# Food Waste Disposers

## Purpose

This Policy Position Statement outlines the main issues relating to the use of food waste disposers (FWD) in the management of food waste from domestic kitchens. FWDs are installed beneath sinks to separate food waste at source and grind it in order that it can be treated via the wastewater collection and treatment system. FWDs are an alternative to disposing food waste with solid waste. The issues include the effect of food waste on the wastewater system, diversion of food waste from landfill to recycling (CEC, 2008a), avoidance of extra vehicle movements for separate collection, avoidance of vermin attraction, improving yield of dry recyclables and avoidance of storing putrescible food waste in or close to kitchens with its associated health and odour implications.

## CIWEM calls for:

1. Policies and strategies should be evidence based.
2. In addition to providing energy, anaerobic digestion (AD) conserves the nutrients from the feedstock into the digestate and using this digestate on land helps to maintain soil organic matter and complete nutrient cycles.
3. Ground food waste is valuable biogas substrate.
4. In-sink FWDs are an environmentally acceptable option for separating food waste at source and conveying it to treatment and use via existing infrastructure.
5. In-sewer processes can reduce or remove dissolved load before it reaches wastewater treatment works (WwTW).
6. The global warming potential of FWD to public sewer and AD is as good as kerbside to AD and better than centralised composting, incineration or landfill.
7. Exclusive emphasis on kerbside collection of source segregated biowaste has been mistaken.
8. A diversity of environmentally valid options for biowaste will ensure as many citizens as possible are willing to participate.
9. FWDs are an opportunity for cost saving to society as a whole.
10. Regarding the management of food waste, 'one size' will not fit all; home composting fits some, kerbside collection fits others and FWD fit others, especially (but not exclusively) people in flatted properties.

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## Context

The food waste disposer (FWD) was invented in 1927 by architect John W. Hammes of Racine, Wisconsin, USA to be a convenience for his wife. In 1938 his company started manufacturing and selling FWD. Some cities in USA mandated FWD for all new build residential properties. FWD fit the standard drain outlet hole of kitchen sinks. They comprise a 'grind chamber' which has perforated walls; the floor is a spinning disc with lugs that throw food scraps against the wall by centrifugal force. There are no knives in a FWD so it cannot cut plastic or fingers. FWDs operate with a stream of cold water that conveys the ground food waste through the drains. Particles cannot escape the grind chamber until they a small enough to pass the outlet screen.

Today approximately 50% of households in the USA have a FWD; in some cities more than 90% have them. Initially sewerage engineers in the USA were apprehensive that the output of FWDs might affect sewers and/or wastewater treatment adversely but a review of experiences in about 300 municipalities concluded their fears were unfounded (Atwater, 1947). New Zealand and Australia also have high rates of installation at more that 30% and more than 20% respectively. Installation in EU Member States (MS) is 5% or less. However the density of installation in commercial kitchens is very much greater. Generally domestic food waste in the EU is dealt with as part of the solid waste system; however in some MS interest in FWD is growing for reasons discussed below.

European policy (CEC, 2008a) advocates the "waste hierarchy" priority order of options: prevention; preparing for re-use; recycling; other recovery, e.g. energy recovery; and disposal. The EU Landfill Directive (CEC, 1999) requires MS to reduce the amount of biodegradable waste disposed to landfill in order to reduce methane emissions. Methane ($CH_4$) has 25-times the climate change effect of carbon dioxide ($CO_2$) over 100 years (IPCC, 2007). The EU also aspires to change from a disposal society to a recycling society.

Quested and Johnson (2009) estimated 5.8 million t/year of food waste is collected by local authorities in the UK, mainly in the residual waste stream (general bin). This equates to 230 kg/household.year. Europe has given emphasis to separate [kerbside] collection of biowaste for many years but even so a large proportion of biowaste is still in mixed waste (CEC, 2008b), this makes resource recovery more difficult. The European Commission's Green Paper (CEC, 2008b) on biowaste says that only 30% of biowaste is separately collected and treated biologically. Clearly, many citizens remain unwilling to participate in separate kerbside collection.

'Kerbside' collection of source segregated wastes requires the solid waste from domestic and commercial premises to be stored in separate containers, collected separately and taken to treatment facilities. Dry recyclables (paper, glass, plastic and metal) can be segregated mechanically after collection but their value is reduced if they are contaminated with wet food waste. The biodegradable fraction of solid waste is generally composted or anaerobically digested (AD). $CH_4$ from AD is used as renewable energy and the digestate as soil improver. Separate collection often necessitates extra truck traffic, especially during summer when it is not acceptable to store biodegradable waste for long periods prior to collection because of odour.

## Discussion

1. Experience from other MS with a longer history of kerbside collection of source segregated food waste than the UK's shows clearly that some citizens are unwilling to participate (e.g. Kegebein et al., 2001) and also that diligence about excluding physical contaminants declines (Riedel, 2008). Waste managers report non-participation is especially problematic in 'flatted' properties.
2. Home composting might be ideal but many households are unwilling or unable to do this. Smith and Jasim (2009) showed that fears about $CH_4$ emission for poor home composting are exaggerated. They found people who composted food waste compensated by putting their more difficult to compost garden waste in the kerbside bin, consequently there was little reduction in the mass of biodegradable waste collected, but the character changed.
3. FWDs use water to transport the ground food waste out of the grind chamber and through the drainage system. Some field studies to measure water use by households with and without FWD showed water use is related to food preparation events, not to the number of people in a household. Two studies from Sweden (Nilsson et al., 1990 and Karlberg & Norin, 1999) and one from Canada (Jones, 1990) were unable to detect any influence of FWD installation on the per-capita volume of water used. The Swedish studies found water use decreased during the period when FWD were used but they concluded it would not be appropriate to attribute this directly to the fact that FWD had been installed. The Canadian study concluded the influence on water use was not significant within the overall "noise" in measured water use. The largest field study into FWD was in New York City, it involved 514 apartments with FWD compared with 535 apartments without FWD. They were in 4 different localities to reflect some of the city's diversity. The survey comprised 2014 people in total; it concluded the average water use attributable to FWD was 6.9 l/hhd.day [1](New York City DEP, 1999). Evans et al. (2010) found the flow into a WwTW did not change significantly between the time when there were no FWD and when 50% of the 3700 households used FWD. On the basis of these and other studies, 6 l/hhd.day (one flush of a modern toilet) would be a conservative (upper) estimate of additional water use, this is of no consequence to sewer hydraulic capacity and negligible in terms of sewage pumping or water resources.
4. Domestic FWD have a 350 to 750 W motor. Based on field studies of usage, the annual electricity consumption is about 3 kWh/hhd.year.
5. Kegebein et al. (2001) estimated that where the ground food waste is treated by AD, the electricity generated from the biogas would be 73 $kWh_e$/hhd.year. Evans et al. (2010) found that when 50% 0f households used FWD, the biogas increased by 46% (P=0.01) and that this equated to 76 $kWh_e$/hhd.year. In 2005, 64% of the UK's sewage sludge was treated by AD, by 2015 this will have increased to 85%.
6. Thermal electricity generation uses about 80 litres water/$kWh_e$, the UK's average electricity generation emission factor is 0.541 $kgCO_2e/kWh_e$, thus the offset from the electricity from biogas is 6000 l water and 41 $kgCO_2e/kWh_e$ this is a net annual benefit of 3900 l water and 40 $kgCO_2e$ per household.
7. Kegebein et al. (2001) measured the particle size distribution of FWD output using two mixtures of foods and also waste from the university's cafeteria. They found 40-50% of the output was <0.5 mm, 98% was <2 mm and 100% was <5 mm by

[1] hhd = household

sieve analysis; between 15 and 36% of the output was in their 'dissolved' fraction. They observed sediment-free transport at 0.1 m/s, which is well within design standards for sewers (0.48 - 0.9 m/s - Ashley et al., 2004). Nilsson et al. (1990) simulated 15 years of FWD use using a mixture of foods that included 8.5% w/w lard and 1.7% w/w margarine, they found no blockage. They also compared apartment buildings with and without FWD and found no difference in their sewers by CCTV inspection [others have reported similar CCTV results].

8. Combined sewer overflows (CSO) are the 'safety valves' on sewers so that when stormwater exceeds the hydraulic capacity of sewerage, the excess wastewater can be released with minimum harm. CSOs are fitted with 6 mm screens; clearly the output of FWDs will not block 6 mm screens but when CSOs do discharge, FWDs will add to the load in the discharge, albeit mitigated by in-sewer processes (see 12 below) and into rivers in spate. The answer to preventing CSO discharges is minimising the input of surface water.

9. Fat, oil and grease (FOG) should never be poured down drains. Instructions on the installation and use of FWD contain information to this effect. FOG blockages in sewers are a significant issue but a conclusion from analysing FOG samples collected from around the USA was that FWD were not implicated (Ducost et al., 2008 and private communication Keener, K. Purdue University, 2010).

10. The unintended consequences of obliging people to store food waste might be nuisance [odour and vermin] and exposing them to health risks. The British Pest Control Association considered that since 98% of the ground food waste is <2 mm, it would not be detectable by rats (Adrian Meyer private communication 2005). In contrast spilled and poorly contained food on the surface does attract rats, gulls and other scavengers. Wouters et al. (2002) reported that keeping separated food waste in kitchens increases bioaerosols and allergens compared with mixed waste that contains food waste; they concluded this is a respiratory risk to susceptible individuals.

11. Life cycle assessments in Australia, Israel and USA have all concluded that FWDs discharging to public sewers are good solutions for food waste. Evans (2007) reviewed the 100-year Global Warming Potentials (GWP) of different options and found the GWP of delivering segregated food waste to anaerobic digestion (AD) via FWD and the sewers was equivalent to kerbside collection and transport to AD by road (≈ -170 $kgCO_2e/t$ food waste). Both routes to AD were better than composting, incinerating or landfilling (-14, +13 and +740 $kgCO_2e/t$ food waste respectively). The incineration and landfilling scenarios both included energy recovery. The composting scenario was based on a survey of in-vessel plants in Netherlands that pre-dated the Animal by-Products Regulation (CEC, 2002) – compliance with ABPR would have increased energy and carbon use. The FWD route saved the local authority (Herefordshire and Worcestershire) more than £19 /hhd.year (based on their 2005 audited data) but [at the time] the cost transfer to wastewater treatment was unknown.

12. The question of cost transfer was resolved by comparing the influent monitoring data for the WwTW that serves Surahammar in Sweden for the period when there were no FWDs with the period when 50% of households used FWDs (Evans, et al., 2010). 24 hour composite samples of influent had been collected 4 weekly (generally on Wednesdays); the average loadings of $BOD_7$, COD, N and $NH_4^+$ all decreased but the differences were not statistically significant. Average annual biogas increased by 46% (P=0.01). This is consistent with the earlier finding (when only 30% of households had FWD) that electricity use in activated sludge had not increased (Karlberg and Norin, 1999). There had been no cost transfer, indeed

were value is obtained from biogas, FWDs confer a financial benefit. Evans et al. (2010) hypothesised that biofilms on the sewer walls had acclimated to the changed wastewater composition and biodegraded the dissolved load, aided by the relative increase in carbonaceous matter from the food waste. Battistoni et al. (2007) from a field study in Italy also concluded that the additional carbonaceous matter aids nutrient removal. Generally, domestic sewage [without FWD] has an excess of nitrogen and phosphate compared with carbon and therefore carbon (e.g. methanol and/or acetic acid) has to be purchased for biological nutrient removal in wastewater treatment unless there is a non-domestic discharger of C, such as a brewery.

13. FWDs do add to biosolids production but the increase is small. Food waste is typically 70% moisture and 90% volatile solids. It is very biodegradable; the volatile solids reduction during AD is about 90%. Thus, 1 t food waste (fresh weight) contributes about 50 kgDS to digestate production, which is recycled as part of the biosolids recycling programme with all of its proven safeguards.

14. Some municipalities have banned FWDs but on examination bans have been based on apprehensions and fears about adverse consequences and have been rescinded when objective assessments have been made. New York City rescinded its 17 year ban following field study (New York City DEP, 1999). Since 2008 both Stockholm, Sweden and Milwaukee, USA have encouraged FWD installation and use because they want to increase biogas production at their WwTWs.

## Key Issues

1. Food waste is one of the largest fractions of household waste and it is the most difficult to manage because it has a high moisture content, sticks to dry recyclables (which reduces their potential for recycling), attracts pests and becomes malodorous.

2. Removing food waste at source unlocks the potential for recycling other fractions (Yang et al., 2010). Some citizens will practice home-composting, others will participate in kerbside collection but experience has shown that some (especially in flatted properties) will do neither of these. FWDs are a means of separating food waste at source and conveying it to treatment using existing infrastructure.

3. CIWEM considers that a diversity of environmentally acceptable options is needed for managing food waste so that there is maximum participation. A substantial body of published research demonstrates that FWDs are an environmentally acceptable option and that the reasonably expected fears of adverse consequences are unfounded. The GWP of FWDs delivering to AD [the dominant form of sludge treatment, by weight, in the UK] is as good as delivering food waste to AD by kerbside collection by trucks and better than centralised composting, incineration [EfW] or landfill.

4. CIWEM considers emphasising kerbside collection of source segregated food waste to the exclusion of other options has been a mistake because experience from around the world has shown that a sizeable proportion of the population do not participate.

5. CIWEM applauds the water utilities in the UK for increasing AD and biogas utilisation and for using such a large proportion of the biosolids on land (83% in

2008/09 for England and Wales) to conserve organic matter and complete nutrient cycles.

6. FWDs save at least £30 /hhd.year for food waste collection and treatment or disposal and appear to have little or no effect on the cost at WwTW, probably because of in-sewer acclimated biofilms. There is negligible impact on water resources. Where there is AD and biogas utilisation, FWDs contribute to wastewater treatment financially.
7. CIWEM considers that in this, as in all other aspects of water and environmental management, policy and strategy should be evidence-based.

## Conclusions

1. CIWEM considers the evidence demonstrates that FWDs are valid tools for separating kitchen food waste at source and diverting it to treatment, use and recycling via the existing infrastructure and that they offer the opportunity for cost savings compared with other routes.

2. CIWEM considers that FWDs offer the opportunity for wider participation in resource recovery from wastes by a greater proportion of the population than has been the case with exclusive advocacy of kerbside collection, which whilst acceptable to some, is not acceptable to all.

3. CIWEM considers food waste and other organic residuals should [wherever possible] be treated and then used on land to conserve soil organic matter and complete nutrient cycles. The use of biosolids and other organic resources on land should be viewed from the perspective of the soil rather than from the origins of the materials. It is important to move to a holistic view of all aspects of organic resource production, use, soil protection, countryside stewardship, water protection, air protection and crop and livestock production. CIWEM considers there is scope for simplified, proportionate, science-based regulation of all organic resources and for co-treatment.

February 2011

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*Note: CIWEM Policy Position Statements (PPS) represent the Institution's views on issues at a particular point in time. It is accepted that situations change as research provides new evidence. It should be understood, therefore, that CIWEM PPS's are under constant review, and that previously-held views may alter and lead to revised PPS's.*