkner who was responsible for the Eco-design preparatory study on circulators.

The Commission Staff Working Document (CSWD) on possible eco design requirements for standalone glandless circulators was presented (see presentation circulated together with these draft minutes). The CSWD was available 4 weeks prior to the meeting on http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum.

The CSWD covers circulators for clean water and proposes that if a circulator can be used either as a standalone product or fitted inside a boiler, then it is covered under the proposed implementing measure. The Europump classification scheme used for circulators is currently being updated. The efficiency levels of the scheme correspond to the existing Europump voluntary labelling scheme. It has been considered that there is no need for further labelling schemes after the introduction of the proposed requirements.

Least life cycle cost considerations allow setting requirements at the level of EEI 0.2 for all sizes of circulators (pending revision of the reference calculations underpinning the Europump classification scheme, as it affects larger circulators). As cost issues also need to be looked at, it was suggested to give industry three years to adapt.

The plan will be to review the requirements no longer than 5 years after the measures come into force.

Europump presentation

Europump presentation explained the existing voluntary Europump A - G labelling scheme (see presentation circulated together with these draft minutes). EN standard 1151 is the only common standard for fixed speed circulators and is currently being revised, with an extended scope to include variable speed circulators under 200 W. There is also a standard covering 200 W – 2500 W circulators under development. The Europump classification scheme is also being revised with the aim of having an EEI value that presents the same technological challenge for all sizes of circulators.

Stakeholder's views:

When asked how the proposed measures and the efficiency levels on which the voluntary labelling scheme is based could fit together, Europump explained that the **Europump classification scheme**, when it was developed in 2001, gave a handicap to the bigger circulators, as they tend to be more efficient, and Europump did not want people choosing oversized circulators just for the sake of efficiency.

ECOS (representing environmental NGO's) does not support the non-linearity of the classification scheme, as there is no physical logic to separate the two circulator sizes. ECOS would like to see just one efficiency line. Europump stated they are just calibrating the scheme to the market today. The starting points were different in 2001 for both sizes; there was more room for improvement for the smaller circulators so the label and the classification scheme took that into account.

Commission asked if the target should be EEI < 0.2, if the technology exists to reach such levels, as it would still be below LLCC level. Europump feels that once the methodology is updated it will be possible also for bigger circulators to meet the "A*" (EEI < 0.3) level. The first priority is to get the classification scheme right.

Germany was concerned about the level of ambition in the CSWD, as legal requirements are based on an outdated scheme (A - G from 2001) that is under revision. Also, there is no agreed standard yet and Germany would like to see the classification scheme included in the implementing measure. Germany stressed that before a vote is taken in the Committee the classification scheme will have to be clear.

ECOS commented that higher targets (EEI < 0.2) for smaller circulators could be reached sooner with a different approach. The transparency of the classification scheme also needs to be improved. The level of ambition and the methodology should be looked at separately.

The **scope** of the envisaged implementing measure was discussed. **Boiler integrated circulators** are considered in Lot 1 study. ECOS reiterated the position that a coordinated approach for ambition and methodology across Lots was essential. However, boiler integrated circulators can have different functions and the classification scheme might need to be adjusted for boiler integrated circulators. ECOS requested to consider the inclusion of boiler integrated circulators, including considerations on drinking water circulators, into the scope of the proposed measure.

The Chairman asked if there was a consistent approach to the measurement of both types of circulators. EHI replied that certain approaches used in the measurement of standalone circulators are not used in boiler integrated circulators, which could give a misleading advantage to standalone circulators.

The Chairman commented that it would make sense to cover all types of circulators and the requirements could be adjusted according to different calculation/measurement methods. There would be more consistency in terms of types of circulators and timing. ECOS agreed more coordination would be important. Europump and EHI supported.

The UK supported consistency but was concerned that, in a Lot 1 stakeholder's meeting a week earlier, boiler integrated circulators were told to be dealt with under Lot 11. The Chairman assured that circulators will be dealt with adequate consistency. Mr. Falkner supported the idea of dealing with all relevant types of circulators within one measure, as far as possible.

Commission asked how much work would be needed to develop efficiency levels for boiler integrated and drinking water circulators and how quickly an updated method could be developed. Mr. Falkner assured that the basis is already established and there are no big barriers to having the necessary method and efficiency levels in place for boiler integrated circulators on time. Europump agreed that it can be ready in the autumn. ECOS welcomed this and suggested that the final requirements could contain more transparent information and reiterated that ECOS would like to see two tiers and a coordinated methodology for all circulators.

The Chairman asked about **impacts for industry**. In principle, costs can be passed on to end-users. The study shows that when the purchase price of a more efficient circulator increases the life cycle cost gets slower. This means that the lower running cost compensate the extra investment cost by the industry. If the higher production cost of the more efficient circulators is below the least life cycle cost (LLCC) level, industry investment is not a problem for other stakeholders, as the increased cost is paid by the consumer, who will benefit from reduced life cycle cost, particularly as the cost of a circulator is minor for a household. Europump agreed that the real issue was capacity. Many of the 6.5 million standalone circulators sold per year would have to be converted to more efficient ones; time for development for testing and manufacturing is needed.

Lithuania asked how much investment cost would be required to comply with the proposed requirements. Europump estimated this would involve shifting to permanent magnet motor technology with an estimated total cost of 150 million Euro for the European industry.

ECOS and the Netherlands had queries on the data behind the presented 150 million cost for industry, which was considered excessive. Mr. Falkner confirmed that the cost calculation to the consumer is based on current prices. Furthermore, when sales of high-efficient circulators increase, the cost for industry will come down with higher production volume.

ECOS commented that they do not find the requirements dynamic, as there is only one requirement and they would like to see a second mandatory tier introduced at the level of EEI < 0.2.

The Chairman asked if targeting a second tier would make the capacity issue more difficult. Europump clarified that only a few small circulators reach the EEI below 0.2 and that the challenge is a change in technology. The Chairman concluded that bigger circulators (sales of 1 million per year) are the main problem, not due to physics but due to the distorted classification scheme. When the scheme is updated, the outlook for equal treatment of circulators of different sizes is positive.

The Netherlands queried how useful **energy labelling,** on top of tough minimum requirements, would be and commented that it would be important to display the energy efficiency index on the circulator pump. ECEEE agreed that the index or other similar indicator should be provided and displayed.

Europump noted that a lot of information is already given on the products and in product documentation and felt it is important not to mix up legal and voluntary requirements. The index is not helpful as the tolerance level needs to be taken into account, it is best to display the efficiency in terms of A or B or C.

Sweden commented that labelling will not have a big role to play after the introduction of the proposed minimum requirements. There will probably only be one premium class and Sweden asked how best to encourage purchasing of this class. Possibly include procurement requirements for premium pumps? ECOS called for mandatory information requirements to aid purchasing.

The Chairman clarified that it is not possible under the current framework to impose procurement rules and the Energy Labelling Framework Directive would have to be revised in order to do this.

France asked for the industry position on **standby** mode with regard to circulators. Europump clarified that for the majority of circulators, standby is not an issue. Usually circulators are either switched on or switched off but in a small number of cases they can be found in BMS systems for security, for example.

End of summary minutes.

ANNEX 2: IMPACT ASSESSMENT METHODOLOGY

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 circulators over the period 1990-2020 (with a start-up period 1960-1990).

The stock-model sets the pace for the sub-options. The direction is determined by trends in terms of increase/decrease in

- number of households,
- ownership (number of circulators per households)
- consumer behaviour, e.g. running hours per year
- and
- energy efficiency

The first three are a given and derived from statistics and trends as described in the preparatory study. The main variable in the various sub-options is energy and its derived parameters.

Outputs for each sub-option are:

- Energy consumption in PJ/a (conversion 1 TWh= 3.6 PJ);
- Carbon emission in Mt C02 equivalent/a, and the values from EcoReport in the preparatory study;
- Consumer-related economical parameters: purchase price, energy expenditure, maintenance costs and total expenditure in € bln./a. [2005 Euro, inflation-corrected at 2 %/a];
- Business-related economical parameters: turnover per sector (industry, wholesale, retail, etc.);
- Employment: calculating job creation/loss using the sector-specific turnover per employee.

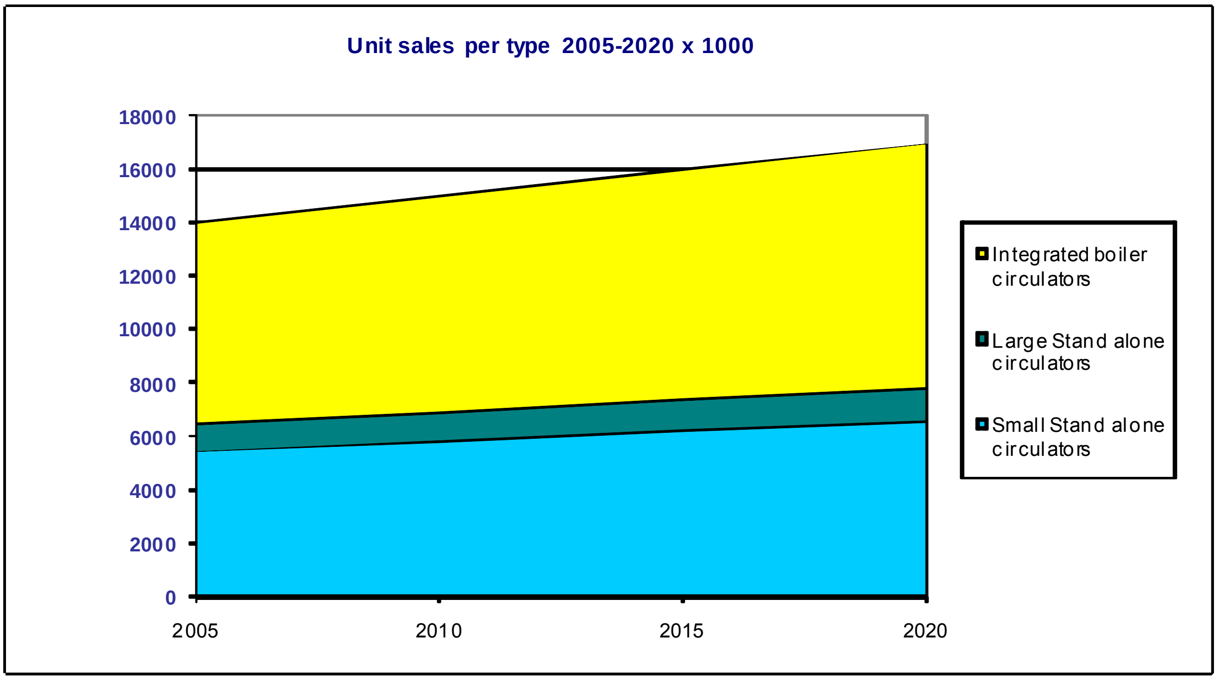
Final outcomes are presented at aggregation level (totals), but in the intermediate stages a distinction is made by the typology and by size.

For economic calculations, an average energy price in €/ kWh primary energy is built from:

- Electricity rates per kWh primary energy in the base-year 2005. E.g. electricity € 0.15/kWhe (→ € 0,060/kWh primary);
- Annual (long-term 2000-2006 average) price rate increase of the individual energy sources. E.g. 2 % for electric.

The preparatory study has found rather large discrepancy between Eurostate sales data for EU 27 and circulator sales data provided by Europump. The Eurostate sales data does not distinquish clearly enough between different types of pumps (glanded and glandless vs. water pumps and other pumps). The study chooses to use the Europump data. The Europump data are used also in this impact assessment. However it is important to notice that there is a certain margin of uncertainty in the sale and stock data used in the analysis.

Figure A.1. Annual circulator sale in the period from 2005 to 2020 (x1000)



ANNEX 3: BAU OPTION, BASE CASE AND TABLES ON COMPARIONS OF INTRODUCTORY DATES

BAU and base case 2005

The base case represents the average product sold in the reference year 2005. The 2005 circulator unit sales amount to about 14 million circulators, of which 6.500 million units are standalone (small and large) and 7.500 million units are boiler integrated circulators.

The BAU (and other sub-options) is carried out for three typical circulator sizes, which are considered being the representative size of circulators within the groups of small and large standalone circulators and boiler integrated circulators. Data on circulators size, price and sales in 2005 is shown in table below.

The selection of base case and the price and sales data are based on the preparatory study. 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 circulator base cases (in 2005)

Type of circulator	**Typical rated capacity** Watt	**Selected base case size** Watt	**Price** Euro/unit	**Price including installation** Euro/unit	**Estimted sales** 1000 Units in 2005
Small standalone	40 - 250	65	120	210	5,500
Large standalone	< 2,500	450	400	490	1,000
Boiler integrated	90 - 120	90	120	210	7,500

The aggregated scenario for all three types of circulators is carried on the basis of an average weighted energy consumption (average of standalone small and large and boiler integrated circulators taking into account the number of each circulator type). The average weighted energy consumption for small and large standalone and boiler integrated circulators is estimated to be 410 kWh per year in 2005.

The values for the period from 1990 until 2025 appear from table 12 (products in the stock) and 13 (products on the market/for sale).

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 sub-options.

Table A.3.2. Total circulator sales, stock, and average weighted energy consumption of circulator stock (BAU).

Energy, sales and stock	1990	1995	2000	2005	2010	2015	2020
Energy per unit in the stock (BaU) kWh/a	362	355	348	341	335	328	321
Sales units (000)	10220	11480	12740	14000	14980	15960	16940
Stock units (000)	106370	114550	126280	140140	153160	164780	175560

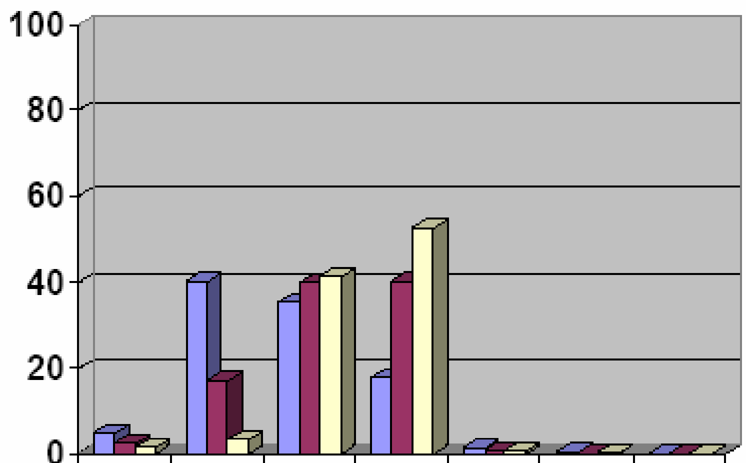
According to the BaU, the 2005 energy consumption of all installed standalone and boiler integrated circulators amounts to about 49.7 TWh/a.

Table A.3.3. Energy consumption of products on the market (net load) and energy consumption of sold products per year (BAU).

Average net load in kWh/a	1990	1995	2000	2005	2010	2015	2020
Small Stand alone circulators	203	200	196	192	188	184	180
Large Stand alone circulators	1699	1667	1635	1603	1571	1538	1506
Integrated boiler circulators	300	294	289	283	277	272	266
kWh/a	**362**	**355**	**348**	**341**	**335**	**328**	**321**

The energy consumption of the average products on the market in the base case year (2005) is estimated according the Europump calculation method for P_{ref} and a distribution of circulator sale on various energy classes as shown in figure 1.

Figure A.3.1: Distribution of circulator sale in 2005 (according to Europump)



	A	B	C	D	E	F	G
2006	5	40.2	35.4	17.7	1.3	0.3	0.1
2005	2.6	17	39.8	40.2	0.8	0.1	0
2004	1.6	3.3	41.3	52.8	0.8	0.2	0

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 CO2 equivalent/kWh electric, which results in 28 Mt CO2 equivalents[1]. Acidificying agents at 0.0027 kg/kWh electric account for 329 kt of SO2-equivalent in the use phase.[2] At 0.7 litre

[1] Compare EU-15 energy-related CO2 equivalent 2005 is 3357 Mt, so ca. 1,5 % (Kyoto-relevance). For EU-27 ca. 4000 Mt (1,3 %).

[2] Compare EU-15 total in 2005: 10.945 kt SOx equivalent (2,6 %). Gothenburg-relevance (also NEC Directive).

process water and 28 litre cooling water per kWh electric the water use from electricity in the use phase amounts to 0.85 mln. m³ process water and 34 mln. m³ cooling water. The production phase is the most relevant for the waste generation.

BAU 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 circulators):

- Population increase 2005- 2020: 8 %;
- Annual sales growth: 1,4 percent pro anno;
- Average product life: 10 years;
- Circulator running hours per year: 5000 hours;
- Installation costs 90 Euros (3 hours of 30 Euros);
- Circulator stock in 2005 according to the study 140 mln.

The data set for 1990 – 2005 is based mainly on the preparatory study and also the estimated increase in the sale (1.4 % per year) is similar to the assumptions used in the study.

In the BAU without any new policy measures only a small increase in the energy efficiency is expected to happen until 2020. Since a slight increase in the circulator energy efficiency has appeared in the last few years this trend is assumed to continue in the BAU. The energy efficiency trend assumed in the BAU appears in table below.

Tabel A.3.4. Energy efficiency trends (BAU).

Weighted efficiency (for load and sales)							
	1990	1995	2000	2005	2010	2015	2020
Small Stand alone circulators	94%	96%	98%	100%	102%	104%	106%
Large Stand alone circulators	94%	96%	98%	100%	102%	104%	106%
Integrated boiler circulators	94%	96%	98%	100%	102%	104%	106%

General considerations

Because labelling is not considered as an appropriate measure for circulators only sub-options evaluating the impacts of various eco design ambition levels and timing for minimum energy efficiency requirements are carried out. The preparatory study has shown that the point of least life cycle costs (LLCC) for all three types of circulators appears for the best available technology (BAT). The BAT technology is circulators with variable speed permanent magnet motors with an EEI ≤ 0.20. Table below summarise main information on the three types of circulators considered.

Table A.3.5. Average price, life-time running costs and total life cycle costs (including purchase and installation) for circulators with EEI=0.45, EEI=0.23 and EEI=0.19 respectively (per product).

Base case	EEI~0.45	Price average (incl. install.)	Life-time running cost	Total LCC
Small Stand alone circulators	100 %	210	259	469
Large Stand alone circulators	100 %	490	2163	2653
Integrated boiler circulators	100 %	210	382	592
Improved technology	**EEI=0.23**	Price average (incl. install.)	Life-time running cost	Total LCC
Small Stand alone circulators	248%	302	105	406
Large Stand alone circulators	212%	560	1019	1578
Integrated boiler circulators	237%	295	161	456
BAT	**EEI=0.20 (BAT)**	Price average (incl. install.)	Life-time running cost	Total LCC
Small Stand alone circulators	297%	332	87	420
Large Stand alone circulators	257%	588	841	1428
Integrated boiler circulators	286%	326	133	459

In total, sub-option 2 represents higher savings over the life cycle of the product than sub-option 3.

Sub-option 1 (EEI ≤ 0.30)

Requirements are implemented on standalone and boiler integrated circulators in 1 stage on 2015 at EEI ≤ 0.30, as proposed by the industry. Requirements are implemented in one stage only based on circulator industry request; two stages were considered useless by circulator manufacturers as the redesign and production of products would anyway be done based on the level of the second stage. Due to the fact that there are no circulators, except two, between the EEI level 0.30 and 0.26, the impact of the considered EEI level would only start de facto at the level of EEI ≤ 0.26, except if manufactures, after the potential coming into force of the measure, would lower the efficiency of circulators, which would be possible for 95% of PM variable speed circulators currently on the market.

Sub-option 2 (EEI ≤ 0.23)

Requirements are implemented on standalone and boiler integrated circulators in 1 stage based on the recommendations of the preparatory study. The requirement would come into force on 2012. The level of the requirement also corresponds to the proposal made by the Commission Staff Working Document to the Consultation Forum.

Sub-option 3 (EEI ≤ 0.23 + EEI ≤ 0.15)

Requirements are implemented in two stages at levels as follows:

In 2012: EEI ≤ 0.23 on standalone circulators;

In 2015: EEI ≤ 0.15 on standalone and boiler integrated circulators.

This sub-option is an additional option developed by the Commission services after the request of the fourth sub-option (below) by environmental NGOs and some Member States and after the request by the boiler industry to have more time for the redesign of boilers to comply with the circulator requirements. The sub-option 3 allows considering a 'dynamic' measure between the second and the fourth sub-option in terms of the level of requirements. The two stages address the impacts of the planned measure on the boiler industry too in providing enough time to adjust to the requirements. The second requirement is introduced in August at the beginning of the heating season in order to minimise any possible distortions on circulator and boiler markets.

The implementation of efficiency requirements for products put on the market in 2012 and 2015 result in a higher relative efficiency and a lower average energy consumption of product sold after 2012 and 2015 compared to the BAU.

Sub-option 4 (EEI ≤ 0.19 + EEI ≤ 0.13)

The requirement of EEI ≤ 0.19 is implemented in 2012 and a second stage requirement of EEI ≤ 0.13 in 2013, as requested by environmental NGOs and some Member States during the Consultation Forum.

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

Introduction of MEPS – policy options to be considered

Sub-option	Organisation	2010	2011	2012	2013	2014	2015
1	Industry						≤ 0.30
2	CSWD backed by preparatory study			≤ 0.23			
3	Commission II			≤ 0.23 Standalone			≤ 0.15 Standalone and boiler integrated
4	Stakeholders (ECOS, MSs)			≤ 0.23	≤ 0.19		

The sub-options 2-4 require a complete change from standard circulator technology to variable speed permanent magnet motor technology. Sub-option 1 would allow a few big circulators to be developed on the basis of standard induction motor technology just below the 0.30 level; the complete technology change is estimated to happen at about EEI ≤ 0.26 level from which the PM technology products with variable speed operation start. That is, sub-options 2-4 set also a minimum requirement on the performance of this technology.

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

Efficiency (100 % = base case) [%]	1990	1995	2000	2005	2010	2015	2020
BaU	94%	96%	98%	100%	102%	104%	106%
Sub. opt. 1: EEI ≤ 0.30 from 2015	94%	96%	98%	100%	102%	175%	176%
Sub. opt. 2: EEI ≤ 0.23 from 2012	94%	96%	98%	100%	144%	229%	232%
Sub. opt. 3: EEI ≤ 0.27 from 2012 + EEI ≤ 0.23 from 2015	94%	96%	98%	100%	130%	228%	230%
Sub. opt. 4: EEI ≤ 0.23 from 2012 + EEI ≤ 0.19 from 2015	94%	96%	98%	100%	102%	275%	278%

Energy consumption per unit [kWh/a/unit]	1990	1995	2000	2005	2010	2015	2020
BaU	385	370	355	341	328	315	303
Sub. opt. 1: EEI ≤ 0.30 from 2015	385	370	355	341	328	188	182
Sub. opt. 2: EEI ≤ 0.23 from 2012	385	370	355	341	233	143	139
Sub. opt. 3: EEI ≤ 0.27 from 2012 + EEI ≤ 0.23 from 2015	385	370	355	341	252	144	139
Sub. opt. 4: EEI ≤ 0.23 from 2012 + EEI ≤ 0.19 from 2015	385	370	355	341	328	119	116

Original Equipment Manufacturers (OEM)

Circulator manufacturers produce most of the necessary components (including the motor technology) in house. Therefore, the OEM factor is relatively low. However there are still some OEM activities for production of material used in components etc. An OEM factor of about 0.3-0.4 is considered being realistic. About 20 % of these OEM activities is estimated to take place the EU (ExtraEUFrac=0.2). The main part that is traded, and can easily be traded on the OEM market, is the motor (induction or permanent magnet).

Almost 100 % of the circulator manufacturers are European (EU-27). 80 % of the European market is dominated by two major circulator manufacturers.

Table A.3.7: List of manufacturers and information on size, employment and turnover

Manufacturer	Size	Production of energy efficient circulators	Employee and turnover	Homepage
Grundfos	Very Large	Yes A-pump + permanent magnet	Employees: 16,457 Turnover: 2,257 mln. EUR (2007)	Denmark www.grundfos.com
Wilo	Very Large	Yes A-pump + permanent magnet	Employees: 5,821 Turnover: 927 mln. EUR (2007)	Germany www.wilo.com
Smedegaard	Medium/Large	Yes A-pump	No information available	Denmark www.smedegaard.com
Calpeda	Medium	Yes A-pump + permanent magnet	Employees: 250 Turnover: No information available	Italy www.calpeda.com
Circulating pumps	Small/Medium	No but part of the Wilo Group	Employees: 150 Turnover: 18 mln. EUR	UK www.circulatingpumps.net
Dab pumps SpA	Medium/Large	No but part of the Grundfos Group	Employees: 500 Turnover: No information available	Italy www.dabpumps.com
Imp-pumps	Small/Medium	Yes A-pump + permanent magnet	No information available	Slovenia www.imp-pumps.com
Laing	Medium/Large	Yes A-pump + permanent magnet	Employees: 500 (worldwide) Turnover: No information available	Germany www.laing.de
Salmson	Part of Wilo	Yes A-pump + permanent magnet	No information available	Member of Wilo group No homepage
Askoll Sei	Large	Yes A-pump + permanent magnet	Employees: 3000 Turnover: No information available	Italy www.askoll.com
Biral	Medium	Yes A-pump + permanent magnet	No information available	Switzerland www.Biral.Ch
Richard Halm GmbH & Co.KG	Medium	Yes A-pump	Employees: > 300 Turnover: No information available	Germany http://www.halm.info/en

Wholesale and retail

The wholesale margin on the manufacturer selling price is estimated to be 30 %. Most circulators are sold by installers. Only about 1 % of the products are sold by retailers (on the DIY market) and this sale is considered to be negligible. The preparatory study assumes 1% sales increase (21% in total) of standard circulators mainly, that is, employment effects are minor as the share of permanent magnet motor technology is not expected to expand.

Installer

The installer marking on the product whole sale price is estimated to be 20 %.

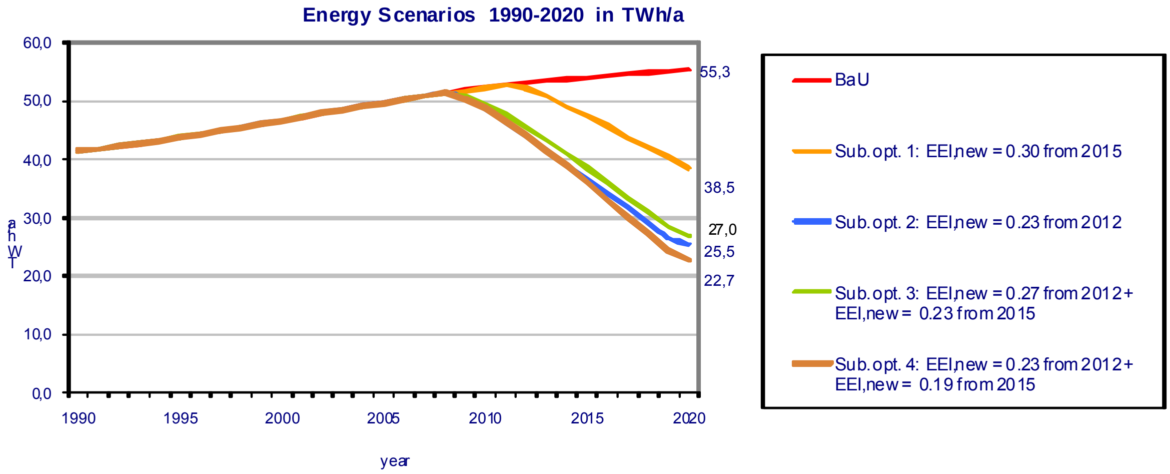
The below table shows the variables used in the socio economic analysis.

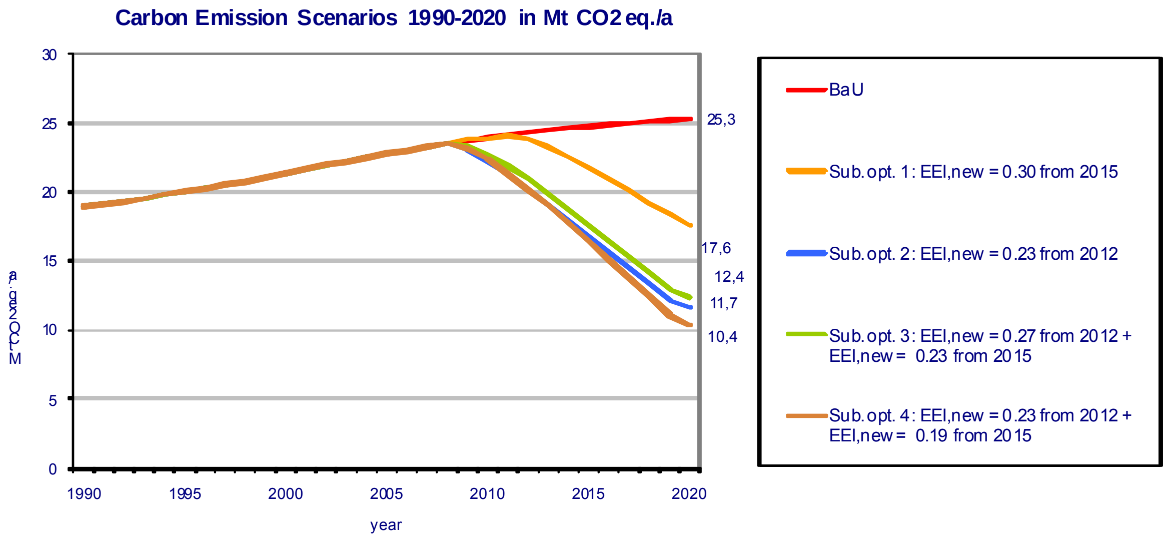
Variables used for the calculation of employment, turnover etc. <u>ECONOMICS</u>		
Baseprice	230.0	Consumer product price incl. installation in year 2005 [€]
PriceInc	0.62	Price increase per efficiency %-point [€/ %]
Rel	0.135	Electricity rate 2005 [€/ kWh electric]
Rgas	0.047	Gas rate 2005 [€/ kWh primary GCV] (NOT USED)
Roil	0.061	Oil rate 2005 [€/ kWh primary GCV] (NOT USED)
Rmaint	0.7	Annual maintenance costs [€/ a]
CO2el	0.458	CO2 emission for electricity [Mt CO2/TWh]
Relinc	1%	Annual price increase electricity [%/ a]
Rgasinc	2%	Annual price increase gas [%/ a] (NOT USED)
Roilinc	2%	Annual price increase oil [%/ a] (NOT USED)
Rmaintinc	1%	Annual cost increase maintenance [%/ a]
PriceDec	2%	Annual product price decrease [%/ a]
InstallDec	0%	Annual installation cost decrease [%/ a]
ManuFrac	51.5%	Manufacturer Selling Price as fraction of Product Price [%]
WholeMargin	30%	Margin Wholesaler [% on msp]
RetailMargin	20%	Margin Installer on product [% on wholesale price]
VAT	19%	Value Added Tax [in % on retail price] (NOT USED)
ManuWages	0.136	Manufacturer turnover per employee [bln. €/ a]
OEMfactor	0.3	OEM personell as fraction of manufacturer personnel [-]
WholeWages	0.261	Whole seller turnover per employee [bln. €/ a]
RetailWages	0.1	Installer turnover per employee [bln. €/ a]
ExtraEUfrac	0.2	Fraction of OEM personnel outside EU [% of OEM jobs]
Inflation	-2%	Inflation rate [%/ a]
DiscountRate	4%	Discount rate [%/a]
ProductLife	10	Product Life [years]

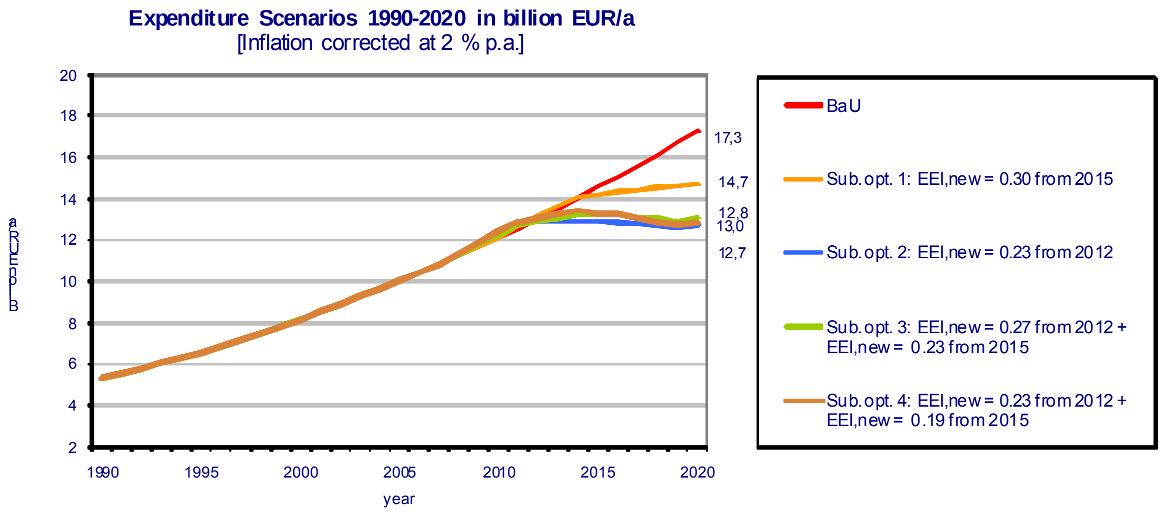
<u>Tables on comparison of introductory dates</u>

Comparison of sub-options for introductory dates:

Figures A.3.1: Implementation of requirements one year earlier







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

Table A.3.8a: Impact on electricity consumption by 2020, if requirements introduced one year earlier

Electricity consumption in 2020 [TWh/year]	Sub-option 1	Sub-option 2	Sub-option 3	Sub-option 4
As per proposed timing	40.6	26.8	28.7	26.5
One year earlier	38.5	25.5	27.0	22.7
Further savings in 2020	2.1	1.3	1.7	3.8

Table A.3.8b: Impact on CO2 emissions by 2020, if requirements introduced one year earlier

CO_2 emissions in 2020 [Mt CO_2]	Sub-option 1	Sub-option 2	Sub-option 3	Sub-option 4
As per proposed timing	18.6	12.3	13.1	12.1
1 year earlier	17.6	11.7	12.4	10.4
Further savings in 2020	1	0.6	0.7	1.7

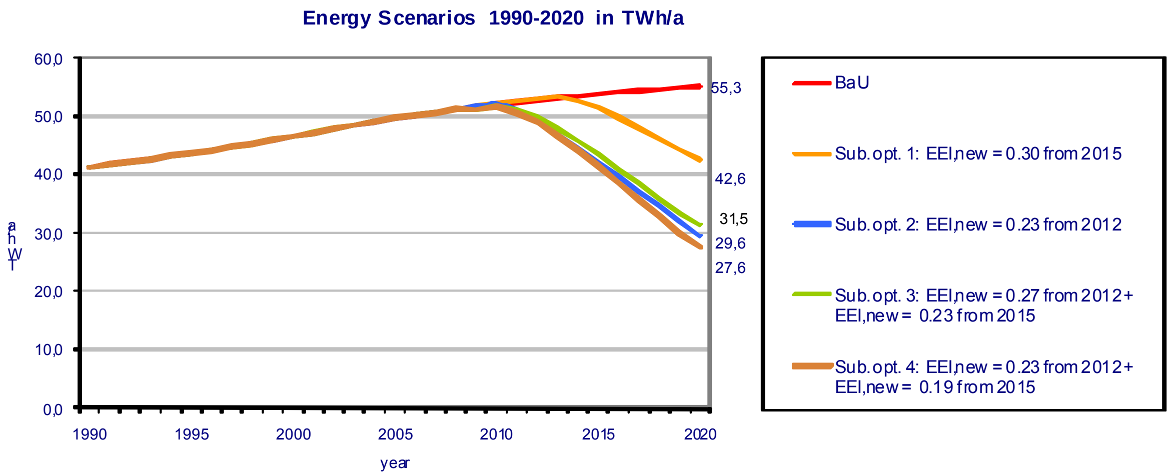
Table A3.8c: Impact on consumer expenditure in 2020, if requirements introduced one year earlier

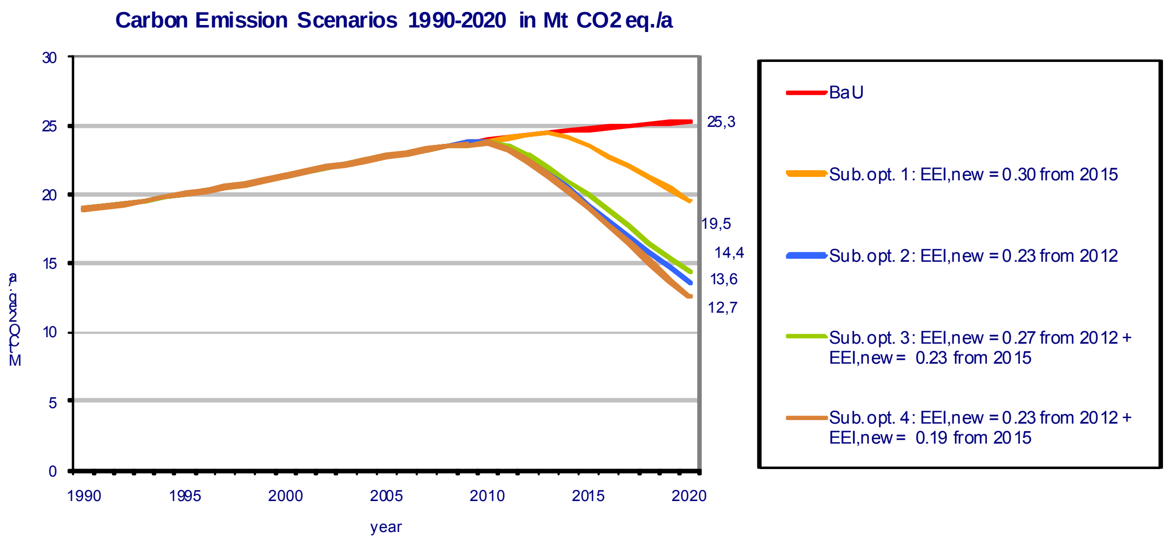
Consumer expenditure in 2020 [Bln. EUR/year]	Sub-option 1	Sub-option 2	Sub-option 3	Sub-option 4
Proposed timing	15.1	13.0	13.4	13.6
1 year earlier	14.7	12.7	13.0	12.8
Further savings in 2020	0.4	0.3	0.4	0.8

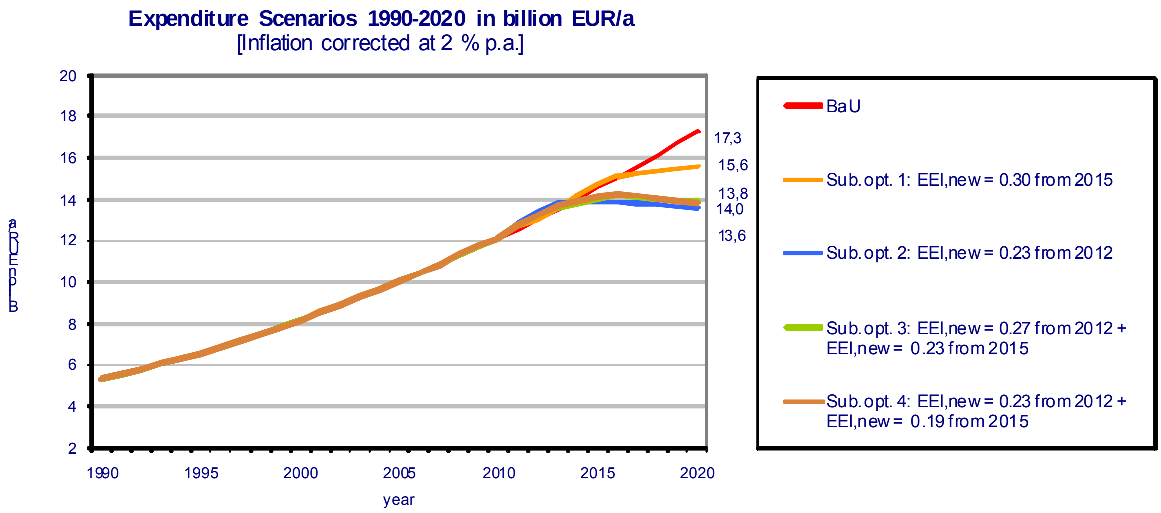
The analysis shows that earlier implementation leads to a very small additional increase in electricity and CO2 emissions savings by 2020 and the savings will be realized one year later in any case. The risk with some of the manufacturers not yet being very familiar with the production of permanent magnet technology increase, when the time period for the entry into force of the requirements shortens; in the case of sub-option 2 it is not considered to be long time enough for the redesign of circulator and boiler production, or for the adoption of the production through purchase of the necessary technology in the OEM market. In the case of sub-option 1, the shortening of this time period is considered to be appropriate but this would lead to considerably lower savings than sub-option 2.

Below, the impacts are compared, if the implementation year is postponed by one year for all sub-options.

Figures A.3.2.: Implementation of requirements one year later







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

Table A.3.9a: Impact on electricity consumption by 2020, if requirements 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	40.6	26.8	28.7	26.5
One year later	42.6	29.6	31.5	27.6
Increase in 2020	2	2.8	2.8	1.1

Table A.3.9.b: Impact on CO2 emissions by 2020, if requirements 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	18.6	12.3	13.1	12.1
1 year later	19.5	13.6	14.4	12.7
Increase in 2020	0.9	1.3	1.3	0.6

Table A.3.9.c: Impact on consumer expenditure in 2020, if requirements 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	15.1	13	13.4	13.6
1 year later	15.6	13.6	14.0	13.8
Increase in 2020	0.5	0.6	0.6	0.2

ANNEX 4: IMPACTS CONSIDERED SEPARATELY ON STANDALONE AND BOILER INTEGRATED CIRCULATORS

In regard to the criteria established by Article 15(2) of the Ecodesign Directive, the Impact Assessment has established the following results for circulators in the EU:

Table A 4.1: Standalone circulators

Article 15 (2a):	Annual sales volume in the Community	6.5 million units in 2005 8.2 million units in 2020
Article 15 (2b):	Environmental impact: energy consumption of circulators (BaU)	27.7 TWh in 2005 30.8 TWh in 2020
Article 15 (2c):	Improvement potential (savings applying cost effective existing technology)	0 TWh in 2005 14.8 TWh in 2020

The latest Europump data on sales volume from 2005 shows an annual sales volume of 6.5 million units. A relative small increase on 1.4 % p.a. in the sales volume is expected, which gives a sales volume of 8.2 million units in 2020.

Table A.4.2: Boiler integrated circulators

Article 15 (2a):	Annual sales volume in the Community	7.5 million units in 2005 9.4 million units in 2020
Article 15 (2b):	Environmental impact: energy consumption of circulators (BaU)	22.1 TWh in 2005 24.5 TWh in 2020
Article 15 (2c):	Improvement potential (savings applying cost effective existing technology) (sub-option 2)	0 TWh in 2005 11.8 TWh in 2020

The latest Europump data on sales volume from 2005 shows an annual sales volume of 7.5 million units. A relative small increase on 1.4 % p.a. in the sales volume is expected, which gives a sales volume of 9.4 million units in 2020.

Impacts per type of circulator

Economic impacts

The graphs below show the electricity consumption of the various sub-options per type of circulator.

Figure A.4.1: Electricity consumption of sub-options by standalone circulators

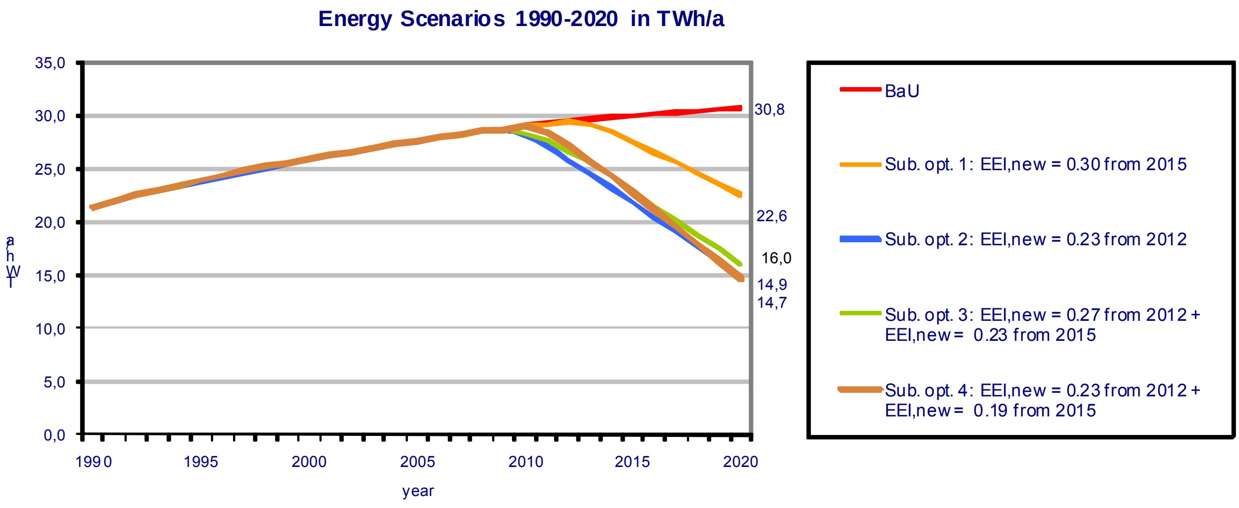
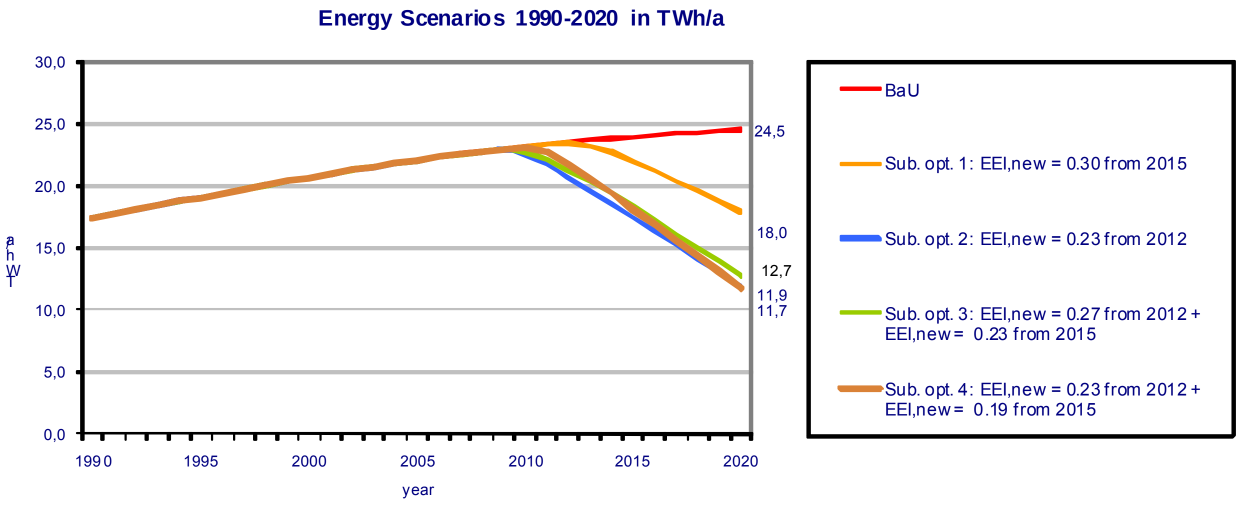


Figure A.4.2 Electricity consumption of sub-options by boiler integrated circulators



Consumer economics and affordability

The below tables show the expected savings from the sub-options per type of circulator.

Figure A.4.3: Expenditure scenarios 1990-2020 for standalone circulators

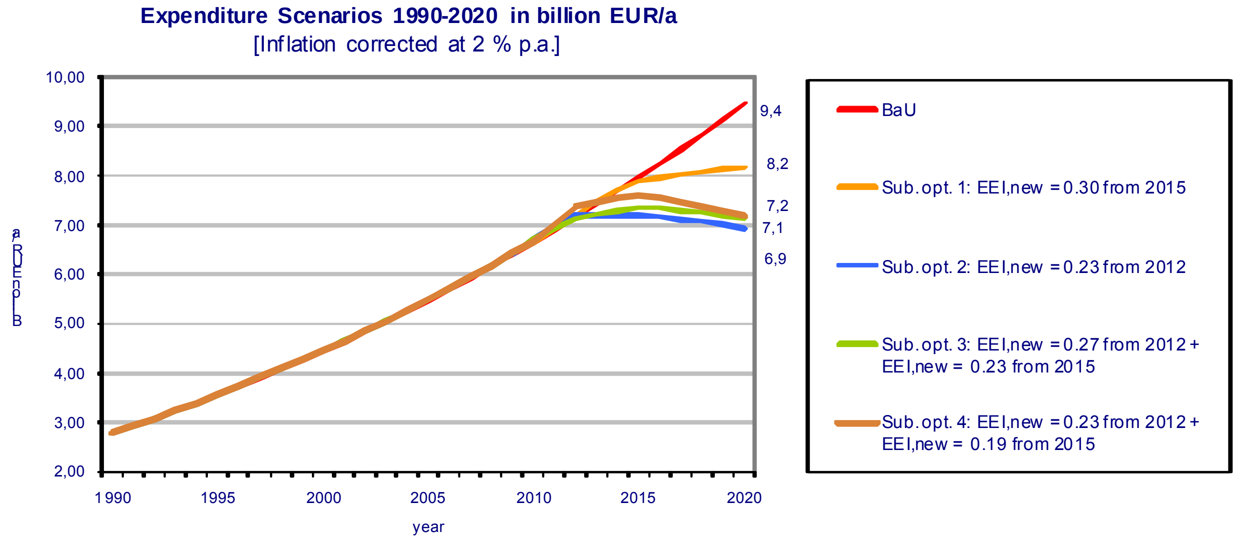
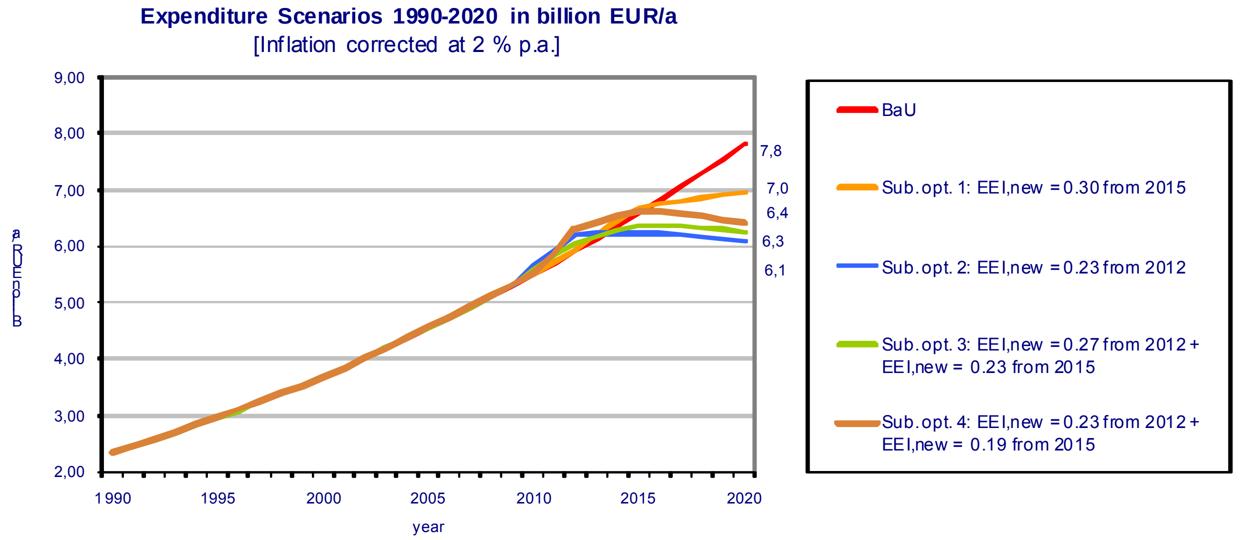


Figure A.4.4 Expenditure scenarios 1990-2020 for boiler integrated circulators



Environmental impacts

The below tables show carbon emissions of various sub-options per type of circulator.

Figure A.4.5 Carbon emissions of sub-options by standalone circulators

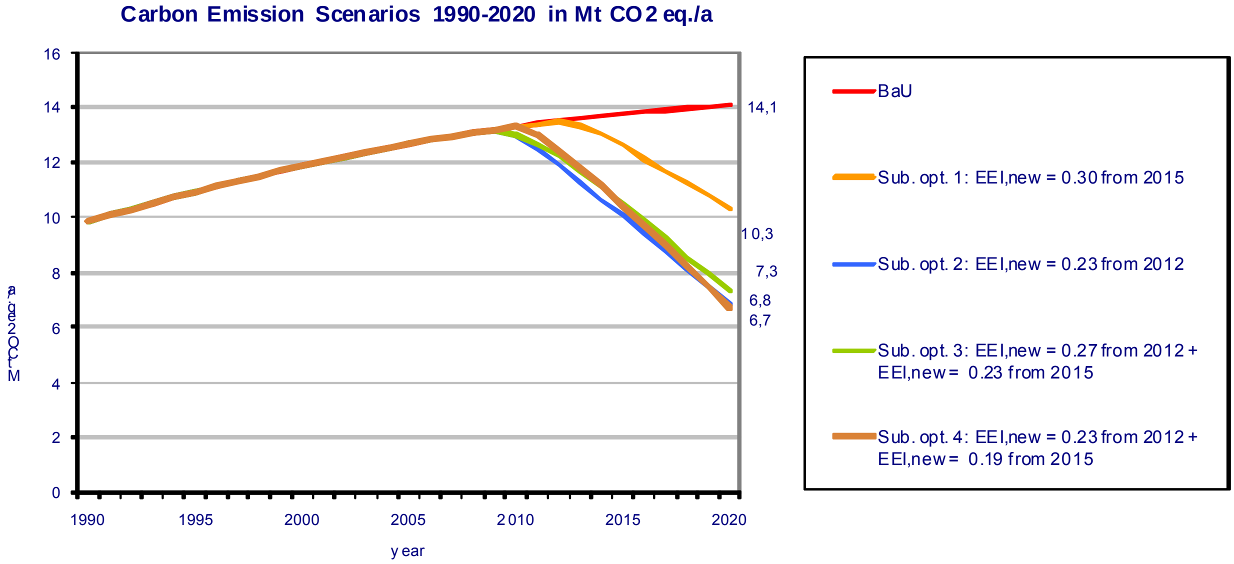


Figure A.4.6 Carbon emissions of sub-options by boiler integrated circulators

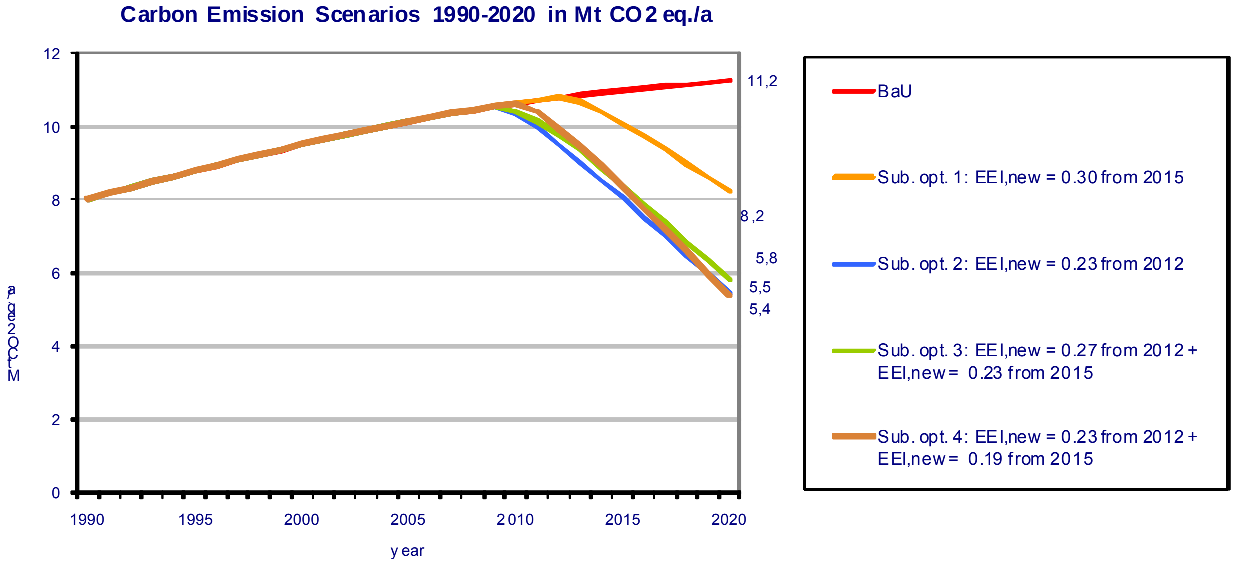


Table A.4.3 Energy consumption BAU and sub-option 3

	BAU			Sub-option 3			Savings sub-option 3compared to BAU		
	Total	Stand-alone	Boiler integrated	Total	Stand-alone	Boiler integrated	Total	Stand-alone	Boiler integrated
2005	49.8	27.7	22.1	49.8	27.7	22.1			
2010	52.7	29.3	23.4	51.2	28.5	22.7	1.5	0.8	0.7
2020	55.3	30.8	24.5	28.7	16.0	12.7	26.6	14.8	11.8

Table A.4.4 CO2 emissions BAU and sub-option 3

	BAU			Sub-option 3			Savings sub-option 3compared to BAU		
	Total	**Stand-alone**	**Boiler integrated**	**Total**	**Stand-alone**	**Boiler integrated**	**Total**	**Stand-alone**	**Boiler integrated**
2005	22.8	12.7	10.1	22.8	12.7	10.1			
2010	23.9	13.3	10.6	23.4	13.0	10.4	0.5	0.3	0.2
2020	25.3	14.1	11.2	13.3	7.3	5.8	12.2	6.8	5.4

Table A.4.5 Consumer expenditures BAU and sub-option 3

	BAU			Sub-option 3			Extra costs sub-option 3compared to BAU		
	Total	**Stand-alone**	**Boiler integrated**	**Total**	**Stand-alone**	**Boiler integrated**	**Total**	**Stand-alone**	**Boiler integrated**
2005	10.1	5.5	4.6	10.1	5.5	4.6			
2010	12.1	6.6	5.5	12.3	6.7	5.6	-0.2	-0.1	-0.1
2020	17.2	9.4	7.8	13.4	7.1	6.3	3.8	2.3	1.5

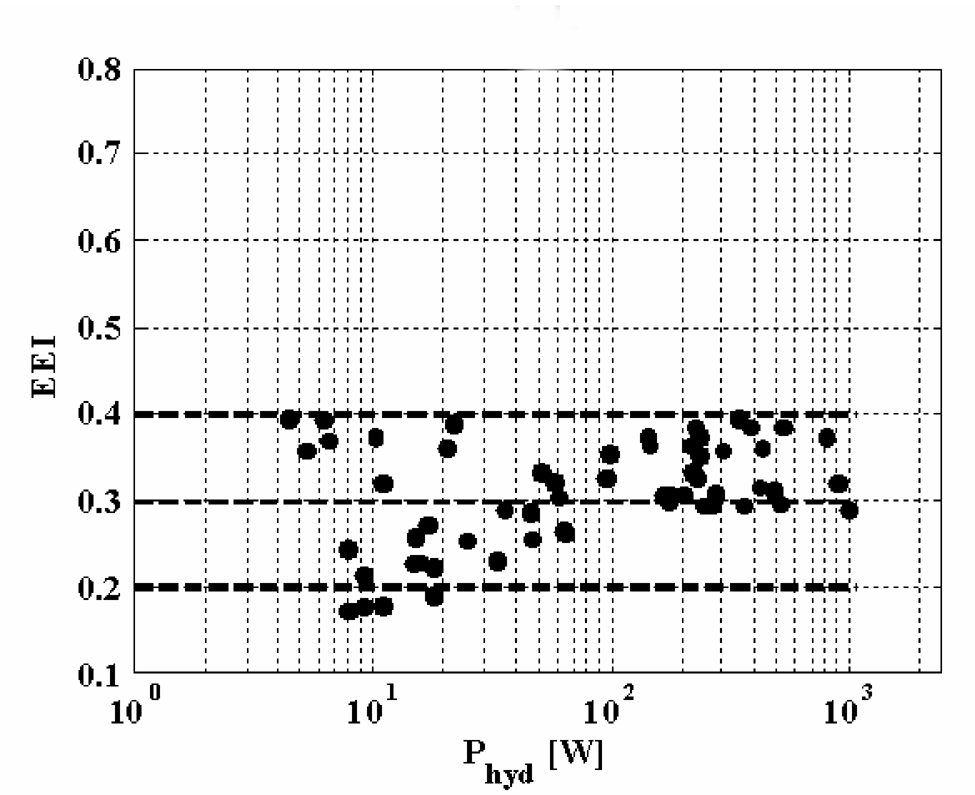
Negative values correspond to savings in costs.

ANNEX 5: EEI CALCULATION METHOD AND FEASIBILITY OF EEI ≤ 0,15

This Annex briefly explains the Europump energy efficiency index (EEI) calculation method, including the impact of its update on 2008 and the feasibility of achieving the efficiency level EEI ≤ 0.15 or below. The Annex 6 provides the technical details on the update of the Europump calculation method.

The below figure shows the EEI values for circulators classed above the A Class efficiency (EEI ≤ 0.4) under the old calculation method.

Figure A.5.1: EEI values under the old calculation method



The update of EEI levels is done via a new P_{ref} curve, as follows:

$$EEI = \frac{P_{Lavg}}{P_{ref}}$$

The weighted average power P_{Lavg} is unchanged and still measured according to the revised EN1151-1.

The current P_{ref} curve is defined as follows:

$$P_{ref,old} = 2.21 \cdot P_{hyd} + 55 \cdot \left(1 - e^{-0.39 \cdot P_{hyd}}\right), \quad 0W \le P_{hyd} \le 2500\ W$$

A new P_{ref} curve was calculated by Technical university of Darmstadt* based on A-rated circulator on the market in 2008, as follows:

$$P_{ref,new} = 1.7 \cdot P_{hyd} + 17 \cdot \left(1 - e^{-0.3 \cdot P_{hyd}}\right), \quad 1\,W \leq P_{hyd} \leq 2500\,W$$

Calculation of updated EEI levels is made as follows:

$$EEI_{old} = \frac{P_{Lavg,old}}{P_{ref,old}}$$

$$EEI_{new} = \frac{P_{Lavg,new}}{P_{ref,new}} \cdot C_{20\%}$$

This gives the final formula as follows:

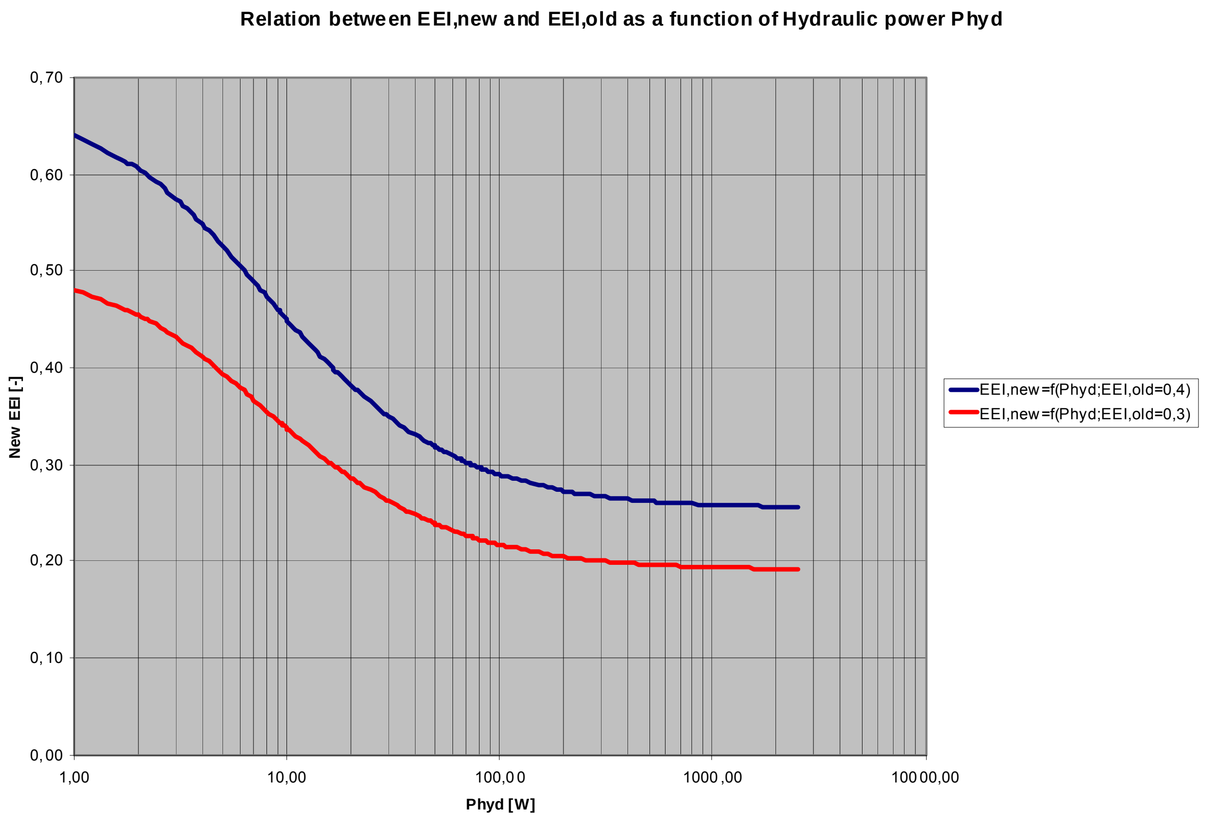
$$P_{Lavg,new} = P_{Lavg,old}$$

$$\boxed{EEI_{new} = EEI_{old} \cdot \frac{P_{ref,old}}{P_{ref,new}} \cdot C_{20\%}}$$

The reason for updating the calculation method is that the EEI circulator classification used for Europump voluntary A-G energy labelling is based on the state of art efficiency levels of circulators on the market in 2001. The classification also included a factor, which gave bigger circulators lower EEI values than they would otherwise have. Due to significant efficiency improvements of small circulators since 2001, the distortion in the EEI classification scheme has further amplified. Consequently, the EEI levels were updated based on A-rated circulators (EEI ≤ 0.40 according to the old method and EEI ≤ 0.30 according to the new methtod) on the market in 2008. Due to the distortion, the technical limit in EEI levels was around 0.3 for large and around 0.2 for small circulators. The distribution of circulators per efficiency can be seen in figure A.5.1 (under the old scheme) and in figure A5.4 (under the new scheme).

The below figure shows the relation between the old and the new EEI as a function of hydraulic power (Phyd)

Figure A.5.2: Relation between the old and the new EEI curve.

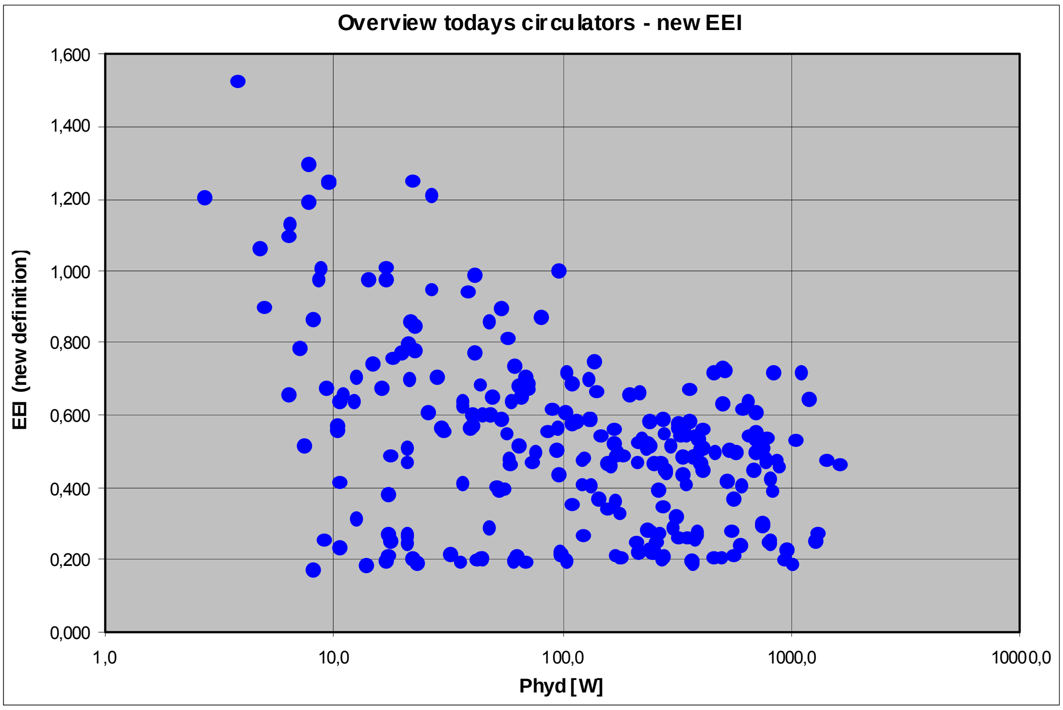


The below figure shows the theoretical minimum EEI values. The theoretical minimum EEI value with 100% efficiency is 0.13.

Figure A.5.3: Theoretical minimum EEI values of circulators under the new calculation method.

The below figure shows the EEI values of all circulators under the new calculation method.

Figure A.5.4: EEI values under the new calculation method



The next figure shows the numerical values behind plots in the above figure.

Figure A.5.5: Table on numerical values per old/new calculation method.

$P_{hydr,100\%}$ [W]	EEI (Eta=100%)	Pref,old	Pref,new	Pref,old/ Pref,new	EEI,new=f(Phyd;EEI,old=0,4)	EEI,new=f(Phyd;EEI,old=0,3)
1,00	0,029	19,972	6,106	3,271	0,64	0,48
2,00	0,032	34,208	11,070	3,090	0,61	0,45
3,00	0,035	44,560	15,188	2,934	0,58	0,43
4,00	0,038	52,283	18,680	2,799	0,55	0,41
5,00	0,040	58,225	21,707	2,682	0,53	0,39
6,00	0,043	62,962	24,390	2,581	0,51	0,38
7,00	0,046	66,883	26,818	2,494	0,49	0,37
8,00	0,048	70,251	29,058	2,418	0,47	0,36
9,00	0,051	73,246	31,158	2,351	0,46	0,35
10,00	0,053	75,987	33,154	2,292	0,45	0,34
20,00	0,069	99,177	50,958	1,946	0,38	0,29
30,00	0,078	121,300	67,998	1,784	0,35	0,26
40,00	0,083	143,400	85,000	1,687	0,33	0,25
50,00	0,086	165,500	102,000	1,623	0,32	0,24
50,00	0,086	165,500	102,000	1,623	0,32	0,24
70,00	0,090	209,700	136,000	1,542	0,30	0,23
73,92	0,091	218,363	142,664	1,531	0,300	0,225
80,00	0,092	231,800	153,000	1,515	0,30	0,22
90,00	0,093	253,900	170,000	1,494	0,29	0,22
100,00	0,094	276,000	187,000	1,476	0,29	0,22
200,00	0,098	497,000	357,000	1,392	0,27	0,20
300,00	0,100	718,000	527,000	1,362	0,27	0,20
400,00	0,101	939,000	697,000	1,347	0,26	0,20
500,00	0,101	1160,000	867,000	1,338	0,26	0,20
600,00	0,102	1381,000	1037,000	1,332	0,26	0,20
700,00	0,102	1602,000	1207,000	1,327	0,26	0,20
800,00	0,102	1823,000	1377,000	1,324	0,26	0,19
900,00	0,102	2044,000	1547,000	1,321	0,26	0,19
1000,00	0,102	2265,000	1717,000	1,319	0,26	0,19
2000,00	0,103	4475,000	3417,000	1,310	0,26	0,19
2500,00	0,103	5580,000	4267,000	1,308	0,26	0,19
10000000000,00	0,103					

The key values, from the point of view of the Regulation, are shown in the below table.

Table A.5.1: Comparison of key EEI values between old and new calculation method.

Old	New
0.60	0.45
0.40	0.30
0.33	0.25
0.30	0.22
0.27	0.20
0.25	0.19
0.20	0.15
0.15	0.11
0.13	0.10

An A-rated circulators (EEI ≤ 0,40 according to the old method and EEI ≤ 0,30 according to the new method) had a market share of 6.7% in 2007.

Technical feasibility

The reachable efficiency of a circulator depends on its operating point (Flow and Head = specific speed). The specific speed n_q is defined as follows:

$$n_q = n \frac{\sqrt{Q}}{H^{0.75}}$$

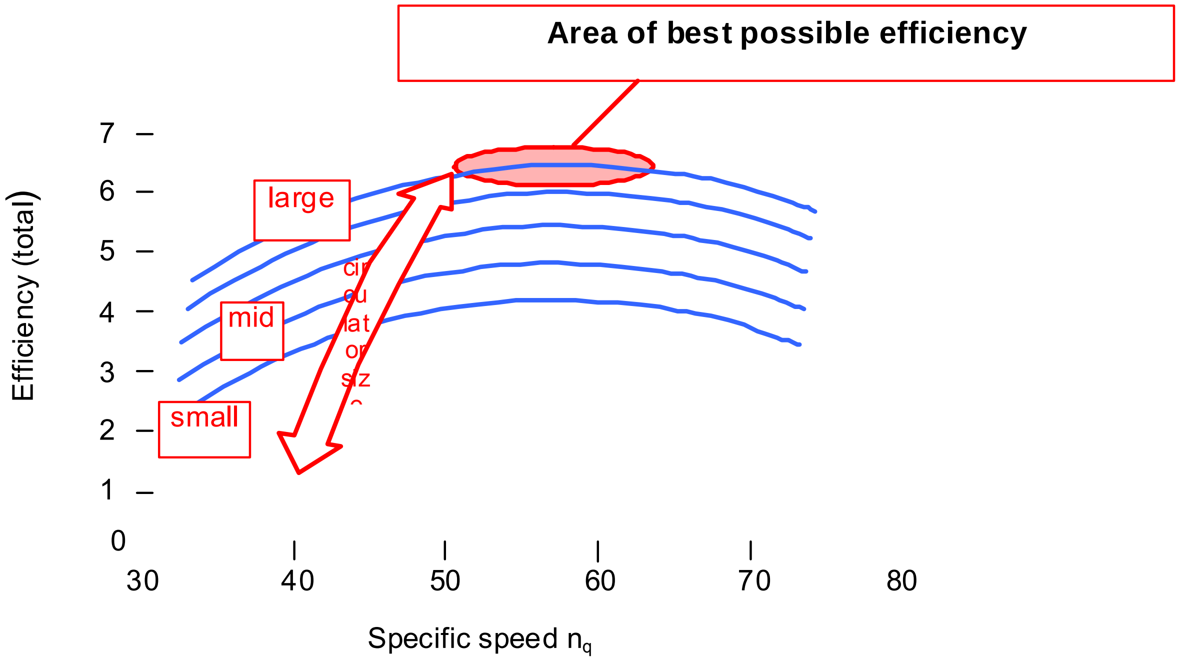
n = speed

Q = flow

H = head

Maximum efficiency of a circulator can be reached within a limited area of operating points, as shown in the below figure.

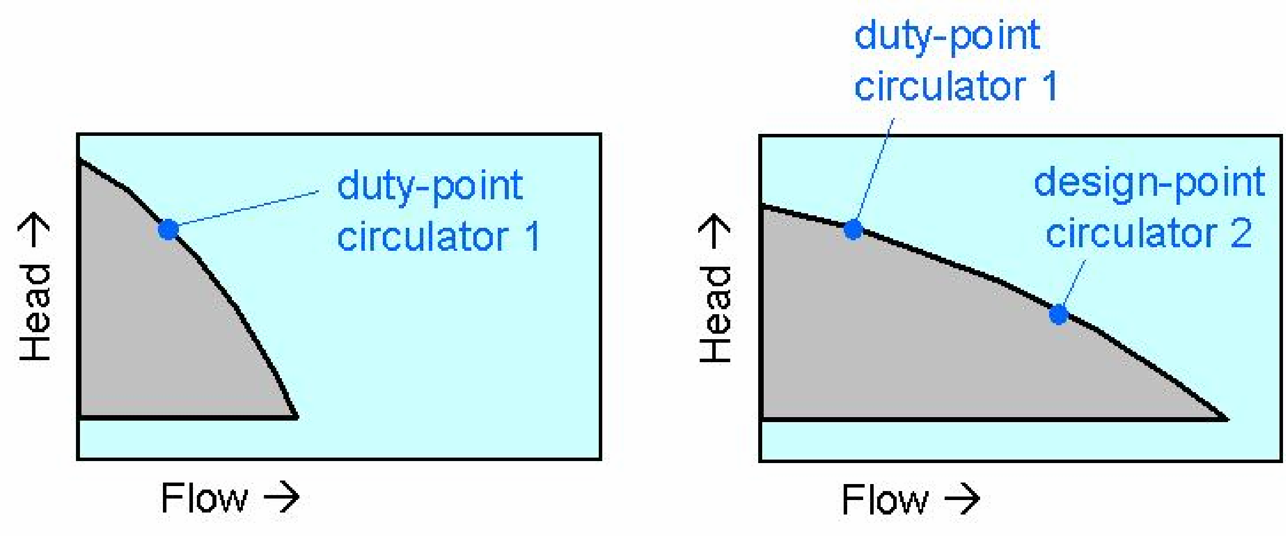
Figure A.5.6: Area of best possible efficiency



It has been confirmed by the industry that the technical level of 0.15 can today not be achieved. Although the BAT level is achievable technically, it may not be achieved by all pumps, as for some duties where there is a particularly high ratio of head to flow, the circulator will have an impeller that is narrow but with a large diameter. This leads to higher internal friction losses than for circulators of similar rated power (head times flow). The ratio of head to flow is known as the specific speed of a pump, with low specific speed pumps being unable to achieve as high an efficiency as that of a higher specific speed pump of the same technology. This is demonstrates in the below figure. The precise relationship between flow, head and specific speed is explained in detail in the preparatory study on pumps[3].

[3] Page 206, http://www.ecomotors.org/.

Figure A.5.7: Circulator 1 with low flow and high head (but not optimal nq) and circulator 2 (with optimal nq in the design point)



The reachable efficiency and the level of EEI depends on the design point (Flow/Head relation = specific speed) of the circulator. Circulators with optimal specific speed value can reach EEI ≤ 0.20 level but as the design point depends on the requirements of the application, not every single circulator on the market can reach the level EEI ≤ 0.20. However, the solution in these rare applications, on which no detailed explanation has been received for this impact assessment, is to use a bigger pump.

For this reason, the setting of the minimum efficiency requirement above EEI ≤ 0.23 would be counterproductive. However, as EEI ≤ 0.20 is met by several existing pumps on the market, it is suggested that EEI ≤ 0.20 is set as a benchmark value.

It can also be mentioned that:

EEI ≤ 0.30 would allow the lowering of the efficiency of permanent magnet variable speed circulators currently available on the market, as the efficiency level for 95% of these circulators starts at around EEI ≤ 0.26.

EEI ≤ 0.23 introduces a minimum efficiency requirement also on circulators based on variable speed permanent magnet technology with **0.03** EEI points (difference between EEI 0.23 and 0.26).

EEI ≤ 0.20 as BAT is introduced with **0.03** EEI points above the minimum energy performance requirement (difference between EEI 0.18 and 0.23).