Solid Waste: Assessment, Monitoring and Remediation
Twardowska, Allen, Kettrup and Lacy (Editors)

VI.2

Success stories of composting in the European Union. Leading experiences and developing situations: ways to success

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VI.2.1. The development of composting strategies and schemes for source separation of biowaste in European countries: a matter of quality

Since the late eighties, composting has been experiencing a huge growth across Europe. Even before that time, actually composting had been adopted as a disposal route for Municipal Solid Waste, (MSW) through the attempt to sort the putrescible fraction mechanically; such strategy proved to be unsuccessful mainly due to the following reasons:

- the increasing presence of contaminants inside municipal waste;
- the lack of suitable refining technologies that could effectively clean up the end product in order to let it be accepted by end users;
- the consequent lack of confidence among farmers and other potential users;
- the increasing awareness, among scientific bodies and institutions, of the importance to keep soils unpolluted – with specific reference to potentially toxic elements such as heavy metals.

As a consequence, the recent and effective growth of composting programs started in parallel to the growth of schemes for source segregation of biowaste that were increasingly adopted as the proper answer to the need to have quality products suitable for a profitable use in farmlands and other cropping conditions (forestry, nursery, gardening, pot cultivation, etc.) (Amlinger, 2000; Barth, 2000; EC DG ENV, 2000).

Figure VI.2.1 mirrors the influence of source segregation on the quality of composted products (taken from a data base including some 400 samples). At a glance, what stems out is the sharp decrease of heavy metals in those composting schemes where source segregation is in place, as compared to compost produced through mechanical sorting of mixed waste. Also sludge often negatively affects the concentration of certain heavy metals, namely copper and zinc, though provisions for "Pollution Prevention Programs" included in the proposed revision of the EC Sludge Directive (EC DG ENV.E3/LM, 2000) could have a positive impact in the future on that side. Still, whenever we come to sludge-derived products, we will have to tackle the problem of organic pollutants also. Amazingly, in most composted products stemming from manure and slurries we can detect relatively high concentrations of zinc and copper, as they get often included in the diet

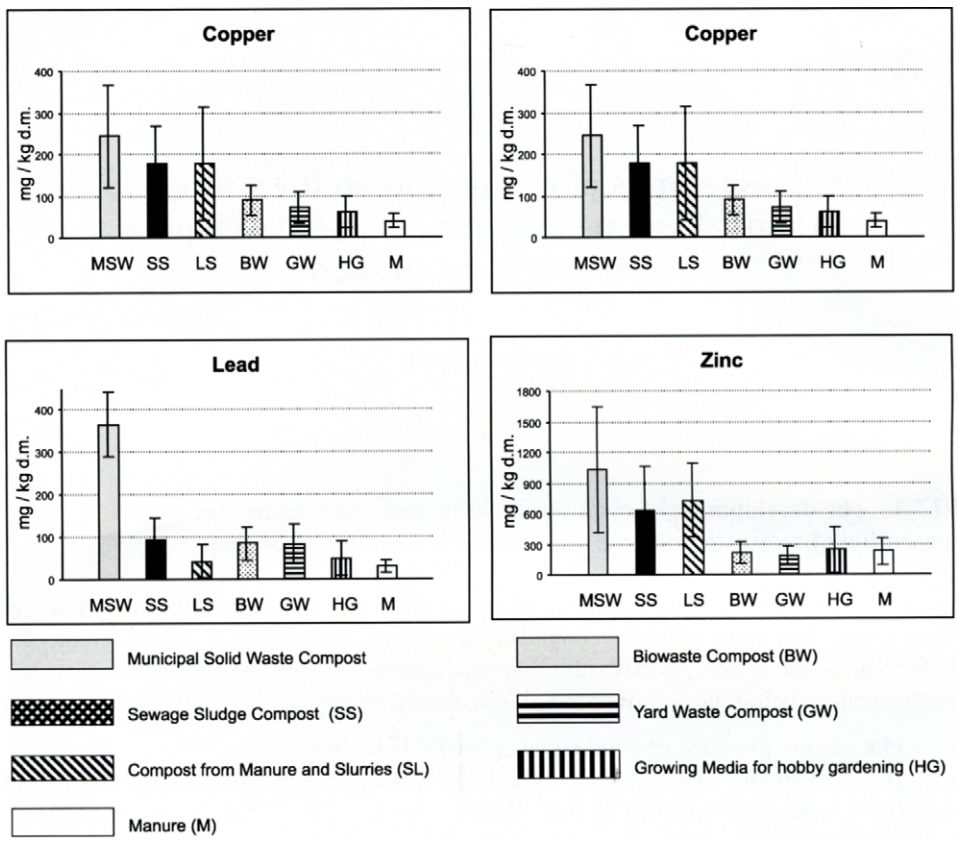

Figure VI.2.1. Concentration of some heavy metals in composts stemming from different waste materials, also in comparison with other soil improvers.

of animals. What matters here is that *the concentration of heavy metals in compost stemming from source-segregated biowaste and yard waste does not significantly differ from that of traditional soil improvers and of manure itself* – above all if we consider that this latter has not undergone yet the mineralization of organic matter, which would make the concentration seem higher.

With reference to activities in the field of source separation and composting of biowaste, European countries can be grouped into 4 categories (Fig. VI.2.2). In *Austria*, Belgium (*Flanders* in particular), *Germany*, *Switzerland*, *Luxembourg* and the *Netherlands* strategies and policies are already fully implemented nationwide. The contribution of these countries – and Germany in particular – to the overall recovery of biowaste in the EU is fundamental and was around 80% in 1999. Anaerobic digestion plays a minor role for the time being, partly due to the higher specific investment cost and to the need for integrated waste and wastewater management schemes that actually still happens fairly seldom.

In the second category we find *Denmark*, *Sweden*, *Italy*, Spain (*Catalonia*) and *Norway*. In these countries the policies are fully outlined but schemes of the needed composting capacity and of the marketing framework are still under an ongoing development.

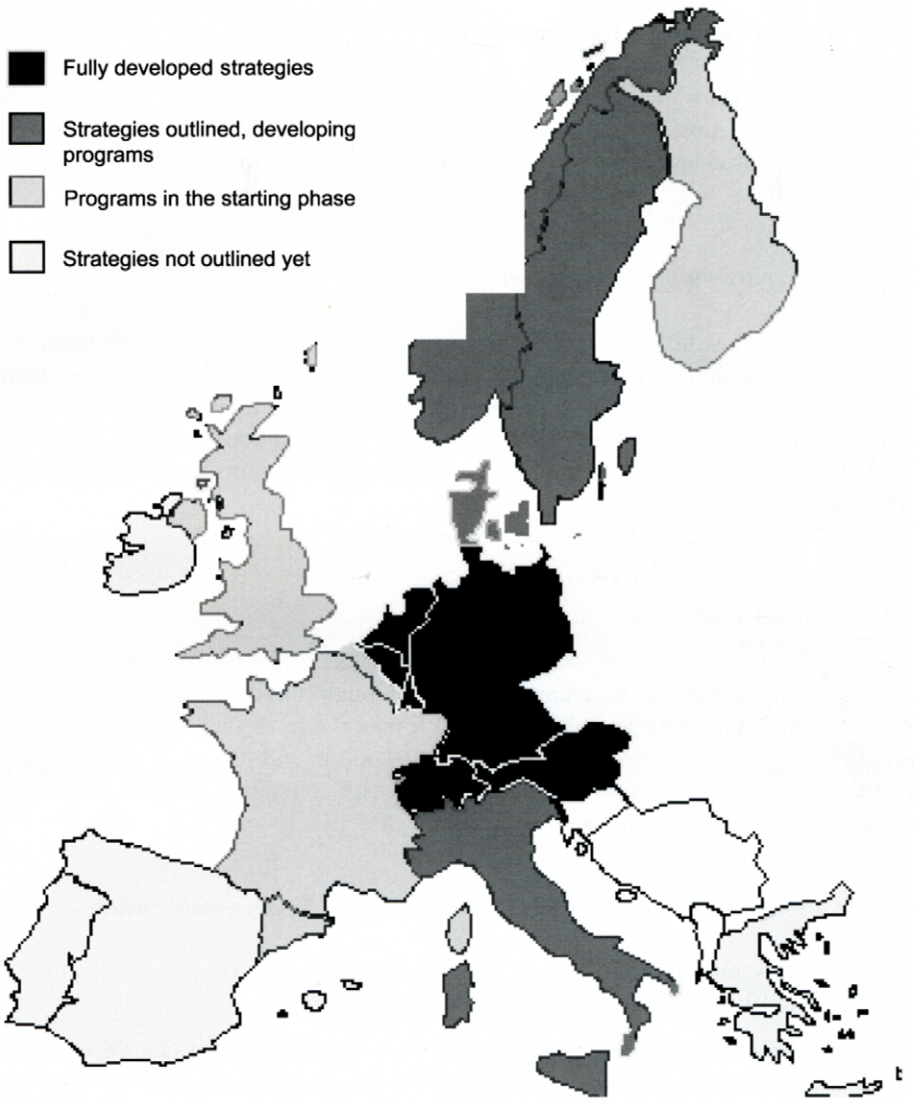

Figure VI.2.2. Development of source separation and composting in Europe (adapted from Barth, 2000).

Finland, *France*, the *United Kingdom* and *Walloon* (Belgium) belong to the third category, where programs are at the starting point though policies have been sometimes fully laid out.

To the fourth category belongs countries where no effort on composting of source-separated organic waste can be detected just yet; these include most regions in *Spain*, besides *Greece*, *Ireland* and *Portugal*. In these countries composting from mixed urban waste is still being practiced and sometimes plays an important role (e.g. many local strategies in Spain and Portugal).

VI.2.2. The driving forces for composting

There is a diffused awareness among technicians and decision-makers that composting will still play the most important role in forthcoming European Strategies for Waste Management. This chapter briefly describes what are the most important driving forces at EU level for that.

VI.2.2.1. Directive 99/31/EC on Landfills

The Directive on Landfills (EC, 1999) basically provides for the landfilled biowaste to be sharply reduced within the next years. This is aimed at effectively reducing the production of biogas at landfilling sites (one of the highest contributions to the global warming potential from waste management) and to improve the conditions at which landfills are operated (e.g. lower chemical strength of leachates, less settlements in the shape of the site after the landfill gets shut down).

Biowaste to be landfilled should be reduced by:

- 25% (with reference to 1995) within 5 years,
- 50% within 8 years,
- 65% within 15 years.

Though this could be accomplished also through thermal treatment, biological treatment and composting are likely to play a major role in this respect. In the end, composting is the most *natural* way to manage biowaste, and its cost is generally lower than that of incineration – above all once this latter has to comply with the provisions of the recent Directive on Incineration (EC, 2000).

VI.2.2.2. Proposed directive on biological treatment of biodegradable waste

The EC recently took the initiative to propose a Directive on Biological Treatment of Biodegradable Waste (EC DG ENV.A2/LM, 2001), in order to:

- Ensure a balanced approach to the commitments on reduction of landfilled biowaste outlined in Directive 1999/31/EC (EC, 1999), i.e. set the need to have recycling of organic matter as a better option than its thermal recovery (once we consider that energetic exploitation of putrescible waste is made most difficult for the high moisture it carries along).
- Fix some recycling targets for biowaste, so as to ensure an even development of composting across Europe.
- Define common limit values and conditions for use and marketing of composted products across Europe.
- Further develop 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 Member States.
- 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 the most important provisions included in the current proposed draft is that source separation of biowaste should be developed, besides in rural areas and small municipalities, also in big cities (with possible exceptions only in inner cities). Such a provision could be disputed, as in general, it is argued that purity of sorted food waste tends inevitably to get much lower in highly populated areas. Actually, on the contrary, *the quality of collected biowaste seems to be much more dependent on the system adopted for collection than on the size of towns*, and many situations are reported where schemes prove to be successful also in big towns and inner cities (EC DG ENV, 2000). Coming to Italian schemes, for instance, the Working Group on Composting and Integrated Waste Management of Scuola Agraria in Monza, Italy, represented by the author of this chapter, has plotted the numbers about purity of separated biowaste (percentage of compostable materials) reported in various sorting analysis performed across Italy (Fig. VI.2.3). What turns out is that no relation can actually be detected between the size of the population covered and the purity. This means that other factors are affecting the purity more than the population covered by the scheme, and namely the *type* of the scheme put in place; doorstep schemes generally perform much better than schemes run through containers on the road. Similar outcomes are reported in Catalonia (Spain), where similarly both types of scheme are currently run (Favoino and Giró, 2001).

Statistical treatment of numbers yields a very low relationship ($R^2 = 0.0174$), and this is in itself a demonstration of a low dependence of purity on the size of towns running the scheme for source separation. Even at a first glance, it is easy to get aware of the presence

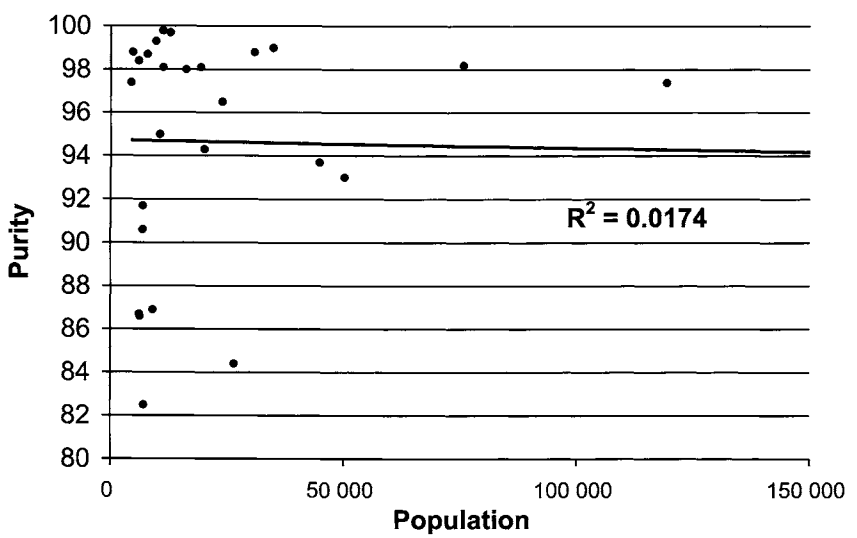

Figure VI.2.3. Purity of collected food waste vs. population covered.

of cases of high purity in medium to big towns, besides low purity, sometimes, in a certain number of tiny villages.

VI.2.3. Keys to success: quality assurance systems and marketing conditions in Central European Member States

The wide development of strategies aimed at recycling of biowaste through composting in the Central European Member States is largely based upon steady marketing conditions. This, in turn, ensures outlets for the end product, thus providing further justification for the strategy (EC DG ENV, 2000).

Quality assurance systems (QAS) for composted products have already long been playing a central role in the composting framework in Central Europe (Amlinger, 1998). As a matter of fact, a QAS links the quality of the end product to all the elements of the process management; a comprehensive quality management of the composting plant gets thus possible.

As Table VI.2.1 clearly shows, QAS play a central role in those countries with a well-developed composting system like Austria, Germany, Denmark, the Netherlands and Belgium. These countries have established an extensive quality management system for the composting plants that in 1998 already covered around 400 composting plants (Table VI.2.2).

Quality criteria for compost differ in each Member State as to requirements and limit values. Quality classes based directly on heavy metal limits exist only in Austria (class I and II such as the types "A" fresh and "B" matured compost) and in the Netherlands (Table VI.2.3). The Dutch requirements for the class "very good compost" are so high that they can only be reached very seldom; therefore the Dutch Compost Plant Association is now proposing different limit values. The Belgian QAS, distinguishes only on the basis of raw materials.

What turns often out is that when diversified compost qualities based on heavy metals are available only the best one gets effectively marketed. As a matter of fact, in such a situation customers are led to believe that the lower quality is not reliable. This means that larger quantities of compost still profitable for many applications will fail to be used in most cases (Barth, 2000).

Quality classes based on the raw material (as in Belgium), or on the features of the product, affecting the suitable application (as in Germany) are on the contrary effective tools to meet the requirements of the compost market.

Countries shown in the Table VI.2.3 have different priorities in their quality criteria and efforts for quality control.

Organic pollutants are highly focused upon in Denmark; the *hygienic aspects* for the moment are the main concern in Germany, and *odor emissions* create problems in Belgium.

An important point is that the development of steady and reliable markets for composted products require a *standardized quality of the product* and a *proper quality assessment*, in order to both develop confidence among customers and users and to ensure proper, "aware" management conditions at composting facilities (that in turn makes the acceptability of plants among local dwellers grow).

Table VI.2.1. Status of compost quality efforts in various EU Member States (modified from Barth, 2000).

Country	Status of quality assurance/certification of compost
Austria	Fully established QAS
Belgium	Fully established QAS in Flanders, the Walloon and the Brussels region will probably follow the Flanders example
Denmark	Just started with QAS for compost (criteria, standardized product definition, analyzing methods)
France	Proposal for quality criteria, research program for a quality management system
Germany	Fully established QAS
Italy	Proposal by the Composting Association (CIC – Consorzio Italiano Compostatori) for QAS, to be implemented
Luxembourg	Some plants according to German QAS
Netherlands	Fully established QAS and certification systems
Spain	Proposal for "Bill on the Quality of Compost" in Catalonia
Sweden	Recently started with QAS for compost
UK	Proposal of quality standard by the Composting Association (TCA – The Composting Association)
Finland	No official efforts until now
Greece	No official efforts until now
Ireland	No official efforts until now
Portugal	No official efforts until now

Table VI.2.2. Status of QAS at composting plants in Central European Member States (as per 1998).

Country	Plants with quality assurance[a]	Plants with quality sign or certificate
Austria	ca. 18	2
Belgium (FL)	ca. 21	5
Germany	ca. 340	ca. 300
Netherlands	22	2

[a]This figure includes plants that have applied for a quality sign or a certificate but the process is not yet finished.

Table VI.2.3. Classification of compost quality in Europe.

Country	Type of compost/quality class
Austria	Quality Class I and II, Type A (mulch) and B (matured) compost
Belgium (Flanders)	Yard and vegetable, fruit and garden VFG compost
Germany	Fresh and matured compost, mulch and potting soil compost
Netherlands	Compost and very good compost

Testing of composts through the application of a QAS proves thus to be a crucial point in the overall development of composting strategies as:

- The quality assurance is a good tool for *sales promotion, for public relations* and a good argument for the building up of confidence in compost.
- The quality label allows the establishment of a branded "quality-tested compost" and a positive compost image.
- *Regular* testing during compost production guarantee a *quality-assured product.*
- *Standardized* analyses carried out in accordance with specified methods enable a nation-wide objective assessment of the compost quality.
- The results of the assessment are a most important basis for the *product declaration* and the *recommendations on suitable application* (that obviously shows to be a powerful marketing tool).

The overall result is a compost of defined quality, which is therefore marketable and saleable on a large scale.

Of course, compost with a quality label or a quality certificate will not be simply sold as such, and further marketing activities are needed. The application of a QAS, however, is a fundamental step for compost plants because products with tested quality always attract more interest on the market. To compete with peat, soil and bark industries in the market of soil improvers and potting mixes, compost plants need to undertake additional and common efforts in their marketing activities.

The successful development of QAS in the Central European Member States has led also other countries to put efforts on such an issue. More and more often, proposals for the introduction of a QAS are being raised across Europe (see Table VI.2.1); governmental bodies often play a major role in fostering the development of the system, as for instance in Sweden. Other times proposals have been developed directly by the associations of compost plant managers – as lately happened in the UK and Italy.

VI.2.3.1. Marketing conditions and trends

Compost marketing shows various trends in Europe. Significant differences on the market situation can be identified. Generally speaking, it turns out that *even in the countries with*

most diffused schemes and the highest compost production, compost is effectively marketed; an effective marketing framework and proper marketing strategies have been fundamental to overcome the initial worries about a lack of enough demand for the product.

In all countries hobby gardening, horticulture and landscaping are a successful market; in general they constitute the main marketing basis for composted products and shows proper conditions for its development.

Green compost (where only yard and wooden waste gets processed) is an organic fertilizer and soil conditioner well accepted by the markets all over Europe. It can be produced in a good quality without much technical equipment.

Market for compost from *biowaste* (including food waste) shows two contrary developments: by means of the decreasing or low tipping fees, some of the composting plants try to minimize their treatment and marketing costs – e.g. producing "fresh" compost, with a low maturity for field applications, which results mostly in delivering the compost free of charge to farmers without additional marketing efforts. On the other hand a lot of composting plants start to add value to their compost products and produce mixtures or special products according to customers' needs and requirements of the market. They either co-operate with producers of growing media or build up a mixing, bagging and marketing activity by themselves.

The quality assurance organizations support these tendencies through the organization of research projects for compost application and for new blends of composted products with other materials.

Table VI.2.4 reports on the market shares in the various Member States in Central Europe; in order to allow a comparison, also data from Italy have been included. It turns out that applications linked to gardening, pot cultivation and landscaping play a major role and the application in agriculture does not cover the main market share – though potentially its size is, of course, the biggest one. The high percentage in Germany is mainly due to the trends on the production of fresh compost already described; in Austria, on the contrary, the diffused presence of rural composting sites ("Bäuerliche Kompostierung") boosts the interest of farmers for a direct application of compost on farmlands.

Coming to Mediterranean countries, there is a strong evidence that the use of compost in farmlands could play on the contrary a major role in the future. There is a also great awareness, among composting plant managers and research centers, that in future the use of compost in field crops has to be developed, besides that for potting mixes, in order to back up the growth of compost production.

It has to be underlined that specific weather and cropping conditions determine – in general – a huge request for organic matter in Mediterranean agriculture. Warm and dry climates and the intensive, humus-consuming crops (e.g. horticulture, fruit growing) make soils hungry for organic matter; decades of chemical fertilization as a complete substitute for organic fertilization have worsened the overall situation. Also in Northern flatlands, many soils are currently reported at less than 1.5% organic matter. Moreover, the recent Dakar Conference has shown that many Mediterranean countries are threatened by the process of desertification.

This picture leads, on the whole, to a favorable situation to promote the use of composted materials (Oriol, 2002; Tittarelli, 2002). Many farmers' associations are now addressing compost as a suitable tool to restore fertility and allow the development of

Table VI.2.4. Market shares of compost sales and market size.

	Market shares in selected EU countries (in %), 1998/99						
	Austria (1998)	Flanders (1999)	Germany (1998)	Denmark (1998)	Italy (1999)	Netherlands (1998)	Market size
Landscaping	30	24	25	19	30	30	Large
Landfill – restoration	5	5	–	13	–	–	Small
Agriculture + special cultures	35[a]	5	43	10	20	40	Very big
Horticulture	5	6	5	3	–	–	Medium
Earth works	5	33	10	–	50	–	Medium
Hobby gardening	20	20	14	48	–	20	Large
Export	–	4	–	–	–	–	Very small
Miscellaneous	–	11[b]	3	7	–	10	–

[a]60% of the Austrian VFG and green waste is on-farm composted.
[b]Decontamination.

those crops that best fit the Mediterranean climate (e.g. horticulture, fruit-trees, etc.) in place of animal husbandry that cannot be competitive to the Central European Member States.

A major challenge is still represented by the *need to find suitable equipment for mechanical spreading*, as old machinery fits the features (moisture content, consistence, grain size) of either manure or chemical fertilizers. Recent trials (e.g. Bisaglia and Centemero, 1998) indicate that such a need has been successfully addressed finding suitable solutions.

From a "strategic" viewpoint, there is a great awareness – by some central institutions – of the importance to restore organic fertility in the soil. For instance, ANPA, the Italian National Environmental Protection Agency, is committed *to promote a National Plan for Organic Matter to the Soil*, in which the overall needs, calculated by fertility restoration programs, have to be supplied by organic fertilizers, among which composted products are forecast to play a key role.

In such respect, more and more often local institutions outline programs and funding to promote the use of compost as an organic amendment; most often, main provisions of such programs are:

- funding farmers with a certain sum per unit area where compost gets land applied,
- the preference for composted products in tenders for public green areas (gardens, parks),
- funding farmers to replace old machinery when the new equipment is mechanically suitable to spread compost as an organic fertilizer.

Supporting the strategy on the agronomic side has to be foreseen in future as one of the key elements in a general strategy that targets full recovery of the role of organic matter from waste materials in agriculture. The size of the potential request is big enough to justify the effort; Table VI.2.5 shows that even at complete development of schemes for

Table VI.2.5. Percentages of arable land area potentially interested by compost application in the EU countries[a].

EU Member State	Inhabitants 1995 (10^3)	Arable land area (ALA)	Food and green waste compost		Arable land needed for compost application	
		Total (10^3 ha)	Potential production (10^3 t)		Total (10^3 ha)	% ALA
			f.m.	d.m.		
Austria	8040	1500	321	161	16.1	1.07
Belgium	10,131	700	405	203	20.3	2.90
Denmark	5216	2500	208	104	10.3	0.41
Finland	5099	2500	204	102	10.2	0.41
France	58,027	18,000	2321	1160	116.1	0.65
Germany	81,553	12,000	3262	1631	163.1	1.36
Greece	10,063	3000	402	201	20.1	0.67
Italy	57,248	10,000	2290	1144	114.5	1.15
Ireland	3577	1000	143	72	7.1	0.71
Luxembourg	407	60	16	8	0.8	1.35
Netherlands	15,423	900	616	308	30.8	3.43
Portugal	9912	3000	396	198	19.8	0.66
Spain	39,170	16,000	1566	783	78.3	0.49
UK	58,276	7000	2331	1165	116.5	1.66
Sweden	8816	3000	352	176	17.6	0.58
EU	370,958	81,200	14,833	7416	741.6	0.91

[a]Calculation: (i) collection of organic waste: 100 kg/in. year; (ii) process yield: 40%; (iii) dry matter 50%; (iv) application rate: 10 t/ha d.m.

source separation of biowaste (100% of the population involved) the potential request is by far bigger than the potential production.

VI.2.4. Countries in the starting phase: the development of programs for source separation of household organic waste in Mediterranean countries

As a consequence of a growing number of provisions in national or local legislation, and/or mandatory programs, a growing number of districts in Southern Member States have lately adopted those strategies already well developed in Central and Northern Europe, aiming at source segregation of the organic fraction of municipal waste. During last years, the development has been particularly noticeable in Northern Italy and Catalonia (Spain) (Favoino, 2000; Giró, 2000; Cortellini and Favoino, 2001).

VI.2.4.1. Italy

In Italy schemes were first developed during the early nineties; Milan Metropolitan Area widely adopted composting and recycling since 1994–1995 as a fundamental tool to seek for solutions to their disposal crisis (Consorzio Provinciale della Brianza Milanese, 1997; Provincia di Milano, 1998a,b). Some 600 municipalities across Italy had already been reported to run source-separation programs for food waste early in 1997–1999 (Provincia di Lecco, 1997; Lazzari, 1998; Azienda Municipale di Igiene Ambientale di Torino, 1999; Favoino, 2000).

For the time being, the development of recycling programs mainly refers to Northern Italy, though many programs are starting in central and southern regions. Among these, noteworthy is the situation in some districts in Abruzzo, where two municipalities were reported in 1999 at more than 50% recycling; thanks above all to door-to-door schemes for sorting food waste.

Table VI.2.6 refers to the 1999 update; numbers are now likely to be at more than 1000 municipalities across Italy (the overall number of Italian municipalities being somewhat more than 8000). During last spring and summer, many more towns – even among those with medium to high population – have started separation of food waste in Southern Italy, e.g. Matera (some 60,000 people) and Battipaglia (60,000).

The main cause for such a growth in source separation of food and green waste has to be found in recent developments of the environmental policy. Decree 22/97, the National Waste Management Law of February 1997, sets a recycling goal at 35% to be met by 2003. Source separation of the organic waste is not compulsory, and it is just depicted as a "priority". Still, food waste source separation is a need in order to reach the medium-term recycling target set by the Decree at 35%. In effect, intensive collection of dry recyclables (paper, glass, plastic, etc.) does not allow local authorities – in general – to meet such a goal (it has to be noted that home composting and demolition debris are not included into the total figure of recycling rate). Thus, most regions and provinces are including source separation of food waste in their waste management plans (Bigliardi, 1998; Lazzari, 1998; Favoino, 2000).

Source separation of food waste has already allowed some provinces, Milan Province included (some 190 municipalities, $>3{,}500{,}000$ inhabitants), to meet the 2003 recycling

Table VI.2.6. Municipalities and inhabitants involved in source separation programs for food waste in Italy (update: January 1999).

Region	Municipalities	Inhabitants
Abruzzo	11	76,511
Campania	8	93,865
Emilia-Romagna	36	218,682
Liguria	2	4900
Lombardia	329	3,027,950
Marche	2	6000
Piemonte	41	109,184
Toscana	12	113,724
Veneto	109	887,151
Trentino-Alto Adige	26	46,012
Total	576	4,583,979

goal (35%), with many single municipalities overcoming 60%; two provinces (Lecco and Bergamo) have already exceeded the 45% recycling rate on aggregate. The use of specific tools and systems for door-to-door source separation of food waste has proven to be effective with relevance to quantity and quality of food waste collected, and very cost-competitive.

The collection of yard waste is even more developed, above all in such regions as Lombardia, Veneto and Piemonte (some 4000 municipalities, 17,500,000 inhabitants) where it has been made compulsory since 1994. Many other regions, above all in Northern Italy, such as Emilia Romagna and Tuscany are also recording a wide extension of programs to collect yard waste, even though they have no compulsory action in such respect.

VI.2.4.2. Spain

Biological treatment on the whole is experiencing a fast growth in Spain, as well. As far as schemes for source segregation are considered, Catalonia is undoubtedly gaining the leading position in Spain (Giró, 2000). Actually source segregation of "bassura orgánica" (organic waste) has been developed also in other areas, both rural and urban. Among these latter, an outstanding scheme – if referred to the population covered – has already long been run in Cordoba (some 300,000 inhabitants).

In Catalonia, as per July 2000, 63 municipalities were reported to source separate biowaste, for an overall population of some 430,000 inhabitants (see also Table VI.2.7); an update in November was reporting 72 municipalities and 640,000 inhabitants. The Catalan development takes its steps from a Regional Law (Law 6/93) that outlines compulsory programs for the source segregation of organic waste in all municipalities with a population over 5000 inhabitants. This mandate affects 158 municipalities with a population of 5.3 million inhabitants, or nearly 90% of Catalan population. The remaining

Table VI.2.7. Source separation of biowaste in Catalonia: development of programs.

Schemes	Compulsory municipalities >5000 inhabitants		Voluntary municipalities <5000 inhabitants		Total municipalities	
	Municipalities	Inhabitants	Municipalities	Inhabitants	Municipalities	Inhabitants
Overall	158	5,304,724	786	785,316	944	6,090,040
Schemes by July 2000	49	393,000	14	40,000	63	433,000
Schemes by November 2000	57	557,000	16	44,000	73	601,000

municipalities, those with populations under 5000 inhabitants, are not required to comply, although they may participate – and many are doing so – on a voluntary basis.

Though deadlines for the full development of programs defined in 1993 had to be postponed, the strategy has steadily grown up and will continue to be fully developed. The Metropolitan Waste Management Plan sets a target for 350,000 t biowaste (including big producers) to be source separated by year 2006 (that means covering all the population inside the metropolitan area).

Underpinned by the success of Catalan schemes, lately a similar regulatory approach has been adopted by the Spanish National Law on Waste Management 10/98 and by the PNRU (National Plan for the Management of Municipal Waste) 2000–2006, which specifies that all municipalities with a population above 5000 inhabitants (within 2001) and those with a population above 1000 inhabitants (within 2006) have to run schemes for the source separation of municipal wastes. Though no further explanation is provided for what materials should be tackled by schemes to be included in "source separation", it seems generally agreed that – also under the spur of what is happening in Catalonia – the strategy will also cover source segregation of organic waste. For instance, it must be noted that a National Composting Program has been defined accordingly. In this program targets and deadlines for recycling of organic matter by means of composting, and anaerobic digestion, have been defined.

This led many regions to include provisions for the development of programs for the source segregation of organic waste in their local plans. Let us quote:

- Comunitat Valenciana ("Pla Integral de Residus de la Comunitat Valenciana").
- The Autonomous Waste Management Plan of the Autonomous Community of Madrid, with provisions for separate collection of biowaste to be established as a general rule in a second phase, as from 2003.
- Comunidad Autónoma de Aragón has included in its "Plan de Ordenación de la Gestión de Residuos Sólidos Urbanos" the implementation of the separate collection of biowaste.
- Comunidad Autónoma de Castilla – La Mancha has also established in its *Plan de Gestión de Residuos Urbanos de Castilla – La Mancha* the implementation of the separate collection of biowaste.

- Comunitat Autònoma de les Illes Balears, by means of the "Pla Director Sectorial per a la Gestió dels Residus Urbans a Mallorca", and, in a near future, with the elaboration of the "Pla Director Sectorial per a la Gestió dels Residus a les Illes Balears" and the Law on Wastes for the Balearic Islands, has also fixed the implementation of separate collection of biowaste.

VI.2.4.3. The composting capacity in Italy

Italy faced a significant development of source-separated waste composting capacity in the last 10 years, also as a consequence of the implementation of the new regulation on waste and the development of source separation.

According to the preliminary results of a survey led by ANPA (the National Environmental Protection Agency) the number of plants increased from 10 in 1993 to 114 in 1999 (135 if also sites with a capacity of less than 1000 t/year are considered). In the same time frame, the overall quantity of raw materials treated (source-separated organic waste) increased from 0.25 to 1.34 million tons (Table VI.2.8). Actually, the overall potential capacity of plants was even higher, topping some 2,020,000 t in 1999.

In 1999, 24% source-separated waste treated in composting plant was food waste, 38% yard waste, 28% sludge, 10% other organic waste materials; 44 additional plants were not yet in operation, or under construction or planned, with an overall capacity of 0.63 million tons/year, so that the overall treatment capacity is expected to increase in the short term from 2 million tons in 1999 to 2.6 million tons.

The Italian composting capacity is mainly concentrated in Northern and Central regions; however, more recently, many efforts have been made in Southern regions, in order to fill the gap starting or increasing the composting capacity. This refers above all to Campania, and Puglia; in this latter region for instance, recently a tender has been issued by the Governmental Task Force on Waste Management, aimed at building 8 large-sized new composting plants. In many cases, public initiatives have been followed or even anticipated by private action that finds a growing place for profitable operational conditions, as fees for landfilling are getting increasingly higher.

As a consequence of the overall composting capacity, the production of high-quality compost in Italy, in 1999, has been estimated at 600,000–650,000 t.

Table VI.2.8. Trend of the composting capacity for source-separated organic waste in Italy (after ANPA, 1999).

Year	Number of composting plants	Treatment of source separated waste (1000 t/year)
1993	10	250
1997	85	899
1999	114[a]	1340

[a]135 if decentralized facilities for yard waste with a capacity below 1000 t/year are also considered.

Also the biological treatment of residual waste is under development as Decree 22/97 asks for the waste to be pre-treated before being landfilled by July 1, 2001. In the past, many mixed MSW composting plants aimed at producing compost for field crops. Some 30 plants under operation have been recently reported (ANPA, 1999). In 1997 the overall capacity for mixed MSW or residual waste reached some 1,650,000 t/year. Referring to 1995, some reported 65 mixed MSW composting plants (with an overall capacity of some 3,000,000 t/year), only 23 of which are in operation (some 850,000 t/year), 16 are shut down and 25 are under construction or are undergoing upgradation (Merzagora and Ferrari, 1996). Many of those plants have been shut down in the past years; accordingly, many others have not been fully completed. Such shortcomings were due to:

- poor environmental conditions (lack of odor-treatment systems);
- poor process management (with production of immature compost) or, most of times;
- the unsuitability of the targeted end use, as farmers seldom have trusted mixed MSW compost to be used in farmland applications, with a few exceptions due to the need for organic amendments to restore fertility in the deep far Southern regions.

The strategy has thus undergone a sharp change; more and more often old composting plants get fully or partially converted to quality composting of source-separated organic waste and/or used for biological treatment of residual waste. Moreover, new ones have been recently opened. In particular, Milan biological treatment plant has probably to be considered as the biggest one across the world, as its capacity is 2000 t/day of residual waste.

Nowadays, biological treatment for residual waste targets different possible aims:

- stabilization prior to landfilling, in order to comply with provisions of both the National Waste Management Act and of Directive 99/31/EC on Landfilling (EC, 1999);
- drying up of residual waste before thermal valorization, along the lines of the *Dry stabilization* method increasingly developed in Central European Member States;
- use of organic soil improvers ("Gray compost" or stabilized organic fraction (SOF)) for land reclamation. It has to be mentioned that the huge needs of organic matter in Mediterranean weather and cropping conditions, leads to the need of saving quality compost only for application in cropping and gardening.

Some regions and provinces have already issued guidelines and/or technical regulations to allow the use of MSW compost for land reclamation (Favoino, 1998); their principles have been taken over by a draft national regulation expected to be issued in the future. Such regulations rely upon the hypothesis of one-off applications with high loads in order to promote biological activities in surface soil layers on exploited mines, slopes to be consolidated, anti-noise barriers, etc. As for technical requirements of such applications, regulations address above all the need to check both:

- heavy metals load and
- nitrogen load.

Loads have to be calculated in order to stay within maximum concentration of potential toxic elements (PTEs) in the soil and to prevent massive release of nitrogen to the groundwater.

VI.4.3.1. Technical features of composting sites: a balanced approach to environmental standards

A fast evolution is taking place in Italy as to *environmental standards* of composting plants, with specific reference (but not only) to odor management. Actually, people are getting increasingly sensitive to the need of ensuring proper conditions for waste management, and nearby dwellers have often been raising complaints against the way "low-tech" sites were performing as to nuisance.

Most operators and institutions are now aware that in order to ensure a steady growth of composting activities, proper standards have to be outlined both for building and running composting sites. This refers not only to "wealthy" Northern regions, where composting is often cost-competitive, even at highest environmental standards, to landfilling; but also to many situations in Southern Italy, where public funding programs to build composting sites enable local institutions to have relatively low operating costs (as they do not have to take into account depreciation of capital costs) even with the utmost care for proper and safe management of exhaust air.

Thus far, no technical guidance has been issued in National Regulations about process management, except in the Decree 5/2/98 on "Simplified Permitting Procedures"; according to the Decree, composting sites treating fermentable feedstock such as sludge and food waste have to be fitted with enclosed processing systems for first steps and technologies for exhaust air treatment, regardless of their size/capacity and distance from dwellings. These provisions have been regarded by experts as too "tough" for many composting sites where odors would not constitute a problem due to:

- low capacities,
- specific processing systems (e.g. piles with cover layers) and
- distances from dwellings.

Moreover, no standard has been issued in the Decree on dimensioning and assessment of effectiveness of odor treatment; this leads to situations where composting plants install biofilters poorly dimensioned that will be too far from being effective.

To date, "regular" permitting procedures (the ones most used) do not undergo any provision for technical features of composting sites. A further Decree is on draft, anyway, and it sets some basic principles as:

- retention of first process steps for fermentable feedstock in enclosed buildings or containers, till a certain fermentation level (to be assessed through the "oxygen uptake" test);
- simplified provisions both for yard waste and for sites processing also food waste at low throughputs (less than 3000 or 6000 t/year); this is also deemed to promote composting in rural and hilly areas (e.g. the Alpine regions), where generally composting is done at less facilities along the lines of the Austrian "Bäuerliche Kompostierung".

Meanwhile, many regions have issued regulations of their own that cover, in a more or less detailed way, environmental standards to be met at composting sites. Table VI.2.9 reports on some of the most significant situations both at national and local level.

One of the most debated topics is the way to assess performances of systems for treatment of odors. In past years, many times institutions were asking for analytical

Table VI.2.9. National and local provisions for environmental standards.

Regional or national regulations	Guidance for:				
	Mandatory enclosure of early process steps for fermentable feedstock (e.g. food waste, sludge)	Dimensioning of systems for odor treatment	Test methods to assess performances of systems for odor treatment	Management of wastewaters	Simplified provisions for yard waste composting
Lombardia	Yes, till a certain residual fermentability	Yes	Yes, including olfactometry	Yes	Yes
Veneto	Yes, till a certain retention time and residual fermentability	Yes	No	Yes	Yes
Piemonte	Yes, till a certain retention time	Yes	No	No	Yes
Emilia Romagna	No	Yes	Yes, only analytical measurements	No	Not needed (see 1st column)
National Decree 5/2/98 ("simplified permitting procedures")	Yes, but only the principle has been outlined, with no retention time	No	No	No	Yes

measurements, including the assessment of volatile organic compounds (VOCs) with limits set at 5–10 mg/N m^3; this was mirroring provisions for much more hazardous facilities, such as incinerators, where a low concentration of VOCs in emissions witnesses good combusting conditions. Actually, as in most composting sites biofilters have been installed as a very effective means to reduce odors; one must consider that biofiltration beds contribute themselves to VOC emission, stemming for example from degradation of wood. This is why many technicians have been harshly disputing the *real* effectiveness of VOC provisions. Lately, the attention of institutions has been attracted to *olfactometric measurements*, according to the internationally adopted methods (CEN/TC 264, 2002); this method is proving to be very effective in describing the real odor potential at composting sites. Olfactometry has already been adopted by Region Lombardia as the reference test method to assess performances of treatment systems for exhaust air.

VI.2.4.4. The composting capacity in Spain

The capacity of biological treatment in Spain, actually, is to date mostly covered by composting of unsorted waste (production of gray compost). Composting facilities in different regions are listed in Table VI.2.10.

The overall composting capacity is reported at some 3 million tons of waste, mostly covered by plants for unsorted waste.

It is anticipated that – along the lines of what already happened in other countries – in the future such facilities will be assigned a different aim (namely biological treatment of residual waste), or will be upgraded into composting plants for source-separated organic waste.

As a consequence of the development of source-separate collection, Catalonia is the region with the larger capacity for composting of source-separated organic waste.

A specific feature of the Spanish situation is that a large capacity for anaerobic digestion is being developed, as mechanisms for public funding of capital investments – mostly through EU financial provisions – tend to make it cost-competitive. Just on the basis of projects already underway, the overall Spanish capacity for anaerobic digestion will be likely at some 2 million tons in the medium term; anyway, as most facilities are meant to treat mixed MSW, the actual capacity of digesters will cover only a minor flux of total input waste being delivered at the plant (underflow materials stemming from primary screening). To date, 8 digesters are under construction.

VI.2.5. The possibility to optimize the schemes and to cut cost down

One of the major concerns of waste managers across Europe is the common opinion that source-separation system aiming at reaching high recycling rates, are bound to suffer from the lack of cost-competitiveness as compared to the traditional mixed collection of MSW. Operators think that in particular, sorting food waste leads to higher costs for the overall collection scheme.

Table VI.2.10. Composting plants in Spain (update: late 2000).

Region	Source-separated waste			Mixed municipal waste			Total
	Operating	Under construction or planned	Total	Operating	Under construction or planned	Total	
Andalucia	2	0	2	8	1	8	10
Aragon	0	8	8	0	0	0	8
Asturias	0	0	0	0	0	0	0
Iles baleares	0	1	1	1	1	2	3
Islas canarias	0	3	3	2	0	2	5
Cantabria	0	0	0	0	0	0	0
Castilla-La Mancha	0	0	0	3	1	4	4
Castilla y Leon	0	0	0	2	2	4	4
Catalonia	9	8	17	0	0	0	17
Comunitat Valenciana	0	10	10	8	3	11	21
Estremadura	0	0	0	0	2	2	2
Galicia	0	5	5	0	0	0	5
Madrid	1	0	1	2	2	4	5
Murcia	0	0	0	1	0	1	1
Navarra	1	1	2	0	0	0	2
Euskadi	1	0	1	0	0	0	1
La Rioja	0	0	0	0	0	0	0
Ceuta	0	0	0	0	0	0	0
Melilla	0	0	0	0	0	0	0
TOTAL Spain	11	39	50	26	12	38	88

It is therefore useful to make a cost-assessment on main systems for source separation currently in operation. Cost analyses carried out so far across Europe have traditionally focused on costs *per kilogram* (or *per ton*) *for a single waste material collected.*

However, there is evidence that this biases the true picture, because *the higher amount of waste is collected, the lower are 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 to the MSW collection route where large-volume road containers get substituted by low-volume bins and bags to be placed at the doorstep;
- the contribution of home composting programs to the overall reduction of organic waste collected.

Furthermore, the evaluation of the cost for a single waste flow, *does not allow for advantages on collection costs for other materials*, flowing from "operational integration". In effect, the collection of food waste – above all when it shows high captures – allows important changes in the collection scheme, by reducing, for instance, frequencies of collection for residual waste (often termed colloquially as "restwaste").

Moreover, it has to be stressed that the cost of the system (collection plus transport) is not paid for by the municipality according to the amount of the waste collected, but considering the general operational scheme (the number and frequency of collection rounds, the number of workers, vehicles, pick-up points, etc). It is therefore incorrect to express the cost of this service per unit mass, rather it should be expressed as cost per person. This is why we have focused in the many surveys we have led on cost optimization, on costs per person (Favoino, 2002).

In order to get an unbiased assessment, we have reported costs of different collection systems run in homogeneous areas, with even weather conditions, dwelling types, social features, etc.

For instance, data from district "Venezia 4", close to Venice (Fig. VI.2.4), clearly show that source segregation of food waste with doorstep schemes *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 food waste segregation by means of road containers.*

To understand the unexpected outcomes of the survey, we must underline that if source separation of food waste is *added* to that of commingled municipal waste, with no modification in the previous scheme for MSW collection, total costs are bound to rise; this actually happens with the collection of food waste by means of road containers. But this is not the case when food collection is *integrated* into the overall collection scheme: namely, when doorstep schemes are implemented, notwithstanding the much higher number of pick-up points.

The trick is 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, which can then be collected less frequently. Furthermore, *food waste on its own needs no compaction* – letting operators use cheaper collection vehicles; however, this only holds true in those schemes where the delivery of yard waste along with food

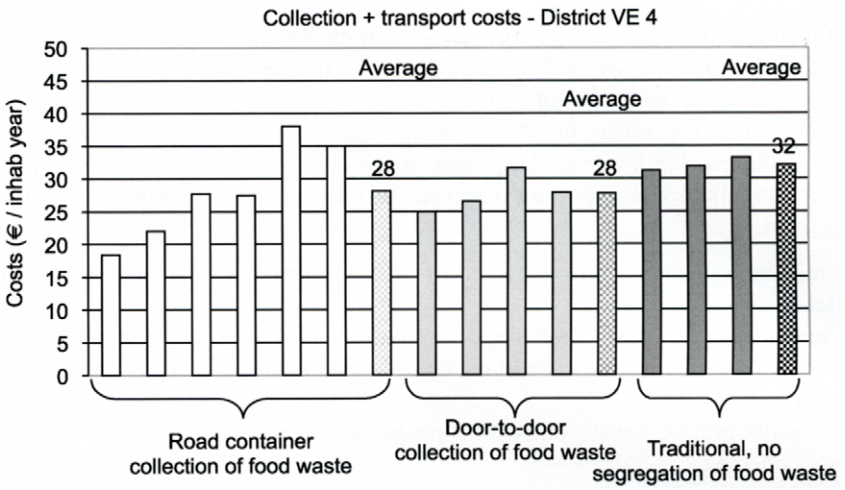

Figure VI.2.4. Cost comparison of different systems for source separation of biowaste in the Province of Verona and in the District "VE 4".

waste (that would be particularly high in areas with detached houses and private gardens) is prevented by means of low-volume buckets (10–20 l). In such situations yard waste gets collected at Civic Amenity Sites (*Recyclinghöfe, Piattaforme ecologiche*) or at the doorstep, but with much lower frequencies.

Table VI.2.11 recaps on most important tools and systems to integrate collection schemes once source separation of food waste gets implemented.

VI.2.6. 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. That means, a new collection scheme is run *in addition to* the previous mixed MSW collection, and cannot therefore yield savings to fund a new scheme. 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, provide 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 large amount of yard waste is to be expected (low-density areas).

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 this standpoint, the use of comfortable tools such as door-to-door schemes and watertight, biodegradable bags has proven to be very effective (Favoino, 1999). This is why an "intensive" collection, run through doorstep schemes, notwithstanding a much higher number of pick-up points, has shown to be less expensive than collection of food waste

Table VI.2.11. Main tools to optimize collection schemes for food waste.

Tool	Details	Applies where...
Reduction of the frequency of collection for residual waste	Effective systems to collect biowaste – allowing people feel comfortable-make its percentage in the "Dry MSW" fall down to 20% and less	...frequent collection rounds for mixed waste are adopted (warmer climates)
Use of bulk lorries instead of compactors	Bulk density of food waste on its own is much higher (0.7–0.8 kg/dm^3) than when biowaste is composed of both food and yard waste	...food waste collection is being managed in order to keep it separated from the collection of yard waste
Lowering the number of washing rounds	The use of "personal bins" and watertight devices allow the requirement for households to take care of bins on their own	...a "door-to-door" program is suitable (private space available)

through road containers, due to the integration of the system and much lower collection costs for residual waste.

Moreover, *door-to-door collection of food waste allows municipalities to perform much higher recycling rates* (up to 60% and more in municipalities with around 10,000 inhabitants, 50% in Monza, which has 120,000 inhabitants) and a much better quality of collected food waste.

A further tool to optimize the scheme is the use of suitable vehicles to collect food waste, due to its high bulk density when yard waste is kept away from the collection scheme. One of main lessons to be learned from these astonishing 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, where huge expenditures have lately been done to buy *only* packer trucks for side-loading road containers. We have to be well aware that *this is fighting against optimized schemes for high-yielding collection of food waste*; the lack of flexibility does not allow optimization at all.

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Permanent Electronic *Biowaste Conference* in the form of a Quarterly Newsletter, links and hints with special information packages. The Austrian Society for Environment and Technology. Website: http://www.biowaste.at; http://www.oegut.at/biowaste/recent.html