Recent optimisation of schemes for source separation of biowaste taking into account local conditions

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Introduction

There is a diffused awareness among decision-makers that, albeit a different implementation of strategies might occur in different situations (e.g. urban vs. rural context, Northern vs. Southern Europe, etc.) biological treatment will play an important role (a growing one in least developed situations) in forthcoming European strategies for Waste Management. Here we briefly describe what are the most important driving forces in the EU regulatory framework (and its scientific rationale) for recycling and composting.

Since one of main concerns, whenever a sorting scheme for biowaste has to be implemented, is *the supposed increase in costs of collection*, we intend to submit information which goes against received wisdom, thereby highlighting what tools may be adopted to achieve an overall operational and economic optimisation of schemes.for source separation.

First of all, anyway, we intend to offer an overview of most important driving forces in the EU for composting and biowaste management, which allows us to understand what are framework conditions for the development of strategies aiming at source segregation of biowaste.

Driving forces in the EU for source separation of biowaste

The Directive 99/31/CE on Landfills

The Directive on Landfills basically provides for the landfilled biowaste to be sharply reduced within next years (up to 65% in a 15 years time frame). This is aimed at effectively reducing the production of biogas at landfilling sites (one of highest contribution to the global warming potential from waste management) and to improve overall conditions at which landfills are operated.

In some 'landfill dependent countries', the key question therefore becomes 'how will diversion of biodegradable municipal waste proceed in future'? Frequently, some balance between thermal treatment and recycling / composting is suggested. The balance should anyway be sought in the light of the following key messages:

1. The key elements of the biodegradable municipal waste stream are paper and board, and biowaste; *both these streams can be collected separately at an affordably low cost (as we will show through this paper) thanks to operational integration and optimisation of schemes*
2. the collection of biowaste could anyway be made mandatory under a Biowaste Directive (the 2nd Draft of which makes this clear);
3. in Mediterranean countries (and also in accessing Countries from Eastern Europe), there is a pressing need for organic matter to be applied to the soil, preferably without presenting any new problems in terms of heavy metal / other toxic element contamination, which entails the need to implement source separation;
4. incineration, which has long been regarded as "recovery", has recently been classified by Sentence C-458 of the European Court of Justice as "disposal" whenever it does not displace fuels (as it actually is at incineration sites)
5. the Incineration Directive and IPPC Directive are likely to increase the costs of non-landfill residual waste treatments (including co-incineration); which actually already occurs in those Countries where regulations have already enforced the tight environmental standards which have been set out by the Incineration Directive

All the above points towards greater emphasis on source separation and composting, albeit somewhat mixed up with strategies for recovery of energy from non-recyclable materials. Both, will contribute to the main goal to overcome substantially current large dependence on landfilling.

The proposed Directive on Biological Treatment of Biodegradable Waste

The European Commission (EC) during last 2 years took the initiative to propose a Directive on Biological Treatment of Biodegradable Waste, in order to:

- seek a balanced approach to the commitments on reduction of landfilled biowaste outlined in Dir. 99/31/EC
- promote programmes for recycling of biowaste, so as to ensure an even development of composting across Europe and overcome the paradox according to which "compost is less produced where it is needed most" (namely, South Europe)
- define common limit values and conditions for use and marketing of composted products across Europe
- develop further the production of high-quality composted soil improvers to be used in organic farming and as a tool to fight desertification processes in Southern European Countries
- cover also those processes, usually worded as Mechanical-Biological Treatment (former MSW composting) that are at present experiencing a wide development above all to treat residual waste, in order to define their role in integrated waste management strategies and conditions of use (e.g. in land reclamation) or landfilling of their end products

One of most important provisions included in the Draft is the provision for Member States to implement mandatory programmes for source separation of biowaste, which ought to cover, besides big producers (as markets, greengroceries, canteens, etc.) also households.

This is particularly consistent with the mandate for the Commission - set in the Communication on the Soil Strategy - to prepare *"by the end of 2004 a directive on compost and other biowaste (...) with the aim to control potential contamination and to encourage the use of certified compost*". Arguably, the most effective tool which may promote the use of certified compost while preventing contamination is source separation of compostable waste.

The role of Organic Matter in the soil as a "sink" for carbon

Throughout last years, another major driver in environmental policy has been the need to comply with Kyoto commitments on climate change.

Under such standpoint, biomass has long been regarded as a potential energy source to displace part of fossil fuels. More recently, on the contrary, a deeper assessment of such issues has led to a scientifically more balanced view, whereby also the role of organic matter inside the soil has been considered as an important factor in the overall picture.

What is increasingly being considered, is that *organic fertilisation promotes over time a build up of carbon inside the soil, and this could prove to be a powerful "sink" of carbon sequestered inside the soil*.

It has been calculated that 2 gigaton per year of carbon is captured in the earth's soil organic matter, a process best known as carbon sequestration. This amount can be compared with the 8 gigaton per year of antropogenic carbon emitted to the atmosphere. This suggests that soil organic matter can play a central role in mitigating climate change. To make an impressive example, it has also been highlighted the fact that an increase of 0.15% of organic carbon in Italian arable soils would lock the same amount of carbon in soil and soil biomass that is currently released into the atmosphere in one year in Italy through the use of fossil fuels[1].

Another important effect of organic fertilisation is the supply of nutrients, which implies the potential displacement of chemical fertilisers, whereby savings on energy and fuels needed for their production may be considered. Other potential advantages, such as improved workability and water retention, better control on root pathogens (thereby leading to less use and production of pesticides), lower erosion and loss of carbon, etc. are difficult to be quantified, but may also contribute to a very wide extent to reduction of energy inputs and carbon losses to and from agriculture, and are therefore being increasingly highlighted.

Such views are getting more and more adopted as a basic driver for policy making in the environmental field. The Communication on the Soil Strategy recently published by the European Commission highly stresses the importance of carbon sequestration in soils. On the other hand, lately the Bonn Conference on Climate Change has acknowledged the role of agricultural soils as "sinks"

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[1] P. Sequi at the Compost Symposium, Vienna, 29-30 October 1998

for carbon sequestration, and the European Climate Change Programme has investigated possible measures to credit the application of composted materials and other soil improvers.

It is important to mention that some Italian Regions have *already issued provisions for subsidies to farmers who use compost in depleted soils*, in order to fight against desertification and to promote sequestration of carbon to be locked up in soils. This may give rise to further similar provisions across Europe in years to come, thereby promoting the strategies for composting.

Innovative, cost-effective design of collection schemes

Received wisdom tells us that *"in strategies aiming at separation of biowaste, costs for collection are bound to increase"*. It turns out, instead, that many times a careful design of features of the scheme has led to an overall optimisation with *costs of collection that on the whole prove to be comparable to traditional collection of commingled waste.* As the combined cost of collection of biowaste and residual waste covers the main part of the overall cost of collection, its optimisation *may in turn allow also the implementation of sorting schemes for e.g. paper, at an overall cost which is comparable to the previous cost of collection of mixed MSW,* whilst of course the new scheme hits high recycling figures.

Cost figures and evaluations herewith reported refer to surveys we've led during last years on schemes implemented in Italy since 1993; pilot schemes recently rolled out in Spain (Catalunya) give further evidence; most of the hints thereby derived may hold valid also for schemes to be implemented in other Areas across Europe. References to the features of collection schemes elsewhere in Europe and across the world are also given, together with an assessment of potential advantages or downsides.

The survey clearly shows that *much can be done to try and optimise performances of sorting schemes*.

The potential overload of garden waste and the need to set a difference between food and garden waste

Organic waste accounts for a major percentage of MSW. It is generally thought that more wealthy economies tend to show a decreasing percentage of organic waste, due to the habit of using precooked and frozen food and to the increase in packaging. Trends get anyway affected also by the quantity of yard waste included in MSW; and this in turn refers to the way yard trimmings get managed.

With reference to the numbers reported in table 1, it is probable that, while they get affected above all – if not exclusively – by food scraps in Southern European Countries, figures from Central Europe are likely to include fairly important quantities of yard trimmings, that have already long been collected as "Municipal Waste"; see for instance numbers referring to Belgium, Luxembourg, Netherlands.

Table 1: **Percentages of biowaste reported in EU Countries**

Country	Organic waste in MSW
Austria	29 % (1991)
Belgium	48 % Flanders (1996), 45 % Wallonia (1991)
Denmark	37 % (1994)
France	29 % (1993)
Finland	35 % (1998)
Germany	32 % (1992)
Greece	49 % (1987 – 1993)
Ireland	29 % (1995)
Italy	32 – 35 % (1999)
Luxembourg	44 % (1994)
Netherlands	46 % (1995)
Portugal	35 % (1996)
Spain	44 % (1996)
Sweden	40 % (1996)
UK	22[2] % (1997)
EU average	**32 %**

Source: [1]

The delivery of garden waste is much stimulated when households are provided with large-volume bins that allow – also in houses with gardens – the delivery of bulky materials as yard waste. Very often in the "biobin" (bin supplied to households to separate Biowaste) a large proportion of garden waste can be found (up to 80-90%) in addition to food waste.

The priority, instead, ought to be to sort foodstuffs out of the waste. We have to remark that recycling of dry packaging materials determines – as an undesired side-effect – the concentration of the fermentable material inside residual waste, if food stuff is not effectively sorted out through high-capture systems for its collection. This is what actually occurs in those Districts and Countries where separation of dry recyclables is more effective than that of food waste. In Central Europe, the percentage of food waste inside residual waste is often reported at 30-50% [2], [3]; this is particularly true of the Netherlands (where a "VGF" collection, which targets only vegetable, garden and fruit, leaving meat and fish into the residual waste). Once transferred to warmer climates – as in Southern Countries – this system would keep a need for a very frequent collection of residual waste.

Considering such undesirable effects, in many Southern European Districts a different scheme for the collection of compostables has been implemented, where the collection of food waste and that of yard waste *are kept separated*. One scheme has to tackle only "food waste" as a whole (including cooked stuffs as meat and fish), by means of *small volume* bins and buckets; whereas a different scheme tackles yard waste only.

[2] The figure referring to the United Kingdom – astonishingly low - has been questioned by many experts as not trustable, and we tend to agree. Possible reasons for such a low figure may be the fact that it probably does not include the figure referring to the undersieve fraction, which actually mostly consists of food waste.

This distinction between the two collection schemes takes into account:

- **the problematic nature of food scraps** (high putrescence and moisture). This requires the adoption of *specific tools, systems and collection frequencies* in order to have the system clean and '*user-friend*'. This leads to better quality and higher quantity collected; it cuts the percentage of food stuffs inside the residual waste, making it possible to collect it less frequently. Sorting analyses on residual waste - where a door-to-door (DtD) collection is adopted – often report the content of food stuffs inside residual waste at 10% and less [4], which is much lower than in previous source separation programs across Europe.
- **the different biochemical and seasonal feature of the food scraps as compared to the yard waste**. "Intensive" features of the collection of food waste (high frequencies, watertight biobags) do not apply to yard waste, which doesn't need such intensive collection patterns.
- **the different bulk density of yard and food waste**. Low density of yard waste requires the use of compacting vehicles (packer trucks), while in the case of food waste compacting vehicles can be replaced by bulk lorries *that are much cheaper at an equivalent working capacity.*

A comfortable system that does not set any difference between food and yard waste is a system where a huge delivery of garden waste is to be expected. It is noteworthy that where a door-to-door collection for compostables in biobins is on place it has often been reported an overall capture of biowaste around 200 kg $inh^{-1}year^{-1}$ and more. This is due, above all, to the easy delivery of yard waste into the same large bin adopted for food waste, whilst it is important to note that «*where there are yard trimmings, there is a garden in which home composting could be performed*». High deliveries of yard waste imply high recycling rates, but also much higher MSW arising. In such situations, often an overall MSW production beyond 600 kg $inh^{-1}year^{-1}$ gets reported. Similar outcomes, have also been already reported in those situations in Italy where such collection schemes have been put in place [5], [6].

The collection of yard waste should therefore be run through delivery to Civic Amenity Sites ("*Piattaforme Ecologiche"* in Italy, *Recyglinghöfe* in German-speaking Countries); door-to-door collection can also be run, with a specific round ('green circuit') but a much lower frequency of collection than that of kitchen waste (i.e. fortnightly to monthly, even less in Central Europe, and only in the growing season, in general April through October).

Systems and tools for the collection of food waste

Running source separation for food waste, both at households and big producers, implies the need to find out tools to face problems linked to the specific features of such material: *its fermentable nature and its high moisture content.* In this respect, a comfortable type of service, whereby households are provided with tools to avoid nuisance, will result in an enhanced participation.

Most innovative schemes have tackled such needs through:

- a relatively "intensive" collection schedule
- the use, in most cases, of collection systems "at the doorstep" so as to have them more "user-friend" and enhance the participation rate
- the use of watertight, transparent tools to hold the waste ("Biobags", be it paper or – more frequently – biodegradable plastic); such tools have also been adopted in many Districts across Europe (e.g. in Norway).

The use of the bags makes it possible to cut sharply the frequency of washing. Bags avoid nuisance generally related to delivery of "loose" material inside the bin and make it possible to collect even meat and fish scraps, thereby increasing overall captures of food scraps (which, in turn, allows a significant reduction in collection frequency for residual waste)

The 'bio-bag' is then kept inside "buckets" (10 to 30 litres) to be placed on the roadside on the collection day. This system is often under adoption in areas with detached houses so as to *reduce the pick-up time for each dwelling* (as hand-picking takes much less time) and *prevent households from delivering garden waste inside the bins*. This in turn affects positively the cost optimisation of the schemes. Only at high-rise buildings bigger bins are adopted, whose capacity usually ranges from 80 to 240 litres to serve 10 to 20 families (depending on the collection frequency) with one single pick-up.

Cost assessment: a matter of methodology

Cost analyses carried out so far across Europe have traditionally focused on costs *per kilogram (*or *per ton) for a single waste stream collected*.

However, there is evidence that this distorts the true picture, because *the more the waste collected, the lower the costs of the collection service per kilogram*. This distortion obscures some important outcomes of integrated source separation and waste management:

- the reduction of total waste delivered as a consequence of effective waste reduction policies
- the much lower delivery of industrial waste into MSW where large-volume road containers get substituted by curbside low-volume bins and bags
- the contribution of home composting programs to the overall reduction of organic waste collected, etc.

Furthermore, the evaluation of the cost for a single waste flow, *does not allow a fair evaluation of advantages on collection costs for other materials*, flowing from "operational integration". As a matter of fact, the collection of food waste – above all when it shows high captures - allows important changes in the collection scheme, by reduction, for instance, of frequencies for collection of residual waste.

The **cost per person** allows a fair comparison of the competitiveness of different systems (in terms of cost, quantity and quality of materials recycled).

Collection costs: a brief overview

ECN/ORBIT e.V. Source Separation Workshop 2003
Pres. No. 12 "Recent optimization of schemes for source separation of biowaste taking into account local conditions" – Mr. E. Favoino

In order to allow a comparison among different collection systems, we carried out a survey on the costs of the different collection systems run in Italy, grouped by their main features and above all according to the way food waste gets separated (or not). The three systems may be grouped as follows:

- **traditional source separation,** based on the use of plastic bags or road containers (up to 3.3 m^3) for mixed MSW and *source separation through road containers only for dry recyclables (paper, glass, plastics). Food waste is not sorted* and it's delivered into the mixed waste; this keeps a fairly high putrescence (actually, food waste gets concentrated in it due to the sorting of paper, cardboard, glass, plastics, etc.) and has to be collected frequently.
- **source separation, including that of food waste,** based on *road containers* (120-240 litres, up to 3.3 m^3) *both for food waste and dry recyclables*; collection of the residual waste gets rolled out through road containers. This is usually referred to as the 'double container' collection. It's pretty diffused in Central Italy and has been the most diffused, so far, also in Spain (e.g. Cordoba, Catalunya).
- **intensive source separation, including that of food waste,** with *collection at the doorstep – otherwise worded as kerbside/curbside colelction or "door-to-door" (DtD) – of food waste and residual waste.* In general, also some high-yield dry recyclables are collected with a DtD system (usually paper and cardboard, due to the much higher capture per person than with road containers). It's the most diffused system in those Italian Municipalities and Provinces where highest recycling rates have been met (up to 80% in single Municipalities, above 50% in Districts). *The system is well diffused in Central Europe, as well, though the "Italian version" adopts buckets in place of bins in case of detached houses with gardens* (to keep control on the delivery of yard waste, according to the foregoing evaluations). Also Catalunya lately reported [7] some successful attempts where this scheme has been implemented.

We report herewith briefly on some outstanding outcomes of our surveys, whilst a full overview of systems might be found elsewhere [8, 9]. Figure 1 reports on the outcomes of a survey in the Province Verona. Each line represents the specific cost per inhabitant in a certain Municipality (they have been grouped into 3 series corresponding to the 3 types of schemes), lines on top of each series represents the average costs in each group. The figure shows that – on the average - *no statistical relationship can be found between the features of the schemes, under the 3 basic conditions as described above, and their specific cost per inhabitant*. What actually turns out is that average costs are very similar to each other.

Data from district "Venezia 4", near Venice (Figure 2), also show that source segregation of food waste with doorstep collection *can be run with no substantial increase in overall cost, and sometimes costs are even lower than with traditional collection (no segregation of food waste) or with segregation of food waste by means of road containers*.

Figure 1: **cost comparison for different collection schemes near Verona. Costs in ITL.inhab^{-1}.year^{-1} ; 1Euro = roughly 1936 ITL**

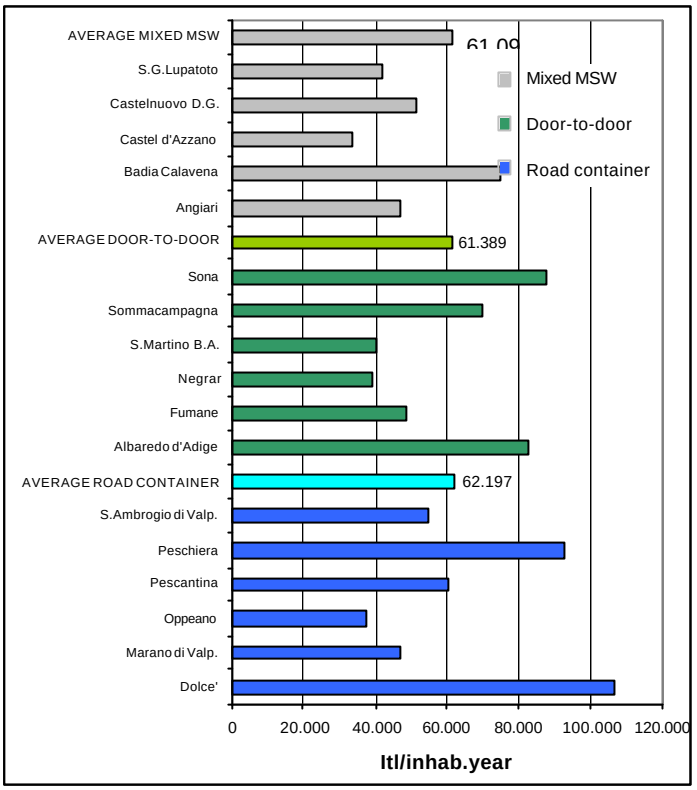
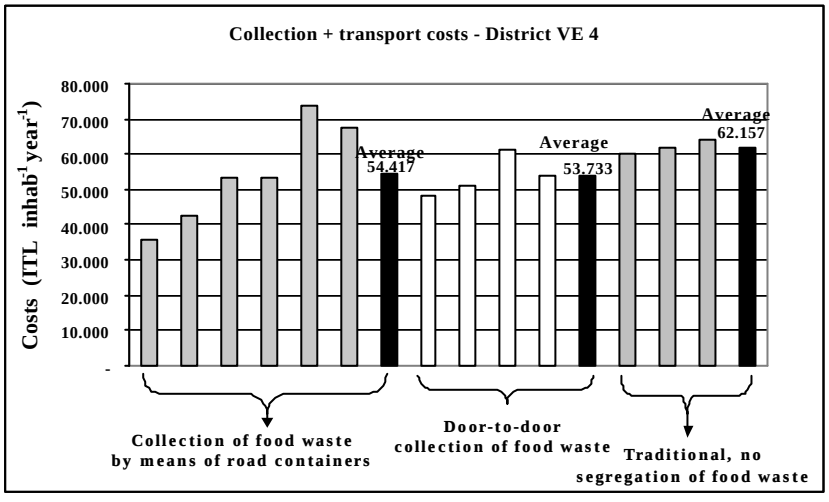


Figure 2: **cost comparison for different collection schemes near Venice. Costs in ITL.inhab^{-1}.year^{-1} ; 1Euro = roughly 1936 ITL**



Tools to optimise the schemes and their suitability in different situations

To understand the unexpected outcomes of our surveys, we've got to remark that *intensive doorstep schemes for food waste – when made "comfortable" for households - yield high captures*. This cuts in turn the percentage of food waste in the residual waste (also referred to as "restwaste"), which can then be collected less frequently.

Collection frequency for residual waste

Obviously collection frequencies for residual waste can be cut only when an effective separation of foodstuffs, yielding high captures, is run. Under such a viewpoint we have to mention (see Table 2) that DtD schemes enable much higher performances. Some 170- 250 grams per person per day have been reported for food waste; outcomes tend to be higher in Southern Regions (up to 300 grams and more), thanks to a higher presence of food scraps in municipal waste (also outcomes from Spain are confirming such high captures). Large road containers yield much lower quantities - actually their capture is sometimes similar, *but a high percentage of yard waste contributes, and real capture of food waste is low*.

Table 2: **performances of different collection schemes for biowaste in Italy**

System	Overall capture (typical)	Yard waste %	Actual capture of food waste
Door–to-door	170-250 g.inhab^{-1}day^{-1}	0% (where delivery is banned) to 10 % (maximum, due to low available volumes)	160-250 g.inhab^{-1}day^{-1}
Road containers	150-200 g.inhab^{-1}day^{-1}	40-70% (seasonal)	60-120 g.inhab^{-1}day^{-1}

Sources: [5], [6], [9]

We could thus assume that "collection using road containers results in a lower participation rate".

Cutting down collection frequencies for residual waste constitutes in itself *one of the most important tools to optimise schemes for source segregation of food waste.* Its adoption is particularly effective in those areas where high collection frequencies are in place for traditional, mixed MSW collection (above all Southern Europe).

	Frequencies for the collection of :			
AREA	**Mixed MSW (with no segregation of food waste)**	**Food waste** ***(both with DtD schemes and road containers)***	**Residual waste in DtD schemes** ***(frequencies cut down, thanks to high capture of food waste)***	**Residual waste in road container schemes** ***(no difference from previous mixed collection)***
Northern Italy	3 times weekly	2 times weekly (sometimes once weekly during wintertime)	1-2 times weekly	3 times weekly
Southern Italy	6 times weekly	3-4 times weekly	2-3 times weekly	6 times weekly

Table 3

The scheme in Table 3 shows typical collection frequencies for mixed MSW collection and for "integrated" collection systems that sort food waste. Frequencies applied in Southern Italy could perfectly work in many Mediterranean situations, as well, where mixed collection is traditionally run 6 times weekly, whereas Northern Italian frequencies may apply e.g. to Southern France.

Reduced pick-up time and optimisation of fleets of collection vehicles

We have to remark once more that *food waste on its own needs neither mechanical loading nor compaction* – which allows operators to adopt cheaper pick-up schemes and collection vehicles; this is only made possible in those schemes where the delivery of yard waste into bins for food waste is prevented by means of small-volume buckets (at detached houses with gardens) that only allow households to deliver their food waste. Food waste, which shows a much higher bulk density (0.6-0.7 kg.litre^{-1}) can thus be collected using bulk lorries instead of packer trucks.

It is therefore advisable to limit the size of receptacles supplied to households where gardens are available, supplying buckets (6-10 litres, up to 30 litres); bins (80-240 litres) have to be supplied only to high-rise buildings, where they may serve up to 15-20 families, thereby cutting the specific pick-up time.

The use of buckets, besides avoiding excess deliveries of yard waste and allowing the use of lorries, makes it possible to cut the pick-up time for each household at detached houses, and this entails large savings on the overall time taken for the service and on its cost. *This very important opportunity is unfortunately neglected in schemes based on joint collection of food and yard waste (be it by means of collection at the doorstep as in the vast majority of Central European schemes, be it by means of road containers, e.g. in Central Italy and many Spanish districts).*

Another important lesson to be learned is that *"the more flexible and varied the fleet of collection vehicles, the better it is"*.

In those schemes preventing the delivery of yard waste in bins or buckets adopted for food waste, households can manage yard waste through:

- home composting, promoted effectively by the municipality
- delivery to local recycling centres (*Civic Amenity Sites*, referred to as *Recyclinghöfe* in German speaking Countries and "*Piattaforme Ecologiche*" or "*Ecocentri*" in Italy)
- specific collection of yard waste at the curb with low frequencies (e.g. 1-2 times per month in Southern Europe, which might be even less in Central Europe, and only in the growing season, in general April through October).

An evaluation of mature and optimised schemes

We have to underline once more that with a cost assessment in *cost per unit weight*, the comparison would not be fair. One important reason for this, is that the quantity of food waste collected is obviously lower than that of residual waste (60-80 kg per person per year, versus 100-200 kg per person per year); but *this latter (residual waste, also referred to as "restwaste") gets collected at a much lower cost than with traditional mixed collection*, thanks to lower collection frequencies. Thus the overall cost of an integrated sorting scheme can be similar or lower.

An effective segregation of food waste allows an overall number of collection rounds (summing up those for different waste fractions) that tends to equal the previous schedule (for mixed collection). For example, one can collect food waste twice weekly and residual waste once per week in those places where mixed MSW collection used to be run three times per week.

Furthermore, we could say that some collection rounds – namely those for food waste – may have costs reduced through shorter pick-up times and the use of low-tech vehicles. In our surveys, we calculated and found out that *a two-shift scheme for food waste collection using bulk lorries tends to equal the cost of a single-shift collection for residual waste with packer trucks.* This is partly due to the higher cost of a packer truck itself, partly to the much higher time spent on each pick-up point as bins have to be hung up to the loading device, then unloaded and put back on their place: too time-consuming – for a single household – as compared to the simple, quick action of picking and emptying a bucket manually. Assessment of course leads to a different outcome if we consider high-rise buildings, where a single bin can serve 10-20 families, thus making much more time-effective the single pick-up.

Table 4: **costs of collection routes (ITL.inhab^{-1}.year^{-1}) for food waste and residual waste in Door-to-door schemes (1 Euro = roughly 1936 ITL)**

Municipality (Province)	**Population**	**Cost for collection of Residual waste** ***(once weekly, with packer trucks)***	**Cost for collection of food waste** ***(twice weekly, with bulk lorries)***
Calcio (Bergamo)	4.765	9.956	8.143
Caravaggio (Bergamo)	14.181	10.578	11.635
Sommacampagna, Sona (Verona)	26.036	14.100	17.195

Cost assessment is for instance confirmed, as we consider numbers reported for some municipalities in Bergamo and Verona Provinces (table 4). The cost of twice weekly collection for food waste (using bulk lorries) is comparable to a weekly collection of residual waste with packer trucks.

Conclusions

According to the numbers shown, it is clear that the main mistake made when planning sorting schemes, is the ***added*** feature of the scheme. This means that a new collection scheme is often run *in addition to* the previous mixed MSW collection, and we cannot therefore have savings on this latter which could fund the new scheme to be implemented. It is vital – on the contrary - that the new separate collection is ***integrated*** into the established waste management system, e.g. changing frequencies and volumes to collect residual waste, and this can only be done where the collection of food waste yields high captures through a *comfortable* scheme. Furthermore, "integration" has to take into account the features of the area where the scheme has to be put in place; above all considering the need to find specifically suited systems for food and yard waste, where a big amount of yard waste is to be expected (areas with a high percentage of gardens).

We have to remember that collection frequencies of residual waste can be cut only where a high capture of food waste reduces the fermentability of residual waste. From such a standpoint, the use of comfortable tools such as door-to-door schemes and watertight bags have proven to be very effective. This is why an "intensive" collection, run through door-to-door schemes, notwithstanding a much higher number of pick-up points, has unexpectedly shown to be less expensive than collection of food waste through road containers, thanks to the integration of the system and a much lower collection costs for residual waste.

Door-to-door collection of food waste allows Municipalities to perform much higher recycling rates (reaching 60% and more in Municipalities around 10.000 inhabitants, 50% in Monza, 120.000 inhabitants) and a much better quality of collected food waste.

A further tool to optimise the scheme is the use of suitable vehicles to collect food waste, due to its high bulk density when the collection scheme prevents yard waste from being delivered in the same containers. One of main lessons to be learned from these outcomes is that *"the more flexible and varied the fleet of collection trucks, the better it is"*. This goes against some tendencies that we have unfortunately recorded across Europe (and also in some Italian Regions), where huge expenditures have lately been done to buy *only* packer trucks for side-loading road containers. *This is fighting against optimised schemes for high-yielding collection of food waste;* the lack of flexibility doesn't allow optimisation at all.

Under such a standpoint, we obviously have to consider the difficult situation in smaller municipalities with direct responsibility for MSW collection, as they often own a single collection truck, and this constitutes a problem when planning changes and "integration" of the system. In such situations, Institutions at higher levels (e.g. the Districts or Provinces), can help. They could, for instance, buy appropriate vehicles and hire them in turn to various municipalities. Such a system is for instance already being run in two provinces in Southern Italy (Chieti and Pescara).

References

[1] Barth, J. 'European Compost Production - Sources, Quantities, Qualities and Use in Selected Countries', *Steps towards an European Directive.* Proc.Conference. Wien. 1999.

[2] Wiemer, K, Kern, M. 'Mechanical-biological treatment of residual waste based on the dry stabilate method', in *Abfall-Wirtschaft: Neues aus Forschung und Praxis,* Witzenhausen, Germany, 1995.

[3] Baden Baden Amt für Umweltschutz.'Versuchsergebnisse Restmüllaufbereitung', *Personal communication.* 1996.

[4] Provincia di Treviso. 'Premiazioni dei Comuni 2002', award to Municipalities with highest captures of food waste; Treviso, Italy. 2003.

[5] Legambiente. 'Comuni Ricicloni 1997. Standings of the National Award to highest municipal recycling rates'. Rome, Italy. 1998.

[6] Legambiente. 'Comuni Ricicloni 1998. Standings of the National Award to highest municipal recycling rates'. Rome, Italy. 1999.

[7] Giro, F.'The state of the art and forecast developments of composting in Catalunya in the framework of the Spanish situation', in *Proc. RICICLA 2000. 2nd National Conference on Composting.* Rimini, Italy. 2000.

[8] Favoino, E. 'Optimisation and cost-assessment of high-capture sorting schemes for compostable waste', in *Proc. EC Conference "Biological Treatment of Biodegradable Waste: Technical Aspects".* Brussels. April 2002.

[9] Favoino, E. "The development of composting in Italy: programs for source separation, features and trends of quality composting and biological treatment of restwaste" in *Proc. National Conference "Jornadas Sobre Compostaje"* , La Rioja, Spain. October 2000.