

Energy Using Product (EuP) Directive Preparatory Study

Lot 11: Water Pumps (in commercial buildings, drinking water pumping, food industry, agriculture)

First Stakeholder Meeting

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1 Product Definition, standards and legislation - 1.1.1 Product classification

The Universe of Pumps (Fig 1.1)

Note: We have excluded the motor, coupling, baseplate and any other ancillary items.

		Pump Type
ROTODYNAMIC	Centrifugal	Single Entry Volute - Conventional
		Single Entry Volute – Solids Handling
		Single Entry Volute – Non-Clogging
		Single Entry Volute – In-Line
		Double Entry Volute
		Two Stage Volute
		Multistage Radial Split
		Multistage Axial Split
		Multistage Barrel Casing
		Single Stage Well
Multistage Well		
Mixed Flow	Volute	
	Bowl	
Axial Flow	Well	
POSITIVE DISPLACEMENT	Rotary	Progressing Cavity
		Sliding Vane
		Peristaltic
		Screw
		Lobe
		Gear
	Reciprocating	Diaphragm
		Plunger
		Piston
	Open	Archimedean Screw

Comments

We have drawn the boundary around the pump, which will include any integral seals.

There are many ways to categorise pumps – for consistency throughout the report we have tried to standardise on the construction of the pump. But not all data sources take this approach....

There are lots of (very small) reciprocating pumps sold in the EU, but these would not be used for the applications specified in the ToR. There are also larger (and comparatively high efficiency) reciprocating pumps available. They could technically be used (functional definition), but the performance and cost would not be acceptable.

On the basis of sales volumes and applications, three basic types have been selected. In terms of the basecase reference model, we have split the single entry volute pump in to two sub types on the basis of mounting arrangement (ESOB and ESCC).

1.1.2 Definition of Primary Functional Parameters

Pressure (m) and Flow (m^3/h) *and bearing arrangement (ESCC/ESOB)?*

1.1.3 Definition of Primary Functional Parameters

Pump volume.
Pump weight.
Position and size of fixing holes.
Bearing arrangements.
Noise.
Expected lifetime of the pump.
Seal arrangements.
Net Positive Suction Head
Minimum clearances required.
Efficiency.
Material

1.2 Inputs on relevant harmonised standards for performance testing/energy use/health and safety

1.2.1 Testing

Testing to EN ISO 9906-1999

- Grade 1 (most accurate), Grade 2 (least accurate)
- Smaller pumps sold without test to annex A
- Samples may be specially prepared for testing.
- Catalogue efficiencies may differ from actual product shipped.

This means that we can not use catalogue data in this study. If we did, any efficiency levels would be set unrealistically high!

The poor quality of catalogue data is itself an issue.

The wide efficiency tolerances allowed under Annex A could make efficiency classification difficult

The motor efficiency is assumed to be as stated!

1.2.2 Harmonised Standards – energy use

Don't know of anything – SparPumpen scheme?

The key challenges are to define the efficiency of a pump, and to devise standard duty profiles.

1.3 Existing relevant environmental legislation inside and outside EU, existing self regulation

- ISO EN 809:1998 (**Common safety requirements**) is the most relevant document for general mechanical construction.
- The **American Petroleum Institute** (API) imposes standards for pumps used in the oil industry.
- The **Pressure Equipment Directive**: The view of Europump is that pumps and pump units are not relevant to this directive.
- A pump supplied without a motor fall outside the scope of the **EMC directive**. Those sold as pumpsets will do.
- The **machinery directive** 89/332/EEC does generally apply
- *WEEE & RoHS should not apply*

- Energy related
- (Circulator agreement)
- Europump / SAVE Procurement scheme

2 Economics and Market

– 2.1 Macro data on EU trade, production and apparent consumption

The Primary Data for all preparatory studies is Eurostats

There are known inaccuracies related to the Eurostats database, but it is still the primary source of statistics for all studies.

We have also received data from Europump which provides a “cleaned up” source of data, although we recognise that this is still subject to uncertainties

Once we understand what the definitions of products are in both sets of data, we will “adopt” one as standard. We will also cross-check this with EU motor energy use data. We will probably select the Europump data as standard as this is more useful to us – but we must always refer back to Eurostats as the ultimate source.

Eurostats – Net EC Consumption (1998)

DECLARANT / PRCCODE	29122413 Submersible motor, single stage rotodynamic drainage and sewage pumps	29122415 Submersible Motors, multi-stage rotodynamic pump	29122417 Glandless impeller pumps for heating systems and warm water supply	29122420 Rotodynamic pumps <= 15mm discharge	29122430 Centrifugal pumps with a discharge diameter > 15mm, channel impeller pumps, side channel pumps, peripheral pumps and regenerative pumps.	29122451 Centrifugal pumps with a discharge outlet diameter >= 15mm, single stage with a single entry impeller, close coupled	29122453 Centrifugal pumps with a discharge outlet diameter >= 15mm, single stage with a single entry impeller, long coupled	29122455 Centrifugal pumps with a discharge outlet diameter > 15mm, single stage double entry impeller.	29122457 Other centrifugal pumps, single-stage	29122460 Centrifugal pumps with a discharge outlet diameter > 15mm, multistage (including self-priming)
France	79,947	38,928	1,247,849	8,898	- 4,812	86,099	15,419	423	-	163,474
Netherlands	295,674	13,254	397,374	17,271	9,816	14,511	17,807	30	-	6,907
Germany	1,113,534	38,244	2,055,379	7,136,325	81,804	1,760,264	- 394,884	- 1,159	8	216,216
Italy	479,274	155,881	1,862,238	18,095,871	30,412	12,555	729,237	182	-	388,573
United Kingdom	1,192,448	- 223,395	- 659,139	110,301	14,039	410,788	34,959	1,200	-	11,019
Ireland	- 76,925	2,199	- 113,877	374	275	10,708	820	1	-	1,971
Denmark	34,100	22,811	228,637	17,198	3,080	523	199,294	- 9	-	38,712
Greece	9,291	15,606	181,649	121	15	8,733	900	2,886	-	13,467
Portugal	- 2,450	32,895	17,586	1,237	78	6,486	5,173	3	-	8,091
Spain	90,746	46,720	351,018	1,468,518	296,801	- 56,571	8,643	- 2,217	-	29,449
Belgium	79,615	8,949	224,400	10,185	- 2,074	4,050	5,603	54	-	12,262
Luxemburg	-	-	-	-	-	-	-	-	-	-
Iceland	-	-	-	-	-	-	-	-	-	-
Norway	-	-	-	-	-	-	-	-	-	-
Sweden	8,048	9,201	270,512	85,462	954	59,499	3,107	203	-	16,504
Finland	18,178	3,649	5,386	6,126	230	16,098	55,366	2	-	2,069
Austria	37,247	19,115	214,105	14,695	1,405	6,395	7,643	52	-	5,793
TOTALS	3,358,727	184,057	6,283,117	26,972,582	432,023	2,340,138	689,087	1,651	8	914,507

Europump – EC Sales data (2006 estimate) for mass produced pumps

Segment	Number	Average Input kW (Annual running hours)	Total linked GWh
Heating Circulators	14,000,000	0.15 (3,000)	6,300
DN < 15mm	16,000,000	0.2 (2,000)	2,400
Domestic Drainage (Submersible)	3,000,000	0.4 (1,000)	1,200
Residential Sewage (Submersible < 2kW)	600,000	1,2 (2,000)	1,500
Total	33,600,000		11,400

NB We originally received 1998 data, but Europump has now supplied this 2006 data, which is their current best estimate. We are reviewing the assumptions behind this, but so far it appears to be reasonable.

The key thing is that even quite wide discrepancies will not alter the selection of types to be considered, and so we should not spend excessive time on this stage.

Europump – EC Sales data (2006 estimate) for engineered pumps

Segment	Number	Average Input kW (Annual running hours)	Total linked GWh
Single Stage close-coupled (SAVE)	2,000,000	3 (2,000)	12,000
Single stage Water (SAVE)	1,000,000	5.5 (2,500)	13,500
Portable Drainage	150,000	4.5 (2,500)	1,500
Municipal / Industrial Sewage Submersible 2 – 70 kW	120,000	7.5 (3,000)	2,700
Submersible Multistage < 4in	530,000	1.5 (1,500)	1,200
Submersible Multistage 6in	130,000	5 (2,000)	1,300
Multistage Water	650,000	2.5 (2,000)	2,500
Chemical Process	40,000	15 (6,000)	4,000
Refining Process OH2	10,000	30 (6,000)	1,800
Total	4,650,000		40,500

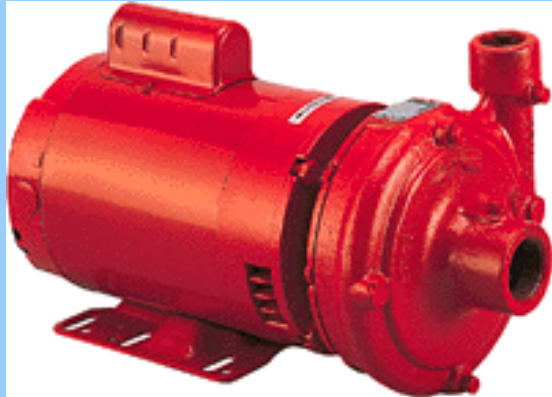
Selection of Pumps for this study

Style	Standard (where applicable)	Selected Duties
End Suction Own Bearings (ESOB)	EN 733:1995, 10 bar rating	1.) 25 m ³ /h at 8m (EN 733-50-160) 2.) 125 m ³ /h at 32m (EN 733-100-315)
End Suction Close Coupled (ESCC)	None applicable, and so suggest base duties on EN 733:1995	1.) 25 m ³ /h at 8m (EN 733-50-160) 2.) 125 m ³ /h at 32m (EN 733-100-315)
Submersible Multistage	None applicable, so have based selection on typical available product ¹	1.) 2.5m ³ /h at 70m 2.) 8m ³ /h at 60m

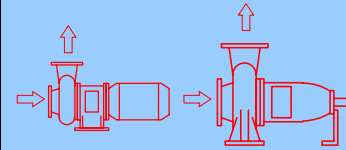
AND

- **Multistage radial split water pumps (standard and mass produced DN<15mm)**
- **DN<15mm single stage – *Once we understand what these physically are, we suspect that they will be outside of the ToR.***

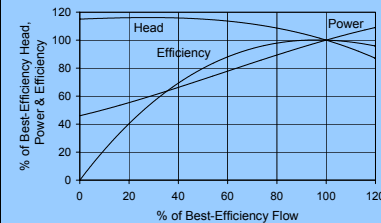
Own bearing and Close coupled End Suction pumps



Single Entry Volute - Conventional



Typical Performance



Smaller pumps tend to be relatively low cost with efficiency on the low side. Back wear rings with impeller balance holes (to reduce thrust and gland pressure) cause some efficiency loss. Efficiency falls relatively slowly as flow moves away from best-efficiency.

Head may fall with reducing flow (as shown). If so, at reduced flow surging may occur and pumps will not run in parallel at low flows.

Power may increase considerably beyond best-efficiency flow. To cover this, larger motors may be needed.

Some small pumps are fitted with integral speed controllers which can be used for energy saving.

Description

Impeller may be mounted on motor shaft, or pump may have its own shaft and bearings with pump driven via a coupling. Standard pumps to ISO 2858 (EN 22858, ex Din 24256) and EN 733, ex DIN 24255, enable back pull-out of rotating element without disturbing pipework and, if using spacer coupling, without disturbing motor. Some pumps have special inlet casings for self-priming.

Shaft is sometimes vertical with pump suspended in a sump by a column pipe, with no pump gland, and discharging to surface through a separate pipe between casing discharge flange and column/motor support/mounting plate.

Applications

General: Cooling water, Service water, Fire-fighting (special characteristics required).

Agriculture: Irrigation (usually with priming device), Borehole (small flows and depths using ejector in borehole).

Chemical/Petrochemical: Transfer (superior construction and special materials, often glandless using magnetic drive or canned motor, sometimes vertical sump type).

Building Services: Pressure boosting in tall buildings.

Dairy/Brewery: Transfer (special stainless steel fabricated construction with crevices avoided to permit 'Clean in place').

Oil/Gas Refining: Fuel oil, Gas oil, Lubricating oil, Kerosene, Petrol ('Process' type, centre-line supported, special shaft seals, complying with API 610).

Paper/Pulp: Medium/low consistency stock (special designs with single shrouded impellers, often stainless steel).

Power Generation: Large cooling water, (vertical shaft, largest have concrete volutes).

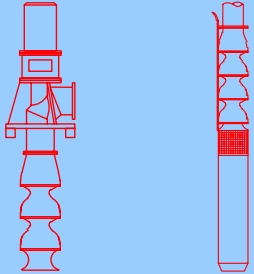
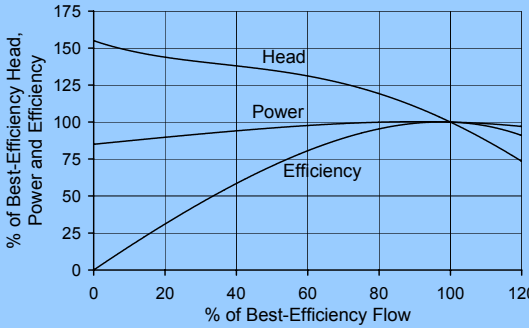
Sugar: Milk of lime and syrup.

Submersible Multistage well pumps

These do fit into the wording of the ToR, but is it in the spirit of what the EC intended?

Also associated pipework, but suggest that it is not necessary to analyse this.

These all have special motors – how does CEMEP distinguish these?

Pump Type / Performance	Description / Applications
<p>Multistage Well</p>  <p>Typical Performance</p>  <p>Pump efficiency reasonably good but submersible motor less efficient than conventional motor. Column pipe losses may be significant in deep well.</p> <p>Head is suitable for parallel operation.</p> <p>Power usually peaks at or near best-efficiency flow.</p>	<p>Description</p> <p>Above-ground motor version is basically similar to Single Stage Well pump, except that several impeller/diffuser stages are connected in series. For high heads or small diameters, radial impellers and diffusers are used (similar to Multistage Radial Split pump arrangement).</p> <p>Shaft drive may be used in wells up to 30m deep, although use in deeper wells may still be economical.</p> <p>Submersible motor version is used in deep wells, with motor mounted below pump to aid cooling. Motor usually water-filled with integral thrust bearing.</p> <p>Applications</p> <p><u>General</u>: Fire-fighting (special characteristics required).</p> <p><u>Agriculture</u>: Borehole (driven by shafting or submersible motor).</p> <p><u>Metal Manufacture</u>: Scrubber circulation.</p> <p><u>Mining</u>: Dewatering underground mines with submersible motor drive.</p> <p><u>Oil/Gas Production</u>: Seawater lift.</p> <p><u>Oil/Gas Refining</u>: Reactor charge (suspended in canister).</p> <p><u>Power Generation</u>: Condensate extraction (special first stage impellers, suspended in canister).</p> <p><u>Water Supply</u>: Borehole extraction (driven by submersible motor or shafting in shallow wells).</p>

Integrated Variable Speed Pumpsets

These are a good thing

In terms of our analysis, it is best to deal with the pump separately:

- Consistent with analysing the motor separately
-it is possible to physically separate the pump
- Don't want to discriminate against users who have a separately mounted VSD
- The study is about pumps, not pumpsets

2.2 Micro market data on prices, sales, installed products, established for reference years in the past (1990), present (most recent) and future (2010 – 2020, stock model calculations).

- We will request typical selling prices for basecase reference models and past and future projections.
- Stock is obtained from agreeing typical lifetimes for each type of pump. We can cross-check this with the assumed motor base.

2.3 Market trends in product features and key parameters (eg energy use, product weight) of best products.

- Greater sales of pumps with pressed stainless steel or plastic impellers.
- Variable speed control incorporated in integrated packages.
- Pumps available with comprehensive condition monitoring, although sales so far are poor.
- Some larger pumps will have friction reducing coatings on the cast iron volute.

This is not exhaustive – what important factors are missed out?

What references do we have to support the above statements?

Implementing measures should refer to the function, not the features. We therefore cannot explicitly support a particular feature – rather have to set eco-levels at a level that indirectly support it.

2.4 Consumer expenditure: Rates, tariffs, prices, multiplier product costs/consumer prices.

- We have requested EC electricity price projections.
- What are the non-energy running costs?

Eg spares, maintenance time and associated travel.

What about the cost of downtime?

Later we will do scenario analysis of different electricity prices.

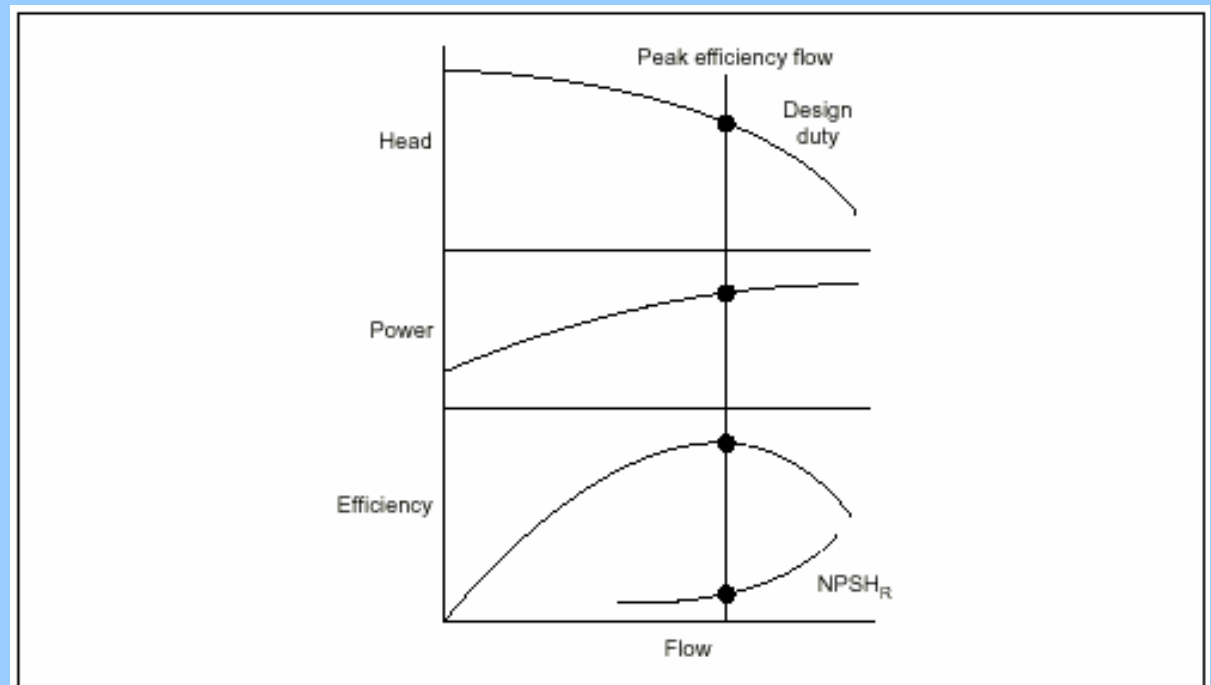
3 Consumer Analysis and Local Infrastructure

3.1 Real load efficiency (vs. nominal)

(Almost) always operating to the left of the BEP – hence actual real life efficiency below CBEP.

3.2 Part load characteristics of pumps

Taking account of wear and working below BEP, we are suggesting that the average pump is working 10-20% below BEP.



3.3 Temperature/timer settings

This refers to settings on washing machines etc, so is not relevant to pumps.

3.4 Dosage of aux. inputs during use

- Lubricant (grease) for bearings
- Replacement seals
- New bearing
- New wear rings

Many are maintenance free.

Difficult to assess – but it's the differences that we need to focus on.

3.5 End-of-Life actual behaviour (present fractions to recycling, re-use, disposal, etc) Product Life (=in practice)

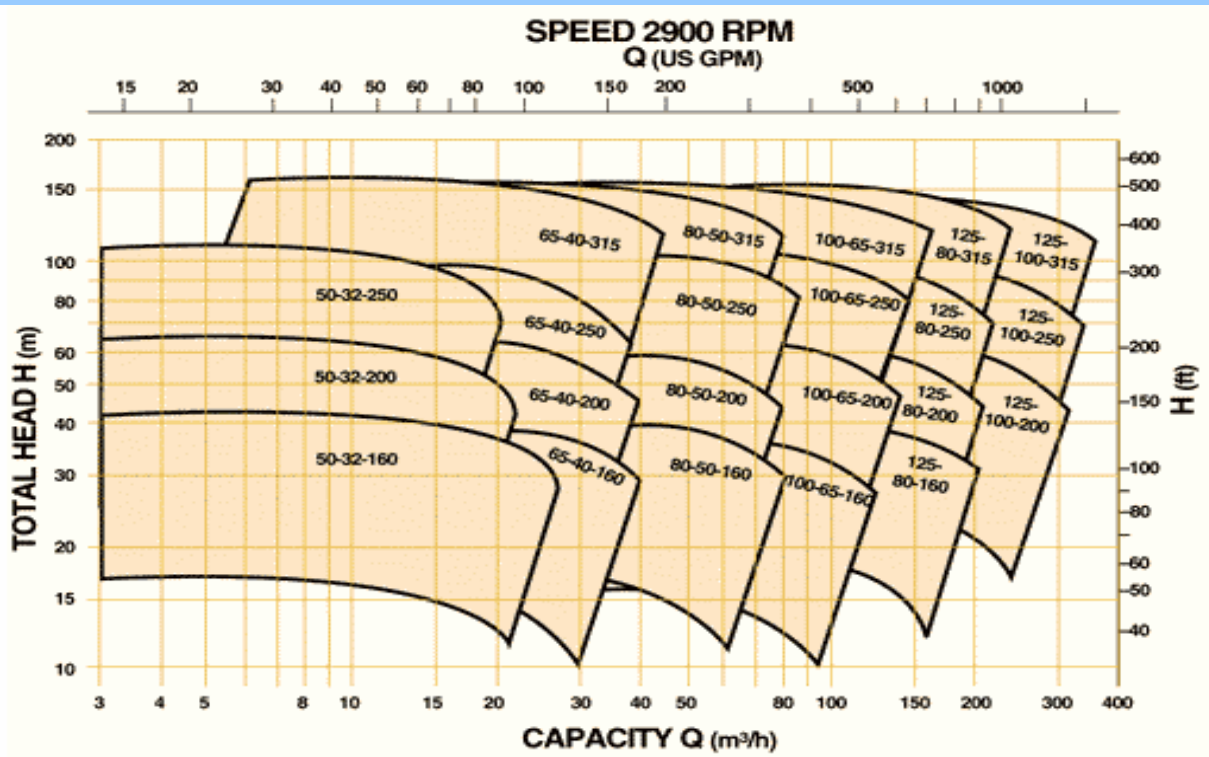
- Ask for suggestions from stakeholders on lifetimes.
- Which are repaired, which replaced?

Is it better to replace or repair – a saving of materials vs a possible deterioration in efficiency.

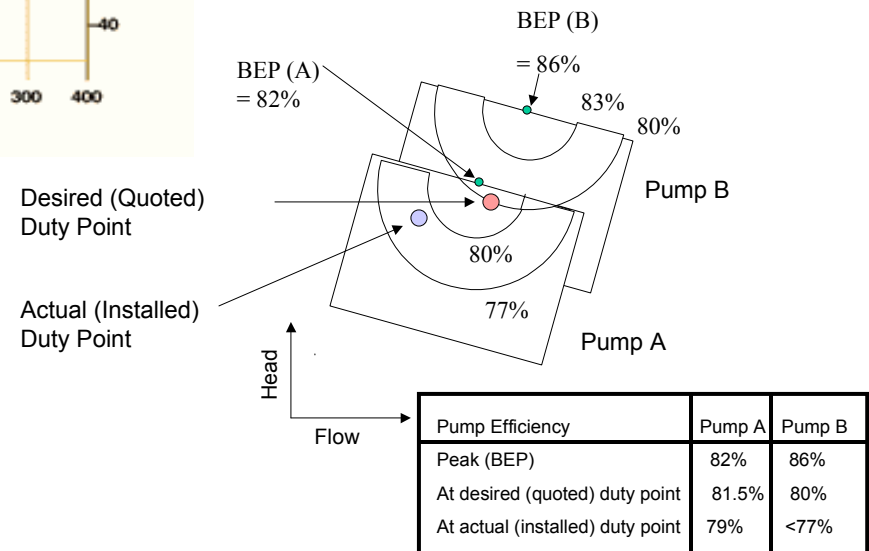
3.6 End-of-Life actual behaviour (present fractions to recycling, re-use, disposal, etc)

What does happen to pumps when they reach the end of their life?

3.7 Best Practice in Sustainable product use



Pump selection is at least as important as rated efficiency!



Best Practice in Sustainable product use - Other issues

- Maintenance
- System Energy Losses
- Condition Monitoring

3.8 Local infrastructure (energy, water, telecom, physical distribution, etc)

- Not really applicable, although a reduced electrical demand is beneficial.

Next steps in the Ecoimpact methodology

5 Definition of Basecase*

- *Selection of average EU representative model or construction of average EU model characteristics from several important product-subcategories in the product group.*
- *Definition of STANDARD BASECASE, ie the environmental impact, functionality and Life Cycle Costs for a reference year measured according to harmonised test standards (that would also be used for compliance testing.)*
- *Definition of REAL-LIFE BASECASE, ie the (estimated) environmental impact, functionality and Life Cycle Costs in real life for a reference year with actual consumer behaviour and ambient conditions.*

* Step 4 is Technical analysis of existing products, but this step is merged into others at this stage

Summary of data needed to run the model

Production Phase

- Bill of Materials (BOMs), including packaging
- Manufacturing processes
- Proportion of scrap raw materials produced
- Volume and weight of the packaged product

Distribution Phase

- Volume and weight of the packaged product.

In Use Phase

- Product lifetime
- Lifetime energy Consumption according to both test standards and the real-life situation.
- Decline in efficiency over time
- Repairs (parts, cost and eco-impact of personnel involved, eco-impact of affected production processes)
- Any product specific direct emissions

End of life phase

- Proportions close-loop recycled, re-used, sent to landfill

6 Technical Analysis Best Available Technology (BAT)

- *State of the art in applied research of the product (prototype level)*
- *State of the art at component level (prototype, test and field trial level)*
- *State of the art of best existing production technology globally (extra-EU)*

For Discussion....

7 Improvement Potential

- *Identification of design options:*
- *Their monetary costs (extra production cost*multiplier = end-use price increase) and – if any – benefits (lower operating expense)*
- *Their environmental benefits and – if any – adverse environmental trade-offs.*
- *Ranking of options according to Life Cycle Costs/Payback Period and identification of point of LLCC, with its environmental improvement potential.*
- *Assessment of (cluster of) options with the highest absolute environmental saving potential: the so-called Best Available Technology BAT, with its environmental improvement potential.*

The critical thing is to focus on the differences between the different design options.

8 Scenario, Policy, Impact and Sensitivity Analysis

- *Policy and scenario analyses: Assessment of what is “significant”, “appropriate”, etc. and what policy measures are appropriate, what would be the gain over “business as usual” etc. We need to be careful to only specify the effects of different options, not enter into discussion about what might be desirable.*
- *Impact analysis industry and consumers: investment level, appropriate timing (in line with platform change) – a critical point for manufacturers*
- *Sensitivity analysis; test of the robustness of the “significant environmental aspects”, varying base assumptions. What factors really matter?*

We will also need to consider the impact in different countries – in general terms pump use is so diverse that it is not practical to differentiate impact in different countries. However, for some specific types there are trends which we will explore once the final choice of pumps has been made, (eg submersible well pumps, apartment circulators).

