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# Greenhouse gas impact of dual stream and single stream collection and separation of recyclables

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ABSTRACT

Over the past decade communities and municipalities have been increasingly switching their recycling systems from dual stream (DS) to single stream (SS). Accordingly, material recovery facilities (MRF) have been constructed and retrofitted in order to accommodate fully commingled input streams. This transition has been driven by a variety of factors, including a general understanding that SS tends to result in increased waste diversion rates for participating communities. This paper examines the greenhouse gas emissions, or "carbon footprint," of recycling systems before and after the transition from DS to SS. This investigation aims to assess the environmental impact of trends in the recycling industry from a holistic perspective. In our analysis we consider several communities around the U.S. on the bases of tonnage and type of material recycled, fuel and electricity consumed in collection and separation, and avoided virgin materials consumption. By examining data from a small range of communities and MRF, we arrive at three main conclusions. First, a change from DS to SS results in approximately a 50% increase in production of recyclable commodities. Second, the net result of the DS–SS transition is approximately 710 kg $CO_2$-equiv. avoided per metric ton of collection. Third, the emissions associated with collection and MRF operation are small in comparison to avoided emissions from avoided consumption of virgin materials.



## 1. Introduction

In the environmental hierarchy of solid waste management options, recycling is prioritized second only to source reduction and reuse (U.S. Environmental Protection Agency, 2011b). Recycling offers environmental, social, and economic benefits stemming from landfill diversion and avoidance of virgin resource consumption (Lave et al., 1999). It has been an objective of communities and recycling collection and separation firms alike to increase both recycling rates and the value and purity of recycled material streams. These objectives are potentially in conflict, for instance with the recent trend of communities switching from dual stream (DS) to single stream (SS) collection schemes (Fickes, 2005; Ryan and Hess, 2004). In DS collection, residents source-separate their recyclables into two bins, one for paper fiber (PF) and the other for commingled plastic, metal, and glass (PMG). These two streams are collected in separate trucks or in separate compartments of the same truck. The streams are separated independent from one another. In SS collection, all permitted materials are combined in a single cart, collected in a single truck, and separated with a single, unified process. While SS collection generally boasts elevated recycling rates and allows for expedited collection, the fully commingled material stream makes separation more difficult, demanding more sophisticated – and more energy-intensive – automated equipment (Lantz and Venters, 2002).

While few dispute the resource conservation benefits of recycling, it is somewhat less obvious how recycling addresses the preeminent environmental concern of our times: anthropogenic climate change. It is of interest to communities and recycling firms alike to better understand the carbon footprint of different types of recycling schemes, both in an effort to mitigate their own contribution to greenhouse gas (GHG) emissions and to avoid pursuing environmental strategies that may result in more harm than good. In this study, we compare the GHG emissions of DS and SS recycling using a systems approach informed by life cycle assessment (LCA) methodology. The main objective is to ascertain the carbon benefit or penalty associated with the transition from DS to SS recycling, considering tonnage and type of materials collected, fuel and electricity consumed in collection and separation, and conservation of virgin resources.

### 1.1. Background

The growth of SS separation capacity in the U.S. has been nearly constant since 1995 at an average of about 14 new MRF per year

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