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*Published in:*  
Proceedings Sardinia 2017

*Publication date:*  
2017

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Pivnenko, K., Edjabou, M. E., Boldrin, A., & Astrup, T. F. (2017). Challenge of material recycling at large public events. In Proceedings Sardinia 2017 S. Margherita di Pula, Cagliari, Italy: CISA Publisher.

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# CHALLENGE OF MATERIAL RECYCLING AT LARGE PUBLIC EVENTS

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**SUMMARY:** Large public events such as festivals, sports events or national celebrations tend to attract a considerable number of people. While some of the events are important sources of entertainment for the participants, such gatherings create a challenge to organize and maintain a functioning infrastructure. Sound waste management is one of the challenges. Some preliminary results presented here, concern waste material flows at a large public event, illustrated on the example of Roskilde Festival (Denmark). Roskilde Festival is a large annual event, which attracts more than 120,000 participants and generates more than 2000 tonnes of waste over eight days. In 2016, approximately 16% of the total waste generated was either recycled or sent to special treatment, the remaining (approximately 85%) ended up as residual waste and was sent to a waste-to-energy facility. While measures to promote material recycling at the festival have been implemented, our preliminary results suggest that there is currently large potential to recover additional materials for recycling and improve sustainability at large public events.

## 1. INTRODUCTION

Gathering of people in large numbers, is a main characteristic of a large public event. However, other characteristic of such events is the short time frame. Most of the events will span from hours to several days. Examples of such events are music concerts and festivals, sports events, national celebrations, political rallies, etc. While bringing masses of people together, large public events may provide an important source of entertainment for participants. Roskilde Festival is the largest music festival in the North of Europe, with more than 120,000 participants from Denmark and abroad. The festival is an annual event that takes place near the city of Roskilde, in close proximity to the capital region of Denmark. During the eight days of the festival (four “pre-music days” and four “music days”), Roskilde Festival becomes the fourth largest city of Denmark by population. This creates a need for an extensive (but temporary) and effective infrastructure to be developed and implemented to cater for needs of the festival participants, while minimizing environmental impacts and promoting sustainability. Functioning and effective waste management system is one of the challenges. The primary goal of a waste management system in general and large public events in particular is to collect, remove and properly dispose waste materials from a specific area. While these basic waste management services at large public events have been improving throughout the years, collecting materials for recycling remains a challenge. Primary limitations for improved recycling at such events is limited understanding of the waste generation, its composition, time-consuming nature of source

separation of waste materials to be recycled and the logistics constrained by limited space and time.

The overall goal of this work is to identify the challenges and opportunities for large public events to contribute to sound material management on the example of Roskilde Festival (Denmark). In particular, i) provide overview of the festival; ii) provide overview of the waste management at the festival; iii) quantify waste material flows at the festival for 2016. Preliminary results of an ongoing work are presented here.

## 2. MATERIALS AND METHODS

### 2.1 Festival area

The total festival area covers approximately 2,500,000 m<sup>2</sup>. Overview of the total area and the three areas it was divided into within the present work is illustrated in Figure 1. Most of the festival area is used for camping, where participants can rest and spend the night. Second largest area is “inner festival”, which includes the six music scenes and a variety of food stands, retail stores, pharmacy, company and university stands, etc. The majority of this area is used primarily during the four “music days”. The smallest area is the “city center” or areas designed to provide necessary facilities to the participants throughout the festival. Common facilities in these areas are retail stores, pharmacies and first aid stations, cloakrooms, hot showers, merchandise stores, recharge stations for mobile phones and small electric devices, etc.

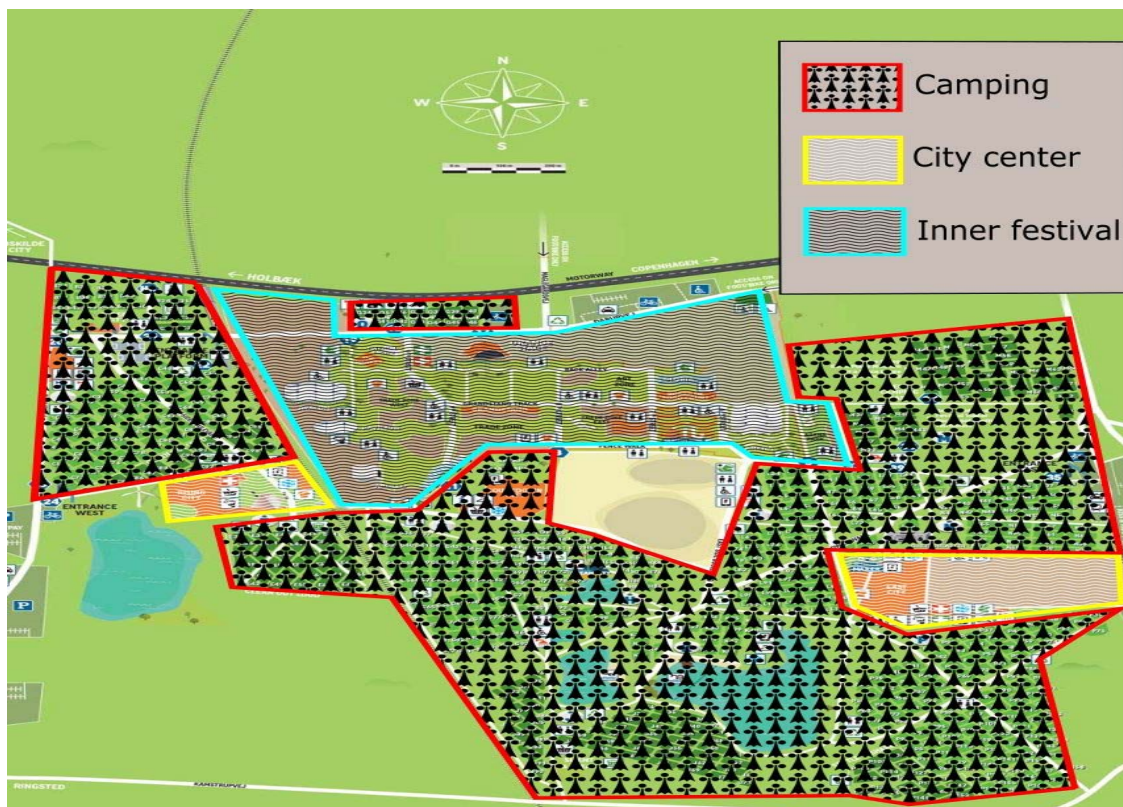


Figure 1. Map of the Roskilde Festival 2016 illustrating three main areas as divided in this work (adapted from <http://roskilde-festival-guide.dk/roskilde-festival-kort-2016-oversigtskort/>).

## 2.2 Waste management

Waste is generated either during the festival or right after the festival, when participants have left the area. During the festival participants have the option of disposing their recyclables at the recycling centers. There are a number of recycling centers at site, where participants bring materials that can potentially be recycled. Although types of waste materials collected at the recycling centers may change from year to year, most commonly following material fractions are collected:

- Metal
- Glass
- Batteries
- Waste Electric and Electronic Equipment (WEEE)
- Other

Waste materials not collected at recycling centers are disposed together with the residual waste in designated collection points spread throughout the festival and are collected as mixed waste. In addition, waste left on the ground during the festival (i.e., litter) is periodically collected by volunteers and either transported to the recycling centers or disposed together with the residual waste. Waste materials left after the festival are screened for selected fractions in need of special treatment (e.g., batteries and WEEE) or recycling (e.g., glass) and the remaining materials are disposed as residual waste. Refund system, used primarily for beverage containers, is used at the festival, but was not included in the present work due to a lack of data.

Waste collected at the festival was assumed to further undergo three types of treatments: i) incineration; ii) material recycling; iii) other treatment. While percentage of waste material collected for recycling is increasing, most of the mixed or residual waste in Denmark is currently incinerated (Danish Government, 2013). "Other" as waste treatment option, potentially includes dismantling, hazardous waste incineration, landfilling, or any other waste treatment options commonly not accounted for in incineration and material recycling.

## 2.3 Data collection

Most data on waste collection and treatment was provided by a third-party company responsible for waste collection and transportation at the festival for the year 2016. In addition to that, detailed composition of the residual or mixed waste generated during or after the festival was studied in a number of waste characterization campaigns. Waste characterization campaigns are designed to obtain material composition (e.g., glass, paper, plastics) of representative waste material samples.

## 2.4 Material flow analysis

System for the present work was defined by the geographical and temporal boundaries of the Roskilde Festival in 2016. Hence, actual fate of waste materials collected either for incineration, recycling or other treatment options was beyond the scope of the present work. Material flows were modelled and illustrated using the STAN software ([www.stan2web.net](http://www.stan2web.net)), a freely available software for material and substance flow modelling (Cencic and Rechberger, 2008).

### 3. RESULTS AND DISCUSSION

Figure 2 illustrates waste material flows at the festival. Figure refers to the total of waste generated both during and after the festival. In total approximately 2500 tonnes of waste were generated at Roskilde Festival in 2016. Assuming 120,000 people participated at the festival in 2016, this would result in a waste generation rate of 21 kg per person for whole duration of the festival or 2.6 kg per person per day. These figures are substantially higher than approximately 0.6 kg/person/day (Edjabou et al., 2015) and approximately 1 kg/person/day (Københavns Kommune, 2013) for residual and total waste generated from households in Denmark.

The majority of waste came from camping (78%), followed by inner festival area (19%) and city centers (4%). Since waste material flows depicted in Figure 2 include waste generated during and after the festival, dominance of camping is rather expected. After the end of the festival, large amounts of materials are left by the participants in the camping areas. Examples of items left in camping area are: sleeping tents and garden furniture, mattresses and sleeping bags, clothes and other textiles, food and beverages, etc.

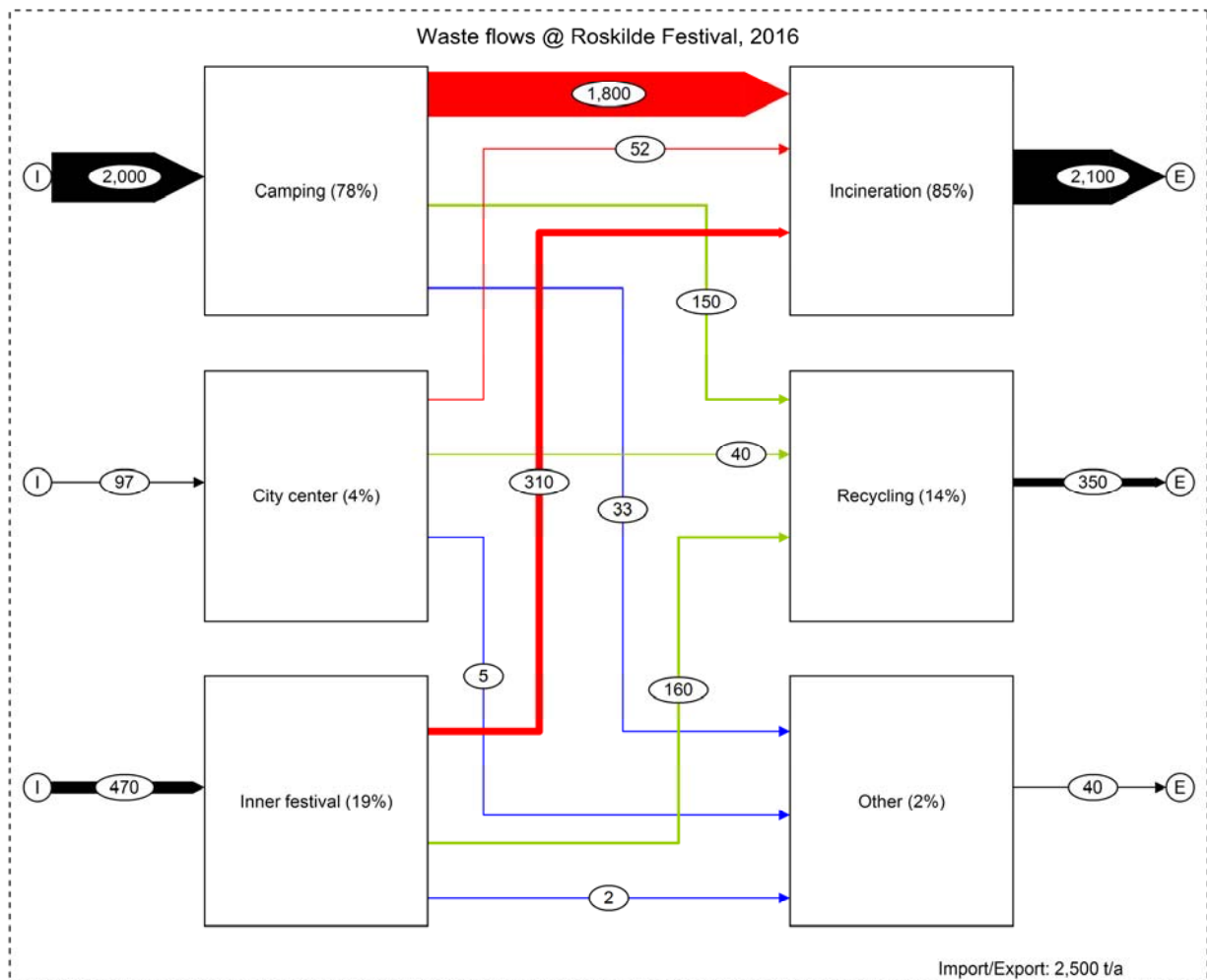


Figure 2. Overview of total waste material flows (tonnes/a) from the three main areas to the respective waste treatment options at Roskilde festival in 2016; percentage values refer to the total waste generated; "other" refers to waste treatment commonly not accounted for in incineration and material recycling (adapted from Kooten, 2017).

Most of the waste generated at the festival (85%) ends up being collected as mixed waste and routed to incineration (see Figure 2 for details). Once again, the majority of the mixed waste is generated from camping areas as discussed before. Approximately 150 and 160 tonnes of recyclable materials are collected from camping and inner festival areas, respectively. Waste materials collected for recycling amount to a total of 350 tonnes, or approximately 14% of the total waste generated. These figures are considerably lower than 36% and 59% as average recycling rates for households and service sector in Denmark (Danish Government, 2013). Majority of waste materials collected for other treatment (2% of the total waste generated) comes from camping and includes predominantly waste materials restricted from incineration by law (e.g., batteries, WEEE, polyvinyl chloride (PVC)-containing materials).

Preliminary results (data not shown) also indicate that the majority of recyclable waste is collected during the festival, as opposed to the mixed waste the majority of which is collected at the end of the festival. Major waste material fractions collected separately are metal, food waste, wood and glass. Metal comes primarily from pavilions, foldable chairs and tents commonly used at the festival. Hence, majority of the metal fraction is expected to be aluminium, although other metals can also be used. Separately collected food waste is primarily generated from kitchens providing for numerous food stands at the festival. The majority of the food and beverage stands, as well as other support structures are made of wood, explaining considerable share of wood in the separately collected waste (data not shown). Glass comes predominantly from packaging for alcoholic beverages and spirits. In addition, waste fractions for other treatment are also collected separately, as previously discussed.

#### **4. CONCLUSIONS**

Roskilde Festival is a good example of a large public event, with more than 120,000 participants every year. Approximately 2500 tonnes of waste were generated in 2016, with largest share being collected as mixed waste and being incinerated. Most of the waste is coming from camping areas, where it is primarily collected at the end of the festival. Materials separately collected for recycling represent 15% of the total waste generated at the festival. Main waste material fractions collected for recycling are metal, food waste, wood and glass. Most recyclables are collected during the festival, while separation of materials for recycling at the end of the festival remains a challenge. Since residual or mixed waste remains major material flow at the festival, efforts should be directed towards its characterization in order to quantify material losses, as well as material recycling potentials. Detailed waste material composition, coupled with source of waste generation can provide a necessary input for functional and more efficient waste separation and collection systems where majority of materials are recovered for recycling and as little material as possible is lost.

#### **AKNOWLEDGEMENTS**

Authors would like to acknowledge the support from Roskilde Festival organizers in data collection and analysis.

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