Collection and recycling of waste paint buckets
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Action 2.2

<table>
<thead>
<tr>
<th>Done by</th>
<th>Marianne Bigum and Line Geest Jakobsen</th>
<th>March-July 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality assured by</td>
<td>Kennet Petersen and Mette Skovgaard</td>
<td>29 July 2014</td>
</tr>
<tr>
<td>Approved by</td>
<td>Søren Løkke</td>
<td>26 August 2014</td>
</tr>
</tbody>
</table>
# Introduction

During 2013 and 2014 the Danish Design Centre, the paint bucket producer RPC Superfos and the City of Copenhagen has collaborated on how to reduce the waste production related to plastic paint buckets. Many ideas were discussed, among others: take-back schemes, redesign of the buckets to ease recycling as well as enabling a direct reuse system. One of the proposed concepts was simply to ensure that the waste buckets were collected for recycling and used to substitute primary plastic in paint buckets – creating closed loop recycling.

The project was considered interesting as the potentials are great in Denmark, as can be observed in the table below. Furthermore, WRAP (2013) finds when comparing life cycle stages that the disposal of water based paints often have the second highest environmental impact phase after the raw material phase.

## Table 1. Packaging provision for paint and varnish in Denmark, 2009

<table>
<thead>
<tr>
<th>Paint type</th>
<th>HDPE (tonnes)</th>
<th>PP (tonnes)</th>
<th>Total (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varnish and paint based on polyesters</td>
<td></td>
<td>62.5</td>
<td>62.5</td>
</tr>
<tr>
<td>Varnish and paint based on acryl- and vinyl-polymers</td>
<td>137.1</td>
<td>137.1</td>
<td></td>
</tr>
<tr>
<td>Varnish and paint based on synthetic polymers</td>
<td></td>
<td>48.8</td>
<td>48.8</td>
</tr>
<tr>
<td>Varnish and paint based on chemically modified natural polymers</td>
<td></td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Plastic - and latex paint with binders of high polymers, suspended in water, based on acryl- or vinyl-polymers</td>
<td></td>
<td>242.9</td>
<td>242.9</td>
</tr>
<tr>
<td><strong>Total (tonnes)</strong></td>
<td>137.1</td>
<td>357.4</td>
<td><strong>494.5</strong></td>
</tr>
</tbody>
</table>

Data was extracted by Econet from the Danish EPA’s packaging provision database 2009.

This demo-project was a part of a project called “Radical Reduction of Plastic Waste” initiated by Danish Design Centre and the City of Copenhagen – a project with collaboration between municipalities, companies, scientists and designers with a vision to minimize, reuse or recycle more plastic waste. Two open knowledge sharing conferences were held in 2012, as well as three project workshops. From this, four concrete projects evolved of which two were selected to be tested in 2013. One of these was this current project regarding paint buckets.

Paint buckets containing leftover water based paints are considered as “grey zone waste” and are currently collected at the municipal recycling stations or through the kerbside collection systems (“hazardous waste bus”, SMOKA). Empty and almost empty paint buckets are currently incinerated with “other combustibles”. The reason is the company contracted to manage the rigid plastics for recycling do not wish to include paint buckets in the recycling fraction due to uncertainty regarding if they are in fact empty. However, the grey zone waste paint does not actually require hazardous waste treatment and is therefore incinerated at the municipal waste incinerator (ARC).

Paint buckets are commonly made of fine grade virgin plastic (polypropylene, PP) and the current practise means that large amounts of plastic could in theory be recycled instead of being incinerated. PP is used because of its flexibility which gives good tightness and good protection in the value chain (RPC Superfos).

Incineration of paint buckets costs money and is also considered a loss of resources as well as contributing with fossil CO₂-emissions. Therefore, a system with recycling of grey zone paint buckets was considered and subsequently tested in the City of Copenhagen in December 2013 and January 2014. This report contains the main findings of the demo-project, including the main findings of an environmental assessment as well as a business case which was conducted in order to assess the environmental and economic effects of the proposed system.
2 Purpose

The purpose of the demo-project can briefly be described as the following:

- To investigate the possibilities for collecting waste paint buckets from Copenhagen’s recycling stations and sending these for recycling as opposed to the current incineration. This includes identifying any barriers e.g. relating to emptying paint buckets from left-over paint and subsequently baling the buckets for transport.
- To investigate the market possibilities for the plastic waste material including the possible price to be obtained.
- To clarify the actual recycling process and what quality of the plastic material that can be obtained.
- To collect the necessary data for a life cycle assessment (LCA) and a business case.
- To determine the environmental impacts of the current system opposed to the proposed recycling system, including any CO₂-reduction potential.
- To determine the cost of the current system opposed to the proposed recycling system.

3 Description of the demo-project

The collection of the paint buckets for recycling was conducted in the period of 25 November 2013 to 24 January 2014 (not including the holidays 20 December 2013 – 6 January 2014).

The pilot consisted of the following main phases:

- The paint buckets were delivered by citizens and businesses at four of Copenhagen’s recycling stations (Borgervænget, Bispeengen, Kulbanevej and Vermlandsgade)
- The paint buckets were transported by SMOKA to a consultancy’s (Econet) facilities where they were emptied. This involved replacing the collection material with empty ones
- The paint buckets were emptied (Econet)
- The empty buckets were baled (Marius Pedersen)
- The plastic waste material was transported to the recycling facility (Vogt-Plastic, Germany)
- Experiences with the demo-project were collected from the stakeholders
- The demo-project experiences were processed
- The environmental assessment was conducted
- The business case was conducted
- A final report on the demo-project was delivered.

Here follows a short presentation of the involved stakeholders:

- City of Copenhagen: local authority with responsibility for collection of hazardous waste and bulky waste
- Amager Resource Centre (ARC): incineration plant and operates recycling stations, owned by five municipalities, among them the City of Copenhagen
- Danish Design Centre (DCC): self-governing institution
- SMOKA: hazardous waste handler, owned by 16 municipalities, among them City of Copenhagen
- NORD: hazardous waste incineration and management facility
- Econet: consultancy company: empties and collects paint buckets
- Marius Pedersen: haulage contractor
- Vogt-Plastic: German plastic recycling facility
- COWI: consultancy company: preformed LCA
- RPC Superfos: paint bucket producer.
Table 1 summarises the main milestones, stakeholders and deliverables of the demo-project. Danish Design Centre covered expenses for collection and recycling, where the City of Copenhagen (LIFE+) covered the LCA and working hours for project managing. See Table 4 for further details on expenses.

**Table 1. Main milestones and deliverables of the demo-project**

<table>
<thead>
<tr>
<th>Milestone and deliverables</th>
<th>Main stakeholder</th>
<th>Date of delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background for the demo-project including financing was clarified</td>
<td>City of Copenhagen</td>
<td>June-October 2013</td>
</tr>
<tr>
<td>Waste paint buckets were collected, transported to a suitable location and emptied</td>
<td>ARC and SMOKA</td>
<td>December 2013 and January 2014</td>
</tr>
<tr>
<td>Waste paint buckets were emptied for leftover paint</td>
<td>Econet AS</td>
<td>December 2013 and January 2014</td>
</tr>
<tr>
<td>The emptied waste paint buckets were classified as green waste and able for transport</td>
<td>City of Copenhagen</td>
<td>December 2013</td>
</tr>
<tr>
<td>LCI data to be used in the environmental assessment was collected</td>
<td>City of Copenhagen</td>
<td>January-March 2014</td>
</tr>
<tr>
<td>The paint buckets were transported to a recycling facility</td>
<td>Marius Pedersen</td>
<td>March 2014</td>
</tr>
<tr>
<td>The evaluation of the demo-project was concluded</td>
<td>City of Copenhagen</td>
<td>March 2014</td>
</tr>
<tr>
<td>The environmental assessment was conducted</td>
<td>COWI</td>
<td>June 2014</td>
</tr>
<tr>
<td>The business case was conducted</td>
<td>City of Copenhagen</td>
<td>June 2014</td>
</tr>
<tr>
<td>A report on the results from the demo-project, the environmental assessment and business case was concluded</td>
<td>City of Copenhagen</td>
<td>July 2014</td>
</tr>
</tbody>
</table>

4 DEMO-PROJECT RESULTS

4.1 INTRODUCING A NEW COLLECTION SYSTEM

The establishment of the demo-project required the involvement of several stakeholders that all needed input from the others before being able to commit to the demo-project.

As a result, preparing the demo-project was actually the most time consuming and difficult part. A take home message is that several meetings between the stakeholders are necessary when wanting to introduce or test a new collection system. Commitment is also an important factor, as stakeholders should feel ownership of the project in order to have a successful process. Informing all stakeholders during the demo-project period is also necessary in case of any changes to the setup, which is likely to occur in a pilot.

Several schemes for collecting paint buckets for recycling were considered for the demo-project:

a) Collection of buckets containing leftover paint residues from recycling stations
b) Collection of empty buckets from recycling stations
c) a + b
d) Collection of paint buckets from the hazardous waste bus (Miljøbilen)
e) a + b + d

In the end it was chosen to test scenario “e”, where both empty buckets and buckets containing leftover paint would be collected from the recycling stations as well as the hazardous waste bus (Miljøbilen). However, due to unknown reasons, buckets from the hazardous waste bus were not delivered at Econet’s site for preparation for recycling. The data from the demo-project therefore only reflect scenario “c”.

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It should be noted that the buckets included in the scenario mainly originate from households. There lies a large potential within the service sector, especially professional painters.

The collection of the plastic waste buckets containing waste paint as a separate fraction at the recycling stations required that the personnel put the paint buckets containing water based paint (grey zone waste) in a separate container. This meant manually checking the containers, which was not much different from the normal procedure as paint buckets containing paint would have been manually handled anyway.

Empty paint buckets would normally have been disposed of by the citizens in the container for small combustibles. The collection of these required a new procedure so citizens delivered the buckets at the hazardous waste reception point, which was located at the recycling station as well.

Information regarding the new procedure was announced with a large sign near the container for small combustibles (see Figure 1). The information stated that the possibilities for recycling plastic waste buckets was being tested, and guided the citizens to another location at the recycling centre where they should leave their buckets.

The amount of collected empty paint buckets was according to Econet lower than expected and could be due to the citizens still discarding the empty buckets with the small combustibles or misplacing them in the container for rigid plastics.

A lesson learned is to include evaluation from involved stakeholders during a pilot project. Furthermore, the project description should also include a description of the communication flows between the stakeholders, such as meetings during the project to discuss communication and evaluation method. As a result some feedback on the new collection scheme or the manual sorting is missing.

The indirect feedback on the manual sorting is available as Econet who subsequently received the buckets, reported that the containers could contain misplaced items (paint buckets containing other than water based paint, emptied joint filler cartridges, silicone containers, print cartridges, glass containers with unidentifiable liquids, electronic items, cables etc.). This only constituted a minor problem to Econet, who had procedures to ensure that they only handled grey-zone waste paint buckets, and who would therefore simply return these items to appropriate treatment.

Evaluation of how the tested scheme was perceived by the citizens and the employees at the recycling centre was not done, as it was not included in the project description.

Transportation of the buckets required collection equipment in the form of containers. These would then be transported to the Econet site where they were emptied. In order to ensure that there was empty containers to replace the filled ones, Econet was required to empty these on a daily basis. This could prove difficult over weekend, and additional containers were therefore introduced. In the end, the additional containers turned out not to be necessary. Another experience from the
demo-project was that the amount of paint buckets collected at the four recycling stations varied. This meant that some recycling stations needed more containers and others fewer. The precise needs of each recycling station were identified by SMOKA who, as they were the ones responsible for the daily pickup and transportation, were the first and best to notice and react to this.

4.2 PREPARING THE PLASTIC BUCKETS FOR RECYCLING

Econet was the company in charge of receiving the buckets and preparing them for recycling, see report in appendix 1. This was done according to the following procedure:

1. The paint buckets were removed from the containers and set aside on a table.
2. The paint buckets as well as their content were checked in order to ensure that only grey-zone waste buckets were handled. Buckets which could not be considered as grey-zone waste was discarded in a separate container and sent to SMOKA, for specialised treatment.
3. Grey-zone waste buckets containing paint were emptied through a hole in a customized table where the paint was collected in a large container for liquids. Paint still in the bucket after this was scraped out and likewise collected in the liquid containers (see Figure 2).
4. The liquid containers were disposed off via SMOKA for specialised treatment as hazardous waste.
5. Emptied buckets were dried off with paper. This paper was collected in large bags and disposed of as residual waste.
6. Emptied, dried and stacked lids and buckets were collected in a large container. When this was full the container was collected by Marius Pedersen, who would bale it for shipment.

Figure 2. Emptying of the paint buckets, conducted by Econet

Econet experienced stacks of partially emptied paint buckets which appeared to have been delivered by professional painters. In numerous cases the buckets were stacked so firmly that they could not be separated and emptied for leftover paint. The consequence of this was that many of these had to be sent to SMOKA for specialised treatment. Not to stack paint buckets unless they are in fact empty is something that would need to be addressed in the eventuality of a permanent scheme.

The preparation for recycling resulted in the following outputs:

- Empty plastic paint buckets (Vogt-Plastic)
- Liquid containers containing paint residues (SMOKA)
- Paint buckets which could not be separated and thus not prepared for recycling required specialised treatment (SMOKA)
- Misplaced items which required specialised treatment (paint buckets containing other than water based paint, emptied joint filler cartridges, silicone containers, print cartridges, glass containers with unidentifiable liquids, electronic items, cables etc.) (SMOKA)
- Residual waste which could be disposed off as “other combustibles” (ARC)

The emptied paint buckets were classified as “green listed waste”, which meant that it was approved as a clean and recyclable fraction which could be shipped abroad for recycling (see appendix 2).

The emptied paint buckets were baled by Marius Pedersen and transported for recycling at Vogt-Plastic, Premnitz, Germany. No problems occurred when baling the paint buckets.

Emptying the buckets has been done in a very professional way, with emptying by gravity, scrapping and paper. In a realistic scenario it is assumed the emptying of paint buckets would not be as well preformed, why more residues must be assumed.

4.3 Amounts

The respective amounts of empty buckets and buckets containing paint were unfortunately not accounted for. However, it was the experience of Econet that approximately 5 % (by quantity) of the buckets was delivered empty and that these were mainly large buckets.

Five filled liquid containers as well as two which were 80-90% filled were in the demo-project period returned to SMOKA. Each liquid container in itself weighs 80 kg and consists of plastic and some metal.

Three containers with misplaced items were in the demo-project period returned to SMOKA. Half of these (both in terms of weight and volume according to Econet’s evaluation) was paint buckets which could not be separated and thus prepared for recycling and the other half misplaced items.

**Table 3. Outputs from treatment at Econet**

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Amount [kg]</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty plastic buckets for recycling</td>
<td>2,480</td>
<td>Vogt-Plastic</td>
</tr>
<tr>
<td>Liquid containers containing paint residues</td>
<td>9,240</td>
<td>SMOKA who sent it to NORD</td>
</tr>
<tr>
<td>- Liquid containers (consisting of plastic and metal)</td>
<td>560</td>
<td></td>
</tr>
<tr>
<td>- Paint residues</td>
<td>8,860</td>
<td></td>
</tr>
<tr>
<td>Paint buckets which could not be prepared for recycling</td>
<td>184</td>
<td>SMOKA who sent it for incineration</td>
</tr>
<tr>
<td>and therefore required specialized treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misplaced items which required specialized treatment</td>
<td>184</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Residual waste which could be disposed off as “other</td>
<td>250</td>
<td>ARC</td>
</tr>
<tr>
<td>combustibles”¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11,970</td>
<td></td>
</tr>
</tbody>
</table>

In 2013, the City of Copenhagen collected 292 tonnes of grey zone waste from recycling stations and through the kerbside collection with the hazardous waste bus, most of it was considered to be paint buckets with water based paint. From the demo-project’s amounts we have estimates that only 60.5 tonnes were actually

¹ Primarily paper used to dry of the buckets, but also plastic, wood, cardboard and paper which was included in the fraction.
plastic buckets ready for recycling (plastic waste) - either empty already or could be emptied. From the Econet report results it is calculated that 3-6 tonnes of paint buckets are empty when collected, why most paint buckets needs emptying before recycling is possible. These data are used later for the scale up of the system in the environmental and economic assessment.

4.4 Demo-project costs
Econet used approximately 2 minutes to empty each bucket, emptied buckets for 31 days and in total spent 398 hours on this. In addition to this Econet spent 9 hours for establishing the equipment (tables etc.) necessary for the task and had some expenses for equipment.

**Table 4. Expenses of the Demo project**

<table>
<thead>
<tr>
<th>Expenses (not including tax)</th>
<th>[EUR]</th>
<th>[DKK]</th>
<th>Stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information material for recycling stations</td>
<td>4,000</td>
<td>30,000</td>
<td>ARC</td>
</tr>
<tr>
<td>Collection of liquid containers from Econet</td>
<td>739</td>
<td>5,544</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Specialized treatment for liquid containers</td>
<td>4,682</td>
<td>35,112</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Lease of collection equipment</td>
<td>320</td>
<td>2,400</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Liners for collection equipment</td>
<td>72</td>
<td>540</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Transportation of collection equipment</td>
<td>10,853</td>
<td>81,400</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Cleaning of collection equipment</td>
<td>140</td>
<td>1,050</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Administrative support</td>
<td>140</td>
<td>1,050</td>
<td>SMOKA</td>
</tr>
<tr>
<td>Wages for establishing equipment</td>
<td>396</td>
<td>2,970</td>
<td>Econet</td>
</tr>
<tr>
<td>Expenses for equipment</td>
<td>1,849</td>
<td>13,870</td>
<td>Econet</td>
</tr>
<tr>
<td>- Customised tables</td>
<td>1,413</td>
<td>10,600</td>
<td>Econet</td>
</tr>
<tr>
<td>- Other equipment</td>
<td>249</td>
<td>1,870</td>
<td>Econet</td>
</tr>
<tr>
<td>- Lease of large container</td>
<td>187</td>
<td>1,400</td>
<td>Econet</td>
</tr>
<tr>
<td>Wages for emptying the buckets</td>
<td>17,512</td>
<td>131,340</td>
<td>Econet</td>
</tr>
<tr>
<td>Baling and transportation of paint buckets</td>
<td>297</td>
<td>2,225</td>
<td>Marius Pedersen</td>
</tr>
<tr>
<td>for recycling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue from plastic material</td>
<td>-248</td>
<td>-1,860</td>
<td>Vogt-Plastic</td>
</tr>
<tr>
<td>Total</td>
<td>40,752</td>
<td>305,641</td>
<td>City of Copenhagen and DDC</td>
</tr>
</tbody>
</table>

4.5 Quality assessment of the collected paint buckets
Vogt Plastic’s handmade analysis showed the following results:

**Table 5. Evaluation of the content of the balled paint buckets to Vogt-Plastic**

<table>
<thead>
<tr>
<th>Fraction</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics from paint buckets</td>
<td>88.4</td>
</tr>
<tr>
<td>Handholds (metal)</td>
<td>8.0</td>
</tr>
<tr>
<td>Residues from paint</td>
<td>3.5</td>
</tr>
<tr>
<td>Films</td>
<td>0.1</td>
</tr>
<tr>
<td>PET</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Vogt-Plastic was positive regarding the quality, and would like to continue to process the collected paint buckets.

A higher amount of residues, i.e. paint and misplaced items, must be assumed if implementation happens with a different setup of emptying the buckets by the

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2 See comment from Vogt-Plastic in section 6.
citizens. In the demo-project the emptying and sorting were performed by professionals, which meant a very clean fraction was sent to recycling.

RPC Superfos produces paint buckets with up to 85% recycled plastic content (rPP). A high content of rPP gives more wear and less strength. It should though be said that RPC Superfos have experienced a quality increase of rPP in recent years. Some costumers have chosen less rPP to be sure of safe shipments and because of uncertainties in product performance and user acceptance.

4.6 ENVIRONMENTAL ASSESSMENT OF THE PROPOSED SCHEME
The main findings from the life cycle assessment (LCA) conducted by COWI were as follows. The LCA can be found in appendix 3.

Recycling of paint buckets in the City of Copenhagen may lead to a reduced emission of global warming gasses of 148 kg CO₂-eq. per tonne paint buckets collected (full and empty), equalling approximately 45 tonne CO₂-eq. per year (292 tonnes full and empty buckets were collected in 2013, a rounded number of 300 tonnes is used). Future changes in the energy system towards more renewable energy may further improve the recycling solution compared to incineration – estimated to be savings of 113 in 2025 and 112 in 2035 calculated with no increase in amounts collected.

Recycling may have higher emission of nitrogen to aquatic environments, but this depends on the actual energy substitution and the energy technologies for reprocessing and virgin production of plastics.

On the basis of this life cycle assessment it cannot be concluded that any of the two scenarios have a lower impact on toxicity categories, as the results in toxic potential impacts are quite similar for the two scenarios.

Normalised results for included environmental impacts are presented in Figure 1.

**Figure 1:** Normalised environmental impacts for 1 tonne of paint buckets. PE is an abbreviation for Person Equivalents

![Graph](image)

378 kg CO₂-eq. per tonne paint buckets collected (full and empty)

374 kg CO₂-eq. per tonne paint buckets collected (full and empty)

Normalised results are scaled according to a common reference (e.g., the amount of impact generated by one person in one year), this scaling enables for the direct comparison of the environmental categories. The characterised results can be found in Life Cycle Assessment, which is an appendix to this report.
If only the empty paint buckets are included in the recycling system, the handling of the fraction will be easier, since no manual cleaning is required. However, the tonnage of recycled plastic will be much smaller (compared to a system including buckets with paint residues) and the environmental benefits correspondingly smaller – estimated to 2 to 4 tonnes of CO$_2$-eq.

The environmental benefits of reusing paint have been estimated by WRAP (2013) to be more than 350 kg CO$_2$-e per tonne collected paint for reuse. It is assumed 60% of the collected paint can be reused, and the calculation is based on UK conditions.

The potential saving of avoiding the left-over paint all together would potentially give a benefit of approximately 860 kg CO$_2$-e per tonne paint avoided (WRAP, 2013). This includes the following stages; design, raw material extraction, production, manufacture, delivery, installation and use. It is assumed all bins are 2.5 L, and the calculation is based on UK conditions.

4.7 ECONOMIC ASSESSMENT OF THE PROPOSED SCHEME

On account of lack of reliable information regarding investment and operational costs involved in the upscaled versions of the test scenario a standard business case based on a cash flow analysis has not been feasible.

To obtain an impression of the financial implications of different configurations of a collection and recycling system for the plastic paint buckets we have consequently felt obliged to base our estimates in the upscaled scenarios on actual expenses and amounts occurring in the test.

A model has been designed to facilitate simulations of costs and revenues attached to collected and recycled amounts in the arrangements mentioned in the following.

4.7.1 The model

Basically the model makes it possible to determine unit costs occurring in the different physical systems outlined below based on assumptions about achievable savings in acquisition and use of technology and re-adjustments of processes when the system is taken from test calibre to full scale.

Every type of cost occurring in the test has been scrutinized thoroughly to make us able to evaluate the possible effects of upscaling in each case.

To get an impression of overall net costs in the systems mentioned below we have established a coarse estimate of current costs of getting rid of plastic paint buckets and accompanying waste in Copenhagen.

These costs are featured as baseline costs in all the other scenarios which in practice mean that they are subtracted from the net revenues calculated in the scenarios.

This eventually makes us able to give an appraisal of total costs in the scenarios themselves but also a rough estimate of the social costs in each arrangement.

4.7.2 Four scenarios

Four scenarios have been outlined:

1. The demo-project scheme (“scheme c”: collection of buckets containing leftover paint residues from recycling stations and collection of empty buckets from recycling stations).
2. An upscaled scenario with no physical changes (60 tonnes)
3. Upscaled scenario – consumers empty buckets (60 tonnes)
4. Empty buckets only (5 tonnes).
In the absence of usable capital- and operations expenditure data we have based this assessment on actual costs in the test and subsequently asked ourselves cost by cost:

Where are savings obtainable and to what extent?

Amounts, cost structure and savings potential in the full scale scenarios have been determined by waste expert, Kennet Petersen, City of Copenhagen.

Note that the 60 tonnes corresponds to the actual buckets of the 292 tonnes collected at the recycling centres and “Miljøbilen” (hazardous waste bus) in Copenhagen in 2013.

The results of the scenarios are presented in Table 2 below.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total net costs/revenue (EUR)</th>
<th>Cost/revenue per tonnes paint buckets collected (incl. paint) (EUR/tonne)</th>
<th>Cost/revenue per tonnes paint buckets ready for recycling (EUR/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The demo-project scenario (2.5 tonnes paint buckets)</td>
<td>-40,000</td>
<td>-3,220</td>
<td>-16,000</td>
</tr>
<tr>
<td>2. 60 tonnes scenario</td>
<td>-210,000</td>
<td>-720</td>
<td>-3,600</td>
</tr>
<tr>
<td>3. 60 tonnes – citizens empty buckets</td>
<td>-97,000</td>
<td>-330</td>
<td>-1,700</td>
</tr>
<tr>
<td>4. Empty buckets only – 5 tonnes</td>
<td>16,300</td>
<td>660</td>
<td>3,300</td>
</tr>
</tbody>
</table>

Based on collection of 60 tonnes and no physical changes as compared to the demo-project scenario there is a drop of 75% in unit costs. Further substantial savings could be achieved if consumers were to take care of the process of emptying the buckets.

In conclusion the scenario with the empty buckets is the only scenario creating revenue compared to the current system of incineration, but on the expense of very low quantities. The scenario with citizens emptying the buckets is though more realistic and the quantities are maximised.

Reusing the paint is considered to decline the costs, as the treatment costs are saved.

5 Discussion

Preparing a setup takes time and is important for a successful result. All stakeholders’ commitment to the project is also an important factor. Communication about the entire project process including the evaluation method and which stakeholders have the responsibilities is significant too.

The collection scheme worked well, but a few improvements should be considered. Information to citizens is of importance for the amount collected as assuming some citizens discarded empty paint buckets as other combustible as is the custom today. In addition, Econet experienced many stacked paint buckets which was not completely empty. In order to increase the amount of recyclable plastic this should be avoided in the future, again information is essential.

Emptying of the buckets went as planned. However, considerations in regard to how much time needed to put into the emptying process and how empty the buckets have to be should be considered. The emptied buckets have been classified
as “green listed waste” and can therefore freely be transported abroad. Baling of the plastic paint buckets to ease transportation showed no problems.

Sorting at Vogt-Plastic was successful and the quality of the recycled plastic was satisfying. Closed loop recycling is not completely possible as RPC Superfos evaluated that up to 85% of new paint buckets can consist of recycled plastic. A closed loop recycling would require that buckets could be made with 100% recycled content. The market for recycled plastic is growing and the quality is improving.

Recycling the paint buckets have a benefit in regards to global warming potential, mainly due to substitution of virgin plastic. There is a trade-off with the impact category eutrophication though, because of longer transportation and the incineration scenario has savings because of substitution of fossil fuels. Other environmental impact categories show no significant differences between the scenarios. A future scenario shows that global warming savings should increase and eutrophication impacts decrease.

The economic scenario with collecting only empty buckets is the only scenario with net revenue compared to the current system. When citizens empty the paint buckets, the costs drop compared to a system similar to the demo-project setup, as the wages for emptying the buckets took up a large part of the finances. Higher amounts of residues are assumed, if the paint buckets are emptied by citizens instead of professional personal, which is not included.

**Figure 4. Comparing environmental and economic results**

Comparing the environmental and economic results there is no clear scenario which could be recommended. If only the empty buckets were to be collected and recycled, there is revenue, but the environmental benefits are insignificant.

The costs and environmental burdens from emptying the buckets and transporting the paint for specialized treatment might be minimized, if citizens were to empty the buckets themselves and the paint residues could be reused.

Projects in other countries have proved that recycling of leftover paint is possible. Recycling of the paint could lower the cost, due to saving the treatment fees of hazardous waste and potential sale of paint (or give social value if donated). In addition, this could increase the environmental benefits, due to prevention of paint production and treatment. Three examples from abroad are described below.

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6 Emissions of nitrogen to aquatic environments
- The Netherlands: Dutch painters association PPG Sigma, AkzoNobel and Ursa Paint has established the project SITA RePaint. The product “EVA” uses 97% recycled paint and have 72% less environmental impact. The source is separated residual paints from household (http://www.sita.be/).

- New Zealand: The paint producer Resene collects and recycles paints. The recycled paint is donated to community groups (http://www.resene.co.nz/paintwise.htm).

- The UK: Community RePaint is through sponsoring from the paint producer Dulux redistributing unwanted reusable paint to community groups and others They estimated that approximately 56 million litres of paint are left unused (http://www.communityrepaint.org.uk).

Reducing waste is the top priority in the waste management hierarchy, why this should also be considered here as the largest environmental benefits could be achieved here. Avoiding the half empty bins could likely be achieved through a combination of better management and ecodesign. There is an economic driver for the City of Copenhagen here; as this would reduce the half empty bins which the economic assessment showed was a large expense.

Before considering introducing a recycling scheme for paint buckets, it would be necessary to improve the business case, i.e. setting up the most realistic scenario and in this way lower the collection costs.

Current regulation does not allow local authorities, like the City of Copenhagen, to set up schemes for recyclable business waste. However, from the service sector (professional painters, paint shops, etc.) there is a large amount and the fraction of buckets which are empty is assumed to be higher.

The possible price to be obtained from the recycled plastic should also be investigated further. Including recycling of paint in one economic scenario should also be considered. The service sector has an initiative to donate unused paint if they can lower their disposal costs.

6 Conclusion

Collecting and recycling plastic paint buckets from private households containing water based paints is possible.

There is a CO$_2$-eq saving of 148.5 kg per tonne or 45 tonnes in the City of Copenhagen if all currently collected paint buckets are recycled, however this comes with a trade-off of releasing in total 0.1 tonne N to the environment (eutrophication) or 0.34 kg N per tonne. The CO$_2$-eq saving will increase in the future, whereas the eutrophication impact is assumed to decrease.

The most realistic scenario with citizens emptying the buckets at the recycling centre, will increase the cost of the paint bucket collection and treatment scheme with 210,000 EUR compared to the current system of incineration. If only the empty buckets that are delivered to the recycling stations are processed, there will be a revenue of 16,300 EUR compared to the current system.

Reducing or reusing paint should be considered, as it would presumably lower the cost and increase the environmental benefit (estimated to respectively 860 kg CO$_2$e per tonne avoided and 350 kg CO$_2$e per tonne collected paint for reuse). Including the potential from the service sector should also be considered.
Comments from Andreas Vogt, Vogt-Plastics:

In the analysis we have used the following recycling rate:

<table>
<thead>
<tr>
<th>Output from VOGT</th>
<th>%</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic for recycling</td>
<td>88.6</td>
<td>Recycling</td>
</tr>
<tr>
<td>Metal for recycling</td>
<td>8.0</td>
<td>Recycling</td>
</tr>
<tr>
<td>Paint residues</td>
<td>3.5</td>
<td>Incineration, German plant</td>
</tr>
</tbody>
</table>

This recycling rate is based on a manual analysis. When the material is processed the material in the factory we tend to lose a certain quantity of good material. A precise value cannot be given but it should not be more than 5%.

In the analysis we have used a substitution ratio of 0.81. I.e. one tonne of recyclate replaces 810 kg of virgin plastic PP granulate. It is a standard value used in the LCA programme EASETECH for recycling of PP plastics. In reality however, manufacturers may be replacing virgin material in a ratio of 1:1 and then the recycling scenario would produce a better result than presented here.

7 REFERENCES


8 APPENDICES

1. Report from ECONET – Emptying paint buckets
2. Green listing of waste
3. Life Cycle Assessment of paint bucket recycling