Energy

Preparatory Studies for Eco-design Requirements of EuPs

(Tender TREN/D1/40-2005)

LOT 14: Domestic Dishwashers & Washing Machines

Part I – PRESENT SITUATION

Task 1: Definitions

Rev. 3.0

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Abstract

A concise summary of contents and structure of the task report will be added

Energy

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NOTE: according to international standards dealing with quantities and units, the numbers in this study are written according to the following rules:

- the comma "," is the separator between the integer and the decimal part of a number
- numbers with more than three digits are divided by a blank in groups of three digits
- in case of monetary values the numbers are divided by a dot in groups of three digits

1 Task 1: Definitions

1.1 The study Tasks

Washing machines and dishwashers, also known as "wash appliances", have been the second and most studied EuP in the European Union with the goal to reduce their energy consumption. In 1995, the study of the Group for Efficient Appliances (GEA, 1995) provided the technical basis for the energy labeling Directive, and later also partially for the Eco-label awarding criteria. Its results and methodology were the starting point for the second study on washing machines (NOVEM, 2000, known as the WASH-2 study) promoted by DG TREN in 1998, which took into consideration the methodological, technical, economical and market developments and proposed a new structure for a revised label and the possible setting of efficiency targets, which then for various reasons were not fully accepted by Member States.
Contemporarily, the European Eco-label Board started to address these two product groups more from the environmental impact point of view with other studies, which resulted in the definition of eco-labeling awarding criteria, the latest being:

- for washing machines: on December 1999[1] the Commission adopted the criteria valid until December 1st 2002. These criteria were then prolonged to November 30th 2005 (Decision 2003/240/EC);
- for dishwashers: on August 1998[2] the Commission adopted the criteria valid until January 20th 2003 through the extension given by Decision 2001/397/EC. Criteria were revised in August 2001 (AEAT, 2001) and are valid until August 26th 2006.

In the meantime, a series of monitoring studies were promoted by the SAVE Programme to evaluate the impact of the EU legislation on the market transformation of washing machines and their energy consumption (ADEME, 2000; ADEME, 2001). Dishwashers were monitored through the annual reports presented by the European Association of Household Appliance Manufacturers (CECED) to the EC and the Regulatory Committee responsible for the management of the EU energy labelling scheme, describing the effectiveness of the industry "Voluntary Commitment on Reducing the Energy Consumption of Household Dishwashers" issued in 1999 and ended in 2004. Also washing machine market was monitored through CECED annual reports under the two Voluntary Commitments issued in 1997 and in 2002 for this product group.

Since markets and technologies change continually, including in response to past policy settings, the present study proposal takes the results and methodology defined in the last decade of studies as the starting point to be updated and upgraded where necessary to evaluate the technical, economic and market developments of cold appliances and the new aspects of these products to be covered following the indications of the eco-design directive 2005/32/EC[3]. This is necessary in order to define the need of implementing measures and possible targets for voluntary or mandatory policies.

The study is divided in two working phases and seven Tasks or Chapters:

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[1] Commission Decision of 17 December 1999 establishing the ecological criteria for the award of the Community eco-label to washing machines (2000/45/EC).
[2] Commission Decision of 20 July 1998 establishing the ecological criteria for the award of the Community eco-label to dishwashers (98/483/EC).
[3] Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for Energy-Using Products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council.

Part I: Present Situation that envisages the following five Tasks:

- Task 1 - Definitions
- Task 2 - Economic and Market Analysis
- Task 3 - Consumer Behaviour
- Task 4 - Product System Analysis
- Task 5 - Definition of base case

Part II: Improvement Potential, with the following two Tasks:

- Task 6 - Technical Analysis
- Task 7 - Scenario, Policy, and Impact and Sensitivity analysis.

Within the first part (Present Situation) the project team will set the study boundaries (Task 1), collect and organise the data for the economic, market (Task 2) and consumers behaviour analysis (Task 3), analyse the interaction of the studied appliances on the energy system to which the product belongs (Task 4) and set up the reference parameters, material, energy and costs inputs to define the starting base case (Task 5). All the data and information analysed within the first part of the study will serve as an input for the second part (Improvement Potential) during which the project team will carry out the technical and economic analysis to set up the optimal eco-design options of the analysed appliance (Task 6) and finally suggest the most suitable policies to achieve the recommended energy and ecological improvements (Task 7). A Glossary and References will be also included in the study.

This report refers to Task 1: Definitions.

1.2 Description of Task 1

In the first Task of the study the product category is defined along with the "system boundaries" for the application of the eco-design concept. This definition in fact is relevant both for a realistic definition of the base-case in Task 5 and the design options and corresponding improvement potential in Task 6 and for the scenarios in Task 7.

1.2.1 Subtask 1.1: Product Groups, Product Categories and Performance Assessment

For dishwashers and washing machines the definition of the product group can be found in the relevant European measurement standard EN 60436 and EN 60456.

EU eco-label defines ecolabel awarding criteria for washing machine and dishwashers, but the product categories are referred to as given in the relevant energy labelling directives 95/12/CE & 96/89/CE and 97/17/CE & 99/19/CE. Wash appliances are not covered by the Energy Star Programme as set in Council Decision 2001/469/EC[4], but they are among the products covered in the US-EPA Energy Star. The relevant criteria will be therefore described in Subtask 3.1.3.

Finally, EUROSTAT defines only macro-categories used for commercial trade purposes, so it is less useful in the context of this specific Task of the study.

[4] Council Decision of 14 May 2001 concerning the conclusion on behalf of the European Community of the Agreement between the Government of the United States of America and the European Community on the coordination of energy-efficient labelling programs for office equipment, OJ L 172, 26.06.2001

The primary product performance parameter, the so called "functional unit" is the weight of the laundry washed per cycle (and knowing the number of washing cycles per year and the appliance lifetime the overall weight of laundry washed over lifetime) or the number of standard place settings washed per cycle (and over the lifetime). For both appliance types also the functional performance (secondary product performance parameters) is defined in the measurement standard:

- for washing machines, the cleaning and spinning performance
- for dishwashers, the cleaning and drying performance.

1.2.2 Subtask 1.2: Existing Standards

The main harmonised standards for washing machines is EN 60456 "*Clothes washing machines for household use-Methods for measuring the performance*" and for dishwashers EN 60436 "*Electric dishwashers for household use - Methods for measuring the performance*". The two standards include the measurement of the energy and water consumption and of the so called functional performance: washing, spinning, drying.

EN standards present a 15% uncertainty in the verification of the rated value for the energy consumption that is the maximum acceptable difference between the measured and the rated values. In case a higher difference is found, three extra samples should be measured for which on average a maximum difference of 10% is accepted. The same applies for functional performance measurement. Some stakeholders and Member States consider this percentage too high. The problem of the "uncertainty" in the verification of the declared energy consumption (and also of other parameters) will be addressed, taking into consideration the latest developments of the measurement uncertainty management under discussion within the preparation of the new of IEC 60456 5th edition.

In addition wash appliances should fulfil the requirements of safety standards (EN 60335 series).

As far as the stand-by issue is concerned, in 1999 the International Energy Agency published the document "*Things that go Blip in the Night – Standby Power and How to Limit It*", addressing the problem of the increasing standby power in the OECD Member countries and proposing some initiatives to decrease it. The standby consumption of household electrical appliances can be measured according to the European standard EN 62301:2005 recently prepared by Technical Committee CENELEC TC59X and including the common modification to the international standard IEC 62301:2005[5] prepared by TC59/WG9. The informative Annex A of EN 62301 provides some guidance on the other expected modes that would be found for various common appliance configurations and designs, including washing machines and dishwashers, even if the definition of such modes is demanded to the relevant standard of each product.

A short description of these and other relevant standards (such as noise measurement standard EN 60704 series) will be reported, along with the main modifications under study by the IEC SC59A for dishwashers and IEC SC59D for washing machines.

1.2.3 Subtask 1.3: Existing Policies & Measures

The legislation covering washing machines and dishwashers will be identified and briefly described for the three levels required: EU, Member States and extra-EU. Reference will be made to the WASH-2 study and IEA work within the Energy Efficiency Working Party and last publications

[5] IEC 60302: 2005 "Household Electrical Appliances – measurement of the standby power, 2005.

where a comprehensive analysis of the worldwide (especially extra-EU) legislation and voluntary measures are reported and compared. Fiscal incentives, procurement actions, etc. will be also mentioned. Additional efforts will be carried out to identify new measures and countries addressing wash appliances. A detailed analysis of standby power policies will also be included.

The standard product quality requirements (failure rates, proven design, etc.) required by the market will be also analysed and taken into account.

1.3 Subtask 1.1: Product Groups, Product Categories and Performance Assessment

1.3.1 Product groups and product categories

The definition of the two product groups are included in the scope of the European standards used for the conformity assessment:

- dishwashers: prEN 50242:2007/prEN 60436:2007[6] "*Electric dishwashers for household use - Methods for measuring the performance (IEC 60436:2004, modified)*", as "**electric dishwashers for household use that are supplied with hot and/or cold water**", where the definition of **dishwasher** is "machine which cleans, rinses and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and electric means. A dishwasher may or may not have a specific drying operation at the end of the programs".
- washing machines: EN 60456: 2005 "*Clothes washing machines for household use - Methods for measuring the performance (IEC 60456:2003, modified)*", as "**clothes washing machines for household use with or without heating devices and for cold and/or hot water supply**", where the definition of washing machine is then better specified in the "Scope" section of the standard as "appliance for cleaning and rinsing of textiles using water which may also have a means of extracting excess water from the textiles". EN 60456:2005 defines then different types of washing machines:
  - *agitator washing machine*: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device moving about or along its vertical axis with a reciprocating motion (an agitator). This device usually extends above the maximum water level;
  - h*orizontal drum washing machine*: washing machine in which the textiles are placed in a horizontal or inclined drum and partially immersed in the washing water, the mechanical action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed;
  - *impeller washing machine*: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device rotating about its axis continuously or which reverses after a number of revolutions (an impeller). The uppermost point of this device is substantially below the minimum water level;
  - *nutator washing machine*: washing machine in which the textiles are placed in a vertical axis basket and partially immersed in the washing water, the mechanical action being produced by a nutation plate in the bottom of the basket, the movement being either continuous or periodically with or without reversion;
  - *washer-dryer*: washing machine which includes both a water extraction (spin) function and also a means for drying the textiles, usually by heating and tumbling.

It should be taken into consideration that the definition of washing machine types will likely change due to the on-going of the IEC 60456 5th Edition[7] under preparation by IEC subcommittee 59D "home laundry appliances", which will be eventually reflected in the new EN 60456 4th Edition. The **proposed new definition**s are reported here for sake of completeness of information:

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[6] the draft standard will be published with a double numbering EN 50242/EN 60346 due to the need to maintain the first number for sake of compliance with the energy labelling scheme. The draft European Standard has been submitted to CENELEC members for formal vote. Deadline for vote is May 2007.

[7] The first DC (Document for Comments) of the IEC 60456 5th Ed. was circulated for comments beginning March 2007 as document 59D/332/DC.

- *vertical axis washing machine*: washing machine in which the load is placed in a drum which rotates around an axis which is vertical or close to vertical. For the purposes of this international standard, vertical axis is where the angle of the axis of rotation is more than 45 degrees to horizontal. Where the drum does not rotate, the washing machine shall be classified as a vertical axis washing machine;
- *horizontal axis washing machine*: washing machine in which the load is placed in a drum which rotates around an axis which is horizontal or close to horizontal. For the purposes of this international standard, horizontal axis is where the angle of the axis is less than or equal to 45 degrees to horizontal;
- *manual* or *automatic washing machine*: an automatic washing machine is where the load is fully treated by the machine without the need for user intervention at any point during the programme prior to its completion. A manual washing machine is where the machine requires user intervention at one or more points during the programme to enable the machine to proceed to the next operation. Examples of user intervention could include manual fill (non automatic water level), transfer of the load between a washing drum and a spin extractor drum or manual draining.

The classification applied by PRODCOM 2007[8] and used by EU customs and Eurostat are included under the codes (1) **29.71** – Manufacture of electric domestic appliances, (2) **29.71.12** – Dish washing machines, of the household type, (3) 29.71.12.00 – Household dishwashing machines for the dishwashers, and under the codes (1) **29.71** – Manufacture of electric domestic appliances, (2) **29.71.13** - Cloth washing and drying machines, of the household type and (3):

- **29.71.13.30** – Fully-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry)
- **29.71.13.50** – Non-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry).

For the EU, the definition of product categories for dishwashers can be found in the energy labelling Directive 97/17/EC[9] (and 1999/9/EC) as "*electric mains-operated household dishwashers sold to the general public. Appliances that may also use other energy sources, such as batteries, or have no internal heat source, are excluded*". The same definition is adopted by the EU eco-label scheme with Commission Decision 2001/689/EC[10] of 28 August 2001, revising former Decision 98/483/EC. Labelling directive (and eco-label) defines two dishwashers "categories" - with 10 or more place settings and with 9 or less place settings - depending on the capacity of appliance in standard place settings.

The definition for washing machines can be found in energy labelling directive 95/12/EC[11] (and 96/89/EC) as "*electric mains operated household washing machines, excluding machines with no spin capability, - machines with separate washing and spin drying vessels (such as twin tubs), and combined washer-driers. Appliances that can also use other energy sources are excluded*". The same definition is adopted by the EU eco-label scheme with Commission Decision 2005/384/EC of 12 May 2005, prolonging the criteria established in Decision 2000/45/EC[12].

A comparison of the different classifications is reported in Table 1 for dishwashers and in Table 2 for washing machines. In Table 2 only the definitions currently in force are reported.

[8] Source: List of PRODucts of the European Community, 2007 version, downloadable from: http://ec.europa.eu/eurostat/ramon
[9] OJ L 118, 07.05.1997, p. 1; and OJ L56, 04.03.1999, p.46.
[10] OJ L 242, 12.09.2001, p. 23.
[11] OJ L 136 , 21.06.1995, p. 1; and OJ L 338 , 28.12.1996 p. 85.
[12] OJ L 16, 21.01.2000, p. 74.

Table 1: Comparison of the different classification scheme for dishwashers at European level

<table>
<tr><td>prEN 50242:2007 /
prEN 60436:2007</td><td colspan="3">electric dishwashers for household use that are supplied with hot and/or cold water</td></tr>
<tr><td colspan="2">Directive 97/17/EC; Decision 2001/689/EC</td><td>PRODCOM</td><td>prEN 50242:2007/prEN 60436:2007</td></tr>
<tr><td>Category</td><td>Electric mains-operated household dishwashers sold to the general public. Appliances that may also use other energy sources, such as batteries, or have no internal heat source, are excluded</td><td>29.71.12 - Dish washing machines, of the household type</td><td rowspan="3">Dishwasher: machine which cleans, rinses, and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and electric means. A dishwasher may or may not have a specific drying operation at the end of the program</td></tr>
<tr><td>≥10 ps</td><td>Dishwashers with 10 or more place settings</td><td rowspan="2">29.71.12.00 – Household dishwashing machine</td></tr>
<tr><td>≤9 ps</td><td>Dishwashers with 9 or more place settings</td></tr>
</table>

Table 2: Comparison of the different classification scheme for washing machines at European level

EN 60456: 2005	clothes washing machines for household use with or without heating devices and for cold and/or hot water supply	
Directive 95/12/EC; Decision 2005/384/EC	**PRODCOM**	EN 60456: 2005 (to be changed)
electric mains operated household washing machines, excluding machines with no spin capability, - machines with separate washing and spin drying vessels (such as twin tubs), and combined washer-driers. Appliances that can also use other energy sources are excluded	**29.71.13** - Cloth washing and drying machines, of the household type	**washing machine**: appliance for cleaning and rinsing of textiles using water which may also have a means of extracting excess water from the textiles
	29.71.13.30 – Fully-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry) **29.71.13.50** – Non-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry).	***agitator washing machine***: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device moving about or along its vertical axis with a reciprocating motion (an agitator). This device usually extends above the maximum water level
		horizontal drum washing machine: washing machine in which the textiles are placed in a horizontal or inclined drum and partially immersed in the washing water, the mechanical action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed;
		impeller washing machine: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device rotating about its axis continuously or which reverses after a number of revolutions (an impeller). The uppermost point of this device is substantially below the minimum water level;
		nutator washing machine: washing machine in which the textiles are placed in a vertical axis basket and partially immersed in the washing water, the mechanical action being produced by a nutation plate in the bottom of the basket, the movement being either continuous or periodically with or without reversion

1.3.2 Product Performance Assessment

The primary product performance parameter, the so called "functional unit", for dishwashers is the number of standard place settings washed per cycle (and over the lifetime) defined in prEN 50242:2007/prEN 60436:2007 as **rated dishwasher capacity**: "whole number of place settings together with the serving pieces stated by the manufacturer, which can be cleaned and dried when loaded in accordance with the manufacturer's instructions".
For washing machines the functional unit is the weight of the laundry washed per cycle (and knowing the number of washing cycles per year and the appliance lifetime the overall weight of laundry washed over lifetime).

For both appliance types also the functional performance (secondary product performance parameters) is defined in the measurement standard (and in the energy labelling directives):

- for dishwashers, the cleaning and drying performance;
- for washing machines, the cleaning and spinning performance.

1.4 Subtask 1.2: Existing Standards

International standards exist for all major household appliances, typically originating with manufacturers' associations, government agencies, or professional societies, and are eventually adopted by a national or international standardisation bodies. The leading international standard-setting bodies for energy tests are the International Organization for Standardization (ISO) which mainly focuses on mechanical performance, and its sister organization, the International Electrotechnical Commission (IEC), which mainly focuses on electrical performance. Implementation and refinement of international standards is left to national and regional counterparts of ISO and IEC. Thus the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have assumed responsibility for developing EU-wide standards, respectively for mechanical and electrical performance. The Japan Industrial Standards Association (JIS) is responsible for developing all appliance test methods in that country. In the United States several organisations are involved in developing standards: among these are the American National Standards Institute (ANSI), the Air-conditioning and Refrigerating Institute (ARI), and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), although final responsibility for the appliance energy standards in policy measures resides with the Department of Energy

Geographic, climatic and cultural differences among countries further complicate efforts to develop internationally standardised test procedures that are sufficiently flexible to reflect local conditions while still allowing results from different countries to be compared. Beyond these basic differences, appliances often vary greatly in their configurations and the range of options on offer. This variety in configurations and options, because it can affect energy efficiency and functional performance, often necessitates the creation of separate standards.

Interest in making measurement methods better reflect local conditions and available appliance models has on one side led many countries to develop national standards, but on the other side many other countries tend to align with ISO/IEC standards, with only minor differences. In general:

- European, including Russia, align their standards with ISO/IEC ones;
- African and most Asian countries including China align their standards with ISO/IEC ones;
- Japan and Korea are often aligned with ISO/IEC but some significant differences exist for certain products;

- India, the Philippines, and Sri Lanka base most of their national standards on ISO/IEC ones, but sometimes there are important differences;
- Chinese Taipei often uses similar test methods to ISO/IEC but frequently introduces significant variations;
- In the Americas, the United States uses its own test procedures, which occasionally align to ISO/IEC tests;
- Because of the economic dominance of the U.S. market in NAFTA, it is not surprising that standards used in Canada and Mexico are substantially similar to those used in the U.S.;
- Most South American countries including Brazil use ISO/IEC standards but some (e.g. Venezuela) use variants or U.S. standards;
- Australia and New Zealand use harmonised standards, which despite being loosely based on ISO/IEC ones often exhibit significant differences.

White goods such as refrigerators, washing machines and dishwashers tend to exhibit the largest differences in standards, product categorisation and energy performance requirements applied from one region to another, possibly because they were the first group of products covered by national policies and measure aimed at reducing their energy consumption. Individual countries have typically taken into consideration country-specific variables such as domestic energy prices and climatic conditions, as well as the features and configurations that describe the appliances sold in their markets. These differences are also reflected in the standards, many of which were first developed nationally and may have been established more than two decades ago.

In recent years there has been a tendency for countries developing new standards to harmonise them with existing ones, as have Argentina, China, Russia, South Africa, Tunisia and Turkey with the EN standards for refrigerators and freezers. In addition, regional activities directed at harmonizing energy efficiency requirements and labels, and the relevant standards that underlies both these measures, are being undertaken by the Asia-Pacific Economic Cooperation (APEC), the South Asia Regional Initiative for Energy Cooperation and Development (SARI), the Pan American Standards Commission (COPANT), the Asia and South East Asia Network (ASEAN), the North American Energy Working Group (NAEWG), and the first of several emerging UNDP/GEF projects in the Andean Region of South America. The European Union has a rich history of regional coordination from individual country requirements and labels to unified EU-wide programs. In particular:

- In Europe, the EU25 countries were working with new Member States (Bulgaria and Romania) and Accession Countries (Croatia and Turkey) to assist them in introducing EU appliance energy efficiency policies. This mirrors the process which previously took place in the 10 new EU member states prior to their becoming EU members.
- Australia and New Zealand have a formal arrangement to develop common energy efficiency requirements for energy using products and apply harmonised standards.
- ASEAN countries are working together to develop a common regional endorsement energy label for energy-using products.
- Six countries in and around the Indian sub-continent have been co-operating through the auspices of the South Asian Regional Initiative programme to share experiences and possibly co-operate in the development of regional appliance efficiency requirements.
- Members of the ANDEAN pact countries are co-operating in a regional initiative to develop energy efficiency labels and efficiency requirements for energy using appliances.

Standards for wash appliances developed at international, European and other non-European countries will be described and where possible compared.

1.4.1 The International Standards

1.4.1.1 The dishwasher performance standard

IEC 60436, 3rd edition, February 2004 "*Electric dishwashers for household use - Methods for measuring the performance*" has been prepared by SC 59A – "Electric dishwashers" of Technical Committee 59 – "Performance of household and similar appliances". The third edition cancels and replaces the second edition published in 1981 and constitutes a technical revision. Major changes introduced in the second edition include:

- changes made to the soils used in the standard;
- the use of an oven and microwave oven to dry the soils;
- the alternate 15 to 18 hour air dry method to dry the soils;
- the addition of a reference dishwasher;
- the recognition of alternate supply voltages and frequencies;
- the recognition of a cold or hot water supply to the dishwasher;
- the detergent and rinse aid compositions have been up-rated to reflect current technology;
- the addition of the US-style load;
- the evaluation of the filter systems.

The performance of the tested machines are measured by comparison with a reference machine (Miele G590 and the Miele G5953 dishwashers are examples, other machines with the same characteristics might be used). Two alternative loads are defined and described, the reference machine to be always loaded with the load set in Annex A (the non-AHAM style load).

Performance tests must be generally carried out on a new machine, with a reference machine running parallel with the machine(s) under test, i.e., at the same time under the same conditions using soil prepared at the same time from the same batch. The reference machine is always installed as a free standing machine independent of the type of machine under test. Dishwashers are tested as free standing except where they are designated as built–in or integrated. Before conducting the performance tests, the dishwasher is operated for at least 3 complete cycles using a clean load with reference detergent and without rinse agent. The following cycle(s) can be a noise test according to Clause 9. No additional cycles are carried out on the machine under test between the sequential steps specified in the following procedure.

The tests are performed in the following order: cleaning performance then drying performance. The determination of energy, water and cycle/program time is done in conjunction with the cleaning performance test. The first programme to be tested is the one recommended by the manufacturer for a normally soiled load. In some countries the manufacturer has to declare the programme to be used, for the purpose of energy labelling which may not be for a normally soiled load, in which case this programme is the one tested first. The same programme is used for measuring the cleaning performance, the drying performance, the energy and water consumption and time and the noise, if tested. The test conditions are specified:

- voltage and frequency
- ambient conditions
- water supply pressure, hardness and temperature both cold (at 15 ± 2 °C) and hot (at 60 ± 2 °C) water inlet
- the reference detergent is used, the quantity as recommended by the manufacturer but no more than 15,0g + 1,25g per place setting. If no recommendation is given by the manufacturer, use 12,0g + 1,0g per place setting

- the reference rinse agent is used, the type (acidic or neutral) is used according to the water hardness
- the reference salt is used.
- the following soiling agents are required: milk, tea, minced meat, egg, oat flakes, spinach, margarine. All food products, at the time they are used for the preparation of soiling agents for the standard, must be within the "use-by" date or before their expiry date stated on the product. The remains of newly opened packets of tea and oat flakes may be used for subsequent tests for a period of up to 60 days after opening, if the contents are stored in a sealed container. Specific directions are provided for storage and re-use of spinach after defrosting. The preparation and application of each soiling agent on the tableware is described. Then the soiled tableware are dried in an oven or air dried.

The standard foreseen the following measurements:

- the cleaning performance (Clause 6): the purpose of this test is to measure how well the appliance cleans normally soiled place settings and serving pieces. The tests are carried out in parallel with the reference machine; soiling of the test loads for the test machine(s) and the reference machine are prepared in parallel. One person must prepare each soil type for all loads and one person must apply each soil type for all loads. Perform at least 5 cleaning test cycles of the test programme without cleaning the dishwasher filters between the measurements; if necessary increase the number of cleaning test cycles until an acceptable defined standard deviation is fulfilled, to a maximum of 8 cleaning test cycles. Any soil residue is assessed and the score noted according to the following score system:

Number of small dot shaped soil particles	Total soiled area mm^2	Score
$N = 0$	$A = 0$	5
$0 < n \leq 4$	$0 < A \leq 4$	4
$4 < n \leq 10$	$4 < A \leq 20$	3
$10 < n$	$20 < A \leq 50$	2
Not applicable	$50 < A \leq 200$	1
Not applicable	$200 < A$	0
Each load item shall be awarded a score from the table according to the category of soil area or number of discrete soil particles adhering to the item. If the requirements for more than one score are met, the lowest applicable score shall be awarded.		

  The type of soil and total number of relevant items is noted and the cleaning index in calculated by comparing the results of the test and the reference machines as the average of the indexes of the run cycles;
- drying performance (Clause 7): to measure how well the dishwasher dries the load. The drying performance measurement is not determined in conjunction with the measurement of the cleaning performance and is undertaken using clean place settings and serving pieces. Drying effect is evaluated by visual inspection and judged to be "dry", "intermediate" or "wet". Inspection of the items in the machine under test and the reference machine are carried out by the same person.
  "Dry" is defined as an article being completely free of moisture. In this case, the article shall be given a score of 2; "Intermediate" is defined as an article having one or two drops of water, or one wet streak (run), the article shall be given a score of 1; "Wet" is defined as an article having more than two drops of water, or one drop and one streak, or two streaks, or water in glass or cup cavity, the article shall be given a score of 0. The single drying index, approximated to 2 decimal places, for the test and the reference machine is calculated as the average of the scores

of the single item types. The final drying index in calculated by comparing the results of the test and the reference machines as the average of the indexes of the run cycles;

– energy, water consumption and time (Clause 8): to determine the electrical energy, the energy contained in the hot water if an external source of hot water is used, and the quantity of hot and/or cold water consumed by the dishwasher and the time it takes to complete a particular programme used for measuring the cleaning performance. Total energy consumption is the sum of the electrical, cold water correction (if any), and hot water energy (if any). The average of the 5 or more cycles run for the test machine is given: the energy consumption is measured in kWh to three decimal places, water consumption in litres, to one decimal place, and time to the nearest minute. The energy and water consumption are not determined during a drying test
– airborne acoustical noise (Clause 9), determined according to IEC 60704-3.

Thirteen annexes are included in the standard:

- Annex A (normative) defines the place setting and serving piece specifications to be used in the test machines according to its capacity in terms of place settings.
- Annex B (normative) defines an alternative load, the AHAM style load, to be used for dishwashers not using load described in Annex A, such as U.S. style machines. Place setting and serving piece specifications are given according to the test dishwasher capacity, along with a table of concordance with load items:

Annex A item No.	Item description – Annex A	Annex B item No.	Item description – Annex B
1	Dinner plate	1	Dinner plate
2	Soup plate	2	Fruit bowl
3	Dessert dish	3	Bread & butter plate
4	Cup	4	Cup
5	Saucer	5	Saucer
6	Glass	6	Glass
7	Fork	7	Dinner fork
8	Soup spoon	8	Salad fork
9	Knife	9	Knife
10	Teaspoon	10	Teaspoon
11	Dessert spoon	11	Teaspoon (same as 10)
12	Oval platter (320 mm)	12	Oval platter (240 mm)
13	Medium serving bowl (160 mm)	13	Medium serving bowl (1 litre)
14	Small serving bowl (13 mm)	14	Fruit bowl (130 mm)
15	Two serving spoons	15	Two serving spoons
16	Serving fork	16	Serving fork
17	Gravy ladle	14	No equivalent item
18	Large serving bowl (200 mm) [a]	12	Medium serving bowl [a] (1 litre)
[a] In dishwashers of 7 or more place settings only. For an Annex B load there are 2 bowls (Item 12).			

- Annex C (informative) illustrates the soil distribution, i.e. the number of each item type soiled for a 12-place setting, a 9-place setting and a 6-place setting dishwasher
- Annex D (normative) specifies the characteristics of test materials: the detergents (two detergents are possible), the rinse agents (with two formulas, “acidic” and “neutral” type) and the salt
- Annex E (normative) describes the characteristics of the reference machine, the reference programme (Universal 65 °C), the installation and the calibration of the machine and the load plan

- Annex F(informative) gives a list of possible suppliers of the materials and reference equipment used in the standard
- Annex G (normative) specifies the characteristics of the microwave oven and through-circulation thermal cabinet to be used for the drying of the soiled tableware
- Annex H (informative) suggests that testing laboratories develop their own internal guidelines for the evaluation of soil and cleaning, to ensure that repeatable results are obtained. An example of guidelines for assessing cleaning performance taken from the Australian/New Zealand standard is also included in the annex.
- Annex I (normative) describes the test enclosure for built-in models
- Annex J (informative) presents a flow chart with the test sequence of the entire standard
- Annex K (normative) specifies the shade numbers for various colours to be used to assess the washing performance
- Annex L (informative) gives and example of the test report format
- Annex M (informative) provides guidance on how to adjust the water consumption of the reference dishwasher in order to achieve the target water consumption of 27,8 litre.

a) The future development for IEC 60436 4th Edition

Experience with the standard has been positive worldwide and the new test method provides a sound globally relevant basis for international testing and comparison of dishwashers. A number of possible changes have been discussed among international experts, none of which will affect the fundamental parameters specified in the standard nor the expected results. They are refinements of the current methodology and specifications. The main elements are:

- better illustrations o soils be considered for use in IEC60436, taken from the European standard
- inclusion of a new microwave oven model in the recommended list of products as the currently specified model is no longer available (production has ceased). The work to qualify at least one current model of microwave oven should be ready for inclusion into the standard revision, but no changes to generic microwave specification are foreseen;
- the statement of the tolerance in a parameter should not allow deliberate adjustment of laboratory parameters, as already specified in the draft of standard IEC 60456 for washing machines, since the tolerance has been chosen to allow for factors such as drift of ambient conditions, instrument error, reading error, uncertainty of instrument calibration and other influences;
- ambient temperature to be harmonised with washing machines and dryers standards at 23±2°C
- recommendation about the limitation on the life of the load to 200 cycles (as in European standard), with a note outlining the reasons for the recommended limit on cycles for the load items (possible degradation of glazing and the influence on wash performance results). A mandatory requirement is onerous as for larger labs this would require tracking of cycles for each load item;
- update the list of qualifying brand and model for the reference equipments and products;
- better qualification of the load temperature (ambient conditions). Important differences are that European tests are conducted at a fixed time after soiled load removal from the oven, making all test runs comparable. IEC loads can be stored for up to 4 days after oven drying so keeping oven dried loads in parity with loads stored at ambient conditions is important in the IEC test method. Measurement data has shown that a requirement of not less than 1 hour will ensure that current requirements in the standard are met (ambient temperature ± 2°C) and this is a simpler way of qualifying the temperature of the loads for laboratories;
- drying performance in IEC is currently specified to commence 30 minutes after the end of the cycle, the European standard commences drying performance evaluation 30 minutes after the completion of the program after the power is disconnected. IEC standard has a technical error to

be corrected to state that the waiting time is 30 minutes from the end of program (not cycle) before commencing drying evaluation;
- the specified reference dishwasher is no longer available. Other models should be included in the Annex with relevant performance and calibration data. However, old reference machines should be included as many testing laboratories still have these dishwashers as reference;
- inclusion of the measurement of the standby power following general approach prepared for the washing machine standard, where two modes "standby mode" and "left on mode" are defined. Also the technical requirements should be the same as for the washing machines;
- in some cases products may be able to sense that there is a clean load and there is concern that these may falsely increase the drying performance evaluation in response. It is recognised that smart machines may have numerous control strategies to adjust performance in response to load conditions and that this is not necessarily a problem but it may increase complexity of testing in some cases. The proposal is to record total program energy consumption for drying tests and the maximum heated water temperature for each operation (washing and drying) in the test report as part of the test report requirements in the next standard edition. Once a body of data has been collected over time, this could be assessed in future to see whether there is a need to modify how the energy is declared in further editions of the standard;
- remove ambiguity in the classification of self cleaning or not self cleaning dishwashers.

b) Elements for further editions of IEC 60436

Main elements to be studied for inclusion in a further edition of IEC 60436 are:
- the current soiling in IEC 60436 focuses more on adhered soil and does not have sufficient soil to assess re-deposition. Substantial development work needs to be undertaken. The issue is whether there needs to be a shift in the balance between adherence and re-deposition;
- there is a need to look at soil composition and quantity; heavy soil loads are often required to assess intensive wash programs;
- testing automatic (sensing or smart) programs: these products are becoming more common on the market and there is the need to asses how smart they are in real life (how they respond to variations in soil load in terms of performance and energy);
- a number of issues need to be resolved in the assessment of water marks as part of washing performance evaluation and whether these are assessed or ignored for drying performance evaluation;
- more realistic load composition: data from actual consumer loads indicates that the total number of items is typically much lower than the standard load for some load item types. Real loads also have plastic items. There is a need to balance a more representative load against manufacturer claims of capacity (maximum capability of the product). Part load and mixed load tests could provide some additional information;
- detergent type and rinse aid formulations: the need of a phosphate-free detergent to be investigated as result of possible EU and US requirements about phosphate content of detergents. In any case there is the need to maintain a stable formulation for reference detergents where possible. Although the dishwasher detergent market in Europe is now dominated by tablets, these are not suitable for use in the IEC standard, since the manufacturing of tablets is very complex and expensive. For shorter and lower temperature programs tablets result in significantly worse performance as they take longer to dissolve. Accurate dosing is not possible for tablets of a fixed size. To be investigated for the long term standard development.

1.4.1.2 The washing machine performance standard

The 4th Edition of IEC 60456 *Clothes washing machines for household use - Methods for measuring*

the performance was published in October 2003, prepared by SC 59D – "Home laundry appliances" of Technical Committee 59 – "Performance of household and similar appliances".

Major changes introduced in the fourth edition include:

- Reproducibility and repeatability of the test results: improved by specifying tolerance limits for instrumentation, base loads and detergents; instrumentation of measuring optical reflectance has been specified;
- Loads: the specifications of cotton and easy-care base load have been revised to include suitable test materials which are currently available on the market. The three loads are named "cotton base load", "easy-care textile base load" and "polyester textile base load"; tolerances for size and mass per unit area of base load materials have been changed; procedures and conditions for pre-treatment, normalization and conditioning are defined more precisely;
- Reference washing machine: the water quantity can be adjusted and controlled more precisely by a special flow meter, which is available from the supplier of the reference washing machine;
- Other changes:
  - the composition of the reference detergent has changed; the detergent is named A*;
  - the formula for the correction of consumption for hot and cold water has been modified;
  - specifications of wool shrinkage specimens have been included;
  - ambient temperature is defined at (23 ± 2) °C.

The tests are performed in parallel with a defined reference machine. The test conditions are specified:

- voltage and frequency,
- ambient conditions:
  - ✓ ambient temperature 23 ± 2 °C
  - ✓ water hardness of 2,5 ± 0,2 mmol/l
  - ✓ water temperature for cold (at 15 ± 2 °C) and hot (temperature indicated by the manufacturer ±2 °C, or if no value is given 60 ± 2 °C) water inlet
- the reference detergent A* is used, the quantity specified in Annex F
- loads: base load for cotton (with composition of sheets, pillowcases and hand-towels as specified), for easy-care textile (consisting of an equal number of shirts and pillowcases) and polyester textile (consisting of specified double knitted polyester textile test pieces); an item must not be used for more than 80 test cycles with a weighted average age of the cotton load between 30 and 50 test cycles; the preparation and conditioning of the base load are defined
- different types of soiling are used to enable the measurement of different characteristics: the scouring effect, mainly due to mechanical and thermal action, with a mixture of carbon black and mineral oil, the removal of protein pigments with blood, the removal of organic pigments, with chocolate and milk and the bleaching effect, with red wine. Soiled test strips consist of square pieces carrying different types of the described artificial soil and joined together into a strip with the different kinds of soil in the order: unsoiled piece, carbon black/mineral oil, blood, chocolate and milk, red wine.

The standard foresees the following measurements:

- the washing performance (Clause 8): this clause contains specifications for the test procedure using standardised soiled test strips, which are washed together with a defined base load (i.e. the test load); the purpose is to evaluate the typical soil removal performance of the washing machine under test, in relation to the reference washing machine; the standard detergent and its dosage are specified; at least five complete test cycles are run for the test and reference machines and the soiled strips are evaluated for each run and machine; the washing performance

is calculated by the reflectance measures of the washed strips, by comparison with the reference machine;

- the rinsing performance (Clause 9): the test uses the residual alkalinity of the detergent solution in the base load after spin extraction as a measure of the rinsing performance. The purpose is to evaluate how well a typical textile load is rinsed; at least five complete test cycles are carried out using the selected programme;
- the spin extraction performance (Clause 10): contains specifications for the measurement of the residual water in the base load. The water extraction efficiency is expressed as the amount of moisture remaining in the base load after spinning relative to the conditioned mass of the same load. The purpose is to evaluate the effectiveness of water removal from a typical textile load at the end of a washing cycle; the spin extraction efficiency is the arithmetic mean of the five values obtained in the five cycles run, expressed as a percentage M
- Water and energy consumption and programme time (Clause 11): specifies the procedure and evaluation for the determination of water and energy consumption during typical operations of washing, rinsing and spin extraction; it also specifies the method for determination of the duration of the complete programme. At least five complete test cycles are carried out using the selected programme, and the arithmetic mean of the measured values is calculated: water volumes are expressed in litres, and rounded to the nearest whole litre, programme duration is rounded to the nearest minute, electrical energy is expressed in kWh rounded to two decimal places;
- Shrinkage during the wool wash programme (Clause 12): the specifications for measuring the shrinkage rate during the wool wash programme are given, using three wool specimen for each washing cycle together with a base load of polyester textiles. On completion of the wool wash programme, including spin extraction. Lengths and widths of the wool shrinkage specimens are measured and recorded. Six test cycles are run. The average of the percentage area felting shrinkage is calculated for the test and reference washing machine.

Ten annexes are included in the standard:

- Annex A (normative) describes the reference washing machine, the different programme types for and the method for its use, calibration and maintenance;
- Annex B (normative) specifies the characteristics of the base loads (cotton, easy care, polyester);
- Annex C (normative) describes the handling of load and calculation of average age of the cotton base load: the way of loading the machine influences the results especially for the washing performance; to get reproducible results it is necessary to define the way of loading the machine and the procedure to determine the weighted average age of the load;
- Annex D (normative): describes the bone-dry method used to determine the dry mass of the cotton and easy care textile loads;
- Annex E (normative) specifies the specimen with standardized soiling: the washing performance is the result of the combination of mechanical and chemical actions. Natural soils contain fatty matter, proteins and organic and inorganic pigments in complex mixtures, some soils are more sensitive to mechanical action and some to chemical action. The typical soil removal performance of a washing machine is determined by means of the different types of standard artificial soils: carbon black and mineral oil (enabling the scouring effect, mainly due to mechanical and thermal action), blood (enabling the removal of protein pigments), chocolate and milk (enabling the removal of organic pigments), and red wine (enabling the bleaching effect). The fabric supporting the soils, the artificial soil composition and the application of soil to cloth are described. Each batch of soiled test pieces must be marked and delivered with information about the correct use;
- Annex F (normative) describes the composition of the reference detergents: A* and the amount to be used, given by: amount = 54 g + 16 g/kg of rated capacity; and reference detergent C is for

use in agitator and impeller washing machines with the amount of 19 g/kg of rated capacity for water hardness 0,5 mmol/l

- Annex G (informative) describes in detail the procedure for the programming of the reference washing machines FOM 71 MP and FOM 71 MP/Lab. The possible programmes are described: cotton 60 °C, cotton 85 °C, easy-care textiles 40 °C, easy-care textiles 60 °C, and wool 40 °C. Due to the fact that the reference washing machines FOM 71 MP and FOM 71 MP/Lab, are no longer available, a new reference washing machine FOM 71 CLS is described in the *Corrigendum*, along with the description of the wash programme for cotton at 60°C;
- Annex H (informative): presents the data to be reported for the reference washing machine and the washing machine under test;
- Annex I (informative): a list of suppliers for the reference machines and test materials are given;
- Annex J (informative): givens an example for the exchange of load items for a 5 kg cotton load to achieve weighted average age of the load between 30 and 50 test cycles

a) The globalisation of IEC 60456

IEC 60456 started as a simple test procedure for clothes washers which focused mainly on horizontal axis (drum or front loading) machines and was first published in 1974. While many of the technical aspects of the standard have been substantially improved in subsequent revisions (Edition 2 in 1994 and Edition 3 in 1998), there are still some severe limitations to the application of this standard to other washing machine platforms such as impeller and agitator machines (in general vertical axis machines).

The 4th Edition of IEC 60456 contains many improvements over earlier editions of the standard. However, this edition still falls short of what many regard as a "globally acceptable" test procedure for machines with vertical axis wash systems. Upgrading IEC60456 to be a truly global test procedure required a huge amount of research and development work which had to be managed carefully during the recent years. In addition, it was critical that any changes to the standard were done in a way that ensured that current users of the standard are able to retain continuity and comparability with previous editions (as far as possible).

Issues and limitations of the 4th Edition are known to include:

- testing is currently limited to a single water hardness of 250 ppm which is too hard for many countries;
- cold water test temperature of 15^{o}C is unrealistically low (too cold) for some countries;
- current reference system needs revision / update / additions:
  - current programs are only reflective of drum machine types and may not be suitable as a vertical axis or impeller machine reference;
  - current range of reference program temperatures (40^{o}C, 60^{o}C, 85^{o}C) is not reflective of wash temperatures of 20^{o}C to 30^{o}C which are typical in some countries;
- the reference detergent specified for vertical axis and impeller machines (Detergent C) is a phosphate based detergent which may not be suitable for many countries and the dosage is only provided for soft water, which is not considered under the standard. As practical consequence, vertical axis and impeller machines have no test method under IEC 60456;
- the specified method of evaluation of the machine performance, while competent, is arbitrary and there are a range of post-test analysis methods that can validly address the different aspects of the washing performance;
- the alkalinity method of assessing rinsing performance is not sufficiently reproducible to allow robust inter-laboratory comparisons, although this method is known to be generally repeatable within a laboratory;

- there are reproducibility issues regarding the wool shrinkage method and the associated evaluation approach;
- Loading plan is only provided for a horizontal axis machine.

Not all users around the world have strong and explicit concerns with the issues listed here, but some of these are known to limit the potential application of IEC 60456 in some countries at present. Possible solutions have already been identified and many will be addressed in the IEC 60456 5th or even further Editions.

b) New items in IEC 60456 5th edition

Maintenance Team 15 is currently working on the new 5th Edition and is also planning for the preparation of a 6th edition in the medium term. A draft for comments of the 5th edition has been released end February for public comments[13]. Key changes and improvements included into the draft 5th Edition of IEC 60456 are:

- Improve the structure of the standard to assist users and improve clarity.
- Introduction of a new soil stain (sebum) in addition to the existing 4 soil stains. The current red wine stain will be replaced with additionally aged red wine. Smaller size of stain strips will be used to accommodate additional stain.
- The inclusion of two new low temperature reference programs Cotton 20°C and Cotton 30°C on the reference machine which are more suitable for use in conjunction vertical axis machines and lower washing temperatures.
- Introduction of soft water requirements, water hardness: soft 50ppm, and hard (current) 250ppm.
- Continued use of Detergent A* for all washing machines platforms and both water hardness values while establishing a new dosage regime (at 2/3 hard water dose) both for soft water as well as the new low temperature cycles. Solubility criteria for Detergent A* added.
- Improved folding and loading method to suit horizontal and vertical axis machines and twin tubs systems.
- Inclusion of two low power modes (“off mode” and " left on mode") and power measurement conditions (see paragraph 1.4.1.5.a).
- An improved alkalinity method for rinse performance assessment, based on extensive research and testing.
- Directions regarding placement of detergent in vertical axis machines, especially where there is no dispenser or the dispenser is inadequate for the specified dose.
- Elimination of the restriction that the rated capacity shall be the only load size to be used (as consequence allowing additional testing at lower load sizes).
- Expanded defined load size up to 15 kg with indefinite expansion beyond.
- Load item distribution modified for very small loads (single sheet eliminated for 2,5kg loads or less).
- Review of volume/capacity ratios for determination of rated capacity in case rated capacity is not declared by manufacturer or not based on clothes load mass (e.g. in North America).
- New volume measurement methods for any machine types.
- Improved wool test procedure and modified wool reference program on the reference machine.
- Informative annex on uncertainty of clothes washing machine performance measurements and options for analysis of test results.
- Informative annex on the selection of reference programs for comparison of different programs and washing platforms.

[13] See document 59D/332/DC “Inquiry on draft of IEC60456 5th Edition”, information available at the SC 59D webpage within the IEC website www.iec.ch .

- Introduction of the Wascator CLS machine (first introduced for cotton 60°C cycles only as IEC 60456 Corrigendum) as a suitable reference machine and improved maintenance and calibration procedures.
- Treatment of clothes washing machines within the test procedure where the manufacturer recommends the use of no detergent in the wash (or materials other than detergent).
- New annex on background to requirements of IEC60456 added to explain the reasons for the requirements in the standard and to explain the impact of deviations (for example, to reduce the testing cost).
- Informative annex on selection of reference programme when compared to typical household machine programmes.
- Guideline for good laboratory practice added.
- Mechanical action (textile damage): a separate Publicly Available Specification 62473 Ed. 1.0 was published in April 2007.

In June 2007, the discussion of the comments received on this first draft[14] of IEC 60456 5th Edition and the input from the experts in charge of the revision of the IEC 62301 lead to the refinement of the circulated text and to the partial modification of the definitions, where the "standby mode" has been substituted by "off mode" (see paragraph 1.4.1.5.a).

The CDV (Committee Draft for Vote) of the new standard, with the modified definitions, is expected to be circulate by IEC SC 59D for public enquiry, including the vote of the National Committees, in September 2007.

c) Future developments for IEC 60456 6th edition

The following issues are still under discussion, some are already under development to be included in the 6th Edition of IEC60456:

- Hygiene
- New reference program to reflect easy care wash items.(Development on CLS).
- New reference program to reflect Hand wash items.(Development on CLS).
- Higher spin speed with CLS on cotton reference programs
- Wool program - cleaning along with shrinkage
- New detergent for wool wash program.
- Mechanical action (gentleness of action): inclusion of a new test procedure to assess the gentleness of action of the washer on the load.
- Improve methods for the assessment of rinse performance (soluble and non-soluble components).
- Detergent: New detergent for 6th edition
- Potential for reducing test runs to 3 from 5 and impact on uncertainty.
- Soil re-deposition
- Fabric care (Tangling, wrinkling)
- Rated Capacity requirements definition
- Inlet temperature harmonisation
- Foreign object handling
- Washer imbalance.

[14] The commenting period of the first Document for Comments was closed beginning June 2007.

1.4.1.3 The standards about safety

Safety is dealt at IEC level through a set of standards: the general elements are defined in **IEC 60335-1 Household and similar electrical appliances - Safety - Part 1: General requirements** that it is common to all the electric motor appliances, while product-specific issues are addressed in a series of **Part 2** documents covering the different appliance types. Each Part 2 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard about safety requirements for the specific products. Part 1 and Parts 2 standards are prepared by Technical Committee 61 - Safety of household and similar electrical appliances.

In particular for wash appliances the following standards apply:

- **IEC 60335-2-5:2005**, *Household and similar electrical appliances - Safety - Part 2-5: Particular requirements for dishwashers*. Edition 5.1 (including Amendment 1) has been published in March 2005 and deals the safety of the deals with the safety of electric dishwashers for household use that are intended for washing and rinsing dishes, cutlery and other utensils, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances. This standard does not apply to commercial electric dishwashing machines[15].
- **IEC 60335-2-7:2006**, *Household and similar electrical appliances - Safety - Part 2-7: Particular requirements for washing machines*. Edition 6.2 (including Amendments 1 and 2) has been published in May 2006 and deals with the safety of electric washing machines for household and similar purposes, intended for washing clothes and textiles. The rate voltage is not more than 250 V for single-phase appliances and 480 V for other appliances. It includes washing machines for communal use in blocks of flats and in laundrettes. Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard. Washing machines with a spin extraction function must also comply with IEC 60335-2-4, and with a drying function must also comply with IEC 60335-2-11.

As far as is practicable, both standards deal with the common hazards presented by appliances that are encountered by all persons in and around the home. However, in general, they do not take into account the use of appliances by young children or infirm persons without supervision and playing with the appliance by young children. The standards do not apply to appliances intended exclusively for industrial purposes and appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas). For appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary. In many countries additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities and similar authorities.

1.4.1.4 Airborne acoustical noise

a) General requirements for noise measurement

In general, noise is measured according to the specifications given in IEC 60704-1, 2nd edition, 1997 *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 1: General requirements*, prepared by IEC technical committee 59: "Performance of household electrical appliances". A series of Part 2 documents address the

[15] Safety of commercial dishwashers is dealt under IEC 60335-2-58 - Household and similar electrical appliances - Safety - Part 2-58: Particular requirements for commercial electric dishwashing machines.

individual appliances describing specific test conditions. Finally, IEC 60704-3: 2006, Ed. 2, *Household and similar electrical appliances - Test code for the determination of airborne acoustical noise – Part 3: Procedure for determining and verifying declared noise emission values*, gives values of standard deviations of reproducibility for several categories of appliances.

IEC 60704-1 permits the use of "semi-anechoic rooms", "special reverberation test rooms" and "hard-walled test rooms" for the measurement of the sound power level of the appliance based on acoustic measuring methods described in ISO 3743-1[16], ISO 3743-2 and ISO 3744[17]. Within the measuring uncertainty specific to the three possible methods described in the standard, the results from the determination under free-field conditions over a reflecting plane are equal to those obtained in reverberant fields. This standards is concerned with airborne noise only, while in some cases, structure-borne noise, for example transmitted to the adjoining room, may be of importance. A classification of different types of noise is given in ISO 12001[18]. The methods specified in mentioned ISO standards are suitable for all types of noise, except for sources of impulsive noise consisting of short duration noise bursts, taken into account in Parts 2.

Part 1 of IEC 60704 applies to electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries. By similar use is understood the use in similar conditions as in households, for example in inns, coffee-houses, tea-rooms, hotels, barber or hairdresser shops, launderettes, etc., if not otherwise specified in Part 2. It does not apply to appliances, equipment or machines designed exclusively for industrial or professional purposes, appliances which are integrated parts of a building or its installations, such as equipment for air conditioning, heating and ventilating (with some exceptions) oil burners for central heating, pumps for water supply and for sewage systems, separate motors or generators and appliances for outdoor use.

Generally, the determination of noise levels is only part of a comprehensive testing procedure covering many aspects of the properties and performances of the appliance. When preparing the standard it was therefore considered important to keep at a modest level the requirements for noise measurements such as test environment, instrumentation, and amount of labour involved; this resulted in Part 1 methods with an "engineering accuracy" (or "grade 2" according to ISO 12001). The resulting airborne acoustical noise is measured as sound power levels (L_W), expressed in decibels (dB) with reference to a sound power of one picowatt (1 pW), within the specified frequency range of interest (generally including the octave bands with centre frequencies from 125 to 8 000 Hz), and for prescribed operating conditions of the appliance to be measured.

The estimated values of the standard deviations of reproducibility of sound power levels determined according Part 1 are given in ISO 3743-1, ISO 3743-2, and of ISO 3744. But for a particular family of appliances of similar size with similar operating conditions, the standard deviations of reproducibility may be smaller than these values. Hence, in Part 2 series, standard deviations smaller than those listed in ISO standards may be stated if substantiation is available from the results of suitable inter-laboratory tests. In case of discrepancies between the measurements where

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[16] ISO 3743-1:1994, ed. 1, "Acoustics – Determination of sound power levels of noise sources - Engineering methods for small movable sources in reverberant fields – Part 1: Comparison methods for hard-walled test rooms" and ISO 3743-2, "Acoustics - Determination of sound power levels of noise sources using sound pressure – Engineering methods for small movable sources in reverberant fields – Part 2: Methods for special reverberation test rooms" (both prepared by ISO TC43/SC1).

[17] ISO 3744:1994, Ed. 2, "Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane" (prepared by ISO TC43/SC1).

[18] ISO 12001:1996, Ed. 1, "Acoustics – Noise emitted by machinery and equipment – Rules for the drafting and presentation of a noise test code" (prepared by ISO TC43/SC1).

the results normally remain inside the foreseen standard deviation, it will be necessary to perform measurements according to the upper grade of accuracy (or "grade 1", laboratory or precision according to ISO 12001) as described in ISO 3741 or ISO 3745.

a) Specific requirements for dishwashers

IEC 60704-2-3, Edition 2.1 (including Amendment 1) "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 2-3: Particular requirements for dishwashers*", has been published in August 2005. These particular requirements apply to single-unit electric dishwashers for household and similar use, with or without automatic programme control, for cold and/or hot water supply, for detachable or permanent connection to water supply or sewage systems, intended for placing on the floor against a wall, for building-in or placing under a counter, a kitchen worktop or under a sink, for wall-mounting or on a counter.
The measuring conditions specified in this Part 2-3 provide for sufficient accuracy in determining the noise emitted, and comparing the results of measurements taken by different laboratories, whilst simulating as far as possible the practical use of dishwashers. In practice, to avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the first Edition (1987) of this Part 2, this second edition additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse.

b) Specific requirements for washing machines

IEC 60704-2-4, Edition 2 "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 2-4: Particular requirements for washing machines*", has been published in July 2001. The relevant text of Part 1 as amended by this publication, establishes the test code for washing machines and spin extractors. These particular requirements apply to single unit electric washing machines, the washing and spinning function of combined appliances for household and similar use, and to spin extractors.
The measuring conditions specified in this part of IEC 60704 provide for sufficient accuracy in determining the levels of noise emitted and comparing the results of measurements taken by different laboratories, whilst simulating as far as possible the practical use of washing machines and spin extractors. The textile load is standardized on the basis of those used for measuring performance (IEC 60456). To avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the first edition (1989) of this Part 2-4, the second edition additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse.

1.4.1.5 The standby measurement

The standby consumption of household electrical appliances is measured according to the standard IEC 60301, Ed. 1, 06.2005 "*Household Electrical Appliances – measurement of the standby power*, 2005. prepared by IEC TC59 "Performance of Household Electrical Appliances". Standby is defined as:

- **Standby mode:** the lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. The standby mode is usually a non-operational mode when compared to the intended use of the appliance's primary function.
- **Standby power:** average power in standby mode measured in Watts.

Since its publication, the standard has been used in Australia and Korea and now forms a fundamental element in the development of policies to influence standby power in these countries. The standard has also been adopted by the US EPA as the base method of test for determination of all low power modes for the International Energy Star program and is also cited under the US Presidential Executive Order for 1 Watt standby power levels as part of the Federal Energy Management Program. An IEA sponsored international conference on standby power in Seoul in November 2005 as a side event held a workshop on the use of IEC 62301.
As a result the worldwide living discussion about this standard and the EC founded study on standby[19] a number of recommendations were made regarding refinements to the IEC 62301 mainly regarding (i) the refinement of the definition of standby mode and (ii) data collection and analysis methods and defining stable conditions, which would improve its accuracy and practical application

A number of changes to both definitions and test conditions of IEC 62301 are under preparation by TC 59/WG 9 "Standby", which were only partially known when this Task Report was prepared.

The standard specifies methods of measurement of electrical power consumption in standby mode. It provides general conditions for measurements (configuration of the tested equipment, environment, power supply, supply-voltage waveform, power measurement accuracy, testing instrumentation, number of tests, and time of measurement) and the test procedure.

Annex A (informative) provides some guidance on the expected modes that would be found for various common appliance configurations and designs based on their circuitry and layout, but the standard does not define these modes.

a) The standby definition and measurement for wash appliances

Although washing machines and dishwashers are considered in IEC 62301, and examples are given on possible low power modes, the current edition of the product specific standards addressing the performance of the wash appliances does not contain any provision about "standby" and/or "low power modes". Therefore, at present, the standby consumption of such appliances is not defined and can not be measured.

Nevertheless, as mentioned in previous paragraph 1.4.1.2, the first draft of IEC 60456 5th Edition (March 2007) proposed a definition of "standby" and "left on" modes for **washing machines** as:

- ***standby mode***: is the lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. In user instructions, this state may be called "off" or "off mode".
  This definition is identical to "standby mode" in IEC 62301:2005. It was anticipated that TC59/WG9 was discussing both adjustments to the above definition and additional definitions for other low power modes. If finalised by TC59 prior to the publication of IEC 60456 5th Edition, the appropriate revised definitions will be included in the new washing machine standard.
- ***left on mode***: is the lowest power consumption mode that may persist for an indefinite time after the completion of the programme and unloading of the machine without any further intervention of the user. In some products this mode may be an equivalent power to standby mode.

[19] Tender TREN/D1/40/Lot 6, "Standby and Off-mode Losses, 2005.

In June 2007, the discussion of the comments received on the April draft of IEC 60456 5th Edition and the input from the experts in charge of the revision of the IEC 62301 lead to the partial modification of the above definitions, where the "standby mode" has been substituted by "off mode" as:

- ***off mode***: off mode is where the product is switched off using appliance controls or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a mains power source and used in accordance with the manufacturer's instructions. Where there are no controls, the washing machine is left to revert to a steady state power consumption of its own accord.

The definition of the *left on* mode has remained unchanged.

For **dishwashers** the standby issues is not considered in the current standard IEC 60346 but will be considered for inclusion in a new Edition following what already done for washing machines.

1.4.2 The European Standards

1.4.2.1 The measurement of energy consumption and other characteristics of wash appliances

The European standards for dishwashers and washing machines are EN 50242/A2 and EN 60456:2005 respectively.

a) The European standard for dishwashers

EN 50242 Ed.2/EN 60436, Electric dishwashers for household use - Test methods for measuring the performance, was published in October 2005. The standard contains the text of IEC60436, Edition 3 with the changes and added text as common modifications EN50242 Ed.2. The standard in Europe gets both numbers, EN60436 and EN50242 due to the labelling mandate of the European Commission.
This European Standard supersedes EN 50242:1998 and its amendments. It contains the first time as a complete version the text of IEC 60436 Ed.3 and additionally all common modifications necessary for application in Europe. The numbering was not changed, therefore it is not expected that this second edition of EN 50242 will influence energy label declaration in any way. The text of the International Standard IEC 60436 Ed.3:2003 was approved by CENELEC as a European Standard with some modifications:

- for energy labelling purposes the measurements are run only using cold water, the use of hot water is not permitted.
- the dishwasher manufacturer's instructions regarding installation and use of the dishwasher must be followed.
- the air dry method is not permitted for the preparation of the soiled place settings, only the microwave oven drying is allowed, using a standardised appliance;
- the cold water energy correction is not applied since the water temperature inlet at 15,0 °C is mandatory in Europe;
- the manufacturer has to declare the programme to be used for the purpose of energy labelling. It must be a programme for normal use, using normal table ware, excluding cooking utensils; .
- the water hardness, detergent (type B) type and quantity and rinse agent type (Formula III rinse aid, acid) are specified;
- better specification and preparation of soiling agents for the load and recommendation of not using a soiled load for more than 200 cycles;

- only the load specified in Annex A *Place settings and serving pieces (non-AHAM style load)* must be used for energy label purpose;
- if no other instruction by the manufacturer is given, the loading of the machine under test must be similar to the loading of the reference machine, especially in mixing the different soiling for the same kind of dishes. The dinner plates prepared with egg or mincemeat and the dessert dishes prepared with egg or spinach should be placed in the test machine alternating.
- when assessing the washing performance, only the cleaning index without machine filter cleaning is used;
- the drying performance tests are carried out in conjunction with the reference machine;
- running of a special normalization cycle of the load with 30 g of anhydrous fine granular citric acid after each cleaning performance and drying performance tests with five to eight cycles, in order to avoid residual scale formation on the test load. For a new test load, ten cycles using detergent and rinse aid are performed in order to avoid the deviations in the test results of tests performed with new load and used load;
- better specification of the assessment of the drying performance
- the standard deviation formulae have been added to evaluate the standard deviation of the measurements (cleaning and drying index) to be compared with a set threshold value;
- a specific Clause Z1 – *Data to be reported* has been set, describing the data to be reported for labelling compliance purposes;
- a specific Clause Z2 - *Tolerances and control procedure*, has been set, dealing with the control procedure of the declared values (cleaning performance, drying performance, energy consumption water consumption, cycle time) which is fundamental for the verification of the compliance to the energy labelling and other EU legislation on cold appliances.

a.1) Future development for EN 50242 Ed. 2/EN 60346

Further development of EN 50242 Ed. 2/EN 60346 will follow the evolution of the corresponding IEC standard.

b) European standard for washing machines

The text of the International Standard IEC 60456:2003 together with the common modifications prepared by the Technical Committee CENELEC TC 59X, "Consumer information related to household electrical appliances", was submitted to the formal vote and was approved by CENELEC as EN 60456 on 2004-10-01. EN 60456, *Clothes washing machines for household use -Methods for measuring the performance* (IEC 60456:2003, modified) published in March 2005 supersedes EN 60456:1999 and its Amendments: A11:2001, A12:2001, A13:2003. Many of the changes in the new IEC 60456:2003 had already been included in EN 60456:1999/A12:2001 and A13:2003. Consequently, the only significant technical difference with the previous edition of the EN is the allowance of three alternative methods to condition the load.

The standard EN 60456 represents the basis of the current European energy labelling system and needs to be revised in parallel with the international standard IEC 60456, the latter will in fact include changes to the test procedure in its 5th edition. An impact on test results is expected, which will effect the European energy labelling of washing machines (and is possible revision as one of the outcome of the preparatory study of the eco-design directive 2005/32/EC. This directive states that harmonized standards are essential in establishing testing methods, being one of the main roles of harmonised standards to help manufacturers in applying the implementing measures adopted under the EuP directive, if any.

b.1) Future developments for EN 60456

A project[20] is planned for the years 2007 to 2009, in order to update the test standard with regard to Ed.5 of IEC 60456 and the expected update of the standardization mandate from European commission.

A project proposal was prepared by CENELEC TC59X WG1. This proposal was made in the context of the standardization mandate M/047 for the elaboration and adoption of a measurement standard concerning the energy labelling of electrical washing machines and related to Council Directives 92/75/EEC and 95/12/EC. TC59X/WG1 is responsible within CENELEC to update the harmonised standard for washing machines under the mandate from the Commission. The main specific objectives of this project are:

- to run measurements of the washing machines performance under the updated methods described in IEC 60456 5th Ed. and to evaluate the possible consequences on the European energy labelling values;
- to identify the impact of the modifications introduced by IEC 60456 5th Ed. and to check the level of uncertainty reached with regard to the European labelling scheme of washing machines
- to confirm the new reference machine based on new procedures introduced with the new edition of IEC 60456
- to confirm the evaluation methods for the washing performance with new stain strips based on the new procedures
- to check the uncertainty in the performance measurements, to achieve more reliable figures, especially in the case the 40°C cotton program is used
- to develop procedures to test other load sizes than full load (the so called "partial load")
- to check the impact of reduced detergent dosage and clarify the possibility of a new approach for detergent dosing (which might have an influence on the washing performance)
- to check the improved rinsing method introduced in the new edition of IEC 60456 and to investigate further possibilities to evaluate the rinsing performance of washing machines (at present not taken into consideration in the European labelling scheme).

The tests planed under this project will pay particular attention to the analysis of the reproducibility of results with the 40°C washing cycle. This is considered a particularly important element since the relationship between achieved measurements and uncertainty is the basis for the repeatability and reproducibility of the test results

Testing for other than maximum load (partial load) has been under discussion for a long time and is considered by Consumer Organizations a possible improvement for further reduction of the energy consumption. Tests are needed to define how the appropriate test methods could be included in the washing machines standard.

Reduced detergent dosage for the standard tests is another field stressed by the detergent industry since long time. WG1 will check if an adjustment of the detergent dosage is acceptable at European level.

Finally, an improved procedure for rinsing performance (through alkalinity tests) will be introduced in IEC 60456 5th Ed. The reached level of uncertainty need to be checked before this test method could be considered in a future labelling scheme.

[20] Source: CLC TC59X/WG1, personal communication.

1.4.2.2 Safety Standards

Safety for wash appliances is mainly dealt by the following standards:

- the general part **EN 60335-1: 2002** *Household and similar electrical appliances - Safety* - **Part 1:** *General requirements* that it is common to all the electric motor appliances and a set of **Part 2** documents addressing the different specific products;
- for dishwashers, **EN 60335-2-5:2003** *Household and similar electrical appliances - Safety - Part 2-5: Particular requirements for dishwashers* applies plus **EN 61770:** *Electric appliances connected to the water mains - Avoidance of back-siphonage and failure of hose-sets* as far as the connection with the water supply is concerned;
- for washing machines, **EN 60335-2-7:2003** *Household and similar electrical appliances - Safety - Part 2-7: Particular requirements for washing machines* applies. If the washing machine includes also a spinning function, then **EN 60335-2-4:2002** *Household and similar electrical appliances - Safety - Part 2-4: Particular requirements for spin extractors* applies and if also a drying function in included in the appliance (the so called washer-dryer", the standard **EN 60335-2-11:2003/A2:2006** *Household and similar electrical appliances - Part 2-11: Particular requirements for tumble dryers* deals with the drying part. As far as the connection with the water supply, also washing machines shall comply with **EN 61770**: *Electric appliances connected to the water mains - Avoidance of back-siphonage and failure of hose-sets*" .

The mentioned standards address and implement an internationally accepted level of protection against hazards (such as electrical, mechanical, thermal, fire and radiation) when appliances are operated as in normal use, taking into account the manufacturer's instructions. The same standards cover also protection against further hazards deriving from abnormal situations that can be expected to happen during normal use.

Safety standards take also into account - as far as possible - the requirements of **IEC 60364**, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics*, to ensure compatibility with the wiring rules when the appliances are connected to the mains. Unfortunately, national wiring rules may differ. The main scopes of the LVD directive 73/23/EEC are also covered by the mentioned standards as well as the essential safety requirements of directives (which can be applied to some household and similar appliances), 98/37/EC (Machinery directive), 89/106/EEC (Construction products) and 97/23/EC (Pressure equipment).

Safety requirements include the definition of the characteristics of the product (rating plate), the construction verifications, the tests for compliance of plastic material with fire risks, and tests about electronic components. For example:

- heating tests for the electric components are run in a voltage range ± 6% of the nominal voltage, to take into consideration the possible variations in the supplied voltage;
- the tests for abnormal operation are performed simulating the lock of the components (locked rotor tests of motors and pumps) or simulating the mechanical lock of different switches (i.e. pressostat) and the closure of the water valve (practically simulating the operation without water in the appliance);
- appliances shall be constructed so that spillage of liquid in normal use does not affect their electrical insulation even if an inlet valve fails to close;
- appliances shall be constructed so that foaming does not affect electrical insulation. The verification of the possibility that water sprinkles penetrate inside the appliance and reduce the distances of insulation is run, to simulate appliances installation in a damp environment;
- the compliance of the materials to the temperatures and the resistance to fire is verified;

- the insulation distance between parts in tension and the mass, and between parts to double insulation is verified;
- tests are performed simulating the breakdown of the electronic components (used both for normal operation an for protection) in order to verify that also under these conditions appliances remain safe.

Future developments will probably include an amendment, where relevant of Part 1 and Parts 2, with respect to reasonably foreseeable situations where children, older people and people with disabilities come into contact with electrical household appliances. The Mandate on this matter was finalised in the European Commission and sent to CENELEC for discussion at the BT (technical bureau) meeting in December 2006. CLC TC61 WG4 "Use of appliances by vulnerable people, including children" has been created for this purpose. This working group studied and proposed the definition of specific categories of vulnerable people related to use of appliances:

1. *Very Young Children*: from 0 to 36 months. They are not expected to use appliances;
2. *Young Children*: older than 36 months and younger than 8 years. They are not expected to use appliances safely unless continuous supervision is given;
3. *Older Children*: age from 8-14 years. These children can use appliances safely after they have been given appropriate supervision or instruction concerning their use. The age of 8 years was taken considering the result of the ANEC report[21] that was the basis for starting the activity of the WG and that is mentioned in the Mandate;
4. *Children*: includes all the three above definitions
5. *Vulnerable people*: persons having reduced physical, sensory or mental capabilities (e.g. partially disabled, elderly having some reduction in their physical and mental capabilities), or lack of experience and knowledge (e.g. older children). These persons can use appliances safely after they have been given appropriate supervision or instruction concerning the use
6. *Very vulnerable people*: persons having very extensive and complex disabilities. These persons are not expected to use appliances safely unless continuous supervision is given or appliances are adapted accordingly with arrangements beyond those foreseen by the safety standards.

A proposal for a modification of EN 60335-2-7 for washing machines was prepared, in which the applicability clause has been modified to cover "the common hazards presented by appliances that are encountered by all persons in household and similar environments. However, in general, it does not take into account: (i) "children" playing with the appliance, (ii) the use of the appliance by "very young children" and "young children" without supervision It is recognized that "very vulnerable people" may have needs beyond the level addressed in the standard.

1.4.2.3 Noise measurement

Noise measurement for dishwashers is described in standard **EN 60704-2-3:2002/A1:2005** "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise -- Part 2-3: Particular requirements for dishwashers*". It applies to single-unit electric dishwashers for household and similar use, with or without automatic programme control, for cold and/or hot water supply, for detachable or permanent connection to water supply or sewage systems, intended for placing on the floor against a wall, for building-in or placing under a counter, a kitchen worktop or under a sink, for wall-mounting or on a counter.

[21] E. Waller, Child protective products – protective function of socket protectors, hob guards, locks and locking devices, Study commissioned by: ANEC (European Association for Consumer Representation in Standardisation), SP REPORT 2004:23.

For washing machines the standard is **EN 60704-2-4:2001** "*Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-3: Particular requirements for washing machine and spin extractors*". It applies to single unit electric washing machines, the washing and spinning function of combined appliances for household and similar use, and to spin extractors. The textile load is standardized on the basis of those used for measuring performance. To avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the previous edition, this standard additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse, therefore the operating conditions during these operations need careful attention.

Both EN standards implement without any modifications the International Standard IEC 60704-2-3:2005 and IEC 607042-4:2001 (see previous paragraph).

1.4.2.4 Standby measurement

The standby consumption of household electrical appliances is measured according to the European standard **EN 62301:2005** including the common modification agreed at European level to the international standard IEC 62301:2005, prepared by Technical Committee CENELEC TC59X "Consumer information related to household electrical appliances". The latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) is 1st June 2006, the latest date by which the national standards conflicting with the EN have to be withdrawn (dow) is 1st July 2008. The common modification to IEC 60301 refer to the definition of the power supply and the control procedure:

- specification **power supply**: where the test voltage and frequency are not defined by an external standard, the test voltage and test frequency shall be 230V ± 1% and 50Hz ± 1%. If the appliances are to be connected to three phases and the test voltage and frequency are not defined by an external standard the test voltage and test frequency shall be 400V ± 1% and 50Hz ± 1%;
- addition of a specific clause on **tolerances and control procedure**: Where tolerances and control procedures are not defined by an external standard, the tolerances and control procedures are:
  - for **power consumption >1W**: the standby power measured on the first appliance shall not be greater than the value declared by the manufacturer plus 15%. If the result of the test carried out on the first appliances is greater than the value declared plus 15%, the test for standby power shall be carried out on a further three appliances, which shall be randomly selected from the market. The arithmetic mean of the values of these three appliances for the standby power shall not be greater than the declared value plus 10%.
  - for **power consumption ≤ 1W**: the measured standby power shall not be greater than the value declared by the manufacturer plus 0,15W. If the result of the test carried out on the first appliance is greater than the declared value plus 0,15W, the test shall be carried out on a further three appliances, which shall be randomly selected from the market. The arithmetic mean of the values of these three appliances shall not be greater than the declared value plus 0,1 W.

The standard clearly states that it is a specific measurement procedure to be normally used as a reference standard in a product performance standard. When data on standby power are needed for a product, a new clause must be incorporate in the relevant performance standard.

EN 62301 specifies methods of measurement of electrical power consumption in standby mode. It is applicable to mains powered electrical household appliances or equipment and to the mains powered parts of appliances that use other fuels such as gas or oil. It does not specify minimum performance requirements nor does it set maximum limits on power or energy consumption. The

objective of the standard is to provide a method of test to determine the power consumption of a range of appliances and equipment in standby mode (generally where the product is not performing its main function). The test method is also applicable to other low power modes where the mode is steady state or providing a background or secondary function (e.g. monitoring or display). In this case the relevant low power modes (in addition to standby mode) to which the test procedure is applied should be defined by performance standards of appropriate appliances.

The power consumption is determined by recording the instrument power reading where the power value is stable or by averaging the instrument power readings over a specified period or by recording the energy consumption over a specified period and dividing by the time where the power value is not stable. The time period is not less than 5 minutes, except if there is an operating cycle.

General condition for measurement (including test room description, power supply, supply voltage waveform, power measurement accuracy) the selection and preparation of the appliance, the measurement procedure where the power value is – or is not – stable and the test report (including appliance details, test parameters, measured data, test and laboratory details) are described. General conditions about test conditions and equipment are applied unless otherwise specified.

Annex A (informative) provides some guidance on the expected modes that would be found for various common appliance configurations and designs based on their circuitry and layout, but the standard does not define these modes:

- ***Type A***: the appliance has no subsidiary load and no power switch. The appliance operates whenever plugged in. There may be some internal regulation of the load (e.g. thermostat or temperature control device). There is no standby power. Examples are: electric storage water heaters, refrigerators.
- ***Type B***: the appliance has a power switch. The appliance operates when it is manually turned on by the power switch and stops when turned off. Power switches can be the auto-off type (automatically turns off at the completion of the operation). There is no standby power. Examples are: electric heaters (with no thermostat), some major appliances (some **dishwashers**, **clothes washers** and clothes dryers) and some ovens.
- ***Type C***: the appliance has no (hard) power switch but has a subsidiary function that controls the operating load or performs some related function. There may be a remote control or electronic power switch. Standby power may be associated with the subsidiary function. Examples are: bread makers, some small kitchen appliances, some major appliances (some **dishwashers**, **clothes washers** and clothes dryers), some microwave ovens, any appliance with a remote control and no hard off switch, any appliance with a "soft" (electronic) power switch.
- ***Type D***: the appliance has a power switch that disconnects the operating load and has a subsidiary function that is permanently connected to the power. Standby power may be associated with the subsidiary function. Examples are: conventional ovens, some types of heaters, VCRs, any appliance that requires some power for a subsidiary function (clock, display, etc.).
- ***Type E***: the appliance has a power switch that disconnects the operating load. It may have a subsidiary function that is permanently connected to the power and/or one that is disconnected with the power switch. Standby power may be associated with the permanently connected subsidiary function. Other low power modes may be associated with the switched subsidiary function. Examples are: some microwave ovens, some major appliances (some **dishwashers**, **clothes washers** and clothes dryers), some types of heaters, any appliance that requires some power for a subsidiary function (clock, display, etc.), TVs, any appliance with permanently connected electronics or EMC filters.
- ***Type F***: the appliance has an external power supply that provides the appliance with power for its primary operation. Supply is usually extra low voltage (< 50V) and may be AC or DC and

may be connected via a plug. Appliance configuration may be A to E above. Standby is associated with the power supply and there may be numerous low power modes. Examples are: any appliance with an external power supply required for normal operation, some toys, some phones and answering machines.

- ***Type G***: the appliance has an external power supply that provides the appliance with power mainly for battery charging. The appliance primary operation is normally performed disconnected from the power supply (battery operated and portable appliances), but some may be used with the power supply connected. Supply is usually extra low voltage (< 50V) and may be AC or DC and is connected via a detachable plug. Standby is associated with the power supply and there are low power modes associated with battery charging and use. Examples are: portable battery operated appliances such as battery shavers, electric toothbrushes and portable vacuum cleaners.

Annex A describes also the major components in the appliance that affect power consumption:

- *Subsidiary function(s)*: subsidiary functions, some function(s) that are ancillary to the primary load, will usually consume small amounts of power. Some subsidiary functions may have a separate switch to disconnect them from the supply. Examples of subsidiary functions are:
  - remote control of power to the operating load (effectively a remote power switch);
  - automatic disconnection of the load on completion (auto off power switch);
  - display (could be mode, program, state or clock etc.);
  - low voltage power supply for memory and clock functions;
  - low voltage power supply for electronic controls and switches;
  - electromagnetic compatibility (EMC) filters;
  - running a cooling fan or auxiliaries.
- *Power switch***:** this allows the user to turn an appliance (or the operating load) ON or OFF. There are a number of variations of a power switch as follows:
  - *All off power switch*: results in the same state as being unplugged from the power supply when the switch is turned OFF.
  - *Auto power off switch*: turns 'ON' manually and turns 'OFF' automatically after finishing operation.
  - *Power control switch*: a power switch that incorporates some sort of power control device such as a dimmer or thyristor.
- *Operating load*: this is the main function of the appliance. Thermostats or temperature control devices to control the operating load are usually considered as part of the operating load and not as a power switch.

The standby consumption is not directly measured, but is indirectly calculated starting from the measurement of the standby power. In this respect, **Annex B** (informative) provides some guidance regarding the conversion of power measurements determined by the standard to energy consumption values and to solve a number of problems associated with power measurement of very small loads (typically less than 10W): non sinusoidal current waveforms, crest factor, harmonic components of the current waveform, cyclic or pulsing load effects, asymmetric current waveforms (DC components) and the characteristics of the instruments to be used for the power measurements.

Annex C (informative) provides some guidance regarding the conversion of power measurements determined under the standard to energy consumption values.
To convert power to energy (e.g. an annual energy consumption), the number of hours of operation in each mode must be assumed for a given period and the average power for each mode must also be known. As most appliances can operate in a number of modes and the usage patterns and profiles may vary considerably between countries, converting power values determined under this standard to energy values is potentially fraught with difficulty.

In the simplest case, an appliance that has only a single mode of operation can be converted to an annual energy value by assuming a constant power for a whole year. A year has 8.760 h (this ignores leap years),
Annual energy consumption can be determined can be determined for more complex user patterns by the sum of power × hours of use for each mode during one year.

Finally, **Annex D** provides information on the determination of uncertainty of measurement. To be meaningful, the uncertainty statement must have an associated confidence level: i.e. it is necessary to state the probability that the true value lies within the range given. A 95 % confidence level was chosen in the standard.

This European standard will follow the modifications of the corresponding IEC standard in due course.

1.4.3 The Standard used in Other Countries

Although an harmonisation process is on-going worldwide, still standards different from IEC ones are used in some regional markets.

1.4.3.1 The dishwasher standards worldwide

Few countries have developed standards for the measurement of dishwashers.

a) Australia and New Zealand

Dishwashers in Australia and New Zealand are measured according to the standard AS/NZS 2007:2005 "*Performance of household electrical appliances - Dishwashers*".

The dishwasher standard **AS/NZS 2007:2005**[22] "*Performance of household electrical appliances - Dishwashers*" was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-015, Quality and Performance of Household Electrical Appliances, to supersede the former standard AS/NZS 2007.1:2003. The AS/NZS 2007 series comprises two Parts:

1. AS/NZS 2007.1 Part 1: *Methods for measuring performance, energy and water consumption*, which includes performance test procedures and minimum performance criteria for dishwashers;
2. AS/NZD 2007.2 Part 2: *Energy efficiency labelling requirements*, which includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application for registration for energy efficiency labelling. It also includes the application form for registration for water efficiency labelling. It has been structured to be suitable for reference in regulatory legislation and to be used in conjunction with Part 1.

The overall objective of the AS/NZS 2007 series is to promote high levels of performance, energy efficiency and water efficiency in electric dishwashers.

AS/NZS 2007.1 standard includes a number of requirements derived from the 3rd Edition of IEC 60436: 2004, which will bring it closer to the IEC standard. It also incorporates the following significant changes in comparison to earlier editions:

i. Test methods have generally been made more repeatable and reproducible;

[22] Source: "Preface and Foreword from AS/NZS 2007:2005: Performance of household electrical appliances-Dishwashers Part 1: Energy Consumption and Performance – 2005", see: http://www.energyrating.gov.au/dw2.html .

ii. It is intended to phase out the AS/NZS test load by December 2007, until that date, the AS/NZS test load (without serving utensils and bowls) is allowed as an alternative to the IEC test load;
iii. A "test program" has been defined and it has been clarified that any program can be tested to this standard, but the performance requirements in Section 4 only apply to the program recommended for a normally soiled load. The program for a normally soiled load is the program mandated for energy efficiency labelling in AS/NZS 2007 – Part 2;
iv. definitions in this Standard are now generally aligned with IEC definitions;
v. program time and cycle time have been added to the definitions;
vi. power measurements on a number of standby modes are now required. Standby modes have been added to the definitions and examples of the types of standby modes have been added in Appendix M (the impact of communication by appliances over a network is under consideration);
vii. there are improved instructions regarding the use of the reference machine;
viii. a recommendation to purchase all test materials from the same sources has been added to minimize variations in test results. These materials will be used for check testing.
ix. A number of performance requirements must be met by dishwashers during a test for energy consumption. These include:
→ *washing index*: the washing index of the test machine must exceed the specified value measured on the reference machine which is tested in parallel. The reference machine is a dishwasher which specially constructed and calibrated for this purpose;
→ *drying index*: the drying index of the test machine must exceed 50% (this is conducted as a separate test);
→ *rated capacity*: all specified load items shall be supported;
→ *water consumption*: shall not exceed 110% of the value stated by the manufacturer.
→ *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
→ *energy consumption* is determined on the program recommended by the manufacturer for energy labelling that is capable of meeting the above mentioned requirements. From April 2004, all dishwashers are to be re-labelled using the "normal" program when tested to the 2003 Edition of AS/NZS 2007.1;
x. the ambient air temperature is 20°C ± 2°C and the humidity is 60% ± 5%. All tests are undertaken with a power supply at 240 Volts and 50 Hz.

AS/NZS 2007:2005 is broadly based on the old Edition of the international standard IEC 60436:1981 and on the revised test method published in IEC 60436, Edition 3, February 2004. Still there are differences between the AU/NZS and the IEC 60436 Ed.3, which can be summarised as:

(a) IEC 60436, Edition 3 uses the "universal 65°C" as the reference program to determine a relative performance index for declaration by the manufacturer (wash and dry performance is included on the EU energy label). The reference program on the reference machine used in the AU/NZ standard is "gentle 45°C" which is used to set a pass/fail for wash performance, rather than a manufacturer declaration of wash performance. IEC 60436, Edition 3 also uses the reference machine to assess drying performance whereas it is not used for assessing drying performance in AS/NZS 2007:2005;
(b) AS/NZS 2007:2005 allows at present the use of an IEC load (without serving items) or the original AS/NZS load as an alternative. IEC also allows an AHAM (US) load as an alternative to the so called European load. The AS/NZS load is to be phased out by December 2007;
(c) there are slight differences in the ambient humidity requirements between AS/NZS (60%) and IEC (55% or 65% dependent on the soil drying method);

(d) the food items used for soiling the load in AS/NZS more closely resembles the soiling from IEC 60436:1981. AS/NZS still uses tomato juice while the IEC 60436, Edition 3 uses milk treated in a microwave as well as minced meat. Some soil items are slightly different (e.g. tinned spinach versus frozen spinach) and the preparation of some items and the allocation of soils to the load itself are also slightly different;
(e) AS/NZS cold water supply temperature is 20°C while IEC is 15°C;
(f) AS/NZS water hardness is soft (45 ppm) while IEC specify both soft (≤70 ppm) and hard (250 ppm) water alternatives; water pressure is 320 kPa in AS/NZS while IEC is 240 kPa;
(g) AS/NZS reference detergent is based on the old IEC type A (phosphate based with chlorine bleach), while IEC specifies type C detergent (phosphate based with oxygen bleach and enzymes). IEC also have new rinse agent formulations (types III and IV). In Europe, CENELEC still use detergent B and the older rinse aid formulations;
(h) AS/NZS requires the manufacturer to specify the amount of detergent to be used, whereas IEC specifies a default detergent quantity where an amount is not specified by the manufacturer. AS/NZS and IEC both specify maximum detergent quantities, which may be used for testing;
(i) In AS/NZS the reference machine water softener is de-activated while in IEC it is allowed to operate normally (noting that most IEC tests will be done with hard water and tests under AS/NZS use soft water). Most dishwashers in Australia and New Zealand do not have a water softener;
(j) AS/NZS use the reference machine only for assessing the washing performance while IEC use it for assessing washing and drying performance;
(k) IEC allows the use of either oven drying or air drying of the soiled load prior to washing while AS/NZS only allow air drying;
(l) AS/NZS and IEC now specify the lighting conditions for washing and drying evaluations. The viewing cabinet previously mandatory in AS/NZS, has been moved to an informative Appendix L;
(m) AS/NZS and IEC evaluation scoring systems are now aligned;
(n) AS/NZS requires filter cleaning between test runs while IEC specify that filters are not cleaned between runs. IEC classify filters into 3 main categories and require a minimum of 5 tests (but could be as many as 10 tests) on each dishwasher, depending on variability and performance without filter cleaning;
(o) AS/NZS now requires standby power measurements on a number of modes (under consideration in IEC);
(p) IEC requires that the load be pre-conditioned in a dishwasher with IEC rinse aid prior to use in a performance test. AS/NZS does not specify any particular requirements other than the load is clean prior to use.

b) USA

In the USA dishwashers are measured under the US Department of Energy Code of Federal Regulations (CFR 10, Part 430, Subpart B, Appendix C - U*niform Test Method for Measuring the Energy Consumption of Dishwashers*), which incorporates and refers to the American National Standard, Household Electric Dishwashers, ANSI/AHAM DW-1-1992. This standard establishes a separate test for soil-sensing machines, compared to non-soil-sensing machines and considers 215 cycles per year compared to the previous edition in 2001 where 264 cycles per year were used. The test procedure for soil sensing dishwashers reflects the combined efforts of many stakeholders who have worked with the DoE to find a more accurate way of testing dishwasher models which use smart technology to sense and adjust the length of the wash cycle according to the soil level of the dish load.

The standard sets first a series of definitions:

- **Compact dishwasher**: a dishwasher that has a capacity of less than eight place settings plus six serving pieces as specified in ANSI/AHAM DW-1
- **Standard dishwasher**: a dishwasher that has a capacity equal to or greater than eight place settings plus six serving pieces as specified in ANSI/AHAM DW-1
- **Cycle type**: any complete sequence of operations capable of being preset on the dishwasher prior to the initiation of machine operation
- **Normal cycle**: the cycle type recommended by the manufacturer for completely washing a full load of normally soiled dishes including the power-dry feature
- **Non-soil-sensing dishwasher**: a dishwasher that does not have the ability to adjust automatically any energy consuming aspect of a wash cycle based on the soil load of the dishes.
- **Soil-sensing dishwasher**: a dishwasher that has the ability to adjust any energy consuming aspect of a wash cycle based on the soil load of the dishes.
- **Standby mode**: the lowest power consumption mode which cannot be switched off or influenced by the user and that may persist for an indefinite time when the dishwasher is connected to the main electricity supply and used in accordance with the manufacturer's instructions
- **Water-heating dishwasher**: a dishwasher which, as recommended by the manufacturer, is designed for heating cold inlet water (nominal 50°F/10°C) or designed for heating water with a nominal inlet temperature of 120°F/48,9°C. Any dishwasher designated as water-heating (50 °F or 120 °F inlet water) must provide internal water heating to above 120 °F in at least one wash phase of the normal cycle.
- **Truncated normal cycle**: the normal cycle interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

The designation of dishwasher type determines whether a dishwasher will be tested with clean or soiled dishes. The two definitions use the ability, or lack of ability, to adjust automatically any energy consuming aspect of a wash cycle based on the soil load of the dishes as the determinant for distinguishing dishwasher type.

Non-soil-sensing dishwashers, tested at a nominal inlet temperature of 50°F/10°C or 120°F/48,9°C, must be tested on the normal cycle with a clean load of eight place settings plus six serving pieces. If the capacity of the dishwasher, as stated by the manufacturer, is less than eight place settings, then the test load must be the stated capacity.

Soil-sensing dishwashers, tested at a nominal inlet temperature of 50°F/10°C, 120°F/48,9°C or 140°F/60°C, must be tested first for the sensor heavy response, then tested for the sensor medium response, and finally for the sensor light response with the combinations of soiled and clean test loads defined for the compact and standard machine type.

Only water-heating dishwashers - that operate with a nominal inlet temperature of 50°F/10°C or 120°F/48,9°C - can be tested according to Appendix C.

Test procedures allow to measure:

- *Machine electrical energy consumption*: M, expressed as the number of kilowatt-hours of electricity consumed by the machine during the entire test cycle, using a water supply temperature and a watt-hour meter;
- *Water consumption*.: V, expressed as the number of gallons of water delivered to the machine during the entire test cycle, using a water meter;

- *Standby power*: for stable operation, standby power, S_m, can be recorded directly from the standby watt meter in Watts or accumulated using the standby Watt-hour meter over a period of at least 5 minutes. For unstable operation, the energy must be accumulated using the standby watt-hour meter over a period of at least 5 minutes and must capture the energy use over one or more complete cycles. Calculate the average standby power, S_m, expressed in Watts by dividing the accumulated energy consumption by the duration of the measurement period.

After the running of the tests, results are calculated from the test measurements:

- **Machine energy consumption**
  - *Machine energy consumption for non-soil-sensing electric dishwashers*, M, the value recorded as the per-cycle machine electrical energy consumption, expressed in kilowatt-hours per cycle;
  - *Machine energy consumption for soil-sensing electric dishwashers*, M, the machine energy consumption for the sensor heavy, normal and light cycle, as defined as:
    $M = (M_{hr} \times F_{hr}) + (M_{mr} \times F_{mr}) + (M_{lr} \times F_{lr})$, where:
    - M_{hr} = the value recorded for the test of the sensor heavy response
    - M_{mr} = the value recorded for the test of the sensor medium response
    - M_{lr} = the value recorded for the test of the sensor light response
    - F_{hr} = the weighting factor based on consumer use of heavy response, equal to 0,05
    - F_{mr} = the weighting factor based on consumer use of medium response, equal to 0,33
    - F_{lr} = the weighting factor based on consumer use of light response, equal to 0,62.

- **Drying energy**
  - *Drying energy consumption for non-soil-sensing electric dishwashers*, E_D, the amount of energy consumed using the power-dry feature after the termination of the last rinse option of the normal cycle, expressed in kilowatt-hours per cycle;
  - *Drying energy consumption for soil-sensing electric dishwashers*, E_D, for the sensor normal cycle is defined as:
    $E_D = (E_{Dhr} + E_{Dmr} + E_{Dlr})/3$, where:
    - E_{Dhr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor heavy response
    - E_{Dmr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor medium response
    - E_{Dlr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor light response

- **Water consumption**
  - *Water consumption for non-soil-sensing dishwashers* using electrically heated, gas-heated, or oil-heated water, V, the value recorded as the per-cycle water energy consumption, expressed in gallons per cycle
  - *Water consumption for soil-sensing dishwashers using electrically heated, gas-heated, or oil-heated water*, V, as the water consumption for the sensor normal cycle, defined as:
    $V = (V_{hr} \times F_{hr}) + (V_{mr} \times F_{mr}) + (V_{lr} \times F_{lr})$, where:
    - V_{hr} = the value recorded for the test of the sensor heavy response
    - V_{mr} = the value recorded for the test of the sensor medium response
    - V_{lr}= the value recorded for the test of the sensor light response
    - F_{hr} = the weighting factor based on consumer use of heavy response, equal to 0,05
    - F_{mr} = the weighting factor based on consumer use of medium response, equal to 0,33
    - F_{lr} = the weighting factor based on consumer use of light response, equal to 0,62.

- **Water energy consumption for non-soil-sensing or soil-sensing dishwashers using electrically heated water**

  - *Dishwashers that operate with a nominal 140 °F inlet water temperature, only*, W, for the normal and truncated normal test cycle, expressed in kilowatt-hours per cycle and defined as:
    W = V × T × K, where:
    – V = water consumption in gallons per cycle
    – T = nominal water heater temperature rise, equal to 90 °F,
    – K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit, equal to 0,0024.

  - *Dishwashers that operate with a nominal inlet water temperature of 120 °F*, W, for the normal and truncated normal test cycle, expressed in kilowatt-hours per cycle and defined as:
    W = V × T × K, where:
    – V = water consumption in gallons per cycle
    – T = nominal water heater temperature rise, equal to 70 °F,
    – K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit, equal to 0,0024.

- **Water energy consumption per cycle using gas-heated or oil-heated water**

  - *Dishwashers that operate with a nominal 140 °F inlet water temperature, only*, W_g, for each test cycle, the water energy consumption using gas-heated or oil-heated water, expressed in Btu's per cycle and defined as:
    W_g= V × T × C/e, where:
    – V = reported water consumption in gallons per cycle
    – T = nominal water heater temperature rise, equal to 90 °F,
    – C = specific heat of water in Btu's per gallon per degree Fahrenheit, equal to 8,2,
    – e = nominal gas or oil water heater recovery efficiency, equal to 0,75.

  - *Dishwashers that operate with a nominal inlet water temperature of 120 °F.* For each test cycle, calculate the water energy consumption using gas heated or oil heated water, W_g, expressed in Btu's per cycle and defined as:
    W_g = V × T × C/e, where:
    – V = reported water consumption in gallons per cycle
    – T = nominal water heater temperature rise, equal to 70 °F,
    – C = specific heat of water in Btu's per gallon per degree Fahrenheit, equal to 8,2,
    – e = nominal gas or oil water heater recovery efficiency, equal to 0,75.

- **Annual standby energy consumption**

To calculate the estimated annual standby energy consumption, first determine the number of standby hours per year, H_s, defined as:

$H_s = H - (N \times L)$

where:
– H = the total number of hours per year or 8 766

– N = the representative average dishwasher use of 215 cycles per year
– L = the average of the duration of the normal cycle and truncated normal cycle, for non-soil-sensing dishwashers with a truncated normal cycle; the duration of the normal cycle, for non-soil-sensing dishwashers without a truncated normal cycle; the average duration of the sensor light response, truncated sensor light response, sensor medium response, truncated sensor medium response, sensor heavy response, and truncated sensor heavy response, for soil-sensing dishwashers with a truncated cycle option; the average duration of the sensor light response, sensor medium response, and sensor heavy response, for soil-sensing dishwashers without a truncated cycle option;

then calculate the *estimated annual standby power use*, S, expressed in kilowatt-hours per year and defined as:

$S = S_m \times (H_s/1000)$, where S_m= the average standby power in Watts.

1.4.3.2 The washing machine standards worldwide

a) Australia and New Zealand

Washing machines in Australia and New Zealand are measured according to the standard: **AS/NZS 2040:2000**[23] *Performance of household electrical appliances - Clothes washing machines* prepared by the Joint Standards Australia/Standards New Zealand Committee EL-015, Quality and Performance of Household Electrical Appliances. The AS/NZS 2040 series comprises two Parts:

1. AS/NZS 2040.1 Part 1: *Energy consumption and performance*, includes performance test procedures and minimum performance criteria for washing machines. It has been structured to be suitable for reference in regulatory legislation and to be used in conjunction with Part 2;
2. AS/NZD 2040.2 Part 2: *Energy labelling requirements*, includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application thereof.

The overall objective of the AS/NZS 2040 series is to promote high levels of performance and energy efficiency in electric clothes washers. It is based on IEC 60456:1994, *Electric clothes washing machines for household use-Methods for measuring the performance*. But it differs from IEC standard in a number of ways, as follows:

1. specific minimum performance requirements for washing, spinning and severity of washing are included (these are not specified by the IEC) in Part 2;
2. the water hardness is specified as 0,45 mmol/litre (in IEC 60456 is 2,5 mmol/litre);
3. the cold water temperature is 20°C (in IEC 60456 is 15°C);
4. a particular phosphate-based detergent is used for other than drum type machines (not specified by IEC);
5. only IEC Type B phosphate-based detergent is used for drum type machines (IEC nominates two detergents, with the stated intention of deleting Type B in the future);
6. AS9 soil swatches are used (IEC specifies four separate soil swatches which include carbon, blood, wine and chocolate);
7. a mixed cotton and polyester/cotton load is used (IEC specifies only sheets, towels and pillowcases for cotton);
8. Each AS9 soil batch is calibrated against a reference batch (soil batch calibration is not specified by IEC);

[23] Source: Preface and Foreword from AS/NZS 2040:2000: Performance of household electrical appliances-Clothes washing machines Part 1: Energy Consumption and Performance - 2005, see: http://www.energyrating.gov.au/cw2.html

9. the laboratory reference machine is not used to normalize results (IEC specifies a Wascator reference machine to normalize results);.
10. the water extraction (spin) index is based on bone dry mass (IEC index is based on normalized mass with a nominal 8% moisture content);
11. whiteness retention test (informative) is included (not specified by IEC);
12. Tests for rinse performance is included in Annex N (added in Amendment 4, of August 2005, with a different method compared with IEC);
13. Tests for mechanical detergent loss in the sump and acoustical noise are not included (these are specified by IEC).

The standard **AS/NZS 2040-1, Amendment No. 4, August 2005** includes Appendix N - *Determination of rinse performance* and Appendix O – *Measurement of PBIS concentration in the supply water and extracted liquor samples*.

Appendix N sets out the procedure for determining the rinse performance of a clothes washing machine, through UV spectrophotometric measurement of a chemical marker (2-phenyl-5-benzimidazole-sulfonic acid or PBIS) in the rinse liquor extracted from the wet load at the end of the program.

The test for rinse performance is carried out in conjunction with tests to determine percentage soil removal, energy and water consumption, water extraction index, and severity of washing action index in accordance with Appendices D, E, F and G respectively of the standard AS/NZS 2040-1.

Rinse performance of a washing machine is determined by measuring the mass, per kilogram of rated load, of a marker (PBIS) present in the rinse liquor that is retained in the wet load at the end of the program. The marker, analytical grade 2-phenyl-5-benzimidazole-sulfonic acid (PBIS) with a purity of 98% or better, is dosed into the wash program in proportion to the rated load, the dosage being 100mg PBIS per kilogram of rated load. A standard percentage soil removal test is then conducted in accordance with Appendix D of AS/NZS 2040-1, using a conditioned load. At the completion of this test (following the weighing of the load) the load is placed in a spin extractor and a sample of rinse liquor recovered. A spin extractor of any size may be used for the purpose of this test provided that it can generate sufficient G force to extract from the rinsed load sufficient rinse liquor (typically 100 ml, but no more than 150 ml) for the purpose of UV spectrophotometric measurement of the extracted sample. Ideally a spin extractor that can accommodate the entire load in a single run should be used. If a smaller spin extractor is used, the entire load will need to be divided into two or more equal parts.

Using UV spectrophotometry the concentration of retained PBIS is then determined by comparison with measurements from solutions of known PBIS concentration.

The rinse performance is then determined from the concentration of PBIS in the extracted rinse liquor multiplied by the mass of retained moisture in the load measured at the end of the program. As a check on the accuracy of the dosing of PBIS, a sample of the wash liquor is also collected during the test and measured for PBIS concentration.

The rinse performance score (in mg/kg of load) is determined from the following equation:

$$\text{Rinse performance score} = \frac{C_m \times m_r}{RC}$$

where:

- C_m = concentration of PBIS found in the rinse liquor adjusted as required for the apparent concentration of PBIS in the supply water (mg/l)
- m_r = mass of retained moisture in the load (kg)
- RC = rated load capacity claimed by the manufacturer for a normally soiled load (kg).

A test is not valid unless the following criterion is met:

$$PBIS_{wash} \geq 0{,}7 \times \frac{M_{PBIS}}{Q_{wash \cdot tot}}$$

where:

- $PBIS_{wash}$ = the concentration of PBIS found in the sample of wash liquor (mg/l)
- M_{PBIS} = the dose (mass) of PBIS used in the test (mg)
- $Q_{wash\ tot.}$ = the total volume of water, including any water added with the detergent, used in the initial wash operation (i.e. up until first pump out) (litres)

The procedure for measuring the concentration of PBIS in the supply water and extracted liquor samples is specified in Appendix O: the test procedure employs the measurement of the absorbance of ultraviolet light by a sample water at the absorbance maximum for PBIS (302 nm) and at a background point of 330 nm. The measurement of a background point at 330 nm enables correction for background absorbance due to turbid samples.

b) China

Energy consumption of clothes washers is specified in the standard GB/T 4288-1992, *Household electric washing machines*, but no other information are available about the measurement method.

c) Japan

Standard for washing machine in Japan is JIS C 9811:1999 "*Electric clothes washing machines for household use - Methods for measuring the performance*", IEC 60456:1994 (MOD). JIS standard reflects the structure of the IEC standard for washing machines, but changes in structure are permitted provided that the altered structure permits easy comparison of the content of the two standards.

d) USA

The test methods for domestic and commercial washing machines in force since January 2004 in USA is described in the Federal Register: 10 CFR Section 430.23(j), i.e. Appendix J1 to Subpart B of Part 430 (2005).

The US government established the first federal policy measure, including the relevant standard, for washing machines in 1977[24]. In the 1990's, concurrent with the development of new energy conservation policies for this appliance group, the Department of Energy began also revising the test method. The existing standard in fact did not cover a number of innovative washing machine technologies such as high spin speed and adaptive water fill control, and DoE published several proposals to address those innovations. Contemporarily, the Association of Home Appliance Manufacturers (AHAM) requested that DoE adopt an additional new standard that would also capture consumer habits that showed a reduction in the use of hot water and energy. AHAM

[24] Source: US Federal Register / Vol. 68, No. 211 / Friday, October 31, 2003 / Rules and Regulations.

proposed also that DoE incorporate this test method as part of the process of revising the washing machine energy conservation policies, and that the test go into effect concurrently with the issuance of new efficiency requirements.
On April 22, 1996, the DoE proposed such a new standard, described in Appendix J1, as well as certain additional revisions to the currently applicable test procedure, described in Appendix J to subpart B of 10 CFR part 430. Appendix J expired on 31st December 2003 and Appendix J1 became mandatory and replaced Appendix J when the energy conservation requirements (adopted on 12th January, 2001) took effect on 1st January 2004.

A key difference between the old Appendix J and the new Appendix J1 test method is the basic energy efficiency descriptor. Appendix J specifies an energy efficiency descriptor called the "**Energy Factor**" (EF). The Appendix J1 test method replaces the EF with an energy efficiency descriptor called the "**Modified Energy Factor**" (MEF). In contrast with the previous EF descriptor which only calculated the energy use of the washing machine itself, the MEF descriptor accounts for the remaining moisture content (RMC) of clothes leaving the washing machine. In order to calculate the RMC, Appendix J1 requires manufacturers to use a particular lot of standardized test cloth to simulate a washer load of clothes. Other substantive differences between the old and new standards include using different water temperatures for testing and using test cloth loads for all classes of washing machines in Appendix J1, but not in previous Appendix J. Nevertheless, still Appendix J1 does not provide a means for determining the energy consumption of a washing machine with an adaptive control system other than an adaptive water fill control.

To insure that the use of a specific manufacturer's product (i.e. a real washing machine) would not influence or bias the test results in any way, the DoE developed also a test using an extractor working at different gravitation forces (g forces) to remove moisture content, instead of using a washing machine. The cloth were also soaked in a tub at a controlled temperature to approximate the agitated soak cycle provided by a typical washing machine. The extractor-based test examined RMC values at different "g" forces so that new batches of test cloth could be compared to the RMC values of a standard reference test cloth. This comparison provided the basis for developing a correction methodology whereby the test results using any new lot of cloth could be ''corrected'' back to the test values of the base reference lot of cloth. This deviation is measured as the root mean square between the set of measured RMC values and the set of standard RMC values. If this absolute deviation is below 2%, then correction factors are unnecessary in MEF tests using that batch of cloth, if the deviation is above 2%, then correction factors are necessary when using the cloth to test the MEF of a washing machine. The range of test conditions (100, 200 and 350 spin g's, with warm (100°F/37,7°C) and cold (60°F/15,5°C) rinse water, and with spin times of 4 minutes and 15 minutes) brackets the actual conditions under which manufactured residential washing machines operate and will be tested according to the Appendix J1 standard. The 100–350g range bounds the lower and upper levels of spin speeds; the use of both warm and cold water temperatures serves to identify any changes in test results of the test cloth due to water temperature variation; the use of 4 and 15 minute spin times bounds the various spin cycle times in a real washing machine. Thus, by averaging of this combination of test cycles, the test procedure created a representative profile of the spin and extraction behaviour of the test cloth. In addition, a second statistical test (ANOVA analysis of variance) to validate new lots of energy test cloth was included.

The new standard, applied to test machines from 1st January 2004 sets the definition of washing machine (named cloth washer in US) and classifies residential ones in 5 main categories based on size and features, such as suds-saving. Main definitions are:

- **Adaptive control system**: a clothes washer control system, other than an adaptive water fill control system, which is capable of automatically adjusting washer operation or washing conditions based on characteristics of the clothes load placed in the clothes container, without

allowing or requiring consumer intervention or actions. The automatic adjustments may, for example, include automatic selection, modification, or control of any of the following: wash water temperature, agitation or tumble cycle time, number of rinse cycles, and spin speed. The characteristics of the clothes load, which could trigger such adjustments, could, for example, consist of or be indicated by the presence of either soil, soap, suds, or any other additive laundering substitute or complementary product;

- **Adaptive water fill control system**: a clothes washer water fill control system which is capable of automatically adjusting the water fill level based on the size or weight of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions;
- **Compact clothes washer**: a clothes washer which has a clothes container capacity of less than 45 litre (1,6 ft^3);
- **Standard clothes washer**: a clothes washer which has a clothes container capacity of 45 litre (1,6 ft^3) or greater;
- **Water-heating clothes washer**: a clothes washer where some or all of the hot water for clothes washing is generated by a water heating device internal to the clothes washer.
- **Non-water-heating clothes washer**: a clothes washer which does not have an internal water heating device to generate hot water;
- **Energy test cycle** for a basic model: means (A) the cycle recommended by the manufacturer for washing cotton or linen clothes, and includes all wash/rinse temperature selections and water levels offered in that cycle, and (B) for each other wash/rinse temperature selection or water level available on that basic model, the portion(s) of other cycle(s) with that temperature selection or water level that, when tested pursuant to these test procedures, will contribute to an accurate representation of the energy consumption of the basic model as used by consumers. Any cycle under (A) or (B) shall include the agitation/tumble operation, spin speed(s), wash times, and rinse times applicable to that cycle, including water heating time for water heating clothes washers;
- **Load use factor**: the percentage of the total number of wash loads that a user would wash a particular size (weight) load;
- **Temperature use factor**: for a particular wash/rinse temperature setting, the percentage of the total number of wash loads that an average user would wash with that setting;
- **Modified energy factor**: is the quotient of the cubic foot (or litre) capacity of the clothes container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption and the energy required for removal of the remaining moisture in the wash load;
- **Water consumption factor**: is the quotient of the total weighted per-cycle water consumption divided by the cubic foot (or litre) capacity of the clothes washer.

The test method is based on an **energy test cloth**, made from specified energy test cloth material, which is prepared (washed and dried) according to the standard specifications. It is then pre-conditioned in a clothes washer by performing 5 complete normal wash-rinse-spin cycles, the first two with AHAM Standard detergent 2A and the last three without detergent. The moisture absorption and retention characteristics are evaluated for each new lot of test cloth following the Standard Extractor Remaining Moisture Content (RMC) Test.

Test loads are prepared using conditioned energy test cloths. The test load sizes and corresponding water fill settings to be used when measuring water and energy consumptions of manual and adaptive water fill control machines are shown in Table 3. Test loads for energy and water consumption measurements are bone dry prior to the first cycle of the test, and dried to a maximum of 104% of bone dry weight for subsequent testing. The energy test cloths is load by grasping them

in the centre, shaking them to hang loosely and then put them into the clothes container prior to activating the clothes washer.

Table 3: Test load sizes and water fill settings required

Manual water fill control system		**Adaptive water fill control system Max**	
Test load size	Water fill setting	Test load size	Water fill setting
Min Max	Min Max	Min Average Max	as determined by the clothes washer

Clothes washers are pre-conditioned before measuring the water and energy consumption:

- non water-heating clothes washer is pre-conditioned by running it through a cold rinse cycle and then draining it to ensure that the hose, pump, and sump are filled with water, if the machine has not been filled with water in the preceding 96 hours;
- water-heating clothes washer is pre-conditioned by running a cold rinse cycle and then draining it to ensure that the hose, pump, and sump are filled with water, if the machine has not been filled with water in the preceding 96 hours, or if it has not been in the test room at the specified ambient conditions for 8 hours. Test room temperature for water-heating clothes washers. Maintain the test room ambient air temperature at 23,9°C ± 2,8°C (75°F ± 5°F).

Clothes container capacity, C, in cubic feet (litres) is determined by measuring the entire volume which a dry clothes load could occupy within the clothes container during washer operation using water as:

$C = \frac{W}{d}$, where:

W = mass of water in pounds (kilograms)
d = density of water or 62,0 lbs/ft^3 for 100 °F (993 kg/m^3 for 37,8 °C); 62,3 lbs/ft^3 for 60 °F (998 kg/m^3 for 15,6 °C).

Procedure for measuring **water and energy consumption values** on all automatic and semi-automatic washers is performed under the energy test cycle(s) specifically defined for the different clothes washer types, based on the number of wash/rinse temperature selections available on the model, and also, in some instances, method of water heating. The procedures are applicable regardless of a clothes washer's washing capacity, loading port location, primary axis of rotation of the clothes container, and type of control system. In particular:

- for automatic clothes washers inlet water temperature and the wash/rinse temperature are set. The wash temperature can be: extra hot (>135 °F/57,2 °C), hot (135±5 °F or 57,2±2,8 °C)., warm (100±10 °F or 37,8±5,5 °C), or cold (60±5°F or 15,6± 2,8°C); rinse is always cold. Total water consumption during the energy test cycle is measured, including hot and cold water consumption during wash, deep rinse, and spray rinse;
- for clothes washers with adaptive water fill control system and alternate manual water fill control systems to be selected by consumers, then both manual and adaptive modes are tested and the average of the two values (one from each mode, adaptive and manual) for each variable is used;
- for clothes washers with not user adjustable adaptive water fill control system, the maximum, minimum and average water levels are interpreted to mean that amount of water fill which is selected by the control system when the respective test loads are used;

- for clothes washers with user adjustable adaptive water fill control system, four tests are conducted combining the possible combinations of test load and adaptive water fill control system;
- For clothes washers with manual water fill control system, the water fill selector shall be set to the maximum water level available on the clothes washer for the maximum test load size and set to the minimum water level for the minimum test load size.

A table specifies the test to be conducted for each machine type depending on the number of wash temperature selections available.

Water and electrical energy consumption is determined for each water fill level and/or test load size according to the standard. Then the **Remaining Moisture Content** is measured, using the wash temperature the same as the rinse temperature for all testing and the maximum test load, as the difference between the "bone dry" weight of the test load and the weight of the test load after the run of the "energy test cycle" according the specific conditions for clothes washers with cold rinse only and for clothes washers with cold and warm rinse options.

After the running of the test, results are calculated from the test measurements:

- **Hot water and machine electrical energy consumption** of clothes washers

  - *per-cycle temperature-weighted hot water consumption* for maximum, average, and minimum water fill levels using each appropriate load size, calculated for the cycle under test for the maximum water fill level, the average water fill level, and the minimum water fill level, expressed in gallons per cycle (or litres per cycle). The general formula is:

    $Vh = [Hm \times TUF_m] + [Hh \times TUF_h] + [Hw \times TUF_w] + [Hc \times TUFc] + [R \times TUF_r]$, where:
    - Hm, Hh, Hw, Hc = reported hot water consumption values, in gallons per-cycle (or litres per cycle), at maximum, average, and minimum water fill, respectively, for the extra-hot, hot, warm and cold wash cycle with the appropriate test loads; .
    - R = the reported hot water consumption values, in gallons per-cycle (or litre per cycle), at maximum, average, and minimum water fill, respectively, for the warm rinse cycle and the appropriate test loads
    - TUF_m, TUF_h, TUF_w, TUF_c and TUF_r = tabulated temperature use factors for extra hot wash, hot wash, warm wash, cold wash, and warm rinse temperature selections, respectively

  - *total per-cycle hot water energy consumption* for all maximum, average, and minimum water fill levels tested. Calculate the total per-cycle hot water energy consumption for the maximum, the minimum and the average water fill level, expressed in kilowatt-hours per cycle and defined as:

    $HE = [Vh \times T \times K]$, where:
    - T = Temperature rise or 75 °F (41,7 °C).
    - K = Water specific heat in kilowatt-hours per gallon degree F=0,00240 (0,00114 kWh/L-°C).
    - Vh = per-cycle temperature-weighted hot water consumption

  - *total weighted per-cycle hot water energy consumption*, HE_T, expressed in kilowatt-hours per cycle and defined as:

    $HE_T = [HE_{max} \times F_{max}] + [HE_{avg} \times F_{avg}] + [HE_{min} \times F_{min}]$, where:

- HE = total per-cycle hot water energy consumption
- F_{max}, F_{avg} and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

➢ *total per-cycle hot water energy consumption using gas-heated or oil-heated water*, HE_{TG}, using gas heated or oil-heated water, expressed in Btu per cycle (or mega-Joules per cycle) and defined as:

$HE_{TG}=H_T \times 1/e \times 3412$ Btu/kWh or $HE_{TG}=HE_T \times 1/e \times 3{,}6$ MJ/kWh , where:
- e = Nominal gas or oil water heater efficiency=0,75.
- HE_T = Total weighted per-cycle hot water energy consumption,

➢ *total per-cycle machine electrical energy consumption* for all maximum, average, and minimum test load sizes and for the maximum, the minimum and the average water fill level, expressed in kilowatt-hours per cycle and defined as:

$ME= [Em \times TUF_m]+ [Eh \times TUF_h]+ [Ew \times TUF_w]+ [Ec \times TUF_c]+ [ER \times TUF_r]$, where:

- Em, Eh, Ew, Ec = calculated electrical energy consumption values, in kilowatt-hours per cycle, at maximum, average, and minimum test loads, respectively, for the extra-hot, hot, warm and cold wash cycle
- ER = reported electrical energy consumption values, in kilowatt-hours per cycle, at maximum, average, and minimum test loads, respectively, for the warm rinse cycle.
- TUF_m, TUF_h, TUF_w, TUF_c, and TUF_r = tabulated temperature use factors for extra hot wash, hot wash, warm wash, cold wash, and warm rinse temperature selections, respectively.

➢ *total weighted per-cycle machine electrical energy consumption*, ME_T, expressed in kilowatt-hours per cycle and defined as:

$ME_T=[ME_{max} \times F_{max}]+[ME_{avg} \times F_{avg}]+[ME_{min} \times F_{min}]$, where:
- ME_{max}, ME_{avg}, and ME_{min} = total per-cycle machine electrical energy consumption
- F_{max}, F_{avg}, and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

➢ *total per-cycle energy consumption when electrically heated water is used*, is the total per-cycle energy consumption for the energy test cycle, E_{TE}, using electrical heated water, expressed in kilowatt-hours per cycle and defined as:

$E_{TE} = HE_T + ME_T$, where:
- ME_T = total weighted per-cycle machine electrical energy consumption
- HE_T = total weighted per-cycle hot water energy consumption

- **water consumption** of clothes washers[25]:

➢ *per-cycle water consumption*: the maximum, average, and minimum total water consumption, expressed in gallons per cycle (or litre per cycle), for the cold wash/cold rinse

[25] these calculations need not be performed to determine compliance with the energy conservation policies for clothes washers

cycle, defined as:

Q = [Hc + Cc], where:
Hc, Cc = measured values for the hot water consumption (Hc) and cold water consumption (Cc) respectively

- *total weighted per-cycle water consumption*, Q_T, expressed in gallons per cycle (or litres per cycle) and defined as:

  $Q_T = [Q_{max} \times F_{max}] + [Q_{avg} \times F_{avg}] + [Q_{min} \times F_{min}]$, where:

  - Q = per-cycle water consumption
  - F_{max}, F_{avg}, and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

- *water consumption factor*, WCF, expressed in gallon per cycle per cubic feet (or litre per cycle per litre), and defined as:

  WCF = Q_T / C , where:
  - Q_T = total weighted per-cycle water consumption,.
  - C = the clothes container capacity

- **per-cycle energy consumption for removal of moisture from test load**, D_E, expressed in kilowatt-hours per cycle and defined as:

  D_E = (LAF) × (Maximum test load weight) × (RMC - 4%)× (DEF) × (DUF) , where:
  - LAF = Load adjustment factor or 0,52
  - Test load weigh, expressed in lbs/cycle
  - RMC = remaining moisture content.
  - DEF = nominal energy required for a clothes dryer to remove moisture from clothes, which is 0,5 kWh/lb (1,1 kWh/kg)
  - DUF = dryer usage factor, percentage of washer loads dried in a clothes dryer, which is 0,84.

- **modified energy factor**, MEF, expressed in cubic feet per kilowatt-hour per cycle (or litres per kilowatt-hour per cycle) and defined as:

  MEF = C / (E_{TE} + D_E), where:
  - C = the clothes container capacity
  - E_{TE} = total per-cycle energy consumption when electrically heated water is used
  - D_E = per-cycle energy consumption for removal of moisture from test load

- Energy factor, EF, expressed in cubic feet per kilowatt-hour per cycle (or litres per kilowatt-hour per cycle) and defined as:

  EF = C / E_{TE}, where:
  - C = the clothes container capacity
  - E_{TE} = total per-cycle energy consumption when electrically heated water is used.

1.5 Subtask 1.3: Existing Policies & Measures

1.5.1 The EU policies and measures

1.5.1.1 The EU energy labelling

The energy labelling scheme for dishwashers was put in place in 1999 with directives 97/17/EC and 99/9/EC. The scheme included three sets of A-G scale: one for the energy efficiency, one for the washing performance and the third for the drying performance. The energy efficiency is calculated as the ratio between the actual model energy consumption (C) and the energy consumption of the reference model (C_R) according to the following formulas:

(eq.1) $C_R = 1{,}35 + 0{,}025 \times S$ if $S \geq 10$
(eq.2) $C_R = 0{,}45 + 0{,}09 \times S$ if $S \leq 9$
(eq.3) $E_I = C/C_R$

where S is the number of place settings. The energy efficiency/washing performance/drying performance classes are defined in directive 97/17/EC as:

CLASS	ENERGY EFFICIENCY	WASHING PERFORMANCE	DRYING PERFORMANCE
A	$E_I < 0{,}64$	$P_C > 1{,}12$	$P_D > 1{,}08$
B	$0{,}64 \leq E_I < 0{,}76$	$1{,}12 \geq P_C > 1{,}00$	$1{,}08 \geq P_D > 0{,}93$
C	$0{,}76 \leq E_I < 0{,}88$	$1{,}00 \geq P_C > 0{,}88$	$0{,}93 \geq P_D > 0{,}78$
D	$0{,}88 \leq E_I < 1{,}00$	$0{,}88 \geq P_C > 0{,}76$	$0{,}78 \geq P_D > 0{,}63$
E	$1{,}00 \leq E_I < 1{,}12$	$0{,}76 \geq P_C > 0{,}64$	$0{,}63 \geq P_D > 0{,}48$
F	$1{,}12 \leq E_I < 1{,}24$	$0{,}64 \geq P_C > 0{,}52$	$0{,}48 \geq P_D > 0{,}33$
G	$E_I \geq 1{,}24$	$0{,}52 \geq P_C$	$0{,}33 \geq P_D$

The energy labelling scheme for washing machines was put in place in 1995 with directives 95/12/EC[26] and amended by Commission Directive 96/89/EC of 17 December 1996. The scheme included three sets of A-G scales: one for the energy efficiency, one for the washing performance and the third for the spin drying performance.

CLASS	ENERGY EFFICIENCY	WASHING PERFORMANCE	WATER EXTRACTION EFFICIENCY
A	$C \leq 0{,}19$	$P > 1{,}03$	$D < 45\%$
B	$0{,}19 < C \leq 0{,}23$	$1{,}03 \geq P > 1{,}00$	$45\% \leq D < 54\%$
C	$0{,}23 < C \leq 0{,}27$	$1{,}00 \geq P > 0{,}97$	$54\ \% \leq D < 63\%$
D	$0{,}27 < C \leq 0{,}31$	$0{,}97 \geq P > 0{,}94$	$63\% \leq D < 72\%$
E	$0{,}31 < C \leq 0{,}35$	$0{,}94 \geq P > 0{,}91$	$72\ \% \leq D < 81\%$
F	$0{,}35 < C \leq 0{,}39$	$0{,}91 \geq P > 0{,}88$	$81\% \leq D < 90\%$
G	$0{,}39 < C$	$0{,}88 \geq P$	$90\% \leq D$

The energy efficiency class of an appliance is determined as the energy consumption "C" for kg of washed load for the standard 60°C cotton cycle. The washing performance index P is defined in

[26] Commission Directive 95/12/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines, OJ L 136, 21.06.1995 p.1

standard EN 60456 as the ratio of the sum of the reflectance values for the stains of the machine under test and the reference machine after the standardised washing cycle. The drying efficiency is expressed as residual moisture content for the standard 60°C cotton cycle.

1.5.1.2 The Industry Voluntary Commitments

a) The voluntary commitment for dishwashers

In November 1999, CECED notified to the European Commission a Unilateral Industry Commitment[27] for the reduction of the energy consumption of household dishwashers. The commitment consists of a graded scenario of two different steps, coming into effect on or to be reached by 31 December 2000, 31 December 2002 and 31 December 2004.

By signing the Voluntary Commitment, participants commit themselves to reduce the total energy consumption of dishwashers and thereby CO_2 emissions caused by power generation. To reach this objective participants will reduce significantly the fleet energy consumption of their production and import range and will stop producing for and importing in the Community Market dishwashers that rank in the less efficient classes of the energy label scheme.

A general improvement of the product range and a ban of certain dishwashers from production and import (step 1) will result in a overall 20% saving by 31 December 2002 related to the base case figures of 1996. An additional elimination of less efficient dishwashers by 31.12.2004 (step 2) will contribute further to the energy saving. In particular:

- step one: participants will stop producing for and importing in the Community Market dishwashers which belong to the energy efficiency classes E, F and G (for ≥10 place settings) or F and G respectively (for <10 place settings) by 31 December 2000.
- step two: participants will stop producing for and importing in the Community Market dishwashers which belong to the energy efficiency class D (for ≥ 10 place settings) or E respectively (for <10 place settings) by 31 December 2004.

Furthermore, all participants engage themselves to strengthen their overall activities to achieve further energy savings and to educate consumer on the way to save energy, through a list of action. Finally, starting from the year 2000 each participant will provide the CECED notary consultant with production weighted energy consumption data in each place setting class for the previous calendar year.

b) The voluntary commitments for washing machines

Two Voluntary Commitments were put in place by industry for washing machines starting from 1997.
In April 1996 the European Committee of Manufacturers of Domestic Equipment (CECED) presented a first Commitment about energy saving to the European Commission. This Commitment was made on behalf of the European manufacturers of domestic washing machines[28] and was aimed at a considerable reduction of energy consumption of washing machines. The proposal was negotiated with the EU Authorities and notified, in October 1997, to EC DG IV. On 9.12.1998, the agreement was published in the official journal and the final approval was given on 24 January

[27] Voluntary Commitment on Reducing Energy Consumption of Household Dishwashers, Final November 19, 1999, downloadable from www.ceced.org .
[28] Voluntary Commitment on Reducing Energy Consumption of Domestic Washing Machines, Final September 24, downloadable from www.ceced.org .

2000 with a derogation to Art. 81 of the EU Treaty was granted by decision of the Commission for the period up to end of year 2001. The overall objective of this first Commitment was the achievement of an average Energy Consumption of 0,24 kWh/kg weighted on the volumes of production for our input in the Community market to be assessed during year 2000. This first commitment included a graded scenario of two different steps:

- Step one: participants will stop producing for and importing in the Community Market domestic washing machines which belong to the energy efficiency classes E, F and G after 31.12.1997. Domestic washing machines with load capacity equal or smaller than 3 kg which belong to class E, and vertical axes machines will still be allowed on the market;
- Step two: participants will stop producing for and importing in the Community Market domestic washing machines which belong to the energy efficiency classes D, E, after 31.12.1999. Domestic washing machines with load capacity equal or smaller than 3 Kg which belong to class D will still be allowed on the market. Domestic washing machines with spin speed lower than 600 rpm which belong to class D will still be allowed on the market.

In addition, each participant was engaged to contribute to the Commitment overall objective of achieving a European production weighted average of 0,24 kWh/kg for the year 2000. Starting from 1998 each participant provided also the CECED notary consultant with production weighted energy consumption data for the previous calendar year. All participants engaged also themselves to strengthen their overall activities to achieve further energy savings and to educate consumer on the way to save energy.

The first Voluntary Commitment successfully expired in December 2001 and was followed by a second phase. The Second Voluntary Commitment on Reducing Energy Consumption of Domestic Washing Machines (2002 - 2008) was notified on 31 October 2002, covering the period from 2002 to 2008. It foresees:

- *Hard target*: By 31.12.2003 participants will have stopped producing for, and importing (including under own brand and private labels) in, the Community Market domestic washing machines which belong to energy efficiency class D. Marginal models on the market (washing machines without heater and with vertical axes) are excluded from this target.
- *Fleet target*: each participant will commit himself to contribute to the Commitment overall objectives of achieving a European production weighted average of 0.20 kWh/kg for the year 2008. Each participant will provide the CECED notary consultant with production weighted energy consumption data for the previous calendar year;
- *Soft target*: all participants commit themselves to strengthen their overall activities to achieve further energy savings and to educate consumers on the way to save energy; in particular, they commit themselves to:
  - support the introduction of the A+ class on the revised energy label, identifying and promoting super efficient machines at a level of 0,17 kWh/kg by giving additional public awareness;
  - support at EU or national level, rebates schemes aiming at fostering the introduction of efficient washing machines, e.g. by replacing old and inefficient machines as long as the balance between energy and washing performance is maintained (minimum class B for washing performance);
  - co-operate in setting up targets and measures for achieving a high level of spinning efficiency for markets where tumble drying is relevant;
  - inform in their brochures about the advantages of a high spin speed washing machine when tumble drying is preferred and promote the energy efficient use of washing machines by giving information in the user manual;
  - co-operate with detergent industry on new energy saving detergents and promotion of an energy saving consumer behaviour;

- push the development of a new standard for testing washing machines, taking into account the change of consumer behaviour, that is targeted to be used as a basis for a revised label in 2008.

In addition CECED established a list of participants and keep it updated to be provided to the European Commission and available to the public free of charge; Continue to operate a database for washing machines. This database contains an analysis of all models of washing machines placed on the Community market by all the participants and is updated yearly. For each single model all those data will be given which are mandatory on the energy label. The database is available to the European Commission, national authorities and, for study purpose, to experts appointed by them. The copyright is owned by CECED.

1.5.1.3 The EU eco-label

a) The EU eco-label scheme

The EU eco-label was initially set in Council Regulation (EEC) No 880/92 on a *Community eco-label award scheme*, revised by Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 *on a revised Community Eco-label Award Scheme*. The Eco-label scheme has to be seen together with five other decisions on procedures and fees (European Eco-labelling board - EUEB, Consultation Forum, Standard Contract, Fees, Eco-label working plan). The key elements of this new Regulation, which entered into force on 24 September 2000, include:

- widening the scope to cover services as well as products.
- reinforced stakeholder participation, in particular in developing the environmental criteria.
- the creation of the EU Eco-labelling Board, comprising of the Eco-label Competent Bodies and interest groups, whose main role is to develop the Eco-label criteria.
- reduced fees for SMEs and developing countries.
- introduction of a ceiling on the annual fee.
- reinforced transparency and methodology.
- renewed emphasis on the promotion of the scheme.
- reinforced co-operation and co-ordination with the national Eco-label schemes.
- more information on the label.
- possibility for traders and retailers to apply directly for their own brand products.
- possibility for non-EU producers to apply directly.

The application of the eco-label scheme has always been critical for household appliances, although the scheme has been successful for other non-EUP products. After very few models of cold and wash appliances being submitted and awarded the label in the first years of the eco-label life, then no supplier (manufacturer or importer) applied for the eco-label for such product groups. This situation is at present persisting, probably due to the complexity and costs of the required criteria/awarding procedure compared to the lack of market value of the ecological label compared to the energy label. Some studies[29] promoted by the Commission addressed this issue, which was also considered in the Community Eco–Label Working Plan set in Commission Decision 2002/18/EC[30].

The Regulation instituting the European Eco-label is at present under further review following the results of the EVER (Evaluation of EMAS and Eco-label for their Revision) study published in

[29] Some of the studies are downloadable at http://ec.europa.eu/environment/ecolabel/documents/studies_en.htm
[30] Commission Decision 2002/18/EC of 21 December 2001 establishing the Community eco-label working plan, OJ L 7, 11.01.2002.

December 2005[31]. The study has been carried out on behalf DG Environment by a consortium of consultants. The fundamental aim of the EVER study has been to provide recommendations for the revision of the two voluntary schemes EMAS and the EU Eco-label. The options and recommendations proposed for the schemes are based on the evidence collected in the different phases of the study, presented, discussed and enriched through two workshops held in September 2005, that involved experts, institutions, companies, practitioners and NGOs. The whole process led to the defining of options and recommendations the revision process, where a major issue for the revision of both the schemes is integrating and linking them with existing legislation and environmental policies (to a wider extent).

b) The eco-label for dishwashers

The eco-labelling scheme for dishwashers was put in place for the first time in 1998 with Commission decision 98/483/EC, modified by Commission decision 2001/397/EC and finally by Commission decision 2001/689/EC. Criteria are valid until 28 August 2007[32]. The scheme includes a set of criteria for energy efficiency, water consumption, prevention of the excessive us of detergent, noise, recovery & recycle extension of the product life, design, washing performance and drying performance.

The thresholds for energy efficiency, washing performance and drying performance are:

PLACE SETTINGS	ENERGY EFFICIENCY	WASHING PERFORMANCE	DRYING PERFORMANCE
≥ 10	$E_I < 0{,}58$		
> 5	$E_I < 0{,}64$	$P_C > 1{,}00$	$P_D > 0{,}93$
≤ 5	$E_I < 0{,}76$		

The water consumption should be less or equal to the threshold given by the following equation:

$W_{(measured)} \leq (0{,}625 \times S) + 9{,}25$, where S is the number of place settings.

Noise should not exceed 53 dB(A) for free-standing models and 50 dB(A) for built-in models. For the other criteria see the Commission decision 2001/689/EC.

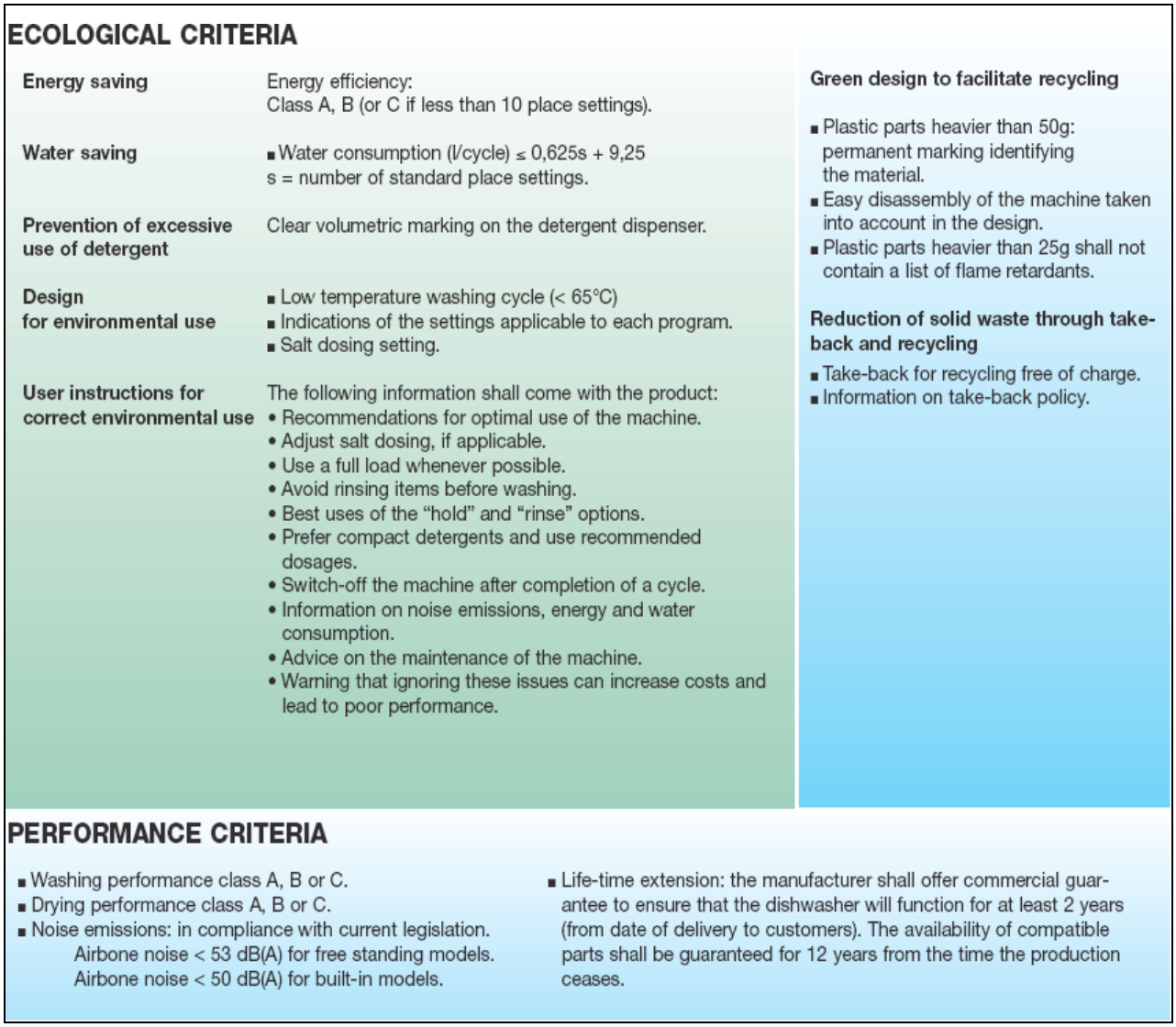
A compliant model for the 12 place settings should have:

- energy consumption: class A
- washing performance: not lower than B
- drying performance: not lower than B
- water consumption: not higher than 16,8 litre/cycle (or 20,16 litre for a 12ps machine)

A summary of the criteria is shown in Figure 1[33].

[31] The executive summary is downloadable at: http://www.ioew.de/home/downloaddateien/ever_executive%20summary.pdf .
[32] See Commission Decision 2005/783/EC, of 14 October 2005, OJ L 295, p. 51.
[33] Source: "The European eco-label for dishwashers", downloadable from www.ec.europa.eu/environment/ecolabel/pdf/infokit/new_2002/fact_dishwashers_2002_en.pdf .

Figure 1: Ecolabel criteria for dishwashers



c) The eco-label for washing machines

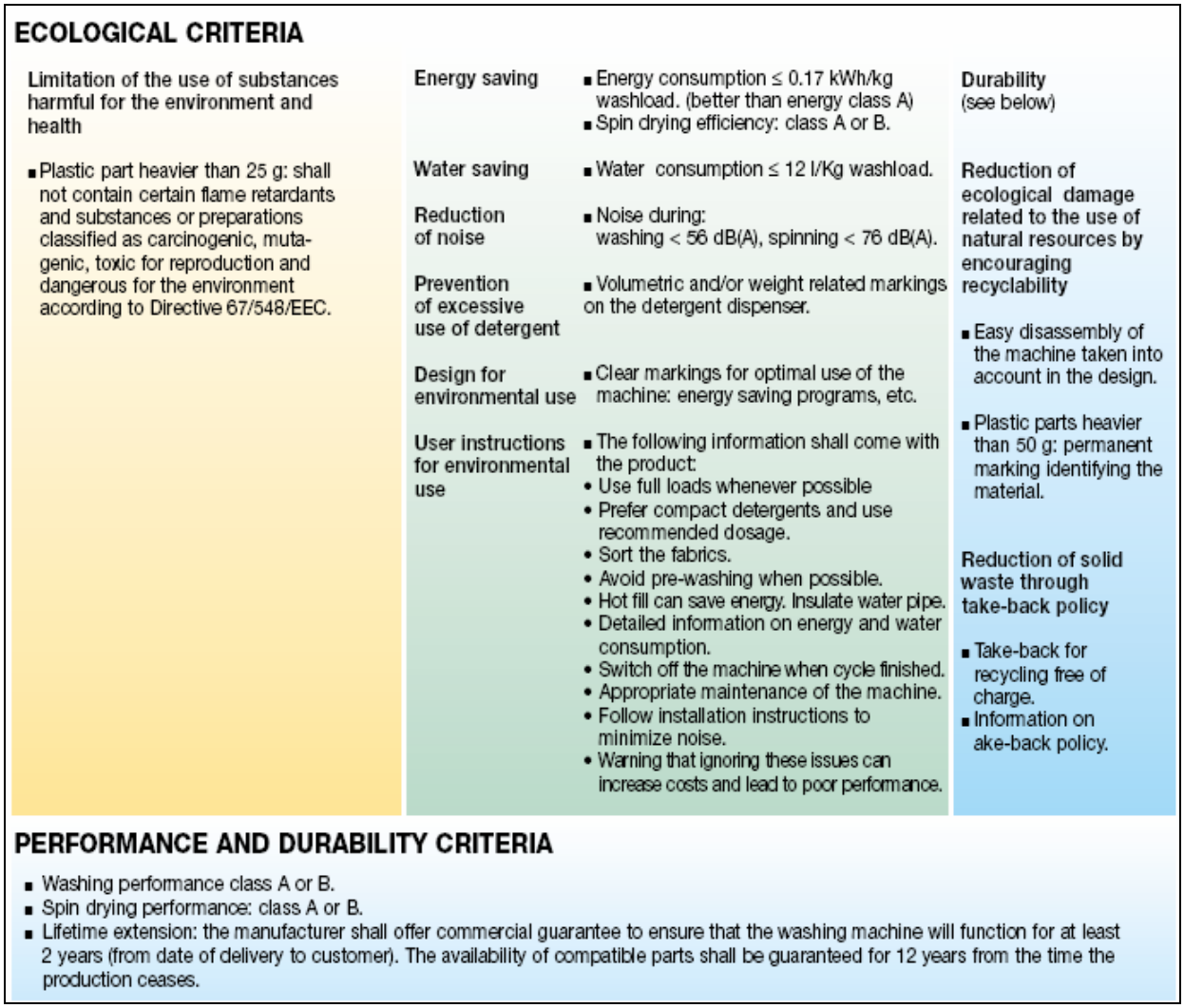
The eco-labelling scheme for dishwashers was put in place for the first time in 1998 with Commission decision 98/483/EC, modified by Commission decision 2000/45/EC of 17 December 1999.

The scheme includes a set of criteria for energy efficiency, water consumption, prevention of the excessive us of detergent, noise, recovery & recycle extension of the product life, design, washing performance and drying performance as shown in Figure 2[34]. Criteria are valid from 17 December 1999 until 30 November 2007[35].

[34] Source: "The European ecological label for washing machines", downloadable from www.ec.europa.eu/environment/ecolabel/pdf/infokit/washmach_en.pdf .

[35] See Commission Decision 2003/240/EC of 24.03.2003, OJ L 89, p. 16 and 2005/783/EC, of 14 October 2005, OJ L 295, p. 51.

Figure 2: Eco-label criteria for washing machines



1.5.2 The Policies & Measures in EU Member States

Legislation at Member States level has been replaced by the EU legislation for household appliances. Only in some national voluntary eco-labels and EPD specific criteria are set for this product group. In addition incentive schemes (run in The Netherlands and the UK) will be described along with the white certificates scheme in force in other countries.

1.5.2.1 The national (eco)label schemes

a) National eco-labelling schemes

A compilation of the product groups addressed in the different eco-labelling schemes in Member States and Accession countries in 2002 resulted (Table 4) in 6 schemes covering refrigerators (the Nordic Swann, the German, Austrian, Hungary, Slovakia and Poland), 6 schemes covering washing machines (the Nordic Swann, the German, Austrian, Slovakian, Czech and Polish schemes) and 2 schemes covering dishwashers (the Nordic Swann and the Polish scheme).

Table 4: Eco-labelling schemes product groups in the different schemes in the EU addressing household appliances in 2002[36]

Category	Subcategory	EU-Flower	Nordic Sw	Spain	Catalonia	France	Germany	Austria	Netherland	Good env choice	TCO	Croatia	Hungary	Slovakia	Czech Rep	Poland	Subtotal	Total (out of 379)
HouseholdM	Dishwashers	X	X													X	3	
HouseholdM	Dryer for wash						X										1	
HouseholdM	Hand dryers, hot air						X										1	
HouseholdM	Mechanical washaid					X											1	
HouseholdM	Refrigerators	X	X				X	X					X	X		X	7	
HouseholdM	Vacuum cleaners					X											1	
HouseholdM	Washing Machines	X	X				X	X						X	X	X	7	21

		washing machines	April 1997- Apr.1999 June 2001- June 2004	none	not available

[36] Source: Compilation of the eco-labelling product groups in the different schemes in the EU and Candidate Countries, downloadable from: http://ec.europa.eu/environment/ecolabel/pdf/work_plan/mtggroups/coop/pdgpsinotherschemes.pdf

A new research in the national scheme websites collected in the EU Ecolabel website page about other eco-labels[37] resulted in only the Nordic Swann, the Hungarian, the Czech Republic and the Slovak Republic schemes addressing cold and/or wash appliances in later years (2004-2007). The available information are summarised in Table 5. The awarding criteria for the different schemes are very close or overlapping with the criteria set in the EU eco-label, with some differences such as the rinsing performance requested to washing machines under the Nordic Swann.

In particular the Nordic Swann applies to washing machines[38] with spin function and a capacity not exceeding 10 kg, but washer dyers are excluded. Main criteria are:

– *Energy efficiency*: machines complying with the EU energy labelling must fulfil two requirements of energy consumption: one specific requirement for the standard 60°C cotton programme and one for the mean value of four different operating modes. Other machines must only meet one requirement. Energy consumption must not exceed the following limit values:

Type of machine	Energy consumption, washing, 60°C, cotton (kWh/kg washing)	Mean value of four different operating modes * (kWh/kg washing)
Machines comprised by the mandatory Energy Labelling Scheme	0,19	0,23
Other machines	-	0,23

* mean value of four operating modes: the standard 60ºC cotton programme at full load and 2 kg load, and the standard 40ºC cotton programme at full load and 2 kg load. Energy efficiency (E) is calculated as: E = (e1 + e2 + e3 + e4)/(m1+ m2 + m3 + m4), where "e" is electricity consumption in kWh and "m" is the mass of washing in kilograms, for each of the four individual operating modes.

– *Water consumption*: the machine must not consume more than 16 litres of water per kilogram of wash load, measured in accordance with the test method specified and using the same standard 60ºC cotton programme as used for measuring energy efficiency.
– *Spin performance*: machines with a capacity >3,5 kg must achieve a residual moisture content of less than 54% when tested according to the stated test method using the same standard 60ºC cotton programme as used for testing energy efficiency. Machines with a capacity ≤3,5 kg must achieve a residual moisture content of less than 60% when tested according to the stated test method using the same standard 60ºC cotton programme as used for testing energy efficiency.
– *Noise*: airborne acoustic noise from the machine, in terms of sound power level, must not exceed 56 dB(A) during the washing cycle, or 76 dB(A) during the spin cycle, measured in accordance with the test method specified and using the same standard 60ºC cotton programme as used for measuring energy efficiency.
– *Washing performance*: the machine must have a washing performance index greater than 1.00 when tested according to the specified test method and using the same standard 60ºC cotton programme as used for testing energy efficiency.
– *Rinsing performance*: the machine must pass a rinsing performance test:
  ✓ using the alkali method (detection of soluble components) with a score ≥ 5
  ✓ using the zeolite method (detection of the solid particles) with a score ≥ 3.

  The standards for the measurement of the rinsing performance are described in the document specifying the eco-label criteria.

[37] See http://ec.europa.eu/environment/ecolabel/other/int_ecolabel_en.htm .
[38] Source: Swan labelling of washing machines, Version 4.0, 18 March 2004 – 17 June 2009.

Table 5: National eco-labelling schemes addressing household appliances in 2004-2007

Ecolabel	Countries	EUP covered (type)	Validity period (from/to)	Licences (number)	Criteria
Nordic Swan	Finland, Sweden, Denmark, Norway, Iceland	refrigerators and freezers	19 October 2004 31 October 2008	none	Requirements almost identical to the EU eco-label with some differences and additional criteria
		washing machines (washer dyers excluded)	18 march 2004 19 June 2009	1	– electricity and water consumption – the reduced use of certain materials that are hazardous to health and the environment – the recycling of materials – washing and rinsing performance
Environmental Friendly products	Czech Republic	washing machines	not available	not available	not available
		dishwashers	not available	not available	not available
The Hungarian Eco-label	Hungary	refrigerators	06 April 2005 2007 and beyond	not available	The appliance must gradually reach the energy efficiency class of A+ or A++ as follows: - until 30.04.2007. the lower limit of energy efficiency shall be 47 % i.e. $I_\alpha < 47$. - from 30.04.2007. the lower limit of energy efficiency shall be 42 % i.e. $I_\alpha < 42$. Other criteria as in the EU Ecolabel
(NPEHOV)	Slovak Republic	refrigerators and freezers	September 1999 - September 2001 Final proposal, 2002	none	not available
		washing machines	April 1997- Apr.1999 June 2001- June 2004	none	not available

Other criteria about *marking of plastic parts*, *content of heavy metals in plastics*, *flame retardants*, r*ecycling*, *safety*, the *working environment* and the *external environment*, *instructions*, *settings*, *programme markings*, *warranty*, *spare parts*, *environment and quality control* and *marketing* apply.

The following requirements will be assessed in future criteria: requirement regarding the automatic dosage of detergent, heavy metals used in alloys and surface treatment, flame retardants in plastics and electronic components and provisions to connect the machine directly to a hot water source.

The application has to be sent to Nordic Ecolabelling in the country in which the washing machine is sold. The application documents comprise an application form and documentation demonstrating fulfilment of the requirements (specified in the criteria). Before a license is granted, normally an onsite inspection is performed to ensure adherence to the requirements.

An application fee is charged to companies applying for a license. There is an additional annual fee based on the turnover of the Swan labelled refrigerator/freezer.

The Nordic Swann ecolabel license is valid providing the criteria are fulfilled and until the criteria expire. The validity period of the criteria may be extended or adjusted, in which case the license is automatically extended and the licensee informed. Revised criteria shall be published at least one year prior to the expiry of the present criteria. The licensee is then offered the opportunity to renew their license.

b) The Energy Saving Recommended label in UK

The Energy Saving Trust (EST) is a non-profit organization funded by the British Government and the private sector. EST develops and runs programs (mostly awareness-raising campaigns) on behalf of the government and serves as a consultants. The goal is to give consumers verified and unbiased information about the advantages of energetically sustainable products and services. It is also in charge of efficient product/service accreditation.

EST issues the ”Energy Saving Recommended”[39] product labelling scheme (formerly known as Energy Efficiency Recommended scheme), a registered certification mark (shown in Figure 3) allowing consumers to spot the most energy-efficient products available on the market. Products carrying the mark meet or exceed the Energy Saving Trust’s established criteria.

Figure 3: The EST “Energy Efficiency Recommended” logo

The Energy Saving Recommended scheme covers 24 products groups, including the following major appliances:

- washing machines

[39] See: www.energusavingstrust.co.uk/myhome/efficientproducts/recommended/.

- dishwashers
- refrigerators, freezers and their combinations
- tumble dryers (including gas fired ones)
- appliances producing and storing hot water.

The scheme aims to review the criteria on an annual basis as the efficiency of appliances improves, to maintain 'best practice' recognition for recommended appliances. This mark is a guarantee that the product will help to reduce energy wastage in the home, as well as benefiting the environment and costing less to run. The Energy Saving Trust's criteria are set to award the label to the top 20% energy efficient products, using the energy efficiency classes set in the EU energy labelling directives as indicator.

For the large household appliances to which Energy Saving Recommended scheme applies, the requirements are:

- washing machines: models rated AAA rated (class A for energy consumption, class A for washing performance, and class A for spin drying efficiency)
- refrigerators, freezers and refrigerator-freezers: models rated class A+ or A++
- dishwashers: models rated class AAA (class A for energy consumption, class A for washing performance, and class A for drying efficiency) plus the eco-label requirement for water consumption
- tumble driers: models rated class B or better, and products that are rated class C if they feature an automatic drying function.

The EST website shows also an on-line database including products types and models complying with the set criteria

c) The Swedish EPD scheme for washing machines and dishwashers[40]

In Sweden, an official system for type III environmental product declarations called EPD (Environmental Product Declaration)[41] has been developed and established. The system is voluntary and can be used worldwide by all interested companies and organizations. At the moment, interested parties from 7 other countries have joined the EPD system at various levels[42]. The Swedish EPD system is the most developed type III product declaration type in the world. EPDs have been developed for the following products: freezers, refrigerators, washing machines, frequency converters, circuit breakers, transformers, waste collection services, landfills, production chemicals, ink, sink mixer taps, district heating, galvanising processes, steel production, pumps, copy- and fax machines, hydro power, nuclear power. Other countries have developed type III product declarations as well, typically used and developed within specific trades. Specifications for washing machines and dishwashers are included in document "Product-Specific Requirements. Household washing machines and household dishwashers, PSR 2001:2. The Swedish Environmental Management Council, Version 1.0, 2001-11-21.

An area, in which a direct comparison between the EU eco label and an environmental product declaration can be made, is washing machines. To compare the two sets of criteria, the EU eco label requirements (Decision 2000/45/EC) are listed together with the product specific requirements for

[40] Source: www2.mst.dk/udgiv/Publications/2006/87-7614-954-4/html/default_eng.htm
[41] http://www.environdec.com/
[42] Countries with existing EPD programs: Sweden, Belgium, Poland, Finland, Italy, Japan, Denmark and South Korea. In Norway, an EPD program is underway.

washing machines The main data requirements for the two environmental performance criteria are presented in Table 6.

Table 6: Data inventory requirements for the EU eco label and PCR for washing machines

Category	EU eco-label	EPD
Manufacturer info		
Manufacturing Company	Yes	Yes
Manufacturing Site	Yes	Yes
Issuer and contact	Yes	Yes
Guarantee statement	Yes	No
Environmental performance declaration		
Refinement	No	Yes
Resource Consumption	No	Yes
Electricity use	No	Yes
Transportation		
Refinement Production	No	Yes
Production Sale	No	Yes
Sale Use	No	Yes
Use Disposal	No	Yes
Production		
Energy Consumption	No	Yes
Use of Chemicals	Yes, detailed	Yes, detailed especially for use of heavy metals as well as halogenated and brominated flame retardants
Material List	Yes, some specific materials, mainly chemicals	Yes, total list
Emission Estimation to air and water	Yes, name of components	Yes
Emissions	No	Yes
Resource Consumption	No	Yes
Use		
Energy Efficiency	Yes	Yes
Water Consumption	Yes	Yes
Spin Drying Efficiency	Yes	Yes
Noise	Yes	Yes
Control of Detergent use	Yes	No (not mandatory)
Criteria for users manual	Yes	No
Washing Performance	Yes	Yes
Estimated Lifetime	No, but a 2 year guarantee	Yes
Disposal		
Recycling rate	Yes, declaration	Yes, specification has to be made
Waste amounts	No	Yes
Hazardous waste amounts	Yes	Yes
Separable hazardous materials	Yes, declaration	No
Information from the company and certification body	Data is sent to the Eco-label secretariat. The label is issued, but the data is kept confidential.	Specific data is kept confidential depending of the PCR, but the environmental key figures and conclusion are to be stated in the EPD, which is public accessible

1.5.2.2 Economic incentives for efficient appliances

Economic incentives in the form of rebate schemes or tax deduction have been enforced in The

Netherlands[43,44]

Energy labels for household appliances were first introduced in the country in 1995. From the beginning the energy label in the Netherlands had a strong relation with the following energy policy instruments: the MAP (Environmental Action Plan from 1991 to 2000) and the EPR (Energy Premium Regulation from 2000 to 2003). Only a MAP or EPR subsidy could be received when the appliance had an A class label. The EPR started in 2000 and aimed to stimulate households to take energy saving measures and to buy energy efficient appliances. Until October 2003, consumers could get an EPR subsidy for appliances with an energy efficiency class A. For some appliances additional conditions where set to receive the subsidy. The EPR subsidy scheme is financed through the Regulating Energy Levy (Regulerende EnergieBelasting) REB, a levy on the electricity, natural gas and oil products sold to the households and SME's.

The MAP was aimed at a CO_2 reduction within households, governmental and the tertiary sector. Several actions where taken by energy distribution companies who where responsible for the implementation. The most important actions within consumers focussed on a change of behaviour and the purchase of energy efficient appliances by subsidising them (since 1995 linked to the energy label).

In total an amount of 25 million Euro subsidy was provided within the framework of MAP and about 159 million Euro EPR subsidy was provided. The total costs for the government for the implementation of the MAP and EPR were: 15 million Euro for MAP and 34 million Euro for EPR. As it is not exactly clear how much costs are made within MAP an estimation is made based on the amount of MAP subsidy received by consumers.

The first round of EPR - Energiepremieregeling (Energy Premium Regulation) scheme started 1 January 2000 and gives households and landlords the possibility to apply for a subsidy when purchasing an energy efficient household appliance or taking energy efficient actions such as roof-insulation. The goal of the EPR was to channel the funds from the Regulating Energy Tax or REB (Regulerende Energiebelasting) back to the citizen through subsidies on the purchase of energy efficient products and services.

In 2000 75% of REB-funds were thus used and in 2001 113%. The amount of funds available to the citizen for 2000 plus 2001 was 158.714.914 Euro, of which 97 % was actually spent. Certain groups of purchasers such as companies or people who buy the appliance for their holiday homes were excluded from the EPR subsidy.

The proportion between implementation costs and actual subsidies was 31% in 2000 (39% for appliances and 7% for other items). In the year 2001 it was 24% (37% for appliances and 6% for other items). The largest part of the subsidies (Table 7) went to refrigerators/freezers plus washing machines (46%), followed by insulation measures (25%) and High Efficiency (HR++) glazing (13%). After some initial hick-ups, utilities and the Tax Office did not encounter problems in handling the subsidy applications by the consumer and within 6 weeks all complete applications could be processed.

[43] Source: Maxim Luttmer, Evaluation of Labelling of Appliances in the Netherlands, Case Study executed within the framework of the AID-EE project, FINAL DRAFT, contract number EIE-2003-114, April 2006.

[44] Source: "Evaluation of the Netherlands energy efficiency subsidy scheme EPR", Tax Office/Centre for process- and product development, 21 June 2002. English summary by VHK, René Kemna, 8 October 2002. Original title "Rapportage van Onderzoeksbevindingen in Het Kader van de Evaluatie van de Energiepremieregeling, Belastingdienst/Centrum voor proces- en productont-wikkeling, 21 juni 2002

Table 7: Energy saving measures for appliances to which a subsidy was given in 2001

EPR-measure	Subsidy		
	(number)	(Euro)	(%)
Refrigerators & Freezers	504 952	24.367.094	22
Washing machines	441 385	22.175.922	20
Dishwashers	145 768	6.614.664	6
Laundry driers	4 488	661.5	0,6
LCD-monitor	12 917	586.148	0,5
Domestic lighting fixture	17	771	<0,01
Simultaneous purchase	113 528	2.575.838	2

In November 2001, almost two years after the start of the EPR, one third of Dutch households had applied for the EPR, and of this, around two thirds concerned domestic appliances. The subsidy was requested for respectively 36%, 47% and 49% of all the sold A class dishwashers, fridge/freezers and washing machines.

The introduction of the EPR has led to an enormous growth of the supply of A labelled appliances (Table 8). The market share of A class washing machines grew from 40 to 71% over the 1999-2000 period and 26% to 55% for refrigerators. This increase is most likely due to the EPR and has led to a situation where retailers very often advice their customers to buy an A class appliance as the best on offer.

Table 8: Share of A labelled appliance: NL and EU (*source GfK*)

Appliance	1999	2000	2001
Refrigerators			
NL	26%	55%	67%
EU*	12%	19%	27%
Freezers			
NL	29%	55%	69%
EU*	12%	16%	n.a.
Washing machines			
NL	40%	71%	88%
EU*	15%	26%	45%
Dishwashers			
NL	27%	55%	73%
EU*	n.a.	n.a.	n.a.

*EU = Germany, UK, Ireland, France, Austria, Belgium, Netherlands, Portugal, Sweden, Spain

The 1999-2000 sales of A class refrigerators, freezers, washing machines and dishwashers (Table 9) have increased by 116%, 95%, 95% and 117% respectively, while in the second year (2000-2001) sales increases were 22%, 35%, 28% and 32% respectively. The absolute level of sales of these appliances has also increased, namely by 4%, 3%, 7% and 6% over the 1999-2000 period. For 2000-2001, when economic crisis set in, sales of refrigerators (-2%) and dishwashers (-0,3%) decreased, but sales of upright freezers (+8%) and washing machines (+3%) continued to rise.

Table 9: Sales of A class appliances in The Netherlands in 1999-2001 (units)

Appliances	1999	2000	2001
Refrigerators	645 000	671 000	658 000
of which A class	167 700	362 340	440 860
Freezers	200 000	206 000	222 000
of which A class	58 000	113 300	153 180
Washing machines	565 000	605 000	623 000
of which A class	220 350	429 550	548 240
Dishwashers	330 000	350 000	349 000
of which A class	89 100	193 600	254 770

In the consumer surveys the advice by the retailer was mentioned most often as reason for the purchase (36% of 1195 appliances bought by the sample group). Second reason (35%) was that the appliance or provision 'was best' (quality). Third reason was the energy saving (22%) and in 62 cases (5,3%) the EPR-subsidy was mentioned as the main reason to buy a particular appliance. In 77% of the cases the purchaser did not consider buying another appliance, after having applied for a subsidy. Some 84% of those purchasers claims the EPR-subsidy did not influence their buying decision (they say they would have bought the appliance anyway), and 83% of the purchasers who did take some time to reflect, decided that their first choice was the right one. These data appear to be pointing at a so-called 'freerider' effect, meaning that consumers would have bought the appliance or provision regardless of the subsidy. On the other hand this is not in line with the drastic rise – much more than in other EU countries - in market share of A class appliances. These high market shares of 70-80% in 2001, caused by the EPR, have led retailers to advice an A class appliance to their customers as being 'the best', which in turn led to the purchase of more efficient appliances.

Savings on CO_2 emissions were calculated for each EPR-item, using reference situations proposed by the Energie Onderzoek Centrum Nederland (ECN). The total calculated emission saving over 2000 and 2001 amounted to 210.333 ton (the total CO_2 saving over the lifetime of the appliances that were bought with an EPR-subsidy was not calculated), due to insulation-measures 30%, glazing 18%, PV systems 18% and condensing CH boilers 15%. Refrigerators/freezers plus washing machines contributed for 15%, although they took up 46% of funds. The savings did not lead to a general decrease of residential energy consumption: between 1999 and 2000 the average electricity consumption per household rose from 3 165 kWh to 3 197 kWh.

The average energy consumption of refrigerators, freezers, washing machines and dishwashers sold in 1999, 2000 and 2001 clearly decreased. Econometric studies have assessed that the Regulating Energy Tax (REB) has led to a lower energy consumption of households than in a Business-as-Usual scenario. These studies estimate that a 10% energy price rise leads to a 4% lower consumption. On the other hand there is a rebound-effect whereby people start using efficient appliances more. This takes away around one sixth of the energy saving achieved through the efficiency improvement, meaning that 5/6of the savings is effective. From 1st January 2002 a second step of EPR subsidy was launched. Subsidies for that year are given in Table 10. The REB generated a state income of 2 383 million Euro in 2002.

In Table 11 the overall market share of the energy efficiency classes A and better is presented for the period 1996-2004. The differences with the data presented in previous Table 8 depend from the different source of the information, which in any case are in good agreement. The market share for both refrigerators and freezers increased considerably since 1996. In the years 2003 and 2004 the

market share of energy efficiency classes A, A+ and A++ decreased a little due probably to the fact that since 2003 no EPR subsidy is given anymore for these appliances.

Table 10: Subsidies for household appliances in the Dutch EPR 2002 scheme

Code	Item	Subsidy (€/unit)
1010	Fridge/freezer A-label	50
1011	Fridge/freezer A-label with EEI =0,42 (e.g. A+)	100
1020	Dishwasher A (energy), A or B for performance and drying	50
1030	Dishwasher A-label for energy	50
1031	Washing machine, A, A, A	100
1041	Electrical tumble drier A-label for energy	160
1050	Gas-fired tumble drier	160
1060	Washer-drier with A-label for energy	205
1080	Lighting fixture with dedicated CFL >30 Watt	50
1090	Stand-alone LCD-monitor with diagonal >35 cm	50

Table 11: Marker share of A and better classes for white goods in the Netherlands in 1996-2004

EE Classes	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)
Refrigerators									
A	7	10	14	23	54	70	71	75	68
A+	--	--	--	--	2	6	13	23	19
A++	--	--	--	--	--	--	1	0	1
Freezers									
A	3	13	18	26	53	n.a.	74	60	58
A+	--	--	--	--	--	--	14	22	21
A++	--	--	--	--	--	--	--	2	3
Washing machines									
A	0	3	19	37	67	91	95	99	99
Dryers									
A					0,5	0,5	0,4	0,3	0,3

source: VLEHAN 2005, VROM 2005, MilieuCentraal 2005

The effect of the subsidy scheme for washing machines has been specifically studied by GfK[45]. The EPR scheme positively affected the increase the share of the higher efficiency machines and an increase of the average machine price (see the increase in the sales and price of the A and A+ washing machines in Figure 4) in the period 1999-2002, followed by a decrease in 2003 when the subsidy ended.

In Figure 5, a comparison between the Dutch and the German market for washing machines in 2001 and 2002 is presented, where the effect of the subsidy can be appreciated from the difference in the units sold per 1000 households in the two countries.

[45] Source: Source: Friedemann Stoeckle, Trends of major domestic appliances sales in the various phases of energy efficiency legislation in Europe, EEDAL 06, London, June 2006.

Figure 4: The effect of the Dutch subsidy scheme for washing machines in 1999-2005

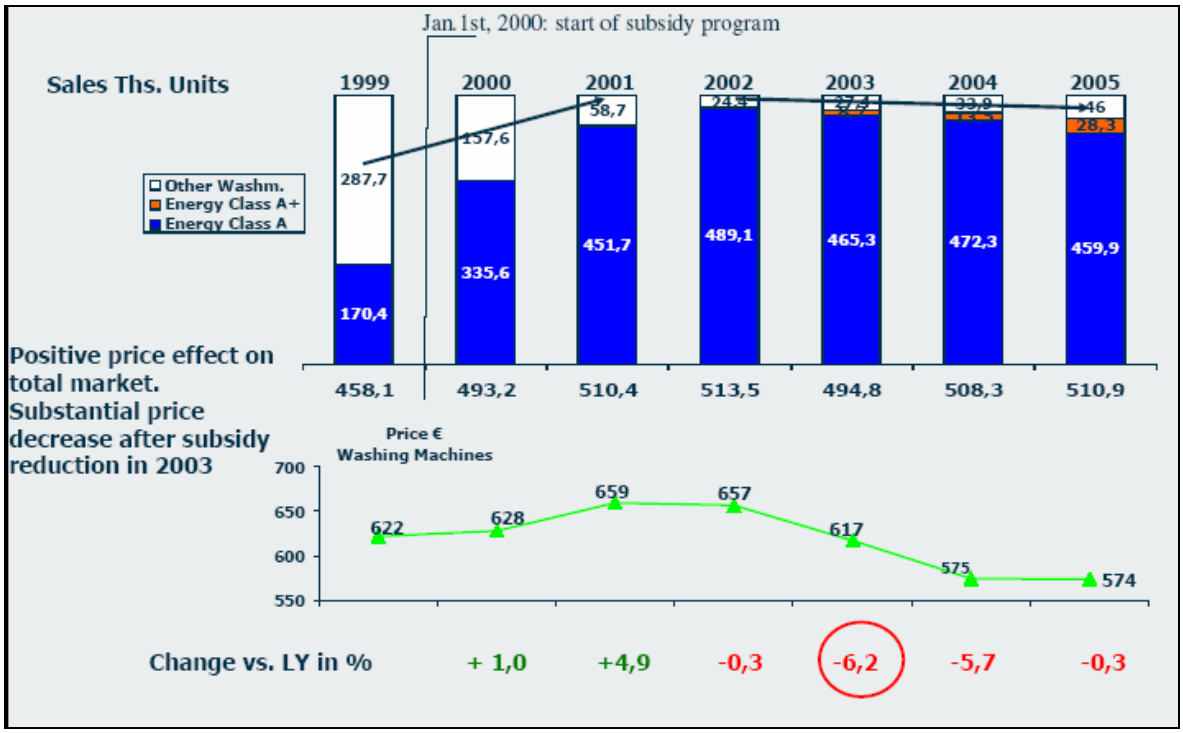
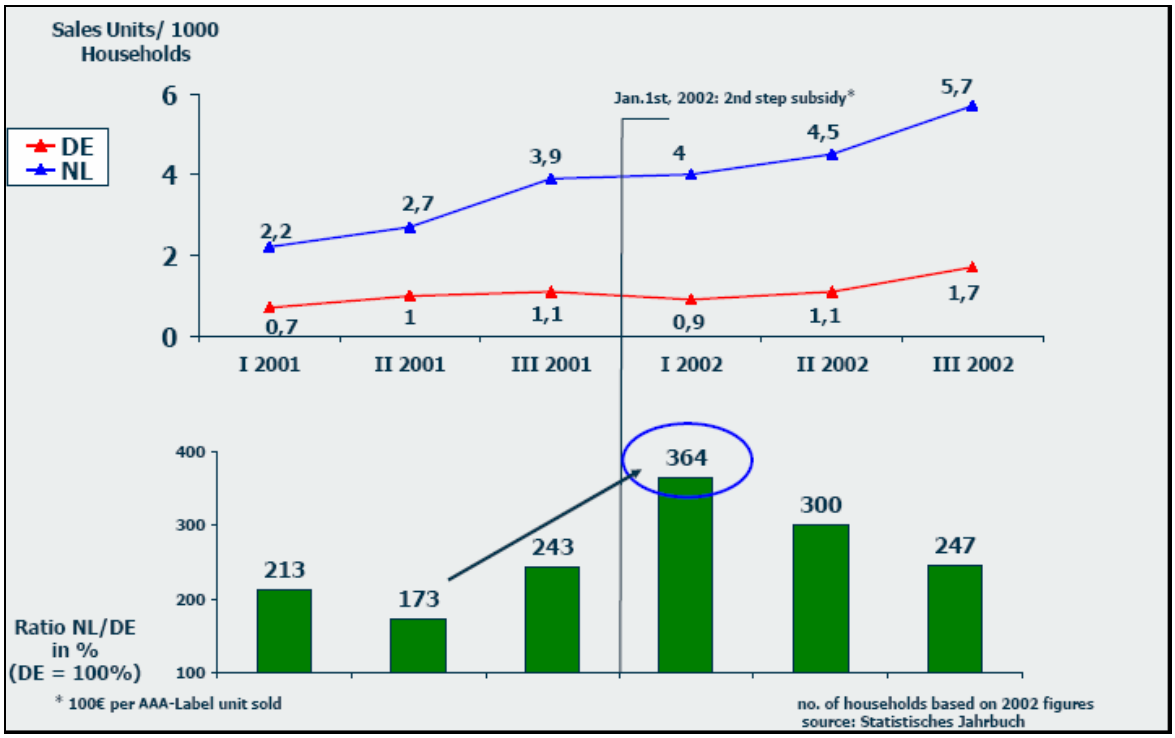


Figure 5: Comparison between the Dutch and the German market for washing machines in 2001 and 2002



1.5.2.3 Additional local legislation

a) The Water Conservation label of Dublin

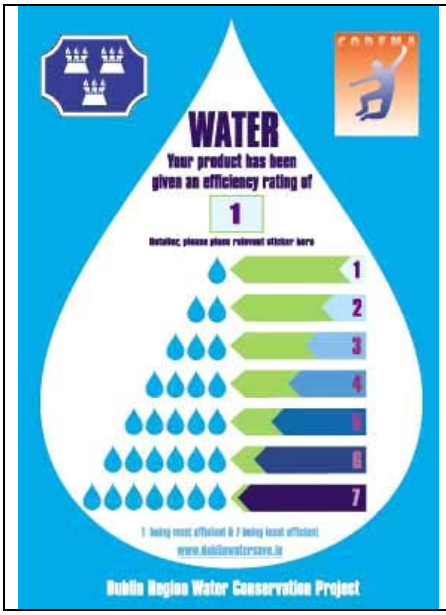
In Ireland, in support of the 276 million Euro water conservation programme, announced by the

Minister for the Environment, Heritage and Local Government in May 2003, Dublin City Council (DCC) started to promote the water conservation through the Dublin Region Water Conservation Project (DRWCP)[46]. CODEMA, the City of Dublin Energy Management Agency, together with DRWCP has developed an innovative label to help promote water conservation in the home and to facilitate the consumer to make a "better informed" decision when purchasing an appliance.

The new water label for white goods was developed in conjunction with the proposed Dublin City Council Water Bye-laws, designed to ensure that best practice is achieved to prevent water wastage and to ensure that practical, efficient and cost effective measures are in place to conserve water. Some of the measures proposed include an update of technical requirements in relation to white goods. In particular the laws require "... clothes washing machines, clothes washer-dryers and dishwasher ... be economical in the use of water."

The Water Conservation labels for dishwashers and washing machines (Figure 6) rates water consumption from 1 to 7, where "1" indicates best efficiency where less water is used and "7" indicates worst efficiency where more water is used. Rating is defined in terms of water consumed per 12 place settings and different load sizes are scaled proportionally. A database including dishwasher models and their water consumption is also available on the website.

Figure 6: Water conservation labels foe wash appliances in Dublin



Water Conservation Rating	Washing Machines* litres of water	Dishwashers** litres of water
1	≤40	≤13
2	41 - 45	14
3	46 - 50	15 - 16
4	51 - 55	17 - 18
5	56 - 60	19 - 20
6	61 - 135	21 - 24
7	136 - 240	25 - 54

*Based on a 5kg load and 60° cotton wash cycle
**Based on a dishwasher capacity of 12 place settings

Part 17 of the proposed Dublin Water Bye-laws refers specifically to washing machines, dishwashers and other appliances. In particular setting water consumption limits for washing machines, washer-dryers and dryers:

- Part 17.3 states that "domestic horizontal axis washing machines shall not have a water consumption per cycle greater than 27 litres per kilogram of wash load (EU Directive 95/12/EC);
- Part 17.4 states that "domestic washer-dryers shall not have a water consumption greater than 48 litres per kilogram of wash load (EU Directive 99/60/EC);
- Part 17.5 states that "domestic dishwashers shall not have a water consumption per cycle greater than 4,5 litres per place setting (EU Directive 97/17/EC)".

[46] See: www.dublinwatersave.ie/Water_Conservation/Home_Page/Navigation.html.

A number of retail outlets have, on a voluntary basis, agreed to participate in the new water conservation labelling scheme, demonstrating their commitment to a sustainable future in water quality and supply.

Rating is defined in terms of water consumed per 12 place settings for dishwashers and per a standard 5kg load for washing machines and different load sizes are scaled proportionally (Table 12).

Table 12: water rating for dishwashers and washing machines

Rating	litres per 12ps	litres per 1 ps	litres/5kg load	litres/kg load
1	< 13	< 1,083	< 40	< 8
2	14	1,084-1,24	41-45	8,1-9,9
3	15-16	1,25-1,40	46-50	10,0-10,99
4	17-18	1,41-1,57	51-55	11,0-11,99
5	19-20	1,58-1,74	56-60	12,0-12,99
6	21-24	1,75-2,0	61-136	13,0-27,0
7	25-54	2,1-4,5	137-240	27,1-48,00

1.5.3 International Policies & Measures

The number of nations adopting energy efficiency requirements and labels for EUPs is growing rapidly, from 9 in 1984 to 36 in 1994 to 56 in 2004. The number of regulations worldwide on individual appliances and equipment is growing even more rapidly, increasing from 543 to 878 between 2000 and 2004[47].

The most common policies and measure for wash appliances outside the EU are labelling (efficiency or other type) and efficiency requirements, implemented in many countries, as described in Table 13. (IEA and OECD Secretariats, based on various sources)

Table 13: Labelling schemes and energy requirements for dishwashers and washing machines around the world[48]

Country	Dishwashers			Washing machines		
	Min. eff. requirements	labelling		Min. eff. requirements	labelling	
		comparative	endorsement		comparative	endorsement
Algeria	--	--	--	UC	--	--
Argentina	--	UC	--	--	UC	--
Australia	**M**[3,5]	**M**[3,5]	V	**M**[3,5]	**M**[3,5]	V
Brazil	--	UC	--	V	**M**[2]	V
Canada	**M**[4]	**M**[4]	V[4]	**M**[4]	**M**[4]	V[4]
Chile	--	UC	--	--	UC	--
China	--	--	--	**M**	--	V
Chinese Taipei	--	--	--	--	--	V[4]
Colombia	--	--	--	--	UC	--
Egypt	--	--	--	**M**	**M**[3]	--
EU-25/27	**V**	**M**	V	**V**	**M**	V
Hong Kong (CN)	--	--	--	--	V	--
Indonesia	--	--	--	UC	--	--
Iran	--	--	--	--	**M**[3]	--

[47] Source: APEC," A Strategic Vision for International Cooperation on Energy Standards and Labeling", June 2006.
[48] Source: www.clasponline.org .

Israel	**M**	**M**	--	**M**	**M**	--
Jordan	--	--	--	--	**M**[3]	--
Korea	**M**	**M**	--	**M**	**M**	--
Malaysia	--	--	--	UC	--	--
Mexico	--	--	--	**M**[4]	**M**[4]	V
New Zealand	**M**[5]	**M**[5]	V	**M**[5]	**M**[5]	V
Peru	--	--	--	UC	UC	--
Russia	**M**	--	--	UC	--	--
Singapore	--	--	--	--	V[2]	--
Switzerland	**V**[2]	**M**[2]	V	**V**[2]	**M**[2]	V
South Africa	--	--	--	**V**[2]	--	--
Thailand	--	--	--	--	--	V
Turkey	**V**[2]	**M**[2]	--	**V**[2]	**M**[2]	--
United States	**M**	**M**	V	**M**	**M**	V
Vietnam	--	UC	--	--	UC	--

M = Mandatory, V = voluntary, UC = under consideration

[1] Framework legislation is passed but the implementing legislation is believed to still be under consideration.

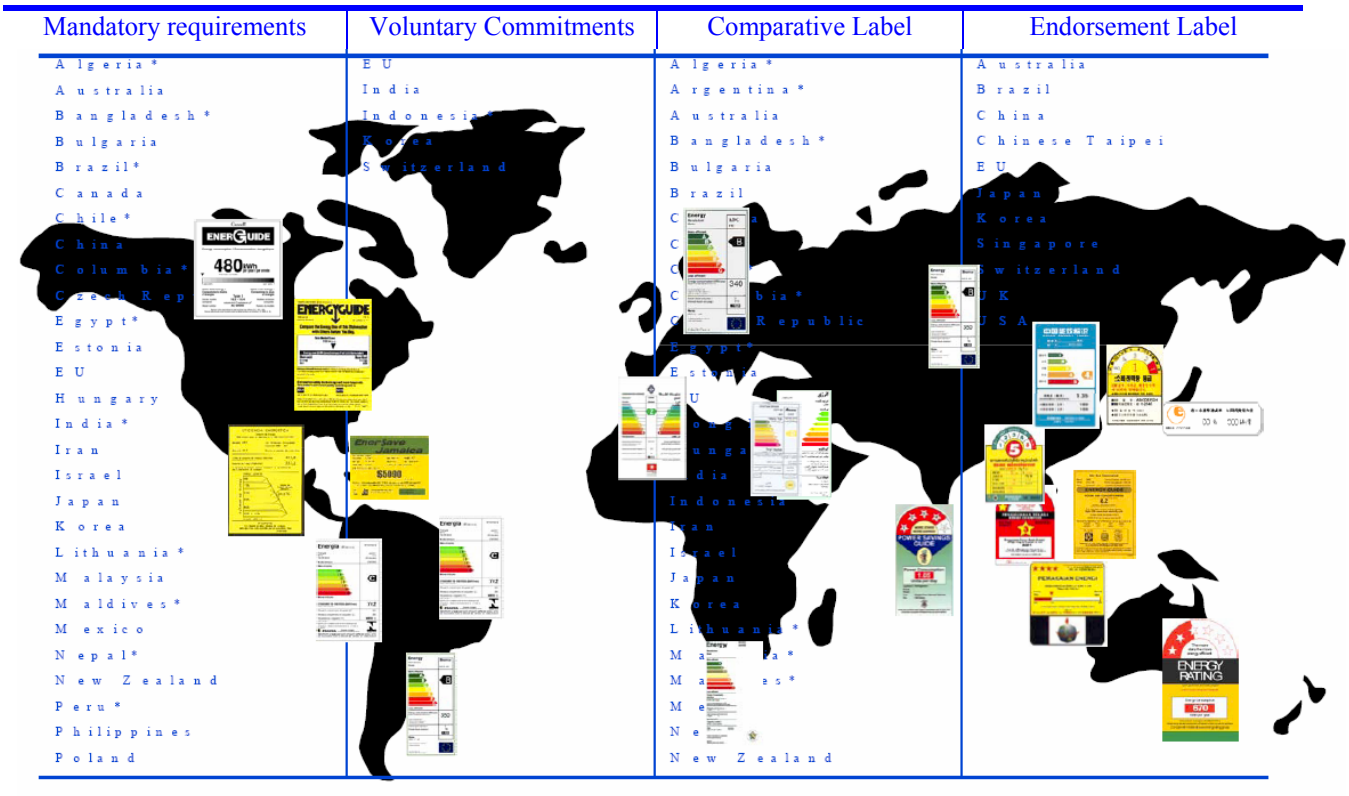
[2] Harmonised with EU;

[3]Partially harmonised with EU;

[4] Partially or fully harmonised with USA

[5] Harmonised between Australia and New Zealand.

Figure 7: International use of mandatory and voluntary policy instruments in 2004[49]



1.5.3.1 Australia and New Zealand

Like other countries, Australia[50] has had a national end-use energy efficiency program with a mandatory energy labelling of appliances, that between 1992 and 2000 delivered cumulative

[49] Source: P. Waide, International use of policy instruments: country comparisons, Copenhagen, April 2006

[50] Source: S. Holt, L. Harrington, Lessons learnt from Australia's standards & labelling program, ECEEE, 2003.

abatement of 5 Mt CO_2-e. Since this was considered a small contribution to the national stationary energy emissions calculated as 295 Mt CO_2-e pa in 2000 a change in perspective was decided. From 2000, Australian governments agreed to a programme of regulation policy matching world-best regulated efficiency requirements (but not exceeding them). Products cannot be sold unless they comply with these minimum levels, stipulated in Australian standards, which are called in law. Industry is a partner, publicly committed to bringing only complying product to market.

Australia has a small manufacturing base and imports many products from Europe, Asia and North America. As a rule Australia is a technology taker rather than developer of consumer products. The key to the policy of matching world best regulatory policies is allowing reasonable time for that technology to filter into our marketplace. It was considered unrealistic to demand Australian industry develop technologies in advance of the rest of the world; it is more realistic to expect locally based industry to match existing, proven technologies within a reasonable timeframe. The focus of policy measures debate therefore was shifted from disputes about technical feasibility issues to discussions about introduction dates. A key benefit of matching an existing technical level is avoiding divisive debates about what the standard level should be: Europe, Asia or North America has determined that for Australia in the last years. The national debate is focused on taking account of any special Australian circumstance to modify those pre-determined efficiency levels.

This specificity should be taken into account when the evolution of the Australian/New Zealand energy efficiency policy measures is considered.

a) The energy efficiency requirements

Although no minimum energy efficiency requirements have been set for **dishwashers**, a number of requirements must be met by this product during the previously described test for energy consumption. These include:

- *washing index*: the washing index of the test machine must exceed the specified value measured on the reference machine which is tested in parallel. The reference machine is a dishwasher which specially constructed and calibrated for this purpose (Miele G590);
- *drying index*: the drying index of the test machine must exceed 50% (this is conducted as a separate test);
- *rated capacity*: all specified load items shall be supported;
- *water consumption*: shall not exceed 110% of the value stated by the manufacturer.
- *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
- *energy consumption* is determined on the program recommended by the manufacturer for energy labelling that is capable of meeting the above mentioned requirements. From April 2004, all dishwashers are to be re-labelled using the "normal" program when tested to the 2003 Edition of AS/NZS 2007.1;

The same occurs for **washing machines**, to be eligible for an energy label. Products are classified into either drum type (generally front loading) or non drum type (all other types such as top loaders with impellers or agitators, twin tub machines). A number of performance requirements must be met by machines during a test for energy consumption. These include:

- *wash performance*: soil removal from soiled swatches which are attached to a clothes load of rated capacity, must exceed 80% (there are also limits on the variability of the wash)
- *spinning performance*: the water extraction index (defined as ratio of the remaining water in the load after the final spin to the bone dry mass) must not exceed 1,1
- *severity of washing*: the severity of washing index must not exceed 0,3 after a single run
- *water consumption*: shall not exceed 110% of the value stated by the manufacturer

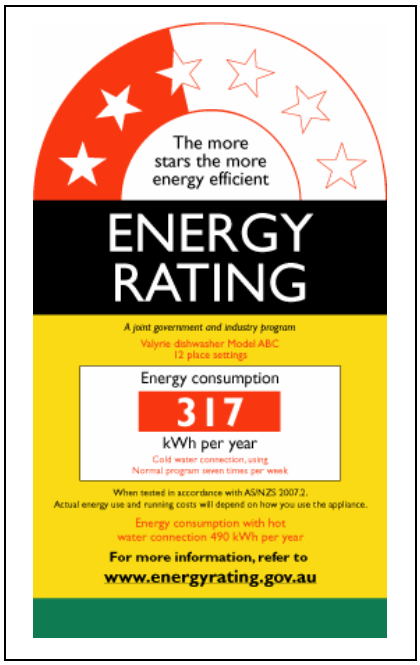
- *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
- *rinse performance*: from July 2006 a rinse performance requirement was set (see paragraph 1.5.3.1.e).
- *energy consumption* is determined on the program recommended by the manufacturer for a normally soiled cotton load at the rated capacity; the minimum wash temperature for energy labelling tests is 35°C.

b) The energy rating labelling scheme

AS/NZS 2007: *Performance of household electrical appliances - Dishwashers Part 2: Energy labelling requirements* – 2003 includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application thereof. Compared to the previous edition of 2000 it has a new requirement for labelling on the program recommended for a "normally soiled" load. In addition, Part 1 has been substantially revised including a 15 hour soil drying time and the option of using an IEC load. The change to the program recommended for a normally soiled load and retesting to the revised Part 1 has been required for all dishwashers remaining on the market after 1st April 2004.
A new edition AS/NZS 2007:2005 has been published in 2005. It refers to AS/NZS 2007.1:2005 for test procedures. From the date of publication until 31 March 2007, regulatory authorities accepted registration of dishwashers in accordance with either AS/NZS 2007.2:2003 or 2005 edition. From 31 March 2007, it is expected that all new registrations or changes to existing registrations submitted in Australia and new records or changes to existing records kept in New Zealand, will need to meet the requirements of AS/NZS 2007:2005.

The energy consumption of a **dishwasher** is measured under conditions specified in AS/NZS 2007.1. Over a year, it is assumed that the dishwasher is used 7 times per week (365 times per year). This gives the Comparative Energy Consumption (CEC) shown in the Energy Rating label (Figure 8).

Figure 8: Energy rating for a 12 place settings dishwasher in Australia



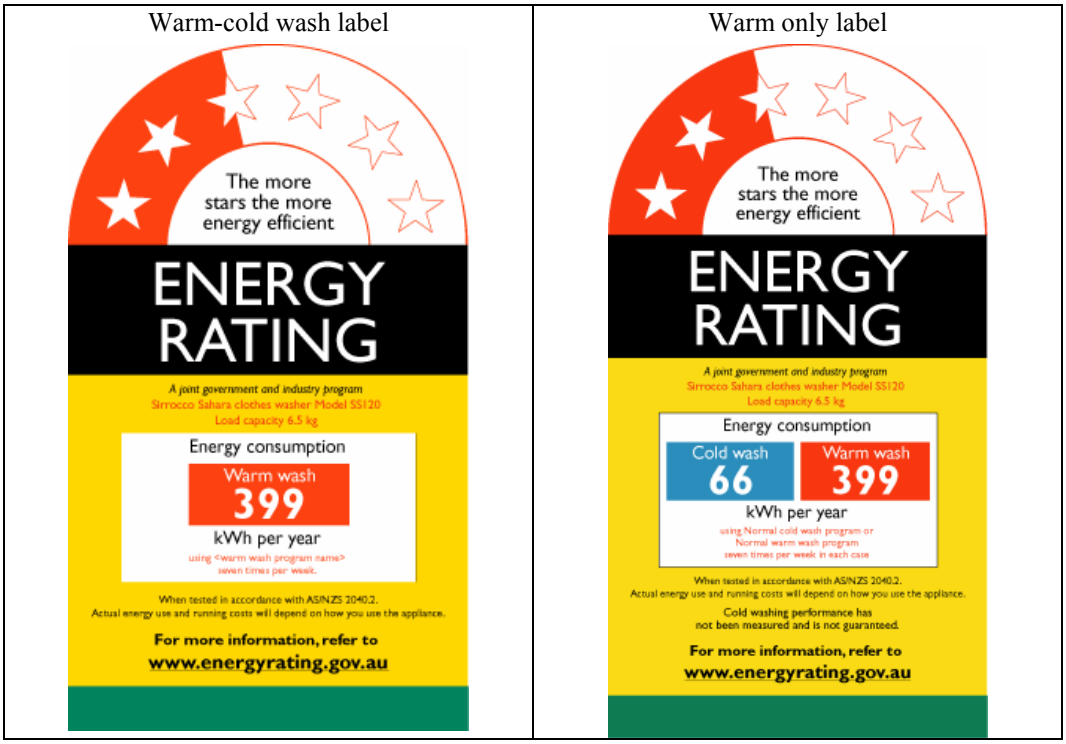
The program used for the energy labelling program is the "normal" program using the revised AS/NZS 2007 Part 1 test method. To be eligible for an energy label, a dishwasher must be able meet the specified wash and dry performance criteria (see previous point). The Base Energy Consumption (BEC) defines the "1 star" line for the specific product. An additional star is awarded when the CEC of the model is reduced by a defined percentage from the BEC. The energy reduction per star is 30% for dishwashers. For example, a model that had a CEC that was 0,70 of the BEC or less would achieve 2 stars. Similar, a CEC of 0,49 (0,70 x 0,70) of the BEC or less would achieve 3 stars and so on (Figure 8).

The energy consumption of a **washing machine** is measured under conditions specified in AS/NZS 2040.1. Over a year, it is assumed that the machine is used 7 times per week at rated capacity on a warm wash (warm Comparative Energy Consumption, in red in the label shown in Figure 9); a value for a cold wash energy of 7 times per week is also shown on the label (cold CEC in blue). The washing machine is labelled on the "normal" or "regular" program (program specified for a normally soiled cotton load).

The Base Energy Consumption (BEC) defines the "1 star" line for the particular product. An additional star is awarded when the CEC of the model is reduced by a defined percentage from the BEC. The energy reduction per star is 27% for clothes washers. For example, a model that had a CEC that was 0,73 of the BEC or less would achieve 2 stars (Figure 9). Similar, a CEC of 0,533 (0,73 x 0,73) of the BEC or less would achieve 3 stars and so on. For clothes washers, front and top loading models are rated on the same basis.

The warm wash energy consumption (warm CEC) and a component of residual moisture (spin performance) is used to define the star rating in comparison with the BEC. Therefore a model that has a good spin performance may get a marginally higher star rating than a model of the same capacity and CEC with a poor spin performance.

Figure 9: Energy rating for washing machines for machines with warm wash only and with warm and cold wash in Australia



c) The TESAW and the future Energy Star scheme

The Tower Energy Saver Award or TESAW[51] is an award system that Australian and State governments and the appliance industry have created in 2003, replacing the previous Galaxy Award system, to recognise the most energy efficient star rated products on the market. It applies to both electric and gas products that carry a star rating energy label. It is an award system that helps consumers quickly identify the most efficient products on the market. TESAW complements the mandatory labelling with an endorsement label. The TESAW label is about half the size of a normal electric energy label and is in the same colours.

Each year, the energy efficiency of all products on the market are reviewed. In consultation with industry, the Government sets energy efficiency criteria (usually the best star rating available) for TESAW awards for the coming year (each label specifies the year of the Award). From the start of the award period (November), manufacturers of existing products or new products that meet the set energy efficiency criteria will be eligible to apply for an award. Once an award is granted, the manufacturer is eligible to display the TESAW label on their products in retail stores.

The award eligibility criteria for TESAW award to electric products are:

- the product must be registered and approved by the relevant regulatory authority for electric products.
- the product must be available for sale in Australia at the time of applying for the award or at some time during the calendar year of the award specified by the applicant. (Note, at the time of registration, all new energy labelling applications have to nominate an "on market" date - this date is used to trigger the appearance of the registration onto the public energy rating website, which also shows whether the product has received an award).
- the product must meet or exceed the performance requirements as set out in the performance criteria schedules. TESAW criteria for 2006 for wash appliances are[52]:
  - dishwashers: appliances which are registered for energy labelling to AS/NZS 2007.2 (Edition 2003 or 2005) and have achieve 3,5 stars or more
  - washing machines: appliances which are registered for energy labelling to AS/NZS 2040.2 (Edition 2000 or 2005) and achieve 4,5 stars or more.

In 2005 detailed discussions and negotiations were held with the US Environmental Protection Agency and the US Department of Energy, resulted in an in-principle agreement that Australia and New Zealand could set local Energy Star criteria for products that were sold in the Australasian market (such as white goods, where the USA had their own domestic criteria), subject to detailed review by EPA and DOE on a product by product basis. This has been agreed on the basis that the energy star label would be available on products that are specifically for sale in Australia and New Zealand and would not appear on the US market. Possibly a version of the energy star that is unique to this region will be developed. On this basis, EEEC (Equipment Energy Efficiency Committee) decided to move towards the use of the Energy Star label as the primary endorsement label for appliances and equipment in Australia and to discontinue TESAW as an endorsement label.

A complete overview of the regulatory and endorsement framework in Australia and New Zealand is in preparation to facilitate further discussions. To allow a smooth transition from TESAW to Energy Star, EEEC has decided to continue the TESAW scheme for each product until suitable Energy Star criteria are finalised.

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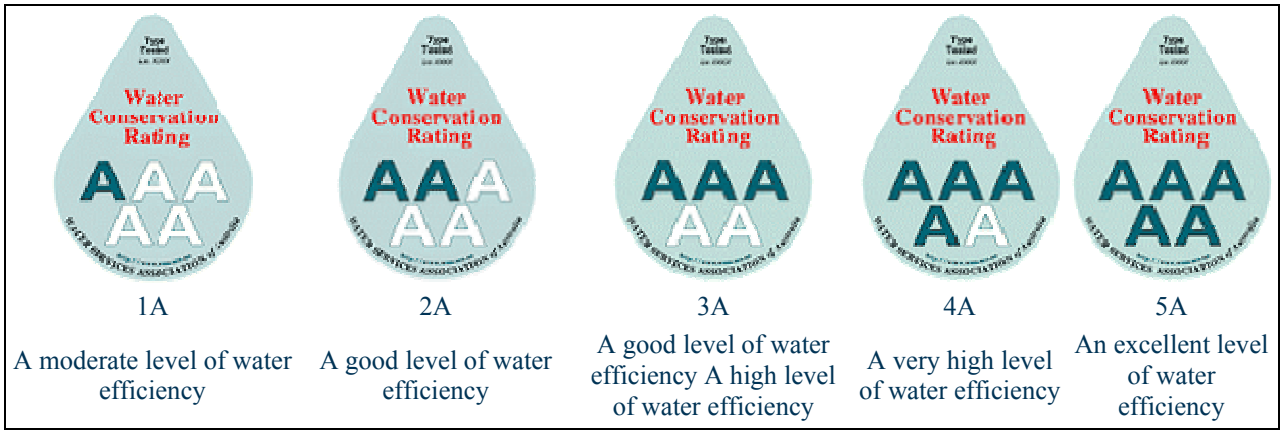
[51] http://www.energyrating.gov.au/tesaw-main.html.

[52] Source: Top Energy Saver Award Winner: Final Award Criteria for 2006 – January 2006.

d) The water efficiency labelling scheme

A voluntary water efficiency labelling scheme has been in existence since 1988. It is now managed by the Water Services Association of Australia (WSAA). The scheme originally covered only shower heads and dishwashers, and offered two efficiency grades (A and AA). A third rating (AAA) was introduced in 1992, and two higher ratings (AAAA and AAAAA) in 2001 (Figure 10). The WSAA program covers shower heads, toilets, taps, clothes washers, dishwashers, urinal flushing devices and flow regulators. The test requirements for each product type, the water efficiency levels required for each rating and the label design are all specified in AS/NZS 6400, Water efficient products – Rating and labelling published in February 2003.

Figure 10: The national water conservation rating and labelling scheme[53]



The technical criteria for water efficiency ratings for dishwashers and washing machines are presented in Table 14[54].

Table 14: Technical criteria for water efficiency ratings in Australia until 1 June 2006

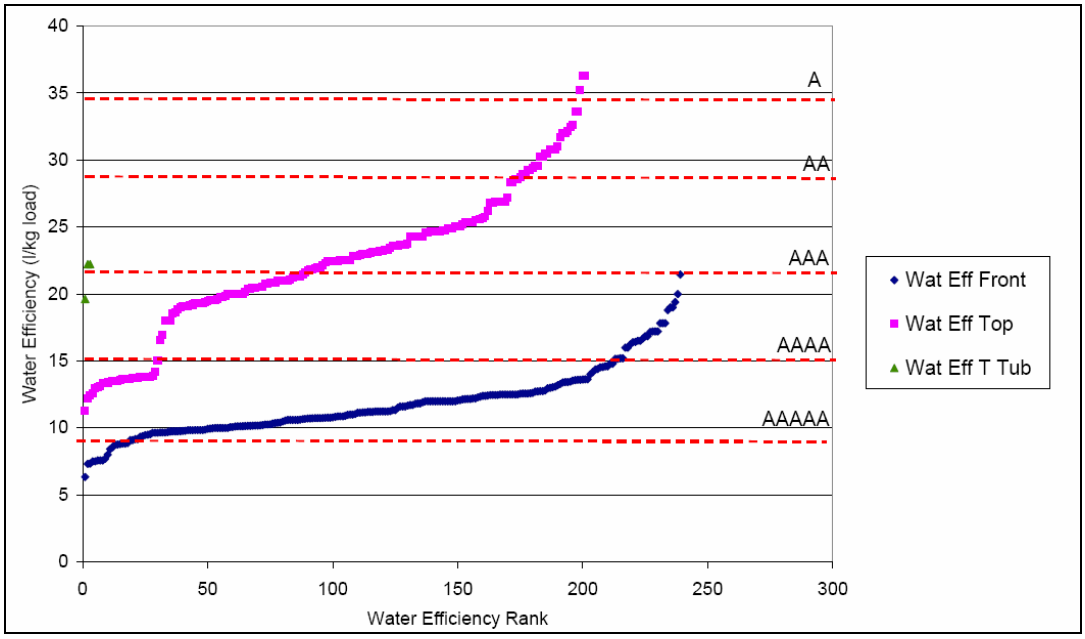
Product	Units of measurement	water efficiency ratings				
		A	**AA**	**AAA**	**AAAA**	**AAAAA**
Dishwashers	litre/place setting	≤2,8 / >2	≤2 / >1,5	≤1,5 / >1	≤1 / >0,8	≤ 0,8
Washing machines	litre/kg load	≤34 / >28	≤28 / >22	≤22 / >15	≤9 / >15	≤ 9

The coverage of the existing program was considered limited for some of the products such as washing machines and good for other products such as dishwashers. The main incentive for labelling has been the support of the water utilities (the members of WSAA), many of whom have publicised the scheme, or offered cash rebates to their customers for the purchase of labelled appliances. Consequently, despite nominally being a *comparative labelling* program it has developed some of the attributes of an *endorsement label*, which assists water utilities and their customers to identify models for rebate purposes, rather than as an effective comparative label, which encourages and enables buyers to compare the water efficiency of different models. Consumer awareness of the existence of the voluntary label and label recognition were also

[53] Source: http://www.wsaa.asn.au/ratings/ratingsabout.htm
[54] Source: George Wilkenfeld and Associates, Regulation Impact Statement: Proposed National System of Mandatory Water Efficiency Labelling for Selected Products, prepared for the Department of the Environment and Heritage, Australia, May 2004

considered low. The water efficiency of washing machines labelled in December 2004 is presented in Figure 11[55].

Figure 11: Water efficiency of labelled washing machines in December 2004



The Commonwealth Department of the Environment and Heritage introduced in 2003 a mandatory Water Efficient Labelling and Standards (WELS) Scheme that applies national mandatory water efficiency labelling and minimum performance requirements to household water-using products and replaces the voluntary Water Services Association of Australia's National Water Conservation Rating and Labelling Scheme (ceased 1st July 2006). Each state has also enacted its own legislation to complement the National scheme.

All products specified under the WELS Act must be registered, rated and labelled according to the requirements of **AS/NZS 6400:2005**[56] (with Amendments 1,2 and 3 December 2006) *Water-efficient products - Rating and labelling*. This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-032, Water Efficient Appliances and was approved on behalf of the Council of Standards Australia on 14 April 2005 and on behalf of the Council of Standards New Zealand on 22 April 2005 and published on 1st June 2005.

From 1 July 2006, mandatory registration and labelling will apply to all of these products (apart from flow controllers, for which this will be optional). All registrations are to be made through the WELS Regulator, preferably via an online form at http://www.waterrating.gov.au/about/registration.html. Registration fees have to be paid. The specified products are: washing machines, dishwashers, lavatory equipment, showers, tap equipment and urinal equipment. Flow controllers may be voluntarily rated and labelled; however, if flow controllers are registered, rated and labelled, they are required to comply with all the relevant aspects of the standard. Lavatory

[55] Source: Energy Efficient Strategies, Method for the Determination of Rinse Performance in Clothes Washers, Summary Report, Report for The Department of Environment and Heritage – Australian Federal Government, June 2005

[56] Published on 28 December 2006. Approved for publication in New Zealand on behalf of the Standards Council of New Zealand on 22 February 2007, see: http://www.waterrating.gov.au/index.html .

equipment is also required to comply with minimum water efficiency requirements. Full details of the WELS scheme implementation dates are in Table 15. A registration fee has to be paid.

Table 15: Transition dates to phase in the WELS Scheme

Critical Dates	Products	Notes
From 1 July 2005	Products may be voluntarily registered and labelled	Unlabelled products and AAAAA-labelled products will co-exist with WELS labelled products. Voluntarily registered products will be subject to the mandatory requirements of the scheme
From 1 July 2006	Products must be registered and labelled. Toilet equipment subject to minimum water efficiency requirements	The AAAAA rating scheme will cease. All new products must comply with the WELS Scheme; however, pre-existing stock may still appear in the shops
Until 31 December 2006	Retail supply of pre-existing tap equipment, showers, toilet equipment and urinal equipment is allowed	Permitted to allow a reasonable timeframe to move existing stock , provided that the products were manufactured in Australia or imported before 1 July 2006
Until 31 December 2007	Supply of pre-existing washing machines and dishwashers with AAAAA labels or without WELS Water Rating labels is allowed	Permitted to allow a reasonable timeframe to move existing stock , provided that the products were manufactured in Australia or imported before 1 July 2006
From 1 January 2008	all products are required to display the WELS Water Rating labels, irrespective of their date of supply	

Throughout AS/NZS 6400 the requirements and dates that relate to the implementation of the WELS scheme apply in Australia only, for New Zealand, the exact details of the WELS process implementation date have yet t be finalised, but the date is intended to be 1st December 2007[57]. AS/NZS 6400 also requires that products that do not comply with specific performance requirements will be given a zero rating and labelled accordingly or, in the case of toilets, no label will be issued.

The requirements of the WELS scheme generally only apply to new products and not to second-hand products. However, products that are imported second-hand to be supplied in Australia will be subject to the requirements.

Dishwashers and washing machines are required to comply respectively with AS/NZS 6400:2005 Clause 2.2 (setting out requirements for the registration, rating, labelling, and performance of dishwashers) and Clause 2.3 (setting out requirements for the registration, rating, labelling, and performance, including rinse performance as specified in AS/NZS 2040.2:2005 for washing machines). The supply of washing machines and dishwashers without WELS scheme labels will only be permitted until 31 December 2007, if the products were manufactured in Australia or imported before the commencement day of the mandatory scheme on 1 July 2006. The SRI (Star Rating Index) for **dishwashers** and **washing machines** is calculated as:

$$\text{Star Rating Index} = 1 + \frac{\log_e\left(\frac{WC}{BWC}\right)}{\log_e(1 - WRF)}$$

[57] Source: Water Efficiency Labelling Standards (WELS), at: www.mfte.govt.nz.

where:

- Star Rating Index = fractional star rating used to determine the number of stars to appear on the label, rounded down to the nearest half star rating
- WC = water consumption of the model in litres
- BWC = base water consumption = 2,5 + P × 1,6 and P = number of place settings of the *dishwasher*
- BWC = base water consumption = 30 × C and C = rated load capacity of the *washing machine* (kg) as determined under AS 2040.1, rounded to the nearest 0,1 litre
- WRF = water reduction factor per additional star (17,5%) = 0,175.

If an appliance achieves less than 1 on the star rating index, the rating is considered zero stars.

The water consumption of a washing machine is the higher of (a) the claimed total water consumption of the warm-wash or (b) the claimed total water consumption of the cold-wash when each is determined under the conditions used for the energy consumption tests as specified in AS/NZS 2040.2.

In Figure 12 the water rating label for dishwashers is shown. A product will be considered labelled if a removable label is attached to the product (or attached to or printed on the packaging, if the product is displayed for sale in the package), and/or if an image of the label is used in any advertising and promotional material, which is intended to inform the prospective buyer of the water efficiency rating of the product and other relevant features.

Figure 12: Water rating label for a 12 place setting dishwasher under WELS scheme

e) The rinse performance requirements

Clause 2.3.3 of **AS/NZS 6400:2005** specifies that "a clothes washing machine shall comply with the performance requirements specified in AS/NZS 2040.2, when tested under the same conditions

used to determine the energy consumption of the appliance. AS/NZS 2040.2:2005 requires compliance with minimum rinse performance requirements".

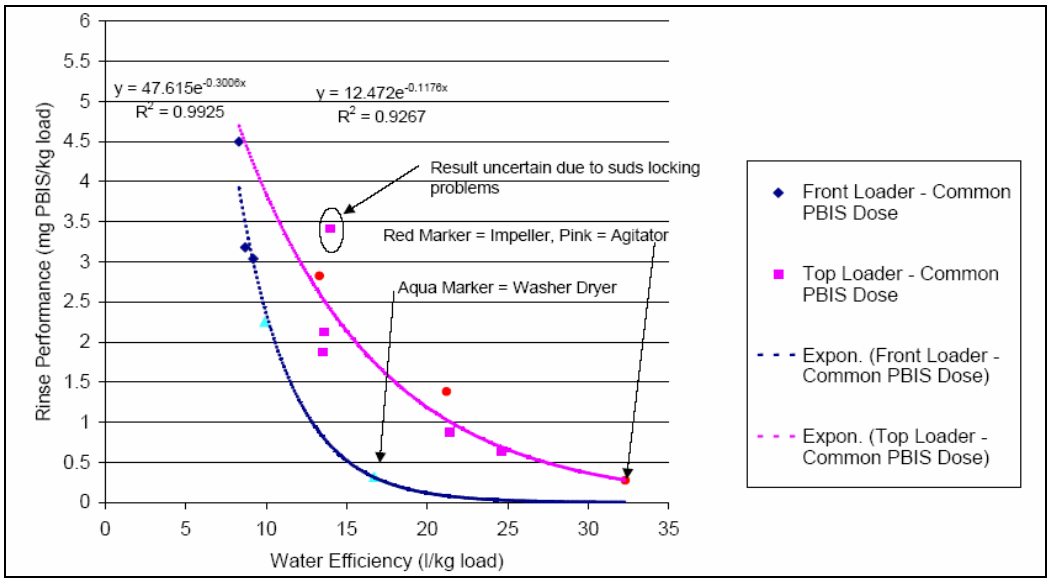
When measuring rinse performance the intention is to measure the effectiveness of the machine in removing from the load various components associated with a typical wash. Primarily these components are detergent and soil (both soluble and insoluble). Assessment of the rinse performance of a washing machine is based upon the measurement of the apparent mass of retained marker (PBIS) in the load at the completion of the program. The marker is dosed into the wash program in proportion to the rated load. A standard soil removal test is then conducted. At the completion of this test (following weighing of the load) the load is placed in a spin extractor and a sample of rinse liquor recovered. The rinse performance is then determined from the concentration of PBIS in the extracted rinse liquor multiplied by the mass of retained moisture in the load measured at the end of the program. The addition of the PBIS marker to the wash water had no discernable impact on the wash performance result or other performance parameters.

The pass mark for rinse performance has been set at 2,25 mg PBIS/kg load.

The introduction of a rinse performance requirement facilitated the introduction of mandatory water efficiency rating and labelling. Without a rinse performance requirement higher water efficiency rating could be achieved by reducing rinse performance levels that may not meet the needs of washing machine users. To assist the standards committee in determining an appropriate pass mark a total of 8 top loader machines and 5 front loader machines, a representative cross section of the product available in 2004 in the Australian market and including a wide range of water efficiencies, were undertaken.

The results of the tests are presented in Figure 13[58], where the mass of retained PBIS is plotted against the water efficiency (l/kg load).

Figure 13: Rinse performance (PBIS) vs. water efficiency for a representative sample of washing machines in the Australian market in 2004



[58] Source: Energy Efficient Strategies, Method for the Determination of Rinse Performance in Clothes Washers, Summary Report, Report for The Department of Environment and Heritage – Australian Federal Government, June 2005

For each data series (front loading machines in blue and washer-dryers in light blue in one series and top loading impeller machines in red and agitator machines in magenta in the other series) an exponential trend line has been fitted. In all cases the fit was good. The trend lines show a clear relationship between water efficiency and rinse performance whereby an increase in water efficiency will result in a decrease in rinse performance. However, for a given water efficiency some significant variation in rinse performance between different models was found.

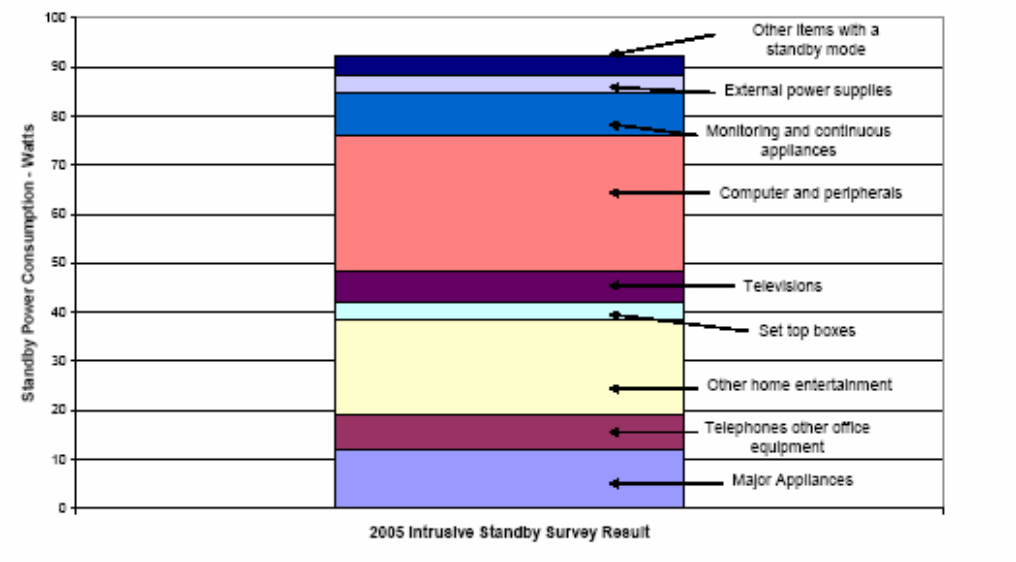
f) The standby requirements[59,60,61]

In 2000 the Australian Greenhouse Office (AGO) and the Equipment Energy Efficiency Committee (E3, formerly NAEEEC) commissioned the first major report into standby which involved an intrusive survey in Australian households; this exercise was repeated in 2005.

In 2002 the Ministerial Council of Energy (MCE) initiated a ten year policy on standby power entitled "Money isn't all you're Saving". This policy set out the "One Watt" target for appliances, with an overall goal that by 2012 all appliances would only use one Watt in their lowest standby mode, although the exact targets were to be determined on a product by product basis.

The 2005 intrusive survey covered some 120 houses including 40 houses in Brisbane, 30 houses in Sydney and 50 houses in Melbourne and Gippsland, Victoria. Field work was undertaken in the period September to November 2005. A total of 8000 individual appliances were recorded during the survey. Appliances were recorded in all relevant standby modes, such as active standby, passive standby or off mode. This includes most appliances that have a continuous power draw which is not associated with their primary function. A small selection of products also had power consumption recorded in on mode (mainly televisions, computers and monitors). The contribution from each appliance group to the overall household standby power consumption was highlighted (Figure 14).

Figure 14: The contribution from each appliance group to the overall household standby power consumption in 2005



[59] Source: Report No 2006/10, Standby Power – Current Status, A report for the Equipment Energy Efficiency (E3) Committee – which documents the state of standby power in Australia and New Zealand, October 2006.
[60] Source: NAEEEC, Quantification of Residential Standby Power Consumption in Australia, NAEEEC, Final Report, 29 April 2001.
[61] Source: 2005 Intrusive Residential Standby Survey Report, Report for E3, March 2006.

The most important product groups in terms of their total contribution to standby are computers and peripherals, home entertainment equipment (including televisions and set top boxes), major appliances and other office equipment. For major household appliances the average power consumption is 1,4 W per item with an average of 8,5 items per household.

The results for dishwashers and washing machines are:

- **Intrusive surveys**: 64 households were surveyed in 2000 and 120 households in 2005. Visits were made to conduct power measurements of all household appliances in off-mode, standby mode and in-use (as applicable). Every plug load in each house was identified and measured where possible. The "on", "standby" and "off" readings were collected. Information about each appliance, such as age, brand name and model number was also collected.

  Dishwasher ownership was found to be 0,31 and 0,57 per household in the two years, washing machine at 0,95 in the two surveys.

  In 2000, almost all models for both appliances were found in "off" mode when not in use, but as for dryers electronics are increasing therefore standby is becoming more common. The stock average in "off mode" for dishwashers was 0,5 W, increased since the late eighties coinciding with the introduction of "soft touch" technology. In use readings during the intrusive survey were hard to obtain as most models were "built in" or difficult to move. For washing machines just over half (56%) of all measured models had an off reading of zero watts – many of these are older machines; the average off mode power consumption for washing machines increased since the late eighties (coinciding with the introduction of "soft touch" technology); the stock average for off mode is 2.0W and looked to be increasing.
  In 2005, about 76% of the dishwashers were found to be switched off, with the rest found in active standby mode. About 66% of units were found to have a hard off switch, about 33% with a soft switch off. One unit was found to have no hard or soft off switch. About 28% of units were found to be hardwired or inaccessible. The average active standby was found to be 2,8 W and the average off mode was found to be 0,8 W. About 25% of dishwashers were found to have delay start capabilities, with 20% of participants with these machines indicating that they use this function. The average power consumption for delay start mode was found to be 3,8 W.

  The average age was found to be 6,6 years. The active standby power consumption of dishwashers for 2005 was that about 29% of units had a power consumption of between 2 W and 3 W, 36% of units were found to use less than 2 W and the other 35% of units found to use more than 3 W. As far ad the off mode power consumption is concerned, in 2005 64% of the units had a power consumption of 0,0 W, with the rest of the sample having a range of consumptions up to 5,0 W. The summary of the dishwashers finding is presented in Table 16.

  About 68% of washing machines were found to be off, 9% were in active standby and 24% were switched off at the power outlet or unplugged. Alarmingly, 25% of the front loaders were found to be left in active standby mode when not in use. About 67% of units were found to have a hard off switch, about 32% had a soft off switch. Two units were found to have no hard or soft off switch. The average active standby was found to be 5,8 W and the average off mode was found to be 1,9 W. About 22% of machines were found to have delay start capabilities, with about 24% of participants with these machines answering that they use this function. The average power consumption for delay start mode was found to be 7,1 W. The majority (75%) of the machines had an active standby power consumption between 2 W and 8 W. Just over half of the units (54%) consume 0,0 W in off mode, the rest of the readings are spread relatively evenly

from less than 1 W to less than 10 W. The summary of the washing machines finding is presented in Table 17.

Table 16: Findings of the Australian 2005 household intrusive survey for dishwashers

Dishwashers	Statistic	Number of Readings
Ownership	0.57	68
Average Age	6.6 years	62
Average Active Standby	2.8 Watts	34
Minimum Active Standby	0.3 Watts	34
Maximum Active Standby	7.0 Watts	34
Average Off Mode	0.8 Watts	44
Minimum Off Mode	0.0 Watts	44
Maximum Off Mode	4.4 Watts	44
Average Delay Start Mode	3.8 Watts	17

Table 17: Findings of the Australian 2005 household intrusive survey for washing machines

Clothes Washers	Statistic	Number of Readings
Ownership	0.95	114
Average Age	7.0 years	110
Average Active Standby	5.8 Watts	65
Minimum Active Standby	0.5 Watts	65
Maximum Active Standby	17.3 Watts	65
Average Off Mode	1.9 Watts	112
Minimum Off Mode	0.0 Watts	112
Maximum Off Mode	9.3 Watts	112
Average Delay Start Mode	7.1 Watts	25

- **Market surveys**: as a key element of the MCE Standby Power Strategy, regular store surveys have been undertaken with the specific goal to "quantify the magnitude of electricity used in standby modes by new appliances offered for sale on the Australian market" since 2001. The methodology used has been to visit a number of large retail outlets and measure the relevant modes for all products that are on display for sale. Measurements are made on 500 to 1 000 new products during each survey. Data is recorded on brand, model, price, details of any energy labels or markings, features, product type and any other relevant features. Power consumption in defined modes is recorded, mostly passive standby and off modes, but also active standby and on mode in some cases. Initially, the surveys were conducted once annually, but since 2003, two to three surveys have been conducted per year. This has resulted in a database of more than 5 500 new products offered for sale in the period. It should be noted that the number and mix of products measured in each year of the survey were somewhat different so the results need to be taken as indicative and trends within each product need to be examined separately. For each

appliance, power consumption was measured while the appliance was in use (mostly home electronics), in standby (passive and/or active) and off modes, where applicable. For many appliances such as washing machines and dishwashers, it was impractical to measure the appliance in use.

Dishwasher results: 181 new products in store surveys 2001 to 2006. the measured value for off mode varies over time but is usually less than 1 W (affected by the sample size and mix of products measured). However, end of cycle mode is the most critical (especially for European products) and little data is available;

Washing machines results: 380 new products in store surveys 2001 to 2006. There was a strong decline in off mode power from 2001 (3,8W) to 2004 (0,7W) probably in response to proposed reporting requirements and incorporation into the energy label. However, there appears to be a slight increase in both off mode and active standby mode for new products in 2004 and 2005 (1,2W) compared to earlier years. However, end of cycle mode is the most critical (especially for European products) and little data is available.

There is an important issue regarding washing machines and dishwashers: most European products have an off switch, which usually disconnects power to most parts of the machines and drops the power consumption close to zero Watts. However to achieve this, the consumer must manually turn the machine off when the cycle has been completed and the load removed. During the intrusive survey in 2005 around 40% of the European front loading machines were found left in active standby mode when not in use (i.e. the users did not manually turn the machines off when the washing cycle was completed). These machines persist in active standby mode indefinitely with the current machine designs. This means that the off mode power consumption for many European machines is probably not all that relevant. A more relevant figure is the active standby power consumption (which in many cases is likely to be similar to end of cycle mode). In 2005 this averaged about 4 Watts, although individual values varied from 1 Watt to 7 Watts in this mode. All non European machines automatically revert to off mode automatically at the end of the cycle, so only off mode measurements for these machines are relevant.

The Standby Power Strategy 2002-2012 contains a wide range of possible policy measures to address excessive standby power. The document sets out the long-term strategy to address excessive standby energy used by consumer appliances and equipment. The strategy foresees:

1. outlines the measures that governments will use to address excessive standby;
2. identifies the products to be targeted in the first of three-year rolling plans under the strategy;
3. establishes the procedure whereby standby targets will be set for each of the targeted products (Stage 1 targets);
4. identifies the sanctions that will apply should suppliers not meet the targets for these products (Stage 2 targets).

The purpose is to provide that Australian products will meet the ultimate target, of one watt in 2012.

Under the strategy, product profiles for specific products were published over 2003-2005. The profiles provided a detailed assessment of current market, ownership levels, product attributes and the range of standby power typically found in new products on the market. The strategy envisaged as a first stage a range of voluntary targets for reductions in standby power on a product by product basis over the initial three year period (so called Stage 1). At a specified date, each product type or category would be assessed against the voluntary targets specified in the product profiles. If satisfactory progress was achieved towards or beyond the voluntary target, further long term

voluntary targets would be confirmed. If adequate progress was not made by the target date, then the government would consider a range of possible actions, some of which may be mandatory or have mandatory components (so called Stage 2). Stage 1 and 2 targets for dishwashers and washing machines are:

- Stage 1 (2007): off mode power < 1W
  end of cycle mode power < 4W
- Stage 2 (2012): off mode power < 0,3W
  end of cycle mode power < 1W

where:

- off mode power = lowest power when connected to the mains. Limit is applicable to models which have an off mode;
- end of programme power = power consumed when the machine has ended the program or cycle, where the unit does not revert to off mode after a fixed period.

The strategy sets out a number of possible policy tools which were to be considered on a product by product basis as follows:

- Promotion of Energy Star
- Industry Codes of Conduct
- Publication of targets in Australian Standards
- Collection of data for new products
- Publication of standby data for products
- Inclusion of standby into the energy label for selected products
- Introduction of MEPS on standby for selected products
- Warning label for products with high standby.

Investigations regarding modes and the inclusion of standby power into the energy label have been concluded for dishwashers and washing machines and these were implemented in late 2005 with a transition period to April 2007. After this date all dishwashers and washing machines will have standby energy consumption included in the energy label value, which will also affect the product star rating.

The initially proposed algorithms for the calculation of the CEC (Comparative Energy Consumption) including standby for wash appliances was:

$$CEC = E_t \times C + [P_d \times 2 \times C + P_e \times 15 \times C + (8760 - T_c \times C - 2 \times C - 15 \times C) \times P_o]$$

where:

- E_t = the cycle energy consumption measured according to the AU/NZS Part 1 standard
- C = is the defined number of cycles per year, 365 for washing machines and dishwashers
- P_d = the measured power (in W) in the "delay start" mode, it is 0 where the appliance does not have a delay start function; the delay start mode is assumed 2 hours where present
- P_e = the measured power (in W) in the "end of programme" mode, it is 0 where the appliance does not have end of programme mode; end of programme mode is assumed for 15 hours when present
- P_o = measured power in off mode (W), for the remaining standby time after delay start and end of programme modes
- T_c = cycle time (in hours).

The value of CEC is in Wh and should be divided by 1000 for use on the energy label.

The proposal was subsequently modified, considering only an average of "off mode" and "end of cycle mode" for inclusion into the energy label CEC and deleting the "delay start mode" from the overall standby calculation, to avoid any penalisation of this mode, which was recognised to have a positive impact on the machine use by allowing the delay of the washing cycle to off-peak hours. In addition, the overall standby power is considered 100% the time in "off mode" where the "end of cycle" mode is not present (when products automatically revert to "off" after the end of cycle) [62]:

$CEC = E_t \times C + [P_s \times (8760 - T_c \times C)]$

where P_s = the average measured standby power, in Watts which is the average of end of cycle mode and off mode, (where this mode is present) where these have been determined in accordance with AS/NZS 2007.1:2005.
Again, the value of CEC is in Wh and should be divided by 1000 for use on the energy label.

Revised edition of AS/NZS 2040, Part 1 and Part 2 for washing machines were published in December 2005. The new standards include standby measurement, rinse performance test methods and registration requirements for mandatory water labelling. All products on the market will be required to register to the new standards by 1 April 2007.

Revised edition of AS/NZS 2007, Part 1 and Part 2 for dishwashers were published in December 2005. The new standards include standby measurement and registration requirements for mandatory water labelling. All products on the market will require registration to the new standards by 1 April 2007.

1.5.3.2 USA (and Canada)

The US has both mandatory and voluntary policy measures for household appliances including dishwashers and washing machines.

During the mid-1970s, several individual states in the United States had begun promulgating their own energy efficiency requirements. With the passage of the National Energy Policy and Conservation Act of 1978, Federal law in this area was given precedence over state laws - unless the Federal government determines that no efficiency requirements are warranted for a particular product, in which case states are then free to establish local requirements. The National Appliance Energy Conservation Act (NAECA) was signed into law in 1987 giving the US Department of Energy (DoE) the power to set federal standards for maximum energy consumption on household appliances. DoE currently imposes minimum efficiency requirements for 25 products including 15 used in the residential sector and manages the two US labelling schemes, the Energy Guide and the ENERGY STAR.
Since 2004, ten states (Arizona, California, Connecticut, Massachusetts, Maryland, New Jersey, New York, Oregon, Rhode Island, and Washington) have established new energy-saving requirements covering between 5 and 30 products, most through new state legislation. In August 2005, Congress took its cue from the states and made 15 of these state standards federal law through the "Energy Policy Act" of 2005. The new law includes two major energy efficiency provisions: it sets (1) manufacturer and consumer tax incentives for advanced energy-savings technologies and practices and (2) minimum energy efficiency requirements for 16 products, including household appliances and directs DoE to set requirements for several other products. The law also sets other provisions including the revision of the long lasting appliances labelling scheme.

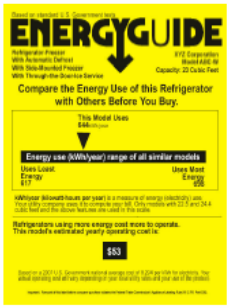
[62] For sake of coherence, the shown algorithm is not the one eventually published in the standard, but is presented in the same form as the previous formula.

Canada and Mexico adopted efficiency requirements identical or very similar to those set by the US DoE.

a) US Energy efficiency labelling programmes

The US has two primary federally funded labelling programmes for consumer products and appliances: "Energy Guide" and "ENERGY STAR". A comparison of the two schemes is presented in Table 18[63]

Table 18: comparison of the Energy Guide and the Energy Star labelling schemes

	EnergyGuide	ENERGY STAR
Logo/Label		
Program type	Mandatory	Voluntary
Label type	Comparison (Continuous) – label compares the energy use of a given model to other similar models by providing a range (with a low-end and a high-end) of energy use of similar models	Endorsement – label indicates that product meets certain levels of performance.
Year Started	1980	1992
Responsible federal agency	FTC (labeling) and DOE (testing)	EPA and DOE[5]
Underlying legislation	Energy Policy and Conservation Act, 1975; National Energy Conservation Policy Act, 1979; FTC Appliance Labeling Rule, 1980	Voluntary government/industry partnership
Products covered	▪ Refrigerators ▪ Freezers ▪ Dishwashers ▪ Clothes washers ▪ Room air conditioners ▪ Water heaters ▪ Furnaces ▪ Boilers ▪ Central air conditions ▪ Heat pumps ▪ Pool heaters *Other products (e.g., lighting) are required to display energy-efficiency information directly on their product labels/packaging.	Products in more than 40 categories: ▪ Appliances (Clothes Washers, Dehumidifiers, Dishwashers, Refrigerators, Room Air Conditioners) ▪ Heating & Cooling (Air-source Heat Pumps, Boilers, Central AC, Ceiling Fans, Dehumidifiers, Furnaces, Geothermal Heat Pumps, Home Sealing (Insulation), Light Commercial, Programmable Thermostats, Room AC, Ventilating Fans) ▪ Home Electronics (Cordless Phones, Combination Units, DVD Products, Home Audio, Set-top Boxes, Televisions, VCRs) ▪ Lighting (Compact Fluorescent Lamps, Residential Light Fixtures, Ceiling Fans, Exit Signs, Traffic Signals) ▪ Office Equipment (Computers, Printers, Copiers, Faxes, Mailing Machines)

Note: the Energy Star logo has been modified in 2005.

a.1) The Energy Guide

Energy Guide is the second longest-running national energy efficiency-labelling program (after

[63] Source: Ecos Consulting,, Policy Recommendations for Improving Energy-Efficiency Labeling in the United States, Report prepared for: National Commission on Energy Policy, October 2004.

Canada's, which began in 1978). Its legislated goals are to improve energy efficiency and assist consumers in making purchase decisions.

It is a mandatory program run by the Federal Trade Commission and Department of Energy (DOE) in the framework of the FTC's Appliance Labeling Rule. Under the Rule, manufacturers must disclose specific energy consumption or efficiency information about their products at the point of sale in the form of an ''Energy Guide'' label affixed to each unit. The information on the Energy Guide label also must appear in catalogues and on internet sites from which covered products can be ordered. The FTC is responsible for the design, implementation and compliance of this program, the National Institute of Standards and Technology (NIST) is responsible for the test procedures.

The Rule directs manufacturers to derive the information from standard test methods issued by DOE. Required labels for appliances must also include a ''range of comparability'' (published by the FTC) that shows the highest and lowest energy consumption or efficiencies for all similar appliance models, and intended to help consumers determine how a specific model compares to others available in the market. Labels for most appliances must provide the product's estimated annual operating cost, calculated by manufacturers using national average cost figures for energy (e.g., electricity, natural gas, etc.) published by DOE. For some products, such as dishwashers, the FTC has changed the applicable ranges several times over the last few years. When ranges are changed, manufacturers must amend their labels to reflect the new ranges and update the operating costs on the labels using a new national average cost of electricity.

The original Energy Guide label created in 1979 contained three energy-related information for most covered products:
(1) The estimated annual operating cost of the model,
(2) the range of operating costs for similar models displayed in the form of a bar graph
(3) a grid which provided the operating cost of the model at different energy costs.
In 1994, the FTC revised the label so that energy use or efficiency (as opposed to operating cost) appears as the primary descriptor on the label. The revised labels continued to display cost information (for most products), but the cost figures were moved to the bottom half of the label. As part of the 1994 review of the Rule, the FTC conducted consumer research and made certain format changes to the Energy Guide label as a result. These changes enhanced the appearance of the range and bar graph on the label in an effort to reduce consumer confusion. In 2000, the FTC issued an exemption allowing manufacturers to include the ''Energy Star'' logo on the Energy Guide label for covered appliances.

No systematic federal evaluation of the Energy Guide program or the efficacy of the current label design has been undertaken in the last 20 years. Small-scale studies and anecdotal evidence, as well as better results in other countries (in terms of consumer awareness, market impacts, and energy savings) suggest that improvements could be made to the Energy Guide program.

Two recommendations for the revision of the Energy Guide were made in 2004[64]:
- revise the current Energy Guide label format to increase clarity and usefulness, employing the categorical rankings that have been proven so effective internationally
- extend the Energy Guide label's coverage to a wider range of products.

The mentioned Energy Policy Act of 2005 directs FTC to review the effectiveness of its current Energy Guide label in assisting consumers in making purchasing decisions and improving energy

[64] Source: Ecos Consulting,, Policy Recommendations for Improving Energy-Efficiency Labeling in the United States, Report prepared for: National Commission on Energy Policy, October 2004.

efficiency and to make appropriate changes to the labelling rules (including categorical labelling) that would improve the effectiveness of consumer product labels. Currently FTC is preparing to conduct consumer research, the results of which will be used to propose amendments to the Energy Guide label. The regulatory review of the "Appliance Labeling Rule" had been scheduled for 2008.[65]

The Energy Guide label on **dishwashers** indicates how much electricity in kilowatt-hours (kWh) a particular model uses in one year. The program covers two dishwasher categories: compact capacity and standard capacity. The standby power consumption is included when calculating estimated annual energy use for all dishwashers.
The ranges of comparability for *standard dishwashers*, effective from 8 December 2004, are: *low energy consumption 176 kWh/year and high energy consumption 247 kWh/year*. Dishwasher manufacturers must base the disclosures of estimated annual operating cost required at the bottom of EnergyGuide labels for dishwashers on the 2004 Representative Average Unit Costs of Energy for electricity (8,60 USD cents per kWh) and natural gas (91,0 cents per therm). These values were not changed in 2006.
The new ranges of comparability for *compact dishwashers*, effective from 23 January 2006 are: l*ow energy consumption 143 kWh/year and high energy consumption 320 kWh/year*. Compact dishwasher manufacturers must base the disclosures of estimated annual operating cost required at the bottom of Energy Guide labels for compact dishwashers on the 2005 Representative Average Unit Costs of Energy for electricity (9,06 USD cents per kWh) and natural gas ($1,09 per therm) that were published by DOE in March 2005.

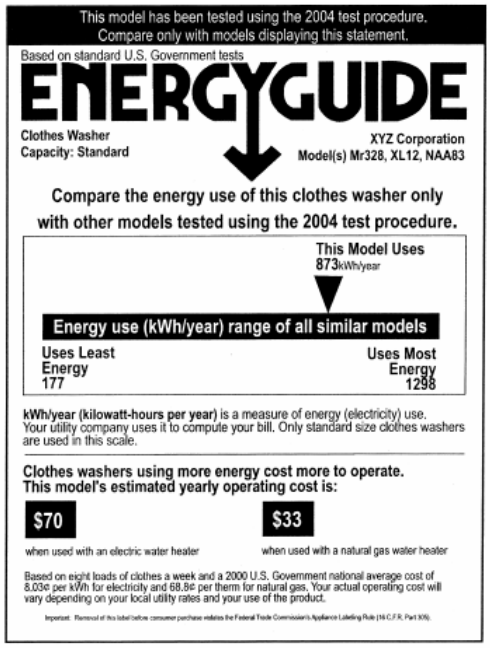
The Energy Guide label on **washing machines** indicates how much electricity in kilowatt-hours (kWh) a particular model uses in one year. The program covers two machine categories: compact capacity and standard capacity, where ''compact'' includes all domestic washing machines washers with a tub capacity of less than 1,6 cu. ft. (45 litre).
On January 2006 required range of comparability for *compact washing machines* were amended[66] as: *low energy consumption 125 kWh/year and high energy consumption 462 kWh/year*. When the above range of comparability is used on Energy Guide labels for compact washing machines, the estimated annual operating cost disclosure appearing in the box at the bottom of the labels must be derived using the 2004 Representative Average Unit Costs for electricity (8,60 USD cent per kWh) and natural gas (91,0 USD cent per therm), and the text below the box must identify the costs as such.
The ranges of comparability for *standard washing machines*, have not been modified and the value in force since April 2005: low energy consumption 113 kWh/year and high energy consumption 680 kWh/year are currently valid. The Representative Average Unit Costs for electricity is the same as for the compact washing machines.

A black and white example of the label is shown in Figure 15. At the top of the Energy Guide label, there are the manufacturer name, model number, type of appliance, and capacity. In the middle, the label shows how a particular model compares in energy efficiency with other models on the market of comparable size and type. Using a line scale, the label indicates where the model falls within a range of most and least efficient units. Appliances such as refrigerators and dishwashers display annual energy consumption (e.g., kilowatt-hour/year). Central air conditioners and heat pumps list Seasonal Energy Efficiency Rating (SEER) or other similar efficiency measures. On the bottom of the label, an estimate of annual operating costs will appear for appliances that are rated by annual

[65] See: Federal Register / Vol. 70, No. 211 / Wednesday, November 2, 2005 / Proposed Rules.
[66] See: Federal Register / Vol. 71, No. 20 / Tuesday, January 31, 2006 / Rules and Regulations.

energy consumption. This estimate is based on the most recent national average of energy prices and assumes typical operating characteristics.

Figure 15: Example (black and white) of Energy Guide for standard washing machines



a.2) The ENERGY STAR

ENERGY STAR, introduced in 1992, is a voluntary labelling program operated jointly by the Environmental Protection Agency (EPA) and Department of Energy (DOE). It is designed to reduce greenhouse gas emissions by identifying and promoting energy-efficient products. The program functions as a voluntary partnership between government and various businesses, including manufacturers and various trade allies like retailers, installers, utilities, and energy service companies. The programme logo has been updated in 2005 (Figure 16).

Figure 16: New US Energy Star logo

Labelled products receive preferential treatment in federal and state procurement processes and in various utility-funded incentive and marketing programs.

The Energy Star criteria for wash appliances are based on the federal NAECA appliance requirements.

Qualified **dishwashers** must have a minimum Energy Factor from 1st January 2007, expressed in cycles per kWh and is the reciprocal of the sum of the machine electrical energy per cycle plus the

water heater energy consumption per cycle as described in the federal energy efficiency legislation. Qualified dishwashers use at least 41% less energy than the federal minimum standard for energy consumption. In detail criteria for dishwasher types are:

Product Type	**Federal EF**	**Energy Star EF**
Standard (≥ 8 place settings + six serving pieces)	≥ 0,46	≥ 0,65
Compact (< 8 place settings + six serving pieces)	≥ 0,62	≥ 0,88

Previous Energy Star criteria for residential dishwashers were in force since 1st January 2001 for standard dishwasher. Any product manufactured after January 1, 2007 must meet the new criteria efficiency levels to be designated as ENERGY STAR. Any product manufactured prior to January 1, 2007 may be labelled as ENERGY STAR at the factory and on the EnergyGuide label if the products meets the current or the January 1, 2007 ENERGY STAR criteria. Retailers will only be permitted to promote previous qualified products for the first three months of 2007.

Only standard sized (with a tub capacity larger than 1,6 ft^3 or 45 litre), front- or top-loading **washing machines** are eligible for the Energy Star clothes washer program. Qualified d machines must have a minimum Modified Energy Factor (MEF) of increasing from the current level of 1,42 to 1,72 plus a maximum water consumption factor (WF) of 8,0 according to Appendix J1 to Subpart B of Part 430 in Title 10 of the Code of Federal Regulations.

MEF is the quotient of the cubic foot capacity of the clothes container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load. The units are (ft^3/kWh/cycle). The higher the value, the more efficient the clothes washer. WF is the quotient of the total weighted per-cycle water consumption divided by the capacity of the clothes washer.

New qualifying levels for washing machines will be established not later than 1st January 2008, for clothes washers, effective beginning 1st January 2010.

b) The energy efficiency requirements

Efficiency requirements for **dishwashers** are described in the Code of Federal Regulations 10, Part 430, Subpart B of 2005, which adds standby energy consumption to the annual energy and cost calculation, but not to the energy factor calculation. Also, the average cycles per year has been lowered from 264 cycles per year to 215 cycles per year compared to the previous edition in 2001. The CFR defines the "dishwasher" a cabinet-like appliance that with the aid of water and detergent, washes, rinses, and dries (when a drying process is included) dishware, glassware, eating utensils, and cooking utensils by chemical, mechanical, or electrical means, and discharges to a plumbing drainage system.

The Energy Factor EF (in cycles/kWh) of consumer dishwashers must be not less than 0,62 for compact dishwashers and 0,46 for standard dishwashers, starting from 1st January 2004.

Energy efficiency requirements for residential **washing machines** are described in Code of Federal Regulations 10, Part 430, Subpart B of 2005, where the following appliance types are described:

- **Compact clothes washer**: a clothes washer which has a clothes container capacity of less than 45 litre (1,6 ft^3)

- **Standard clothes washer**: a clothes washer which has a clothes container capacity of 45 litre (1,6 ft^3) or greater
- **Front-loading clothes washer**: a clothes washer with the clothes container compartment access located on the front of the machine
- **Top-loading clothes washer**: clothes washer with the clothes container compartment access located on the top of the machine
- **Suds-saving**: a feature or option on a clothes washer which allows the user to store used wash water in an external laundry tub for use with subsequent wash loads.

The energy efficiency requirements for residential washing machines are described in Table 19. For top loading standard and compact washing machines and front loading washing machines the MEF Modified Energy Factor (in ft^3/kWh/cycle) must be higher than the value indicated in the Table.

Table 19: Energy efficiency requirements for residential washing machines in USA in 2003-2007

Appliance	*Minimum Energy Factor [ft^3/(kWh/cycle)] Effective May 14, 1994 Through December 31, 2003*	*Minimum Modified Energy Factor [ft^3/(kWh/cycle)]**	
		Effective January 1, 2004	*Effective January 1, 2007*
Top-loading compact clothes washers	0.90	0.65	0.65
Top-loading standard clothes washers	1.18	1.04	1.26
Top-loading, semi-automatic	N/A[1]	N/A[1]	N/A[1]
Front-loading clothes washers	N/A[1]	1.04	1.26
Suds-saving	N/A[1]	N/A[1]	N/A[1]
[1]Must have an unheated rinse water option. *The sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load.			

Top-loading semi-automatic and suds-saving washing machines do not need to meet the Modified Energy Factor standard but must have an unheated rinse water option. The MEF of a washing machine is the quotient of the ft^3 capacity of the clothes container divided by the total washing machine energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load.

c) The 2006 Appliance Efficiency Regulations for California

The 2006 Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections 1601 through 1608) dated December 2006, were adopted by the California Energy Commission on Oct 11, 2006, and approved by the California Office of Administrative Law on Dec 14, 2006.

The Appliance Efficiency Regulations replace all previous versions of the regulations[67] and include standards for both federally regulated appliances and non-federally-regulated appliances. Twenty-one categories of appliances are included in the scope of these regulations, including wash

[67]Downloadable at: http://www.energy.ca.gov/appliances/2006regulations/index.html .

appliances: for dishwashers the federal requirements apply, for domestic washing machines the federal requirements about energy efficiency apply, while for the water efficiency specific requirements have been set.

The WF Water Factor (in gallons per cubic foot) of washing machines must not be greater than the values shown in Table 20. The Water Factor is the quotient of the total weighted per-cycle water consumption divided by the capacity of the washing machine.

Table 20: Water efficiency requirements for washing machines in California in 2007 and 2010

Appliance	Maximum Water Factor (gallons/cubic foot)	
	effective 1st January 2007	effective 1st January 2010
Top loading	8,5	6,0
Front loading	8,5	6,0

d) The standby

Annual standby energy consumption for **dishwashers** and is calculated in kWh per year as:

$S = S_m \times (H_s/1000)$ and
$H_s = H - (N \times L)$

where:

- S_m = measured average standby power (in Watt) and
- H = the total number of hours per year, or 8.766
- N = the representative average dishwasher use of 215 cycle/year
- L = the average of the duration (in hours) of the normal washing cycle, measured for the different types of dishwashers addressed in the test procedure

In order to determine standby power usage, the energy use of each dishwasher in the Energy Star products database was calculated. Since EF (Energy Factor) is simply calculated by the average number of cycles per year (215) divided by kWh/year, the standby power can be calculated by finding any models where the kWh/year is above the range for each EF[68]. Of the 565 models in the Energy Star product database:

- 339 (or 60%) have some standby power usage, the other 40% of the models apparently have not;
- 148 models show standby power usage of less than 1 kWh/year
- 98 active models use more than one dollar per year in standby power (or 11,6 kWh/year assuming an electric rate of 8,6 cents per kWh).
- the highest standby power use is 25 kWh/year.

Since 60% of current qualified products use standby power and the trend for new products is to offer more features that will draw power in the standby mode, comments were required to stakeholders on the value of incorporating a standby power requirement into the new criteria for

[68] For example, a dishwasher with an EF of 0,60 will have an average energy use of 358 kWh/year, but since EF is rounded to the hundredth, the model can have actual energy usages from 355 kWh/year to 361 kWh/year. Any energy use above 361 kWh/year must be standby power or the machine would have a lower EF.

dishwashers. In addition, DoE is trying to determine whether it is preferable the (a) setting a maximum amount of standby power in terms of Watts or kWh/year or (b) setting the maximum total allowable Energy Star qualified product usage in terms of kWh/year instead of EF.

e) The tax incentives for manufacturers

The Energy Policy Act of 2005 offers incentives that promote the use of more efficient appliances. This legislation is expected to increase the market penetration of products meeting and exceeding the act's Energy Star criteria. The new legislation provides credits to the manufacturer for very efficient refrigerators, washing machines and dishwashers. The incentives are for products sold in 2006 and 2007, relative to *additional* sales by each manufacturer above the average of the previous three years (Table 21). This type of policy has the distinct advantage of minimizing the problem of free riders that would have purchased the new model in any case; and thus is more effective than such policies as rebate or reduction in value added taxes, which allow and pay for free riders.

For washing machines there is only one efficiency tier, a 100 USD credit for units meeting the 2007 Energy Star criteria. The same applies for dishwashers where the amount of credit is 3 USD for every percent beyond the Energy Star criteria in force in 2005.

All the appliance credits only apply to products produced in the USA, which could affect the foreign production plans of US manufacturers and also means that imported products are not eligible. There is also a total cap per manufacturer of 75 million USD, a figure some larger manufacturers may reach but the smaller manufacturers will not.

1.5.3.3 China

a) Appliance energy efficiency programmes

In 1980, there was little home appliance manufacturing in China: the total output of household refrigerators in that year was less than 50 000 units. By 2004, China's output of colour televisions, room air-conditioners, refrigerators, and clothes washers had each reached 73,3 million, 66,5 million, 30,3 million, and 23,5 million units, respectively. In early 1980s, it was rare to find major electric appliance in any Chinese households. By 2004, penetration levels have reached to 96% for clothes washers, 90% for refrigerators, and 70% for room air-conditioners, respectively, for 100 urban households.

In 1989, the former State Bureau of Technical Supervision (SBTS) issued the first set of standards related to energy efficiency. They included energy efficiency requirements for eight types of products: refrigerators, room air conditioners, clothes washers, television sets, automatic rice cookers, radio receivers, electric fans, and electric irons.

Since then, China has significantly expanded its efficiency requirement program, both covering more product categories and raising the stringency of the performance levels. At present, the Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) has succeeded SBTS as the requirements setting agency in China, with the China National Institute of Standardization (CNIS) providing much of the technical analyses in the development process.

Table 21: Summary of the Energy Efficiency Tax incentives in Energy Policy Act of 2005

Summary of Energy Efficiency Tax Incentives in Energy Policy Act of 2005

Product	Eligibility Level	Units	Amount of Incentive	Years Covered	Notes
Existing homes and other non-business applications					$500 per taxpayer cap for existing home credits
Central air conditioners (split systems)	15	SEER	$300 if meets SEER & EER	2008 & 2007	For list of qualified products, go to the Consortium for Energy Efficiency Product Directory-
	12.5	EER			www.ceehvacdirectory.org/continue.html
Central air conditioners (package systems)	14	SEER	$300 if meets SEER & EER	2008 & 2007	Look for "Residential Tier 2" Air Conditioners
	12	EER			
Heat Pumps (air cooled)	15	SEER	$300 if meets SEER, EER & HSPF	2008 & 2007	See CEE list (link noted above) for products that meet 15 SEER and 9 HSPF. There is no way to identify equipment that meets 13 EER without contacting manufacturer/distributor (or contractor).
	13	EER			
	9.0	HSPF			
Group-source heat pumps					All Energy Star labeled Geothermal Heat Pumps qualify for credit
Closed loop	14.1/3.3	EER/COP	$300	2008 & 2007	System must also provide water heating.
Open loop	16.2/3.6	EER/COP	$300	2008 & 2007	System must also provide water heating.
Direct expansion (DX)	15/3.5	EER/COP	$300	2008 & 2007	System must also provide water heating.
Water heaters (non-business applications)					See GAMA Web site for list of qualifying products:
Electric	2.0	EF	$300	2008 & 2007	www.gamanet.org/gama/inforesources.nsf/vContentEntries/Product+Directories?OpenDocument
Gas and oil	0.8	EF	$300		
Gas and oil furnaces and boilers					See GAMA Web site (link above) for list of qualifying products.
High combustion efficiency equipment	95%	AFUE	$150	2008 & 2007	Can earn either one or both incentive with the same unit.
High electric efficiency equipment	Meets CEE spec		$50	2008 & 2007	CEE spec requires electricity use to be <=2% of site use.
Envelope improvements to existing homes					
Insulation, exterior doors, duct sealing and infiltration reduction	Meet 2000/2003 IECC + supplements		10% up to $500	2008 & 2007	Includes duct sealing and infiltration reduction. All Energy Star windows and doors qualify for credits.
Windows and skylights	Same as above		10% up to $200	2008 & 2007	Credits cover cost of components only, and do not include
Pigmented metal roofs	Meet Energy Star spec		10% up to $500	2008 & 2007	costs of onsite prep, assembly or installation.
Appliances					All appliance incentives go to manufacturer, not consumer;
Refrigerators					manufacturers are expected to reduce prices accordingly.
Save 15-19.9% relative to federal standard	Look to left		$75	2008	
Save 20-24.9% relative to federal standard	Look to left		$125	2008 & 2007	
Save 25% or more relative to federal standard	Look to left		$175	2008 & 2007	
Clothes washers	1.72 MEF, 8.0 WF		$100	2008 & 2007	This is the 2007 Energy Star specification.
Dishwashers	2007 Energy Star		TBD -- based on final Energy Star	2008 & 2007	Incentive likely to be around $30.

Table 21: Summary of the Energy Efficiency Tax incentives in Energy Policy Act of 2005 (continued)

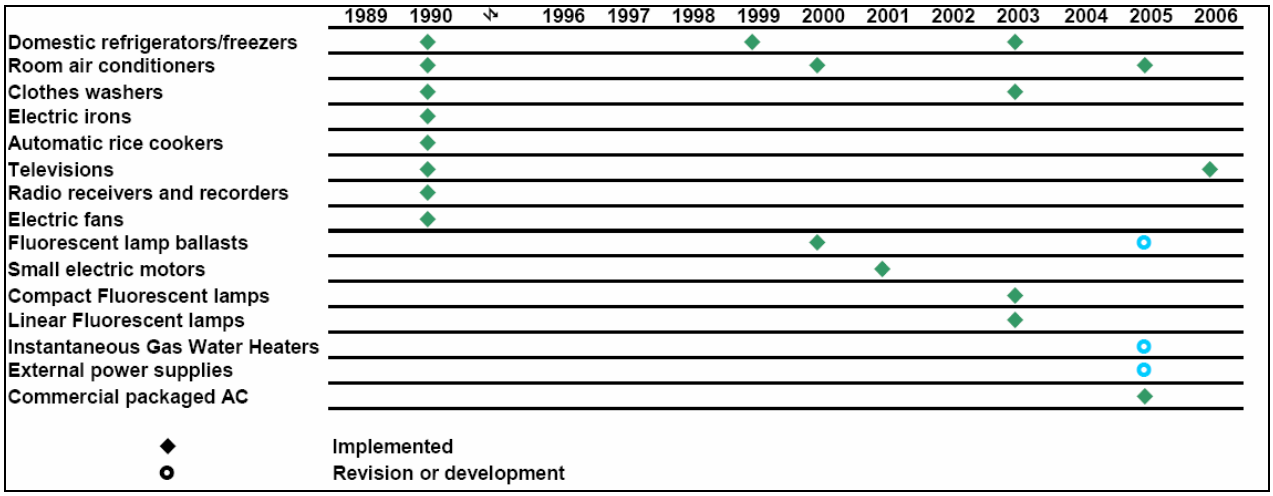
Summary of Energy Efficiency Tax Incentives in Energy Policy Act of 2005

Product	Eligibility Level	Units	Amount of Incentive	Years Covered	Notes
New homes					Incentives go to the builder, not the homebuyer.
Site-built or manufactured homes	50%	savings	$2,000	2006 & 2007	Savings relative to 2004 IECC.
Manufactured homes	30%	savings	$1,000	2006 & 2007	Savings relative to 2004 IECC.
	or meets Energy Star			2006 & 2007	
Commercial buildings					Max. is $0.60/sq.ft. per system or $1.80/sq.ft. for whole bldg.
Whole building	50%	savings	Deduction of $1.80/sq.ft.	2006 & 2007	Savings relative to ASHRAE 90.1-2001.
Lighting, HVAC or envelope	50%	savings	Deduction of $0.60/sq.ft. per system	2006 & 2007	Savings relative to ASHRAE 90.1-2001.
Lighting savings of at least 25%	25-50%	savings	Sliding scale: $.30/sq.ft. for 25% svgs	Unclear	Term of this provision depends on Treasury rulemaking.
Fuel cells and microturbines					
Fuel cells (business or individual credit)	30%	efficiency	30% up to $1000/kW	2006 & 2007	Systems >=0.5 kW for business credit. No size floor or efficiency requirements for individual credit.
Microturbines (only business credit)	26%	efficiency	10% up to $200/kW	2006 & 2007	Systems < 2000 kW.
Passenger vehicles	Complicated formula -- see http://aceee.org/press/0508hybridtaxcr.htm				
Heavy-duty vehicles	Complicated formula -- a description of the credit will be put on www.aceee.org shortly.				

Key: AC= air conditioner; AFUE= annual fuel utilization efficiency; ASHRAE = American Society of Heating, Refrigerating & Air-Conditioning Engineers; CEE = Consortium for Energy Efficiency COP= coefficient of performance; EER= energy efficiency ratio; EF= energy factor; HP= heat pump; HSPF= heating season performance factor; IECC= International Energy Conservation Code kW= kilowatt; MEF= modified energy factor; SEER= seasonal energy efficiency ratio; WF= water factor.

In 2004 (Table 22) China had minimum efficiency requirements for refrigerators and freezers, room air conditioners (windows and split types), TVs, fans, rice cookers, radios and audio receivers, fluorescent lamp ballasts, clothes washers, motors and irons. Requirements for external power supplies were under development. The first fuel efficiency requirements were enacted the same year.

Table 22: Summary of minimum efficiency requirements in China



The stringency of the requirements has also been raised: for example, the requirements for room air-conditioners has been raised in 2005 from a coefficient of performance (COP) of 2,2 to 2,6 in the most popular category (4 500 Watt and below); a further rise is due in 2009 as well[69].

China is one of relatively few countries that have both an endorsement label and an information label. In March 2005 a categorical energy information label was launched, aimed at assisting consumers with their purchasing decisions. The label classifies appliances into five efficiency categories, with level one being the most efficient, and level five set at the minimum efficiency requirements level. At the moment, the information label is only applied to refrigerators and room air-conditioners, and is likely to be extended to other appliances in the future. In addition, China Standard Certification Centre (CSC) runs since 1999 a voluntary endorsement label, granted to products that are certified to meet both quality assurance and energy performance specifications.

China's standards are mostly harmonised with ISO/IEC procedures.

b) Efficiency requirements for wash appliances

GB 12021.4-2004 includes the maximum allowable values of the energy consumption and Energy efficiency grade for household electric washing machines. The mandatory efficiency requirements covers all household electric washing machines (pulsator type and drum type) and spin dryer and are based on a maximum value of the energy consumption (in Wh) per kg of load, as shown in Table 23. The requirements are effective since 1st May 2005.

No efficiency requirements are set for dishwashers.

[69] Jiang Lin, LBNL - Environmental Energy Technologies Division, Mitigating Carbon Emissions: the Potential of Improving Efficiency of Household Appliances in China, July 2006.

Table 23: Minimum efficiency requirements for washing machines in China

Washing machine (type)	Machine technology	Maximum energy consumption (Wh/kg)
Pulsator type	Single-tub	24,0
	Twin-tub	28,0
	Half-automatic single-tub	29,0
	Half-automatic twin-tub	32,0
	Automatic	38,0
Drum type	Automatic without water heating	Not set
	Automatic with water heating	Not set
	Spin dryer	4,0

c) Voluntary endorsement label for energy efficiency

The State Economic and Trade Commission (SETC) and the China State Bureau of Quality and Technical Supervision (CSBTS) together established the China Certification Centre for Energy Conservation Product (CECP) to promote advanced energy conservation technology and the wide use of high efficiency products on October 1998. The first batch of energy efficient products were certified on April, 1999 and the first energy product certified on September, 1999. Products under this certification program now include 41 types of consumer appliances, including washing machines (but dishwashers are not covered) since November 2003, as well as selected industrial equipment. The criteria used for the associated endorsement label (Figure 17) were developed in parallel with the efficiency requirements, allowing any manufacturer to apply for efficiency certification and labelling if a model consumed 75% or less energy than the minimum requirements. The vast majority of Chinese product manufacturers have voluntarily decided to use the label since it can enhance the attractiveness of their products in the Chinese consumer marketplace.

Figure 17: Voluntary endorsement label for energy efficiency in China

d) Appliance noise limits

In 2005[70], a new appliance noise regulation "*Noise Limit Value for Household and Similar Electrical Appliances* went into effect in China on 1st August. Appliance manufacturers are required to mark the noise value on the product label or instruction booklet. Products that exceed the noise limits will not be allowed on the market. In addition, China intends to compulsorily withdrawn products that are already on the market. The Chinese government may start checking products on the market in the next several months.

[70] V. Han, China Implements Appliance Noise Standard, Appliance, October 2005, p.18

The first phase impacts refrigerators, freezers, air conditioners, washing machines, microwave ovens, kitchen ventilation hoods and fans. For washing machines the noise limits are: wash 62 dBA, spin cycle 72dBA; microwave oven noise limits: 68 dBA.

The new noise legislation has three aims: (i) to standardise the market and provide consumers with guidance; (ii) to control imports of appliances that do not meet noise regulations, specifically imported low-end products and second-hand appliances that could not previously be rejected for noise problems due to a lack of a standard ; and (iii) to increase the technical level of Chinese appliances by causing appliance makers to address relevant technical issues.

China has had ongoing appliance noise issues for years, but they were never addressed because of the lack of noise standard. The new standard, designated *China National Standard GB4214.1*, was issued jointly by the China Quality Surveillance Examination Quarantine Bureau and the National Standardisation Management Committee.

1.5.3.4 Brazil

Brazil has developed voluntary efficiency requirements and two types of energy label: one is a comparative energy label, mandatory for some products and voluntary for others and grades the efficiency of appliances from A to G as in the EU, the other is a voluntary endorsement energy label. Labels are currently in place for room air conditioners, freezers, refrigerators and refrigerator-freezers, ballasts, clothes-washers and lamps. The Brazilian government also recently passed legislation allowing the imposition of mandatory efficiency requirements for a broad range of equipment and these are currently under development.

The Brazilian energy labelling program or PBE (*Programa Brasileiro de Etiquetagem*) started to address household appliances in mid '80s, as shown in Table 24.

The Brazilian Energy Conservation Program, PROCEL, is managed by Eletrobras, the Brazilian government holding of the power sector. PROCEL has granted the "*Stamp Procel de Economia de Energia*" annually, since 1993 (Figure 18). It is awarded to the electric equipment that is the most energy efficient in its category in the given year. Its duel purpose is to stimulate the national manufacture of more efficient products and guide the consumer to purchase the most efficient appliance.

Figure 18: The PROCEL Stamp Procel de Economia de Energia for appliances

Table 24: Brazilian INMETRO PBE, summary as per beginning 2004

	Product	Working Group Initiation Date	Specific Regulation	Standard-Type	Type of Label	Endorsement Label
1	Refrigerators	Nov-84	RESP-01	ISO	comparison	yes
2	Combined Refrigerators	Nov-84	RESP-01	ISO	comparison	yes
3	Vertical Freezers	Nov-84	RESP-01	ISO	comparison	yes
4	Horizontal Freezers	Nov-84	RESP-01	ISO	comparison	yes
5	Water Coolers	Mar-01			comparison	
6	Commercial Freezers	Mar-01			comparison	
7	Commercial Refrigerators	Aug-03	RESP-01	ISO	comparison	
8	Electric Instant Showers-Chuveiros	May-92	RESP-02	NBR/IEC	comparison	
9	Electric faucets *(torneiras)*	May-92	RESP-02	NBR/IEC	comparison	
10	Instant Water Heaters (Passagem)	May-92	RESP-02	NBR/IEC	comparison	
11	Storage Water Heaters	Dec-03		NBR/IEC	comparison	
12	Hybrid Storage Water Heaters	Dec-03		NBR/IEC	comparison	
13	Hidro. Heaters	May-92	RESP-02	NBR/IEC	comparison	
14	Intelligent Instant Water Heater -Chuvei	Sep-98			comparison	
15	Room Air Conditioner (domestic)	Oct-00	RESP-03	NBR	comparison	yes
16	Split Air Conditioner	Jun-00	RESP-03		comparison	
17	Electric Motors - Tri-Phase	Aug-92	RESP-04	NBR	approval	yes
18	Electric Motors - one phase	Sep-98			approval	
19	Centrifugal Pumps	Jul-01				
20	Washing Machine	Jul-95	RESP-05	IEC	comparison	
21	Centrifugas Machine	Aug-04			comparison	
22	Dryer				comparison	
23	Dishwasher				comparison	
24	Flat panel solar collectors - bathroom	Mar-96	RESP-06	NBR/ASTM	comparison	yes
25	Flat panel solar collectors - pool	Mar-96	RESP-06	NBR/ASTM	comparison	yes
26	Termicos Reservatorio	Oct-00	RESP-06	NBR/ISO/IEC	approval	yes
27	Acoplados Coletores	Oct-00	RESP-06	ISO	comparison	yes
28	Installation Project	Mar-00			approval	
29	Installation Approved				approval	
30	Compact Fluorescent Lamps	May-99	PROCEL 01	NBR	approval	yes
31	Incandescent Lamps	Sep-99	RESP-07	NBR	comparison	
32	Decorative Incandescent Lamps	Jan-02	RESP-07		comparison	
33	Dicroicas Lamps	Jan-02	RESP-07		comparison	
34	Flourescent Tube Lamps				comparison	
35	Sodium Vapor Lamps				comparison	
36	Electromagnetic Reactors	Apr-00	RESP-11		approval	
37	Electrical Reactors	Apr-00			approval	
38	Magnetic p/Sodium Reactors	Apr-00	RESP-10		approval	
39	Public Lighting fixtures w/components					
40	Fixtures and components					
41	Residential Gas Stoves	Apr-01	RESP-08	NBR	comparison	
42	Residential Gas Furnace	Apr-01	RESP-08	NBR	comparison	
43	Heaters - Passagem	Apr-01	RESP-09		comparison	
44	Storage Heaters	Apr-01	RESP-09		comparison	
45	Transformers	Aug-04				
46	Vehicle Emissions	Mar-81	IBAMA	NBR	approval	
47	Vehicle Consumption	Mar-81				
48	Microwaves	Aug-01	RESP-12		comparison	
49	Electrics Stoves				comparison	
50	Electric Ovens				comparison	
51	Photovoltaic Panels	Dec-02	RESP-13	ISO	comparison	
52	Photovoltaic Storage Devices	Dec-02	RESP-13	NBR	approval	
53	Inversores CC/CA	Dec-02	RESP-13	IEC	approval	
54	Load Controlers	Dec-02	RESP-13	IEC	approval	
55	Photovoltaic Energy Systems	Dec-02	RESP-13		approval	
56	Wind Energy Systems	Jul-03	RESP-13	ISO	approval	
57	Solar Exhaust	Dec-03	RESP-13	ISO	approval	
58	Televisions		RESP-13		stand-by	
59	Monitors		RESP-13		stand-by	
60	Ventilator *de teto*		RESP-13		comparison	
61	Industrial Ventilators					
62	Tire Compresors - Pneumaticos					

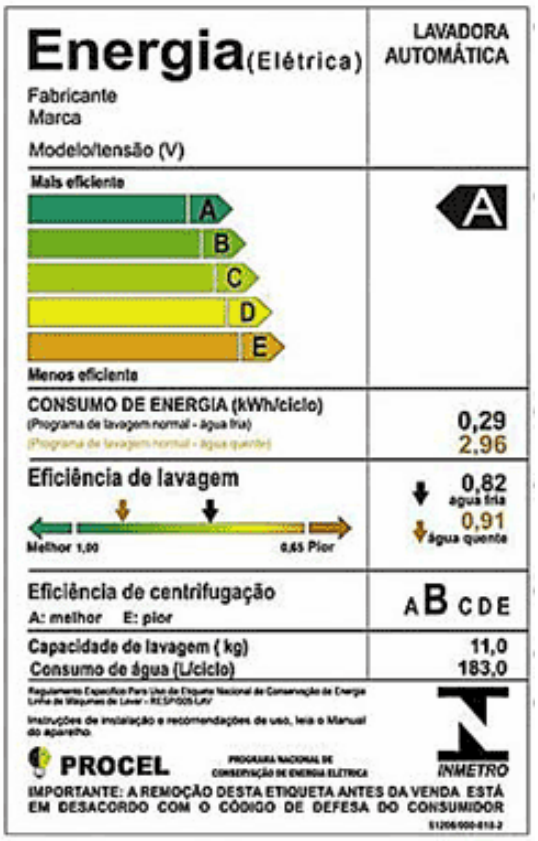
products with labels (25)
products that already have working groups initiated (22)
proposed labels/programs (15)

a) Energy labelling for washing machines

INMETRO (Instituto Nacional de Metrologia, Normalizao e Qualidade Industria) and

Procel/Eletrobras have jointly launched on September 2005, in Sao Paulo, the PBE scheme for washing machines. Requirements are described in the "*Regulamento Específico para Uso da Etiqueta Nacional de Conservação de Energia – Ence: Edição nº 01 - Revisão 01 - Máquinas de Lavar Roupa*". The reference standards is IEC 60456. The labelling is mandatory since 1st January 2006. The label is shown in Figure 19.

Figure 19: PBE label for automatic washing machines in Brazil



The energy efficiency and the spinning performance are respectively expressed in kWh per kg of load and as percentage of residual moisture and classified in an scale with 5 classes only, from A to E. The energy efficiency for the warm wash and for the cold wash for automatic and semi-automatic machines and the spinning performance are expressed in kWh/cycle/kg load in Table 25

Table 25: Warm and cold wash for the washing machine labelling in Brazil

Classes	Warm wash	Cold wash		Spinning performance
		automatic	semi-automatic	
	(kWh/cycle/kg)			(%)
A	0,190	0,031	0,019	60
B	0,230	0,035	0,022	68
C	0,270	0,039	0,025	76
D	0,310	0,043	0,028	84
E	0,350	0,047	0,031	94

The washing performance is expressed as a continuous scale (Figure 20) between a minimum and a maximum values (Table 26) and where the position of the specific machine is indicated by an

arrow. The scale is defined for the three types of machines: with heating, automatic without heating and semi-automatic with specific values for the more performing and less performing models.

Figure 20: washing performance scale for automatic washing machines without heating

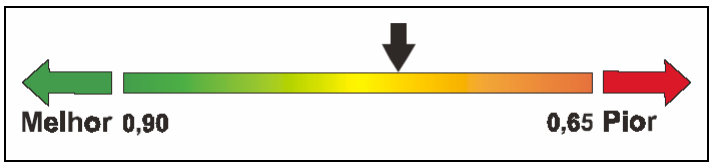


Table 26: Warm and cold wash for the washing machine labelling in Brazil

Washing machine types	Better	Worse
automatic with heating	1,00	0,65
automatic without heating	0,90	0,65
semi-automatic	0,80	0,55

The program is conducted by PROCEL (*Programa Nacional de Conservacao de Energia Electrica*), the national energy efficiency program and the government agency INMETRO (*Instituto Nacional de Metrologia, Normalizacao e Qualidade Industrial*) which is responsible for verifying the manufacturers data. Class A models can also bear the PROCEL endorsement label (Figure 18).

1.5.3.5 Other countries

The **Korean** government set both minimum efficiency requirements and a more stringent "target energy performance requirements". The former establishes the bottom (a rating of 5) of Korea's mandatory comparative energy labels, and the latter value (a rating of 1) the top. When minimum efficiency requirements are revised upwards (typically every three to five years) also the targets are. In 2005 Korea also announced mandatory 1 Watt targets for a wide range of products[71].

Russia first implemented minimum efficiency requirements in 1983 and between then and 1991 introduced regulations for room and other types of air conditioners, audio signal amplifiers, computers, dishwashers, refrigerators, refrigerator-freezers, freezers, graphical input devices, monitors, printers, ranges & ovens, TVs and electric water heaters. Most of these standards have not been updated and hence have since become largely obsolete; however, in 2001 Russia passed a general law allowing the issuing of efficiency requirements and labels for a large range of appliance types.

Other countries: a summary and description of mandatory and voluntary policy measures for cold appliances worldwide can be also found at:
- Energy Labelling and Standards Programs Throughout the World, NAEEEC Report 2004/04[72];
- CLASP (Collaborative Labeling and Appliance Standards Programme)[73];
- APEC (Asia-Pacific Economic Cooperation) energy standards information system (ESIS)[74].

[71] Standby Korea 2010: Korea's 1-Watt Plan, Korea Energy Management Corporation and Ministry of Commerce, Industry and Energy, Korea. See: www.mocie.go.kr and www.kemco.or.kr .
[72] See document L. Harrington, Energy Efficient Strategies, Australia, "Energy Labelling and Standards Programs Throughout the World", NAEEEC Report 2004/04. Downloadable from www.energyrating.gov.au/library /publications2004.html .
[73] See: www.clasponline.org/main.php .
[74] See: www.apec-esis.org/home.php .

1.5.3.6 Seal-of-approval and other voluntary environmental labels worldwide

A part from the EU eco-label award scheme, seal-of-approval labels[75] are voluntary and selective, and are awarded only to products that meet relatively strict environmental requirements, including requirements related to energy performance. Many of these labels are administered by governments and are closely co-ordinated with their corresponding mandatory energy labelling programmes. Examples include the China "Great Wall" energy certification label, India "Ecomark" scheme, Korea "Energy Boy" label, Singapore "Green Labelling Scheme", Chinese Taipei "Greenmark", and the USA "ENERGY STAR" programme. In addition there are several voluntary labelling schemes administered by non-profit organisations, such as Japan "Eco Mark" scheme, Korea "Energy winner", the USA "Green Seal" and Thailand "Green Labelling Scheme". Canada third-party multi-criteria "Environmental ChoiceM Programme" is owned by the Federal Government and licensed to a "for profit" organisation to administer. In Australia and Thailand, associations of respectively gas and electric utilities sponsor their own voluntary energy-labelling schemes.

1.5.4 The RoHS and the WEEE directives in Europe and worldwide

In the past five years, the EU has developed and adopted major electric and electronic equipment directives, which member states will begin to implement during 2007. The WEEE and the RoHS directives require electric/electronic equipments manufacturers to offer free disposal of consumers' used equipment and also to prohibit the export of hazardous waste to developing countries for disposal. The rules affect a list of 10 product categories including household appliances, toys, computers and many more. Meanwhile, the just approved REACH regulation on chemical safety will introduce requirements for importers of products and for information flow in the supply chain (the description of the REACH regulation is out of the scope of the present study).

The United Nations Environment Programme estimates that the world's population discards 20 to 50 million tons of electrical and electronic waste each year and predicts the amount will increase by 3% to 5% each year. Much of that waste ends up in China.

1.5.4.1 The RoHS and WEEE directives provisions

Directives on Waste Electrical and Electronic Equipment (WEEE), 2002/96/EC, aims to prevent WEEE arising, to encourage reuse, recycling and recovery of WEEE and to improve the environmental performance of all operators involved in the lifecycle of electrical and electronic equipment, especially those dealing with waste management. The directive sets requirements relating to criteria for the collection, treatment, recycling and recovery of WEEE and makes producers responsible for financing most of these activities. Retailers/distributors also have responsibilities in terms of the take-back of WEEE and the provision of certain information[76].

The main requirements and obligations were scheduled to become mandatory from 13 August 2005 onwards and some specific actions, e.g. producer registration and reporting of data on equipment placed on the market, were scheduled to be started from January 2005 onwards. However, many EU Member States have encountered major practical difficulties in meeting the directive's legal deadline of 13 August 2005 for implementation of their obligations on producers and retailers. Before the WEEE Directive came into force several European countries (e.g. Belgium, the

[75] Source: R. Steenblik, S. Vaughan, P. Waide, Can Energy-Efficient Electrical Appliances be considered "Environmental Goods"? OECD Trade and Environment, Working Paper No. 2006-04.

[76] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.

Netherlands, Sweden and Denmark as well as Norway and Switzerland) defined national regulations and organised management schemes for WEEE. These systems respond to sometimes very different national situations and philosophies. Some of these countries will have to adapt their national laws when implementing the WEEE Directive. Other countries that have not developed any management systems are developing new ones in order to comply with the Directive.

The key aims of the WEEE Directive are:

- reduce WEEE disposal to landfill;
- provide for a free producer take-back scheme for consumers of end-of-life equipment from 13 August 2005;
- improve product design with a view to both preventing WEEE and to increasing its recoverability, reusability and/or recyclability;
- achieve targets for recovery, reuse and recycling of different classes of WEEE;
- provide for the establishment of collection facilities and separate collection systems of WEEE from private households;
- provide for the establishment and financing of systems for the recovery and treatment of WEEE, by producers including provisions for placing financial guarantees on new products placed on the market.

The WEEE directive covers a list of 10 product categories:

1. Large household appliances (refrigerators, washing machines, stoves)
2. Small household appliances (vacuum cleaners, toasters, hair dryers)
3. Information and telecommunications equipment (computers and peripherals, cell phones, calculators)
4. Consumer equipment (radios, TVs, stereos)
5. Lighting (fluorescent lamps, sodium lamps)
6. Electrical and electronic tools (drills, saws, sewing machines)
7. Toys, leisure, and sports equipment (electric trains, video games)
8. Medical devices (ventilators, cardiology and radiology equipment)
9. Monitoring instruments (smoke detectors, thermostats, control panels)
10. Automatic dispensers (appliances that deliver hot drinks etc).

Producers are responsible for the costs of picking up waste electrical and electronic equipment from collection facilities and for refurbishing waste products for reuse or for recycling and recovery. For "historical" products (i.e., those put on the market before August 13, 2005), the costs of waste management are to be shared by all producers in existence at the time those costs are incurred. These producers may impose a separate "visible fee" (one that is explicitly designated) to cover these costs for eight years (ten years for large household appliances). End users other than households may be made partly or totally responsible for financing the management of historical products. For new products (i.e., those put on the market after August 13, 2005), producers have "individual responsibility." That is, they must pay the cost of managing their own products. They can do this through programs set up by individual companies or through participation in collective schemes. No visible fees are permitted to fund the management of waste from new electrical and electronic products. When producers put a new product on the market, they must provide a financial "guarantee" that waste management of the product will be paid for. Producers can make good on this guarantee by participating in a producer responsibility organization (PRO), paying recycling insurance, or setting up a special bank account for this purpose.

Every "new" product must bear a label that verifies that it was put on the market after August 13, 2005, verifies that it will be separately collected, and bears the name of the producer according to an EU standard. Producers must provide information to consumers on the collection systems

available and on the environmental and health impacts of hazardous substances contained in waste electrical and electronic products. Producers must also provide information to facilitate the environmentally sound reuse, recycling, and treatment of waste electrical and electronic products. Such information includes the identity of components and materials and the location of dangerous substances inside a product.

Member States must establish a register of producers and collect annual information on the amounts of electrical and electronic equipment that are put on the market, collected, reused, recycled, and recovered. They must transmit this information to the EU Commission every two years according to an established a standard format for the reporting. The first set of information will cover the years 2005 and 2006. Member States must establish inspection and monitoring systems and impose effective penalties for lack of compliance. The recovery and recycling targets to be met by EU Member States (excluding those who have received derogation[77]) at 31 December 2006 is outlined in Table 27. It should be noted that for medical equipment the target will be established by the end of 2008.

Table 27: Targets for recovery and reuse/recycling, by weight at 31 December 2006

Product category	**Recovery target** (%)	**Recycling target** (%)
Large household appliances	80	75
Small household appliances	70	50
Information and telecoms	75	65
Consumer equipment	75	65
Lighting	70	50
Tools	70	50
Toys, Leisure, Sports	70	50
Medical Equipment	n.a.	n.a.
Monitoring instruments	70	50
Dispensers	80	75

There are two clear generic categories of national organisation, the "national collective system" (monopoly) and the competitive "clearing house system". National legislators as well as producers have different views on the preferred system: some support the laws of the competitive market while others see the benefits of managing risk collectively. There are advantages and disadvantages with both systems. National collective schemes properly managed are considered by many stakeholders as providing the simplest and most effective route to collecting and recycling WEEE. Additionally, collective systems as run in the Netherlands, Belgium and Sweden are "tried and tested" and represent the only approach that has so far been shown to work in practice. The clearing house model, on the other hand, lacks experience and data to make good analyses and comparisons with existing collective schemes. Before the WEEE Directive came into force several European countries (e.g. Belgium, the Netherlands, Sweden and Denmark as well as Norway and Switzerland) defined national regulations and organised management schemes for WEEE.

In Figures 21-22 the costs and the recycling rates of the existing systems in Belgium, Netherlands, Norway, Sweden and Switzerland are compared[78].

[77] Greece, Ireland and Slovenia had a 12-month extension, Cyprus, Czech Republic, Estonia, Hungary, Malta, Latvia, Lithuania, Poland and Slovakia has a 24-month extension.
[78] Source: M. Dempsey , The WEEE Directive: The UK Experience, APSWG, 2006.

Figure 21: Economic costs of existing disposal systems for electric and electronic equipment

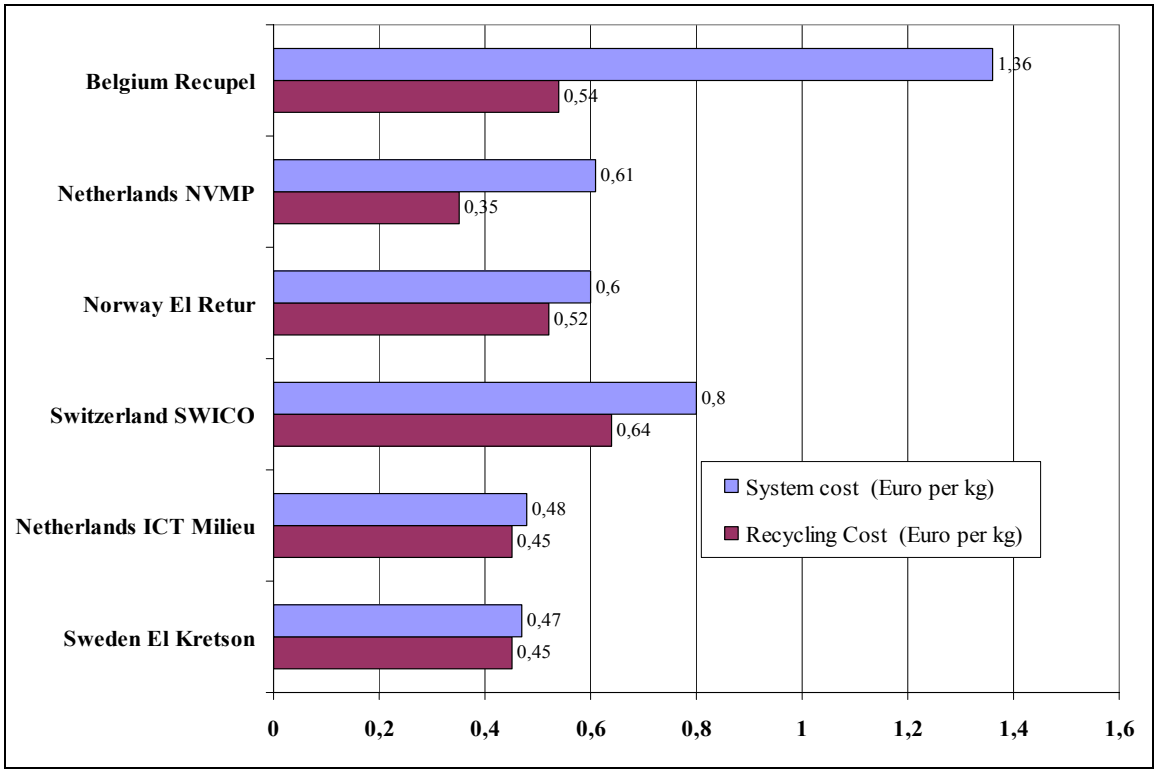
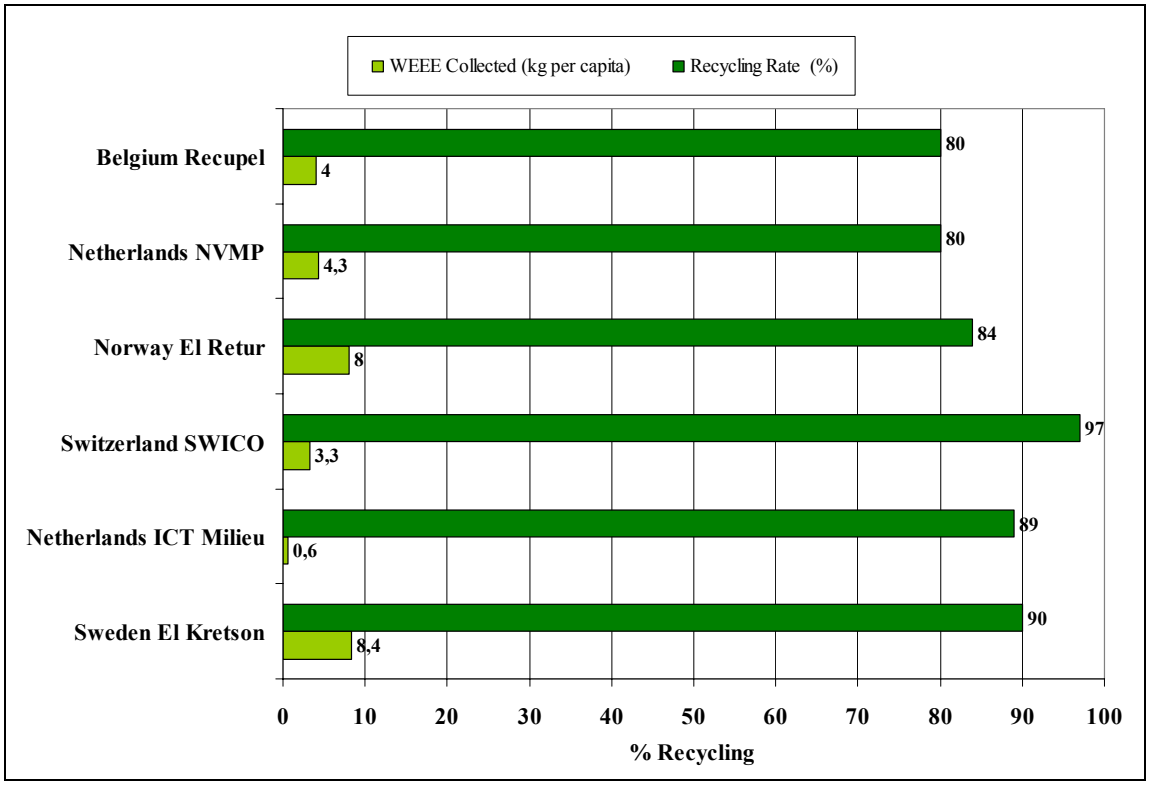


Figure 22: Recycling rates of existing disposal systems for electric and electronic equipment



These systems respond to sometimes very different national situations and philosophies. Some of these countries will have to adapt their national laws when implementing the WEEE Directive. Other countries that have not developed any management systems are developing new ones in order

to comply with the Directive. The clearing house model is the preferred industry route where the market is large and the potential cost savings are substantial. For smaller markets, including those countries with existing schemes, the benefits of market mechanisms are not big enough to outweigh the greater simplicity of structure and financing of collective models.

The development of legislation and compliance structures for the WEEE directive is an ongoing process in all EU countries. The final national legislative and operational situation was defined by the end of 2006 but its effectiveness will remain unclear for a considerable period of time. The interaction and overlap with other areas of legislation, e.g. hazardous waste regulations, transfrontier shipment regulations, health and safety related marking etc., may have delayed the process of transposition and development of national legislation. In addition, where countries experience significant cross-border trade and imports, the efforts devoted to coordinate the implementation of the legislation between neighbouring countries and the tendency to resist first-mover disadvantage, have caused further delay.

While legislators in Member States have spent considerable time studying the legal and operational approach in those countries with established WEEE schemes, all have indicated the importance of building systems that meet local specifics of culture, geography and industry, and that take into account existing practices of waste collection.

Cooperation between Member States is already taking place. In the WEEE technical committee, discussions are on-going regarding whether details provided by producers for registers can be harmonised (i.e. the same type of information for all registers). Work is also being done at the European level on financial guarantees and how they will work. The quality of recycling facilities will be another area for cooperation. Recycling may be concentrated at a few facilities for the whole EU.

The Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive (2002/95/EC) affects manufacturers, sellers, distributors and recyclers of electrical and electronic equipment containing lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls or polybrominated diphenyl ethers. The RoHS directive covers the same scope as the WEEE Directive except for medical devices and monitoring and control instruments. It also applies to electric light bulbs and light fittings in households. It aims to protect human health and the environment by restricting the use of certain hazardous substances in new equipment and to complement the WEEE Directive.
From 1 July 2006, producers of new electrical and electronic equipment must demonstrate that their products do not contain more than the maximum permitted levels of:

- lead, including lead/tin solder,
- mercury,
- cadmium,
- hexavalent chromium,
- polybrominated biphenyls (PBBs) or
- polybrominated diphenyl ethers (PBDEs).

These substances must be replaced by other substances. Certain applications are exempt from the requirements of the directive, including mercury in certain types of fluorescent lamps, lead in the glass of cathode ray tubes, electronic components and fluorescent tubes, lead in electronic ceramic parts, lead in certain types of solder and hexavalent chromium as an anti-corrosion treatment of the carbon steel cooling system in absorption refrigerators. The exemptions will be reviewed every four years.

1.5.4.2 The WEEE directive implementation worldwide, a comparison

The exact nature of national WEEE legislation, in terms of elements such as the scope of products covered and the range of instruments used, varies from country to country. For example, the political culture in some countries or regions might mean that extensive market intervention is regarded as a viable and desirable policy alternative whereas legislation in other areas might be more heavily influenced by a value system that promotes deregulation. The EU, China, and to a lesser extent Japan might be characterised by the former, while Australia, Canada and the US prefer to develop initiatives at a state or regional level, on a voluntary basis where possible, and to avoid legislative solutions, considered to have a lower impact upon economic competitiveness.

Australia[79]: Activity in Australia remains voluntary. The main electrical and electronic industry associations are developing voluntary product stewardship initiatives. The Australian, State and Territory Governments are working with industry to develop product stewardship schemes for televisions and computers, primarily because of the CRT which contains large quantities of lead. Once schemes have been developed for these products, these may serve as models for a broader range of products. With the support of major television manufacturers, state environment ministers in Australia are considering a plan to impose an 18,75 USD recycling fee on the sale of new TVs. The collected funds would be used to develop and operate a nationwide recycling scheme.

Canada[80,81]: at the national level, the Canadian Council of Ministers of the Environment (CCME) adopted landmark national stewardship principles for electronics products in June 2004. The principles are intended to provide a framework to help develop and deliver WEEE programmes in each Canadian province and territory and also to ensure harmonisation of key elements that are necessary for balancing environmental and economic considerations. In October 2004 Alberta started its WEEE management scheme, the first regulated electronics recycling programme in the country. The initial phase includes computer monitors, laptops and notebook computers, CPUs (including keyboards, cables, speakers), printers and televisions, and more products may be added later. Since 1st February 2005 retailers have applied a visible fee to those products, ranging from C$5 for laptops/electronic notebooks to C$45 for televisions. Under the Ontario Waste Diversion Act of 2002, the government of the province of Ontario has recently requested the development of a waste diversion program for WEEE materials, including refrigerators. Although the process for WEEE recovery and required recovery rates have yet to be established, it also requires manufacturers to take responsibility for diversion of WEEE. A study was completed mid-2005 including recommendations on the adequacy of a year-long timeline for developing the program with a launch possible in 2007.

China[82]: the State Development and Reform Commission (SDRC) drafted the "Management Regulations on the Recycling of Used Household Electronic Products and Electronic Products" in 2004 using the Chinese translation of the EU 2002/96/EC directive as a key reference document. The State Council issued the so called "China WEEE" in late 2005. Its objective was to regulate the recycling and treatment of waste and used household electrical and electronic appliances and promoting resource recycling and reuse, environmental protection and human health. China WEEE

[79] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.
[80] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.
[81] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.
[82] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.

would initially cover the following product categories: televisions, washing machines, refrigerators, air conditioners and computers. The Regulations focuses on household products and computer related and only covers product disposal. Household appliance producers are responsible for: adopting product design favourable to recycling and reuse, selecting non-hazardous and non-toxic materials and substances, and materials favourable to recycling and reuse, and providing major components and other information in the instruction manual. They must also undertake their own treatment of waste and used household appliances or entrust this treatment to qualified treatment enterprises and provide the provincial authorities with information on the categories, quantities, sales volumes and export volumes of the household appliances they produce. Issues of financing and producer responsibility remain poorly defined and the recycling system is largely unorganised. In 2004, China's State Development Reform Commission announced that Zhejiang province and the city of Qingdao would be the first two locations in the country to set up recycling systems for scrap electronics. China's top state-owned electronics manufacturers Haier and Hisense are located in Qingdao, while Zhejiang is an affluent province that is thought to have a high diffusion of electronics. Large enterprises and volunteer environmentalists are also involved in the recycling of electrical and electronic wastes, mainly mobile phones with their batteries and other accessories. Meanwhile, the country's largest electrical and electronic waste disposal plant using non-polluting processes - the Citiraya Environment Industry - is already under construction in Wuxi of Jiangsu Province, at a cost of 65 million USD. When the first phase of the project is completed, it will have the capacity to dispose of 30.000 tons of electrical and electronic wastes annually. This capacity will eventually be raised to 60.000 tons per year.

Japan[83]: the Japanese Home Appliance Recycling Law, enacted in 1998 and fully enforceable in 2001, requires industry to establish a recovery and recycling system for used products. The law allows for financing through end-user fees and the collection of used products by municipalities and retailers. The law initially covered 4 products (televisions, air conditioners, refrigerators, and washing machines) as obligatory items, but was extended to electronic products such as personal computers and copiers on a voluntary basis. The recycling goals contained in the law are lower than those of the WEEE directive and they do not escalate over time. Japanese legislation tends to follow EU legislation (thereby ensuring conformity and enabling exports to Europe), but whereas the EU uses environmental legislation, Japan often uses advanced technical specifications to achieve the same objective. Manufacturers are obligated to finance the recycling of their own products and every time they sell a new product, they must take back from the consumer either a similar used product or some other product that they sold in the past. The level of fees in Japan tends to be slightly higher than those in the EU. However, Japan's law does impose specific obligations on individual producers which have individual responsibility for their own products. The end-of-life fee financing system, while effective in meeting the law's recycling goals, has proven to be very expensive for individual consumers (18-24 Euro for TVs, 30-38 Euro for refrigerators and 16-22 Euro for washing machines) and for the system as a whole, since the law provides few incentives to pursue a more efficient model.
Japanese government estimates that the four product categories targeted by the law account for 80% by weight of all discarded electrical and electronic equipment.

New Zealand[84]: *The New Zealand Waste Strategy* sets out the proposed long-term approach to reducing waste, improving recycling and reuse of waste materials, and better management of residual waste. Released in 2002 in partnership with Local Government New Zealand, the strategy sets the overarching strategic direction of solid, liquid, gaseous and hazardous wastes in New

[83] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.
[84] Helen Bolton, Ministry for the Environment, NZ

Zealand. The Waste Strategy signalled the Ministry for the Environment's preference for product stewardship solutions for the country's waste problems. For some wastes, a product stewardship regime can be an extremely effective solution. The volume or toxicity of certain wastes can be cut significantly by steps taken throughout the product's life cycle, from manufacture through to disposal. The New Zealand approach to product stewardship is set out in the discussion document *Product Stewardship and Water Efficiency Labelling* released last year. It outlines product stewardship options to deal with wastes that are particularly hard to manage or dispose of, such as electronic waste, end-of-life vehicles, used oil. The preferred option is voluntary agreements by industry, with legislation as a backstop only if required. The discussion document can be found on the Ministry for the Environment's website[85], where a summary of the submissions on it are also available[86].

USA[87]: WEEE management varies from state to state within the USA and is focused on electronic wastes such as CRT. At the national level the EPA is active in shaping WEEE management. Under its Resource Conservation Challenge the EPA work with retailers and manufacturers of electronic products, as well as with government agencies, to reduce the environmental impacts of the production, use and disposal of electronic products. Goals include increasing the national recycling rate to 35%. One of the main issues facing the US is the challenge of establishing effective governance structures to deal with the waste electronics issue due to the specific political structure of the country. At present, there are not waste disposal or recycling requirements for refrigerator-freezers and other white goods. Some manufacturers indicated that they believe similar requirements as in the Ontario Waste Diversion Act of 2002 could be extended to all of Canada and, in the future, potentially to the U.S. This could cause manufacturers to alter product re-designs to facilitate product recycling. At this point in time, DoE is not familiar with any similar legislation in the United States, but acknowledges that the Ontario legislation could have an impact on refrigerator-freezer design because of the tight integration of the U.S. and Canadian white goods markets.

1.5.4.3 The RoHS directive implementation worldwide, a comparison

The major implementations of RoHS[88] to date have been the EU, China, Japan and California and Korea. There are numerous aspects of RoHS that can be legislated differently leading to non-harmonization. Main aspects include:

- Scope
- The Restricted Substances
- Restriction or disclosure only.
- Maximum Concentration Values (allowable limits)
- The level at which the restriction is applied (Component or Homogeneous material
- Exemptions

Scope: the EU RoHS provided a list of 10 categories listed in the WEEE Directive plus a number of exclusions, listed in both the WEEE Directive and the RoHS Directive. This was a comprehensive

[85] http://www.mfe.govt.nz/publications/waste/product-stewardship-water-labelling-jul05/.
[86] http://www.mfe.govt.nz/publications/waste/product-stewardship-water-labelling-aug06/.
[87] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.
[88] Source: Roland Sommer, Newsletter No. 9, November 2006, RoHS and WEEE Specialists International. The newsletter and the www.electronicssouth.com RoHS and WEEE website are made possible by an initiative and funding from New Zealand Trade and Enterprise

approach but led to a number of “grey areas” that have caused much confusion and uncertainty not only in industry.
China has produced a 35 page, detailed list of products split into 11 broad categories. They have described the list as fully comprehensive, however at the end of each category is the catch-all “other”. The notable exclusion from the China scope is the major category of white goods such as washing machines, clothes dryers, refrigerators etc. The motivation for this is still unclear. They have included medical devices, which are out of scope of EU RoHS until 2012, and as a result have created a very difficult situation for many medical device manufacturers.
Japan has 7 categories that do not directly relate to either the EU or China categories, although the equipment would all be covered by the EU categories in some manner.
Korea has 10 products but intend to implement the EU's scope in the long term. They are beginning with only 10 items: TVs, refrigerators, air conditioners, laundry machines, personal computers, audio devices, cellular phones, printers, copy machines, fax machines.
California covered electronic devices with a LCD, CRT or Plasma screen of greater than 4 inches measured diagonally. However they are proposing adopting EU ROHS in its entirety in 2010.

Restricted Substances: the EU Restricted lead, cadmium, mercury, hexavalent chromium, PBB (polybrominated biphenyls) and PBDE (polybrominated diphenyl ethers). All other countries have followed, except California who has a pre-existing legislation which effectively performs the same function. The net effect is that banned substances are consistent across all implementations.

Restriction or Disclosure only: the EU and California physically restrict the substances in the products. China, Japan and Korea are disclosure only. “Disclosure only” means that companies still have to collect all the material composition data on their components, but instead of designing out non compliant components they have to declare, usually in the users manual, where any of the restricted substances are. This is generally being used as a soft introduction for industry, with China certainly intending to physically restrict the substances in the future. So, there is a pretty even split between the two approaches, with the EU and California enacting physical restrictions and China, Japan and Korea following the “disclosure only” approach.

Maximum Concentration Values (allowable limits): the EU set a limit of 0,1% for all substances except Cadmium which is set at 0,01%. This has been universally adopted, but with a couple of improvements. The major use of hexavalent chromium is in corrosion protection passivation (chromating) on metals. The way the limits are applied in the EU (weight/weight) makes it impossible to accurately measure the amount of hexavalent chromium. China bans all intentionally added hexavalent chromium in metal treatment, which very nicely gets around the issue and meets the original aim of the ban which was to prohibit the chromate treatment.
The other issue was with small parts which again are practically impossible to test. China improved on the EU RoHS by introducing a category for components smaller than 4 mm^3. Components of this size and smaller, under certain conditions, will be considered one homogeneous material and will be tested as a whole. Subsequent to this the EU *Enforcement Authorities Informal Network* announced similar measures, no doubt for very pragmatic reasons. So, apart from the issue of hexavalent chromium in chromate conversion coatings, the “Maximum Concentration Values” are consistent across all legislations.

Component or Homogeneous material (the level at which the restriction is applied): the EU applies the prohibitions at the homogeneous level, but found difficulties to define “homogeneous material” which, in simple terms, is any material that cannot be mechanically disjointed into sub- materials by unscrewing, cutting, grinding or abrasive actions. The rest of the world has followed this verbatim. The Chinese translation to English comes back with the same phraseology and examples. The

original definition has now been tempered by the limitations of testing technology, with the emergence of the Chinese category of components of $4mm^3$ or less under certain conditions.

Exemptions: only the EU and California so far have enacted an actual restriction of the substances, with California adopting the EU exemptions. California is planning to fast track exemptions locally, to overcome the lengthy process that the EU exemptions need to follow. China is also expected to follow suit. They previously had a category of materials called EIP-D which was the list of EU exemptions; this has been withdrawn but is expected to be reintroduced when China go ahead with phase 2, which involves the actual restriction of the substances rather than just disclosure. Interestingly this country will continue to require disclosure of any substance above the limit irrespective of whether it is in an exempt application or not.

There are some aspects of RoHS which are not harmonizing well at a global level such as scope, but the fundamentals such as the banned substances, the limits applied and how they are applied are harmonized. Whether to start with a straight ban or to take a phased approach appears to be very much a country by country decision.

1.6 Annex 1: Sound, Noise and Household Appliances

Sound power: is the amount of energy per unit time that radiates from a source in the form of an acoustic wave. The unit of measurement is the Watt, like the electric power. This distribution of sound power over the area of the propagating wave is designated as **sound intensity** and is measured in W/m^2 (Watts per square meter). Sound power cannot be measured directly. It is possible to measure intensity, but the instruments are relatively expensive and must be used carefully. Under most conditions of sound radiation, sound intensity is proportional to the **sound pressure**.

Sound power level: indicated with SWL or L_w is a measure of the sound power in comparison to a specified reference level. Since in the case of sound, the amount of power is very small, the reference selected for comparison is the picoWatt (10^{-12} Watt), which is the lowest sound persons of excellent hearing can discern. Sound power levels are connected to the sound source and **independent of distance** and are measured in decibel (dB). The sound power level is defined as :

$L_w = 10 \log (W / W_0)$, where W_0 = reference power

Sound pressure: the instantaneous difference between the actual pressure produced by a sound wave and the average or barometric pressure at a given point in space. It is measured in Pa.

Sound pressure level: Sound Pressure Level (SPL or L_p) is 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound measured to the reference pressure, which is 20 mN/m^2. In equation form, sound pressure level is expressed as:

$SPL\ (dB) = 20 \log p/p_0$

Although a decibel scale is actually a means for comparing two sounds, a decibel scale of sound level by can be defined by comparing sounds to a reference sound with a pressure level of :

$p_0 = 2 \times 10^{-5}\ (N/m^2)$

assigned to a sound pressure level of 0 dB. SPL quantifies in decibels the intensity of given sound sources. It **varies substantially with distance** from source, and also diminish as a result of intervening obstacles and barriers, air absorption, wind and other factors.

There is a significant advantage to using decibel notation rather than the wide range of pressure (or power): a change in sound pressure by a factor of 10 corresponds to a change in sound pressure level of 20 dB:

- $p = 40\ \mu Pa$: $L_p = 20 \log (40/20) = 6$ dB
- $p = 400\ \mu Pa$: $L_p = 20 \log (400/20) = 26$ dB

Sound pressure can be measured more easily, so sound measuring instruments are built to measure the sound pressure level in dB.

Correlation between sound power and sound pressure: the sound power is proportional to the square of sound pressure and $10 \log p^2 = 20 \log p$.

Correlation between sound power level and sound pressure level: doubling the sound pressure level increases the sound power level by 3 decibels (dB) as described in the first row of Table 28.

Table 28: Correlation between sound power level and sound pressure level

Increase magnitude (times)	**Increase in sound power level** (dB)	**Increase in sound pressure level** (dB)
2	3	6
3	4,8	9,6
4	6	12
5	7	14
10	10	20
15	11,8	23,6
20	13	26

A-Weighted sound level: a measure of sound level designed to reflect the acuity of the human ear, which does not respond equally to all frequencies. The ear is less efficient at low and high frequencies than at medium or speech-range frequencies. Therefore, to describe a sound containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dB(A). **The A-weighted sound level is also called the "noise level".**

The A-weighted sound level L_A is widely used to state acoustical design goals as a single number, but its usefulness is limited because it gives no information on spectrum content. A-weighted comparisons are best used with sounds that sound alike but differ in level. They should not be used to compare sounds with distinctly different spectral characteristics; that is, two sounds at the same sound level but with different spectral content are likely to be judged differently by the listener in terms of acceptability as a background sound. One of the sounds might be completely acceptable, while the other could be objectionable because its spectrum shape was rumble like, hissing, or tonal in character. A-weighted sound levels correlate well with human judgments of relative loudness, but give no information on spectral balance. Thus, they do not necessarily correlate well with the annoyance caused by the noise.

Therefore, many different-sounding spectra can have the same numeric rating, but have quite different subjective qualities

Comparing decibel A, B and C:

Relative response (dB)	Frequency (Hz)								
	31,5	63	125	250	500	1000	2000	4000	8000
dB(A)	-39,4	-26,2	-16,1	-8,6	-3,2	0	1,2	1	-1,1
dB(B)	-17	-9	-4	-1	0	0	0	-1	-3
dB(C)	-3	-0,8	-0,2	0	0	0	-0,2	-0,8	-3

If the frequency weighting employed (A, B or C) is not indicated, the A-weighting is implied.

The noise chart below gives an idea of average decibel levels for everyday sounds:

- Painful:
  - 150 dB = rock music peak
  - 140 dB = firearms, air raid siren, jet engine
  - 130 dB = jackhammer
  - 120 dB = jet plane take-off, amplified rock music, car stereo, band practice
- Extremely loud:
  - 110 dB = rock music, model airplane
  - 106 dB = timpani and bass drum rolls
  - 100 dB = snowmobile, chain saw, pneumatic drill
  - 90 dB = lawnmower, shop tools, truck traffic, subway
- Very loud:
  - 80 dB = alarm clock, busy street
  - 70 dB = busy traffic, vacuum cleaner
  - 60 dB = conversation
- Moderate:
  - 50 dB = moderate rainfall, quite office
  - 40 dB = quiet room, bedroom
- Faint:
  - 30 dB = whisper, quiet library
  - 20 dB = very quiet room
  - 10 dB = calm.