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Master thesis

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**WASTE PREVENTION AND
REDUCTION IN THE MUNICIPALITY
OF QUINTO VICENTINO (VI)**

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Al mio papà

*“Around here, however, we don't look backwards for very long.
We keep moving forward, opening up new doors and
doing new things, because we're curious...
And curiosity keep leading us down new paths.”*

-- (*Walter Elias Disney*)

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Introduction

This work aims to investigate the actual situation of the waste production in the municipality of Quinto Vicentino (VI) situated in Veneto, in the northern part of Italy.

It should be noted that in this territory the level of separate collection is relatively high (the waste collection is almost 70%) compared to the mean Italian municipality: this work should consider this, and purposes to avoid waste production, and refine the already present separate collection system.

This study is articulated into two levels, related to families (domestic utilities) and the municipality. Experimental data regarding quantity and quality of residual waste are collected from a sample of families living in the territory, and the results obtained are used to make a projection to the whole municipality.

The final aim of this master thesis is to demonstrate the possibility of a residual waste reduction, and the related economic gain derived from this.

Chapter 1

European and Italian legislation

1.1 The European Directive

The most relevant document we must refer when speaking about waste is the European Directive 2008/98/CE. This directive defines the principal concepts related to waste management, such as the definition of waste, prevention, reuse and recovery.

Here below are quoted the most relevant concepts for this work, directly taken from the directive.

12. "prevention" means measures taken before a substance, material or product has become waste, that reduce:

- (a) the quantity of waste, including through the re-use of products or the extension of the life span of products;
- (b) the adverse impacts of the generated waste on the environment and human health; or

-
- (c) the content of harmful substances in materials and products;
 - 13. "re-use" means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived;
 - 15. "recovery" means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function, in the plant or in the wider economy;
 - 17. "recycling" means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

In article 4 is described the waste management hierarchy that shall be applied by the legislation of the EU Member States, described in the next figure.



Figure 1.1 Waste management hierarchy according to the European Directive 2008/98/CE
(<http://ec.europa.eu/environment/waste/framework/>)

As can be seen, the waste management starts before the product becomes a waste, and this directive explains also when waste ceases to be waste and becomes a secondary raw material to be utilized (article 5).

The Directive lays down some basic waste management principles: it requires that waste be managed without damaging human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing noise or odors, and without adversely affecting places of special interest.

It introduces the "polluter pays principle" and the "extended producer responsibility". This will enhance the production of long lasting goods which, at the term of their lives, can be easily recovered or safe disposed.

It includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste.

The Directive requires that Member States adopt waste management plans and waste prevention programmes; in this way the decisions took at the European level can be applied to each country.

1.2 The Italian directive

Since 2006 all the laws and directives concerning the environment were collected together in the so called Decreto Legislativo 3 aprile 2006, n. 152 "*Norme in materia ambientale*". This document regulates in its fourth part the waste management and the remediation of contaminated sites, and aims to an high level of

environmental protection as stated in the communitarian Directive.

Through this decree the public administrations are asked to promote initiatives which should have as principal goal the prevention, the reduction of waste and the reduction of waste harmfulness, utilizing the best available techniques stated at the European level.

In article 180 is briefly described how to apply the prevention principle to waste, that is promoting:

- ⊕ Economic tools (..)
- ⊕ Environmental certification systems
- ⊕ Life cycle analysis
- ⊕ Information and sensitization of consumers
- ⊕ The utilization of environmental labeling
- ⊕ Agreements, program contracts, memoranda of understandings aimed at the prevention and reduction of the quantity and harmfulness of waste.

All these themes are very wide and can be applied in many different ways, according to the contest and the needs.

1.3 The regional directive

The directive to which must refer in Veneto is the Regional Law 21 January 2000, n.3, “*Nuove norme in materia di gestione dei rifiuti*”. It was updated and completed in May 2012 when the Regional Plan for the management of municipal and special waste, including hazardous, was approved and adopted through the regional official bulletin (BUR) n. 40 of 25/05/2012.

These documents have as main objective the execution of the European directives “in accordance with the principles of economy, efficiency and effectiveness ensuring at the same time the highest standards of environmental protection and public health and safeguard the natural and scenic values and resources of the planet”(Legge regionale 21 gennaio 2000, n. 3, article 1).

Always in the first article it is written that this law “promotes and supports, even with financial initiatives, interventions aimed at the construction of a waste management system that promotes:

- 1) the reduction of production and hazardousness of waste;
- 2) the separate collection of municipal waste;
- 3) the selection and recovery of waste;

- 4) the marketing of the materials coming from the waste recovery;
- e) promote the unitary management of municipal waste in local basins in order to achieve self-sufficiency in their disposal.”

The second article describes the main objectives.

“This law aims to achieve the following objectives:

- ⊕ the enhancement of the capacity of the proposal and of self-determination of local authorities through their involvement in updating procedures and adoption of regional plans for waste management;
- ⊕ the source reduction of the quantity and hazardousness of waste products;
- ⊕ incentives for maximum recovery of reusable materials from waste;
- ⊕ encouraging maximum use of the waste after recovery operations as a fuel or other means to generate energy;
- ⊕ the progressive reduction of landfill disposal as ordinary system;

- ⊕ the regional self-sufficiency for the disposal of urban and other waste, including through the reduction of waste to disposal operations.”

At chapter X of this Regional Law are present a pair of articles regarding the prevention and reduction of waste. In particular, article 50 in its first six points declares that “The Region shall pursue the objectives of the prevention and reduction of waste production by implementing the following actions:

- ⊕ information campaigns, training and educational activities addressed to the entire population and especially to schools [...]
- ⊕ information campaigns aimed at manufacturers, traders and artisans, that promote the reduction of waste of all kinds [...]
- ⊕ dissemination and promotion of the practice of home composting of food waste and gardening;
- ⊕ testing, adoption, diffusion and incentive in the office activities, methodologies and tools that reduce the production of waste and which promote the use of reusable materials, saving disposable

materials and the use of materials and products from recycling [...]

- ⊕ promotion of prize competitions open to the different economic and social groups in order to promote and encourage the prevention and reduction of waste;
- ⊕ promotion and encouragement of non-use of disposable tableware in cafeterias and public festivals or open to the public.”

Article 51 is specific for the utilization of recycled paper in public offices , and was stated that the share of recycled paper should be at least forty percent of the yearly requirements.

As can be seen in these examples, the suggestions of what can be done are not only a general indication, but there is plenty of examples and detailed explanations. That's the reason because it is important that each region sets up a specific law apparatus, in order to provide to the territory the most appropriate tools.

Chapter 2

The state of the art

In this chapter the concepts of prevention will be investigated, starting from its definition given in the European directive 2008/98/CE. Beside this, the second part of the chapter is dedicated to what has already been done in some municipalities and provinces in Italy in order to reduce waste at source.

2.1 Prevention, Reuse and Recycle

Waste are one of the most representative indicators of the kind of society we are living in, and particularly is a clear signal of inefficiency and loss in energy and materials.

In a sustainable system, the regeneration of resources compensate perfectly the need of materials, so that there is equilibrium between losses and gains, and the circle perfectly closes.

This is clearly an ideal way to think at the perfect system we won't probably reach, but what's important is to approach that purpose in order to "leave the world a little better", which could be enough.

The main purpose suggested by the European directive is to desalinate the waste growth from the economic growth (PIL) , believing that a reduction in waste production is possible without decreasing the welfare and the productivity, and that a modern country should be prepared to do that still keeping growing economically. This is the big dare for the European countries of the new millennium.

Inside the VI European environmental action program is described the waste hierarchy, a priority list to follow in order to reach the more sustainable way to manage waste, as said in the 4th article of the new European directive.

Prevention actions include both the reduction at source, to be done in the projecting phase utilizing a life cycle thinking model, and the reuse of the good.

The prevention has two main goals: the prolongation of the product's life, and the reduction of the waste quantities.

These two objectives are the most important because they

don't need any physical process to be done on materials, and then there is no production of additional waste to be treated and no need of energy.

Usually, in the common life, the attention is concentrated in recycling instead of reducing waste. This way of thinking can be improved moving the focus on what can be done in order to do not produce waste at all, because also recycling has a meaningful impact on the environment, although the goal is the material recovery.

As said, "the best waste is the waste that is not produced". Prevention (source reduction and reuse) and material recovery (preparation to reuse and recycling) together are called waste minimization, to be distinguished from the energy recovery and final disposal, which must be the final treatments to be done, because they are the most impacting ones.

2.2 What has already be done

The prevention phase should start from the geographic, economic and social contest, because the focus must be on the change in behavior and lifestyle of people, local administrations and economic activities.

In order to be effective, the different purposes must take into account different factors.

The first is the social and cultural contest, which determines in this case the degree of sensibility and attention to the environment. These aspects are relevant also because it is possible to predict if and how fast the society will change its behaviors.

Beside this, the same importance have got all those data which characterize a community, like the number of inhabitants, their age and degree of studies, information about services and economic activities, and, what's more relevant, all the data regarding the waste management system.

The prevention theme has been present in a meaningful way inside the purposes of many municipalities in our country since a decades of years. Since all the towns and cities has its own story, it seems relevant to underline that a specific action can work well as predicted in a specific contest, but can be quite inefficient if applied to a very different reality.

Here below are presented some examples of waste prevention actions, done by different cities and towns

around Italy, which can be taken as suggestions and adapted to similar realities with the necessary adaptations.

2.2.1. *The public water*

In Italy more than other countries there is the habit to buy and drink bottles of water, without considering the possibility to use the tap water. This phenomenon got out of control considering also that very often the preferred water comes from far away, thanks to the big organized distribution, and that water coming from a narrow source is also transported far away. This mechanism implies the waste of tons and tons of CO₂ done by transport, and the production and disposal of a decade of milliard bottles each year.

The solutions proposed in Italy are mainly two.

The first is a system of bottling and sell of water and drinks in glass bottles, which each time are returned back, washed and refilled again. For each bottle is paid a caution, an incentive to bring it back and reuse it the next time.

This system was proposed by ItalGrob, the Italian federation of drinks distributors, with the project “*Vetro*

indietro”, and is actually an experimentation done in some cities in the north, central and southern part of Italy.

The main advantages of this system are correlated to the economical savings, which can be obtained through a correct management and a big basin of buyers, a return of image due to the environmentally sound concept, and to the creation of a relationship between the store and the buyer, which is induced to return there every time he needs.

The second system is proposed by many municipalities in Italy, and starts from the concept that the tap water is one of the best water in trade.

These projects are widespread:

- “Anch’io bevo l’acqua del sindaco” in Venice
- “Acqua in brocca” in Arezzo
- “Imbrocchiamola”, a campaign promoted by Legambiente and Altra Economia.

All those projects need a great work of formation and sensitization, and to do that many paths are possible.

Some ideas, coming from the projects above mentioned:

- the distribution of glass carafes as a gift, with a logo on the side

- the elimination of the bottles from the scholastic cookhouses
- the distribution of flasks in the schools
- tests and quiz in the schools, to the children and their parents
- public demonstrations and laboratories, in which are compared different kinds of waters
- to publicly advertise the domestic water treatment systems.

The tap water can be an alternative to the bottles even for the pubs and restaurants which would appear environmental friendly, and are interested in having a good image.

2.2.2. Reusable tableware

The main occasions in which throwaway cutlery are utilized are mainly local festivities, the scholastic restorations, during manifestations and whenever many people can eat together. The waste connected to this kind of events is very relevant, also because plastic sheets and glasses are not recyclable when they aren't washed, as they aren't. This huge quantity of non recyclable waste can be

avoided by means of dedicated actions, as can be read here below.

A curious practice that is coming out nowadays starts from the concept that to prevent the formation of waste is sufficient not to produce waste at all, and related to this some restaurants and pubs promoted the so called “finger food”. This is principally a commercial idea, which contributes to make those places different from the others: all the meal is eaten with the hands without forks, nor spoons or knives. This can be done even during weddings, birthdays and aperitifs.

Another way to solve partially this problem is to substitute the plastic cutlery with metallic ones, and the same for non recycling dishes and glasses. This was done in some local festivities, in order to reduce waste and promote the environmental sustainability of the festivity.

One of the most famous examples of this are some local festivities in the Province of Bolzano. The public administration since 2004 shares dishwashers, together with rigid plastic dishes, glasses and metallic cutlery, to all those organizations, associations or privates which need them.

This solution was possible since the project was organized at the provincial level, to keep low the costs and use the dishwasher as much as possible. This solution lowers the costs of sharing and make the choice an alternative not too much prohibitive (150€/d for the first two days and 50€/d for the others, with a set of 200 units. More informations are available on the Bolzano province website).

A less smart but still valid idea is that of the compostable dishes and cutlery, and this can be interesting in those cases where isn't possible to bring a dishwashing machine (for example, if there isn't the water pipeline). In this case all the setting is collected together with the organic waste, and this can be handy for the operators because there is not the need to separate the remnants of food. This solution can anyway work only in a contest where the organic fraction of waste is treated aerobically to produce compost. This solution was adopted in the gastronomic event “Salone del Gusto e Terra Madre” in Turin, where shoppers, cutlery and napkins were made in pulp and Mater-Bi, in order to be biodegradable and compostable.

The main problem correlated to this is the great difference in costs between plastic and compostable materials, which can only partially reduced by buying once huge quantities.

2.2.3. Reduction of paper

Sometimes it could be difficult to understand how the behavior of people can change so much by changing the contest in which they are. An example of that can be found in the expenditure of paper sheets, which in public and private offices isn't a relevant matter of concern.

Some elementary suggestion, although heard repeatedly:

- ⊕ print back and front
- ⊕ replace paper mails with e-mails
- ⊕ use computer archives
- ⊕ print using small fonts
- ⊕ use paper with reduced thickness
- ⊕ use recycled paper

In 2005 the municipality of Florence signed a protocol in order to prevent and reduce waste and their impact, and involved principally the local authorities of the province. Regarding the use of paper, a monitoring action regarding the implementation of good practices at the local level was promoted, and the obtained results were collected inside a

document, the “*Linee guida per la riduzione dei consumi di carta negli uffici*”.¹

The increase in urban waste production was speeded up greatly by the presence of paper, together with the packaging in general, and this share should not be underestimated. Paper prevention, intended as the most correct utilization of the necessary quantity of paper, can be a necessary step towards waste reduction, since they are the most important fraction on weight basis of waste generated in the offices, in the tertiary and the commercial sector. In addition, it is at the second place in the urban waste production hierarchy (21% of the separated fractions, after organic waste, 48%) (ARPAV 2012). An original idea in order to promote the use of recycled paper comes from the regional administration of the Emilia Romagna region, which created a line of stationery

¹ This protocol comes from the American project “cutting paper”, implemented by the Lawrence Berkeley National Laboratory (California), and was utilized by the U.S. Department of Energy, Waste Minimization Program. The project was then adapted to the province of Firenze and applied to municipalities and public administrations.

products utilizing the discarded paper of the regional Printing Center. The project, called “Sfrido!”, presents a series of paper blocks and notebooks with a wide choice of sizes and weights.

2.2.4. Refuse detergents

Plastic waste are a very relevant fraction on the total of urban waste if we consider the occupied volumes, and the reduction of this fraction is desirable from the environmental point of view, even if the recovery of this fraction leads to economic advantages.

The idea of recharge liquid detergents is valid because it changes the way of thinking the selling of goods, and requires the active participation of the buyer. It seems important to underline again that what we're looking for are actions able to change the behaviour of people, intended as citizens, parents, workers, buyers or electors.

What can be done in this field is very simple and effective:

- to prefer liquid refuse detergents (the best form of prevention)
- buy concentrated liquid detergents
- use products with the Ecolabel, grant for environmental excellence considering the whole life cycle of the product.

These solutions are present not only in the biggest supermarkets, but also by little retail outlets.

The most critic point regarding the diffusion of these initiatives is related to the communication actions towards the public, that should be promoted for a long period of time to convince about the quality, and to remember the bringing of the can.

Another point to be solved is the economic investment at the very beginning of this commercial activity, and in this sense a series of economical incentives can help the start up of these outlets.

A positive point is lastly the fact that the buyer is induced to return to the same shop to refill his tank, and this is without doubts an advantage for the activity which does also improve its image towards the public.

A practical example of that is the 1000 bolle point, an idea coming from a soap shop in the province of Verona, which is actually widespread in the northern part of Italy, where several kinds of refuse detergents are sold (see paragraph 3.3.2 for more details). As said by the company, at least 30% of the domestic plastic waste production can be reused by refilling.

2.2.5. Non utilized food

The theme of food waste should make reflect seriously on behaviours and habits we have, because this waste of resources implies not only economical and environmental consequences, but also social ones, and this makes the problem much more relevant.

The best way to solve this problem is to programme as best as possible the buying ad the preparation of foods and meals, and this can be done as much easy as the food request are low (the familiar level).

Where the production of residual food is unavoidable, the parts that are still clean can be destined to charities, or to structures that deals with animals.

These initiatives are without doubts the best solution for the fate of the still edible food, but there's the need of a strict cooperation between the structures that are involved, since the transport and the distribution of these products should happen in the shortest time.

The national law regulates this kind of activities by means of the law 25/06/2003 n.155, the legge del buon samaritano, and the application of that can be found in many similar initiatives spread in the national territory

(Banco Alimentare, Caritas, and local projects or programs like the “Buon samaritano project” of Turin).

The economic advantages of this kind of projects are related to that structures which receive goods, but reflects positively also on the municipality, which should not treat and dispose this material, and on the original owner of this food, which shall not have too high costs of storage.

The most common reasons which cause the waste of edible food are the presence of:

- products near the expiration date
- non sold products (bread, fruits or vegetables)
- ruined packagings

The proposed system has also the advantage of reduce dramatically the needs of logistic structures like the warehouses, and this is evidently a great economical benefit.

2.2.6. Composting

As stated in the Report 2012 of production and waste management in Veneto, the organic waste, composed by kitchen waste and green waste, represent the 48% of the total amount of separately collected waste in Veneto.

Normally this kind of waste undergoes a preliminary anaerobic treatment followed by an aerobic stabilization in order to produce both biogas and stabilized compost. Both these products can be valuable on the market, but normally the management of putrescibles requires more money than earned, since it isn't a self sustaining market. This is the starting point for the homemade composting activities, which purpose is to create an aerobic environment where kitchen waste can be easily decomposed in order to create a fertilizer useful for gardening activities. This kind of practice can be useful if properly applied, since the composting bell should be correctly used to prevent the production of annoying odors or the presents of rats or other undesired animals.

In many municipalities this activity is promoted with a percentage reduction in the environmental fee (actually, the TARES), together with a monitoring system.

The results are evident at the municipal level, since both fix and variable costs related to organic waste are reduced. This can be possible anyway only with a proper and effective sensitization program, acting at least at provincial level, and normally the costs of formation and buying of

material are comparable with the gains obtained, if some forms of incentives aren't applied.

2.2.7. *The WEEES*

In the Rapporto Rifiuti Urbani 2013 edited by ISPRA is shown that the total national production of electric and electronic equipments in 2012 is about 220 900 tons, of which 27 600 tons were produced only in Veneto. This huge amount of waste (1,2% of the regional total waste production) is actually disposed, but a lot could be done in order to prevent its formation. A series of preventing actions were implemented by different Italian municipalities , and some of them are listed here below. The main purposes are to ensure a longer duration of this kind of goods with a proper utilization, and a well managed maintenance.

The province of Bolzano has set up a project called *Ex novo*, that is a computer store which collects and links together all those activities that repair, rent and sell already utilized objects, in order to make supply and demand met each other.

Beside this, it was proved that old computers can be recovered by installing the GNU/Linux operative system,

and many projects are recently working on this (*Binario etico* in Rome, *RicicloPC con Linux* in Ferrara). This is important not only to recover old equipments, but also to give technical assistance, start informatics courses, diffuse open source software and help those people that hasn't the possibility to buy a computer.

2.2.8. Long lasting goods and clothes

The most effective way to do waste prevention is to prevent that still functioning goods would become waste too early. As said for electronic equipments, the best things to do are maintenance and the selling of old goods, if they are still in a good state, and this is valid for many long lasting goods like furnishings or clothes.

This kind of materials can be found principally together with bulky waste, and the idea is to intercept them before the conferral into the ecocenters, for example bringing them to second hand stores.

This is what is actually done in many cities and towns in Italy, where dismissed goods are repaired and entered again in the market.

Together with the presence of these stores, a series of frame initiatives help the success of the main prevention

objective: an example of this are the developing of web sites which promote the exchange of goods and the second hand markets, which is rapidly growing; another could be the promotion of weekends or events in which people are invited to bring and exchange second hand goods, like what was done in Brescia (*S...cambio di stagione*, Legambiente), in Vicenza (evenings promoted by Equobar Vicenza), and in Follonica (*Ecoscambio*).

The same was done for the second hand clothes market, which could be both managed for sale or for social utilization. In particular, the Caritas Italiana is present in most of the bigger Italian towns, and is an important point of reference for those who need staples, like clothes or blankets.

2.2.9. Washable diapers

A separated chapter deserves this topic, which recently attracted the attention of a growing number of families. This solution allow to reduce completely the amount of non recyclable waste deriving from baby diapers, because of the composition of the new washable diaper, which has a compostable part and a washable and reusable part, made in cotton.

This solution needs a big action of sensitization towards this, even because of the initial investments required, and a number always bigger of municipalities promotes this environmentally safe solution. The advertising and answers to the most critical points regarding the diaper of new generation are available on the internet, and a local application is presented on chapter 3.3.3.

2.2.10. Further suggestions

It seems important to underline that every action that a public administration would like to promote in its territory would be as much effective as it is supported by the citizen. In every town and city there are many different ideas regarding all those choices that a public administration can sign, and the aim is to take into account all the different points of view and take the best decision for the whole community. The methods available to ask the opinion of people are different, depending on what must be asked and the type and quantity of people that must be reached.

Some of them are listed here below (source: dispensa di Valutazione di Impatto Ambientale, ICEA department, University of Padova):

- operative units: used for the resolution of one specific problem, it is composed by 10-20 people, and is supervised by some technicians;
- advisory committees: they could be composed by 50 or 100 citizen, or by a group of technicians;
- group dynamics: This specific technique involves groups of 10-25 people for a limited period of time (30-90 minutes), supervised by some technicians as above, and could be similar to a role play;
- opinion surveys, which could be done on telephone, door to door, to public assemblies or with other methodologies.

The attention to have in this case is to avoid oversimplifying the questions, unless the results would be useless;

- the Delphi technique is a prevision of the consensus of the citizen, done by different technicians, and is followed by a public consultation.
- public assembly: it is one of the most used technique. It is very useful since it becomes a debate only between the public administration and the technicians.
- Referendum: it is simple to do and to understand, but the risk is to undergo politic instrumentalization.

- La charrette: this is an old technique, in which the different purposes or points of view are illustrated and brought on the street, where people can see them and commented.

In addition, if a single strategy is promoted by different municipal departments, it is easier that a good result in a shorter period of time would be reached.

Normally the actions done by the single environmental department are not supported by many others, because it's simpler to keep separate the different ambits.

It has been noted anyway that the waste theme is present in so many activities promoted by the public administration, and that a collaboration, even when difficult, leads to greater results.

2.3 The European and national contest

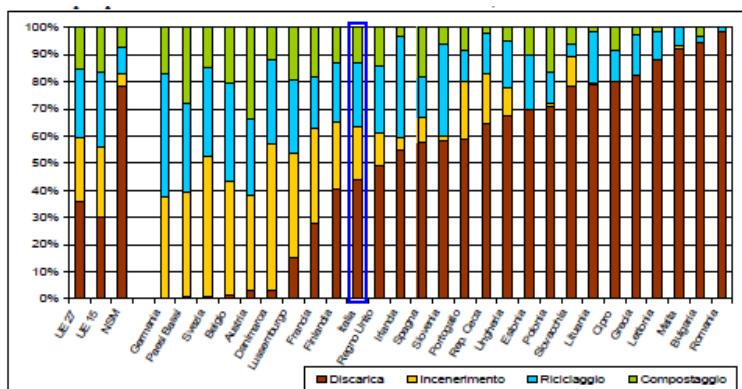
Before to have a look about the waste management and the results obtained in the municipality of Quinto Vicentino, it seems important to understand the results obtained at an higher level, having an overview also on the Italian and regional situation.

Comparing the national overall waste production , which in 2012 was 29 962 thousand tons (ISPRA, 2013) with the other main European countries, it can be said that the Italian production is little above the mean European value, as shown in table 2.1, related to 2011.

Table 2.1 Comparison between *pro capita* waste production in some European countries in 2011 (ISPRA 2013).

Countries	Waste production [kg/(inh.*y)]
UE (27 states)	502
Denmark	718
Germany	597
Spain	531
Italy	528
France	527
United Kingdom	518
Greece	496

These waste are managed differently in each country, depending on environmental and economical choices, as well as on technological possibilities; the fate of collected waste is illustrated in figure 2.1.



Fonte: elaborazioni ISPRA su dati Eurostat

Fig. 2.1 Percentage breakdown of European waste management in 2011 (ISPRA 2013). In blue is highlighted the Italian situation.

Italy disposes in landfills near half of its waste, more than the European mean value if considering the total amount of waste to be disposed, as can be seen.

Concerning the national production, the reference situation is described in the following graph. The actions to develop at any local level can't disregard the provincial or regional situation, and from this point must start any discussion about system improvements.

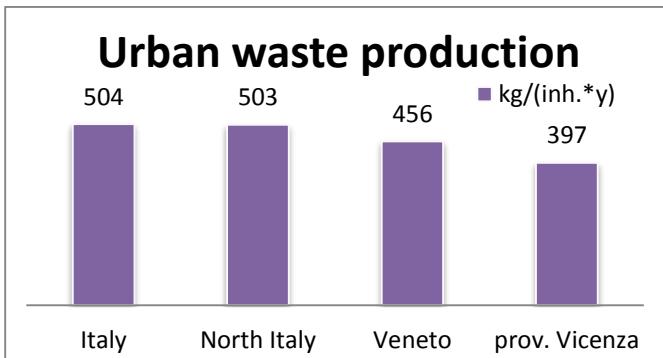


Fig. 2.2 *Pro capita urban waste production in 2012 (ISPRA 2013)*

Concerning the separate collection done in the national territory (for the definition of separate collection, see paragraph 2.4), the situation is well described in fig. 2.3, where the different Italian situations are compared. In particular, the province of Vicenza is one of the most virtuous in this sense, since this value is about 64,11 %. Unfortunately this was not sufficient to meet the national goal of 65%, attended for 2012 by the D.Lgs. 152/2006 and the law 27 December 2006 n.296.

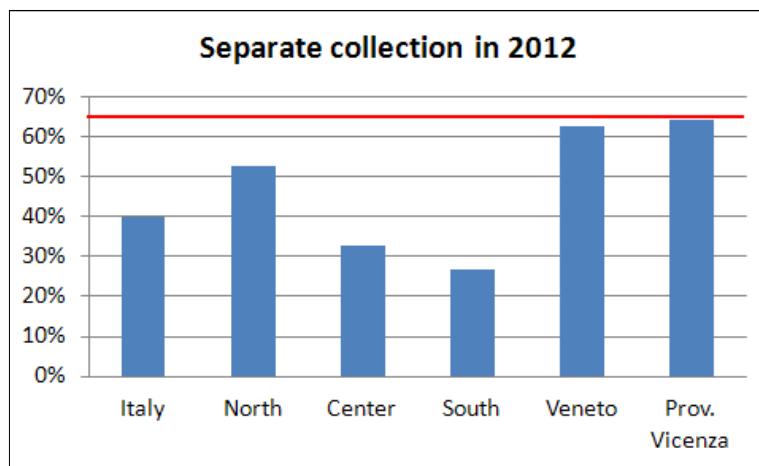


Fig. 2.3 Separate collection percentages in Italy (ISPRA 2013). In red is signed the objective for 2012 proposed by the Italian law
27/12/2006 n.296

The management of the waste produced in Italy can be described in the following graph, referred to 2011. The most utilized disposal kind is the landfill, as said before, followed by material recovery and incineration.

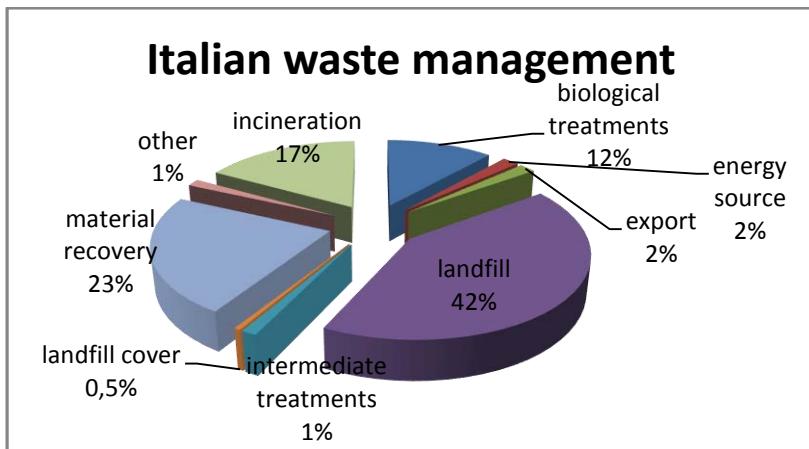


Fig. 2.4 Waste destination and percentages in Italy, referred to 2011
(ISPRA 2013)

The material recovery in Italy is supported, for the packaging fractions, by CONAI. This consortium stipulates directly with the municipalities a convention (Accordo ANCI-CONAI, 23/12/2008, valid 5 years from 1 January 2009) which requires the separation of packaging materials, their collection and sending to recycling, followed by an economic fee towards the municipality. The quantities of packaging collected and recycled in 2011 are described in the following table 2.2.

Table 2.2 Amount of packaging released to the market and their further recovery percentage (ISPRA 2013)

	Produced thousand tons	% recycled	% energy recovery	% total recovery
Plastic	2075	36	32	68
Wood	2306	55	4	59
Paper	4436	80	8	88
Aluminum	69	60	5	65
Steel	486	73	-	73
Glass	2245	70	-	70

The incineration solution is recently increasing its importance, following the European tendencies, and on the other hand the landfill disposal is slowly decreasing.

The total amount of urban waste disposed in Italy has been decreasing from the 17 526 thousand tons of 2006 to 13 206 thousand tons of 2001 (ISPRA 2013), due to different factors:

- ⊕ A decrease in waste production (1,1 million tons) due to the economic crisis,

- ⊕ The change in final disposal (loss of 1,8 million tons),
- ⊕ The reduction of unsorted waste (loss of 1,5 million tons).

As a matter of fact, 288 landfill closed their activity from 2003 to 2012, 80% of which in south Italy (*Rapporto Rifiuti Urbani 2013*, ISPRA); this tendency started in 2003 with the emanation of D.Lgs. 36/2003, which actually regulates the landfill authorizations and management². It must be underlined anyhow, that the closure of the mentioned landfills “didn’t always lead to an effective system evolution towards integrated solutions”, confirming the necessity to improve the managing system especially in the southern parts of Italy.

² In particular, the D.Lgs. 36/2003 art.5 states that each region must approve a regional plan for the reduction of biodegradable waste. Actually the Veneto Region allows with his plan to dispose the urban waste in landfills since the putrescible content (putrescibles and green waste) is less than 15%. In article 6 of the same D.Lgs is required also to have a lower calorific value (LCV) lower than 13000kJ/kg from 1 January 2013, slightly in contrast with the regional statement.

2.4 The regional contest: waste production and management

The Regional Waste Management Plan for urban and special waste of the Regione Veneto was adopted by the regional council on 5/03/2013 and is now attending the final approval.

The waste production and the tendency to save waste by means of a well done separate collection is illustrated in the picture below, where the residual waste and separated waste collection are compared.

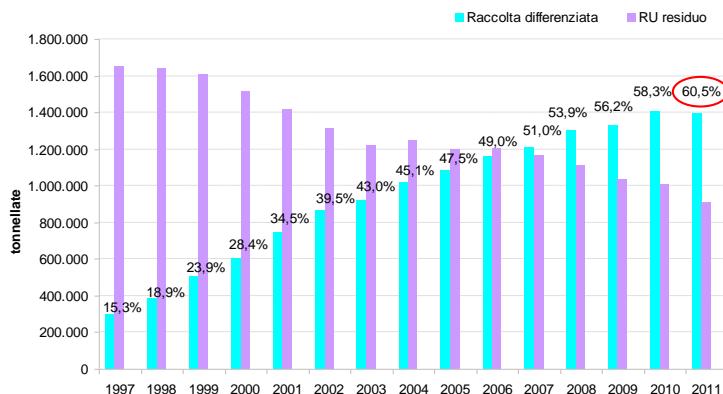


Fig. 2.5 Separated and residual waste production from 1997 to 2011 in the Veneto region (ARPAV-Osservatorio Regionale Rifiuti)

The composition of the collected fractions is shown in figure 2.6. It can be seen that the main fraction is

composed by putrescible matter, followed by paper and cardboard. Plastic materials have a low specific weight, and even their volumes are very relevant, the total weight collected in the region approaches only the 200 thousand tons.

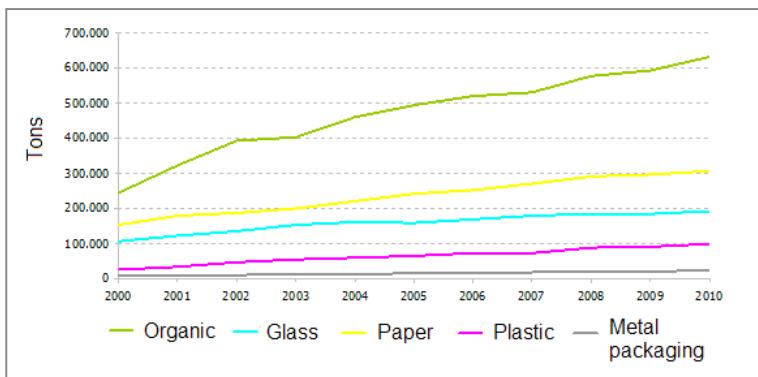


Fig. 2.6 Collected separated fractions trend in Veneto(ARPAV-Osservatorio Regionale Rifiuti)

The composition of the collected waste is presented in the following figure 2.7. As can be predicted, the main fraction is composed by residual waste, which merceological composition is presented in fig.2.8

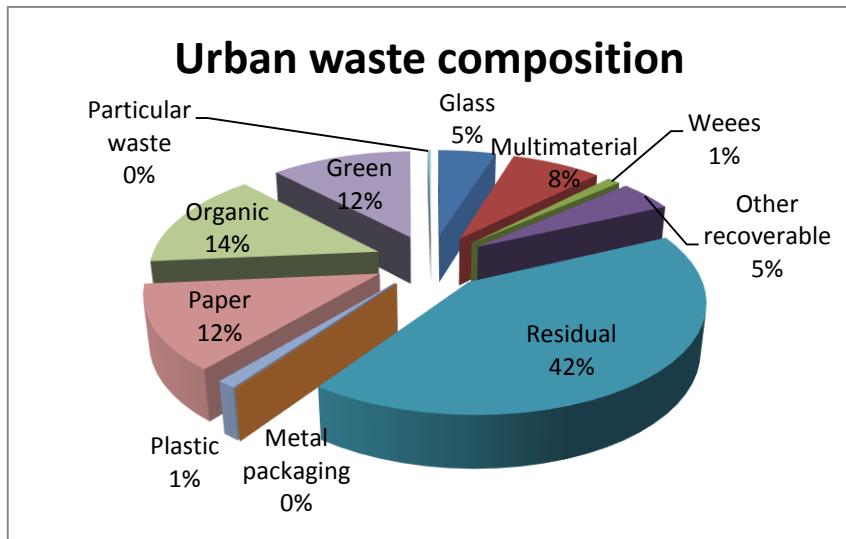


Fig. 2.7 Percentage urban waste composition in Veneto Region, 2010
(ARPAV-Osservatorio Regionale Rifiuti)

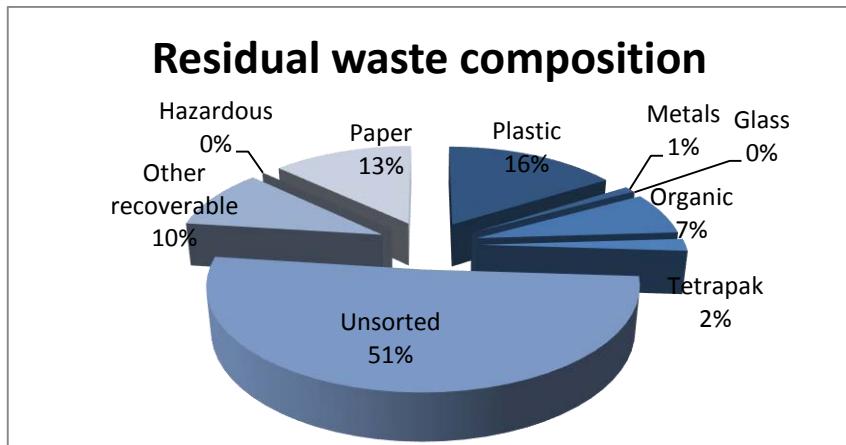


Fig. 2.8 Merceological analysis result of a residual waste sample in Veneto (ARPAV-Osservatorio Regionale Rifiuti)

The composition of the residual waste was obtained with a merceological analysis done on waste sample coming from municipalities with a percentage of separate collection (calculated with the ARPAV definition, see paragraph 2.5) higher than 60%.

The overall waste management system in Veneto, in 2010, is presented in the graph below.

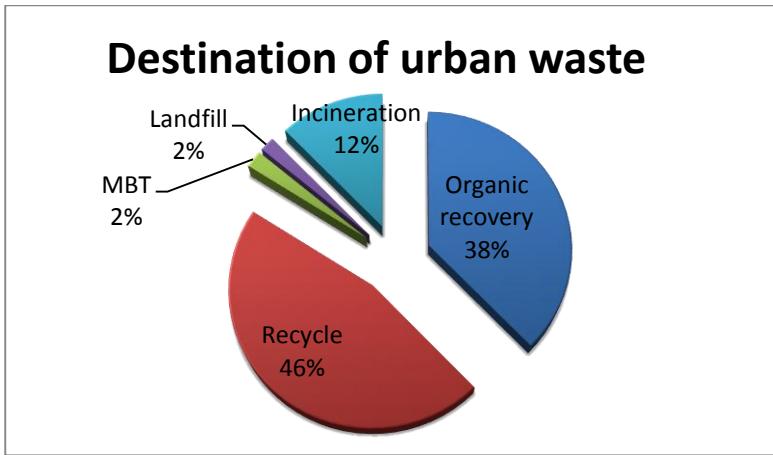


Fig. 2.9 Waste management in Veneto, 2010(ARPAV-Osservatorio Regionale Rifiuti)

The organic recovery in 2010 was about 631 043 tons.

Recently the aerobic treatment of green waste and putrescible waste has been complemented in a few plants by a previous step of anaerobic digestion, in which is produced biogas, to allow a further energy recovery that in

2010 was estimated of 50 thousand MWh (already considering the plants energy needing).

Regarding recycling, all the collected recyclable fractions (paper, glass, plastic, steel and aluminium) should be selected and prepared for the recycling step.

It should be said that the less efficient selecting process is that of the plastic materials, which depends on the collecting system (the door to door system is much more efficient), on the fact that there are many different polymers and it is more difficult to recognize and separate them, and on the general formation of the citizen. On a general indication, the rejects obtained from a plastic selection can be 10% for a monomaterial door to door collection to 30% for multimaterial door to door system, because there is the needing to select at least twice the whole material.

The metals selecting system leads to very low rejects (1%), but the collected amount are much less relevant related to plastics.

40% of bulky waste is sent to recovery facilities, and after the sorting could be recovered only the 12% of the initial amount.

Recently also the 45% of the waste from street sweeping is sent to sorting facilities, to recover inert materials like sands and gravel.

The mechanical-biological treatment is an important step to recover materials from the residual waste; in Veneto are accepted approximately 400 000 tons of residual waste each year. This quantity is sent to:

- CDR production plants (96 000 tons, of which 96% is furthermore sent to incineration and co-incineration plants)
- biostabilized waste production (19 000 tons)
- recovery treatments (15 000 tons; the most relevant recovered fractions are metals, earths, wood and glass).

The remaining fraction (160 000 tons) is disposed in landfill (41%), sent to mechanical biological treatments (28%), to CDR production plants (16%), or burnt into incineration and co-incineration plants.

Analyzing the Regional Plan of municipal urban waste, it can be observed on paragraph 2.3.6, *Tariffe degli impianti di smaltimento*, that the disposal costs are much higher than those of the CDR production and incineration. This situation can't be solved without a change also in the

mentality and in the actual regulation, which gives no sufficient inputs to disincentive the landfill disposal towards material and energy recovery.

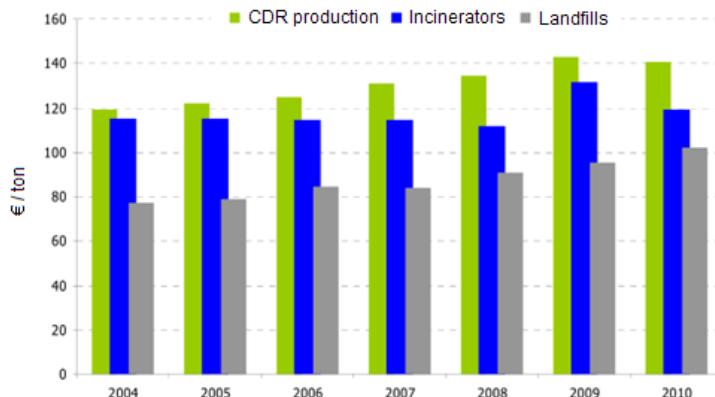


Fig. 2.10 Mean disposal costs in Veneto from 2004 to 2010, Urban waste regional Plan, Veneto Region 2013.

An example of economical input could come also from the local administration by introducing the so called “punctual fee”, a payment system which takes into account the specific waste production instead of the owned surfaces. As can be seen in the figure, the overall waste production diminished, and this reflects positively on the costs.

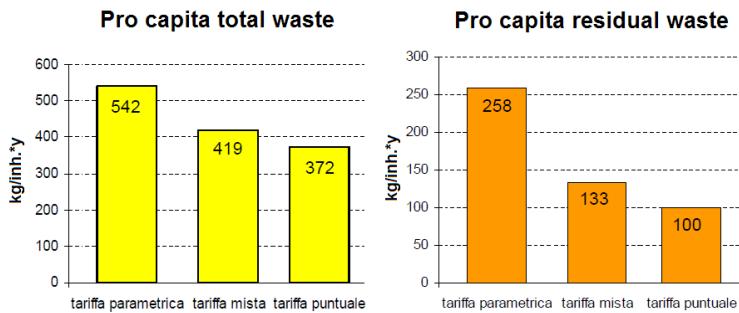


Fig. 2.11 Comparison between different types of taxation and their relative waste production

It must be underlined anyway, that the punctual fee can be applied only in those contest in which there is already an high level of formation obtained in many years of activity, otherwise this system would be not only ineffective, but also counterproductive for the non-authorized phenomena of waste littering among the streets or rivers.

2.5 The percentage of separate collection

As said in the European directive 2008/98/EC, “*separate collection means the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment*”. This concept often needs to be translated into a numerical indicator, to define a specific

degree of separate collection and allow comparisons between different realities.

Unfortunately, there isn't today a national definition of this indicator, although the national legislation required that in D.Lgs 152/06, art.25 comma 4.

The most important alternatives utilized in the Region are the models proposed by:

- ❖ ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) at national level
- ❖ ARPAV, Osservatorio Regionale Rifiuti at regional level.

Here are briefly illustrated the methodologies. This is shown to point out that changing the calculation method the value would necessarily change, and a great attention should be paid in understanding the source of those percentages and how they were built.

ISPRA presented, in its *Rapporto Rifiuti Urbani 2013*, the system utilized since 1997 in its official documents, which refers to the formula

$$RD \% = \frac{\sum_i RD_i}{(\sum_i RD_i) + RU_{ind} + I + S_{RD}} * 100$$

where:

$\sum_i RD_i$ = quantities that compose the separate collection, on net of residues, composed by:

- Organic fractions (putrescibles and green waste)
- Packaging in paper, plastic, glass, wood and metal
- Other typologies of paper
- Weees of domestic source
- Bulky waste that underwent recovery treatments
- Used clothes and textiles
- Selective collection (batteries, expired medicinal, paints and other urban hazardous waste)

RU_{ind} = residual waste (CER 200301), waste from street cleaning (CER 200303) and other residual urban waste (CER 200399).

I = disposed bulky waste (CER 200307)

S_{RD} = residues of separate collection

In this calculation are not considered the inert waste, since they are classified as special waste.

This methodology is utilized evenly in the whole national territory in order to make the different evaluation comparable each other.

The second methodology utilized at regional level is that presented by the *Osservatorio Regionale Rifiuti*, which

considers only the collected fractions without highlighting the recovery operations done after the collection.

The utilized formula is:

$$RD \% = \frac{\sum_i RD_i}{\sum_i RD_i + RUR}$$

where:

$\sum_i RD_i$ = quantities that compose the separate collection, composed by:

- Organic fractions (putrescibles and green waste)
- Packaging in paper, plastic, glass, wood and metal
- Other typologies of paper, plastic, glass, wood and metal
- Weees of domestic source
- Long lasting goods
- Other recoverable material (wood, textiles, pneumatics, packagings, and others)
- Selective collection (batteries, expired medicinal, paints and other urban hazardous and non hazardous waste)

RUR = residual urban waste, composed by

- Unsorted urban waste
- Waste from street cleaning
- Bulky waste
- Other non biodegradable waste

This methodology leads to slightly different results because it includes in the separate collection also the residues, and doesn't

consider the further treatments (biostabilization, CDR, further treatments of street cleaning waste, bulky waste and unsorted waste).

In order to consider also the residues that aren't recovered, the Osservatorio Regionale Rifiuti, together with the IMAGE department of the Padova University of Studies, introduced the IR (material recovery index):

$$IR = \frac{\sum_i RD_i * R_i + \sum_i RUR_i * R_i}{RD + RUR}$$

where:

RD_i = quantity of the i^{th} fraction composing the separate collection

RUR_i = residual waste destined to a recovery plant

R_i = recovery percentage connected with each fraction

$RD + RUR$ = total of produced urban waste

This index is an estimation of the material quantities that are introduced again on the market and comes from different recovery processes (mechanical recovery, chemical and biological systems), and allows to describe if a separate collection leads to an high degree of material recovery, which implies less residues to dispose, and an higher fee due to the selling of this material.

Chapter 3

How to reduce waste in Quinto Vicentino

The aim of this study is to investigate the actual waste management system and individuate those behavior that could be improved, both on the individual and on the municipal level.

If many stakeholders are involved in this work, this kind of work can lead to several benefits:

- ❖ a better knowledge of the waste production system
- ❖ to realize what could be done by each family to reduce its own waste
- ❖ a sound economic balance which takes into account the benefits of saving waste but also the energies utilized to achieve these results
- ❖ the possibility to compare the obtained results with those of other communities.

Keeping in mind these objectives, here below is explained the work that has been done.

3.1 The municipality of Quinto Vicentino

The town of Quinto Vicentino is a little municipality (5762 inhabitants at 31 July 2013, for a total of 2194 families) situated in the eastern part of the province of Vicenza, quite in the middle of the Veneto Region in the northern part of Italy.

We are inside the Padana plain, and the territory is mainly a countryside characterized by a town center, some little industries and many cultivated lands, for a global surface of 17 km².

The waste management is entrusted to Soraris S.p.A., a society which collects, transports and disposes the municipal waste of 15 municipalities in the province of Vicenza.

The waste management system actually present in Quinto Vicentino involves the separate collection of waste in two different categories:

- ⊕ Residual waste
- ⊕ Organic waste

- ⊕ Plastics and cans
- ⊕ Paper and cardboards
- ⊕ Glass

In addition, inside the ecocenter present in the periphery of the municipality, it is possible to carry other kinds of waste, that are:

- ⊕ Paper and cardboard
- ⊕ Iron and metals
- ⊕ Green waste
- ⊕ Wood materials
- ⊕ Waste material from demolitions
- ⊕ Plastic packaging
- ⊕ Tin packaging and cans
- ⊕ Mineral and vegetal exhausted oils
- ⊕ Exhausted batteries
- ⊕ Weees
- ⊕ Bulky waste
- ⊕ Expired drugs
- ⊕ Toner and ink cartridges for printers
- ⊕ Fluorescent lamps

It should be noted that the level of organization in the waste management and the participation of the citizen is

sufficiently high compared with the average Italian behavior, and this work cannot disregard this.

But many steps can be done to go further, if the target is to reach the better levels.

This work focus mainly on methods and programs to reduce residual waste. The first issue to be analyzed is the quality and quantity of residual waste produced and collected. In the next graph is shown the total amount of residual waste produced since 2006 in the municipality of Quinto Vicentino.



Fig. 3.1 Annual trend of waste production in Quinto Vicentino (source: Soraris S.p.A)

3.1.1 Merceological analysis

The only data regarding residual waste available refers to a merceological analysis done on October 2012 on a sample of waste coming from each single municipality handled by Soraris S.p.A.. It is than representative of the waste production of 15 municipalities, of which:

- 6 have less than 5000 inhabitants
- 4 are comprehended between 5000 and 10000
- 5 are comprehended between 10000 and 13000

Besides the approximation needed to consider reliable this estimation for the considered area, the analysis results are resumed in the following graph.

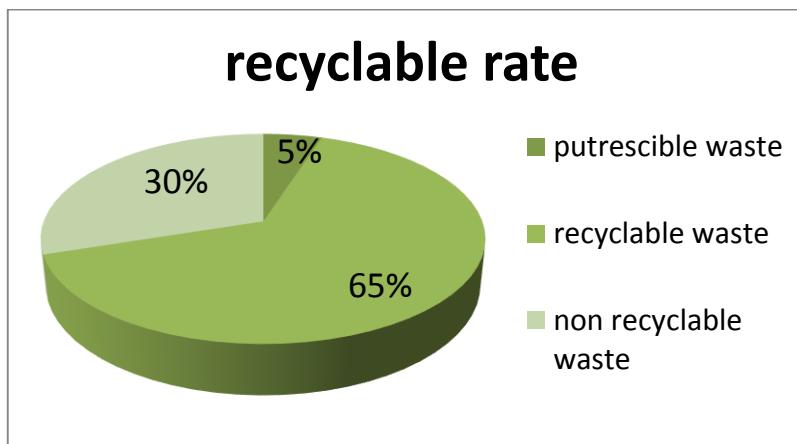


Fig. 3.2 Merceological analysis done on 15 municipalities (Soraris S.p.A., 3/10/2012)

This situation is the starting point for a synergic program of waste reduction. Since almost 70% of residual waste can be recovered, there is great margins of improvement both on the degree of separation and also on the absolute quantities of waste produced, as can be seen further on chapter 4.

3.2 The familiar level

One of the merits of this work is the fact that it underlined the importance of the engagement of all the citizen, because nobody can affirm to live without making waste. Since residual waste are considered the index of the inefficiency of a community, the investigation must start from here, that is the refuse waste bin.

3.2.1 *The weight of refuse waste*

It has been chosen a sample of 20 families to be studied. In order to make this work significant, these families have different compositions: age, number of persons and lifestyles have been chosen in order to represent as well as possible the social fabric of the chosen municipality.

To each family I asked to realize how many waste they produce every week in terms of weight.

The choice of asking families to weight their own waste was taken to reach two objectives: first, it allows a comparison between the sample and the official data of the municipality, and allows also to realize if there is a change in the trend of the production of waste after a sensitization program; second, it is the best way I found to make the people to realize the amount of waste they produce.

These twenty family kept weighting their waste for a period of 8 week. I chose this trial period because it is sufficiently long to highlight the real behavior of the studied families, and at the same time not too much exacting and demanding. It seems obvious that if the work required is too much hard, the data obtained could be highly inaccurate and, what is more important, the attitude towards the environment would decline, that is the opposite of the goal of this work.

The environmental training is one of the key we have in order to approach the so-called “zero waste” society, and the work done on the families has training as his principal goal.

The steps followed in order to reach this goal were:

- ⊕ probe the average knowledge concerning how to separate waste
- ⊕ weight the waste bags produced every week, for a period of 2 months (8 weeks)
- ⊕ after a period of 2 weeks of study, each family was asked to control periodically into the refuse waste bin if there were some recyclable objects and to sign it.

I think that this last point should be emphasized.

As R. Cavallo wrote in his book, the refuse waste bin normally keeps growing uncontrolled without letting us understand when and how. This behavior can be contrasted controlling what is present inside the bag, and normally there are some objects to pull out and put in the right bin. This action, apparently simple and insignificant, leads to a very huge revolution in the normal way of thinking, in which what is inside the bag cannot be pulled out anymore.

The goal is to think at waste as something that is not at his final stage, and the best thing we can do is not to think about a waste at all.

The next step that could be done, after recognizing what's inside the refuse waste bin, it's to realize how many times during the journey we approach the waste bin. This is a very impressive test to do, that make us thinking how much waste are present in our lives. After this kind of experiences I think it is much easier to pay attention to our behavior concerning waste, and in particular the goal of waste reduction can be approached.

3.2.2 The questions

During the two months of study each family was asked to answer to some questions, regarding simple actions that can help to understand the situation taken into account: by these interviews the degree of attention to the environment and the doubts possibly present have been checked.

The test was composed of a total of 7 questions, collected here below.

- 1) Answer a test concerning where to throw 12 different kinds of waste.

This kind of survey is very useful because it is simple and entertaining. The focus was not on the single correct answer, but allows to understand whether there is confusion or bad information of people

- 2) Advantages and disadvantages of the home made composting.

As written before, we are in a countryside and this kind of practice can be widely used. The investigation was done in order to understand how it is made, and if it is useful for this kind of reality to decrease the amount of organic waste.

- 3) The utilization of bulk detergents
- 4) Second hands stores
- 5) The attention to reuse and material saving in the working environment
- 6) To describe all those actions that help that family to produce a low quantity of waste
- 7) The easier methods to get informed about how to correctly separate waste

The results of this survey will be discussed in the next chapter.

3.2.3 *The formation*

After a period of six week of observation of the produced quantities, I visited each family in order to help them to

confirm or deny their doubts regarding the correct way of waste separation in our municipality.

This was done almost at the end of the work because I would like to focus especially on the average behavior of the people living in the town, without altering the knowledge of the samples.

This formation was done after a documentation phase, in which I went to the Soraris S.p.A., the society which manages the waste of the considered municipality together with other 14 neighboring municipalities and asked for the correct separation. In this way I could have the official answers of the test proposed to each family at the beginning of the study.

In addition, the official communications published by the municipal council in the site of the town available on the internet were also considered.

With these two data sources I made a mini guide to the appropriate separation of waste in the municipality of Quinto Vicentino. The language utilized in this document is intentionally simple and completed by examples, in order to be useful and practical.

I insist on the formation because I think it is one of the most effective tools against those actions done out of habit.

3.2.4 The merceological analysis

After a period of three months and a half from the formation work, during which each family wasn't contacted, an analysis was done on their refuse waste. A sample of one bag each was collected and brought to the laboratory sited in Voltabarozzo (Padua), and a merceological analysis was made on this material (see Appendix 1 for further details).

The analyzed categories of waste are illustrated in the table below, in which is shown also their recycling possibility. The term “recyclable” utilized below means the effective possibility for the municipality to give the material to a recycling or composting facility, and does not imply the effective recycling of the considered material.

Table 3.1 *The waste categories considered during the merceological analysis and their recyclability (ARPAV- Osservatorio Regionale Rifutti)*

Separated fractions	recyclable
rigid plastics (not packagings)	no

rigid packaging plastics	yes
soft plastics (films and shoppers)	yes
plastic cutlery (sheets and glasses)	yes
organic material	yes
clean wipes	yes
paper and cardboard	yes
tetrapak	yes
metals	yes
textiles	yes
Polylaminated (aluminates)	no
Diapers	no
Others non recyclable	no
underscreen	no

The total amount of analyzed waste was 9,93 kg, and its composition is shown in the graph here below.

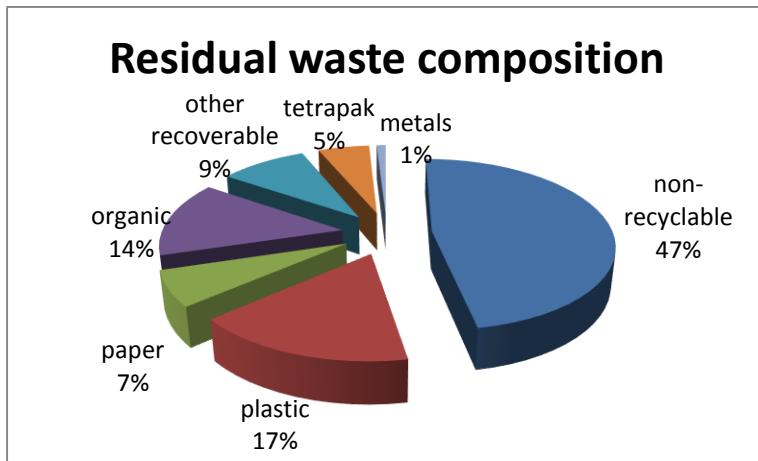


Fig. 3.3 Composition of the residual waste after a few months from the formation work. The percentages are expressed on weight basis.

What seems relevant to underline is the huge amount of plastic packagings (in terms of weight, but especially in volume) still present in the residual waste. This plastics had the following composition:

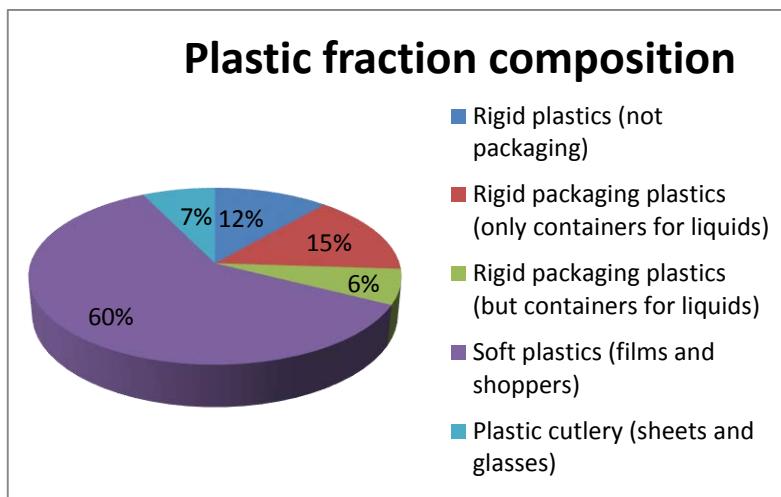


Fig. 3.4 Composition on weight basis of the plastic fraction of the refuse waste considered.

The main part of this plastics is composed by plastic films, mainly made by food packaging (crackers, pasta and others). This fraction can be easily recycled as it is, and a great margin of improvement can be stated.

Another discussion can be made on those plastic films which covered oily or greasy foods, that cannot be recycled in these conditions. The best home treatment that can be done is to rapidly clean the surface with a kitchen paper, which can be collected together with kitchen putrescible materials, and the plastic can be treated with plastic packaging.

No glass was found in the considered sample, and a relatively low quantity of metals (given by aluminum films), and this can be a clear signal of correct separation of those fractions.

No baby diapers at all diapers was found, because they are collected in a dedicated bin.

An interesting evaluation can be done considering the percentage of reusable and recyclable materials present inside the residual waste.

The reusable materials that were found are:

- small clothes and other textile materials (more or less half of the textile present)
- paper bags and plastic shoppers
- an aluminum jar
- a sponge
- small toys.

This would mean that only a little part was thrown away without necessity, and this reflects the kind of society that hardly throws away what can be used still a bit.

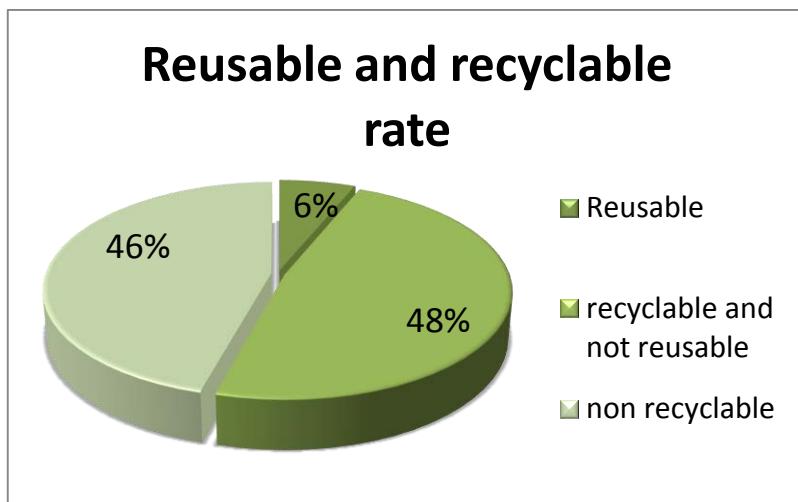


Fig. 3.5 Weight composition of the residual waste in the considered sample

3.3 Public and private waste prevention

Inside the municipality of Quinto vicentino has been developed a series of measures to reduce at source the total amount of waste. In this paragraph some of them are described, and an environmental and economic balance has been developed.

3.3.1 The public water

In March 2013 was installed a public platform in the center of the municipality, aimed to deliver tap water both still

and sparkling. This initiative was clearly implemented as a waste prevention action, to promote the public water instead of the bottled.

The distribution takes place utilizing a prepaid card, furnished by the Acqua Tecnica s.r.l. which manages the service.

From 15th March the distributed liters of water are about 137000 (data obtained on 27/09/2013), which correspond more or less to 91300 plastic bottles of 1,5L.

Considering that the medium weight of a PET 1,5L bottle is 40g, the projection of the saved plastic weight in a year is 3652 kg.

This result would mean a lot in terms of environment, because even if there isn't the immediate economic advantage deriving from the selling of this plastics, there is the social need to mitigate the widespread commercialization of this good, that in many case (not always) isn't better than the public one.

The bottle water has a noteworthy environmental footprint, considering both the plastics production, but especially the transport phases; this problem would be partially solved if each region would drink only its own water, reducing a lot

the big distribution market that involves the biggest water companies.

3.3.2 Detergents on tap

A private form of waste prevention can be found in a small commercial activity sited in the town center. It is an agrarian store (Franzoni fratelli s.n.c.) in which from 2010 are sold detergents on tap, branded *Millebolle*.

In one year of activity this store sells more or less 4600 liters of detergents, which can be of different kinds of products:

- ⊕ dishwashing liquid
- ⊕ laundry detergent
- ⊕ dishwasher detergent
- ⊕ detergent for floors
- ⊕ softener
- ⊕ degreaser for surfaces
- ⊕ glass cleaner
- ⊕ hand soap
- ⊕ shampoo
- ⊕ bubblebath

Aside from the wide range of products sold, this business activity offers sales twice a year, and this permits to be

competitive with the other big companies selling inside the supermarkets.

Normally all these detergents are sold in a 2 liters jerry can, which means almost 2200 containers per year saved, if we consider to sell a hundred jerry cans every year.

The sold bottles weight 85g each, and doing a rapid weight estimation, the total amount of saved plastics is 187 kg/year. This is really a little percentage of the net production of plastics (0,4%, source: Soraris 2012), and does not change very much the total amount of plastics to be managed.

In addition to that, from the economic point of view this could be counterproductive, since plastic packaging is collected and sold to CONAI. This loss of income (100€/ton, from the *Bilancio Consuntivo 2011* of the municipality of Quinto Vicentino) can be justified as investment in the environmental education of citizens. The environmental goal of waste reduction can be reached by means of the synergic effects of different measures stated not only by the municipality, but also at provincial or regional level.

3.3.3 The experience of cloth diapers in a baby daycare

In the municipality of Quinto Vicentino the proposals implemented in order to reduce the amount of non-recyclable waste are present in both the public and private sectors. Here below is presented the experience of the daycare of Lanzè, a hamlet of Quinto Vicentino.

Since the beginning of the present school year the school administration promoted the initiative “washable diapers” for all the babies welcomed in the daycare, almost composed by twenty babies every year.

The daycare divides the babies into three age groups: between 0 and 12 months, 12 and 24 months and 24-36 months. Normally the experience of the daycare aims to accompany the child’s growth also taking care of the child’s autonomy in going to the toilet, so that at the moment of the passage into the kindergarten (almost 3 years old) he is able to realize its needs in this sense, and utilize the diaper only for the afternoon nap, if there is the necessity.

The adoption of washable diapers signed an important change in direction towards a more sustainable waste management, since this directive allowed not to produce several kg per day of non-recyclable waste, as can be seen in the estimates here below.

3.3.3.1 How to use cloth diapers

Washable diapers are made by three parts:

- ❖ The diaper body, made in cotton.

This is the washable part, which is cleaned and disinfected every day, since is utilized for all the babies present in the daycare.

- ❖ An absorbing band cotton covered, which can be insert inside the main body of the diaper.

Also this part can be cleaned in the washing machine, together with the main diaper's body.

- ❖ A light cotton swab, which lies above the diaper and collects all the feces. This swab is biodegradable and compostable, and can be collected and treated with the organic waste.

The procedure adopted in the nursery to clean those diapers is:

- Remove the cotton swab and collect it together with the organic waste
- Leave the diapers and the absorbing band to soak in soap and disinfectant all night long
- Wash at 70° in the washing machine and then let dry up.

This kind of diapers can be utilized until they get old, that means many years of utilization.

It seems clear that the saving in terms of non-recycling waste is 100%, and this is a remarkable achievement considering that this kind of waste is one of the most relevant in terms of weight in the kindergarten.

3.3.3.2 Practical aspects

It seems important to analyze the effective benefits that the utilization of washable diapers brought, together with its disadvantages, from different points of view. Here below were taken into account: practical aspects, economic and environmental aspects.

Respect to classical diapers, the washable diapers are doubtless less comfortable, both for the child and for the mothers. In fact, they have a lower capacity, which leads

to the needing of a more frequent change. Inside the daycare , babies are changed normally four times a day, depending on the age and on the year period.

The difference in capacity of this kind of diaper is sensitive, compared with that of the normal non-recyclable diaper, and this must be clear to those families who would like to approach this new product.

Another big difference with the classical diaper is the absence of the dry feeling, which is so advertised on the television. When babies get wet during the day, they stay wet until the diaper gets changed; that's why it's important a frequent cleaning of the skin (globally, six or seven times per day). These disadvantages can represent clearly a big problem of time required, but the positive aspects are, in my opinion, much more effective from many points of view, as can be seen below.

- ❖ The increase in washing needs leads to a higher degree of cleaning, which is without any doubt an advantage from the health point of view.

As a matter of fact irritation or allergies are prevented, and so the diseases to the genitourinary system, or candidiasis phenomena. We must not confuse the comfort derived

from a baby changed little during the day with the shortage of cleaning.

- ❖ The adoption of the cleaning diapers contributed greatly to reach the baby's autonomy objective.

The nature of the diaper, significantly less comfortable when gets wet during both the day and the night, causes in the baby a sense of uneasiness which helps to reach the sphincter control a few months before compared to babies using classical diapers.

This unexpected result was noted by the school educators, which normally remove the diaper during the day to 2 years old babies at April or May, and this year completed this operation between January and February.

This important result from the educational point of view reflects on the economic and environmental one, because by far less diapers are utilized.

3.3.3.3 Economic aspects

Since this is a long-lasting product, there must be a significant initial investment, which can be amortized during the utilization.

Note that, if at home the diapers can be washed three times a week, the total needing is about 25 diapers per child.

Table 3.2 Economic comparison between classical and reusable diapers

	Unit cost	Daily demand	Monthly spending
Washable	~ 15€ each	7	380 € (first) + 16,18€
Classical	~ 0,30€ each	4	36 €

Considering a study made in the province of Vicenza (www.casasalute.it) the costs to add due to the washing of the diapers is more or less 25€/year (water and electric energy consumption), and the estimation of the detergent cost is about 0,30€/washing.

Supposing that the baby keeps needing the same number of diapers per day, the cost of utilizing washable diapers equals that of the non-recyclable ones after one year and a half, considering that the cotton swab is the only part to be purchased again (approximately 5€ for 100 swabs).

The advantages are much higher when considering that if other children are coming, the economic benefits are undisputed and overt.

Regarding the kindergarten of Lanzè, the initial costs were a bit lower than what said before, because the great quantities of diapers needed and purchased allowed a lower unitary cost.

3.3.3.4 Environmental aspects

The impact on the environment of all the diapers produced by a daycare is very relevant, because every day must be disposed a significant amount of it.

In the considered daycare there are 20 babies, of which 10 have got the diaper all the day, 5 use it only for the nap and 5 doesn't use it at all.

Making a fast operation, that means:

$$10*5 \text{ times/day} + 5*\text{once at day} = 55 \text{ diapers/day.}$$

It means that, every week must be disposed:

$$55*6 = 330 \text{ diapers,}$$

That is over a thousand of diapers per month.

As said before, the gain in material recovery is 100%, if we don't consider the treatment done for cleaning the diapers themselves.

3.4 The composting of organic waste

During the experience with the familiar waste management, the system of disposal of organic waste has been evaluated. Since Quinto Vicentino is a town situated in a rural area, the composting strategy could be applied without too much difficulties, compared to high density areas. The main part of the families live in a house and not in a condominium, and in any case fast every family has his own garden or kitchen garden. Considering this environmental background, it seems reasonable to assume that it is the ideal town where to introduce the home made composting.

Analyzing the sample of families, 7 on 20 declared to utilize a composting bell to treat at home their organic waste.

This practice is actually done in the territory without a serious formation towards the composing, which needs to mature in an aerobic environment and with the correct content in ligneocellulosic material (leaves, branches and other dry green waste). When these attentions are not present, the composting bell works as an anaerobic

putrescible bell, with animals and annoying odors problems.

The stabilization takes place in any case, but it is slower compared to the aerobic one, and some anaerobic areas could remain trapped inside the earths blocks. There is also the problem of the presence of animals, especially rats.

All these observations lead to assess that it is convenient to utilize a composting bell to treat organic waste only if there are the time, the competences and willings to do a proper work.

Chapter 4

Results analysis

In this chapter are discussed the experimental data obtained in the two months of studies, and all the projects and purposes taken into account into this work.

4.1 Waste reduction and minimization in families

The work done on families has three main objectives:

- ⊕ Have data regarding the mean home waste production in the considered municipality
- ⊕ Ensure that people realize how much waste they produce, and how to improve their habits
- ⊕ Do training about the correct way to separate waste, according to the municipal criteria.

In doing that, both the concepts of reduction and minimization are involved.

The most immediate way to approach people and talk about waste is the separate collection. This kind of management has been utilized in this territory since about two decades, and people are used to this system, but this is not reduction. The best way to manage waste is work in order to have no waste at all: a good level of home separation is to be considered as a minimization action. The reduction of waste can be reached only with a proper formation of both the people and those person who should communicate with them.

4.1.1 Waste quantities

In my opinion, to work on minimization ad do the separate collection in the best way can help to raise awareness and approach to reduction, but the best way to realize what we produce is to have a look into our own waste bins.

In the graph presented here below is shown the pro capita production of waste in each family studied, compared with the official municipality mean of 86 kg/(inhabitant*year) (2012). That value comes from the ratio between the total amount of refuse waste produced by both households and small commercial activities, and the official number of citizen living in the town. This means that this values is

comprehensive also of a part of commercial activities that cannot be compared with data coming from households only. Officially, the percentage of commercial utilities is 25% of the total, but this indication doesn't give informations about the real quantities of produced waste, even because the amount of waste produced depends on the kind of the considered activity, and all the residual waste is collected together.

My work aims to focus on domestic waste production, even because many of the small commercial activities present in the town are managed by people living nearby; so reaching and forming those families, at the same time a significant part of the small activities are attatined.

In order to do the graph below, the weekly data obtained were extrapolated on a period of 52 weeks to give the annual value, assuming that the two months of study (approximately April and May 2013) were representative of the whole year.

The blue line is the mean pro capita yearly production of the whole sample, which mean value is 24,1 kg/(inhabitant*year).

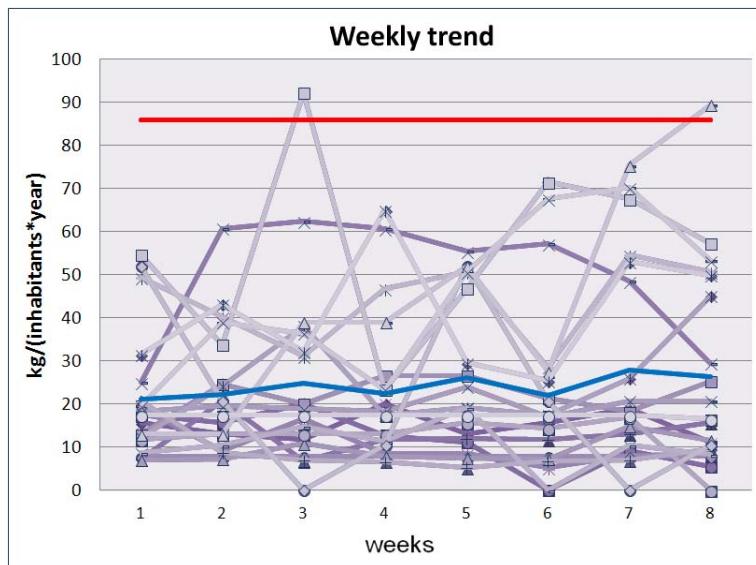


Fig. 4.1 Comparison between the pro capite residual waste production of each family (purple), their mean value (blue), and the municipal mean value (red). Data obtained in April and May 2013.

As can be seen, the mean waste production is far below the complessive mean, approximatively one fourth.

The municipality mean value (red) takes into account two different types of utilities, the domestic and the non domestic ones. Since refuse waste are collected together and there's no data available of the real production of each part (but only their sum), an estimation³ was done by the

³ See Appendix 2

public administration in order to supply the absence of these experimental data: the non domestic utilities are supposed to contribute to the 25% of the total weight, and this fraction shouldn't be taken into account in the present discussion.

It can be seen that the main part of the families (11) has a net production of waste which stays always below the 24 kilos per inhabitant per year, a pair of families are more or less around the media, and the remaining 7 stays above the mean value.

This means that there are some realities in which the attention to the environment as a general concept is quite high, and the results are comparable with the most virtuous municipalities in the northern part of Italy, and other in which a good work of formation and training can be done. The fact that the trend of the medium value (in blue) is arising isn't meaningful, because of the great oscillation of the data, particularly of the biggest values.

On the contrary, I think that if this work was done on a more representative sample for a longer period of time (talking about years), there were a great decrease in

quantities if a good work of formation and sensitization was done.

4.1.2. The knowledge of domestic separation

At the very beginning of the survey was proposed to each family a test which aimed to understand the mean level of knowledge regarding the correct way to separate waste in the municipality of Quinto Vicentino.

The final goal was to understand if there is confusion or uncertainties about the domestic separation process, and to solve these doubts for the involved families, while propose a more efficient way to reach and inform as much citizen as possible.

The proposed test was the following:



“Rispondete in maniera intuitiva alle seguenti domande.

Dove buttereste i seguenti rifiuti?

- 1) scottex di carta unto d'olio: secco/ carta/ umido/ altro
- 2) lampadina rotta: secco/ vetro/ pile esauste/ altro
- 3) paletta da spiaggia rotta (in plastica): secco/ plastica/ altro

4) contenitore di succo di frutta in tetrapak: secco/ carta/
plastica e lattine

5) tappo di vero sughero: secco/ carta/ umido/ altro

6) olio di frittura: nel water/ nel lavandino/ nel campo/
altro

7) scatola dei cereali (carta plastificata): secco/ carta/
plastica/ altro

8) calzini rotti e molto consumati: secco/ umido/ altro

9) involucro del cerotto singolo: secco/ plastica/ carta/
altro

10) bustina del the usata: secco/ carta/ umido/ altro

11) pennello con manico in legno: secco/ carta/ altro

12) cellulare: secco/ pile esauste/ plastica/ altro”

Fig. 4.2 Test proposed to families

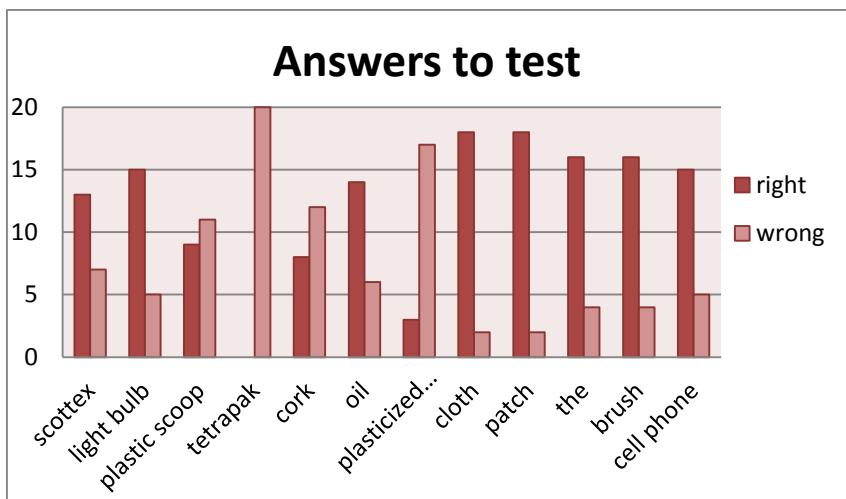


Fig. 4.3 Test results

The most impressive result that could be deducted from the graph above is that there are some misunderstandings regarding a few categories of waste.

In particular, no one of the families involved was informed about the possibility to recycle the tetrapak in his own municipality. This can be understood considering the fact that this technology is relatively recent, and since few years ago this material was disposed together with refuse waste.

Another topic where some difficulties were observed is the concept of prevalence of material in a packaging.

The plasticized cardboard box of the 7th question of the test is mainly made in paper, although the external stratum was plasticized. Therefore it is collected together with cellulosic materials (paper and cardboard), and all these materials can be recognized by slightly tearing an edge of them.

The plastic materials that can be collected are only those which were a packaging, so all those plastics which had not this function should be collected together with refuse waste.

Regarding this, it seems relevant to note that recently (since 1st may 2012) plastic glasses and sheets (but not cutlery) can be recycled together with plastics.

There are some recent developments regarding the collection of plastic materials that were not packaging. For example, in the province of Treviso this is already possible thanks to the collection of these plastics inside the ecocenter. This is managed by Consorzio Priula (Contarina S.p.A)⁴, which send this material to a recycling facility

⁴ This was presented in occasion of the Green Week 2013, where Contarina S.P.A. presented “Rifiuti, da spreco a risorsa”, a journey in

where it is converted to new plastic raw material by means of the co-treatment of different polymers.

Another interesting result is that some people doesn't exactly know what can be collected inside the ecocenter, and the difference between refuse waste and bulky waste. Since the criterion is to throw inside the residual waste bin all what we do not know wherever else to throw it, the most correct answers were those related to non-recyclable objects.

This is a good indicator, which means that inside the recyclable streams there is probably only a small part of foreign materials, and this enhance the value of the separate collection and increases its retribution.

4.2 The results of the survey

Concerning the rest of the questions proposed to the families, here are the answers and some personal evaluations about.

The present in the market of bulk detergents is well known by all the analyzed sample, and more than half (12/20) declared that they have already tried them. Someone was very satisfied of the quality of this kind of product, and someone else said that only for a specific kind of detergent and not for all.

A perplexity emerged about the possibility to find at the supermarket discounted detergents, that makes not always convenient this purchase.

Near all the sample was at least once inside a second hand store, and periodically returns there more or less frequently. If in their municipality there was this kind of store, the main part declared their willing to visit it periodically (approximately each season change) and to bring there something that they do not use anymore, but the frequency doesn't change very much compared to what they actually done in the stores present nearby the municipality.

Six families on twenty declares that in their working environment the degree of environmental attention is worse than the domestic one, because there isn't the real interest in saving waste. Three on twenty didn't answer,

two declares that the working environment is better from this point of view, and the remaining nine declared to have more or less the same degree of attention.

This result can be a useful tool to investigate about the real waste management situation in the working environment.

The most preferred methods to get informed about waste separation and environmental initiatives are leaflets (inside the *Informa Quinto* that already exist) and the municipality web site. Other purposes are to prepare some pamphlets to release in the municipality offices, an ecologic day or some leaflets to distribute inside the school.

Here below are collected the few advices that the

considered families wanted to give to their fellow citizen:

“Buy products with the least amount of packaging”

“Evaluate time by time each object before throwing it into the waste bin”

“Separate as much as possible the recyclable parts”

“Overcome laziness to be faster by throwing all together”

“Grow hens to treat organic waste”

“Burn in the stove small cardboard packaging”

“Buy bulky detergents”

“Drink tap water”

“Make homemade bread and pasta”

“Press waste”

“Buy the meat to the butcher’s, it has less packaging”

“Buy concentrate detergents and then dilute them at home”

“Organize zero waste parties, by bringing from home
tableware and dishes”

“Utilize again containers and tanks”

“Wash plastic packagings”

“Buy fruits and vegetables not packaged”

“Fix broken things”.

Fig. 4.4 Suggestions from the interviewed families (April and May 2012)

4.3 Economical evaluations

When a public administration sets up a new plan or project, it cannot disregard an accurate economic evaluation, in order to realize if there are the resources necessary to go on. A cost-benefit analysis is required also for this work, to evaluate if the environmental goals are linked also to economical benefits or not.

Since this year, the economic tribute to be payed at national level is the TARES, and an deepening on that is presented in Annex 2.

The first thing to understand is that a reduction in waste doesn't reflect linearly on the waste management costs, because they are composed of two parts (fix and variable), and only the variable costs depends on the saved waste weight.

Considering the official data given by Soraris S.p.A., the total amount of residual waste ("secco non riciclabile", which doesn't consider the bulky waste collection activity, nor the street sweeping) was 488,91 tons in 2012.

The calculation of the residual waste cost is described.

Table 4.1 Actual costs referred to the residual waste, 2012. Sources: tons: Soraris S.p.A; transport and operators costs (CRT): municipality of Quinto Vicentino

ton	€/ton	Treatment costs	Transport and operators* costs
488,91	100	48 910 €	~50 200 €

** the operators cost is divided between fix and variable costs, as required by the financial plan guidelines, see Appendix 2. The term presented includes only the variable costs fraction.*

The objective of the proposed intervention is to obtain in all the domestic utilities of this municipality the mean results of the studied sample, that is 24,09 kg/(inh.*y) which mean 138,81 tons per year.

This goal isn't the maximum to aspire, since the merceological analysis shows that half of the analyzed waste could be destined to material recovery, as shown in paragraph 3.2.4, but could be an interesting starting point towards a more sustainable waste management.

An interesting discussion can be done by observing that the total amount of waste produced by the sample (of which 50% is still recyclable, as shown in paragraph 3.2.4) is assumed to be less than the non-recyclable part of the merceological analysis done in 2010. This means both that:

- the separate collection is made with higher attention (minimization action)
- the total amount of waste was reduced (prevention action).

These goals are obtained together, and could be present in citizen only because of an higher attention towards waste and their impacts. Banally, it's helpful to form towards waste prevention speaking also about separate collection (and other minimization actions), since it is simpler to explain, because is very much present in our daily lives.

The calculations done presuppose a formation and sensitization campaign done on citizen, which for simplicity are supposed to react alone, without the contribution of the non domestic utilities that are supposed to produce the same amount of waste as today (25% in weight of the total amount, corresponding to 122,23 tons).

The formation campaign was assumed to be done in a continuous way during the years, and to cost approximately 1€/inhabitant per year (approximation done by ARPAV, June 2013). It is reasonable to think that the formation would lead to the desired results after some years, and a monitoring system can help to prove these results more precisely than mere suppositions done in this contest.

The waste reduction to obtain (assumed from the merceological data and the mean sample weight value) is

about 40% of the actual residual waste, and the same reduction percentages were assumed also for recyclable fractions (this is a loss of income due to the non-sale of this material). The remaining recyclable fractions were maintained each other in the same proportions as in the sample.

Considering both the loss of production and the better separation done (from 30% to 47% of non recyclable waste inside residual waste), the projection of tons that could become recyclable has been evaluated, since it is of some economic interest.

Due to the great reduction in residual waste weight, the studied scenario foresees both the possibility to reduce (half) the number of monthly collection, or to maintain it as it is, knowing that this practical choice depends on the management of many municipalities together. It can be seen that this contribute has a great influence in the overall costs, as could be foreseen.

The environmental results obtained are listed in the table below, considering that the reduction of non-recyclable

waste (~40%) obtained by the experimental data would reflect also on the recyclable fractions.

Table 4.2 Environmental results in terms of prevention (saved waste) and minimization (additional waste sent to recycling)

Saved residual waste	Saved recyclable waste	Residual waste sent to recycling
61 tons	137 tons	65 tons

For a more intuitive comprehension, the environmental results obtained are illustrated in the next figures. For the projection graph, the percentages were obtained by utilizing the merceological analysis done on the sample. For the actual waste composition, the only available datum was the percentage of non-recyclable waste (30%). The other fractions (70%) were assumed to be proportional to the corresponding fractions found in the studied sample.

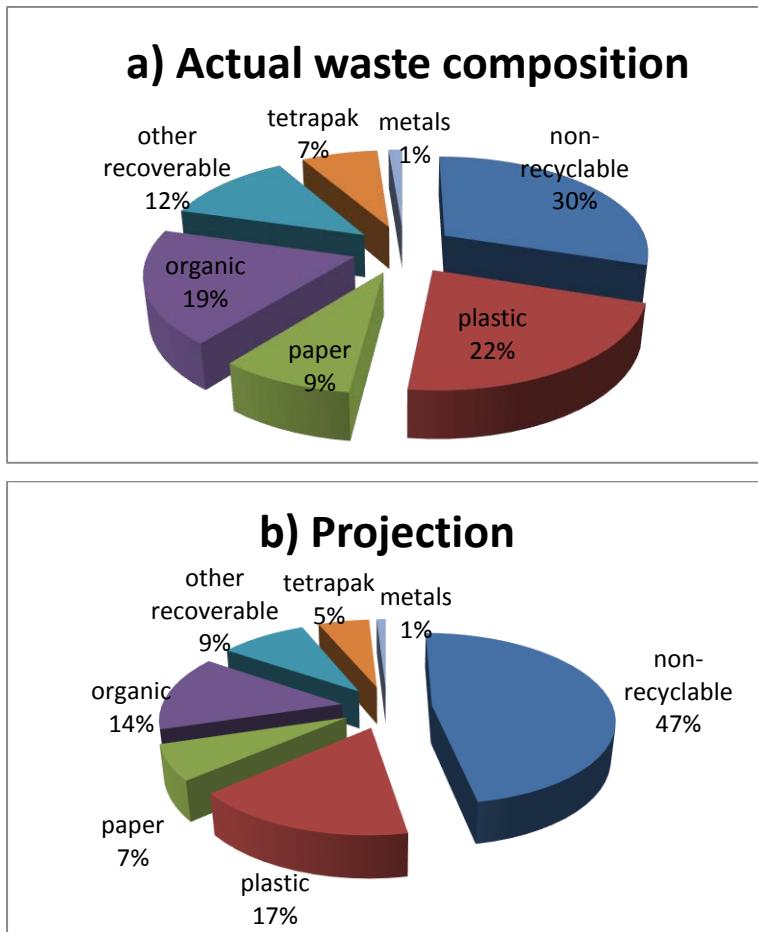


Fig. 4.5 Actual (a) and projected (b) residual waste composition. The total amount of waste in the two scenarios are 489 tons (a) and 139 tons (b).

Regarding economical benefits, considering an overall TARES contribute of 430 000€, the gains obtainable by a

formation and sensitization program done towards the domestic utilities are resumed below.

Table 4.3 *Economical results considering the possibility to reduce the number of collection rounds*

	Actual transports	Halved transports
Formation	+ 5 762 €	
Disposal	+ 22 633 €	
Selling recyclables		- 2 513 €
Transport	+ 50 200 €	+ 25 100 €
Total	76 082 €	50 982 €
Saved money	23 009 €	48 109 €
% TARES	5,4%	11,2%

Conclusions

The study aimed to investigate the actual waste production system in the municipality of Quinto Vicentino, focusing on the domestic production of residual waste.

The mean residual waste production of the municipality and the sample of 20 domestic utilities has been compared, and this second value is approximately one fourth of the official mean value.

This result is far below the mean value of the residual waste in the municipality, 86kg/(inh.*y), approximately one fourth, and this can be due both to the sensibility and correct formation of the main part of the studied sample, and the fact that it was under observation.

The prevention goal, intended as the way to grow economically without letting also waste to increase, could be met with the adoption of sensitization and formation programs and projects, and some examples to imitate or copy are presented in Chapter 2.

Talking about minimization, a great margin of improvement of the separate collection was highlighted, since a considerable percentage (50%) of the residual waste can be recovered also in the chosen sample of domestic utilities.

The tools to obtain a more efficient domestic separation are the already mentioned formation programs (starting from the considerations shown on paragraph 4.1.2), the adoption of a charging system that rewards the utilities which produce less, and a more efficient system of domestic checks.

Assuming a formation and sensitization campaign done on the domestic utilities of the municipality (75% of the total), were evaluated the environmental and economical benefits resulting from this work, assuming to reach a situation (quantities and quality of waste) equal to the observed sample.

From the environmental point of view, an hypothetical save in waste was observed of 61 tons of residual waste and 137 tons of recovered materials that were previously

disposed (results of prevention); an additional 65 tons of waste can be sent to recycle (result of minimization).

Compared to the actual total amount of residual waste (489 tons), this is the 54%, a very relevant result.

On the other hand, if the prevention result only (198 tons of saved waste) is compared with the total amount of waste produced in the municipality, the percentage decreases to the 8,7%.

The economical balance takes into account the outgoings needed by the sensitization campaign, and evaluates the loss in charges due to the reduction of residual waste, considering conservatively that the non domestic utilities still keeps to produce the same waste in quantity and quality as the present situation. In addition, the economical gain due to the selling of separated materials was taken into account.

The projection results show that could be saved 23000€ (5,4% of the TARES incomes) without changing the number of collection rounds, and 48100€ (11,2%) by halving the passages, considering that also the total amount of residual waste would half.

This proves the relevance of the fix costs compared to the variable ones, that often make almost insignificant the environmental efforts.

At the end of the work it could be said that the municipality alone can do something in order to improve the prevention, but much more can be obtained (from both the environmental and economical points of view) if this work was insert in a more complete and widespread prevention and minimization program, at provincial or regional level, because the tools available are much more effective. An example of this tools is listed in par. 3.1 of the regional waste management plan of Regione Veneto.

Further insights of this work can show what can be said about non domestic utilities, which weren't considered here, and the effective reliability (pros and cons) of halving the collection rounds number.

In addition to that, I would like to underline some further points regarding how people behaved in response to this study. No one of the people involved, considering the

families, the administrative staff of the municipality, the experts and technicians that I met and the few commercial activities that were involved in this work, have been shown indifferent to the proposed topic, and got drawn with a lot of enthusiasm.

I think that it is a clear signal of a change in direction of the society, which is regarding the environmental topics with an interest that only two decades ago was hardly conceivable.

This approach can be valuable for the approval and actuation of programs aimed at enhance the prevention and the waste reduction, both in public, private sectors, and domestic realities.

Appendix 1

Merceological analysis

The complete merceological analysis subdivided per screens is presented here below.

Since there are no regulatory references to be observed for the merceological analysis of refuse waste, the complete procedure observed is here described.

This work was done on Monday 23rd September 2013, in the laboratory structure of Voltabarozzo (Laboratorio di Ingegneria Sanitaria Ambientale, LISA) sited in Padua.

The sample of waste considered was composed by 20 bags of refuse waste coming from the 20 families observed during the two months period of April and May. This material was collected few days before the analysis.

With the collaboration of Rossana Russo, the bags were opened and screened over 4 screens (100mm, 75mm, 40mm, 20mm) then separated into homogeneous fractions (plastics, paper, putrescibles, multimaterials, metals and

refuse), each fraction was further split into more detailed classes and eventually weighted.

Since all the sample was considered, no quartering has been done on the whole sample of waste.

The graph presented below illustrates the percentage composition of the dimensions of each class of waste.

It seems relevant to underline the dimensions of the plastic materials, which are mainly composed by large size components, and the same could be said for cellulosic materials (paper and clean wipes), and for tetrapak containers. Since these waste can be recycled if they are clean, a huge part of the actual residual waste can be recycled with an higher level of separation; the only care to have is to clean or wash the dirty surface of food packagings.

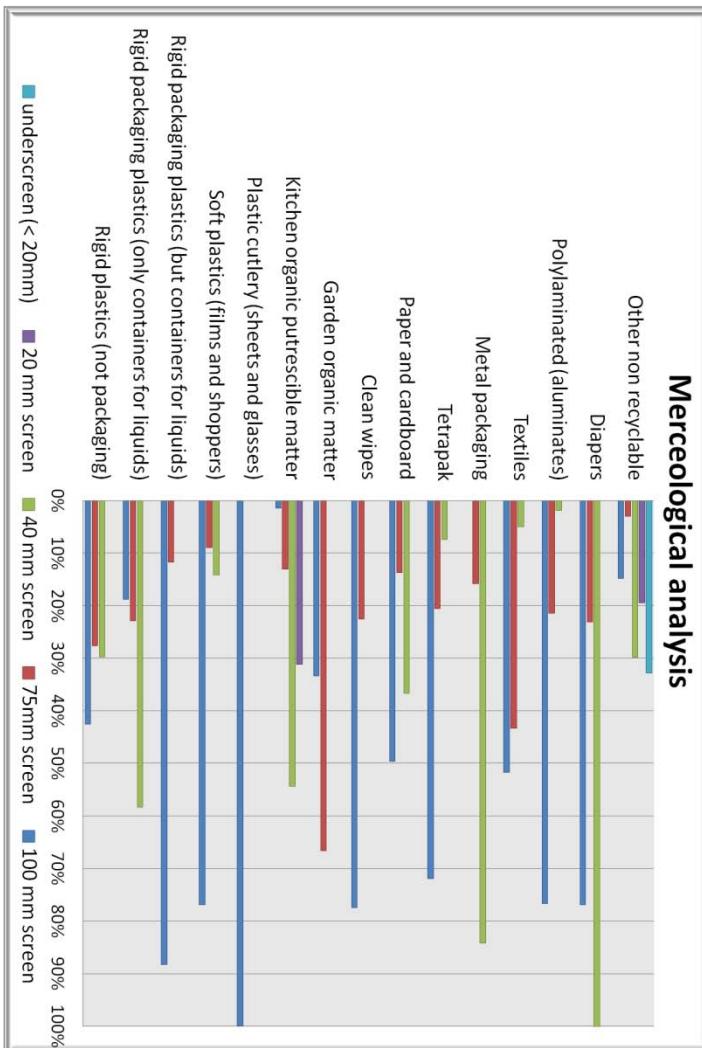


Fig. A1 Size of each class of waste, resulting from the merceological analysis of the analyzed sample

In addition to what already written, an estimation was done on what can be recyclable or not (fig. A2 and A3).

Concerning the dimensions of the waste, was considered non-recyclable the underscreen material, and all those waste remaining trapped by the 20mm screen.

Here below some considerations about bigger sized waste. In this municipality, all that plastic that was an object and not a packaging cannot be recovered, and was considered non-recyclable. The same could be said for those packaging made by different materials (but tetrapak), which also were considered non recyclable.

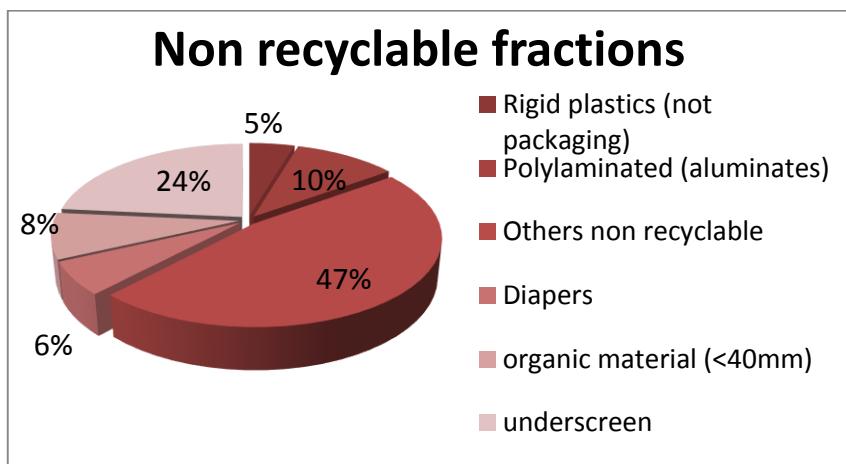


Fig. A2 Composition of non recyclable waste of the analyzed sample

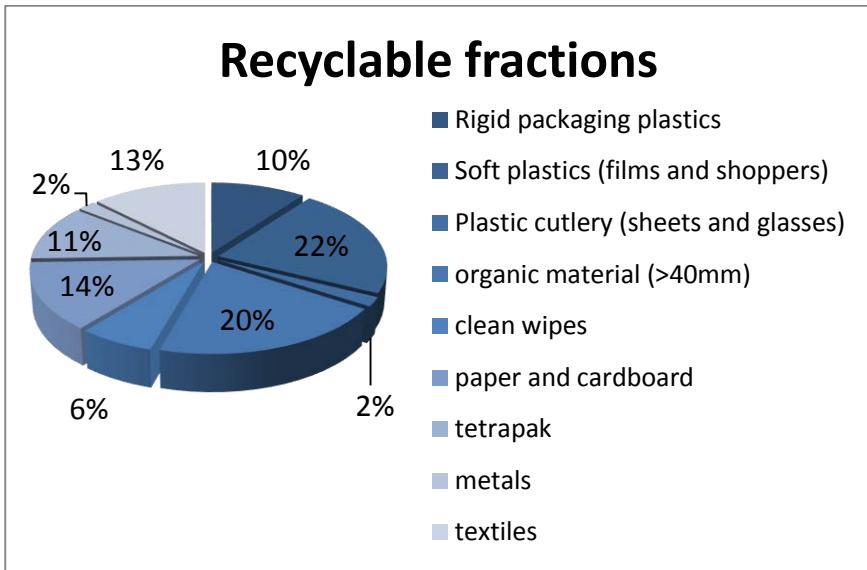


Fig. A3 Percentage composition of the recyclable fraction of the analyzed sample

Appendix 2

References to the

Linee guida per la redazione del piano finanziario e per l'elaborazione delle tariffe, 2013

This document is the guideline to set up the local tax revenues that each municipality should require for the waste management system. This year the contribution to which refer is the TARES (*tassa rifiuti e servizi*), which should cover the 100% of the services connected to the waste management, unlike the old system (TIA or TARSU) which were required to cover approximately 90% of the costs. This measure would result in an increase of the tax, considering also the new further standard increase of 0,30€/mq to be devolved directly to the State.

The overall contribution can be calculated using the formula present in the second part of the guidelines.

$$\sum T_n = (CG + CC)_{n-1} * (1 + IP_n - X_n) + CK_n$$

where:

$\sum T_n$ = total contribution (€)

CG = operative management costs (fix and variable)

CC = common costs (fix)

CK = costs for the utilization of capital (fix)

IP = programmed inflation

X = productivity recovery

n = reference year

As can be seen, the total amount is composed of two parts, relative to different reference years, since the amortization and depreciation (CK) of the capital are already programmed for the considered year, but there's the need to foresee the managing costs utilizing the data of the previous year (CG+CC). These data are then actualized by means of the term (1+IP-X), chosen at municipality level.

It must be underlined that at least 50% of the cost of personnel should be included in the common costs (fix) instead of operative costs.

A matter of concern is represented by the determination of the percentages of waste to impute to domestic and non domestic utilities, and this is explained in the third part of the guidelines. The weight bipartition, knowing the total amount of urban waste, could be calculated in two ways:

- 1) by using sample measurements on the domestic utilities, and deriving by difference the non-domestic fraction
- 2) utilizing a list of statistical productivity coefficient, specific for the kind of activity and the considered Italian area (north), and consider a range of results; the domestic production is then calculated by difference.

This second methodology was the one preferred and utilized by the Quinto Vicentino municipality, and the result obtained (25% non domestic production and 75% domestic production) reflects the utilities composition, assessing the substantial equivalence in weight between the residual waste of the two kinds of utilities

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ISPRA, *Rapporto Rifiuti Urbani*, edizione 2013

Legge Regionale Veneto 21/01/2000 n.3, *Nuove norme in materia di gestione dei rifiuti*.

Some public documents were officially required to the public administration of Quinto Vicentino with the only purpose to write this work:

- The merceological analysis of waste done in 2010 and 2012
- An economic balance related to waste management in 2012
- Incomes and expenses related to waste management in 2011
- The TARES municipal parameters of year 2013

Web sites (last consultations: September and October 2013):

http://consorziopriula.it/raccolta_ecocentro.php

<http://ec.europa.eu/environment/waste/framework/>

<http://www.arpa.veneto.it/temi-ambientali/rifiuti/>

<http://www.casasalute.it/contenuti/Materiale.htm#614>

<http://www.comune.quintovicentino.vi.it/>

<http://www.provincia.bz.it/agenzia-ambiente/rifiuti/>

<http://www.provincia.fi.it/rifiuti/le-buone-pratiche/come-ti-riduco-la-carta/>

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