# Product Definition: Laundry Dryers

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## 1 Summary Definition and Categorisation

This work covers laundry dryers. Following consultation with all participant countries, the definition and categorisation shown in Table 1 is proposed for these products. Sections 2, 3 and 5 explain the rationale for this in more detail.

***Table1: Simplified Product Categorisation Matrix***

| | |
|---|---|
| Definition & scope | ***Laundry dryers that are an energy using appliance for use in households designed to remove the moisture of a (given) load of clothing or other textiles and in which textile material is dried by tumbling in a rotating drum, through which heated air is passed[1].*** <br> ***Only electrically powered tumble dryers are included, with capacities up to 10 kg (with full analysis only for capacity 4kg to 10kg).*** <br> ***Washer dryers are excluded.*** |
| Heat source | Electrical |
| Air usage | Vented and condensing products analysed together |
| Other in variables to be noted (but not separately plotted or analysed in detail) | Proportion of market accounted for by condensing versus vented product types <br> Efficiency of compact dryers (less than 4kg capacity) <br> Front loader or top loader <br> Condensing by air, heat pump or water <br> Presence of moisture sensor |

[1] Adapted for this project purposes from EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009, p33.

# 2 Product Sub-Category Rationalisation

This section explains the rationale behind the summary definition presented in Section 1, and how this was developed. Table 2 shows the first proposed way to break down the product category, and each aspect is discussed sections 2.1 and 2.2.

**Table 2: Initial matrix definition of possible tumble dryer sub-categorisation.**

| | | **Aspect** | **Possible Permutations** | | | |
|---|---|---|---|---|---|---|
| A | Technology | Heat source | Electricity | Gas<br>(Note: only 'air usage' option for gas is vented) | | |
| B | | Mode of drying | Heated cabinet | Tumble dryer | Centrifugal spin | |
| C | | Air usage | Vented (single pass)<br>(fresh air is heated, passed through textiles and exhausted from the appliance) | Condenser<br>(air used for the drying process is dehumidified by cooling and reused) | | |
| | | | | Air condenser | Water condenser | Heat pump condenser |
| D | Functionality | Layout | Top loader | Front loader | | |
| E | | Capacity, including size format (dry load) | Less than 4 kg (compact format) | Between 4kg and 10 kg capacity | Over 10 kg capacity | |
| F | | Wash capability | Dry only | Wash and dry | | |
| G | | Automation | Moisture sensor switches off the drying process | Timer or manual control | | |

## 2.1 Technology

***Matrix Row A): Heat source (gas or electricity)***

The scope of this Annex is restricted to electrically powered products only. However, for completeness the following information is included. Gas tumble dryers in many countries represent a very small percentage of the total market – reported as 0.3% for UK, Netherlands and Portugal according to one study[2], but in the US sales are far more similar for gas and electricity.

There is currently no European standard that defines test and performance measurement methods enabling comparison of gas with electric dryers (separate test methods are in place). Comparison of performance of electric and gas powered dryers would depend upon deriving assumptions for carbon factors of electricity and gas, and compensation for any differences in the calculation and test method.

*Proposal:*

- ***Gas dryers are out of scope for this Annex and so cannot be analysed.***

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[2] Environmental Change Institute, Oxford (2000).

***Matrix Row B): Mode of drying (Heated cabinet, heated room, tumble dryer or centrifugal spin)***

The EuP preparatory study reported that sales of heated cabinets for drying are very low in Europe, but more common in the US, no data has been identified on sales in other parts of the world. The TopTen scheme in Austria has categories for room air dryers up to 10kg wash weight[3], and for 15kg to 20 kg wash weight, and also a category for drying cupboards. Centrifugal spinners reduce water content but cannot strictly be defined as dryers and so are not considered part of the study. Tumble dryers represent the majority of textile trying appliances.

*Proposal:*

- **To include tumble (rotary drum) dryers within the scope of this project. These are defined as[4]: *'an appliance in which textile material is dried by tumbling in a rotating drum, through which heated air is passed'.***
- **To consult with participants on whether there is a desire to examine drying cupboards or room air dryers, which would require additional budget allocation.**

***Matrix Row C): Air usage (vented or condenser)***

Around 60% of the European market was of a condenser type in 2007[5], but the proportion is low in Australia and the US. Assessment of both types would seem appropriate as condensers can be more efficient.

Commercially available condensing tumble dryers can use three possible technologies to achieve condensation: cooling it using air from the room (air to air), cooling using a heat pump to transfer the heat back into the circulating air, or cooling using water[6]. Heat pump driers account for a very small proportion of the market at present and are significantly more expensive than conventional dryers. Only one product has been identified that uses water, but the EU energy label has a requirement for water usage to be stated if that method is used.

When analysed on a strictly kWh consumed per 6 kg load, condenser dryers consume around 5% more energy[7] and so appear less efficient. This additional energy is associated with the fan, which has to force air through a heat exchanger. A further potential complication in comparing vented (single pass) with condensing tumble dryers is that the heat energy released from the condensing steam could be useful heat (ie saves other energy consumption) for a proportion of the year. This heat is released back into the surroundings, displacing some room heating during heated times of year, or conversely in some cases increasing air conditioning load during summer. The assumed net heating benefit for EU climates is credited under the EU energy labelling Directive by allowing condensing dryers to consume around 8% to 10% more energy within each energy label class. E.g. an energy label C condensing dryer must consume less than or equal to 0.73 kWh per kilogram of load; whereas an energy label C vented dryer must consume less than or equal to 0.67 kWh per kilogram of load.

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[3] http://www.topten.ch/index.php?page=raumluftwaschetrockner_bis_10kg.

[4] European test methodology EN 61121:2005 'Tumble dryers for household use - Methods for measuring the performance'.

[5] EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009, p91.

[6] A fourth possibility, Mechanical Steam Compression, has undergone laboratory testing and compares well with heat pump tumble drying, update being sought (Palandre / Clodic (2003) Comparison of Heat Pump Dryer and Mechanical Steam Compression Dryer, Ecole des Mines Center for Energy Studies).

[7] Inferred from data in Table 59 of EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009 p224, comparing consumption of C rated vented and condenser dryers.

Only with a heat pump dryer is the recovered heat returned to the air stream flowing into the drying drum, and so the overall efficiency of heat pump driers far exceeds that of condenser dryers, with around half the energy consumption per kilogram of textiles compared to a vented appliance. The additional power demand to run the heat pump is far exceeded by the energy recovered and used to re-heat the circulated air. Note that air to air condensing and water condensing dryers *may* be more efficient than vented products depending on how the heating benefits are counted, but not necessarily nor significantly so.

The boundary for the analysis in this project is around the product itself. This analysis cannot extend to the room containing the product and its heat requirements. Hence the existence of some room heating benefit arising from condensing dryers can be noted in the text but will not influence the graphs nor reported efficiency data. Similarly, this analysis will not attempt to compensate condensing dryers for the additional energy required for fans as this is simply a technology choice to deliver the same utility as a vented product. It is therefore proposed that both condensing and vented dryers be plotted on the same graph, with no normalisation required.

*Proposal:*

- **To request data on whether a product is vented (single pass) or condenser type.**
- **For condensing products, to request data on whether condensing is achieved through a heat pump, air to air heat exchanger or using water.**
- **To plot efficiency and consumption data from both vented and condensing products on the same graphs, without compensation.**

## 2.2 Functionality

***Matrix Row D): Layout (top loader or front loader)***

Front loader tumble dryers have a drum with a horizontal axis of rotation and a door opening one face of the drum. Top loaders also have a horizontal axis drum, with a door on the top face of the product accessing the drum through a hatch in its side. In Europe around 80% of driers are front-loaders, with a few percent top-loaders (remainder unknown)[8]; US has very few if any top loaders. It is understood that test methodologies generally cover both types and so direct comparison should not be problematic.

*Proposal:*

- ***To collect data on both top loader and front loader appliances, noting which is which, to compare performance if necessary, but to plot both on the same graphs.***

***Matrix Row E): Capacity and size format***

Household tumble dryers are typically around 6 kg dry load capacity. Above this level, appliances with over 6 kg capacity accounted for less than 10% of the European market in 2005, but the average size was rising. Appliances used in households would generally not exceed 10 kg capacity. Any higher than that would almost certainly be commercial appliances and (certainly in Europe) not subject to the same test methodology. Capacities in the US are generally stated as volume, rather than dry weight of textiles, and the units are significantly larger (appliance dimensions typically twice as large). It is yet to be verified if US machines have capacity data in kg; if not, factors will have to be derived to enable comparison.

EU compact driers with smaller external dimensions and a typical capacity of up to 4 kg are also available for use in small kitchens/utility spaces. Appliances with less than 4 kg capacity accounted

[8] EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009, p91.

for around 6% of sales in Europe in 2005[9]. Available data indicates that compact format tumble dryers do not achieve as high energy efficiency ratings as full size format. Test methodologies in most regions appear to cater for the full range of domestic capacities and so data should be comparable. However, it must be considered whether machines of all capacities can be fairly compared (with kWh per kg load) in the same dataset. This is because a larger appliance inherently produces better efficiency figures than a smaller appliance with identical technical design (smaller units tend to have lower insulation, less space for effective tumbling etc). Also, since compact tumble dryers are aimed at a different market, there is little rationale to plot their performance on the same graph (this would make the market average and appear poorer than it really is for standard format appliances). Full analysis in parallel with standard format appliances does not appear worthwhile and so analysis will focus on products with between four and 10 kg capacity.

*Proposal:*

- ***To invite data on any capacity appliance up to 10 kg dry textile weight, but to analyse fully only data for appliances with 4 kg to 10 kg dry textile capacity.***
- ***Performance of compact tumble dryers (taken as those with less than 4 kg capacity) will not be analysed.***

***Matrix Row F): Wash capability***

Washer dryers use cold water to condense from humid air and so are technologically different to conventional tumble dryers. Performance of washer dryers is already being assessed as part of the washing machine product group. Washer dryers are therefore proposed to be excluded from this analysis.

*Proposal:*

- ***To exclude washer dryers from the analysis, only tumble dryers to be included.***

***Matrix Row G): Automation***

A 2006 survey indicated that well over 60% of tumble dryers in use in UK, France and Poland had only timer controls[10]. But moisture sensors can achieve some energy savings[11] as they halt the cycle once the textiles reach a predetermined level of dryness. Test methodologies rely on the product to halt its drying cycle either when a timer runs out or when the moisture sensor stops the programme, and the energy consumed up to that point is measured. Market penetration of moisture sensors would be useful information for policymakers and so will be requested.

*Proposal:*

- ***To invite information on presence of moisture sensors for analysis.***

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[9] EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009, p93.
[10] EuP Preparatory Study: Ecodesign of Laundry Dryers, Lot 16, Final Report March 2009, p132.
[11] The level of savings may be less than intuitively expected because once a dryer with a timed cycle has removed all moisture, temperature safety sensors will switch off the heater to avoid (eventual) risk of fire. Consumption after full dryness is achieved will therefore be much less than during the drying process.

# 3 Revised Categorisation

Based on the proposals made, Table 3 provides a rationalised Product Definition Matrix. This rationalised matrix may then be rearranged to provide a simplified view of the product categorisations for which data should be sought, as shown in Table 1.

***Table 3: Rationalised Matrix Definition of laundry dryers Sub-Categorisation***

| | | **Aspect** | **Possible Permutations** | |
|---|---|---|---|---|
| A | Technology | Heat source | Electricity | Gas<br>(Note: only 'air usage' option for gas is single pass) |
| B | | Mode of drying | Tumble dryer | |
| C | | Air usage | Vented<br>(fresh air is heated, passed through textiles and exhausted from the appliance) | Condenser (noting whether air condenser, or heat pump condenser)<br>(air used for the drying process is dehumidified by cooling and reused) |
| D | Functionality | Layout | Noted whether top loader or front loader. | |
| E | | Capacity (dry load) | Less than 10 kg.<br>Full analysis only for appliances with capacity between 4 kg and 10 kg. | |
| F | | Wash capability | Washer dryers are excluded from the analysis. | |
| G | | Automation | To be noted whether the appliance has moisture sensor or just timer /manual control. | |

# 4 Metrics

The key metrics to be used in mapping graphs are:

*Energy efficiency:* *kWh / kg load*

This metric is widely used around the world. European, Japanese and Chinese national test methodologies are based on the same IEC test method (IEC 61121); test methodologies for other countries will require further analysis assisted by country leads (for example, Australia appears to use kWh per kg of water removed).

*Note: The moisture content at the start of the test has been changed between IEC 61121:1999 and IEC 61121c:2005. This could cause data problems through not knowing whether or not the results have been 'corrected' using formulae given in the test methodology (BS EN 61121:2005 Clause Z1). This correction makes it look like the tumble dryers have improved, but in fact they are just tested differently.*

*Unit energy consumption:* *kWh per cycle*

The product's annual energy consumption can be calculated from an assumed kWh per cycle, and assumed number of cycles per year. In order to present data that more closely reflects the product's intrinsic performance, it is proposed to use kWh per cycle as the metric for unit energy consumption. This eliminates the additional uncertainty and potentially significant variation in the number of cycles per year assumed by each country. This will, however, require an assumed kWh per cycle to be provided, or calculated based upon assumptions of typical load.

**Additional notes on metrics:**

Several factors will have to be assessed for each dataset / test methodology. These include:

**Fabrics used for test load**. I.e. cotton, easy care fabrics. This is not considered likely to have a significant effect on the results, especially as most test methodologies make use of a cotton cycle as the basis of the test. Normalisation for this factor is not considered necessary.

**Programme used during test**. Modern machines often have a wide selection of possible cycles to use. These will have to be compared across test methodologies to ensure comparable results. Normalisation for this factor may have to be carried out, depending upon practical differences between methodologies that are found.

**Drying performance**. Some test methodologies provide assessment of the accuracy of achieved moisture levels in the finished load, and evenness of drying.

**Condensation efficiency**. EN61121 provides assessment of the condensation efficiency of condensing dryers. This is considered a secondary requirement. Less effective condensation will result in moist air being ejected into the surroundings that may cause inconvenience to the owner. The product consumption will be reflected in the test results presented; heat re-use in the home will not be reflected in test results and cannot be easily assessed. It is not proposed to gather data nor to normalise for condensation efficiency.

**Moisture levels**. Both the starting and finishing moisture levels are important to the overall energy assessment and will usually be stipulated in the test methodology. Normalisation for these factors will have to be included in the analysis process.

**Ambient temperature and humidity**. This will affect the drying efficiency. Small differences of a few degrees are unlikely to produce significant skew of results; normalisation for larger differences will have to be included in the analysis.
Note: the ambient temperature and humidity test conditions for EN61121 were changed in 2005, as well as final moisture level required (23°C for ambient temperature instead of 20°C; 55% for ambient humidity instead of 65%; 60% of initial moisture instead of 70%). Factors were published for how to compensate for these changes in order to keep the energy label comparable to those derived from the previous methodology. These three changes together made a 14% difference in performance of a condensing dryer and a slightly higher difference for a vented drier. For vented dryers, the normalisation calculation (as used for EU energy labelling) requires knowledge of the cycle time in hours **and so this will be requested as part of the data set.**

# 5 Data requirements

To enable the most effective analysis of data and comparison between countries, we would like to collect the following data:

***Information on new products on sale***

For all years available between 1996 and 2008 and for all categories as defined in Table 3, ideally this will be in the form of **individual model information** including (in approximate order of priority)**:**

1. Appliance capacity (ideally in dry textile weight, kg).
2. Energy consumption / efficiency in kWh / kg dry textiles (or equivalent)
3. Energy efficiency label class
4. Heat energy source (electricity or gas)
5. Vented or condensing type
6. If condensing type, then: Air, heat pump or water condensing sub-type
7. Top loader or front loader layout
8. Whether the dryer has a moisture sensor
9. Number of cycles per year assumed for modelling
10. Any standby consumption
11. Whether dryer alone, or washer-dryer
12. Where this is not possible, other information that allows the identification of best, worst and sales weighted average consumption of products available on the local market.

***Information on stock and sales***

For all years available between 1996 and 2008:

13. The country / regional stock of dryers in use at that time:
    a. Overall number of products installed in homes (or average number per household), ideally by type.
    b. Indicative sales weighted average energy consumption
    c. Average product lifetime
14. Where this is not possible, other available information on stock, eg overall average energy consumption etc.
15. Total annual sales volume, by type and/ or capacity if possible.

***Additional Information Required for Data Processing***

16. Test methodology(ies) used to derive the data, and any relationship to known international standards (e.g. clone of test standard [ABC112233], clone with amendments [X Y and Z], etc.)
17. Initial and final moisture content required by the test method
18. Ambient temperature and humidity requirements
19. Dates at which any changes to test methods (eg humidity levels) occurred and description of changes
20. Cycle time in hours for the standard cycle for which energy is reported
21. Whether any energy corrections are required to be applied to the results in the test methodology
22. List of local regulations that define and affect product efficiency
23. If water is used for condensing, the volume of water consumed per cycle (litres)

***Additional Information Required for Other Planned Analysis***

24. Summary of all major policy actions affecting laundry dryers over the period data is available including whether voluntary or mandatory, the year when policy was first considered, the year of formal announcement of the policy plans, and the year when the policy came into force.
25. Summary of any major cultural or other issues that are thought to affect this product at the local level (cultural preference / weather related / or space restriction influence for or against ambient air / outside drying, etc).