Everyman´s Means for Everyday´s Energy Efficiency

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Synopsis

The consumption of electricity and water relate to households' everyday practices. The user has to be aware about the effect of various alternatives on energy consumption.

Abstract

The presentation includes an overview of technical options relevant to the various sectors of household management - cooking, refrigeration, dishwashing, waste separating, washing, drying and smoothening (besides ironing) of textiles, lighting, personal hygiene - with the focus on the energy consumption and energy efficiency of the options in terms of kWhs and litres. Knowing the background of real figures of energy is an integral part, when explaining connection of human behaviour and energy consumption.

Annual consumption is the result of individual, and often daily, repeated usage of electricity and water. Each member of the household is constantly engaged in making energy-saving choices. When using the cooker, we make these decisions nearly all the time with a refrigeration appliance forming the other extreme from the point of view of the energy consumption. The foremost decisions pertaining to energy consumption relate to appliance type, size and make, location, and installation.

When compared to saving usage and habits it is possible to use 10-50 % more water or electricity every usage time. The user has to be aware about the effect of various alternatives on energy consumption to be able to influence on his or her consumption.

The issue at stake is partly one of attitude and usage forms learnt at home, partly one of education, of information dissemination and advice, and of research necessary as the base for all these. The following sections review options relevant to Finland. They have been compiled from the results of several studies and experiments.

1. Introduction

Do we know the options available nationally for households, and their applicability in cultural tradition.? Do we know the influence of various options on energy consumption, when quiding people to adopt energy saving manners? Do we know, how households really do at home? Simply by asking in inquires we cannot handle all the details necessary to make conclusions about the way or manner. The other difficulty is, that an answer's scale or point of view may be different from that of a researcher's, or an answer is not honest—with or without intention. We recognise the differences when comparing our ways with others'.

1.1. Level of Consumption of Electricity and Water in Households

The consumption of electricity and water varies greatly even in households of the same size. For example, in 1990 the least-electricity-consuming Finnish households consisting of four persons with a refrigerator, freezer, washing machine, dishwasher, and an electrically heated sauna stove, consumed 3750 kWh/a. Every third household out of the group were those with the highest consumption level, i.e. over 7090 kWh/a. (Melasniemi-Uutela 1996).

The average price of electricity to households other than electrically heated houses is ca. FIM 0.45/kWh.

The calculated moderate and adequate nominal consumption of water in Finland is 155 litres per person per 24 hours, excluding waste but not compromising on convenience (Work Efficiency Institute 1976). Not all water, however, is consumed at home. Some is consumed at day-care centres, at school, at the workplace, and in the course of leisure activities. It would be necessary to know how much time people spend away from home, in order for an appraisal to be made of the nominal consumption. Dwelling-specific measurement of water is provided for about half of all households. The cost of a cubic metre of water varies between FIM 11.oo and FIM 18.oo, this figure including the water charge and the waste water charge. Some of the water is hot water. E.g. in houses supplied with district heating, heating up of water from 4°C to 55°C consumes 59 kWh/m^3.

1.2. Reasons of Variations

In cases where there is variation in the consumption of household electricity and in the nominal consumption of water by households of apparently the same size, (1) some of the differences are due to differences in the amount of housework done at home (Sillanpää 1984). Some people do everything at home while others buy them as services, and thus the consumption of electricity and water required by these services takes place outside the home. For instance, if you bake bread for your 4-person family, your annual electricity consumption will be 100 kWh more than without baking. If you stay at home and nurse your children, your energy consumption for heating would be higher compared with the situation when you are able to lower room temperatures on weekdays. In addition, you consume more electricity for ligthing and more water for using WC than if you worked outside home and your children were at crèche, etc.

In our childhood (2) we have adopted different ways of using energy; to turn out lights, to accept lower room temperature and to compensate it with clothings, to run water - or not to run. Therefore, parents and other upbringers provide important examples for us. It is also important for the ways and values we see at home, at the day-care centre, and at school to be non-conflicting with energy sound pribciples.

The electricity consumed by appliances performing mechanical work is small compared to heating or refrigerating appliances; it no sense to stress people to focus on the use of such appliances. Considering heating or refrigerating appliances, (3) there are differences between makes. The standardised methods for measuring the performance of household appliances include the measurement of energy and water consumption. “Concealed consumption” must also be taken into consideration, e.g. laundry drying based on condensing of moisture by water. Energy-labelling provides guidance in our choice of machine make. However, (4) the ways in which machines are used is a significant factor.

1.3. Electricity and Water Consumption of Functions other than Housework

When looking at energy and water consumption figures, we should notice that especially in one-family houses, the consumption of electricity also includes consumption by functions other than those of the housework or activities. One-family houses have HVAC devices such as pumps, electrically heated floors of washing facilities, air conditioning and heat recovery, and their average energy consumption varied between 9% and 24% of all household energy consumption, or between 37 - 163 kWh/month. In individual households this may rise to 40% to 46 (Haakana and Sillanpää 1996).

When comparing household electricity consumption in one-family houses and in appartments, the consumption of the last-mentioned does not include electricity consumed to run HVAC devices. Tap water is used for purposes such as watering the garden and washing the car. Swimming pools are a rarity nowadays. If a remarkable share of consumption originates from other than housework, it must be ignored when evaluating the effectiveness of saving measures aimed to housework.

2. Where the figures originates?

Part of the consumption figures are (1) based on the standardised measuring methods used in laboratories . The following methods are used: IEC 350, IEC 705, EN 153, EN 28187, EN 60456+A11, EN 601121 and IEC 436.

Some of the consumption values have been obtained (2) by simulating in the laboratory the usage ways applied in households with the relevant information having been obtained through user interviews, observations and questionnaires. E.g. ways of using the oven, of washing dishes, washing the laundry, drying it, and smoothing it. The methods used in cooking were selected by turning to the cooking instructions given in especially school cookery books. Refrigeration appliances' installation and locating ways are based on the observations of the situation in households and on user instructions and standards. When using running water, the appropriate small flow of water was sought out by doing laboratory experiments. This is done to measure which way and corresponding consumption is adequate and to explain the reasons of too high consumptions.

Part of the figures are (3) based on product and method studies, e.g. "rolling" of laundry, development of pre-sorting of household refuse and the development of a device which removes air moisture using heat-pump technique.

Part of the figures are (4) based on device-specific measurements carried out in a few households over a period of about one year, e.g. electrically heated sauna stove, aquarium, water beds, TV with stand-by mode.

3. Examples of Options and their Energy Consumption

One of the primary tasks of research is to produce comparative data for advicers, informers and authorities, when pursuing energy saving. A considerate consumer makes his or her choice.

3.1. Cooking and Use of Cooking Appliances

The cooker differs from all other kitchen appliances in that the user has a major role to play in its energy consumption. The user is constantly involved in making energy-related decisions. Heating up of water is among the commonest functions in the household. The quantity to be heated decides the way of heating. For example, half a litre is brought to boil quickest when using an electric kettle and it consumes the least energy (0.05 kWh). An electric cooker or a microwave oven consume both more time and energy. (Marjomaa et al. 1994)

Cooking food is often a matter of maintaining a certain water temperature. A suitable cooking vessel, a suitable amount of water, and a suitable power setting are the factors involved in energy-saving cooking. Depending on the cooking method used, a kilo of potatoes requires 0.18-0.36 kWh to cook - using the same equipment. The conventional way of cooking consumed 0.24 kWh. If a power-setting-based cooker plate is used and the power is not turned down in time, the energy consumption can increase manyfold. (Kanerva 1986)

A small amount of potatoes (0.250 kilos) takes 5 mins and 0.07 kWh to cook in a microwave oven. On an electric cooker, it takes 25 min and 0.12 kWh. Fish fillets (0.8 kilos) place in a microwave oven take 9 min and 0.17 kWh, but in the cooker oven they take a fivefold amount of time and energy. (Work Efficiency Institute 1992)

Heating up the oven to 200 °C consumed 0.3-0.5 kWh. The heat loss of the oven at 200 °C was 0.4-0.8 kWh/h. It is worthwhile to use the whole oven capacity in cooking. Pre-heat and post-heat can also be often benefited from. When using a conventional oven, a shiny-surfaced mould or vessel slows down the transfer of heat to the food to be cooked. An oven with assisted circulation saves about 20% of time and energy. (Sillanpää & Korhonen 1996). Thermo-containers keep the contents hot or cold.

3.2. Dishwashing

When full machine loads of dishes are washed, the amount of water consumed is the same as when washing the same amount of dishes using the least water consuming method (i.e. washing and rinsing in basins of water). One machine load consumes 20-45 litres of water. When there are just a few dishes to be washed, it is best to wash them under running water with a flow of 3 litres per second being sufficient. (Sillanpää 1977). By the way, how many really knows, what is ”full load”?

Dishwashers are connected to hot water in Finland. This means that the dishwasher uses hot water in rinsing as well. A cold water connection is more economical when electricity is bought on a time-rate tariff and the dishwasher is used when the rate is lower.

If the dishwasher is of appropriate size, it becomes full and the wash programme can be started before the unclean dishes get dry, and the pre-wash or pre-rinse stages can be omitted. A programme heating the water to 55 °C consumes 0.3-0.6 kWh (with hot water connection) while a 65 °C programme consumes 0.5-1.2 kWh. Drying (0.1-0.2 kWh) can be omitted and the hatch can be opened if the worktop above the machine can withstand steam.(Reisbacka & Rytkönen 1994)

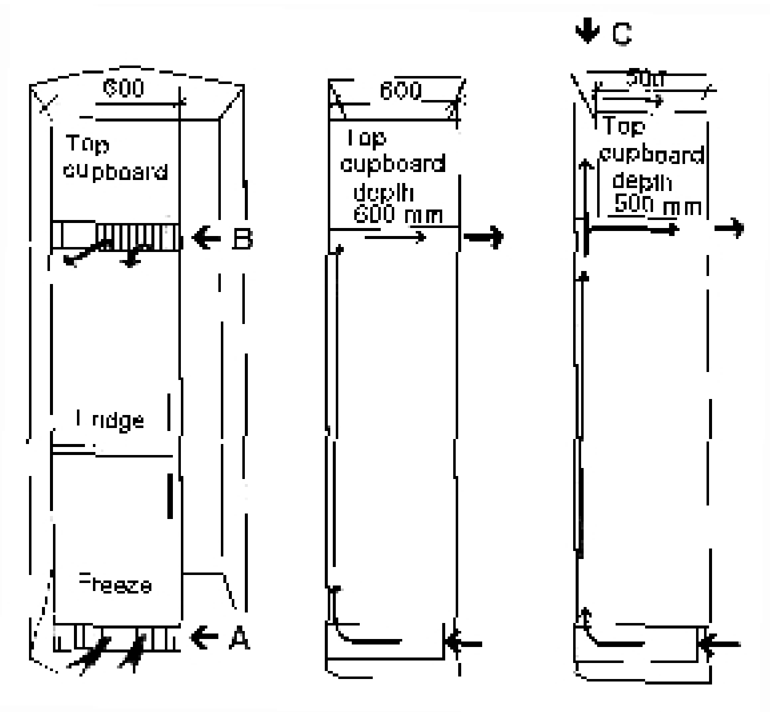
Many environmentally friendly detergents leave deposits on the inside of dishwashers. An acid-alkali treatment removed such deposits, i.e. first a washing operation using citric acid (20-30 g) followed by dishwasher detergent treatment.

3.3. Refrigerators and Freezers

The location and installation of a refrigaration appliance is important. Energy efficiency loses its meaning if such an appliance (which is constantly switched on) is incorrectly placed. Essential aspects are air temperature around the compressor and the condenser. Therefore, adequate air circulation has to be attended to. If simply air circulation is partly impaired, energy consumption can increase 10%, which in one year amounts to

30-50 kWh more in the case of refrigerators
60-75 kWh more in the case of refrigerator-freezers and
65-80 kWh more in the case of freezers.

If the air circulation gratings on the front or back of the appliance is missing or it is covered, the appliance’s energy consumption can even double and its service life can significantly shorten. (Malin & al. 1993)



Placing a floor-standing fridge-freezer into kitchen furnishings did not influence the appliance’s energy consumption as long as the top cupboard had the space for air circulation (C) in addition to the appliance’s own air circulation (A,B). In case that the top cupboard had no space for air circulation (C), the energy consumption increased by 7-13%. Closing the appliance’s own air circulation partly or entirely, increased it’s energy consumption by 10-160%.

Closing of	Energy cons. increased, %
A	10-100
B	54-115
A and B	44-162

Figure 3-3. Effect of air circulation on fridge-freezer’s energy consumption.

There are various solutions to how the air circulation space is arranged. In some units it is built into the machine. In others it has to be accounted for when installing. Installation instructions do not always describe in sufficient detail how the air circulation space has to be arranged. A person not aware of the significance of this aspect may even remove the grating, especially the lower grating, for appearances' sake. (Malin et al. 1993)

Placing the appliance in a warm surroundings has the same effect as subjecting it to inadequate ventilation, i.e. the appliance has to function in unnecessarily warm surroundings. The energy consumption of a refrigerator increased by 40-200% and that of a freezer by 15-65% when the temperature of the surrounding air was changed from 25 °C to 32 °C. Correspondingly, running time ratio increased from 16..29% to 27..100% and that of the freezer from 27..61% to 49..100%.(Malin et al. 1993)

Mere storing of foodstuffs in a refrigeration appliance increased its energy consumption by 1-8%. When the door of a 390 litre refrigerator was opened 20 times for 20 seconds at a time and 4 kilos of produce were taken out twice for half an hour at a time, energy consumption increased 25%. Kitchen designers should take into account the need to place a worktop adjacent to refrigeration appliances as this reduces the time required to keep the door of such an appliance open. (Malin et al. 1993)

When the contents of a freezer are decreasing, the rest of the produce should be placed in the coldest parts of the freezer and set the storage temperature so that it is -18 °C only in those places and thus save energy. To be able to do so, you need to know the temperature zones in your appliance.

It is important to look after and care refrigeration appliances. The proper maintenance of a machine increases its service life and so reduces indirect energy consumption. Dust should be vacuumed from the surface of the condenser and from the surroundings of the compressor sufficiently often. A frost layer of 1 cm or more needs to be removed as frost has an insulating effect and hinders the functioning of the thermostat. (Reisbacka and Rytkönen 1995).

3.4. Washing, Drying and Smoothening

The main reason for the reduction in energy consumption by washing machines has been in the reduction in the amount of water set for the washing stage. Nevertheless, there are differences even among new machines. The energy consumption of white wash programmes is 2-3 kWh, that of 60 °C programmes about 1 kWh, and 40 °C programmes about 0.5 kWh. The water consumption per wash load is only about 100 litres, whereas washing clothes by hand consumes more than twice the amount of water per kilo. Saving programmes differ in structure: fast programmes have reduced wash cycles or less rinsing, energy-saving programmes use lower water temperatures and longer wash cycles or reduced pre-wash cycles or wash cycles or both, and allergy programmes have more rinse cycles (Work Efficiency Institute, e.g. 1996). It is more economical to wash one full machine load than two loads using the half-load option. Again, how many really knows, what is ”full load”, especially thinking front-loaded machines?

Residual moisture of the laundry should be below 75% especially when using aa appliance for drying. This moisture level can be generally achieved with a spin-drying speed of 800 rpm. For a washer load of 3.4 kilos to dry this consumes time and energy as follows:

tumble-dryer	1.5 h	2-3 kWh
drying cabinet	2.5 h	ca. 4 kWh
washer-dryer	2.5 h	ca. 3.5 kWh + ca. 70 litres of water

An air-vented tumble-dryer requires an air-evacuating flue capable of evacuating 40-50 litres per second. If the outgoing air is led into the room air, it will bring with it fluff, detergent residuals and a lot of moisture (2-2.5 litres of water), which can damage surfaces and structures. A condensing tumple dryer needs sufficient compensation air, otherwise the drying process slows down and energy consumption will go up. A drying cabinet for laundry is in the Nordic countries as common as a tumble dryer. A drying cabinet with an air flow of (11-17 litres/s) does not cause problems for ventilation even in houses with mechanised ventilation. Laundry can also be left to dry in such a cabinet without heating, if there is no hurry and thus avoid to consume electricity. (Work Efficiency Institute 1990)

It is a good idea to consider the washing and post-washing treatment of textiles when acquiring textiles for the home. A non-mechanised method has been developed for post-washing treatment of linen. This “rolling” method combines drying and smoothing as ironing or mangling. After spinning, textiles are rolled around perforated plastic tubes (length 50-60 cm, diameter 5 cm). An auxiliary device, to which one end of the textile is attached to, is useful when rolling the textiles. The rollers are then placed in a rack to dry or stacked criss-cross onto a table. Towels and pilowcases will dry in 10-12 hours in room temperature with normal humidity, RH 30-50%. The drying of large textiles such as sheets and tablecloths can be speeded up by opening the rollers as the drying proceeds. This method also shortens the overall post-washing treatment time. The resultant textile surfaces are pleasant to touch and attractive to look at. (Work Efficiency Institute 1990)

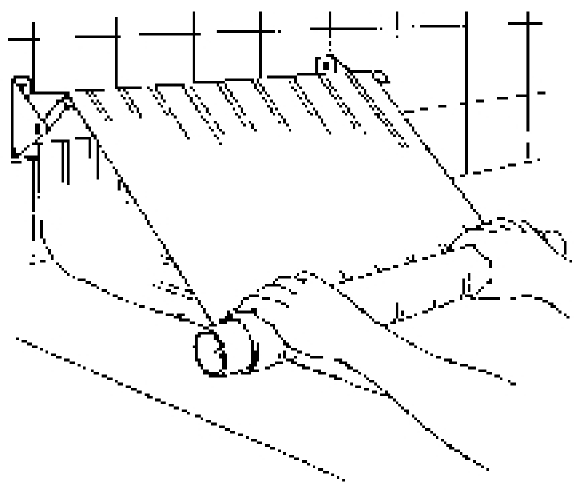


Figure 3-4. Using the “rolling” method instead of drying and ironing or mangling saves energy and time used for post-washing treatment of linen. In Finland, packeges of accessories are sold in some detaprtment stores. Ca. 10% of households have adapted the method.

Especially in old apartment houses, laundry often has to be dried in the bathroom which is typically poorly ventilated. A moisture-removing device has been developed to solve this problem. It functions on the heat-pump principle, condensing the moisture in the air by means of a refrigerant. The device is connected to the mains by means of a plug and it is 300 x 310 x 550 (mm) in size and weighs 25 kilos. Depending on the rate of mechanised air venting, the device consumes 2.2-2.5 kWh of electricity to dry a washer load of laundry (3.4 kg). (Reisbacka 1996)

3.5. Lighting

The share of the lighting in electricity consumption has increased. In many households it already amounts to 15-20% of the household’s electricity bill. New technology means more efficient energy utilisation in lighting. A 15 W fluorescent, energy-saving bulb corresponds to a 60 W incandescent bulb in terms of amount of light produced.

The tone of the light produced by the small-screwed, fluorescent, energy-saving bulbs differs from that of incandescent bulbs, but some are very close to it. There are differences among fluorescent lamps as regards lighting up in sub-zero temperatures and some are less bright when it is cold. Due to these differences, the purpose of use determines the choice of lamp. Small fluorescent bulbs have a long service life but their luminosity is gradually reduced with age. It has been calculated that it is uneconomical to switch over to fluorescent lamps in houses heated by electricity if the average time that lamps are on daily is 3 hours and the lamps cost FIM 60.oo. In dwellings heated by some other means fluorescent lamps are a worthwhile investment. (Mustonen 1993)

3.6. Miscellaneous Electricity Consumption

The typical energy consumption of an electric sauna stove in Finland is 6 kWh. During one sauna session (1.5 h) such a stove consumes ca. 8 kWh when the stove temperature is set to 80 °C, which is ”the right” temperature. If the temperature is set to 100 °C, energy consumption rises by more than 30%.

There are also other electricity consuming devices in homes. The following are some examples of their consumption according to measurements in households (Haakana and Sillanpää 1996):

hairdryer or föhn	0.2 kWh/10 min
evaporating air humidifier	0.2 kWh/h
aquarium, 300 litres (filter, light, heating)	300 kWh/a
water bed	150-800 kWh/a
TV or VCR (with stand-by)	50-100 kWh/a

3.7. Water Consumption

The way of using water is something that is especially learnt at home, e.g. unnecessary running of water or turning off of the tap or the rate at which water is allowed to flow when using it. Water consumption in the dwelling may be subdivided as follows (Reisbacka and Speeti 1983):

Consumption, %	of all water	of all hot water	of all cold water
Washing	40-60	45-70	15-40
Kitchen	20-30	30-50	15-20
WC pan	20-35	-	45-60

The distribution of water consumption according to purpose of use has been studied by monitoring the number of times water is used in households and by measuring the water consumption of the various functions in laboratory conditions (Work Efficiency Institute 1976).

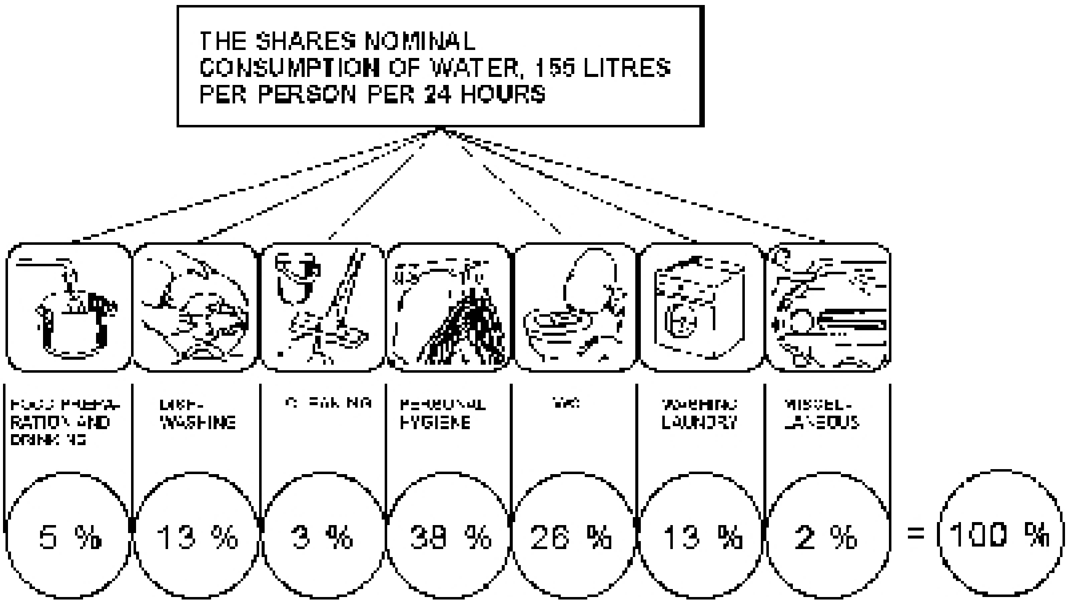


Figure 3-7. The shares of nominal consumption of water, 155 litres per person per 24 hours, used for different household chores on the average.

At least one of the two basins in the kitchen sink should be closable by means of a plug. The flow (litres/minute) is an essential parameter when using running water. Based on experiments, it has been noted that 2-3 litres/minute is a sufficient flow when washing large vessels, vegetables and fruits. If no attention is paid to the flow of water, wasteful levels such as 10-12 litres/minute may result. In test conditions, the preferred flow was 12-16 litres/min, but suitable shower nozzles produce the same sensation at lower flow levels, e.g. 8-10 litres/min (-Sillanpää 1977).

3.8. Sorting of Refuse

Annually 150-250 kilos of household refuse are produced per person. A fundamental precondition for the recycling of refuse is properly arranged pre-sorting before the refuse leaves the household. This calls for practical refuse containers. The adoption of compact drain traps has made it possible to locate these containers in the cabinet underneath the kitchen sink (Roos 1996).

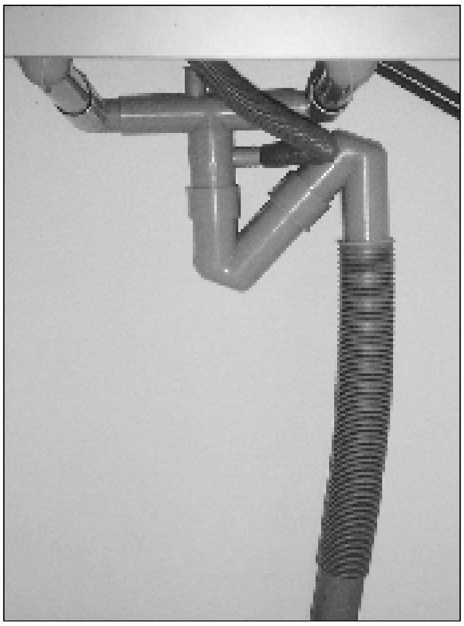


Figure 3-8. Space-saving drain trap, compact drain trap, enables to fully furnish the space under the sinks, the sink unit. The compact trap is standardised in Finland.

4. Conclusions

Households' energy consumption cannot be reduced simply by technological means because the user is always a human being. There is also no behavioural mystery in energy consumption. The consumption of water and electricity is made up of "open-shut", "on-off" and "lower-higher" functions. Constant information has to be available on their effects as otherwise consumers will not be able to comprehend the factors involved in energy consumption.

Consumers' possibilities to implement energy saving are partly depending on authority measures. Regulations and standards provide a steering mechanism, e.g. for the furnishing of kitchens and other functional spaces in the home by way of water and energy connections, air ventilation and spatial planning guides. Building regulations etc. may not be barriers to energy saving means. Consumer's self-knowledge is needed to identify the basic ways of energy usage. Updated information on energy consumption and other properties of new techniques and applying them to working methods is needed as well. Proper use and maintenance enable consumers to directly influence their energy consumption and even their indirect energy consumption by lengthening the service life of appliances.

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