Preparatory Studies for Eco-design Requirements of Energy-using Products

Lot 24: Professional Washing Machines, Dryers and Dishwashers

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Part: Washing Machines and Dryers

Task 4: Technical Analysis of Existing Products

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For reasons of better readability, two Task 4 reports were prepared.

The report at hand covers ***professional washing machines and dryers***.

The Task 4 report on *professional dishwashers*
is published separately.

For the benefit of the environment, this document has been optimised for **double-sided printing**.

Part: Professional Washing Machines and Dryers

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1 Introduction

1.1 Objective

Task 4 entails a general technical analysis of current products on the EU market. It comprises the Bill of Materials and the whole life cycle analysis of the 14 product categories identified (see Task 1). It provides first results on annual the energy, water and detergent consumption of professional washing machines and dryers over their lifetime. Furthermore, Task 4 serves as a basis for the subsequent Tasks, especially Task 5, definition of base cases as well as the identification of the improvement potential (Task 7).

1.2 Methodology and assessment of data quality

All information has been collected through a self-administrated survey amongst stakeholders. For this purpose, first of all a working paper including preliminary assumptions on the use phase parameters has been prepared on the basis of discussions with stakeholders (two on site manufacture visit) and available literature. The working paper included all aspects regarding the use phase, i.e. user behaviour, specific consumption and changes of consumption parameters with regard to changes in user behaviour, thus covering Task 3 (user behaviour) and certain aspects of Task 4. It has been circulated to stakeholders (manufacturers, industry associations, user associations, see annex 5.1) for both Tasks 3 and 4. Additionally, an Excel file and further questions with respect to the manufacturing, distribution and end-of-life phase (see annex 5.2 and 1.1) have been distributed amongst manufacturers and their industry associations (see annex 5.1).

Five stakeholders answered to the first working document regarding the use phase. As outlined in Task 3 their answers can be judged as reliable, trusted with regard to information on user behaviour. The same argumentation is true for the appliance specific information asked for in the working document: the manufacturers answering to the working document represent a substantial share of the European manufacturer market (60 to 70%) which also includes the Eastern European market as the responding manufacturers also sell and represent the major market share in these countries. The lack of responding users / use associations is not of relevance with regard to technical information, assuming that they cannot contribute to product specific questions in such detail.

Regarding the questions on manufacturing, distribution and end-of-life phase, only two manufacturers provided feedback. Thus, we supplemented manufacturers feedback on these life cycle phases by own assumptions based on specified manufacturers' data (e.g. booklets).

2 Technical analysis of professional washing machines

2.1 Technical analysis of the production phase

The technical analysis of the production phase provides product weight and Bill-of-Materials (BOM), distinguishing the weight of different materials fractions and electronic components at the level requested by the EuP EcoReport Unit Indicators as proposed in the MEEUP report. This includes packaging materials and an assessment of the primary scrap production during metal sheet manufacturing.

2.1.1 Main operating principles of professional washing machines

The following table gives an overview of the seven washing machine categories identified in Task 1 and their main characteristics. For a more detailed description see Task 1.

Table 1 Categorisation of professional washing machines and main characteristics

<table>
<tr><th>Product category</th><th>Key market segment</th><th>Main operator / user type</th><th>Filling ratio[1]</th><th>Type of loading</th><th>Product dimensions</th><th>Application</th></tr>
<tr><td>WM1: Semi-professional washer extractor</td><td rowspan="2">Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)</td><td rowspan="2">Mainly private customers and non trained personnel (with few exemptions)</td><td rowspan="2">1:8 - 1:10</td><td rowspan="4">Manual, front / loading</td><td>Typical dimension: height x width x depth 850 x 600 x 600 mm</td><td>Semi-professional</td></tr>
<tr><td>WM2: Professional washer extractor, <15 kg</td><td rowspan="6">Dimensions are rather variable depending on amount / type of textiles to be washed and dried and spatial possibilities</td><td rowspan="6">Professional</td></tr>
<tr><td>WM3: Professional washer extractor, 15-40 kg</td><td rowspan="2">Hospitality Laundry (HPL)</td><td rowspan="2">Non and trained personnel</td><td rowspan="3">1:9 - 1:12</td></tr>
<tr><td>WM5: Professional washer dryer</td></tr>
<tr><td>WM6: Professional barrier washer</td><td>Healthcare Laundry (HCL)</td><td rowspan="3">Trained personnel</td><td>front / side / top loading</td></tr>
<tr><td>WM4: Professional washer extractor, >40 kg</td><td rowspan="2">Commercial Industrial Laundry (CIL)</td><td rowspan="2">1:10 - 1:12</td><td>manual or automatic top, loading and tilt unloading</td></tr>
<tr><td>WM7: Washing tunnel machine</td><td>Pass-trough</td></tr>
</table>

[1] The applicable filling ratio depends on the density of the laundry to be washed/dried.

To keep track of the various washing machine categories and their main characteristics, the following section presents an analysis of the principal function of each washing machine category. The analysis describes the most important components of the different professional washing machines and is completed with the amount of material (Bill-of-Material, BOM) used for each category.

2.1.1.1 Category WM1: Semi-professional washer extractor

With a load capacity of up to 7 kg, washing machines and washer extractors for the semi-professional use belong to the category with the smallest appliances being similar to the household washing machines. They are operated by professional or non-professional users. Three different types of manual loading are possible: front, side and top loading. The top loading design is especially popular in the United States, Canada and Australia. In Europe and the Middle East, front or side loading is most common. Semi-professional washing machines and washer extractors always have a hot and a cold water connection and are operated according to pre-fixed programmes or are manually programmed. An example of a front-loading semi-professional washer extractor is illustrated in Figure 1.

(Source: Miele, http://www.miele-ebrochures.co.uk/professional/files/Little_Giants_April06.pdf, sighted 07.09.2010)

Figure 1 Semi-professional washer extractor (category WM1)

The wash process works as follows: At the beginning of each wash cycle, the water management system ensures that the detergent is automatically flushed out of the appropriate chamber of the dosing system. The drum is perforated to ensure proper flushing of the laundry. The laundry is lifted up by paddles on the inside wall of the drum and then dropped. This motion flexes the creases of the fabric and forces water and detergent solution through the load. As the paddles are also perforated, they carry the water up and sprinkle the laundry from above.

The mechanical energy for cleaning the laundry is provided by the drum movement rotating alternatively clockwise or counter-clockwise. To obtain a good washing result for different textiles, the speed and frequency of the drum rotation varies between the different washing programmes. In programmes for delicate fabrics such as silk, for example, the drum rotates at a slower speed than in the cotton programme. Another factor influencing the washing process is the temperature. Heat pipes located below the washing drum heat up the washing water. As soon as the set temperature is reached, the actual washing phase begins in which the dirty textiles are exposed to the washing liquor. At the end of the washing phase, the drain pump drains off the washing liquor including the soil particles.

Table 2 gives an overview of the characteristics of two typical front-loaded appliances of this category. The following BOM, however, is also valid also for the other loading types (top and side loaded appliances).

Table 2 Characteristics of semi-professional washer extractors (category WM1)

Main characteristics of category WM1	**Data**	
Feature of performance	**Model A**	**Model B**
Washing capacity, kg	5.5	7
Drum volume, litres	54	65
Filling Ratio	1:8–1:10	1:8–1:10
Max. Spin speed, rpm	1500	1300
Residual moisture %	43	50
G Factor	526	350
Number of fixed (optional) washing programs	6 (9)	4 (12)
Dimensions		
Height, mm	850	1115
Width, mm	590	720
Depth, mm	550	690
Weight net, kg (without packaging)	70–106	97–154
Heating and water connection		
Voltage, V	230–440 1–3 phase	230–440 1–3 phase
Total load electric, kW	2.1–4.8	2.2–7.4
Cold and warm water connection	Yes	Yes
Others		
Type of loading	front	front

According to stakeholders, the material composition is equivalent to that of a household washing machine as described in the preparatory study on “washing machines and dish-washers” (Lot 14).[2] The following Bill of Materials (BOM) is taken from task 4 report of that study, scaled to a **6 kg** washing machine and partially interpolated for a typical semi-professional washing machine

[2] Further information Lot14 Final Report Tasks 3-5: www.ecowet-domestic.org

Table 3 Material composition of a semi-professional washer extractor (category WM1)

Material / Component	weight in g	weight in %	Material category
Stainless Steel	20 606	27.9%	3-Ferro
Steel Sheet galvanized	564	0.8%	3-Ferro
Cast Iron	11 192	15.2%	3-Ferro
Polypropylene (PP)	8 021	10.9%	1-BlkPlastics
Polyamide (PA)	94	0.1%	2-TecPlastics
Polycarbonate	190	0.3%	2-TecPlastics
Epoxy	260	1.6%	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	1 145	0.9%	1-BlkPlastics
Polystyrene (PS)	678	0.0%	1-BlkPlastics
Polybutylene Terephthalate (PBT)	8	0.3%	1-BlkPlastics
Polyvinylchloride (PVC)	221	2.4%	1-BlkPlastics
EPDM-rubber	1 752	1.5%	1-BlkPlastics
Plastics others	1 101	3.0%	1-BlkPlastics
Aluminium	2 233	1.8%	4-Non-ferro
Cu wire	1 305	0.1%	4-Non-ferro
CuZn38 cast	99	2.4%	4-Non-ferro
Chrome	1 761	0.1%	4-Non-ferro
Bitumen	38	24.6%	7-Misc.
Concrete	18 205	2.4%	7-Misc.
Glass	1 773	0.4%	7-Misc.
Wood	2 452	3.3%	7-Misc.
Electronics (control)	165	0.2%	6-Electronics
Total net	**73 863**	**100%**	
Packaging			
PE-Foil	51		1-BlkPlastics
Wood	2 452		7-Misc.
Cardboard and paper	223		7-Misc.
Total weight	**76 589**		

The “ferro” material is mainly used for the drum and the tube. The porthole is composed of glass. The concrete is needed to counterbalance the vibrations during the spinning phase.

2.1.1.2 Category WM2, WM3, WM4: Professional washer extractors

Figure 2 and Figure 3 show a typical professional washer extractor with a loading capacity of maximum 15 kg (category WM2) and a washer extractor with a loading capacity from 15 to 40 kg (category WM3).

(Source: Electrolux W4105H, 11 kg)

Figure 2 Manually loaded professional washer extractor <15 kg (category WM2)

(Source: Primus RS22, 22 kg)

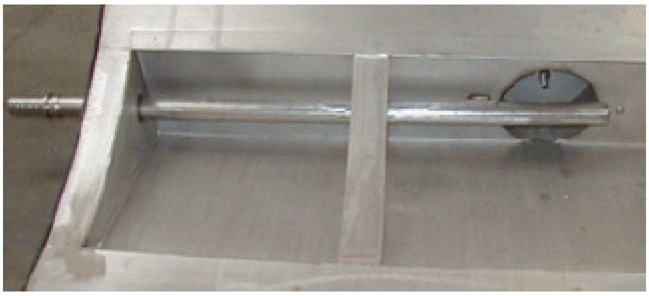
Figure 3 Manually loaded professional washer extractor <40 kg (category WM3)

Those washer extractors are larger than semi-professional washing machines and are built to be extremely durable, to handle the high g-force of the spin cycles. Professional washer extractors are loaded manually either from the front or the side. Like semi-professional appliances, they are equipped both with a warm and a cold water connection as standard and are partly or fully programmable. Moreover, they have various heating options: electric heating is applicable for machines with a maximum load capacity of 62 kg.[3] In addition to electric heating (see Figure 4) and direct steam heating (see Figure 5), there are various alternatives with regard to heating, such as gas, hot water, indirect steam heating (one possibility: see Figure 6) or a combination of direct steam and electric heating.

[3] http://www.gewerbegas-online.de/index.php?id=264#c687

(Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-2_Washer_Extractors.PDF, sighted on 20.09.2010)

Figure 4 Heat resistance for electrical heating



(Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-2_Washer_Extractors.PDF, sighted on 20.09.2010)

Figure 5 Direct steam injection

(Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-2_Washer_Extractors.PDF, sighted on 20.09.2010)

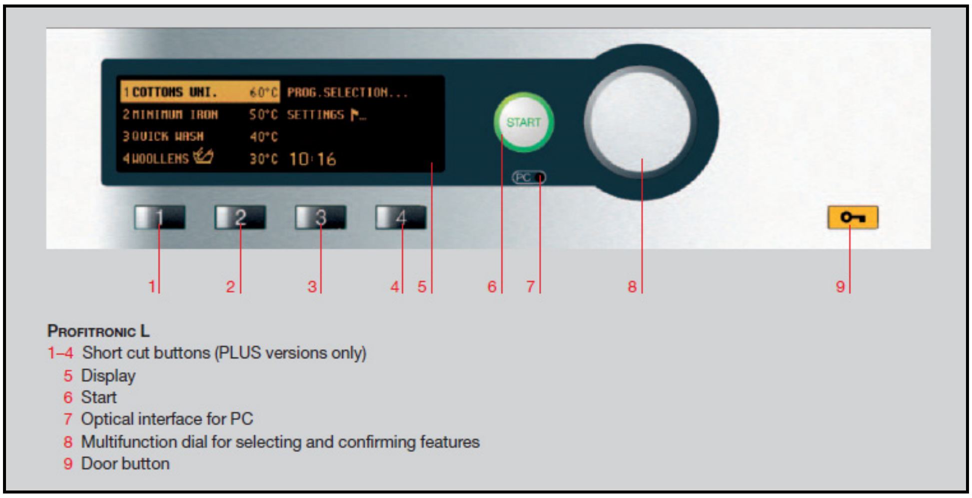
Figure 6 Stainless steel piping for indirect heating with hot water, thermo oil or steam

Further basic elements of washer extractors are:

- Outer case fitted with a door through which machine can be loaded and unloaded, and an immovable liquor tank.

- Inner drum: Perforated cylinder which rotates on a horizontal axis within an outer case (see above); depending on the load capacity, the inner drum can be subdivided into sections (cf. Figure 13 and Figure 14).
- Reversing mechanism which allows the inner drum to make several rotations in one direction followed by the same number of rotations in the opposite direction, to avoid the load becoming tangled and knotted,
- Electric drive, heating elements or steam coils, inlet and outlet valves (water, steam), electronic control system.
- Drain valve, an electromagnet opens the valve and the wash liquor flows out. Therefore it is necessary that the drain hose have an appropriate slope.

The appliances are usually equipped with an electronic control, providing the customer a wide range of programmes, both predefined standard programmes and others, being freely programmable. An example of electronic control is shown in Figure 7.



(Source: Miele, http://www.miele-ebrochures.co.uk/professional/files/Little_Giants_April06.pdf, sighted 07.09.2010)

Figure 7 Electronic control

Further, the control systems allow to display and control the laundry process by connecting the washer extractor to a multimedia workstation (personal computer (PC)). If several washer extractors are in use, they can be interconnected to a network, thus enabling the operator to view and control each machine of the system from one single PC.

Figure 8 illustrates a typical professional washer extractor of category WM4 with a load capacity of 57 kg.

(Source: Girbau, HS-6057, sighted 07.09.2010)

Figure 8 Typical professional washer extractor (category WM4), load capacity 80 kg

Category WM4 includes also heavy duty washer extractors which need to be operated by trained personnel. They are fully programmable and offer for most applications (customer segments) a large variety of additional equipment. Their front or side loading is either manual or automatic. Since the loading capacity may reach up to 400 kg, heavy duty washer extractors can be equipped with an optional tilting system for an easy loading and unloading.

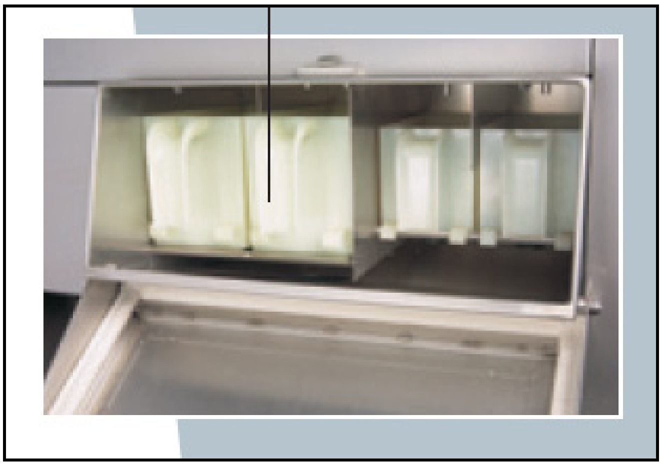
(Source: Kannegiesser FAVORITplus 20-270 kg, sighted 07.09.2010)

Figure 9 Heavy duty washer extractor (category WM4)

(Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-2_Washer_Extractors.PDF)

Figure 10 Automatically top loaded and tilt unloaded washer extractor

In addition, this kind of appliances automatically calculates the amount of water and detergent necessary to achieve an effective chemical concentration. It is possible to wash with both powder and liquid detergents. An example of a dosing box is shown in Figure 11.



(Source: ISPO)

Figure 11 Example of dosing box

Those appliances have a wide variety of drum designs. The most common ones are illustrated in the following figures: Open Pocket, Pullman Division and Y-Division.

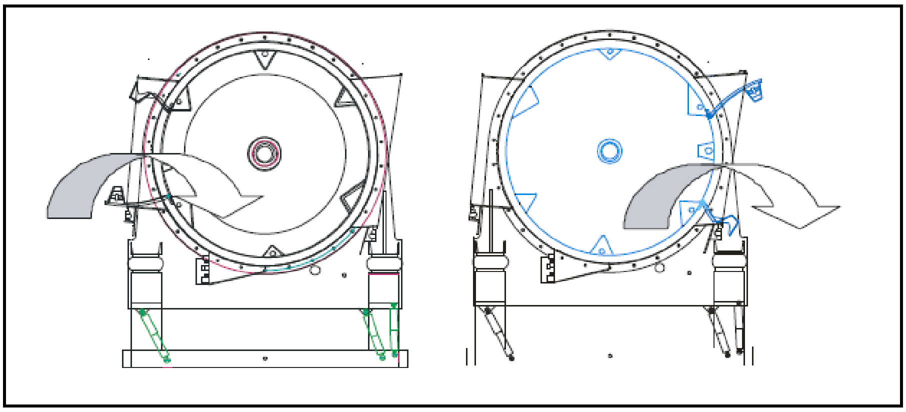


Figure 12 Drum Design: Open Pocket

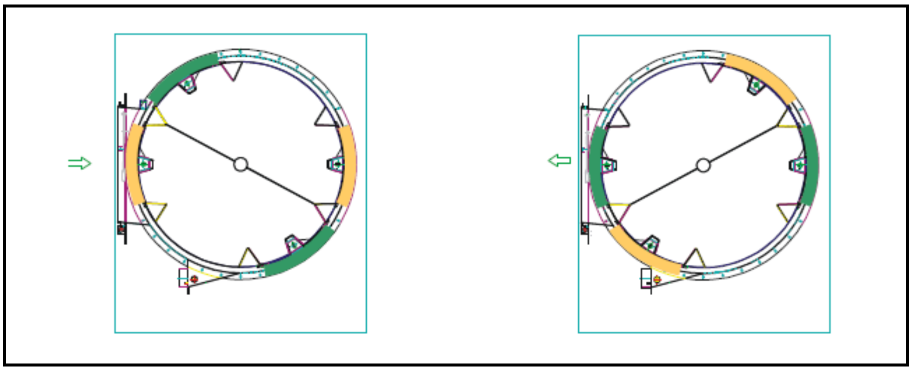


Figure 13 Drum design: Pullman Division

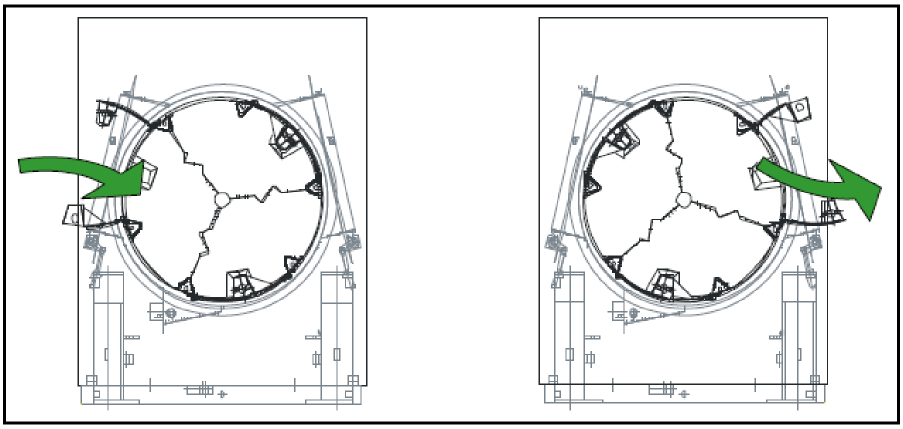


Figure 14 Drum design: Y Division

Depending on the wash speed, the different drum designs have advantages and disadvantages. With a higher wash speed, the Pullman-Division and the Open Pocket perform the best regarding friction, compression and flow through. With a lower wash speed, the Pullman-Division performs the best followed by the Y-Division and the Open Pocket.

Category WM2: Main characteristics and material composition

Table 4 gives an overview of the characteristics of three typical professional washer extractors <15 kg (category WM2).

Table 4 Characteristics of a professional washer extractor <15 kg (category WM2)

Main characteristics[4] of category WM2	Data		
Feature of performance	**Model A**	**Model B**	**Model C**
Washing capacity, kg	8	11	14
Drum volume, L	80	105	136
Filling Ratio	1:8–1:10	1:8–1:10	1:8–1:10
Spin speed, rpm	580–1 200	500–1 150	400–1 000
G Factor	375	350–475	350
Residual Moisture %	49	49	49
Number of fixed washing programs	10–40	10–40	10–40
Construction details			
Height, mm	1 020	1 200	1 325
Width, mm	700	830	800
Depth, mm	730	705	890
Weight net, kg	140–180	201–264	330–410
Electricity and water connection			
Voltage, V	230–400	230–400	230–400
Total load electric, kW	2–6 1–3 phase	9.7 1–3 phase	9–12 1–3 phase
Total load gas, kW	n.a.	n.a.	n.a.
Total load steam, kg/h	18–21	23–26	27–31
Cold and Warm water connection	Yes	Yes	Yes
Others			
Type of loading	front	front	front

The following table shows the BOM of a typical professional washer extractor of category WM2. The weight data indicates details on the shares of the different materials for a "typical“ professional washer extractor. Besides, the data were validated by additional, more detailed response of two manufacturers with regard to the materials that are assigned. Furthermore, the amount of material is shown as percentage of the weight of the product. The packaging material is listed separately.

[4] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of three typical models within category WM2.

Table 5 Materials composition of a professional washer extractor <15 kg (category WM2)

Material / component	Weight in g[5]	Weight in %	Material category according to MEEuP
Stainless steel	52 625	25%	3-Ferrous
Galvanized steel	105 250	50%	3-Ferrous
Cast Iron	18 945	9%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	5 200	2.5%	1-BlkPlastics
Zinc	630	0.3%	4-Non-ferrous
Aluminium	13 900	6.6%	4-Non-ferrous
Copper	3 500	1.7%	4-Non-ferrous
PVC (cables)	210	~0.1%	1-BlkPlastics
Electronics	4 300	2%	6-Electronics
EDPM rubber	2 740	1.3%	1-BlkPlastics
Glass	2 100	1%	7-Misc.
Polyamid (PA)	1 050	0.5%	2-TecPlastics
Total net	**210 450**	**100%**	
Packaging			
Polystyrene	500		1-BlkPlastics
Wood	14 000		7-Misc.
Cardboard	4 000		7-Misc.
Total weight	**228 950**		

Category WM3: Main characteristics and material composition

Table 6 gives an overview of the characteristics of typical professional washer extractor 15–40 kg (category WM3).

Table 6 Characteristics of a professional washer extractor 15–40 kg (category WM3)

Main characteristics[6] category WM3	Data		
Feature of performance	**Model A**	**Model B**	**Model C**
Washing capacity, kg	16	24	34
Drum volume, L	165	234	304
Filling Ratio	1:9–1:12	1:9–1:12	1:9–1:12
Spin speed, rpm	250–1 100	250–1 100	250–1 100
G Factor	350–500	350–542	300–475
Residual Moisture %	50	49	50
Number of washing programs	10–40	10–40	10–40
Washing time, min	60	60	60

5 Average weight value is based on a typical washer extractor with 10 kg washing capacity.

6 Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of three typical models within category WM3.

Main characteristics[6] category WM3	Data		
Feature of performance	**Model A**	**Model B**	**Model C**
Construction details			
Height, mm	1 175	1 500	1 530
Width, mm	780	900	1 060
Depth, mm	998	1 010	1 147
Weight net, kg	363–454	534–640	620–731
Electricity and water connection			
Voltage, V	230–400	230–400	230–400
Total load, kW	16.8	28.2	33.6
Cold and Warm water connection	Yes	Yes	Yes

The following table shows the BOM of a typical professional washer extractor of category WM3. The weight data indicates on the one hand details on the share of the different materials for a "typical" professional washer extractor. Besides, the data were validated by additional, more detailed response of two manufacturers with regard to the materials that are assigned. The amount of material is shown as percentage of the weight of the product. The packaging material is listed separately.

Table 7 Material composition of a professional washer extractor 15–40 kg (category WM3)

Material / component	Weight in g[7]	Fraction in %	Material category according to MEEuP
Stainless steel	133 200	22%	3-Ferrous
Steel tube	72 800	12%	3-Ferrous
Galvanized steel	163 500	27%	3-Ferrous
Cast Iron	102 900	17%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	12 700	2.1%	1-BlkPlastics
Zinc	2 400	0.4%	4-Non-ferrous
Aluminium	54 500	9%	4-Non-ferrous
Copper	23 000	3.8%	4-Non-ferrous
PVC (cables)	1 800	0.3%	1-BlkPlastics
Electronics	18 200	3.0%	6-Electronics
EDPM rubber	9 100	1.5%	1-BlkPlastics
Glass	7 900	1.3%	7-Misc.
Polyamid (PA)	3 600	0.6%	2-TecPlastics
Total net	**605 600**	**100%**	
Packaging			
Polystyrene	800		1-BlkPlastics
Wood	38 000		7-Misc.
Cardboard	10 500		7-Misc.
Total weight	**654 800**		

7 Average weight value is based on a typical washer extractor with 24 kg washing capacity.

Category WM4: Main characteristics and material composition

Table 8 gives an overview of the characteristics of a typical professional washer extractor >40 kg (category WM4).

Table 8 Characteristics of a typical professional washer extractor >40 kg (category WM4)

Main characteristics[8] category WM4	**Data**			
Feature of performance	**Model A**	**Model B**	**Model C**	**Model D**
Washing capacity, kg	44	63	90	122
Drum volume, L	400	569	850	1100
Filling Ratio	1:10–1:12	1:10–1:12	1:10–1:12	1:10–1:12
Spin speed, rpm	up to 825	275–800	275–720	250–680
G Factor	up to 380	up to 390	up to 390	up to 390
Number of washing programs (programmable)	20 (190)	20 (190)	20 (190)	20 (190)
Construction details				
Height, mm	1 794	1 925	2 230	2 256
Width, mm	1 390	1 570	1 600	1 838
Depth, mm	1 455	1 493	1 700	2 058
Weight net, kg	1 200–1 400	1 500–1 930	2 200–2 600	~4 000
Electricity and water connection and consumption				
Voltage, V	230–480	230–480	230–480	230–480
Total load electric, kW	36 3 phase	36–54 3 phase	45–50	45–50
Total load gas, kW	n.a.	n.a.	n.a.	n.a.
Total load steam, kW	5.5	n.a.	n.a.	n.a.
Cold and Warm water connection	Yes	Yes	Yes	Yes
Others				
Type of loading	front / side / top	front / side / top	front / side / top	front / side / top

n.a. = not applicable

The following table shows the BOM of a typical washer extractor of category WM4, the share of the different materials and the category to which the materials are assigned. The share of the amount of material is comparable to category WM3. The packaging material is listed separately.

[8] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of four typical models within category WM3.

Table 9 Material composition of a professional washer extractor >40 kg (category WM4)

Material / component	**Weight in g**[9]	**Weight in %**	**Material category according EcoReport**
Stainless steel	506 000	22%	3-Ferrous
Steel tube	276 000	12%	3-Ferrous
Galvanised steel	621 000	27%	3-Ferrous
Cast Iron	391 000	17%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	48 300	2.1%	1-BlkPlastics
Zinc	9 200	0.4%	4-Non-ferrous
Aluminium	207 000	9%	4-Non-ferrous
Copper	87 400	3.8%	4-Non-ferrous
PVC (cables)	6 900	0.3%	1-BlkPlastics
Electronics	69 000	3.0%	6-Electronics
EDPM rubber	34 500	1.5%	1-BlkPlastics
Glass	29 900	1.3%	7-Misc.
Polyamid (PA)	13 800	0.6%	2-TecPlastics
Total net	**2 300 000**		
Packaging			
Polystyrene	4 500		1-BlkPlastics
Wood	165 000		7-Misc.
Cardboard	38 000		7-Misc.
Total weight	**2 507 500**		

2.1.1.3 Category WM5: Professional washer dryer

The following figure shows a typical professional washer dyer (category WM5).

(Source: Electrolux WD4130, 6.5 kg)

Figure 15 Example of typical professional washer dryer (category WM5)

9 Average weight value is based on a typical washer extractor with 90 kg washing capacity.

As washing and drying is done in one machine, there is no need for re-loading[10]. Therefore, it is also possible to use both functions separately. Washer dryers usually require less space (being optimum for apartment-house-laundry) compared to a separate washing machine and clothes dryer of the same capacity. Many washer dryer units are also designed to be portable in such a way that they can be attached to a sink instead of requiring a separate water line. Designed to handle different types of fabrics and garments such as clothes, sheets or towels, professional washer dryers usually have functions such as temperature controls and customizable cycle controls for washing and drying. For the washing process, washer dryers need space for a water tank around the drum which limits the drum capacity compared to a conventional tumble dryer of the same size.

Table 10 gives an overview of the characteristics of a typical professional washer dryer (category WM5).

Table 10 Characteristics of a typical professional washer dryer (category WM5)

Main characteristics[11] category WM5	**Data**	
Feature of performance	**Model A**	**Model B**
Washing / drying capacity, kg	8/18	15/33
Drum volume, L	130	240
Washing only capacity, kg	14	27
Drying only capacity, kg	8	15
Spin speed, rpm	980	890
G-factor	350	350
Dimensions		
Height, mm	1 330	1 450
Width, mm	910	1 020
Depth, mm	1 110	1 350
Weight net, kg	382	555
Electricity and water connection		
Voltage, V	230–415	230–415
Electric heating (washing/drying), kW	20.5 (12.5/8.0)	35.9 (19.4/16.5)
Gas (drying), kW	10	19
Non-heated (washing)	n.a.	n.a.
Cold and warm water connection	Yes	Yes

The following table shows the BOM of a typical washer dryer (category WM5), the shares of the different materials and the category to which the materials are assigned. The packaging

10 Source: by Electrolux Professional

11 Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of two typical models within category WM5.

material is listed separately. The weight in percentage is based on direct stakeholder input and provides average values of this category.

Table 11 Material composition of a professional washer dryer (category WM5)

Material / component	**Weight in g[12]**	**Weight in %**	**Material category according EcoReport**
Stainless steel	30 560	8%	3-Ferrous
Steel tube	19 100	5%	3-Ferrous
Galvanized steel	267 400	70%	3-Ferrous
Cast Iron	15 280	4%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	7 640	2%	1-BlkPlastics
Zinc	7 640	2%	4-Non-ferrous
Aluminium	7 640	2%	4-Non-ferrous
Copper	15 280	4%	4-Non-ferrous
PVC	764	0.2%	1-BlkPlastics
Electronics	10 696	2.8%	6-Electronics
Total net	382 000		
Packaging			
Polystyrene	1 500		1-BlkPlastics
Wood	17 500		7-Misc.
Cardboard	6 000		7-Misc.
Total weight	407 000		

2.1.1.4 Category WM6: Professional barrier washer

The following figure shows a typical professional barrier washer (category WM6).

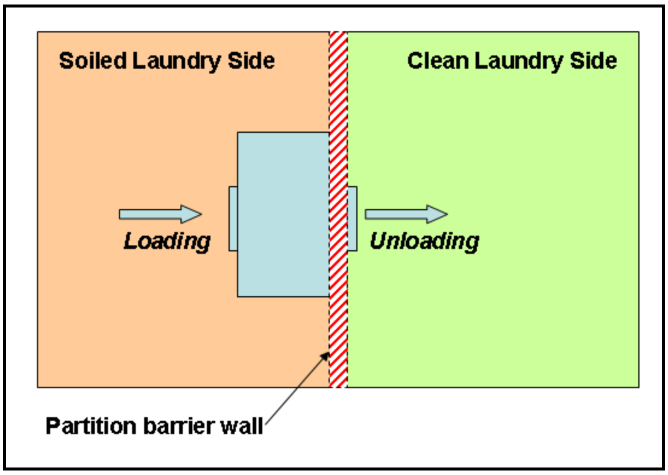
(Source: Stahl)

Figure 16 Example of professional barrier washer with side loading

[12] Average weight value is based on a typical washer dryer with 8/18 kg capacity (wash/dry).

Where sanitation demands are particularly high, e.g. in hospitals, nursing homes, prisons, or in the pharmaceutical, medical, micro-electronic, cosmetic, food or nuclear industries, a so-called "barrier washer extractor" is used. Synonyms are “hygienic barrier washer extractor”, “medical barrier washer” or “pass-through concept”. To ensure the highest standards of hygiene, a special "barrier" wall physically separates the soiled loading side of the washer from the clean unloading side. The laundry is loaded into the drum through a door opening on one side of the laundry, the soiled side. After the laundry has been washed, the clean linen is removed from the washer extractor into another room, the clean side of the laundry area. By use of this dual door design (soiled and clean room), contact between contaminated linen and sanitised laundry can be avoided.

Professional barrier washer extractors are either manually loaded from the top or from the side or automatically top loaded and tilt unloaded (see also Figure 10).



(Source: own compilation)

Figure 17 Schematic illustration of the functionality of a barrier washer

The following table gives an overview of the characteristics of a typical professional barrier washer extractor (category WM6).

Table 12 Characteristics of a typical professional barrier washer extractor (category WM6)

Main characteristics[13] category WM6	**Data**		
Model	**Model A**	**Model B**	**Model C**
Washing capacity, kg	32	67	110
Drum volume, L	320	667	1080
Filling ratio (recommended)	1:10	1:10	1:10
Spin speed, rpm	up to 975	up to 975	up to 975

13 Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of three typical models within category WM6.

Main characteristics[13] category WM6	Data		
Model	**Model A**	**Model B**	**Model C**
G Factor	up to 350	up to 975	up to 975
Number of washing programs (programmable)	40 (200)	9 (200)	9 (200)
Residual moisture %	50%	50%	50%
Construction details			
Height, mm	1 720	1 690	2 040
Width, mm	1 300	1 965	1 956
Depth, mm	1 180	1 053	1 363
Weight net, kg	930–1 050	1 570	~2 900
Electricity and water connection and consumption			
Voltage, V	380–415	230–400	380–415
Total electric load, kW	27–31	50–54	~72
Total gas load, kW	n.a.	n.a.	n.a.
Total steam load,	n.a.	n.a.	n.a.
Cold and warm water connection	Yes	Yes	Yes
Others			
Type of loading	front / side	front / side	front / side

n.a. = not applicable

The following table shows the BOM of a typical barrier washer extractor of category WM6, the shares of the different materials and the category to which the materials are assigned. Besides, the data were validated by additional, more detailed response of two manufacturers. Furthermore, the amount of material is shown as percentage of the weight of the product. The packaging material is listed separately.

Table 13 Material composition of a typical professional barrier washer extractor (category WM6)

Material / component	Weight in g[14]	Weight in %	Material category according EcoReport
Stainless steel	441 500	44%	3-Ferrous
Steel tube	170 600	17%	3-Ferrous
Galvanized steel	50 100	5%	3-Ferrous
Cast Iron	80 300	8%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	48 200	4.8%	1-BlkPlastics
Zinc	20 100	2%	4-Non-ferrous
Aluminium	30 100	3%	4-Non-ferrous
Brass	20 100	2%	
Copper	30 100	3%	4-Non-ferrous

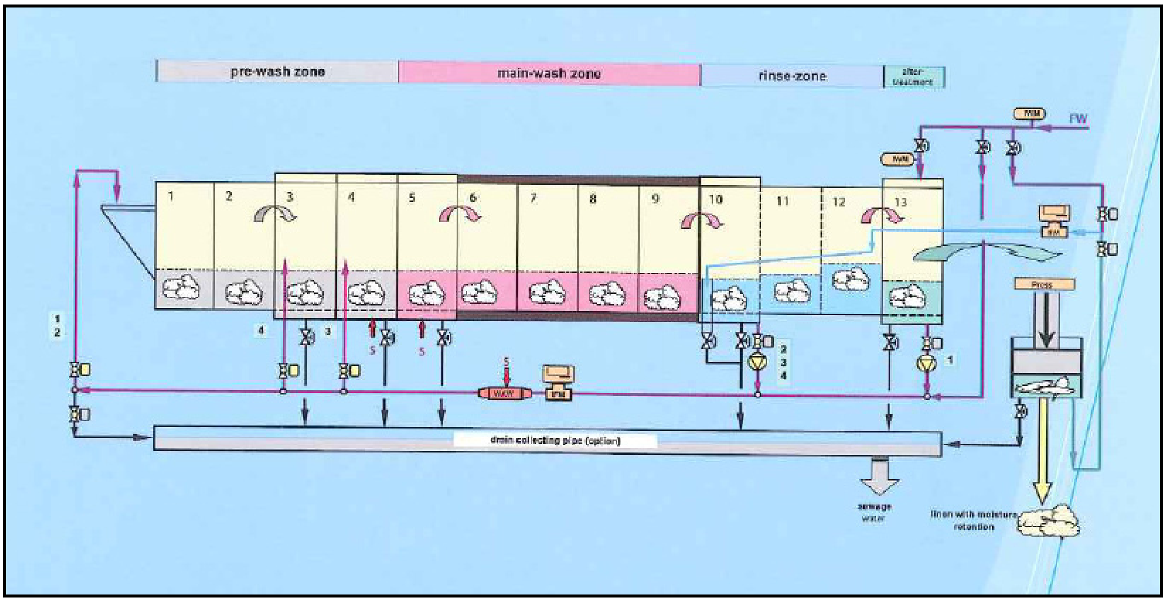
[14] Average weight value is based on a typical barrier washer extractor with 32 kg washing capacity.

Material / component	Weight in g[14]	Weight in %	Material category according EcoReport
PVC (cables)	2 000	0.2%	1-BlkPlastics
Electronics	60 200	6%	6-Electronics
EDPM rubber	20 100	2%	1-BlkPlastics
Glass	10 000	1%	7-Misc.
Polyamid (PA)	20 100	2%	2-TecPlastics
Total net	**1 003 500**		
Packaging			
Polystyrene	2 800		1-BlkPlastics
Wood	53 000		7-Misc.
Cardboard	15 000		7-Misc.
Total weight	**1 074 300**		

2.1.1.5 Category WM7: Washing tunnel machine

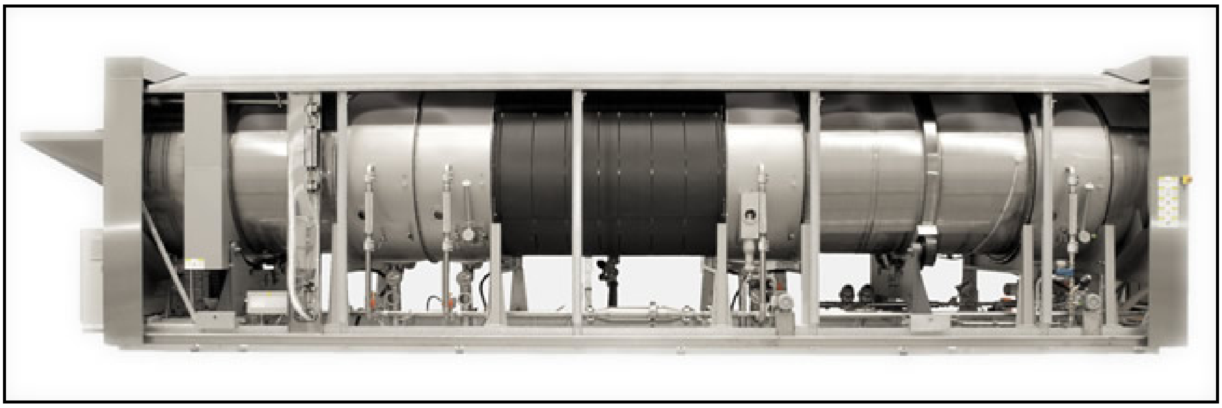
Tunnel washers, also called washing tunnels, tunnel batch washers or continuous (batch) washers are used for large quantities of laundry. The tunnel in the machine consists of several sections, each with its own function: pre-wash, main wash, rinse, after treatment and extraction. Normally, this category is heated by steam (low-pressure steam).

The following figure illustrates exemplary tunnel washers (category WM7).



(Source: Jensen, Senking continuous Batch, Universal SL)

Figure 18 Schematic illustration of a tunnel washer



(Source: Jensen, Universal)

Figure 19 Continuous batch washer (category WM7)

The laundry is transported through the sections of the tunnel, each section of the tunnel leading the laundry on to the next section. As the water flows in the opposite direction to the laundry, the laundry gets thoroughly soaked and washed.

While, at the end of a cycle, one batch of linen arrives at the following mechanical dewatering system (press or centrifuge), the first compartment is emptied and can be filled again with soiled linen. Since tunnel washers do not have to be stopped for the loading and unloading of linen, they provide a more continuous flow of clean laundry.

Within tunnel washing machines, principally two different design processes can be distinguished regarding the drum movement: Oscillating washing action with bottom transfer and rotating washing action with centred transfer (see Figure 20).

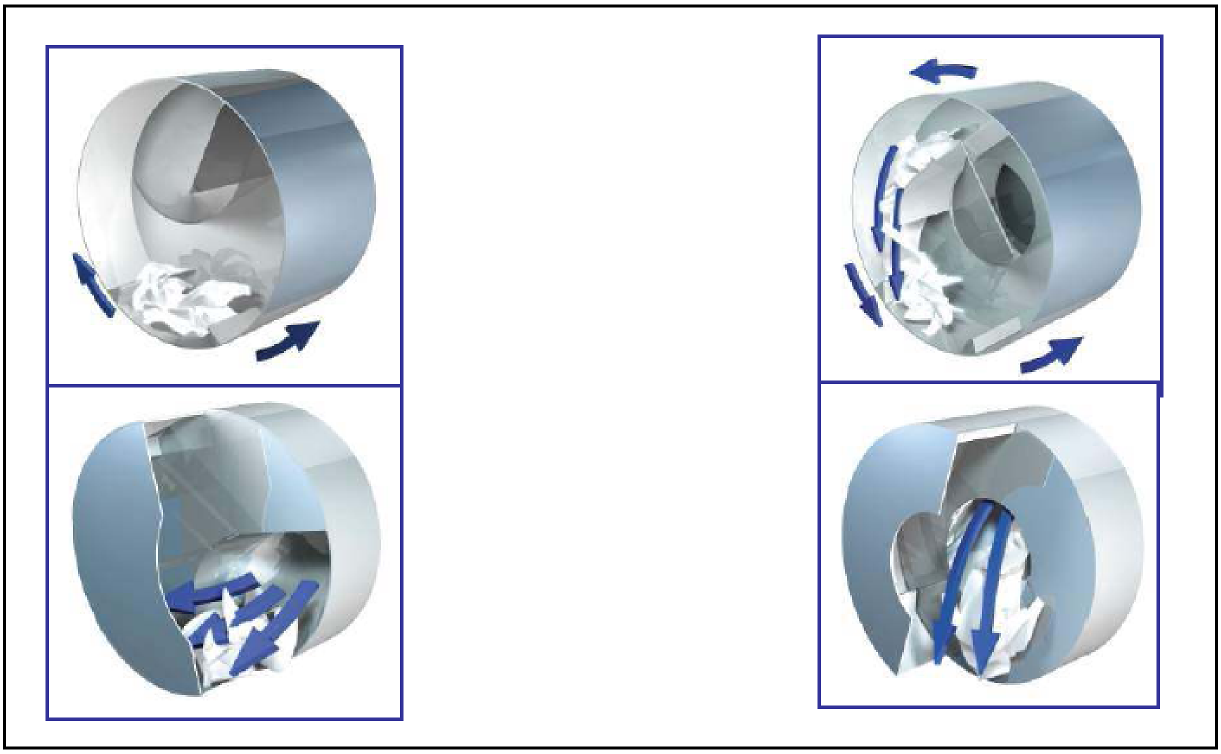


Figure 20 Oscillating drum movement (left side) and rotating drum movement (right side)

By using the oscillating drum movement, the linen is moved by beaters. Due to the mechanical action on the textile surface there is a constant fold-over and friction of the linen. In contrast, the rotating drum movement works with a penetrative mechanical action. During the washing process the linen is compressed and in free fall.

The mechanical action of the drum designs is shown in Figure 21, visualizing the fact that the share of rubbing within the rotating drum movement is reduced in favour of compression and flow through.

Washer programmable control is provided by a modular industrial-type programmable logic controller. It might be programmed in ladder logic[15] and constructed in such a way that, if necessary, the customer's staff themselves may replace and programme it.[16]

15 Ladder logic is a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay-based logic hardware (Source: http://en.wikipedia.org/wiki/Ladder_logic)

16 http://www.geneva-scientific.com/pdf/SL1200%20Specifications.pdf

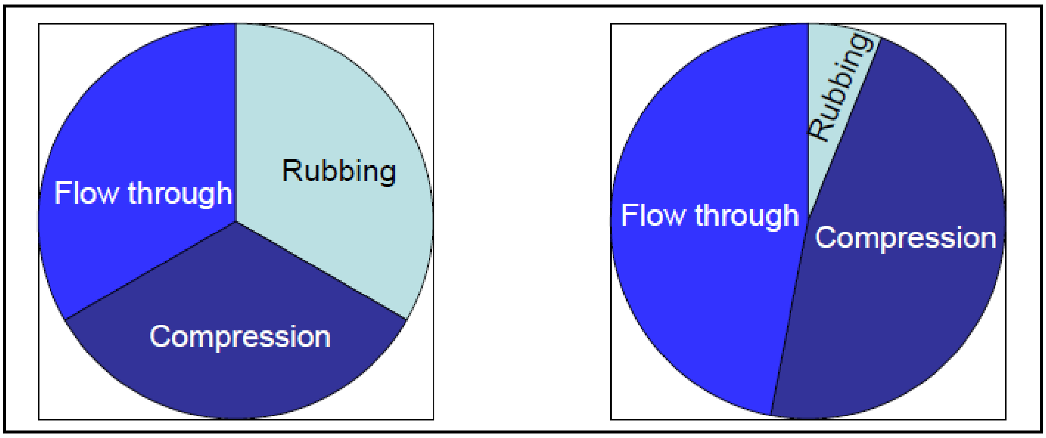


Figure 21 Components of the mechanical action: oscillating washing action and rotating washing action

Rotating cylinder movements are more efficient regarding the adsorption of detergents, the dilution of chemicals during rinsing and the treatment of the linen.

Table 14 gives an overview of the characteristics of a typical washing tunnel machine (category WM7).

Table 14 Characteristics of a typical washing tunnel machine (category WM7)

Main characteristics[17] category WM7	**Data**
Program	**Model A**
Batch capacity, kg	36–120
Washing capacity, kg/h	500–4 000
Filling ratio	1:48–1:83 (depends on rotating movement)
Inside drum, mm	1 600–1 900
Number of compartments	5–20
Number of washing programs	Up to 100 free programmable washing programmes
Steam demand, kg/kg dry linen	0.45
Construction details	
Height, m	1.9–2.5
Width, m	2.2–2.5
Length of tube, m	4.7–18
Weight net, kg	6 600–18 000
Electricity and water connection	
Connection load in kW	10–36
Water connection in DN mm	50–65
Steam connection in DN mm	50–65

[17] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of a typical tunnel washer within category WM7.

The following table shows the BOM of a typical washer extractor of category WM7, the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately. The weight in percentage is based on direct stakeholder input and provides average values of this category.

Table 15 Composition of materials of a typical washing tunnel machine (category WM7)

Material / component	**Weight in g**[18]	**Weight in %**	**Material category according EcoReport**
Stainless steel	9 600 000	80%	3-Ferrous
Galvanized steel	1 200 000	10%	3-Ferrous
Cast iron	600 000	5%	3-Ferrous
Copper (cable)	240 000	2%	4-Non-ferrous
EPDM rubber	< 120 000	< 1%	1-BlkPlastics
Electronics	120 000	1%	6-Electronics
PE	< 120 000	<1%	1-BlkPlastics
PVC (cables)	< 120 000	<1%	1-BlkPlastics
Total net	**~12 000 000**		
Packaging[19]			
Polystyrene	n.a.		1-BlkPlastics
Wood	n.a.		7-Misc.
Cardboard	n.a.		7-Misc.
Total weight			

About 90 percent of a continuous tunnel washing machine is a steel construction. All wetted parts (doors, wash and rinse tanks, etc.) shall be of stainless and galvanized steel.

2.1.1.6 Overview of all professional washing machine categories

In the following table an overview of the shares of the material categories according to MEEuP (including packaging material) is shown for the different categories of professional washing machines.

18 Average weight value is based on a typical tunnel washer with 12 numbers of compartments and a typical load capacity of 1 500 kg/h.

19 Due to the heavy machines the distribution is realised without packaging (source: stakeholder feedback).

Table 16 Share of material categories (according to MEEuP) for the different categories of professional washing machines (including packaging)

Materials-category	Unit	WM1	WM2	WM3	WM4	WM5	WM6	WM7
Bulk Plastics	g	16,9%	3.8%	3.7%	3.8%	2.4%	6.8%	3.0%
Tec Plastics	g	0,7%	0.5%	0.5%	0.6%	0.0%	1.9%	0.0%
Ferrous	g	42,3%	77.2%	72.1%	71.5%	81.7%	69.1%	96.0%
Non-ferrous	g	7.0%	7.9%	12.2%	12.1%	7.5%	9.3%	0.0%
Coating	g	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Electronics	g	0,2%	1.9%	2.8%	2.8%	2.6%	5.6%	1.0%
Misc.	g	32.8%	8.8%	8.6%	9.3%	5.8%	7.3%	0.0%
Total weight	**g**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

WM1: Semi-professional washer extractor
WM2: Professional washer extractor, <15 kg
WM3: Professional washer extractor, 15-40 kg
WM4: Professional washer extractor, >40 kg
WM5: Professional washer dryer
WM6: Professional barrier washer
WM7: Washing tunnel machines

In all categories, the share of ferrous metal (mainly stainless steel) is with 42% to 96% (including packaging) predominant.

2.1.2 Other materials

According to MEEuP, certain material categories are assessed. In professional dishwashers, there are some further materials not covered by MEEuP which are described below.

- **Mercury**: According to stakeholders' feedback, the professional washing machines and dryers do not contain mercury. All materials used within the products comply with the restrictions set out in the RoHS Directive.[20]
- **Silver ions**:
  - Application: Nowadays there is a wide range of products containing silver because of its antibacterial activity. Silver can be applied individually as a solution, as a suspension or in the form of nanoparticles. Whenever silver is exposed to moisture, silver ions are released. Their antibacterial characteristic is used in following scopes and products: Water treatment, washing, medical applications, impregnation of fibres etc[21].

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[20] Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment 2002/95/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:037:0019:0023:EN:PDF) (see Task 1).

[21] http://www.umweltdaten.de/publikationen/fpdf-l/3673.pdf

- Advantages: Silver provides advantages e.g. when they are added to wall paints which are used in surgeries to improve the hygienic conditions. Used in washing machines, silver prevents retention of bacteria on laundry after the cleaning process.
- Disadvantages: There are also negative aspects which have to be mentioned. For example, due to the increasing use of silver as a bactericide, environmental impacts could be bacterial resistance to silver ions because of a pollution of sludge in sewage plants. Further, there is lack of knowledge concerning possible impacts of silver ions, e.g. toxicity for terrestrial and sediment organisms, residuals in municipal wastewater, characteristic and quantity of emissions from products containing silver, toxicity of silver nanoparticles in comparison to silver compounds, occurring of different reactions in the environment, etc.
- Use of silver in washing machines: According to stakeholders' feedback, the use of silver is not applied anymore. In Germany, warnings from the German Federal Institute for Risk Assessment[22] with regard to possible harmful aspects and missing comprehensive data to allow conclusive risk assessments, especially for nano-silver, induced a rethinking process on the market. Moreover, according to stakeholders there is no need of silver ions in washing machines, because there are other possibilities (temperature, chemistry, steam) to guarantee the same hygienic standard. As the negative aspects associated with the use of silver outweigh the positive ones, silver is not longer considered an acceptable alternative

[22] Bundesinstitut für Risikobewertung (BfR) www.bfr.bund.de

2.2 Technical analysis of the distribution phase

The following table shows the average volume of the final packaged product. These values are used to calculate the environmental impacts resulting from distribution. We know that especially in case of transport of professional washing machines there are quite large differences. However for the Eco-report tool we need only the value of the average volume of the final product.

Table 17 Average volume of the final packaged product of the different categories of professional washing machines (Source: information provided by data sheets of manufacturers)

Washing machine category	Average volume of the final packaged product	Source of information
WM1: Semi-professional washer extractor	0.75–1.14 m³	According to Lot 14
WM2: Professional washer extractor, <15 kg	0.94–1.14 m³	Information provided by stakeholders
WM3: Professional washer extractor, 15-40 kg	1.14–3.30 m³	Information provided by stakeholders
WM4: Professional washer extractor, >40 kg	3.00–9.30 m³	Based on assumed dimensions from the technical data sheets
WM5: Professional washer dryer	1.61–2.42 m³	Information provided by stakeholders
WM6: Professional barrier washer	3.99–6.09 m³	Based on assumed dimensions from the technical data sheets
WM7: Washing tunnel machine[23]	~16.58 m³	Based on assumed dimensions from the technical data sheets

2.3 Technical analysis use phase (product)

This section provides an assessment of the annual resources consumption (energy, water, detergent) during product life. Usually, the consumption values should be measured according to existing test standards. However, there are no standardised measurement methods for quantifying the energy and water consumption of professional washing machines (see Task 1). Therefore, the assessment of data quality and comparability in the following sections should be seen with regard to this context.

2.3.1 Ratio of energy use in professional washing machines

This section exemplifies how much energy is used for the different washing phases in a typical professional washing process.

[23] Corresponds to the average volume of the machine as the distribution is realised without packaging.

The relative energy consumption of professional washing machines can be mainly sub-divided into energy used for water heating and energy needed for the motor for mechanical action and for the functioning of the electronic components. The following table shows the respective energy consumption for each machine category.

Table 18 Share of the average energy consumption in the different categories of professional washing machines (Source: information provided by manufacturers)

Washing machine category	Percentage of energy consumed for motor and electronic components etc. (always electricity)	Percentage of energy consumed for water heating
WM1: Semi-professional washer extractor	13.5%	86.5%
WM2: Professional washer extractor, <15 kg	13.5%	86.5%
WM3: Professional washer extractor, 15-40 kg	13.5%	86.5%
WM4: Professional washer extractor, >40 kg	12.5%	87.5%
WM5: Professional washer dryer	20%	80%
WM6: Professional Barrier washer	12.5%	87.5%
WM7: Washing tunnel machine[24]	5.0%	95.0%

Depending on the category, 5 to 13% of the incoming energy is used to drive motors, pumps and electronic components to control the whole system (always electricity). Most of the energy input, however, is used to heat up the water: approximately 95% of the total energy consumption. As outlined in Task 3, electric energy is one energy source for water heating in professional washing machines. Other energy sources used for heating the water are natural gas, steam (or thermo oil as a heat transfer medium, cf. Task 3). The different heating systems will result in different environmental impacts, and different operating costs in the end.

In the following Tasks, we will further use these inputs to derive the environmental impacts and the improvement potential of the technological options.

2.3.2 Typical composition of detergents and laundry aids for professional washing machines

As in the case of professional dishwashers, there is no defined standard composition of detergents and laundry aids for professional washing machines. To keep the use of raw materials in the washing process to a minimum, suppliers of detergents for professional washing machines offer a great variety of products, adjusting the constituents of a product to the individual requirements of various types of laundry. The modular system allows an almost limitless number of mixes which can be tailored to fit the customer’s needs, thus avoiding

[24] Only the average volume of the machine due to the distribution ensued without packaging.

chemical waste and unnecessary disposal into the environment[25]. However, all detergents (powder, liquid, paste) use fundamentally the same ingredients to achieve the wash performance; most often modular detergent systems comprise an alkali booster, a sequestrant builder, a surfactant blend, an enzymatic additive and peroxy bleach.

In their latest sustainability report, A.I.S.E provides a short description of the different types of professional laundry detergents: fully formulated detergents, powder/liquid detergents, prewash additives, boosters, pH-adjustment, water hardness regulators, bleach additives, disinfectant detergents/additives for hygienic laundry (hospital, food industry), fabric softeners, starch finishing, ironing aid, fragrance rinse, etc.

The Leonardo da Vinci project[26] provides some general information with regard to the usage of detergents and the background of ingredients in commercial laundering processes. The detergent options are quite numerous depending on the increasing number of laundry classifications:

- Auto-dosed powders;
- Stock solution powders;
- Dry feed powders;
- Single shot liquid auto-dosed from bulk;
- Multi liquid systems auto-dosed from bulk;
- Detergent pastes with auto-dose system.

According to A.I.S.E., the institutional laundry detergent segment has developed towards a higher acceptance of concentrated detergents, both for granular and liquid detergents. This development has moved forward faster in the last few years and is expected to continue.

The industrial laundry market uses mostly concentrated granular detergents and liquids. ‘Paste-type’ products or anhydrous liquids can also be found. The use of concentrates reduces the amount of packaging and chemicals and therefore might have a reduced total environmental impact.[27]

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25 Source : A.I.S.E., “Industrial & Institutional Sector – Environmental dossier on Professional laundry”, (2000). A.I.S.E., the international Association for soaps, detergents and maintenance products represents the industry which manufactures these products for household and for industrial and institutional (I&I) use.

26 http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_4_-_1_Backg__ingredients.PDF

27 So called volume concentrates have a higher bulk density (0.6-0.9 g/cm^3) compared to regular detergents (0.5-0.6 g/cm^3). However, the ingredients do not differ considerably besides the almost total absence of the bulking agent sodium sulphate. Thus, with volume concentrates not the entry of chemicals into the waste water is reduced but the packaging, as the same amount is realised with a smaller volume. A further development is provided by the so called super concentrates. Besides a higher bulk density and the absence of bulking agents, the composition is changed resulting in less pollution of the waste water – optimum dosage provided.
(Source: http://www.oekoplus.sepeur-media.de/fp/archiv/RUBsonstiges/Waschmittelkonzentrate.php)

The following figure shows an example of a modular detergent system and wash programme, specifically for blue work wear.[28]

Soiling	Mineral oil, Pigment		
Textile	PES/Cotton 65/35		
Washing Machine	CBW		
Water hardness	0-2°dH		
Water Consumption total	12 l/kg		
Liquor/Cloth Ratio	1:5		
Temperature	Pre-wash: 35°C Main wash: 70°C		
Wash time total	45 Minutes		
Dosage: (g/kg Wash)	Pre-wash	Main wash	Total
Main wash Detergent A	12	12	24
Booster B	3	2	5
Acid C (Rinse)		0.5	0.5
Formulation Model-Products			
Main wash Detergent A	**%**		**Ingredients in Liquor g/kg Wash**
Sodiummetasilicate 5aq	50		12
Sodium triphosphate	15		3.6
Soda ash	24		5.76
Polycarboxylate	2		0.48
LAS	2		0.48
Fatty alcohol ethoxylate C12-14, 5 EO	5		1.2
Carboxymethylcellulose	1		0.24
Methylcellulose	1		0.24
Water	0		0
Sum	**100**		**24**
Booster B			
Fatty alcohol ethoxylate C12-14, 5 EO	97		4.85
Water	0		0
Alcohol	3		0.15
Sum	**100**		**5**
Acid C			
Formic acid	100		0.5
Water	0		0
Sum	**100**		**0.5**

Remark : Dosage dependent on: Degree of soiling, machine type, quality level

Figure 22 Example of a modular detergent system and wash programme, specifically for blue work wear

No further data could be obtained regarding the composition of professional laundry detergents. The following figure additionally provides a typical composition of detergents for

[28] Industrial & Institutional Sector Environmental dossier on Professional laundry Source: http://www.aise.eu/downloads/AISE_pro_laundry_dossier.pdf

household washing machines.[29] As appliances in the major semi-professional market segments, Coin & Card Laundry (CCL) and Apartment Household Laundry (AHL) are mainly operated by non-professional users, the use conditions with regard to laundry types, types of soil, and thus also the detergents are expected to be similar to the conditions in household use.

(Massenanteile der Bestandteile in %)

Funktionsbausteine	Beispiele	Voll-WM Normalware Kompaktat Zeolithbasis	Voll-WM Normalware Kompaktat Lösliche Enthärtersysteme	Color-WM Normalware Kompaktat Lösliche Enthärtersysteme	Voll-WM Superkompakt	Color-WM Superkompakt
Anionische Tenside	LAS, FAS	8 - 15	8 - 15	10 - 20	10 - 25	10 - 25
Nichtionische Tenside	FAEO	1 - 5	1 - 5	1 - 5	5 - 15	5 - 15
Seife		1 - 3	1 - 3	1 - 3	< 1	< 1
Gerüststoffe	Zeolith A	25 – 50	-	-	20 - 40	20 - 40
	Lösliche Silicate (Natriumdisilicat)	5 - 10	5 - 10	1 - 5		
Alkalien	Soda	20 - 40	20 - 40	20 - 40	1 - 5	1 - 5
Co-Builder	Polycarboxylate	3 - 5	3 - 5	3 - 5	2 - 8	2 - 8
Bleichmittel	Natriumpercarbonat	10 - 25	10 - 25	-	10 – 20	-
Bleichaktivatoren	Tetraacetylethylendiamin - TAED	1 - 3	1 - 3	-	3 – 10	-
Stabilisatoren	Phosphonate, andere Komplexbildner	0 – 1	0 – 1	0 - 1	0 – 1	0 – 1
Enzyme	Proteasen, Amylasen, Lipasen, Cellulasen, Mannanasen	0 – 1	0 – 1	0 - 1	0,5 – 2,0	0,5 – 2,0

Figure 23 The essential components of a laundry detergent for household use (Europe 2009)

[29] Source: Waschmittel, Guenther Wagner, ISBN: 978-3-527-32678-5

Detergent components for laundry disinfection[30]

Disinfection of textiles is achieved by a combination of physical removal (promoted by the combination of detergent, water, mechanical action and subsequent rinsing) and inactivation of microbes, whereby the latter may be achieved by thermal means (i.e. washing at higher temperatures) and/or by chemical inactivation by a biocidal ingredient, assisted in both cases by a final drying, which may also use high temperatures. It is important to ensure that microbes that are physically removed rather than inactivated are thoroughly rinsed away, and not re-deposited elsewhere in the same, or a following load. Different countries specify different conditions in terms of times and temperatures for achieving disinfection by thermal means alone (thermal disinfection).

Chemical inactivation of microbes in the laundry process is most often delivered by oxidising agents such as peroxygen or hypochlorite bleaches. These products release amongst others peracetic acid or hypochlorite respectively. Peracids bleaches (such as perborate or percarbonate) work most efficiently at higher temperatures (70°C and above), though peracetic acid can be used to help reach disinfection at lower temperatures. Hypochlorite and similar bleaches are used in many countries for bleaching and disinfecting white textiles at low temperatures.

The professional detergent products are often part of complete delivery systems requiring special packaging, dosing and control equipment. The objective for industrial and institutional (I&I) companies is considered three-fold:

- to ensure hygienic conditions for all customers segments,
- to safeguard users;
- to protect the environment.

The products can be supplied in a small trigger-spray bottle (0.75 to 1 litre) for institutional use and up to delivery in bulk (above 3 tons)[31] for commercial customer segments.

2.3.3 Energy, water and detergent consumption

In general, the primary function of a (professional) washing machine is to clean and rinse textiles using water. The machine may also have a system for extracting excess water from the textiles. Further important functional parameters are the hygienic performance, energy consumption, water consumption or the detergent consumption (cf. Task 1).

There are some requirements for professional laundry appliances that have to be taken into account and that vary to a great extent for different customer groups:

[30] Source: A.I.S.E "Industrial and Institutional Sector – Professional Hygiene for Health and Well-being" (2004)

[31] An introduction to the industrial & institutional sector of A.I.S.E.; September 2005

- The amount of laundry and types of fabrics to be washed are very different depending on the application.
- High capacities / short running cycles are usually important.
- The spatial requirements are different depending on the customer segments.

As described in Task 3, the energy, water and detergent consumptions of professional washing machines are influenced by different real-life usage parameters and also depend on the usage in the relevant market or customer segment.

The following input parameters were specified to define the respective energy, water and detergent consumptions of professional washing machines during the use phase. The parameters have already been compiled and discussed in Task 3 on user behaviour. The following sections summarise the assumptions and the annual consumption of the different washing machines categories.

2.3.3.1 Category WM1: Semi-professional washer extractor

The following data are based on cold water connection of the washing machines.

Table 19 Energy, water and detergent consumption of a semi-professional washer extractor

	Energy	**Water**	**Detergent**
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 6 kg	7 000		
Specific consumption operation (ideal conditions)	*0.15 kWh/kg laundry*	*9 litres/kg laundry*	*17 g/kg laundry*
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 20%	+ 20%
Additional consumption through maloperation	+ 15%	+ 15%	+ 15%
Specific consumption operation (real life user behaviour)	*0.19 kWh/kg laundry*	*12 litres/kg laundry*	*23 g/kg laundry*
Annual consumption operation (real life user behaviour)	*1 330 kWh*	*85 050 litres*	*161kg*
Annual consumption standby	1.8 kWh	-	-
Annual consumption (real life)	***1 332 kWh***	***85 050 litres***	***161 kg***

2.3.3.2 Category WM2: Professional washer extractor <15 kg

Table 20 Energy, water and detergent consumption of a professional washer extractor <15 kg (category WM2)

	Energy	Water	Detergent
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 10 kg	14 400		
Specific consumption operation (ideal conditions)	0.17 kWh/kg laundry	12 litres/kg laundry	17 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 20%	+ 20%
Additional consumption through maloperation	+ 15%	+ 15%	+ 15%
Specific consumption operation (real life user behaviour)	0.21 kWh/kg laundry	16 litres/kg laundry	23 g/kg laundry
Annual consumption operation (real life user behaviour)	*3 024 kWh*	*233 280 litres*	*330 kg*
Annual consumption standby	1.8 kWh	-	-
Annual consumption (real life)	***3 026 kWh***	***233 280 litres***	***330 kg***

For comparison:

Since 2008, the Danish Technological Institute (DTI)[32] has been measuring data on energy and water consumption, cycle duration (time) and washing, spin extraction and rinsing performance as well as washing temperature for around ten different professional washing machines (comparable to washing categories WM1 and WM2). The data have been determined for five manufacturers. In November 2010, the website www.faellesvaskeri.dk only contained data from five washing machines/programmes which is probably due to the fact that manufacturers may ask to remove older test results as soon as newer tests have been performed by DTI on the manufacturer's demand. All test data are the property of the manufacturer.

The modifications follow as far as possible the European standard EN 60456 for household washing machines (see also cf. Task 1).

The following table gives an overview of the DTI results compared to the data provided from manufacturers for EuP Lot 24 and the results achieved in Lot 14.

32 www.dti.dk

Table 21 Comparison of performance data of professional and household washing machines

	Energy consumption kWh/kg laundry			Water consumption litres/kg laundry		
Source	**EuP Lot 24**	**DTI**[33]	**EuP Lot 14**[34]	**EuP Lot 24**	**DTI**	**EuP Lot 14**
	0.12-0.18 (WM1) 0.14-0.20 (WM2)	0.10-0.19	0.187	8-10 (WM1) 10-14 (WM2)	4.2-12.6	9.3
Average value	**0.16**	**0.15**	**0.19**	**11**	**8.2**	**9.3**

2.3.3.3 Category WM3: Professional washer extractor 15–40 kg

Table 22 Energy, water and detergent consumption of a professional washer extractor 15–40 kg (category WM3)

	Energy	**Water**	**Detergent**
Main customer segment	Hospitality Laundry		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 24 kg	42 200		
Specific consumption operation (ideal conditions)	0.21 kWh/kg laundry	13 litres/kg laundry	14 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 20%	+ 20%
Additional consumption through maloperation	+ 15%	+ 15%	+ 15%
Specific consumption operation (real life user behaviour)	0.26 kWh/kg laundry	18 litres/kg laundry	19 g/kg laundry
Annual consumption operation (real life user behaviour)	*10 972 kWh*	*740 610 litres*	*798 kg*
Annual consumption standby	1.3 kW/h	-	-
Annual consumption (real life)	***10 973 kWh***	***740 610 litres***	***798 kg***

33 Source DTI: http://faellesvaskeri.dk/index.asp?m=1. The 5 latest tests present on the website.

34 EuP Lot 14, Base case page 381

2.3.3.4 Category WM4: Professional washer extractor >40 kg

Table 23 Energy, water and detergent consumption of a professional washer extractor >40 kg (category WM4)

	Energy	Water	Detergent
Main customer segment	Commercial Industrial Laundry		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 90 kg	194 400		
Specific consumption operation (ideal conditions)	0.35 kWh/kg laundry	14 litres/kg laundry	18 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 10%	+ 10%
Additional consumption through maloperation	+ 10%	+ 10%	+ 10%
Specific consumption operation (real life user behaviour)	0.42	17	22
Annual consumption operation (real life user behaviour)	*81 648 kWh*	*3 265 920 litres*	*4 199 kg*
Annual consumption standby	negligible	-	-
Annual consumption (real life)	***81 648 kWh***	***3 265 920 litres***	***4 199 kg***

2.3.3.5 Category WM5: Professional washer dryer

Table 24 Energy, water and detergent consumption of a professional washer dryer (category WM5)

	Energy	Water	Detergent
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 8 kg	7 400		
Specific consumption operation (ideal conditions)	0.80 kWh/kg laundry	10 litre/kg laundry	14 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 20%	+ 20%
Additional consumption through maloperation	+ 15%	+ 15%	+ 15%
Specific consumption operation (real life user behaviour)	1.00	14	19
Annual consumption operation (real life user behaviour)	*7 400 kWh*	*99 900 litres*	*140 kg*
Annual consumption standby	n.a.	-	-
Annual consumption (real life)	***7 400 kWh***	***99 900 litres***	***140 kg***

2.3.3.6 Category WM6: Professional barrier washer

Table 25 Energy, water and detergent consumption of a professional barrier washer (category WM6)

	Energy	Water	Detergent
Main customer segment	Healthcare Laundry		
Typical use intensity: Annual amount of cleaned laundry (kg/year) for a typical machine capacity of 32 kg	56 300		
Specific consumption operation (ideal conditions)	0.39 kWh/kg laundry	16 litres/kg laundry	18 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 10%	+ 10%
Additional consumption through maloperation	+ 10%	+ 10%	+ 10%
Specific consumption operation (real life user behaviour)	0.47	19	22
Annual consumption operation (real life user behaviour)	*26 461 kWh*	*1 080 960 litres*	*1 216 kg*
Annual consumption standby	n.a.	-	-
Annual consumption (real life)	***26 461 kWh***	***1 080 960 litres***	***1 216 kg***

2.3.3.7 Category WM7: Washing tunnel machine

Table 26 Energy, water and detergent consumption of a professional washing tunnel machine (category WM7)

	Energy	Water	Detergent
Main customer segment	Commercial Industrial Laundry		
Typical use intensity: Annual amount of cleaned laundry (kg/year)	3 825 000		
Specific consumption operation (ideal conditions)	0.35 kWh/kg laundry	6 litres/kg laundry	9 g/kg laundry
Real-life user behaviour			
Additional consumption through partial workload	+ 10%	+ 10%	+ 10%
Additional consumption through maloperation	+ 10%	+ 10%	+ 10%
Specific consumption operation (real life user behaviour)	0.42	7	11
Annual consumption operation (real life user behaviour)	*1 606 500 kWh*	*27 540 000 litres*	*41 310 kg*
Annual consumption standby	negligible	-	-
Annual consumption (real life)	***1 606 500 kWh***	***27 540 000 litres***	***41 310 kg***

2.3.3.8 Overview of all professional washing machine categories

The following Table 27 summarizes the annual energy, water and detergent consumption to be used as input data for Task 5 (environmental impact assessment of base cases).

Table 27 Annual energy, water and detergent consumption (real life conditions) of all professional washing machine categories

	Energy consumption	**Water consumption**	**Detergent / laundry aid consumption**
Category	***kWh/year***	***litres/year***	***kg/year***
WM1: Semi-professional washer extractor	*1 332*	*85 050*	*161*
WM2: Professional washer extractor, <15 kg	*3 026*	*233 280*	*330*
WM3: Professional washer extractor, 15-40 kg	*10 973*	*740 610*	*798*
WM4: Professional washer extractor, >40 kg	*81 648*	3 265 920	4 199
WM5: Professional washer dryer	*7 400*	*99 900*	*140*
WM6: Professional barrier washer	*26 461*	1 080 960	1 216
WM7: Washing tunnel machine	*1 606 500*	27 540 000	41 310

2.4 Technical analysis of the use phase (system)

Professional washing machines are used in hotels, clinics, health care, laundrettes and in many other places (see Task 3). The surroundings of these places may be quite different and can influence the energy and water consumption of the washing machines. This section provides an overview on how different ambient conditions can influence the energy, water and detergent consumption of the professional washing machines.

Type of laundry: Textiles can be made from different materials and fabrics (cotton, wool, mineral, synthetic etc) and result in particular types of laundry (work wear, hospital linen, high visibility garments etc.). The majority of the laundry is washed using the cotton programme. However there are some types of fabrics retaining the water more than other fabrics, thus increasing the amount of energy needed to dry them. Different products and systems take account of varying needs in accordance with the different types of clothes to be washed.

Wash temperature: The wash temperature has a strong influence on the energy consumption. The higher the temperature, the more energy is needed. According to the sinner's circle (cf. Task 3), temperature, chemistry, time and mechanics interact and have to be optimally adjusted. Thus, if one factor is reduced, another has to be increased.

Contamination/Soiling: The soiling of the clothes can greatly vary within the different customer segments. Depending on the treatment required (e.g. hygienic requirements in the sanitary field, preservation of the protective function of fire protection suits etc.), a different range of product and programme solutions exist. As a consequence, the user may choose different appliances and programs of the washing machines. In case of none satisfying washing results, additional washing cycles might be necessary leading to an increased overall energy and water consumption.

The spin speed (g-factor) of the washer extractor: The g-factor is a measure of centrifugal force which has a significant effect on laundry during spinning. A higher spin speed results in a higher g-force and thus less residual moisture in the laundry. The lower the residual moisture (%) of the washed laundry, the less energy is required in the subsequent drying process.[35]

2.5 Technical analysis of the end-of-life phase

This section provides information regarding the end-of-life of the professional washing machine's material flows for handling as pure waste (landfill, pyrolytic incineration), heat recovery (non-hazardous incineration optimised for energy recovery) and/or re-use or closed-loop recycling.

At the end of their life, heavy duty and larger washing machines are usually taken back by the manufacturer. In some cases, parts of the machine can be reused, the rest of the machines – mostly valuable stainless steel – will be sold to recycling companies where they are cleaned up, shredded and disassembled. Reusable materials are separated and then returned to the material production. The semi-professional and smaller washing machines could be also dismantled by certified scrap dealers.

As already described in Task 3, only 1–5% by weight of the material from professional washing machines is not recovered (i.e. go to landfill), as the materials (mostly stainless steel, >50-80%) are too valuable. According to stakeholders, more than 95% of the products are recyclable and will always either be refurbished or recycled for scrap parts or materials.

[35] http://www.miele-professional.de/us/professional/13_490.htm

Table 28 Landfill (fraction of products not recovered) in % of professional washing machines (based on stakeholder input)

Washing machine category	Landfill (fraction of products not recovered) %
WM1: Semi-professional washer extractor	5
WM2: Professional washer extractor, <15 kg	5
WM3: Professional washer extractor, 15-40 kg	5
WM4: Professional washer extractor, >40 kg	~1
WM5: Professional washer dryer	5
WM6: Professional barrier washer	~1
WM7: Washing tunnel machine	~1

The plastic share of all professional washing machines is less than 10% of their overall weight. All plastic components weighing more than 50 grams are marked in accordance with ISO 1043[36]. According to stakeholder information this plastic parts are disposed of as follows:

- Thermal recycling: 70%.
- Material (or mechanical) recycling: 29%
- Re-use, closed loop recycling: 1%

Printed wiring boards (PWB) are used in the professional washing machines of all categories. According to stakeholder information, these parts are easy to dismantle and are completely recycled by certified scrap dealers.

If a professional washing machine with an installed heat pump is dismantled, specialized technicians will extract the refrigerant from the heat pump. In this process, only a technically unavoidable, small amount of refrigerant will escape.

3 Technical analysis of professional dryers

3.1 Technical analysis of the production phase

In this chapter entails a general technical analysis and description of each dryer category. This description explains the function of the different components of a dryer and is completed with an average bill of material (BOM) for each technology.

[36] ISO 1043 – Part 1, Plastics – Symbols and abbreviated terms – Basic polymers and their special characteristics

3.1.1 Main operating principles of professional dryers

The following table gives an overview of the seven dryer categories identified in Task 1 and their main characteristics. For a more detailed description see Task 1.

Table 29 Categorisation of professional dryers

Product category	Key market segment	Main operator / user type	Filling ratio[37]	Type of loading	Product dimensions	Application
D1 Semi-professional dryer, condenser	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)	Mainly private customers and non trained personnel (with few exemptions)	1:18 - 1:25	Manual, front loading	Typical dimension: height x width x depth 850 x 600 x 600 mm	Semi-professional
D2 Semi-professional dryer, air vented						
D3 Professional cabinet dryer				Hangers, front loading	Dimensions are very variable depending on amount / type of textiles to be dried and spatial possibilities	Professional
D4 Professional tumble dryer <15 kg				front loading manual or automatic		
D5 Professional tumble dryer 15-40 kg	Hospitality Laundry (HPL)	Non and trained personnel				
D6 Professional tumble dryer >40 kg	Commercial Industrial Laundry (CIL)	Trained personnel	1:20 - 1:25			
D7 Pass-through (transfer) dryer				Pass-through, Automatically, loading and unloading, doors on opposite sides		

37 The applicable filling ratio depends on the density of the laundry to be washed/dried.

3.1.1.1 Category D1: Semi-professional dryer, condenser

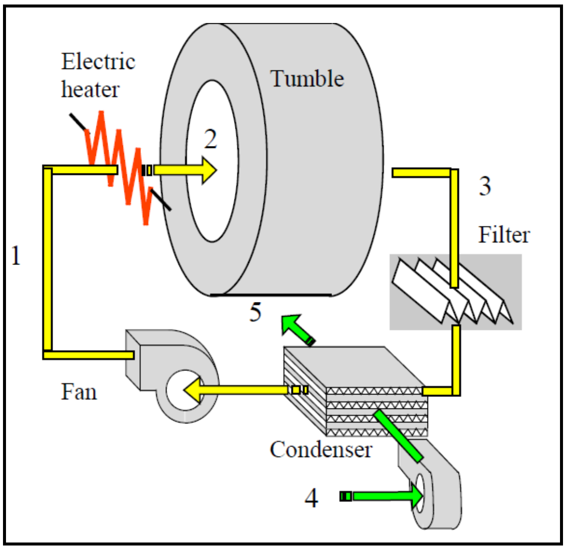
A typical semi-professional condenser dryer is shown in the following figure.

(Source: Miele Duo-Star 6.5 kg, http://www.miele-professional.de/de/prof/produkt/33_14148.htm, sighted on 07.09.2010)

Figure 24 Semi-professional dryer, condenser (D1)

A condensation dryer passes heated air through the load. However, instead of exhausting this air, the dryer uses a heat exchanger to cool the air and condense the water vapour into either a drain pipe or a collection tank. Two types of condenser dryers can be found on the market: air condenser or water condenser dryers. The difference lies in the heat exchange process, the internal warm air being cooled either using ambient air (air condenser dryers) or cold water (water condenser dryers). Water condensation is the most common system of professional wash and dry machines, whereas the vast majority of professional tumble dryers currently available are air condenser models. We will therefore focus our technical description on this type of condenser dryers.

The air circuit (see Figure 25) is mainly constituted of 4 components: an air filter (see Figure 26) at the base part of the tumbler, an air-cooled heat exchanger (condenser), a fan and an electric heater at the tumble inlet. In following figure, the typical condenser principle is shown.



(Source: http://www-cep.ensmp.fr/francais/innov/pdf/ICR0143SLV%20_IIR_IIF%20Conf.pdf)

Figure 25 Condenser dryer principle

These dryers can be equipped with an electronic moisture sensor (residual moisture control – RMC) that monitors the residual moisture level of the load (cf. Task 6).

(Source: Miele, http://www.miele-ebrochures.co.uk/professional/files/Little_Giants_April06.pdf, sighted on 07.09.2010)

Figure 26 Possible filter for a semi-professional dryer

In addition, there are two heating options: only electric or combo electric with heat pump (cf. Task 6). By using the latter, the hot, humid air from the tumbler is passed through a heat pump, where the cold side condenses the water vapour either into a drain pipe or a collection tank and the hot side reheats the air. In this way, the dryer does not only avoid the need for air ducting, but it also conserves much of its heat within the dryer instead of exhausting it into the surroundings.

Table 30 gives an overview of the characteristics of a typical appliance of this category.

Table 30 Characteristics of a semi-professional dryer, condenser (D1)

Main characteristics[38] category D1	Data
Feature of performance	
Drying Capacity, kg	6.5
Drum Volume	130
Filling ratio	1:20
Number of fixed drying programs	12–20
Condensation efficiency	~80%
Construction details	
Height, mm	850
Width, mm	600
Depth, mm	700
Weight net, kg	60–65
Electricity	
Voltage, V	230–400 1–3 phase
Total load, kW	2.2–3.7

According to stakeholders, the material composition is equivalent to that of a household tumble dryer as described in the preparatory study on dryers (Lot 16). The following Bill of Materials (BOM) is taken from task 4 report of that study and partial interpolated for a typical semi-professional condenser dryer with a drying capacity of 6 kg.

Table 31 Material composition of a semi-professional dryer, condenser (category D1)

Material / Component	weight in g	weight in %	Material category
Stainless Steel	34 600	57.5%	3-Ferro
Steel Sheet galvanized	3 500	5.8%	3-Ferro
Cast Iron	2 400	4.0%	3-Ferro
Polypropylen (PP)	7 700	12.8%	1-BlkPlastics
Polyamid (PA)	400	0.7%	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	2 100	3.5%	1-BlkPlastics
Plystyrene (PS)	400	0.7%	1-BlkPlastics
Styropor expandable polystyrene (EPS)	450	0.7%	1-BlkPlastics
Polyvinylchlorid (PVC)	150	0.2%	1-BlkPlastics
Plastics others	2 500	4.2%	1-BlkPlastics
Aluminium	900	1.5%	4-Non-ferro
Cu wire	2 600	4.3%	4-Non-ferro
Glass for lamps	600	1.0%	2-TecPlastics
Electronics (control)	1 900	3.2%	6-Electronics
Total net	**60 200**		

[38] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of one typical model within category D1.

Material / Component	weight in g	weight in %	Material category
Packaging			
PE-Foil	500		1-BlkPlastics
wood	5 000		7-Misc.
cardboard	1 300		7-Misc.
Total weight	**67 000**		

3.1.1.2 Category D2: Semi-professional dryer, air vented

Semi-professional dryers are mostly used by non-professional operators. Air vented dryers operate in this way: the humidity of the washed laundry is evaporated to the ambient air through a tube. Different connections for this tube are offered by manufacturers to adjust the dryer to the location conditions. The air vented dryer is mainly composed of a motor and fan, drum and cabinet, an air circuit system and a control system. Only one motor provides the rotation of the drum and the blower.

(Source: Miele PT 7136, 6.5 kg)

Figure 27 Semi-professional dryer, air vented (category D2)

Table 32 Characteristics of a semi-professional dryer, air vented (category D2)

Main characteristics[39] category D2	Data
Feature of performance	
Drying capacity, kg	6.5
Drum volume	130
Filling ratio	1:20
Number of fixed drying programs	>10

[39] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of one typical model within category D2.

Main characteristics[39] category D2	Data
Construction details	
Height, mm	850
Width, mm	600
Depth, mm	700
Weight net, kg	57–60
Electricity	
Voltage, V	230–400 1–3 phase
Total load, kW	3.2–6.4

According to stakeholders the material composition is equivalent to that of a household washing machine as described in the preparatory study on dryers (Lot 16). The following Bill of Materials (BOM) is taken from task 4 report of that study and partial interpolated for a typical semi-professional air vented dryer with a drying capacity of 6 kg.

Table 33 Materials composition of a semi-professional dryer, air vented (category D2)

Material / Component	weight in g	weight in %	Material category
Stainless Steel	32 800	57.3%	3-Ferro
Steel Sheet galvanized	3 500	6.1%	3-Ferro
Cast Iron	2 800	4.9%	3-Ferro
Polypropylen (PP)	7 200	12.6%	1-BlkPlastics
Polyamid (PA)	400	0.7%	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	2 100	3.7%	1-BlkPlastics
Plystyrene (PS)	400	0.7%	1-BlkPlastics
Styropor expandable polystyrene (EPS)	450	0.8%	1-BlkPlastics
Polyvinylchlorid (PVC)	150	0.3%	1-BlkPlastics
Plastics others	1 500	2.6%	1-BlkPlastics
Aluminium	900	1.6%	4-Non-ferro
Cu wire	2 600	4.5%	4-Non-ferro
Glass for lamps	600	1.0%	2-TecPlastics
Electronics (control)	1 800	3.1%	6-Electronics
Total net	**57 200**		
Packaging			
PE-Foil	500		1-BlkPlastics
wood	5 000		7-Misc.
cardboard	1 300		7-Misc.
Total weight	**64 000**		

As a matter of fact, around 68% of the weight of an air vented tumble dryer is made of ferrous metals. Regarding the plastic parts, the most commonly used plastic is polypropylene (12% of the dryers' weight).

3.1.1.3 Category D3: Professional cabinet dryer

While conventional dryers rely on a tumbling action, drying cabinets simulate an accelerated clothesline in an internal environment by circulating air throughout the cabinet. Drying cabinets (category D3) are mainly used for laundry that should not be dried in a tumble dryer, in order to avoid the risk of shrinkage or damage by the tumbling action. Such laundry could be for example wet and damp clothes, shoes, boots, gloves, hats, or delicate linen like protective clothing. They have proved to be very popular with construction companies, the police force, fire departments, ambulance and offshore rescue services, the army, airport handling services, theatres, sports and leisure clubs and many other applications where there is a need to regularly dry outdoor clothing and work wear without necessarily washing garments every time. Furthermore, drying cabinets are a common way to dry laundry in Scandinavian countries where they are used in addition to traditional clothes tumble dryers.[40]

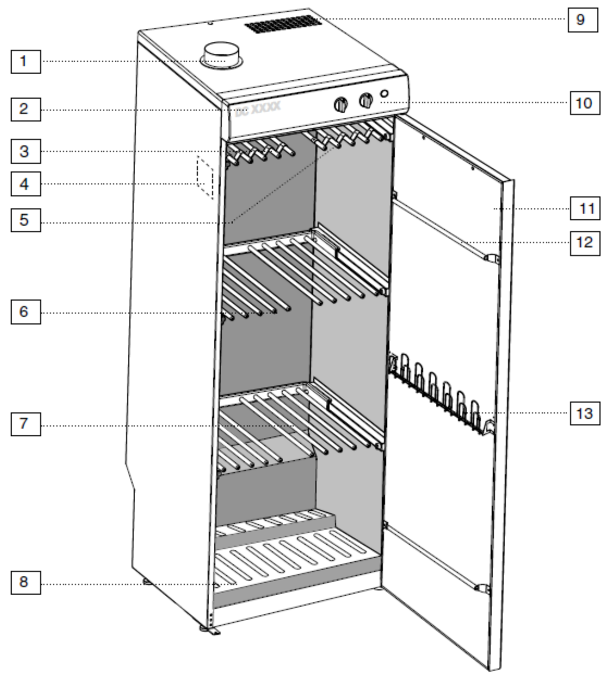
Drying cabinets operate with two separate heated air systems. One system dries the laundry by blowing warm air through the hangers into the garments and out the arms and legs, thus drying the laundry from the inside. The other system blows warm air from the side of the cabinet around the outside of the garments.

The following illustration shows a typical cabinet dryer.


(Source: Podab TS 6 MPR)

Figure 28 Professional cabinet dryer (category D3)

[40] Source: http://www.staber.com/dryingcabinet, sighted on 23 June 2010



1 Exhaust collar
2 Drying cabinet model
3 Hanger hooks
4 Rating plate (inside)
5 Upper hanger section
6 Middle hanger section
7 Lower hanger section
8 Shoe rack (optional)
9 Air intake
10 Control panel
11 Door
12 Door hanger for lighter articles
13 Glove hanger

(Source: ASKO DC 7171)

Figure 29 Construction of a professional cabinet dryer (category D3)

The following table gives an overview of the characteristics of a typical professional cabinet dryer (category D3).

Table 34 Characteristics of a typical professional cabinet dryer (category D3)

Main characteristics[41] category D3	**Data**	
Feature of performance	**Model A**	**Model B**
Drying capacity, kg	8	16
Number of drying programs	3 (2)	3 (4)
Heater temperature, °C	<90	90
Drying time, min	10–260	10–260
Drying performance, g/min	65–78	93
Air flow, m^3/h	250	300
Noise level, dB(A)	>70	>72
Construction details		
Height, mm	2 080	2 000
Width, mm	1 200	1 800
Depth, mm	750	800
Weight net, kg	120–160	~235

41 Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of two typical models within category D3.

Main characteristics[41] category D3	Data	
Electricity		
Voltage, V	230–400	400
Total load electric, kW	6	9.3

The following table shows the BOM of a typical dryer of category D3, the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately.

Table 35 Composition of materials of a typical professional cabinet dryer (category D3)

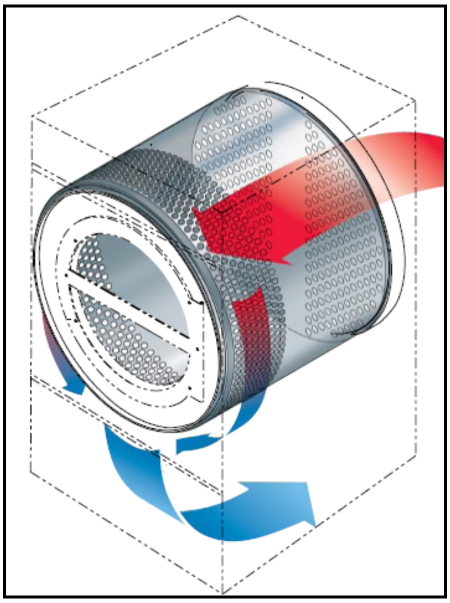
Material / component	Weight in g[42]	Weight in %	Material category
Steel	4 350	3%	3-Ferrous
Steel sheet galvanized	108 750	75%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	2 175	1.5%	1-BlkPlastics
Aluminium	20 300	14%	4-Non-ferrous
Copper	1 450	1%	4-Non-ferrous
PVC	~145	~0.1%	1-BlkPlastics
Electronics	3 045	2.1%	6-Electronics
EDPM	1 450	1%	1-BlkPlastics
Other	3 480	2.4%	7-Misc.
Total net	**145 145**		
Packaging			
Polystyrene	1 800		1-BlkPlastics
Wood	18 600		7-Misc.
Cardboard	6 500		7-Misc.
Total weight	**172 045**		

3.1.1.4 Category D4, D5, D6: Professional tumble dryer

Professional tumble dryers continuously draw in the cool, dry, ambient air around them and heat it by electric, steam or gas before passing it through the moist laundry in the tumbler. The resulting hot, humid air is simply vented outside to make room for more dry air to continue the drying process. Therefore they require an external duct out to open air (open system). The gas or heat pump tumble dryer operate like an air vented dryer; however, the electrical heating element is replaced by a gas burner or a heat exchanger.

The longitudinal air flow draws the heated air from the dryer back along the drum to the front out (axial air flow). On the opposite of this is the radial air flow (from top to bottom) with a perforated drum.

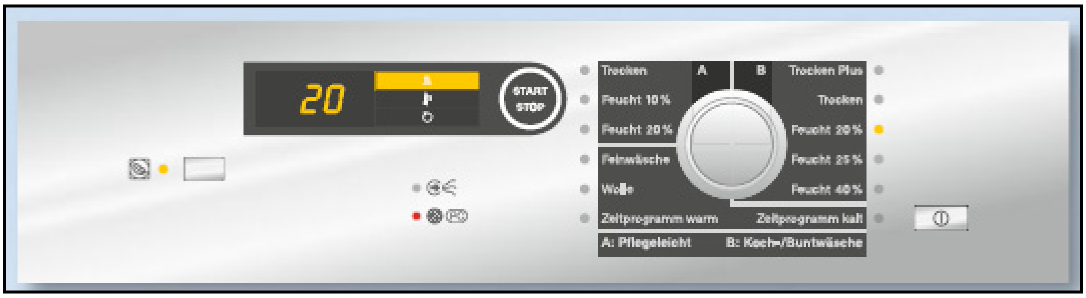
[42] Average weight value is based on a typical cabinet dryer with a drying capacity of 8 kg.



(Source: Primus)

Figure 30 Radial and axial air flow system of an air dryer

Professional dryers are equipped either with freely programmable controls or with electronic controls offering standard programmes. One exemplary control is illustrated in Figure 31.



(Source: Miele Profitronic B Plus)

Figure 31 Temperature and time control of professional tumble dryers

A further type of control is customised for the laundrettes (coin & card laundries), where a simple user operation could be selected for the cycle selection. A visual indicator signal shows the end of the drying cycle, as illustrated in the following figure.

(Source: Primus)

Figure 32 Coin control

Furthermore, the appliances have various design options like final cool down cycle, residual moisture control or drum interior lighting. They are typical for front loading dryers as well as for stacker tumblers[43]. They can be used for all kind of linen and are equipped with the following heating options: electric, steam, gas and heat pump. Steam and gas heating, the two most common alternative heating options are described in Figure 33.

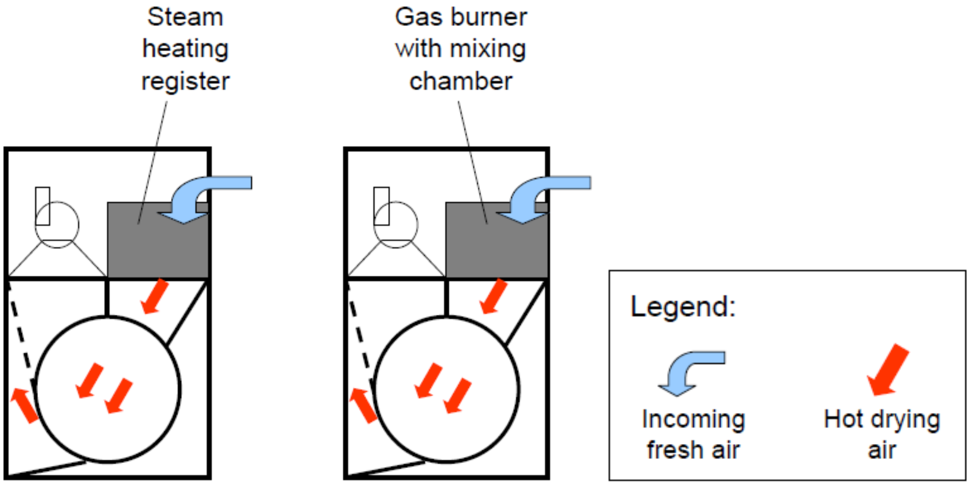


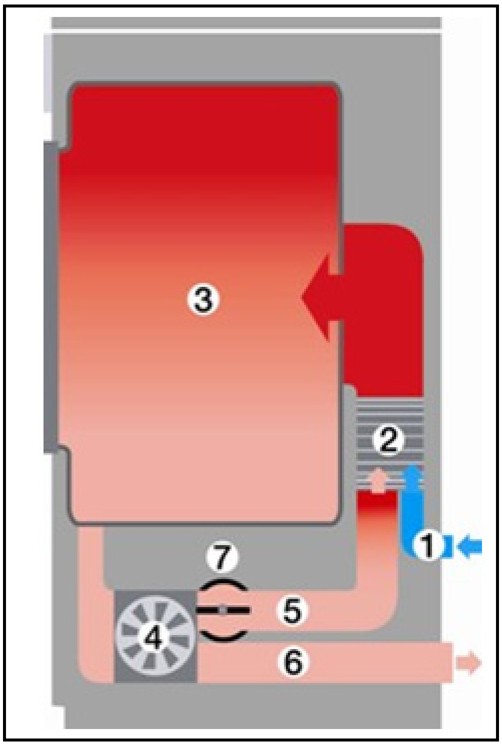
Figure 33 Heating systems of dryers[44]

Many of the appliances operate with a so-called air recycling using the already heated air again for the next drying process (see Figure 34). According to one manufacturer, 60% of the drying air is supplied again for the drying process. With the use of an optional air flap, a

[43] Two dryers on top of each other, http://www.laundrysystems.electrolux.com/node350.aspx?productId=51

[44] Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-5_Drying_of_textiles.PDF, sighted on 06.09.2010

temperature sensor may switch between the used (exhaust) air and the circulating air, resulting in an effective way of drying laundry.



1 Fresh air
2 Heating
3 Drum
4 Blower
5 Circulating air
6 Exhaust air
7 Air flap

(Source: http://www.miele-professional.de/de/prof/7680_7872.htm#p7681, reviewed on 20.09.2010)

Figure 34 Air recycling

Furthermore, both the rotation speed of the drum as well as the temperature can be controlled.

Tumble dryers of this category usually have a freely programmable control with various standard programmes for special laundry. In addition to the heating options of steam and gas, a heat pump can be used. Heat pump dryers combine a condenser dryer with an integrated heat pump. The warm, moist air from the drum is passed immediately to the heat pump (evaporator) where it is dehumidified; at the condenser the warm, dry air is returned to the drum. Compared to condenser dryers, the process is a closed system (see 3.1.1.1).

In order to specify the duration of the drying process, there are the following options:

- Defining a fixed drying time;
- Determining the switch-off point by the difference between the ingoing and outgoing air;
- Precisely direct measuring of the residual moisture in the textiles by an infrared control system (see also Task 6).

Professional tumble dryers with a load capacity up 15 kg (category D4) can be used for all types of wash ware and are mainly applied in coin and card laundry. A typical professional tumble dryer up to 15 kg is shown in Figure 35.

(Source: Primus Tams13, 13 kg)

Figure 35 Professional tumble dryer <15 kg (category D4)

Category D4: Professional tumble dryer <15 kg

Table 36 gives an overview of the characteristics of a typical professional tumble dryer <15 kg (category D4).

Table 36 Characteristics of a professional tumble dryer <15 kg (category D4)

Main characteristics[45] category D4	**Data**		
Feature of performance	**Model A**	**Model B**	**Model C**
Drying capacity, kg	8–10	10–12	11-13
Drum volume, L	200–170	220–250	250–285
Filling ration	1:18-1:25	1:18-1:25	1:18-1:25
Number of drying programs	5–9	5–9	5–9
Heater Temperature	4 steps, max 70°C	4 steps, max 70°C	4 steps, max 70°C
Drying performance, L/min	0.15	0.17	0.20
Air flow, m^3/h	250	360–600	430–630
Construction details			

[45] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of three typical models within category D4.

Main characteristics[45] category D4	**Data**		
Height, mm	1 092	1 460–1 640	1 900
Width, mm	711	842	710
Depth, mm	683	793	110
Weight net, kg	70–120	140–160	160–220
Electricity and steam consumption			
Voltage, V	230–400	230–400	230–400
Total load electric, kW	5.05–5.25	15.4	13.5–18
Total load gas, kW	1.1	1.1	1.1
Total load steam output, kW/h	7-10	8–12	13–14

The following table shows the BOM of a typical dryer of category D4, the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately.

Table 37 Material composition of a professional tumble dryer <15 kg (category D4)

Material / component	**Weight in g[46]**	**Weight in %**	**Material category**
Stainless steel	12 240	8%	3-Ferrous
Galvanized steel	107 100	70%	3-Ferrous
Steel	7 650	5%	3-Ferrous
Cast Iron	6 120	4%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	~3 820	~2.5%	1-BlkPlastics
Aluminium	3 060	2%	4-Non-ferrous
Copper	6 120	4%	4-Non-ferrous
PVC	300	0.2%	1-BlkPlastics
Electronics	4 600	3%	6-Electronics
Glass	1 990	1.3%	7-Misc.
Total net	**153 000**		
Packaging			
Polystyrene	600		1-BlkPlastics
Wood	12 500		7-Misc.
Cardboard	1 400		7-Misc.
Total weight	**167 500**		

Category D5: Professional tumble dryer 15-40 kg

Professional tumble dryers with a load capacity of 15–40 kg (category D5) are for example used for hospitality laundry. A typical device of this category is shown in Figure 36.

---

46 Average weight value is based on a typical tumble dryer with a drying capacity of 10 kg.

(Source: Miele PT8807, 36 kg)

Figure 36 Professional tumble dryer 15–40 kg (category D5)

Table 38 gives an overview of the characteristics of a typical professional tumble dryer 15–40 kg (category D5).

Table 38 Characteristics of a typical professional tumble dryer, 15–40 kg (category D5)

Main characteristics[47] category D5	**Data**	
Feature of performance	**Model A**	**Model B**
Drying capacity, kg	23	34
Drum volume, L	518	609
Filling ration	1:25–1:18	1:25–1:18
Number of drying programs	5–9	5–9
Heater Temperature	4 steps, max 70°C	4 steps, max 70°C
Drying performance, L/min	0.35	0.48
Air flow, m^3/h	1 062	1 415
Construction details		
Height, mm	1 829–1 910	1 908–1 965
Width, mm	878	970
Depth, mm	1 295	1 270
Weight net, kg	290–370	320–400

[47] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of two typical models within category D5.

Electricity		
Voltage, V	230–400	230–400
Total load electric, kW	30	33
Total load gas, kW	1.5–2	1.5–2
Total load steam output, kW	1–2	1–2

The following table shows the BOM of a typical dryer of **category D5**, the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately.

Table 39 Composition of materials of a professional tumble dryer 15–40 kg (category D5)

Material / component	Weight in g[48]	Weight in %	Material category
Stainless steel	24 400	7%	3-Ferrous
Galvanized steel	243 600	70%	3-Ferrous
Steel	17 400	5%	3-Ferrous
Cast Iron	13 900	4%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	12 200	3.5%	1-BlkPlastics
Aluminium	6 950	2%	4-Non-ferrous
Copper	13 900	4%	4-Non-ferrous
PVC	700	0,2%	1-BlkPlastics
Electronics	10 400	3%	6-Electronics
Glass	4 550	1.3%	7-Misc.
Total net	**348 000**		
Packaging			
Polystyrene	1 000		1-BlkPlastics
Wood	23 000		7-Misc.
Cardboard	2 800		7-Misc.
Total weight	**374 800**		

Category D6: Professional tumble dryer >40 kg

Professional tumble dryers with a load capacity of more than 40 kg (category D6) can be used for all ranges for hotel, work wear, etc. They can be used as isolated applications as well as within a washing system. A typical professional tumble dryer of category D6 is shown in Figure 37.

[48] Average weight value is based on a typical tumble dryer with a drying capacity of 23 kg.


(Source: Electrolux, T4900, T41200, 48–60 kg)

Figure 37 Typical professional tumble dryer >40 kg (category D6)

Table 40 gives an overview of the characteristics of a typical professional tumble dryer > 40 kg (category D6).

Table 40 Characteristics of a typical professional tumble dryer >40 kg (category D6)

Main characteristics[49] category D6	**Data**	
Feature of performance	**Model A**	**Model B**
Drying capacity, kg	48	70
Drum volume, L	1 200	1 410
Filling ration	1:18–1:25	1:18–1:25
Number of drying programs	5–9	5–9
Heater Temperature	4 steps, max 70°C	4 steps, max 70°C
Drying performance, g/min	~900	n.a.
Air flow, m^3/h	2 500	n.a.
Construction details		
Height, mm	2 500	2 500
Width, mm	1 300	1 400
Depth, mm	1 500	1 800
Weight net, kg	440–510	710–790
Electricity		
Voltage, V	230–400	230–400
Total load electric, kW	63–75	n.a.
Total load gas, kW	3–3.5	1.5–2
Total load steam output, kW	3–3.5	1–2

n.a. = not applicable

[49] Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of two typical models within the category D6.

The following table shows the BOM of a typical dryer of category D6, the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately.

Table 41 Composition of materials of a professional tumble dryer >40 kg (category D6)

Material / component	Weight in g[50]	Weight in %	Material category
Stainless steel	52 150	7%	3-Ferrous
Galvanized steel	521 500	70%	3-Ferrous
Steel	37 250	5%	3-Ferrous
Cast Iron	29 800	4%	3-Ferrous
Plastics (PP, Polyester, ABS etc.)	26 100	3.5%	1-BlkPlastics
Aluminium	14 900	2%	4-Non-ferrous
Copper	29 800	4%	4-Non-ferrous
PVC	~1 500	~0.2%	1-BlkPlastics
Electronics	22 350	3%	6-Electronics
Glass	~9 650	~1.3%	7-Misc.
Total net	**745 000**		
Packaging			
Polystyrene	n.a.		1-BlkPlastics
Wood	n.a.		7-Misc.
Cardboard	n.a.		7-Misc.
Total weight	**n.a.**		

3.1.1.5 Category D7: Pass-through (transfer) tumble dryer

Pass-trough or batch transfer dryers (category D7) have the loading and unloading of the wash ware on opposite sides. With a load capacity of 40 to 240 kg they belong to the industrial appliances segment.

A typical batch transfer tumble dryer is shown in Figure 38.

50 Average weight value is based on a typical tumble dryer with a drying capacity of 70 kg.

(Source: Jensen, DT 60-240)

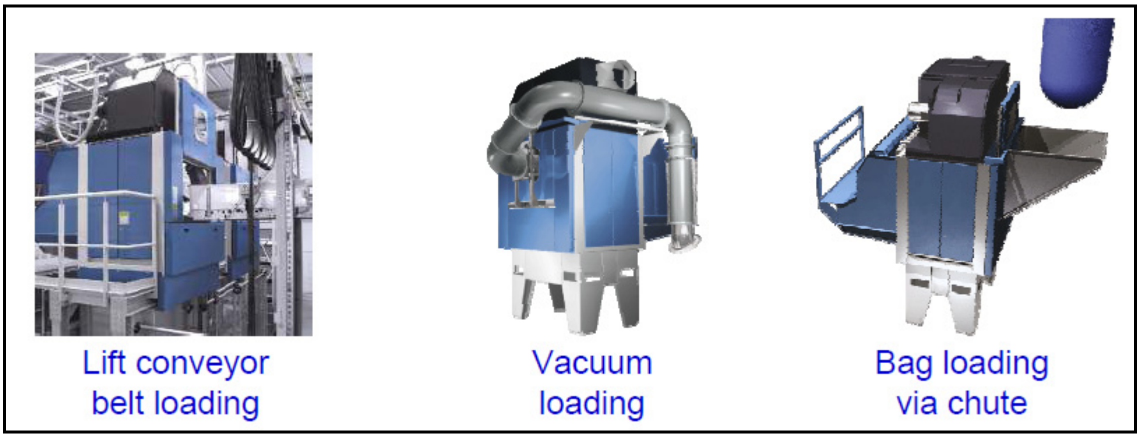
Figure 38 Typical batch transfer tumble dryer (category D7)

Transfer tumble dryers can be equipped with various design options, for example:

- Electric, steam-, gas-, or thermo oil heated,
- Temperature regulation and control,
- Cool-down via partially opened loading door or fresh air flap,
- Heat recovery,
- Infrared control to measure the temperature of the linen,
- Vacuum loading and unloading,
- Residual moisture control (RMC).

Some of these features will be described more detailed in Task 6 (Best Available Technologies).

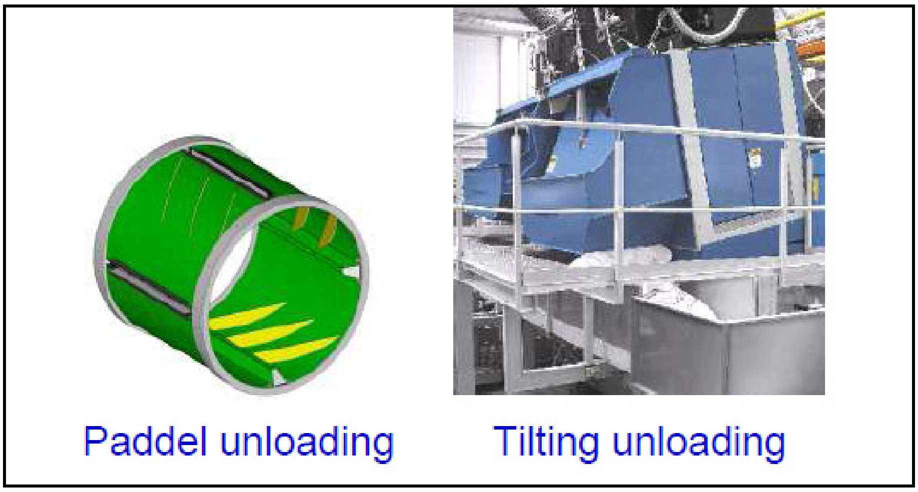
In compliance with their design there are three different loading systems for transfer tumble dryers, as shown in Figure 39. Loading and unloading takes place automatically.



(Source: www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-5_Drying_of_textiles.PDF, sighted on 08.09.2010)

Figure 39 Possible loadings of transfer tumble dryers

According to an e-learning tool for sustainable laundry[51] conducted inter alia by the wfk (Cleaning Technology Research Institute), a lift conveyor belt loading is the most common way of loading. Besides, there are different possibilities for unloading the tumble dryers (see Figure 40).



(Source: http://www.laundry-sustainability.eu/en/Microsoft_PowerPoint_-_Module_2-5_Drying_of_textiles.PDF, sighted on 08.09.2010)

Figure 40 Possibilities for unloading pass-through tumble dryers

As illustrated in the figure, the pass-through tumble dryers can be unloaded by paddle or by tilting. In addition to these two possibilities, pass-through dryers can also be unloaded by airflow, blowing out the laundry.

[51] http://www.laundry-sustainability.eu/en/index.html

There are several design options like a pneumatic tilting device, temperature control, separate heat and cool down timers or a heat exchanger. The heat exchanger illustrated in Figure 41 uses the energy of the exhausted hot air of the tumble dryer to preheat the fresh incoming air. According to the manufacturer, energy savings are possible by using this technology.

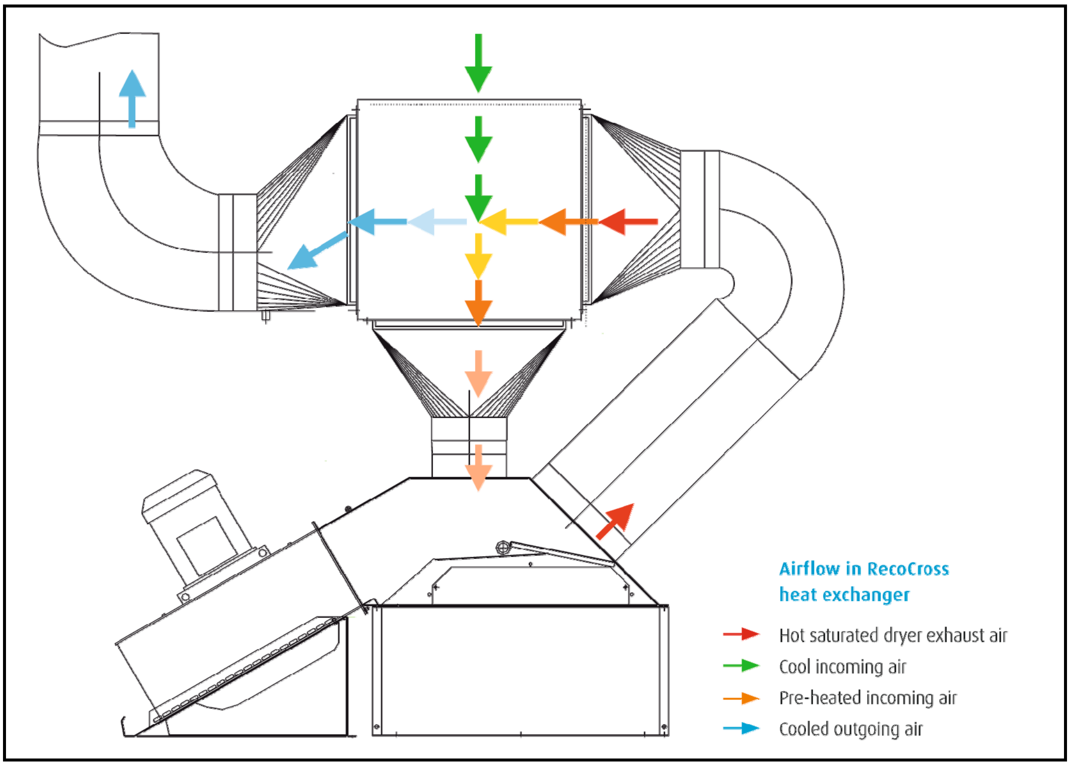


Figure 41 Heat exchanger of Jensen

Table 42 gives an overview of the characteristics of a typical heavy duty industrial pass-through (transfer) tumble dryer (category D7).

Table 42 Characteristics of a typical heavy duty industrial pass-through (transfer) tumble dryer (D7)

Main characteristics[52] category D7	**Data**
Program	
Drying capacity, kg	1 000–2 000 kg/h
Filling ration	
Heater temperature	Fresh air 200°C, exhaust air 100°C
Drying performance	
Air flow, m^3/h	2 600–9 000
Construction details	
Height, mm	2 000–2 500
Width, mm	2 000–2 600
Depth, mm	2 300–3 300
Weight net, kg	2 150–4 500
Electricity and water connection and consumption	
Electric connection load, kW	14–32
Gas connection load	50–90 m^3/h

No data available yet

The following table shows the BOM of a typical dryer of category D7 with the shares of the different materials and the category to which the materials are assigned. The packaging material is listed separately.

Table 43 Material composition of heavy duty industrial pass-through (transfer) tumble dryer (D7)

Material / component	**Weight in g[53]**	**Weight in %**	**Material category**
Stainless Steel	16 600	5%	3-Ferrous
Steel	2 826 600	85%	3-Ferrous
Cast Iron	6 650	2%	3-Ferrous
Copper	6 650	2%	4-Non-ferrous
EPDM rubber	<3 325	<1%	1-BlkPlastics
PE	< 3 325	<1%	1-BlkPlastics
Electronics	3 325	1%	6-Electronics
PVC (cables)	<3 325	<1%	1-BlkPlastics
Total net	**3 325 800**		
Packaging	**negligible**		
Polystyrene	n.a.		1-BlkPlastics
Wood	n.a.		7-Misc.
Cardboard	n.a.		7-Misc.
Total weight			

n.a. not applicable

52 Main characteristics in this table are based on the analysis of technical product information sheets and shall reflect average values from different manufacturers of a typical model within category D7.

53 Average weight value is based of a typical heavy duty batch transfer dryer.

3.1.1.6 Overview of all professional dryer categories

In the following table an overview of the shares of the material categories according to MEEuP (incl. packaging material) is shown for the different categories of professional dryers.

Table 44 Share of material categories (according to MEEuP) for the different categories of professional dryers (including packaging)

Materials-category	Unit	D1	D2	D3	D4	D5	D6	D7
Bulk Plastics	g	20.2%	19.3%	12.3%	23.4%	25.4%	53.9%	0.3%
Tec Plastics	g	1,5%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Ferrous	g	60,4%	63.1%	69.9%	78.6%	79.9%	86.0%	99.3%
Non-ferrous	g	5.2%	5.6%	8.4%	5.5%	5.6%	6.0%	0.2%
Coating	g	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Electronics	g	2,8%	2.9%	8.2%	17.2%	19.0%	46.1%	0.1%
Misc.	g	9.8%	7.5%	79.5%	59.4%	55.5%	0.0%	0.0%
Total weight	**g**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

D 1: Semi-professional dryer, condenser
D 2: Semi-professional dryer, air vented
D 3: Professional cabinet dryer
D 4: Professional tumble dryer, <15 kg
D 5: Professional tumble dryer, 15-40 kg
D 6: Professional tumble dryer, > 40 kg
D 7: Pass-through (transfer) tumble dryer

In all categories, the share of ferrous metal (mainly stainless steel) is with approximately 60% to 99% (incl. packaging) predominant.

3.2 Technical analysis of the distribution phase

The following table shows the average volume of the final packaged product. These values are used to calculate the environmental impacts resulting from distribution.

Table 45 Average volume of the final packaged product of the different categories of professional dryers

Dryer category	Average volume of the final packaged product
D 1: Semi-professional dryer, condenser	0.53 m³
D 2: Semi-professional dryer, air vented	0.53 m³
D 3: Professional cabinet dryer	1.76 m³
D 4: Professional tumble dryer, <15 kg	1.14–1.90 m³
D 5: Professional tumble dryer, 15-40 kg	1.75–3.40 m³
D 6: Professional tumble dryer, > 40 kg	3.90–7.44 m³
D 7: Pass-through (transfer) tumble dryer[54]	> 13m³

(Source: Information provided by data sheets)

[54] Corresponds to the average volume of the machine as the distribution is realised without packaging

3.3 Technical analysis of the use phase (product)

The drying process consists in removing the water with hot air from the wet textile. Therefore, a certain amount of energy is needed to make water evaporate and to evacuate the residual steam.

As described in Task 3, energy is consumed by different processes during a typical working day of professional dryers. The following input parameters were specified to define the respective energy consumption of professional dryers during the use phase. The parameters have already been compiled and discussed in Task 3 on user behaviour. The following sections summarise the assumptions and the annual consumption of the different dryer categories, differentiated according to the processes.

3.3.1 Ratio of energy use in professional dryers

This section exemplifies how much energy is used for the different process steps in a typical drying process.

The relative energy consumption of professional dryers can be mainly subdivided into energy used for air heating and the motor energy for mechanical action or electronic devices. The following table shows the respective energy flows of each category.

Table 46 Share of the average energy consumption in the different categories of professional dryers (Source: information provided by manufacturers)

Dryer category	Percentage of energy for motor and electronic devices etc. (always electricity)	Percentage of energy for air heating
D 1 Semi-professional dryer, condenser	5.0%	95.0%
D 2 Semi-professional dryer, air-vented	5.0%	95.0%
D 3 Professional cabinet dryer	5.0%	95.0%
D 4 Professional tumble dryer, <15 kg	8.0%	92.0%
D 5 Professional tumble dryer, 15-40 kg	8.0%	92.0%
D 6 Professional tumble dryer, >40 kg	15.0%	85.0%
D 7 Pass-trough (transfer) tumble dryer	11.0%	89.0%

Depending on the category, 5 to 15% of the incoming energy is used to drive motors, pumps and electronics components to control the whole system (always electricity). Most of the energy input, however, is used to heat up the air: approximately 95% of the total energy consumption. As outlined in Task 3, electric energy is one energy source for air heating in dryers. Other energy sources used for heating the air are natural gas, steam (or thermo oil). The different heating systems will result in different environmental impacts, and different operating costs in the end.

In the following Tasks, we will further use these inputs to derive resulting environmental impacts and potential improvement options.

3.3.2 Energy consumption

The following input parameters were specified to define the energy consumption of professional dryers during the use phase. The parameters have already been compiled and discussed in Task 3 on user behaviour. The following sections summarise the assumptions and the annual consumption of the different dryer categories.

3.3.2.1 Categories D1 and D2: Semi-professional dryers, condenser and air vented

Table 47 Energy consumption of semi-professional dryers, condenser and air vented

	Condenser dryer (D1)	**Air vented dryer (D2)**
Dryer Category	**Energy**	**Energy**
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)	
Typical use intensity: Annual amount of dried laundry (kg/year) (typical machine's capacity of 6 kg)	6 500	6 500
Specific consumption operation (ideal conditions)	0.60 kWh/kg laundry	0.56 kWh/kg laundry
Real-life user behaviour:		
Additional consumption through partial workload	+ 10%	+ 10%
Additional consumption through maloperation	+ 15%	+ 15%
Specific consumption (operation, real life user behaviour)	0.75 kWh/kg laundry	0.70 kWh/kg laundry
Annual consumption (operation, real life user behaviour)	*4 875 kWh*	*4 550 kWh*
Annual consumption standby	2.25 *kWh*	2.25 *kWh*
Annual consumption (real life)	***4 877 kWh***	***4 552 kWh***

3.3.2.2 Category D3: Cabinet dryer

Table 48 Energy consumption of a professional cabinet dryer

Dryer category D3	**Energy**
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)
Typical use intensity: Annual amount of dried laundry (kg/year) (typical machine's capacity of 8 kg)	6 300
Specific consumption operation (ideal conditions)	0.75 kWh/kg laundry
Real-life user behaviour:	
Additional consumption through partial workload	+ 10%
Additional consumption through maloperation	+ 15%
Specific consumption (operation, real life user behaviour)	0.94 kWh/kg laundry
Annual consumption (operation, real life user behaviour)	*5 922 kWh*
Annual consumption standby	1.98 kWh
Annual consumption (real life)	***5 924 kWh***

3.3.2.3 Category D4, D5, D6: Professional tumble dryer

Table 49 Energy consumption of professional tumble dryers (category D4-5-6)

Dryer Category	**<15 kg (D4)**	**15–40 kg (D5)**	**>40 kg (D6)**
	Energy	**Energy**	**Energy**
Main customer segment	Coin & Card laundry (CCL) and Apartment Household Laundry (AHL)	Hospitality Laundry	Commercial Industrial Laundry
Typical use intensity: Annual amount of dried laundry (kg/year)	14 400 (typical capacity of 10 kg machine)	40 500 (typical capacity of 23 kg machine)	168 000 (typical capacity of 70 kg machine)
Specific consumption operation (ideal conditions)	0.55 kWh/kg laundry	0.65 kWh/kg laundry	0.85 kWh/kg laundry
Real-life user behaviour:			
Additional consumption through partial workload	+ 10%	+ 10%	+ 10%
Additional consumption through maloperation	+ 15%	+ 15%	+ 10%
Specific consumption (operation, real life user behaviour)	0.69 kWh/kg laundry	0.81 kWh/kg laundry	1.02 kWh/kg laundry
Annual consumption (operation, real life user behaviour)	*9 936 kWh*	*32 805 kWh*	*171 360 kWh*
Annual consumption standby	n.a.	n.a.	negligible
Annual consumption (real life)	***9 936 kWh***	***32 805 kWh***	***171 360 kWh***

n.a. no information available

3.3.2.4 Category D7: Pass-through (transfer) tumble dryer

Table 50 Energy consumption of a pass-through dryer

Dryer category D7	**Energy**
Main customer segment	Commercial Industrial Laundry
Typical use intensity: Annual amount of dried laundry (kg/year) (typical machine's capacity of 400 kg/h)	1 020 000
Specific consumption operation *(ideal conditions)*	0.8 kWh/kg laundry
Real-life user behaviour:	
Additional consumption through partial workload	+ 10%
Additional consumption through maloperation	+ 10%
Specific consumption *(operation, real life user behaviour)*	0.96 kWh/kg laundry
Annual consumption *(operation, real life user behaviour)*	*979 200 kWh*
Annual consumption standby	negligible
Annual consumption (real life)	***979 200 kWh***

3.3.2.5 Overview of all dryer categories

The following Table 51 summarizes the annual energy consumption to be used as input data for Task 5 (environmental impact assessment of base cases).

Table 51 Annual energy consumption (real life conditions) of all dryer categories

Category	**Energy consumption**
	kWh/year
D1: Semi-professional dryer, condenser	*4 877*
D2: Semi-professional dryer, air vented	*4 552*
D3: Professional cabinet dryer	*5 924*
D4: Professional tumble dryer, <15 kg	*9 936*
D5: Professional tumble dryer, 15-40 kg	*32 805*
D6: Professional tumble dryer, > 40 kg	*171 360*
D7: Pass-through (transfer) tumble dryer	979 200

3.4 Technical analysis use phase (system)

Professional laundry dryers are used in hotels, clinics, health care, and laundrettes and in many other places (see Task 3). This section provides an overview of how different ambient conditions can influence the energy consumption of the professional laundry dryers.

Drying temperature: The drying temperature has a strong influence on the energy consumption. The higher the temperature, the more energy is needed.

Type of laundry: Textiles can be made from different materials and fabrics (cotton, wool, mineral, synthetic etc) and result in particular types of laundry (work wear, hospital linen, high visibility garments etc.). The majority of the laundry is dried using the cotton programme. However there are some types of fabrics retaining the water more than other fabrics, thus increasing the amount of energy needed to dry them. Different products and systems take account of varying needs in accordance with the different types of clothes to be dried.

The spin speed (g-factor) of the washer extractor: The energy demand of the laundry dryer depends on the remaining water in the clothes after spinning in the washing machine. The more efficiently clothes have been spun, the smaller the energy is needed for drying them. It appears that a better spin speed and a better g-factor ensure shorter drying times and lower energy consumption.

Ambient air humidity: Regarding air vented dryers the energy demand also depends on the air humidity. The energy demand decreases with a lower air humidity.

3.5 Technical analysis of the end-of-life phase

Our assumptions for End-of-Life Phase for dryers are as follows: While the large heavy duty machines can last for up to 20 years, the semi- professionals and smaller dryers will only have an average lifetime of 10 to 15 years. Industrial machines are used as intensively as the professional (category D3–D6) and semi-professional machines of categories D 1–2 and have to a longer lifetime. According to the manufacturer, the average lifetime is about 12 years. At the end of their life, heavy duty and larger dryers are usually taken back by the manufacturer. In some cases, parts of the machine can be reused, the rest of the machines – mostly valuable stainless steel – will be sold to recycling companies where they are cleaned up, shredded and disassembled. Reusable materials are separated and then returned to the material production. The semi-professional dryers could be also dismantled by certified scrap dealers.

As already described in Task 3, only 1 to 5% of the material from a professional dryer will end at a landfill, as the materials (mostly stainless steel >60%) are too valuable. According to the stakeholders, more than 95% of the products are recyclable and will always either be refurbished or recycled for scrap parts or materials.

The plastic share of all professional dryers is less than 10% related to its overall weight. All plastic components weighing more than 50 grams are marked in accordance with ISO 1043[55]. According to stakeholder information this plastic share is disposed of as follows:

[55] ISO 1043 – Part 1, Plastics – Symbols and abbreviated terms – Basic polymers and their special characteristics

Table 52 Landfill (fraction of products not recovered) in % of professional dryers (based on stakeholder input)

Dryer category	Landfill (fraction of products not recovered) %
D1: Semi-professional dryer, condenser	5
D2: Semi-professional dryer, air vented	5
D3: Professional cabinet dryer	5
D4: Professional tumble dryer, <15 kg	5
D5: Professional tumble dryer, 15-40 kg	~1
D6: Professional tumble dryer, >40 kg	~1
D7: Pass-through (transfer) tumble dryer	~1

The plastic share of all professional dryers is less than 10% related to its overall weight. All plastic components weighing more than 50 grams are marked in accordance with ISO 1043[55].

According to stakeholder information this plastic share is disposed of as follows:

- Thermal recycling: 70%.
- Material (or mechanical) recycling: 29%
- Re-use, closed loop recycling: 1%

Printed wiring boards (PWB) are used in the dryers of all categories. According to stakeholder information, these parts are easy to dismantle and are completely recycled by certified scrap dealers.

4 Recommendation on standardisation needs

On the basis of the analysis carried out in Tasks 1 to 4, this section provides first recommendations for the content of possible mandates to be issued by the European Commission to the European standardisation organisations on (measurement) standards for professional washing machines and dryers.

As already initiated by CENELEC TC59X (see Task 1), a standardised definition of the terms and respective appliances “professional, commercial, and industrial” will be necessary.

To date, there are no directives or regulations in Europe and not even voluntary agreements between manufacturers concerning a consistent and applied measurement methodology for the energy consumption and functional performance measurement for professional washing machines and dryers. This means that data provided by manufacturers is currently neither comparable nor subject to any control. Therefore, end-users willing to buy a professional washing machine or dryer with a lower environmental impact and least life cycle costs are confronted with the following challenges:

- In many cases no data on the energy consumption of professional washing machines and dryers are provided.
- The information in brochures and catalogues concentrates on the figures for energy consumption reduction (for example 30%) compared to an undefined product of a competing company or of an own product without a clear set of characteristics. The worse comparative value is frequently not communicated at all or in detail.
- If the energy consumption is provided, it is not really comparable to similar information on other appliances of other or sometimes even the same manufacturer, because there is no standard method applied for measuring the performance of professional washing machines and dryers.

This in turn results in the following:

- Consumers base their purchasing decision on non-comparable information.
- Competition between manufacturers is distorted.
- Manufacturers who provide realistic information on energy and water consumption are disadvantaged compared to those who communicate over-optimistic information.
- The development of efficient technologies is slowed.
- Additional environmental impacts may result from purchasing decisions made on the basis of insufficient information.

A further consequence of the current situation is that certain policy instruments cannot be implemented. The setting of performance requirements, energy labelling requirements, the introduction of binding life cycle cost accounting, financial incentives for the promotion of efficient appliances as well as other instruments, presuppose a reliable data basis for assessing the consumption and performance of the appliances. Precondition for the reliable data basis, however, is the development and introduction of a generally applicable measuring method for determining the consumption of professional washing machines and dryers at European level. Note: The existing approaches and considerations have already been set out in Task 1.

A prerequisite for determining the efficiency of a professional laundry process and the washing machine and dryer respectively is the implementation of standardised measuring methods. The following aspects would need to be defined for each of the laundry machine categories in order to deliver comparable results of the performance and consumption parameters:

- Ambient temperature and humidity;
- Energy source for heating water / air;
- Input water temperature;

- Residual moisture of laundry before drying process;
- Selection of program ('standard' washing or drying program);
- Washing / drying capacity (kg laundry per hour); filling ratio
- Type (formulation) and dosage of detergent and laundry aid;
- Standard laundry in terms of type, amount and soiling.

The following parameters would need to be evaluated / measured:

- Cleaning / drying performance and, if necessary, hygienic performance; for washing machines additionally spin extraction performance and rinsing performance;
- Energy and/or water consumption per kg laundry or per standard cycle;
- Energy demand in low-power modes (left-on, and if applicable: off mode); if possible, the definition of low-power modes should follow the definitions of Commission Regulation (EC) No. 1275/2008 on Standby.
- Real-life use conditions: Energy and water consumption in partial load / discontinuous operation; possible declaration of the consumption in other than 'standard' program

Standard conditions should represent real-life conditions as precisely as possible. However, as there is a great variation in the user behaviour of professional washing machines and dryers within the categories as well as customer segments identified, therefore the energy and water consumption in day-to-day operation may still differ from that under standard test conditions. Similar arguments with regard to the variety apply for the amount and type of detergent: manufacturers are in favour of not defining a standard detergent in the measurement standards. Nevertheless a standard detergent would be necessary to be defined for standardised performance measurements.

In summary, the following data categories need to be assessed according to a possible standard test procedure.

Table 53 Data for measuring a possible standard test

	Performance parameters	**Consumption data**
Washing machines	Cleaning performance, spin extraction performance, rinsing performance, time, temperature, (optional: fibre protection)	Energy consumption, water consumption, detergent consumption[56]
Dryers	Drying performance (residual moisture content), time, (optional: fibre protection)	Energy consumption

[56] Detergent consumption is to be fixed in the measurement procedure.

5 Annex

5.1 Stakeholder involvement

The following table provides a list of addressees of the working paper containing preliminary assumptions on aspects regarding main applications of professional washing machines and dryers, the typical user behaviour, the influence of real-life conditions on ideal consumption and specific consumption values. An additional Excel file and questions regarding production, distribution and end-of-life phase was circulated. The table also indicates from whom a response has been received.

Table 54 Documentation of institutions to whom the working document on use phase and the Excel file and questions regarding production, distribution and end-of-life phase have been sent and their responses

	Working paper use phase and Excel file (covering Task 4)	
	Sent out	Feedback
Manufacturers and Industry Associations		
Miele Professional (sub divison laundry equipment currently not member of an industry association)	Yes	Yes
Electrolux Professional (currently not member of an industry association)	Yes	Yes
IMESA	Yes	No
GIRBAU	Yes	No
PRIMUS	Yes	Yes
Schulthess	Yes	No
- VDMA, Germany, representing ▪ Kannegiesser ▪ Jensen Group ▪ Eazy Clean ▪ Veith ▪ Seibt Kapp	Yes Yes Yes Yes Yes Yes	No No Yes No No No
Fagor Industrial	Yes	No
Schulthess	Yes	No
User associations		
ETSA	Yes	No
DTV-Bonn	Yes	No
INTEX	Yes	No
AFEC	Yes	No
Others		
Danish Technological Institute	Yes	Yes

5.2 Working document on use phase and additional questions for stake-holders

The general working paper and additional questions for the final report concerning heating options are provided separately in the following documents:

- EuP_Lot24_Wash_T3_T4_Annex_Workingpaper.pdf
- EuP_Lot24_Wash_T2-T7_Questionnaire_for_Final_Report.xls

5.3 Contents of Excel file on production, distribution and end-of-life phase

EuP Lot 24: Professional washing machines, dryers and dishwashers

Task 4 – Technical Analysis of Existing Products – Part on Professional Washing Machines

The data should be valid for a "typical" device of each category.
We know that within each washing machine and dryer category there is a certain degree of variation. Please specify the appliance for which the data is valid in more detail if necessary (e.g. regarding capacity etc.).

The data is used to determine the environmental profile and impact analysis of the identified product categories with the "EuP-EcoReport" tool for:

1. Production Phase
2. Assembling / Distribution Phase
3. Use Phase*
4. End of Life Phase

* data collection included in seperate working paper on use phase, including user behaviour

PRODUCTION (including packaging material)									
Main Materials Category type	**Material (EuP EcoReport)**	**Example Average data Washing Machine 5 kg model[57] [g]**	**WM 1 Semi-profes. washing machine and washer extractor [g]**	**WM 2 Professional washer extractor, small <40kg [g]**	**WM 3 Profess. washer extractor, large >40kg [g]**	**WM. 4 Profes-sional Wash Dryer [g]**	**WM 5 Profes-sional Barrier washer [g]**	**WM 6 Washing tunnel machines [g]**
Bulk Plastics	Low-density polyethylene (LDPE)	1 850						
	High-density polyethylene (HDPE)	51						
	Linear low density polyethylenes (LLDPE)							
	Polypropylene (PP)	8 021						
	Plystyrene (PS)	678						
	Styropor expandable polystyrene (EPS)							
	High Impact Polystyrene (HI-PS)							
	Polyvinylchlorid (PVC)	221						
	Styrol-Acrylnitril (SAN)							
	Acrylonitrile Butadiene Styrene (ABS)	1 145						
Bulk Plastics		***11 966***	***0***	***0***	***0***	***0***	***0***	***0***

57 (data from Lot 14)

PRODUCTION (including packaging material)								
Main Materials Category type	**Material (EuP EcoReport)**	**Example Average data Washing Machine 5 kg model[57] [g]**	**WM 1 Semi-profes. washing machine and washer extractor [g]**	**WM 2 Professional washer extractor, small <40kg [g]**	**WM 3 Profess. washer extractor, large >40kg [g]**	**WM. 4 Profes-sional Wash Dryer [g]**	**WM 5 Profes-sional Barrier washer [g]**	**WM 6 Washing tunnel machines [g]**
TecPlastics	Polyamide (PA)	94						
	Plolycarbonate (PC)	190						
	Polymethylmetacrylate (PMMA)							
	Epoxy							
	Rigid-Pur							
	Flex-Pur							
	Talcum filler							
	E-glass fibre							
	Aramid fibre							
TecPlastics		***284***	***0***	***0***	***0***	***0***	***0***	***0***
Ferrous metals	Steel Sheet galvanized	564						
	Steel tube/profile							
	Cast Iron	11 192						
	Ferrite							
	Stainless 18/8 coil	20 605						
Ferrous metals		***32 361***	***0***	***0***	***0***	***0***	***0***	***0***
Non ferrous metals	Al sheet/extrusion	1						
	Al diecast	2 232						
	Cu winding wire	869						
	Cu wire	436						
	Cu tube/sheet							
	CuZn38 cast	99						
	ZnAl4 cast							
	MgZn5 cast							
Non ferrous metals		***3 637***	***0***	***0***	***0***	***0***	***0***	***0***

PRODUCTION (including packaging material)									
Main Materials Category type	**Material (EuP EcoReport)**	**Example Average data Washing Machine 5 kg model[57] [g]**	**WM 1 Semi-profes. washing machine and washer extractor [g]**	**WM 2 Professional washer extractor, small <40kg [g]**	**WM 3 Profess. washer extractor, large >40kg [g]**	**WM. 4 Profes-sional Wash Dryer [g]**	**WM 5 Profes-sional Barrier washer [g]**	**WM 6 Washing tunnel machines [g]**
Coating	pre-coating coil							
	powder coating							
	Cu/ni/Cr plating							
	Au/Pt/Pd							
Coating		***0***	***0***	***0***	***0***	***0***	***0***	***0***
Electronics	LCD per m² scrn							
	CRT per m² scrn							
	big caps & coils							
	slots / ext. Ports							
	IC's avg., 5% Si, Au							
	IC's avg., 1% Si							
	SMD/LED's avg.							
	PWB 1/2 lay 3.75kg/m²							
	PWB 6 lay 4.5kg/m²							
	PWB 6 lay 2kg/m²							
	Solder SnAg4Cu0.5							
	controller board							
Electronics		***165***	***0***	***0***	***0***	***0***	***0***	***0***
Miscellaneous	Glass for Lamps	1 773						
	Bitumen	38						
	Cardboard	107						
	Office Paper	116						
	Concrete	18 205						
Miscellaneous		***20 239***	***0***	***0***	***0***	***0***	***0***	***0***
OUT of Scope EUP**	others	260						

PRODUCTION (including packaging material)									
Main Materials Category type	Material (EuP EcoReport)	Example Average data Washing Machine 5 kg model[57] [g]	WM 1 Semi-profes. washing machine and washer extractor [g]	WM 2 Professional washer extractor, small <40kg [g]	WM 3 Profess. washer extractor, large >40kg [g]	WM. 4 Profes-sional Wash Dryer [g]	WM 5 Profes-sional Barrier washer [g]	WM 6 Washing tunnel machines [g]
	Resins							
	thermostat							
	Cotton							
	Cotton+Resins noise absorbers							
	adhesive							
	PBT polybutylene terephthalate							
	Plastics, others	1 101						
	wood	2 452						
	PU Foam - Insulation							
	Cr	1 761						
OUT of Scope EUP		*5 574*	*0*	*0*	*0*	*0*	*0*	*0*
TOTAL		74 226						

** For some materials no correspondance with EuP EcoReport is possible, in that case please allocated the materials in the main category "out of scope"

ASSEMBLING / DISTRIBUTION							
	Example Average data Washing Machine 5 kg model[57]	WM 1 Semi-professional washing machine & washer extractor	WM 2 Professional washer extractor, small <40kg	WM 3 Professional washer extractor, large >40kg	WM. 4 Professional Wash Dryer	WM 5 Professional Barrier washer	WM 6 Washing tunnel machines
Energy (kWh)							
Electricity	28.98						
Heat	14.79						
Water (m3)	0.59						
Other materials (g)	92						
Volume of packaged final product (m3)	0.36						
Transport average (km)	160						

END OF LIFE							
	Example Average data Washing Machine 5 kg model[57]	**WM 1 Semi-profess. washing machine and washer extractor**	**WM 2 Professional washer extractor, small <40kg**	**WM 3 Professional washer extractor, large >40kg**	**WM. 4 Professional Wash Dryer**	**WM 5 Professional Barrier washer**	**WM 6 Washing tunnel machines**
		in %	in %	in %	in %	in %	in %
Landfill (fraction of products not recovered)		5	5	5	1	1	
Recycling of plastics							
Re-use, closed loop recycling	27	25	25	25	10	10	
Materials Recycling	70	70	70	70	80	80	
Thermal Recycling (%)	3	5	5	5	10	10	
Total	**100**	**100**	**100**	**100**	**100**	**100**	

EuP Lot 24: Professional washing machines, dryers and dishwashers

Task 4 – Technical Analysis of Existing Products – Part on Professional Dryers

The data should be valid for a "typical" device of each category.
We know that within each washing machine and dryer category there is a certain degree of variation. Please specify the appliance for which the data is valid in more detail if necessary (e.g. regarding capacity etc.).

The data is used to determine the environmental profile and impact analysis of the identified product categories with the "EuP-EcoReport" tool for:

1. Production Phase
2. Assembling / Distribution Phase
3. Use Phase*
4. End of Life Phase

* data collection included in seperate working paper on use phase, including user behaviour

PRODUCTION (including packaging material)										
Main Materials Category type	**Material (EuP EcoReport)**	Example Average data household **air vented dryer** [g][58]	Example Average data household **condenser dryer** [g][58]	**D 1 Semi-professional dryer, condenser [g]**	**D 2 Semi-professional dryer, air vented [g]**	**D 3 Professional tumble dryer <40kg [g]**	**D 4 Professional tumble dryer >40kg [g]**	**D 5 Cabinet Dryer [g]**	**D 6 Heavy duty Pass-trough (transfer) Tumble dryer [g]**
Bulk Plastics	Low-density polyethylene (LDPE)								
	High-density polyethylene (HDPE)	29	86						
	linear low density polyethylenes (LLDPE)								
	Polypropylene (PP)	4 157	7 715						
	Plystyrene (PS)	364	378						
	Styropor expandable polystyrene (EPS)								

58 load size 6kg (data from Lot 16)

PRODUCTION (including packaging material)										
Main Materials Category type	**Material (EuP EcoReport)**	Example Average data household **air vented dryer** [g][58]	Example Average data household **condenser dryer** [g][58]	**D 1 Semi-professional dryer, condenser [g]**	**D 2 Semi-professional dryer, air vented [g]**	**D 3 Professional tumble dryer <40kg [g]**	**D 4 Professional tumble dryer >40kg [g]**	**D 5 Cabinet Dryer [g]**	**D 6 Heavy duty Pass-trough (transfer) Tumble dryer [g]**
	High Impact Polystyrene (HI-PS)								
	Polyvinylchlorid (PVC)	100	115						
	Styrol-Acrylnitril (SAN)								
	Acrylonitrile Butadiene Styrene (ABS)	1 307	2 117						
Bulk Plastics		***5 957***	***10 411***	***0***	***0***	***0***	***0***	***0***	***0***
TecPlastics	Polyamide (PA)	99	198						
	Plolycarbonate (PC)	4	23						
	Polymethylmetacrylate (PMMA)	30	30						
	Epoxy								
	Rigid-Pur		330						
	Flex - Pur								
	Talcum filler								
	E-glass fibre								
	Aramid fibre								
TecPlastics		***133***	***581***	***0***	***0***	***0***	***0***	***0***	***0***
Ferrous metals	Steel Sheet galvanized	2 856	2 515						
	Steel tube/profile								
	Cast Iron								
	Ferrite								
	Stainless 18/8 coil	19 722	17 616						
Ferrous metals		***22 578***	***20 131***	***0***	***0***	***0***	***0***	***0***	***0***

PRODUCTION (including packaging material)										
Main Materials Category type	**Material (EuP EcoReport)**	Example Average data household **air vented dryer** [g][58]	Example Average data household **condenser dryer** [g][58]	**D 1 Semi-professional dryer, condenser [g]**	**D 2 Semi-professional dryer, air vented [g]**	**D 3 Professional tumble dryer <40kg [g]**	**D 4 Professional tumble dryer >40kg [g]**	**D 5 Cabinet Dryer [g]**	**D 6 Heavy duty Pass-trough (transfer) Tumble dryer [g]**
Non ferrous metals	Al sheet/extrusion	611	653						
	Al diecast								
	Cu winding wire	231	710						
	Cu wire								
	Cu tube/sheet								
	CuZn38 cast								
	ZnAl4 cast								
	MgZn5 cast								
Non ferrous metals		***842***	***1 363***	***0***	***0***	***0***	***0***	***0***	***0***
Coating	pre-coating coil								
	powder coating								
	Cu/ni/Cr plating								
	Au/Pt/Pd								
Coating		***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Electronics	LCD per m² scrn								
	CRT per m² scrn								
	big caps & coils								
	slots / ext. Ports								
	IC´s avg., 5% Si, Au								
	IC´s avg., 1% Si								
	SMD/LED´s avg.								
	PWB 1/2 lay 3.75kg/m²								
	PWB 6 lay 4.5kg/m²								

PRODUCTION (including packaging material)										
Main Materials Category type	**Material (EuP EcoReport)**	Example Average data household **air vented dryer** [g][58]	Example Average data household **condenser dryer** [g][58]	**D 1 Semi-professional dryer, condenser [g]**	**D 2 Semi-professional dryer, air vented [g]**	**D 3 Professional tumble dryer <40kg [g]**	**D 4 Professional tumble dryer >40kg [g]**	**D 5 Cabinet Dryer [g]**	**D 6 Heavy duty Pass-trough (transfer) Tumble dryer [g]**
	PWB 6 lay 2kg/m²								
	Solder SnAg4Cu0.5								
	controller board								
Electronics		***1 556***	***1 987***	***0***	***0***	***0***	***0***	***0***	***0***
Miscellaneous	Glass for Lamps								
	Bitumen								
	Cardboard								
	Office Paper								
	Concrete								
Miscellaneous		***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
OUT of Scope EUP **	others	1 778	1 856						
	Resins								
	thermostat								
	Cotton								
	Cotton+Resins noise absorbers								
	adhesive								
	PBT polybutylene terephthalate								
	Plastics, others	1 337	2 475						
	wood								
	PU Foam - Insulation								
	Cr								
OUT of Scope EUP		***3 115***	***4 331***	***0***	***0***	***0***	***0***	***0***	***0***
TOTAL		**34 181**	**38 804**						

** For some materials no correspondance with EuP EcoReport is possible, in that case please allocated the materials in the main category "out of scope"

ASSEMBLING / DISTRIBUTION								
	Example Average data household **air venture dryer**[58]	Example Average data household **condenser dryer**[58]	**D 1 Semi-professional dryer, condenser**	**D 2 Semi-professional dryer, air vented**	**D 3 Professional tumble dryer <40kg**	**D 4 Professional tumble dryer >40kg**	**D 5 Cabinet Dryer**	**D 6 Heavy duty pass-trough (transfer) Tumble dryer**
Energy (kWh)								
Electricity								
Heat								
Water (m3)								
Other materials (g)								
Volume of packaged final product (m3)	0.4	0.4						
Transport average (km)	160	160						

END OF LIFE								
	Example Average data household air **venture dryer**[58] [%]	Example Average data household **condenser dryer**[58] [%]	**D 1 Semi- profess. dryer, condenser** [%]	**D 2 Semi-professional dryer, air vented** [%]	**D 3 Professional tumble dryer <40kg** [%]	**D 4 Professional tumble dryer >40kg** [%]	**D 5 Cabinet Dryer** [%]	**D 6 Heavy duty pass-trough (transfer) tumble dryer** [%]
Landfill[59]	5	5	5	5	5	1	1	1
Plastics recycl.								
Re-use, closed loop recycling	0	0	0	0	0	0	0	0
Materials Recycling	67	67	67	67	80	80	90	90
Thermal Recyc.	28	28	28	28	20	20	10	10
Total			**95**	**95**	**100**	**100**	**100**	**100**

[59] fraction of products not recovered

5.4 Additional questions on production, distribution and end-of-life phase

Attached you find an excel-file, where we kindly ask your members to fill in the following data:

1. Production:

Material composition of the defined product categories (incl. packaging material)

The data should be valid for electrically heated washing machines and dryers (as we assume this as standard). If possible, we would like to ask you to specify the additional materials required for other heating possibilities (steam / hot water and gas heating respectively, therefore 3 columns there). Either possible as percentage or in absolute values.

The data should be valid for a "typical" washing machine and dryer of each category. We know that especially in case of transport washing machine and dryer there are quite big differences.

2. Assembling, Distribution:

Energy, water and other material demand for the manufacturing process at the manufacturer. It is obvious, that this can be only rough values, perhaps not differentiated per category, as it is difficult to allocate them to specific products.

Volume of packaged final product

Transport average (manufacturer - user)

3. End of life

Fraction of products not recovered ("landfill" in any sense)

Fraction of plastics that (1) is re-used, (2) goes to material recycling or (3) goes to thermal recycling (you find an assumption in the excel-file already)

Additionally we would like to ask the following questions:

Which percentage of the used sheetmetal is made of scrap metal?

Are the PWB (printed wiring boards) easy to disassemble?

Do the products contain refrigerants? If yes, which and how much? We assume that this is the case, if the waste steam condensation takes place with a heat pump, which, however we assume not as "standard" but rather as BAT.

How is the refrigerant of the heat pumps being disposed of in the end-of-life phase? Which fraction of it is retained?

Do the products contain mercury? If yes, how much and for which purpose? Which fraction is retained in the end-of-life phase?

5.5 Explanations to data collections (Task 4)

The data should be valid for a "typical" device of each category. We know that within each washing machine and dryer category there is a certain degree of variation. Please specify the appliance for which the data is valid in more detail if necessary (e.g. regarding capacity etc.).

1. Production

Material composition of the defined product categories (incl. packaging material)

2. Assembling, Distribution

- Energy (Electricity, and heat energy), water and other material demand for the manufacturing process at the manufacturers'. It is obvious, that these can be only rough values, perhaps not differentiated per category, as it is difficult to allocate them to specific products.
- Volume of packaged final product
- Transport average (manufacturer – user)

3. End of life

- Fraction of products not recovered ("landfill" in any sense)
- Fraction of plastics that 1. is re-used, 2. goes to material recycling or 3. goes to thermal recycling (you find an assumption in the excel-file already)

Additionally we would like to ask the following questions:

- Are the PWB (printed wiring boards) easy to disassemble?
- Which percentage of the used sheetmetal is made of scrap metal?
- Do the products contain refrigerants? If yes, which and how much? (We assume that this could be the case, if there is a heat pump in the appliance, which, however we assume not as "standard" but rather as BAT.) How is the refrigerant being disposed of in the end-of-life phase? Which fraction of it is retained?
- Do the products contain mercury? If yes, how much and for which purpose? Which fraction is retained in the end-of-life phase?

You will find in both Excel-files the data for a washing machine from Lot 14 and from Lot 16 the dryer data.

In general we assume that production, distribution and end-of-life have a rather small share at the overall environmental impacts over the entire product life cycle. Therefore the data can be reasonably rough.

The data is only going to be published on an aggregated basis that does not allow tracing back to data of single manufacturers. It is also possible that you or your member associations deliver already aggregated data to us. We also prepared a non-disclosure agreement (NDA), if necessary.