

Critical analysis of the integration of residual municipal solid waste incineration and selective collection in two Italian tourist areas

Waste Management & Research
2014, Vol. 32(6) 551–555
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DOI: 10.1177/0734242X14533605
wmr.sagepub.com


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Abstract

Municipal solid waste management is not only a contemporary problem, but also an issue at world level. In detail, the tourist areas are more difficult to be managed. The dynamics of municipal solid waste production in tourist areas is affected by the addition of a significant amount of population equivalent during a few months. Consequences are seen in terms of the amount of municipal solid waste to be managed, but also on the quality of selective collection. In this article two case studies are analyzed in order to point out some strategies useful for a correct management of this problem, also taking into account the interactions with the sector of waste-to-energy. The case studies concern a tourist area in the north of Italy and another area in the south. Peak production is clearly visible during the year. Selective collection variations demonstrate that the tourists' behavior is not adequate to get the same results as with the resident population.

Keywords

Incineration, Mechanical-Biological Treatment, municipal solid waste, selective collection, Solid Recovered Fuel, tourist area

Introduction

In some Italian regions selective collection (SC) is not yet optimized, thus the composition of the residual municipal solid waste (RMSW), i.e. the stream not collected separately for recycling purposes, is expected to change significantly in time (Ionescu et al., 2013; Rada, 2013; Rada and Ragazzi, 2014; Velis and Cooper, 2013).

SC refers to source separation mainly of recyclable materials according to the European Union (UN) and national regulations in force. In this article SC concerns only municipal solid waste (MSW) and not special waste.

Tourism can affect quantity and quality of MSW and can modify the management of existing plants as incinerators (Mateu-Sbert et al., 2013; Ragazzi and Rada, 2008). In particular, in tourist regions, the significant presence of tourists and the consequent accommodation facilities (which often do not organize SC) are one of the main causes of the bad results in terms of SC performance (Bhat et al., 2014; Caramiello et al., 2009; Mendes et al., 2013). Other causes of inefficiency are lack of awareness of the citizens, lack of correct information by public administration, etc. (De Feo and De Gisi, 2010; Marconsi and Rosa, 2013; Rada et al., 2013; Zhang et al., 2012).

In this article two case studies are analyzed in order to point out some strategies useful for a correct MSW management in tourist areas. In the first case study, the MSW SC system is

evolving from road containers to kerbside collection mixed with street containers; in the second one a mix of road and kerbside containers are used for MSW SC. Also the influence of SC on the future and present strategies of energy recovery from RMSW are analyzed and discussed in order to support decision makers in their activity.

MSW collection characterization in the case studies

In order to allow the critical analysis of the integration of RMSW incineration and SC in tourist areas, two Italian case studies have been selected, one in the north and the other in the south of Italy.

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The two areas have significant differences today, but a similar target for the future. Both the regions must comply with the EU target of at least 50% of MSW re-use and recycling, as requested by the revised Waste Framework Directive updated per 2008/98/EC Directive, and also with the national regulation 152/2006 that imposed an Italian target of 65% of SC for 2012 (Consonni et al., 2011; Rada, 2014; Ragazzi et al., 2012).

- In the first case study the SC has reached significant results, but in tourist areas some troubles are yet to be solved and an incinerator is proposed.
- In the second case study the SC has not yet reached a high efficiency, MSW collection in tourist areas must be optimized and an incinerator is present.

The first case study concerns a tourist area (47,714 residents) in a region in the north of Italy with around 500,000 inhabitants, where the tourist fluxes affect the local MSW generation with an increase of about 10% of inhabitant equivalent on a yearly basis (PAT, 2012). This case study refers to a territory named Alto Garda and Ledro, belonging to the Autonomous Province of Trento.

The regional average efficiency of SC is high, but the tourist areas in the region are facing the problem of guaranteeing the quality of the SC streams. The behavior of most of the tourists in the analyzed area (district) is not adequate in terms of efficiency of source separation. The present average SC efficiency in the district is 56.3%, and the annual per capita amount of RMSW is equal to 218 kg, respectively, lower and higher than the regional targets fixed equal to 65% and 126 kg, respectively (PAT, 2012; Rada and Ragazzi, 2014).

The MSW trend is not favorable, thus the local authorities decided to start a special project in order to improve the SC efficiency, with a re-organization of the collection and with additional communication to the citizens and tourists (Castagna et al., 2013; Ragazzi et al., 2011). The current SC system is organized with a frequency that differs greatly from area to area and between summer and winter, also mainly owing to tourism peculiarities of the area. The SC organization is completed by some eco-centers, which are open daily so that resident and tourists can deliver their MSW fractions. These centers solve the problem of citizens that must leave the area during days not compatible with the SC scheduling. This last one has the same organization and frequency in summer and in winter: the only difference concerns the frequency of food waste collection, which varies from once per week in winter to twice per week in summer; the other fractions are collected once per week always.

In Figure 1 the per-capita generation (monthly average) of MSW in the tourist area is reported. August is the month that shows the highest generation of MSW. It must be pointed out that August and July are the months of high season. The medium season refers to May, June, September (in summer) and December, January (in winter). From Figure 1 it can be seen a correlation between tourist presences and MSW per capita generation.

The efficiency of SC during 2011 is presented in Figure 2. Arrival of tourists gives a decrease in the SC efficiency (in

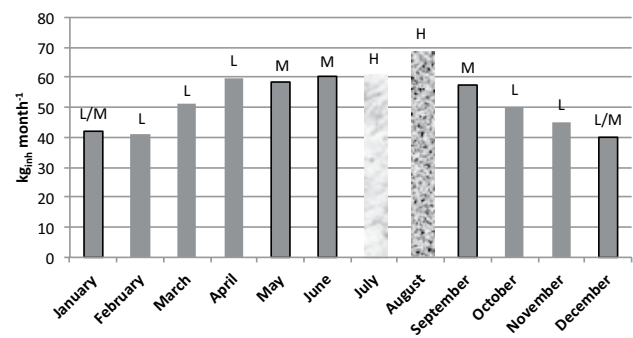


Figure 1. Monthly per-capita generation of MSW for case one.

H: high season; M: medium season; L: low season.

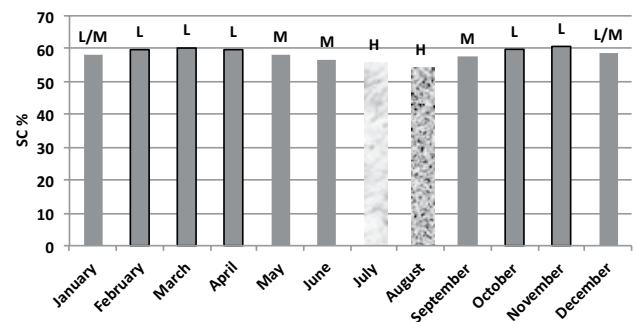


Figure 2. Percentage of SC during 2011 for the case one.

H: high season; M: medium season; L: low season.

August). A partial explanation is that a significant number of tourists come from abroad, with consequent problems of understanding the SC criteria. On the contrary, SC efficiency is higher when mainly resident people are present.

Taking inherent characteristics of the tourist and urban area of case one, the district administration, together with the University of Trento, proposed an optimized solution for MSW collection. The new proposed SC system contains *street containers* in the old towns, *kerbside collection* for RMSW and food waste for the other areas, integrated with street containers for the other fractions. Data acquisition in the sector of waste management in Trentino is performed by a specific provincial agency (PAT, 2012).

The second case study concerns a region in the south of Italy (Apulia) with around 4,000,000 inhabitants, where the tourist fluxes affect the local MSW generation with a noteworthy increase of inhabitant equivalent in summer. Some tourist areas, Fasano and Monopoli municipalities particularly, increase their population up to 100% during the summer period. The inadequate summer waste collection system creates problems for the whole collection and sometimes also for the tourist development.

SC has grown up only in the last five years, and now thanks to road and kerbside collection reaches 15%. The kerbside system is operated by three domiciliary visits per week for the different waste fractions. In the summer period, the kerbside collection increases to four times per week. Each family has four

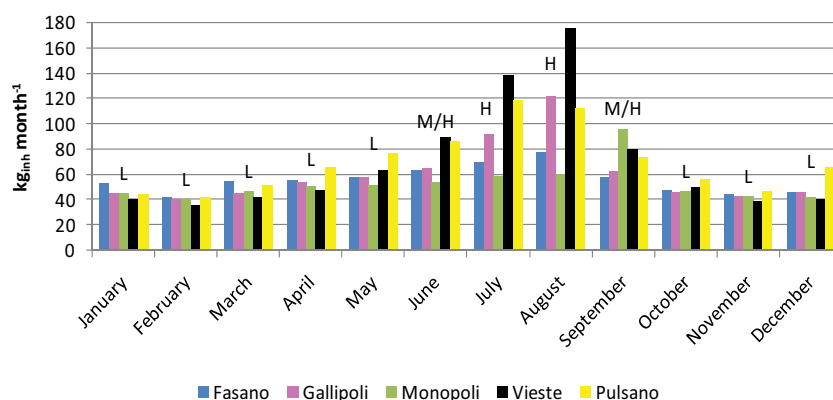


Figure 3. Monthly per-capita generation of MSW for the second case. H: high season; M: medium season; L: low season.

containers, respectively for the collection of paper (blue container), plastic and aluminum (yellow container), organic waste (brown container) and residual MSW collection (gray container). Each container is marked by a representative code of the family/user. Users are required to deposit containers near their homes on a predetermined time to facilitate kerbside collection. A flyer that shows the days when the various fractions will be collected was given to each user. But in the summer period, owing to the high number of tourists who frequent the streets of countries even at night, the system of kerbside collection could prove to be problematic.

Compared with the first case study, much higher RMSW is clear as a consequence of the low value of SC. However, a positive trend of SC is referenced against the last three years.

In Figures 3 and 4 the dynamics of the amount of per-capita MSW production and of the SC efficiencies for five Apulian tourist municipalities are reported (Fasano, Gallipoli, Monopoli, Pulsano and Vieste, having 133,373 residents). It must be noticed that the summer period shows the lowest values of SC and the highest values of MSW generation. This can be explained by the unefficient behavior of the tourists in SC activities and on the increase of population equivalent in the summer period. Compared with the first case study, the peaks of August are more visible.

Data acquisition in the sector of waste management in Apulia is performed by a specific regional office (Regione Puglia, 2013).

Results and discussion

In the first case study, an incineration plant has been planned with a capacity equal to the RMSW expected with a SC of 65%. This means no landfilling of RMSW when the plant will be operating. The expected capacity is around 100,000 tonnes year⁻¹ of RMSW. Co-generation will be implemented for energy exploitation. It is clear that a variability of the RMSW during the tourist seasons (winter and summer) could overload the plant. In reality, as the plant is proposed for the overall amount of RMSW at provincial

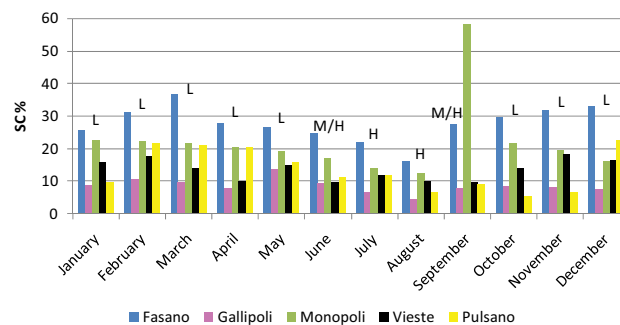


Figure 4. Percentage of SC during 2011 for the second case. H: high season; M: medium season; L: low season.

level, the peaks of RMSW collection in some tourist areas are “diluted” in a wider amount of steady RMSW streams collected from more residential areas. The lower heating value (LHV) of the input of the plant has been assessed at around 12 MJ kg⁻¹ as an effect of the low percentage of food waste. Even if the tourist area shows SC efficiency in agreement with the EU targets, the local results are considered regular compared with the highest performances obtained in most of the region (Rada, 2013; Rada and Ragazzi, 2014; Ranieri and Giansante, 2012; Ranieri et al., 2011). The main problem in this area concerns the difficulty that tourist users have to be accustomed to a waste collection generally quite different to their area of origin. A tourist could have a too-short time to learn the rules of the collection system before the end of the holiday. A positive side effect of this “interaction” could be a sort of export of the concept of SC in the EU and extra EU regions where waste collection is not yet well organized, considering the international characteristics of the local tourism. The aim of reaching the highest SC efficiency in the selected tourist area has oriented the system towards enhanced approaches.

The option of improving the environmental performance of RMSW treatment accepting lower SC rates has been considered unviable because of the presence of the official targets to be reached.

From the data analysis of the second case study, a decrease of the SC average in the four summer months (from June to

Table 1. Data comparison between selected areas.

Parameter	Units	Case 1	Case 2
MSW	kg inh ⁻¹ month ⁻¹	Min 40–max 69	Min 40–max 110
SC	%	Min 54–max 61	Min 8–max 23
RMSW	kg inh ⁻¹ month ⁻¹	Min 16–max 31	Min 34–max 101
Treatment/disposal of RMSW	—	Present: landfilling Future: incineration	MBT

MBT: Mechanical-Biological Treatment; MSW: municipal solid waste; RMSW: residual municipal solid waste; SC: selective collection.

September) compared with the remaining eight months of the year can be observed. Values are reported as follows.

- Gallipoli: from 9.4% in the eight months to 7% in the four summer months (–25.5%).
- Fasano: from 30.3% in the eight months to 22.5% in the four summer months (–25.7%).
- Pulsano: from 15.3% in the eight months to 9.7% in the four summer months (–36.6%).
- Vieste: from 15% in the eight months to 10.3% in the four summer months (–31.3%).
- Monopoli: from 20.4% in the eight months to 25.4% in the four summer months (+19.6%).

Only in Monopoli, where a wide information campaign was made, an increase of the SC average for the four summer months, and particularly in September, was reported. This demonstrates the importance of the role of municipalities who should inform and educate citizens and tourists on environmental and economic benefits related to SC.

The low efficiency of SC in the area oriented the local authorities to a strategy based on a Mechanical-Biological Treatment (MBT) before combustion, with energy recovery in the existing incineration plant. The Massafra MBT plant is part of an integrated waste recovery system producing biodried Refuse Derived Fuel (RDF) to be used for power generation in a centralized RDF-to-energy plant. This strategic concept is based on the environmental benefit offered by the combustion of a homogeneous fuel derived from the mechanical and biological treatment of the residual waste fraction.

In detail, the process design indicates that after primary shredding and ferrous separation, waste is transferred to the biological stabilization process, which takes place in nine composting tunnels. The biological process, which includes stabilization and drying, requires 7–14 days, depending on the quality of waste. Exhaust air is sent to a centralized biofilter to control odours (Albanese and Castelli, 2006).

The average per capita generation of municipal waste in the territory served by the Massafra MBT plant is around 1.5 kg day⁻¹, thus the total production is approximately 120,000 tonnes year⁻¹.

The MBT plant has a daily capacity of 350 tonnes day⁻¹ and a permitted capacity of 110,000 tonnes year⁻¹ (Albanese and Castelli, 2006).

The amount of Solid Recovered Fuel (SRF) produced by the MBT and treated yearly in the incinerator, demonstrates that

the capacity of the plant is not calibrated on the total amount produced in the region. This means that the variability of MSW/RMSW during the tourist season can be faced with a different use of landfilling (that compensates the limited incineration capacity). Table 1 compares the waste management system of both areas. It is clear that an improvement of the performances of the waste management system for the second case study is compulsory.

Conclusions

The present article analyses two case studies where tourism significantly affects MSW generation and SC efficiency. The role of incineration is analyzed too, in order to verify if the presence of tourism affects design or management of the plant. In the first case study, two peaks are visible during the year and the MSW management is well suited for the tourist income increase. In the second case study, the high summer peak and the lack in the SC system result in some inefficiencies. The available data demonstrate that the fluctuations of RMSW can be significant, but on a wider area of collection, the effect of “dilution” in more steady RMSW streams can reduce significantly the consequences on design and management of incineration.

The presented data point out the differences that can be found in MSW management across Italy too.

However, the fluctuation of RMSW during tourist periods seems to have moderate consequences on the efficiency of a waste management system when the area involved in tourist activities is only a part of the total one to be serviced. An efficient SC in the tourist areas is necessary in order to comply with the regulation in force, even if the cost to perform it could be high.

Acknowledgements

This article was made possible due to the collaboration of the Autonomous Province of Trento.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

Funding

This research has been partially financed by the PRIN Program, Italian Minister of University.

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