

# STRIVE

## Report Series No.108

# Water saving technologies to reduce water consumption and wastewater production in Irish households

## STRIVE

Environmental Protection  
Agency Programme

### 2007-2013

# Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Community and Local Government.

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- Office of Environmental Assessment
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet several times a year to discuss issues of concern and offer advice to the Board.

**EPA STRIVE Programme 2007–2013**

**Water saving technologies to reduce water  
consumption and wastewater production  
in Irish households**

**(2010-W-LS-3)**

**STRIVE Report**

Prepared for the Environmental Protection Agency

by

Trinity College Dublin

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## **ACKNOWLEDGEMENTS**

This report is published as part of the Science, Technology, Research and Innovation for the Environment (STRIVE) Programme 2007–2013. The programme is financed by the Irish Government. It is administered on behalf of the Department of the Environment, Community and Local Government by the Environmental Protection Agency, which has the statutory function of coordinating and promoting environmental research. This report forms part of the overall EPA STRIVE funded project 2010-W-LS-3, *Assessment of disposal options for treated wastewater from single houses in low permeability soil/subsoil settings*.

The authors wish to acknowledge the assistance of Arne Backlund (BACKLUND ApS, Denmark) who provided valuable information from his research and expert knowledge in the field of ecological sanitation.

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The EPA STRIVE Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

## **EPA STRIVE PROGRAMME 2007–2013**

Published by the Environmental Protection Agency, Ireland

ISBN: 978-1-84095-504-0

Price: Free

Online version

## Project partners

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# 1. Introduction

Typical on-site wastewater treatment systems for single houses in rural areas with no mains drainage consist of septic tanks and/or package treatment plants followed by a percolation area (soil attenuation system). If the subsoil permeability is not sufficient to take the effluent load, surface ponding may occur with associated health risks and a risk of runoff of pollutants to surface water.

Thus, a lower limit was defined for the subsoil permeability up to which the discharge to ground is permitted (T-value = 90 (EPA, 2009)). At lower subsoil permeability water will not be able to percolate into the ground at typical hydraulic loads.

However, the reduction of water consumption by water saving devices such as low flush toilets, low-flow shower heads and low-flow taps will reduce wastewater production and hence hydraulic loadings on percolation areas.

This could improve the functioning of the soil attenuation system (i.e. minimise surface ponding and runoff) and should be investigated for sites with subsoils of limited permeability.

Technologies based on the principles of eco-sanitation, whereby the organics and nutrients from wastewater are recycled via composting toilets and urine separation, could also be a potential solution for the wastewater disposal problem in such areas but will require acceptance and high dedication from the home owners. However, the implementation of some of these principles can help to reduce the daily water consumption/wastewater production that needs to be treated and disposed of.

Finally, it should be noted that with current political developments and the expected introduction of domestic water charges in 2014, the information on how to reduce water consumption will be of interest to households not only in rural areas in terms of their wastewater disposal but also in urban areas in terms of water and related energy cost savings. Furthermore, a significant uptake rate of water saving devices and actions could reduce the domestic water demand in urban areas and improve water security in areas where water resources and/or the supply of treated water are under pressure (as evidenced, for example, by the Dublin Water Supply Project).

## 2. Water consumption, usage patterns and water prices

Currently there is little information on domestic water consumption in Ireland. The Irish Code of Practice (EPA, 2009) uses a daily hydraulic load of 150 Lcd in order to calculate the design load for on-site wastewater treatment systems. This is supported by the per capita consumption (PCC) of 147 Lcd that was obtained from water demand analysis for domestic users in the greater Dublin area (WSP, 2010).

However, in rural areas there is an indication that PCC is lower than expected. For example, a study of 74 households, located across Ireland and served by Group Water Schemes, over a period of 13 months (January 2010–February 2011) revealed an average household consumption of 335 L/d, with a decrease in PCC with increasing household occupancy. The average PCC for a three-person household, which reflects the most prevalent occupancy rate across Ireland, was observed to be 111 Lcd (pers. comm. Jennifer Brady, 2012). Equally, Gill et al. (2005; 2009) measured the wastewater flow in six different houses (4–5 PE<sup>1</sup>) with on-site treatment systems and found the average wastewater generation ranging from 60 to 123 Lcd (mean = 96.5 Lcd).

Due to the lack of Irish data in terms of detailed water usage patterns, international data were collated (Fig. 1) to enable determination of potential water savings that can be achieved

with the installation of water saving devices in Irish households.

The Water Research Centre (WRc) UK conducted a large-scale survey to investigate water consumption trends in different parts of the UK (Liu et al., 2010), which was assumed to provide a good estimate for the Irish situation due to the similarity in housing and living standards. The survey used flow meters and data loggers to identify flow characteristics and classify water use events in 100 three-person households. The results (Fig. 1), together with an estimated PCC of 150 Lcd, have been used as the basis for the water saving calculations.

It should be noted that the 32% tap usage statistic was broken down in comparison to international data as follows: 14% in the bathroom, 14% in the kitchen and 4% for irrigation, cleaning and other outdoor purposes.

It should also be noted that these are average PCC, and individual water use will depend on various factors such as household type, age and occupancy, lifestyle (e.g. time spent at home and the use of facilities at work or at sports centres) as well as personal awareness of the value of water (WSP, 2010).

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<sup>1</sup> PE= Population equivalent



While there are no direct water charges for domestic users in urban areas, the average volumetric charge for domestic users across 22 group water schemes in rural Ireland is 0.75 €/m<sup>3</sup>, ranging from 0.22 to 1.80 €/m<sup>3</sup>. For non-domestic use the average combined water and wastewater tariff across Ireland is 2.35 €/m<sup>3</sup> with prices ranging from 1.49 up to 3.04 €/m<sup>3</sup> (pers. comm. Jennifer Brady, 2012). Dublin City for example, currently charges 1.90 €/m<sup>3</sup> ([www.dublincity.ie](http://www.dublincity.ie)), which was used to estimate

potential cost savings and payback periods for different water saving devices. In comparison, the Global Water Intelligence survey including 310 cities worldwide found an average domestic water and wastewater charge of 1.98 \$/m<sup>3</sup> (1.50 €/m<sup>3</sup>, at an exchange rate of 0.7555 on 2 January 2013). The average tariff from the eight UK cities in the survey was 4.33 \$/m<sup>3</sup> (3.27 €/m<sup>3</sup>, at an exchange rate of 0.7555 on 02/01/2013) (GWI, 2012).

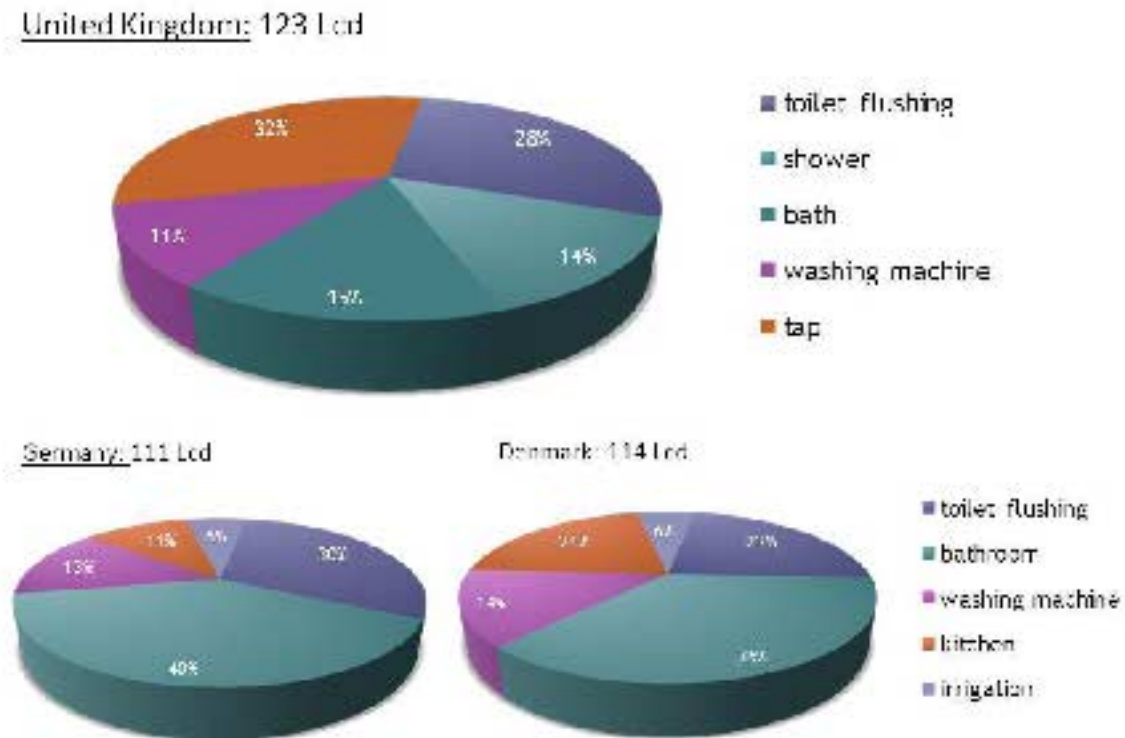


Figure 1: Daily per capita water consumption and usage patterns in the UK (Liu *et al.*, 2010), Germany ([www.bdew.de](http://www.bdew.de) data from 2011) and Denmark (Revitt *et al.*, 2011).

### 3. Water saving technologies

#### 3.1 Toilet systems to reduce water consumption

Toilet cistern capacities have decreased from 20L in the mid-20th century to 6L or less today ([www.idealstandard.ie](http://www.idealstandard.ie)). Flush toilets installed before 1993 typically have cistern capacities of 9L, whereas toilets installed between 1993 and 1999 use flush volumes of 7-9L ([www.greenhome.ie](http://www.greenhome.ie)).

In the UK it is reported that about 16% of toilets still use 13L per flush, compared to 11% using the latest low-flush models with 6L (full) and 4L (short) flushes ([www.waterwise.org.uk](http://www.waterwise.org.uk)).

Nowadays there are technologies on the market that reduce the water volume per flush to between 0.6-1L, as described in the following sections.

Table 1 summarises the potential water and cost savings for the different toilet systems compared to a 9L single flush toilet, which was estimated as the average flush volume in the UK and in the greater Dublin area (Liu *et al.*, 2010; WSP, 2010).

Using more water-efficient toilet systems 14–40 Lcd of flushing water can be saved, resulting in a PCC reduction of 9–27%.

**Table 1: Potential water and cost savings for different toilet systems compared to a reference 9L single flush toilet**

	Single flush toilet	High efficiency toilet	Dual flush toilet <sup>3</sup>		Urine diverting dual flush toilet <sup>3</sup>	Vacuum toilet	Urine diverting vacuum toilet <sup>3</sup>
<b>Flush volume</b>	6 L	4.8 L	3/6 L	3/4.5 L	0.6/4 L	1 L	0.2/1 L
<b>Water saving<sup>1</sup></b>	14 Lcd	19.6 Lcd	24.5 Lcd	26.25 Lcd	35.23 Lcd	37.33 Lcd	40.13 Lcd
<b>Saving in flushing water<sup>1</sup></b>	33.3%	46.7%	58.3%	62.5%	83.9%	88.9%	95.6%
<b>Water cost savings per person<sup>2</sup></b>	9.71 €/y <sup>4</sup>	13.60 €/y	16.99 €/y	18.20 €/y	24.43 €/y	25.89 €/y	27.83 €/y
<b>Reduction in total PCC<sup>1</sup></b>	9.33%	13.1%	16.33%	17.5%	23.5%	24.9%	26.8%

<sup>1</sup> based on an avg. daily per capita consumption (PCC) of 150 Lcd

<sup>2</sup> assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for the non-domestic use in Dublin City in 2012

<sup>3</sup> assuming 3 out of 4 flushes (75% of all flushes) are small flushes

<sup>4</sup> y = year

### 3.1.1 Dual flush toilets

Many toilets available today feature a dual flush option ([www.waterwise.org.uk](http://www.waterwise.org.uk)) where the user has the option of a short flush (3L) for liquids or a long flush (6L) for solids. The Irish Building Regulations Part G 2008 introduced the requirement that “Sanitary conveniences shall be of such design as to facilitate efficient use of water for flushing” and the technical guidance document to part G (TGD G) effectively requires that all new and replacement WC suites have “a dual flush facility combining a maximum flush volume of 6 litres and a reduced flush volume no greater than two thirds of the maximum”.

With an average of 4.66 flushes per person in an average household (and assuming that the long flush is only needed one out of four times) the

water saving would be 24.5 Lcd compared to a 9L single flush toilet (Table 1).

This will reduce the water consumption by 16.3% - but these savings are dependent on the correct use of the system by its users, including visitors and children. There are also dual flush systems on the market that use 4.5L and 3L (e.g. Caroma, Australia) or 4L and 2L (e.g. Ifö, Sweden) for long and short flushes, respectively.

Dual flush toilets will vary in price primarily due to aesthetic design, but quotes from randomly selected sanitary ware suppliers in Dublin showed that 6/3L models start at €200 while the 4.5/3L can be slightly more expensive at €250–300. The toilets’ payback periods depending on the household’s occupancy rate are listed in Table 2.

**Table 2: Payback periods for dual flush toilets based on predicted water cost savings<sup>1</sup>**

Household occupancy	Payback period [y] <sup>3</sup> for 6/3 L dual flush toilet (€200) <sup>2</sup>	Payback period [y] <sup>3</sup> for 4.5/3 L dual flush toilet (€250-300) <sup>2</sup>
3 PE	3.9	4.6/5.5
4 PE	2.9	3.4/4.1
5 PE	2.4	2.7/3.3
6 PE	2.0	2.3/2.7

<sup>1</sup> assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for the non-domestic use in Dublin City in 2012

<sup>2</sup> estimated as lowest price from quotes obtained from randomly selected sanitary ware suppliers in Dublin

<sup>3</sup> y = year

However, reducing flush volumes leads to a higher possibility of restricted performance whereby the toilet pan might need to be cleaned manually with a brush more often. Also if the technology is not appropriate (i.e. if the designs of flush valves and bowls are not adapted properly to the low flush volume), the need for double flushing might arise and the expected water saving would not be achieved (Schlunke *et al.*, 2008). Therefore some countries, such as the United States, Australia and Sweden, introduced an independent testing and labelling system (US EPA Water Sense, WELS and INSTA-Cert) to ensure satisfactory discharge performance of low flush technologies. However, there are concerns that the low flush volumes might affect an efficient sewerage network performance through increased blockage (Drinkwater *et al.*, 2008; Schlunke *et al.*, 2008; WSP, 2010; PERC, 2012).

The Plumbing Efficiency Research Coalition (PERC) tested the drainline transport distance for three flush volumes (6, 4.8 and 3 L) using a test apparatus with 4-inch (100 mm) PVC pipes at slopes of 1% and 2%. Flush volumes of 4.8L and 6L resulted in an orderly and predictable movement of the test media together with paper, proving that such flush volumes should not cause any problems in new constructions (PERC, 2012).

In new buildings the likelihood of blockages can be reduced by changing the design standards for the drainage systems using smaller diameter pipes (up to a certain limit) and steeper gradients (e.g. 2.5% for 4-inch pipes) (Drinkwater *et al.*, 2008; Boynton, 2009).

Further information on sanitary pipework layout and calculation can be found in the Standard IS EN 12056 "Gravity drainage system inside buildings". In retrofit applications it is suggested to inspect the drainline layout and its conditions (root intrusions, sagging or other physical conditions) before deciding whether a replacement with a low flush solution would be viable (Drinkwater *et al.*, 2008; PERC, 2012). In Australia 4.5/3L toilets are the current standard and problems in sewer lines due to reduced flows have only been observed in Sydney at times of water restrictions, where they were linked to informal grey water<sup>1</sup> reuse (Schlunke *et al.*, 2008). However, results from the tests using 3L to flush solids indicated a higher possibility of blockages in 4-inch drainage pipes and will need further investigation (PERC, 2012).

Other scenarios that need to be considered at risk due to low flush volumes could be, for example, one storey buildings with long horizontal runs (George, 2009; PERC, 2012).

Also there might be a higher risk of blockage related to remote fixtures with low or sporadic usage and no upstream flow that could assist the toilet in providing drainline transport of solids (Drinkwater *et al.*, 2008; Schlunke *et al.*, 2008; George, 2009; PERC, 2012). Therefore, new pipe networks for low flush applications should be designed in such a way that pipes with very little flow are avoided (Drinkwater *et al.*, 2008). The PERC research also found that different paper brands directly impact drainline transport

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<sup>1</sup> Grey water is usually defined as all domestic wastewater except for toilet wastewater (black water). This includes water from showers, bath, hand basins, laundry and kitchen (dishwasher).

distances, and a strong inverse correlation with the wet tensile strength values of tested toilet paper was observed (PERC, 2012). Problems are also expected with certain user behaviours such as excess paper use in public toilets (e.g. to line the toilet seat) and the inappropriate use of sewers to dispose of food and wipes or other objects flushed with the toilet. Therefore, appropriate education of the public is needed and could solve some of the blockage problems (Drinkwater *et al.*, 2008; Schlunke *et al.*, 2008).

### **3.1.2 High-efficiency pressure-assist toilet systems**

Pressurised tank toilets use water line pressure to achieve a higher flush velocity. Water is stored in a tank that compresses a pocket of air and releases pressurized water into the bowl and out the trapway (Fig. 2). This creates a shorter flush with a higher flow rate compared to the gravity fed system. The system uses between 4.0L and 4.8L per flush and saves at least 19.6 Lcd compared to a 9L single flush system, which reduces the water consumption by 13%. This is slightly less than a dual flush toilet can achieve (Table 1). However, these water savings are guaranteed and independent of the user and whether the flush volume is chosen correctly.

Disadvantages are that the flushing can be slightly louder, repairs can be more difficult and the system can be 1.5 to 2 times more expensive than gravity fed toilets.

It should also be noted that the system requires a minimum water line pressure of 20–30 psi (pounds per square inch) or 1379–2068 hPa (hectopascal), which may be a problem in houses with low water pressure (International Association of Certified Home Inspectors, ([www.nachi.org/pressure-assist-toilets.htm](http://www.nachi.org/pressure-assist-toilets.htm))). Therefore, systems fed from a cold water storage tank will probably not be able to achieve the required pressures which equals to a hydraulic head of 14–21 m. With respect to Part G of the current Building Regulations which requires cold water storage in domestic dwellings, at present a pressure-assist toilet will consequently not be a functional option for most Irish households.

It should be noted that pressure-assist tanks cannot be retrofitted into existing toilets. The units operate in conjunction with specially designed toilet bowls (Fig. 3), and will not function if installed in a gravity-type bowl. These bowls have an extra-large trapway (the hole where the water exits the bowl) that contributes to the efficiency of the flush and no siphon bend.

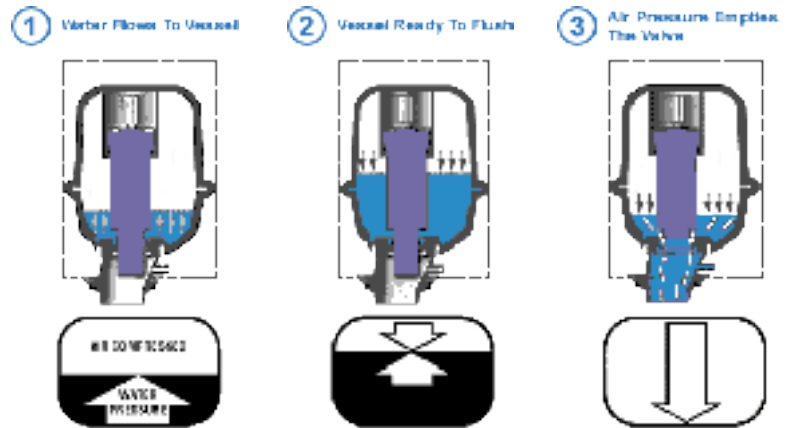


Figure 2: Pressure-assist toilet system ([www.flushmate.com](http://www.flushmate.com))

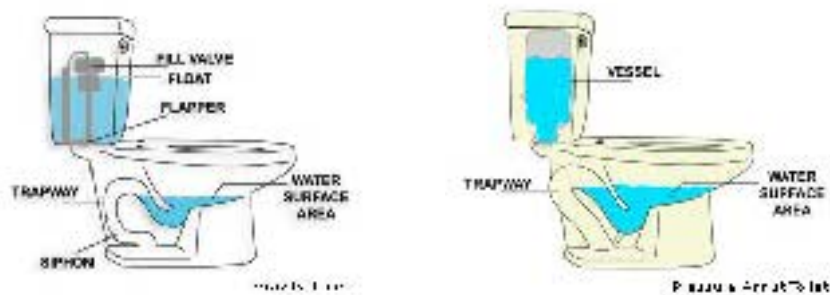


Figure 3: Toilet bowl design of a gravity fed toilet (left) compared to a pressure-assist toilet (right) with a wider trapway, fewer bends and without a siphon. ([www.toiletabc.com](http://www.toiletabc.com))

### 3.1.3 Urine diverting dual flush toilets

If urine is collected in a separate section of the toilet bowl (Fig. 4), only a minimum amount of water (0.4 to 0.6 L) is needed to clean off residuals. However, this requires separate disposal of the toilet paper in a bin provided next to the toilet. To flush away solids a volume of 4 or 6L can be used. The newest model uses only 0.3L and 2.5L for a short and long flush, respectively. However, this would seem to be close to the limit and could risk an occasional need for double flushing (pers. comm. Arne Backlund).

A 0.6/4L system saves about 35L potable water per person per day and reduces average water consumption by 23% (Table 1). The diverted urine can be used as fertiliser for garden plants after appropriate storage periods. During storage urea is converted to ammonia, which increases the pH and has a sanitizing effect so that bacteria concentrations diminish quite quickly. Prolonged storage is necessary to reduce the number of viruses and protozoa (WHO, 2006). In Sweden the use of own urine is legally as well as culturally accepted. The regulations for urine

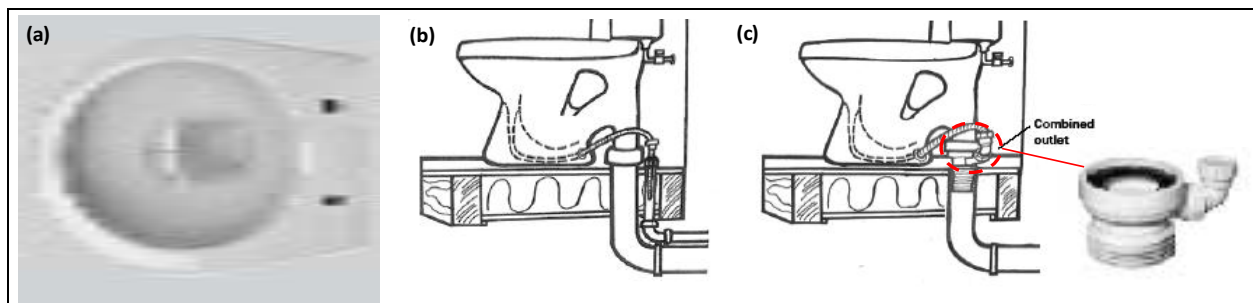
storage before usage differ between the municipalities and vary from no required storage up to 4-6 month storage (pers. comm. Arne Backlund). However, urine separation can also just be a way to save flush water where the stream rejoins the main sewer pipe of the toilet (Fig. 4), so that no dual plumbing is necessary and retrofitting will be relatively easy.

The use of the toilet is only slightly different from an ordinary dual flush toilet but requires a certain degree of behavioural change. For the source diversion to work, all users have to sit down when using the toilet and paper used after urinating needs to be disposed of separately.

Case studies in Sweden and Denmark showed good results and users' satisfaction with the operation of the system (Holtze and Backlund, 2002).

No problems with the flush mechanism or with odours were reported, although blockages in the urine system were frequently observed in toilets flushed with hard water containing large amounts of calcium; these blockages can be removed with a mechanical cleaning wire or by flushing with NaOH (Backlund, 2002). In Sweden this system currently costs 5,800 SEK (€676.72, at an exchange rate of 0.1667 as of 2 January 2013) incl. 25% VAT.

However, at present this system is not available in Ireland and would need to be imported from Sweden at the costs of 2,375 SEK (€277.11, at an exchange rate of 0.1667 on 2 January 2013) incl. 25% VAT for the shipping of a single toilet to Dublin. Payback periods for this system can be found in Table 3 but it should be noted that these are solely based on water cost savings and will shorten where wastewater treatment costs are considered as well.



**Figure 4:** (a) View into the bowl of a urine diverting dual flush toilet, (b) installation with separate urine line and (c) with a combined outlet (EcoFlush installation manual)

**Table 3: Payback periods for a urine diverting dual flush toilet based on predicted water cost savings<sup>1</sup>**

Household occupancy	Annual water cost savings [€] <sup>1</sup>	Payback period [y] <sup>2</sup> based on unit costs	Payback period [y] <sup>2</sup> based on total costs (unit + shipping)
3 PE	73.29	9.23	13.01
4 PE	97.72	6.93	9.76
5 PE	122.15	5.54	7.81
6 PE	146.58	4.62	6.51

<sup>1</sup> assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for the non-domestic use in Dublin City in 2012

<sup>2</sup> y = year

### 3.1.4 Vacuum toilets

Vacuum toilets are used in areas in some Scandinavian countries where householders want to minimise the flush water collected in a storage tank. Although these systems are easy to use their successful installation is more complex compared to standard systems. Hence, vacuum toilets are an expensive solution and will only be reasonable if major difficulties (e.g. with ordinary pipes, with percolation, with complicated and expensive transport of collected material) have to be overcome.

A standard vacuum toilet uses 0.6–1L per flush. This saves about 37L potable water per person per day and reduces the water consumption by 25% (Table 1). Urine diverting models have a dual flush option and use only 0.1–0.2L for a short flush (for urine), saving slightly more water than the single flush model. To create the vacuum in the system, vacuum pumps are needed that can be run constantly or on demand. If the grey water is also collected in the same tank as the black water (the normal situation in Ireland), the systems need to be installed in a pipe on top of the tank so that the tank itself is not put under pressure. Where vacuum systems are used they should meet the

requirements of I.S. EN 12109:1999 “Vacuum drainage systems inside buildings” or I.S. EN 1091: 1997 “Vacuum drainage and sewerage systems outside buildings”.

The power consumption for a “vacuum on demand” (VOD) system is 6 kWh/y for a three-person household so that running costs of around 1 €/y are negligible. The system is currently not available in Ireland and would need to be imported from Sweden, where it currently costs 24,530 SEK (€2,862, at an exchange rate of 0.1667 on 2 January 2013) incl. 25% VAT. It would also need qualified contractors in Ireland to install and service the system, who do not exist at present.

However, air assisted flush toilets, such as the Popelair which has been developed in the UK and is expected to launch on the market very soon ([www.propelair.com](http://www.propelair.com)), could be a reasonable low-tech alternative to vacuum toilets. When the lid is closed an air seal is formed and air displaces the content of the bowl. Water (1.5L per flush) is only used to replenish the water trap seal. The toilet requires only a small electric motor to displace the air used



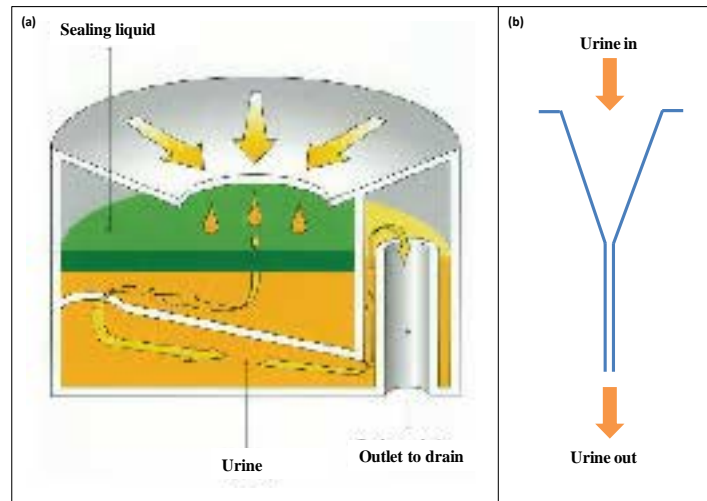
during flushing and uses 500 J per flush (Gandy *et al.*, 2012) which would result in an annual power consumption of 0.24 kWh per person. Tests conducted by the Water Research Centre (WRc) in the UK showed low average flush volumes with 84% flush water saving compared to 9L single flush toilets, as well as good user acceptance (Waylen, 2006). A study by the Centre for Research into Environment and Health (CREH) further showed that the used flush mechanism reduces the number of aerosolised *E. coli* by 95% compared to a modern dual flush toilet (Watkins *et al.*, 2007). It is an established opinion that vacuum and air assisted flush toilets such as Propelair avoid the drain line carriage issues so that it will be possible to install the toilet in new as well as in existing houses (Schlunke *et al.*, 2008).

### **3.1.5 Waterless urinals**

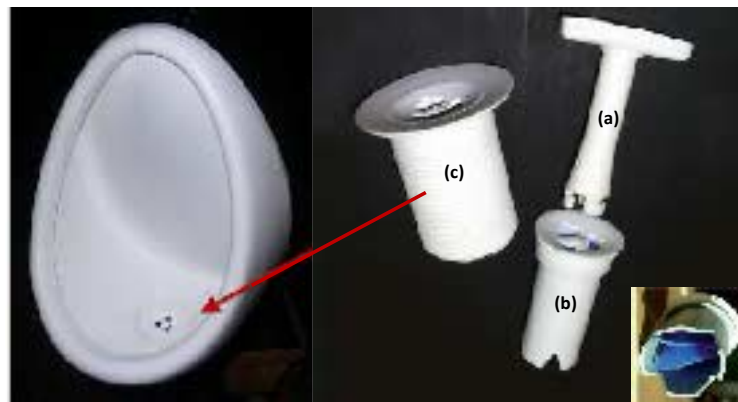
The most common systems used in waterless urinals are sealant liquid traps and curtain valve seals (Fig. 5). In the sealant liquid trap a blocking liquid made out of vegetable oils or aliphatic alcohols, which are biodegradable if released into the sewer, floats on top of urine contained in the trap (Fig. 5a) and thus provides an effective odour barrier (von Münch and Winker, 2011). For the curtain valve system an adapter in which the valve is fitted (Fig. 6) replaces the existing insert and trap in a standard urinal. The membranes (in blue, Fig. 6) have a special self-cleaning surface and are responsible for the closing mechanism of the valve, which closes airtight and only opens in the direction of the drain (Fig. 5b).

It has been shown that waterless urinals can be operated hygienically and odour free if they are maintained and cleaned according to manufacturer's instructions (Backlund, 2002; Demiriz, 2009; Gandy *et al.*, 2012). Since no water is used for flushing, residuals will remain in the bowl so that a frequent/daily cleaning with a special cleaning solution (water will reduce the lifetime of curtain valves) is required. Although it is possible to retrofit the systems into existing urinals it is recommended to use specially designed (i.e. angles supporting the flow to the drain) and coated (non-stick, e.g. wax coating) bowls to minimise the amount of residuals on the bowl surface (Backlund, 2002; von Münch and Winker, 2011).

As part of the maintenance and to keep the urinal fully functional in terms of odour control, cartridges or valves will need to be replaced in regular intervals according to the manufacturer's specifications. However, the frequency of replacement will vary depending on the system, the number of uses per day as well as user and cleaning staff behaviour (von Münch and Winker, 2011). The supplier of the curtain valve system in Ireland recommends that it should be changed approximately every 10,500 uses at a cost of €25 per replacement kit (Smart Energy Systems Ltd, Ireland). The provided maintenance key (Fig. 7a) enables a touch-free exchange of the valves. Sealant liquid cartridges can be cleaned and refilled but the disposal of small valves might be more convenient (von Münch and Winker, 2011).



**Figure 5: The most common odour control systems used in waterless urinals: (a) sealing liquid trap and (b) side view of the curtain valve (modified after Demiriz (2009))**



**Figure 6: Components of the curtain valve replacement kit for a waterless urinal; (a) maintenance key, (b) valve with self-sealing membranes (blue), (c) adapter (modified after von Münch and Winker (2011))**

Although dry urinals have been optimised to increase the lifetime of traps and to extend maintenance intervals, making them more cost-efficient, there is still a problem with urine sedimentation and incrustation in the drainlines (Demiriz, 2009). Research conducted by the National Plumbing Regulators Forum (NPRF) for Australia and New Zealand has shown the potential for drainline blockages from Struvite.

The findings highlighted the need for ongoing maintenance and cleaning of the urinal's discharge pipe at regular intervals to control the build-up (WPI, 2009).

While waterless urinals have the potential to achieve significant water and cost savings in public places and offices, the savings in a single household, compared to a dual flush toilet, are not high enough to pay back for the additional urinal bowl in a reasonable time.

### 3.1.6 Composting / dry toilet

The reasons for avoiding the use of flush toilets and using instead composting toilets are to reduce water consumption (thereby protecting water resources), to avoid pollution of water in the receiving environment with wastewater effluent and to recycle nutrient-rich organic matter that can be reintroduced into the soil.

The two main types of indoor dry toilet technologies are remote composting and self-contained composting systems.

Self-contained systems compost the faecal matter within the toilet unit itself whereas in a remote composting system faecal matter is removed from the toilet on a regular basis and brought to an outside composting location. However, whichever system is chosen, the compost use<sup>1</sup> and the composting method appropriate to the needs of the users must be considered by taking account of both hygiene and physical abilities (FH Wetland Systems, 2009).

In a composting toilet no water is used for flushing, which reduces the wastewater production by 28% to 108 Lcd. Moreover, the black water is completely removed from the wastewater. With urine and faeces accounting for 91% of nitrogen discharge and 83% of phosphate (Holtze and Backlund, 2003), a major source for pollution has also been eliminated and only the lightly polluted grey water needs to be treated and disposed of.

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<sup>1</sup> Land spreading of organic compost must be in compliance with the limits defined by the current Nitrates Directive at 170 kg N/ha.

#### Remote composting system: Separett waterless toilet "Villa" ([www.separett.com](http://www.separett.com))

The Separett Villa 9000/9010 is very popular in Denmark and Sweden, with approximately 45,000 toilets produced since 2003 (pers. comm. Arne Backlund). In this toilet system liquid and solid waste are routed separately. The urine is collected in the front of the bowl (Fig. 7a) and led via a waste pipe into the domestic wastewater system or a tank where it is collected and used as fertiliser. A small amount of water (100–200 mL) should be manually used to flush the urinal bowl and remove any residuals after urinating. The solid waste, faeces and toilet paper are collected in a container (23 L) (Fig. 7d) inside the toilet. The toilet is equipped with a view screen (blue) that covers the solid waste container (Fig. 7a) and opens through a pressure mechanism in the seat. At the same time, the container is rotated to ensure an even distribution of its content.

By keeping the urine separate and the faeces dry, unpleasant odours are kept to a minimum. A two-speed fan (Fig. 7b) keeps the bathroom free from any moisture and odours. It runs continually on low speed, but can be changed to high speed after heavy use or in order to expel excess amounts of condensation, such as after a shower, to ensure the faeces are kept dry. To change the container a lid is placed on top and everything is lifted out for composting (Fig. 7c). Compostable waste bags allow clean handling of the faeces and will degrade when buried into soil. For health and safety reasons, the content has to be left to compost for a minimum of 6 months before it can be used as soil improver in

the garden. The urine can be collected in the Separett Ejectortank (Fig. 8) from where it can be used as a fertiliser for the garden (hose and nozzle included). Details on international regulations for the use, handling and storage of collected urine can be found in section 3.1.3 and are available from the WHO (2006). A connection to the water supply allows the system to dilute the urine automatically (about 8 parts water to 1 part urine) in order for plants to absorb the nutrients without damage. The potential water cost savings for this system would be around €29 per person per year. The operating costs consist of the electricity for the fan and the costs for the compostable waste bags. The average power consumption for the two-speed fan is 0.336 kWh/d resulting in annual running costs of €21.

The system is popular in Scandinavian countries such as Denmark and Sweden, where it is used

in summer cottages. In Denmark the price for the Separett toilet is 5,295 DKK (€709.73, at an exchange rate of 0.134 on 2 January 2013) incl. 25% VAT. Due to the high shipping costs the system's price is significantly higher in Ireland, where it is currently available from Microstrain Ltd (Dublin) for €800 + VAT (pers. comm. Patrick Boylan).

Additionally, an outside composting facility is needed. Standard composters are available at a cost from around €40 to €120. To ensure that all faeces are well composted when removing the end product, the use of composters that allow removal from the bottom while still being loaded with fresh material at the top is not recommended. Instead, at least two large or many smaller outside composters should be used where one is loaded with fresh material while the others are left to mature.



**Figure 7: Features and use of the Separett waterless toilet; a) urine separating toilet bowl, b) fan, c) change of faeces container, d) faeces container with compostable bag ([www.separett.com](http://www.separett.com))**



**Figure 8: Separett Ejectortank for urine collection and garden application ([www.separett.com](http://www.separett.com))**

It is recommended that bulking materials such as wood chips, bark chips, sawdust, ash and pieces of paper (depending on availability) are regularly added to optimise the composting conditions. They absorb moisture, improve aeration of the pile and balance the C/N ratio (Berger, 2011).

In cold climate zones the isolation of the compost heap might be needed but with the moderate climate in Ireland this is not expected to be an issue (pers. comm. Arne Backlund; Berger, 2011).

In Scandinavian holiday homes the toilet is very easy and cheap to install compared to flush toilets (pers. comm. Arne Backlund), but this will be more difficult in Irish houses due to the different construction type. As there are no sockets in Irish bathrooms that the fan could be plugged into, an electrical connection would need to be made. Furthermore, the wall drilling for the installation of the fan vent and the urine pipe will be a much harder job in a house with brick walls.

This composting toilet may be a good solution for a summer cottage but the householder must accept the idea of emptying the faeces bucket. In terms of operation and maintenance the system is seen as suitable if the user is committed to operate the system carefully and to accept the responsibility involved. Regular maintenance is critical to ensure good and safe operation. This involves proper cleaning, controlling the composting process as well as safe handling and application of faecal compost and urine (Berger, 2011). However, it is not clear

how composting toilets are currently viewed under existing Irish legislation. Detailed *Guidelines for the Safe Use of Wastewater, Excreta and Greywater* are available from the WHO (2006).

#### Self-contained composting system: Sun-Mar composting toilet

The Sun-Mar composting toilets do not separate urine from faeces; they compost the solids and evaporate liquids.

The composting process takes place in the Bio-drum (Fig. 9; highlighted in brown). Manual rotation of the drum optimises mixing and aeration to allow moisture and oxygen to be evenly distributed. Vent stacks for natural drafting or electric fans are used to ensure fast and odour-free composting. In the evaporation chamber, thermostatically controlled heat and air movement create ideal conditions to remove liquids from the compost. This process requires a lot of energy, resulting in annual running costs of about €250.

Isolated from the exposure to new waste (Fig. 9; section highlighted in green), the composting and sanitation process can be completed before removing the finished product. Compost is usually removed a few times per year (every 3–6 months) when used on a day-to-day basis.

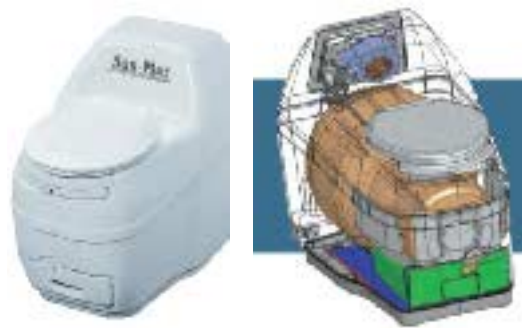
The capacity of the self-contained composting systems is limited to a certain number of people, with different model sizes available serving up to three to four adults (six to eight adults for vacation use). The Sun-Mar is certified in the US by the National Sanitation Foundation (NSF) to

NSF/ANSI Standard #41 (2005) for residential and cottage use. The Sun-Mar is available in Ireland from Microstrain Ltd (Dublin) for €1800 + VAT (pers. comm. Patrick Boylan). For the installation of the toilet no plumbing is required but an electrical power supply as well as ventilation is needed.

Advantages over the remote composting type is that emptying frequency intervals are longer, user involvement is minimised and the organic matter is already composted before the user gets in contact with it. Due to controlled composting conditions the hygienic quality is usually higher than in many other types of composting toilets. However, with continuous systems there is a risk of fresh material contaminating mature material, so it is recommended that the end product is always

handled with caution and a second composting treatment is still recommended before applying it to the soil (Berger, 2011). Having no source separation could also, under certain circumstances, cause a disproportion of faeces and urine towards the urine, which would increase the nitrogen content and affect the efficiency of the composting process if not counteracted with the addition of bulking material.

Further disadvantages are the higher unit price and the high electrical consumption to perform the liquid evaporation. As long as the technical equipment works reliably, these semi-automatic systems usually require less user intervention compared to the remote system, but in case of a breakdown special parts and servicing might be needed (Berger, 2011).



**Figure 9: Sun-Mar composting toilet and its inner structure (right) (source: Sun-Mar product brochure)**

### **3.1.7 Retrofit options**

Reducing flush volumes of older toilet systems using certain retrofitting devices is possible but should be considered with caution. Older toilets are not designed for low flush volumes so that these could result in unsatisfactory performance, especially when solids are flushed. Where a compromised performance and the need for double flushing are observed after reducing the original flush volume of a toilet, replacement with a dual flush toilet might be the more efficient and sustainable solution.

#### Water displacement products

For all toilet cisterns with a volume of more than 6L, water displacement products are available that save up to 3L per flush. The Hippo Water Saver for example is a product available in Ireland which is installed in the water of the cistern sitting right underneath the float. When the toilet is flushed, the water confined within the bag is the volume saved. For example, installing one of these devices in a 9L cistern will save 3L per flush, which results in potential water cost savings of €9.71 per person per year and will achieve a reduction in the average water consumption (150 Lcd) of 9.33%. The price of a Hippo Water Saver is about €4.25, so the payback period for a household of three would only be about 2 months. Flush volumes can also be reduced by water displacement without using commercial products (i.e. submersing a water-filled bottle in the cistern), but care should be taken that the flush volume is never reduced to less than 6L.

#### Interruptible flushing siphon – Interflush

The interflush system is a retro-fit kit that gives full control over the flush volume: the toilet flushes when the handle is held down and stops when the handle is released. It is applicable to most standard single flush toilets with front-mounted handles.

From observed water savings in hotels and schools where this system was installed, the supplier claims that up to 47% of flushing water can be saved. Retrofitting this device in a household would on average save 19.7 Lcd, reducing the daily per capita consumption by 13%. The price of this retrofit kit is about €24. With potential water cost savings of €13.69 per person per year, the payback period for a three-person household is about 7 months.

#### Dual flush conversion device

Other retrofit kits are available which transform a standard toilet into a dual flush model, although they need to be treated with caution (Gauley and Koeller, 2009). As for the pressure assist toilet flushing system (Section 3.1.2), the dual flush system uses a toilet bowl design different to the standard gravity fed system (siphon-jet) so that a conversion is not advisable without exchanging the toilet bowl. A converted gravity-fed toilet might not be able to perform a complete water exchange, which will result in unsatisfactory performance and will increase the need for double-flushing. For the same reasons the creation of hybrid toilets, where new dual flush cisterns are fitted to old existing toilet bowls, should be prevented (Schlunke *et al.*, 2008).

### 3.2 Other domestic water saving devices

#### 3.2.1 Low-flow shower heads

Low-flow shower heads usually have a vacuum booster valve that aerates water when it exits the shower head, creating a powerful shower stream at a flow rate of 4–6L/min. The flow rate is adjustable depending on the existing water pressure in the house.

For the following water and energy saving calculations an average flow rate of 8.5L/min is assumed for the existing standard shower heads. Together with further assumptions such as the average shower time (7 min) and the number of showers per week (five showers), this compares well with the average water consumption for baths and showers that was observed in the UK (Liu *et al.*, 2010).

Table 4 shows that the installation of a low-flow shower head can save 17.91 Lcd, reducing water consumption by about 12%. At the same time there is the potential to save energy, as less hot water needs to be supplied. In an average household with three occupants this saving can be up to €51 (gas) or €118 (electricity) per year, depending on the source of energy used to heat the water. Together with water cost savings the payback period for a low-flow shower head would be less than 16 months (Table 4).

Considering only water cost savings the shower head would pay back within 2 or 3 years, depending on the model.

Furthermore, shower timers can help to control the length of the shower. Cutting the shower time by 2 min down to 5 min could save another 7.7 Lcd, which increases the reduction of the total PCC to about 17%.

This would increase the average household's energy cost savings to €168 or €73 per year for electricity and gas, respectively.

However, concerns were raised where flow restrictors have been retrofitted to non-compensating shower valves. When a nearby cold water valve is opened this could lead to pressure disturbances in the shower valve creating a hot water crossover to the cold water pipe. In this case only hot water will exit the shower head, leading to an increased risk of scalding for the user (George, 2009; ASSE, 2012). Therefore retrofitting should only be allowed in connection with an automatic compensating type shower valve which balances any changes in incoming pressure and/or temperature. Furthermore, the shower valve should have a minimum flow rate (recommended by the manufacturer) equal to or lower than the maximum flow rate of the showerhead.

Therefore regulations need to be found to prevent the mismatching of retrofitting devices with existing fixtures. This could be realised through product labelling or licensing (i.e. products can only be sold as a complete system), or might involve inspection and installation via a properly trained and licensed plumbing contractor (ASSE, 2012).



**Table 4: Water and energy cost savings for a low-flow shower head compared to a standard one**

	Standard shower head	Low-flow shower head
Avg. flow rate	8.5 L/min	5 L/min
Avg. shower time	7.16 min	7.16 min
Avg. no. of showers per week	5	5
Water usage for showering averaged over a week	43.5 Lcd	25.59 Lcd
Water savings <sup>1</sup>	n/a	17.91 Lcd
Reduction in total PCC <sup>1</sup>	n/a	11.94%
Average no. of residents per household	3	3
Total household shower water usage	47,633 L/y <sup>6</sup>	28,019 L/y
Water cost savings per household <sup>2</sup>	n/a	37.27 €/y
Energy usage (electricity) <sup>3</sup>	1653.43 kWh/y	972.61 kWh/y
Energy usage (gas) <sup>3</sup>	8083.43 cf/y	4754.96 cf/y
Energy cost savings:		
using electricity	n/a	117.71 €/y
using gas	n/a	51.23 €/y
Payback period <sup>4</sup> for a low-flow shower head:		
standard plastic (€65) <sup>5</sup>	n/a	5/9 months
high quality solid bass (€115) <sup>5</sup>	n/a	9/16 months

<sup>1</sup> based on an avg. daily per capita consumption (PCC) of 150 Lcd

<sup>2</sup> assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for the non-domestic use in Dublin City in 2012

<sup>3</sup> assuming 73% of used shower water is hot and energy requirements of 0.0476 kWh or 0.2325 cf of gas to heat water from 13 to 49°C (US EPA Water Sense 2010)

<sup>4</sup> for households heating water with electricity/gas

<sup>5</sup> [www.smartenergysystems.ie](http://www.smartenergysystems.ie)

<sup>6</sup> y = year

### 3.2.2 Tap aerators

Aerators introduce air into the water stream to produce a large, soft and non-splashing stream (Fig. 10a). Flow rates will be around 6L/min with a selection of aerators available that should match the specific pressure and flow requirements of the house.

The spray aerator (Fig. 10b) is even more water efficient with 2.3 L/min and should preferably be used in the bathrooms wash hand basins as

such a low flow rate might not be practical in the kitchen (such as the length of time to fill a kettle etc.). There are certain aerators available that are designed for the use in a kitchen (Fig. 10c). They have a swing head and give the opportunity to choose between a spray (2.3 L/min) and wide full (6L/min) aerated water stream.

Assuming that 14% of the total water consumption is used from the bathroom tap, Table 5 shows that 6.18 and 15.32 Lcd can be saved by installing an aerator or a spray aerator onto the bathroom tap, respectively.

This would reduce the total water consumption by 4.12% and 10.21%, respectively and could save up to €40 or €100 per year on electricity costs for the warm water supply.

If the water is heated using gas, €17 or €43 can be saved on an annual basis by a tap aerator and spray aerator, respectively. The costs for tap and spray aerators (€5.50) would pay back within 2 months.

Even without the energy savings the payback period would be only 5 and 2 months for a tap and spray aerator, respectively.



Figure 10: Water streams resulting from the adaptors of standard tap aerators (a), spray aerator (b) kitchen aerator connector (c) ([www.smartenergysystems.ie](http://www.smartenergysystems.ie))

Table 5: Water and energy cost savings for tap aerators compared to a standard tap

	Standard tap	Aerator	Spray aerator
Avg. flow rate	8.5 L/min	6 L/min	2.3 L/min
Proportion used from bathroom tap <sup>1</sup>	14%	14%	14%
Water savings <sup>1</sup>	n/a	6.18 Lcd	15.32 Lcd
Reduction in total PCC <sup>1</sup>	n/a	4.12%	10.21%
Average no. of residents per household	3	3	3
Total household bathroom tap water usage	22,995 L/y	16,232 L/y <sup>4</sup>	6,222 L/y
Water cost savings per household <sup>2</sup>	n/a	12.85 €/y	31.87 €/y
Energy usage (electricity) <sup>3</sup>	798 kWh/y	563 kWh/y	216 kWh/y
Energy usage (gas) <sup>3</sup>	3,902 cf/y	2,755 cf/y	1,055 cf/y
Energy cost savings:			
using electricity	n/a	40.59 €/y	100.67 €/y
using gas		17.66 €/y	43.81 €/y
Payback period	n/a	1 or 2 month	within 1 month

<sup>1</sup> based on an avg. daily per capita consumption (PCC) of 150 Lcd

<sup>2</sup> assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for non-domestic use in Dublin City in 2012

<sup>3</sup> assuming 73% of used shower water is hot and energy requirements of 0.0476 kWh or 0.2325 cf of gas to heat water from 13 to 49°C (US EPA Water Sense, 2010)

<sup>4</sup> y = year

### **3.2.4 Water-efficient washing machine**

Old washing machines (pre-1980) used up to 150L per cycle but over the past 20 years the average water consumption has been reduced to about 50L. When comparing the water efficiency of different models, the water usage should be adjusted to the machine's capacity and will range from 20L/kg for low-efficiency down to 6L/kg for high-efficiency models, with a water consumption of less than 7.5L/kg generally being considered as water-efficient ([www.waterwise.org.uk](http://www.waterwise.org.uk)). Comparing the water consumption of 51 high-efficiency models with the average of 232 lower efficient models available on the market in 2007 revealed that the former are about 24% more water-efficient. In the UK survey (Liu *et al.*, 2010) it was found that 11% of the water consumption (16.5 Lcd) is used for washing clothes, so there is a potential to save about 3.96 Lcd by using a more efficient washing machine. This will only reduce the PCC by about 3% and so to replace an existing, working machine with a more efficient one from the perspective of water conservation would not make economic sense, but should be considered when a faulty machine needs replacement.

### **3.2.5 Water-efficient dishwasher**

There is a common misconception that a dishwasher uses more water than washing up by hand. In the 1970s a dishwasher used >50L per cycle, but modern models can use as little as 10L. With an efficient model and wise use (i.e. running only full loads, using Eco or Economy setting and not pre-rinsing dishes), dishwashers have been shown to save water ([www.waterwise.org.uk](http://www.waterwise.org.uk)). An efficient, standard-sized dishwasher should be able to use 8–10L per run. To compare the efficiencies of different models, the water usage (in L per cycle) should be related to the capacity (in place settings).

### **3.2.6 Water butt**

A water butt is a container that collects the rainwater runoff from the roof, which can be used for watering indoor and outdoor plants. Especially in houses with many indoor plants and for those growing their own vegetables this can be an efficient way to save potable water, although it should be noted that it will have no impact on reducing wastewater effluent production.

## 4. Discussion and Conclusions

In areas where wastewater is treated on-site but subsoil permeability is limited, a decreased wastewater production brought about by water-saving devices will reduce the hydraulic loading rate, thereby improving the performance of the soil attenuation system. However, the findings with respect to savings in domestic water demand are also of relevance to the strategic planning of future water resources, particularly for larger conurbations (as evidenced by the Dublin Water Supply Project).

In order to reduce a household's water consumption significantly, it is advised to replace existing single flush toilets with dual flush toilets according to Part G of the current Irish Building Regulations. Models with a 6/3L flush volume should not pose a threat to effective drainline transport unless the existing drainage network is poorly constructed or very old and in poor physical conditions. In new-build houses, where the drainage system can be constructed to meet the requirements for solid transport under low flush volumes, the installation of a 4.5/3L flush model will be possible. In special cases where the reduction of the wastewater is essential for the functioning of the wastewater disposal system or would improve the cost efficiency of on-site disposal solutions, urine diverting toilets should be considered as an option. Where 4.5/3L or urine diverting dual flush toilets are considered for retrofitting, the existing drainline layout and its conditions should be inspected.

Due to the high costs, their limited availability and their technical complexity, vacuum toilets are currently not seen as a viable option for Irish houses. However, air assisted flush toilets, which are expected to be available on the market soon, could be a reasonable low-tech alternative while achieving very similar water savings. Finally, composting toilets could be a possible option for dedicated homeowners, especially for holiday homes. However, the owner needs to be aware of all responsibilities and consequences (e.g. limited selling opportunities of the house where retrofitting of a standard toilet is not possible) that relate to the system.

Table 6 summarises the available water minimisation technologies and shows the expected daily wastewater production per person for certain combinations of installed water saving devices. Without changing existing standards of living and with only a small change to people's behaviour by using dual flush toilets, it is possible to reduce the water consumption from 150 Lcd to 101.4–86.6, Lcd which can be equated to water cost savings of 32%–42% (Table 7). At the same time an average three-person household can potentially save between €69 and €218 in energy costs, depending on whether water is heated using gas or electricity, respectively. Even by installing relatively simple retrofit devices (providing that toilet flush performance is not impaired) the per capita

consumption and therefore water costs can be reduced by 25–38%.

Table 8 summarises again the water as well as cost savings and payback periods for the main water saving devices.

However, when water saving devices are installed to reduce the wastewater production, it follows that the concentration of organics, nutrients and other pollutants thereby increase proportionally which can increase the risk of shock loading and may have an impact on the wastewater's treatability.

Where packaged biological treatment units are used for secondary wastewater treatment, care should be taken to ensure that they will be able to deal with the high influent concentrations. Ideal solutions would be to use treatment systems based on fixed film biological treatment (e.g. filter media technology) and/or incorporate the recirculation of effluent so that the incoming wastewater is diluted with treated effluent.

The occurrence of shock loads in systems can also be avoided by large primary settlement or buffering tanks which equalise the concentration throughout the day and ensure a uniform load.

**Table 6: Achievable water consumption [Lcd] for certain combinations of installed water saving devices (based on an average water consumption of 150 Lcd)**

<b>Toilet systems</b>	<b>Shower head, Tap aerator</b>	<b>Shower head, Tap aerator, Washing machine</b>	<b>Shower head, Spray aerator</b>	<b>Shower head, Spray aerator, Washing machine</b>
Single flush (6 L)	111.9	108.0	102.8	98.8
High efficiency (4–4.8 L)	106.3	102.4	97.2	93.2
Dual flush (3/6 L)	101.4	97.5	92.3	88.3
Dual flush (3/4.5 L)	99.7	95.7	90.5	86.6
Urine diverting (0.6/4 L)	90.7	86.7	81.5	77.6
Vacuum (0.6-1 L)	88.6	84.6	79.4	75.5
Vacuum urine diverting (0.2/1 L)	85.8	81.8	76.6	72.7
Composting toilet	83.9	80.0	74.8	70.8
<b><u>Retrofitting options</u></b>				
Water displacement (6L)	111.9	108.0	102.8	98.8
Interflush (variable flush)	106.2	102.2	97.0	93.1

**Table 7: Achievable water cost savings [%] due to the use and installation of certain combinations of water saving technologies (based on an average water consumption of 150 Lcd)**

<b>Toilet systems</b>	<b>Shower head, Tap aerator</b>	<b>Shower head, Tap aerator, Washing machine</b>	<b>Shower head, Spray aerator</b>	<b>Shower head, Spray aerator, Washing machine</b>
Single flush (6 L)	25.4	28.0	31.5	34.1
High efficiency (4-4.8 L)	29.1	31.8	35.2	37.9
Dual flush (3/6 L)	32.4	35.0	38.5	41.1
Dual flush (3/4.5 L)	33.6	36.2	39.7	42.3
Urine diverting (0.6/4 L)	39.5	42.2	45.6	48.3
Vacuum (0.6–1 L)	40.9	43.6	47.0	49.7
Vacuum urine diverting (0.2/1 L)	42.8	45.5	48.9	51.5
Composting toilet	44.1	46.7	50.2	52.8
<b><u>Retrofitting options</u></b>				
Water displacement (6L)	25.4	28.0	31.5	34.1
Interflush (variable flush)	29.2	31.9	35.3	38.0

**Table 8: Potential water and cost savings as well as costs and payback periods for certain combinations of installed water saving devices.**

<b>Water saving device</b>	<b>PCC saving</b>	<b>Annual household cost savings*</b>	<b>Cost of device</b>	<b>Payback period*</b>
Cistern water displacement	9.33%	€29.13	up to €4.25	2 months
Interruptible flushing device	13%	€41.07	€24	7 months
Dual flush toilet	16.3–17.5%	€51 - 54.60	€200–300	4-5 years
Propelair	23.3%	€72.71	n/a	n/a
Low flow shower head	12%	€88.50 - 155	€65–115	5–16 months
Tap aerator	4.12%	€30.51 - 53.44	€5.50	1–2 months
Tap spray aerator	10.21%	€75.68 - 132.54	€5.50	within 1 month

\* includes water cost and where applicable energy cost savings for gas or electricity in an average three-person household, assuming a volumetric water charge of 1.90 €/m<sup>3</sup> as for the non-domestic use in Dublin City in 2012

#### 4.1 Main conclusions and recommendations

- Several low flush toilet systems are available on the market that can be installed in Irish households to reduce the daily water consumption. However, when deciding on a product, the inhabitants' sociological behaviour as well as the engineered drainline configuration needs to be considered. The installation of 4.5/3L dual flush and urine diverting toilets will be possible after inspection of the existing drainline condition or in new buildings using new design standards to improve drainline carriage (pipe diameter, slope, other fixtures such as showers installed upstream of toilets).
- Together with the uptake of water-efficient toilets, users need to be educated about what can be flushed down the toilet. This will help to change users' behaviours that could cause sewer blockages and prevent a successful implementation of low flush devices.
- Water displacement products are not recommended when they reduce flush volume below 6L and are considered not suitable where solid discharge from the bowl is significantly impaired.
- Vacuum toilets are an expensive solution and will only be reasonable in the future if major difficulties (e.g. with ordinary pipes, with percolation, with complicated and expensive transport of collected material) need to be overcome.
- Waterless urinals are not feasible in single houses but could be installed in public places and offices under the conditions that the manufacturers' cleaning and maintenance requirements are followed to ensure trouble-free and hygienic operation. Retrofitting existing urinals should be considered with caution as the possible roughness of the bowls' surface could trap urine residuals, leading to odour and hygiene problems if not cleaned very frequently (i.e. several times per day).
- Composting toilets could be a possible option for holiday homes where homeowners are fully aware of the operational and maintenance requirements. These systems might become more accepted in the future due to an increasing awareness of the value of clean water and with the global depletion of nutrient resources.
- Tap aerators and low-flow shower heads that aerate the water are already fairly standard in other countries for many years and should be used in Irish households. However, it is not recommended to restrict the water flow rates of showerheads through a non-automatic compensating shower valve, as this can lead to significant pressure imbalances which can cause thermal shock and scalding issues.
- A quality control system similar to those in other countries (Water Sense, WELS) could be useful in Ireland to protect users from technologies that are not designed or functioning correctly. However, there is still a risk that users might mismatch new with existing old fixtures, such as with hybrid toilets and low-flow showerheads.

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# An Gníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomhnithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil, Pobal agus Rialtais Áitiúil.

## ÁR bhFREAGRACHTAÍ

### CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreal;
- scardadh dramhuisce;
- dumpáil mara.

### FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí chomhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

### MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOIL

- Monatóireacht ar chaighdeán aer agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéal agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

### RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Caimníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

### TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdeán aer agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

### MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

### PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

### BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

### STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Gníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstíúrthóir agus ceithre Stíúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar inní iad agus le comhairle a thabhairt don Bhord.

### **Science, Technology, Research and Innovation for the Environment (STRIVE) 2007-2013**

The Science, Technology, Research and Innovation for the Environment (STRIVE) programme covers the period 2007 to 2013.

The programme comprises three key measures: Sustainable Development, Cleaner Production and Environmental Technologies, and A Healthy Environment; together with two supporting measures: EPA Environmental Research Centre (ERC) and Capacity & Capability Building. The seven principal thematic areas for the programme are Climate Change; Waste, Resource Management and Chemicals; Water Quality and the Aquatic Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations. In addition, other emerging issues will be addressed as the need arises.

The funding for the programme (approximately €100 million) comes from the Environmental Research Sub-Programme of the National Development Plan (NDP), the Inter-Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); and EPA core funding and co-funding by economic sectors.

The EPA has a statutory role to co-ordinate environmental research in Ireland and is organising and administering the STRIVE programme on behalf of the Department of the Environment, Heritage and Local Government.



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