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## Maximizing Waste Management Efficiency through the Use of RFID

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### Executive Summary

Much attention has been given to our environment, the need to be more efficient and reduce the negative impact we have on it. Websites are dedicated to helping you measure your carbon footprint and provide tips to be more 'green'. For example, the Yahoo® Green site notes each person produces roughly 4.5 lbs of waste a day. Though that seems like a macro example, what about the impact each household has on the environment with the amount of waste we throw into our trash cans or recycling bins? In fact, large and small city governments and municipalities are reviewing how they handle the collection processing and management of trash and recycled products. Most major cities have active recycling programs and thousands of cities have taken it a step further by making each household financially tied to their trash. This means that you pay for the amount of garbage you generate and, in some programs, households are offered incentives through credits or points for how much is recycled. In the following paper, we will discuss programs such as this which are collectively called Pay-as-You-Throw or PAYT.

Additionally, we will take a look at how the waste hauler companies have a strong desire to help communities achieve their green goals while also improving their own processes. We will specifically discuss how technology is playing a vital role in waste hauling operations, the PAYT system and how the application of low frequency radio frequency identification (RFID) technology is making a positive impact on the way communities address waste management.

## The Business of Waste Management

To better understand the opportunities for how RFID can maximize waste management efficiency, it is important to understand the processes involved, the current collection methods and payment models. Not only can RFID enhance waste management operations, but new systems also offer communities the opportunity to be more environmentally responsible. For these reasons, more and more urban areas are taking a closer look at how waste management processes can be improved.

The rationale for using RFID as a solution to create and streamline waste management efficiencies is articulated best by the waste hauler companies themselves. There is a great deal of intelligence that RFID facilitates and in speaking with the waste hauler companies, there is a great deal of process intelligence that these companies seek to capture. Not only are the waste haulers interested in time-related factors (such as time spent to, from and at locations), but more importantly they are interested in the accurate tracking of a container's serial number and location. These elements are important to ensure the proper collection and management of waste.

Typically, recording the trash collection is a manual operation and is the responsibility of the trash collection vehicle driver. **Figure 1** shows a traditional, curbside collection method without the use of RFID technology.

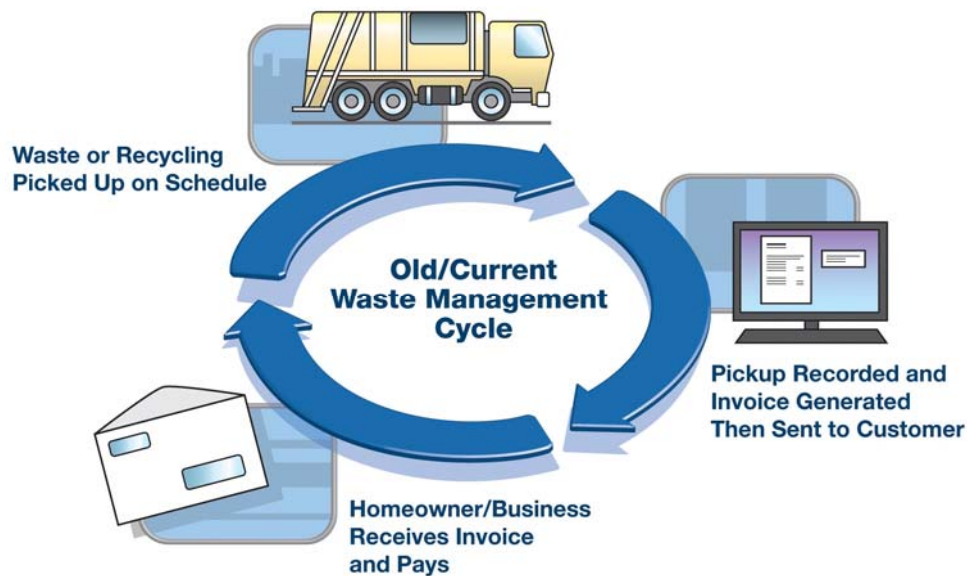


Figure 1  
Illustrates Waste Management without RFID technology

Although the hauler companies employ GPS systems to capture the time metrics they desire, accurate container tracking is another matter. With manual operations, numbers can be misread, misreported, mistyped or left blank altogether; and unfortunately, barcodes cannot survive the environmental stresses in this application. Furthermore, asking drivers to manually collect this data is a significant distraction to their main responsibility – driving.

To address this risk and solve the manual data collection problem, Texas Instruments' low frequency (LF) RFID system technology is an ideal solution. Texas Instruments' integrated LF RFID reader and antenna system, which resides onboard the vehicle, reads and transmits the container's transponder serial numbers. These serial numbers, provided through the vehicle waste management computing system, give the waste hauler operations and dispatch personnel 100 percent accurate data. Automation removes the burden of responsibility from the driver, so he or she can focus on the most important part of their job: driving safely and concentrating on the route. Finally, as mentioned earlier, hauler companies currently employ GPS technology to understand various time intervals and stops made in the field. The tag data, combined with the GPS data and possibly even camera still photographs, make for a complete data solution creating 100 percent service verification. Additionally, RFID is proven to withstand severe environmental stresses that waste applications present.

### **Changes to the Traditional Model**

Not only is the business of waste management improving because of RFID, but RFID technologies are serving as a catalyst to change the way customers are billed for waste services. New billing models are emerging and gaining momentum inside of city governments and municipalities as they learn of the multi-layered benefits offered through new waste management models. The Pay-As-You-Throw model is a program that ties recycling to a cost incentive program whereby users are charged according to the amount of waste they produce and recycle. This is a bit different from the basic system that waste hauler companies seek to employ because in some cases, PAYT requires the use of load cells or strain gauges on the front/side/rear loader or grabber arm of the trash collection hauler vehicle. Nevertheless, PAYT is gaining momentum because many of the current waste collection and billing programs are inequitable. This is because the amount of trash generated per individual household varies. In most U.S. cities, domestic household trash and recycling bins are emptied weekly from the curb. Waste collected is then transported to a regional landfill or recycling center. Under this collection model users are charged a flat rate that is determined by the city's fee structure.

However, a flat rate model may not account for variations in the amount of waste generated by each household. To that end, many city officials and governments are interested in programs that enable them to equalize the fees and encourage recycling. To implement such a system, they need accurate information so that private and public customers are billed based on the actual garbage collected and in some programs, credited for the amount recycled.

### **The Role of LF RFID in Waste Management**

All the changes and renewed interest in waste management across multiple constituents including city governments, waste haulers, and environmental organizations, make the role of low frequency RFID technology that much more relevant. Low frequency RFID provides a solution that addresses each constituent and gives each entity a reason to implement improvements in waste management practices. With an integrated RFID system in place, the technology provides an automated process for logging each container as the waste is dumped into the truck. The system verifies container pick up, tracks customer usage and measures route efficiency.

TI's 18 years experience in RFID asset tracking -- with 10 years of waste management expertise -- demonstrates our ability to solve customer problems in a variety of application scenarios ranging from: livestock tracking, library efficiencies, protecting luxury goods, and access control, just to name a few. Texas Instruments is a market leader in asset tracking management and is a

leading provider for low, high and ultra-high frequency applications. The application of LF RFID in waste management is a classic use case which demonstrates the many attributes and benefits that LF RFID has to offer this industry.

For example, LF RFID offers resistance against environmental influences which is a key application requirement because waste receptacles are often stored outdoors and are exposed to a variety of elements. LF RFID is also shock resistant, needs no line of sight to be read, and makes automatic detection and selection methods possible. RFID's ability to provide a unique serial number by customer or household that is not replicable makes it easily incorporated into billing/management systems. Other RFID benefits are its advanced memory/information storage inherent in each tag, as well as its proven reliability and the fact that there are existing ISO standard for waste management. In **Figure 2**, we see an example of an RFID-enabled waste collection process. RFID technology enables automatic wireless data collection at all stages of the waste/recycling process from pick up through customer invoicing.



Figure 2  
RFID and Technology Enabled Waste Management Cycle  
(Automation of the waste collection process)

## Low Frequency RFID – How it Works

The RFID components are part of a larger, highly integrated, vehicle mounted system. Components of a basic system include an RFID reader controller with dash-mounted status box, an RFID antenna, and passive low frequency RFID tags mounted on the containers. RFID data logs can be automatically downloaded from the controller to designated servers via an 802.811 wireless connectivity or by other connectivity schemes/means. The download process can be automatically initiated when the truck comes within range of the receiving node (typically at the

dumping weigh station) with the complete process being fully automated and requiring no action from the driver.

The system can be installed on both semi-automated and fully automated trucks. The transponder or “tag” is the unique identifier which is affixed to the container. In most cases, the transponder is an Ingress Protection-rated (IP-rated), encapsulated RFID transponder. The benefit of the transponder is its reliability and quality requiring little, if any, maintenance. The reader, which reads the tag also requires little, if any, maintenance when properly installed. The antenna, connected to the reader, creates a magnetic field or “read zone” that the transponder must enter to be read from or written to. The figures below illustrate examples of a reader and antenna mounted enclosure, an RFID-equipped truck and a container that is tagged with a low frequency RFID tag.



Truck-mounted RFID antenna



RFID-equipped truck



Container with RFID tag

## Implementation Models

The accurate count/service verification model as discussed in the waste hauler situation overview offers the most effective method for maximizing waste management efficiencies. The need for real-time verification of the what/when/where of the service stop is the most frequently requested feature and addresses the critical values that are needed to satisfy the waste hauler's business metrics.

PAYT is a usage pricing model for disposing of municipal solid waste and is sometimes referred to as unit pricing or variable rate pricing. PAYT has been written about in various journals since the 1970s<sup>1</sup>, with increased attention given to programs by city governments in Illinois, North Carolina, Oregon, and Massachusetts as of the late 1980s and early 1990s. ([www.epa.gov/payt/research](http://www.epa.gov/payt/research)). To date, more than 6,000 cities<sup>2</sup> have implemented PAYT systems citing benefits including reduced waste, increased recycling and social responsibility.

Under the PAYT plan, users pay a variable rate based on how much waste they generate, and recyclable waste is usually collected free of charge. Again, this is a more involved system that might have a third party (aside from the waste hauler operation) managing that data, interfacing with and giving credit to both residents and participating retailers who issue recycling credits.

<sup>1</sup> MSW Management article; [http://www.stormh2o.com/mw\\_0506\\_rise.html](http://www.stormh2o.com/mw_0506_rise.html)

<sup>2</sup> MSW Management article; [http://www.stormh2o.com/mw\\_0506\\_rise.html](http://www.stormh2o.com/mw_0506_rise.html)

At the crux of this discussion is determining the real cost of waste hauling and disposal. Starting with the recording of a container's serial number and location, as provided by the Texas Instruments LF RFID system, RFID technology can transform the manual, error-prone data collection process used today with one that increases accuracy for a waste hauler's accounting system. Better data gives way to enhanced operation visibility whereby the waste hauler can see the areas that need improvement and then make the necessary changes for any number of operational processes.

Furthermore, with an RFID system, the data is precise and reliable, allowing accountants and dispatchers to spend less time verifying daily data and more time maximizing route efficiencies. With greater data integrity, waste haulers can determine their true costs and margins. Whether the overall system is a real-time verification only model or used in conjunction with PAYT functionality does not matter -- both waste hauling companies and city municipalities need the fundamental data provided by the RFID system to begin optimizing their processes or providing billing/credit for waste disposal or recycling.

To make the point very clear, both the payment system and container tracking model are improved through the implementation of RFID, and benefit all parts of the value chain: the waste hauler, the city/town and its community.

## **Implementation Costs**

For waste haulers interested in adopting RFID, the system's cost can often be shared with whomever they might have a contract with. A return on investment (ROI) will be realized with the high-quality data provided by RFID-enabled vehicles. As trucks begin to stream in from the field and the operations or dispatchers can better optimize routes and schedules, the benefits of RFID come into full focus. Further ROI realization will occur as the waste haulers determine the optimized routes for their fleets and repeat this process on a regular basis. The waste hauler can also work with the landfill or transfer station operators to place an RFID reader at the landfill which tracks a transponder attached to the vehicle. This ensures the vehicle is authenticated for access to the landfill site, and it also helps to streamline the job ticket paperwork.

When looking at this implementation from a municipal standpoint, communities that implement a PAYT system will have to do so in conjunction and cooperation with a hauler. The city government will choose among the three basic types of pricing systems: proportional, variable, or multi-tiered. Proportional systems offer residents a pricing structure that charges the same amount of money for each unit of waste they set out for collection. These are usually bag-or tag-systems, with the bags sold at local retail stores or municipal offices. In the variable rate pricing systems, the residents are charged or credited different amounts per unit of garbage and recyclable material collected. Finally, in the two-tiered or multi-tiered systems, residents pay a flat fee for a base level of service, and then pay a "second-tier" fee based on how much waste they set out. Second-tier fees can be either proportional or variable.

It is important to determine the right mix of success factors before selecting a pricing model. Therefore, though the approaches may vary from one city to the next, the overall fiscal and environmental benefits remain positive. To maximize recycling, for instance, some communities use variable rates which charges substantially more for a second or larger trash can. If a more equitable system is a primary goal, implementing a tagging and weighing system is a model that charges residents for exactly what they dispose. If covering the cost of solid waste management is the primary concern, a two-tiered system can help ensure a reliable revenue stream. Here, basic "fixed" costs (expenses not tied to the amount of Municipal Solid Waste (MSW) generated)

can be recovered through a utility or tax bill, while “variable” costs such as landfill disposal fees are recovered through a separate per unit fee.

An added, but sometimes overlooked, benefit of increased waste management collection is reducing the amount of waste collected versus the amount recycled. Participants in the PAYT model have reported that communities are encouraged to recycle more which means that more recycled materials can be used instead of new, raw materials.

## **Conclusion**

Increasing recycling and reducing disposal, while making the fee structures equitable, are the primary waste management operations poised to benefit from low frequency RFID technology. As cities and corporations seek to improve their waste collection processes, RFID technology presents an opportunity to maximize waste management efficiency. With RFID, the process is automated, and has the potential to provide improved value for the waste management companies and the communities/citizens they serve. Additionally, the environmental impact is yet another incentive and positive byproduct of implementing change in the manual system. In models that implement a PAYT system, individuals are more inclined to reduce, reuse or recycle if they are charged for the amount of waste they produce and are credited in some way for the amount of recyclable material they place out for collection. The hauler companies have an interest in better understanding the true cost structure of their businesses and how they can be more effective and thus, improve their processes. The RFID piece of the equation plays a pivotal role in the waste management industry because it introduces a proven, rugged, low maintenance, unique identifier that the collection and billing processes can use to truly automate the system. Texas Instruments, with its application experience in waste management, offers low frequency RFID solutions that automate and improve the entire waste collection process. For more information about TI's low frequency RFID products in this and other applications, visit us at [www.ti.com/waste-tracking](http://www.ti.com/waste-tracking)

## **About the Author**

Josh Wyatt is currently an RFID applications/systems engineer for the Texas Instruments RFID Systems Group. In this role, he provides technical and new business development support for LF and HF asset tracking customers, enabling them to successfully leverage the benefits and functionality of TI's industry leading RFID technology. With more than five years of service to TI, Josh has also served as a senior electrical engineering/design technician where he primarily supported Texas Instruments RFID contactless commerce products. (ExxonMobil Speedpass™, American Express® ExpressPay® and MasterCard® PayPass™)

## **About TI RFID Systems:**

Texas Instruments RFID Systems, a market leader in asset tracking management, has more than 18 years experience in the market. The application of RFID in waste management illustrates many of the benefits RFID has to offer. For example, RFID provides resistance against environmental influences which is key in the waste management application since receptacle are often stored outdoors and exposed to a variety of elements. RFID is also shock resistant, needs no line of sight for detection/confirmation, makes automatic detection and selection methods possible which is ideal for the PAYT billing management system and RFID provides for a unique serial number by customer or household and is not replicable. Other RFID benefits are the advanced memory/information storage provide inherently in each tag as well as its proven reliability and the fact that it is an existing ISO standard for waste management. For more information please visit [www.ti.com/rfid](http://www.ti.com/rfid), e-mail [rfidsupport@ti.com](mailto:rfidsupport@ti.com), or call 1-800-962-RFID (7343).

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