

# ANALYSIS OF DISCARDED CRTS IN FLORIDA: SURVEY RESULTS AND QUANTITY FLOW TOOL

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## ABSTRACT

The average number of televisions per home was 2.4 in 2001 (US Census, 2005). According to the U.S. Census Bureau, 62% of Americans owned one or more computers in 2003. This was an increase from 56% in 2001 and 8% in 1984 (Day, et al. 2005). Additionally in 2001, 98.2% of homes had at least one television, which is up from 87% in 1960. High definition televisions are rapidly replacing the standard definition television. CRTs are quickly becoming obsolete in developed countries and are a major component in the electronic and hazardous waste stream (National Recycling Coalition, 1999).

This paper presents results of a study on the current CRT waste stream in the state of Florida (volume of CRT discarded, existing facilities, practices) as well as makes projections on trends in future CRT waste streams. The goal of this study to answer questions about trends in volume of discarded CRTs in the future, current CRT waste management practices and trends, and capacity for handling increase in CRT disposal. A survey was conducted among county household hazardous waste managers and electronics recyclers in Florida. A materials flow model that tracks CRTs from the time a consumer purchases a television or monitor to when it is stored, reused, recycled, and disposed was developed. In addition, a user-friendly management tool is developed to allow managers, regulators, and policy makers to compare scenarios for the recycling and disposal of CRTs.

## INTRODUCTION

### Background

An estimated 300,000 tons of electronic waste (e-waste or e-scrap) was disposed in landfills in 2000 (Gable and Shireman, 2001), with CRTs comprising approximately one-third of this mass. CRTs can range in weight between 8 and 70 lbs depending on the size of the television or computer monitor (Townsend et al., 1999). Exposure to lead is the primary concern of CRT handling and disposal. Lead exposure may cause moderate to severe health effects especially in children.

Estimates anticipate that the amount of electronics discarded will increase 16-28% each year, which is three times faster than the average growth rate of municipal solid waste (EEA, 2003). Furthermore, data indicate that the rate at which CRTs have become obsolete has steadily increased and was similar to the rate of CRT production in 2003 (Kang and Schoenung, 2005). CRTs are significant e-scrap products given their volume, recycling costs, and disposal restrictions in certain states (Kang and Schoenung, 2005). Approximately half of the mass of a TV or computer monitor is in the CRT (Lee et al., 2004), and about one-third of the total mass of a CRT is lead-containing glass while other CRT components also contain lead (M  ar et al., 2006). Most CRTs contain as much as 4 to 8 lbs of lead (Kiuchi et al, 2001). However, glass-to-glass recycling is the preferred option for the reuse of CRT glass; however, it is labor intensive and expensive and limited users of the recycled material exist. In the U.S., glass-to-glass recyclers exist in Arizona, Ohio, and Pennsylvania.

With the June 2009 transition to over-the-air digital television broadcasts and the decrease in prices for newer technologies such as LCD and plasma, it is anticipated that the CRT waste stream will further increase when CRT television sets are replaced. Electronics recyclers estimate that 1 in 4 households will dispose of at least one television because of the digital conversion. Based on Florida's estimated population of 18,680,000 and households of 7,425,000, this forecast estimates that approximately 1.85 million televisions (or approximately 1 television for every 10 Floridians) will be discarded in the next few years (FDEP, 2008a). In another study, the National Safety Council (1999) estimated that between 1999 and 2003, the number of obsolete televisions in Florida increased slightly and was approximately 1.4 million units, while the number of obsolete computer monitors increased over 40% from about 900,000 to 1.3 million units, with only a small percentage being recycled.

### Objectives

The focus of this study is on discarded CRTs from both television sets and computer monitors. The goal of this research to answer questions about trends in volume of

discarded CRTs in the future, current CRT waste management practices and trends, and capacity for handling increase in CRT disposal in Florida. These questions include:

- What are the trends in the volume of CRTs discarded in Florida – both currently and expected in the near future?
- What is the currently available infrastructure for handling disposed CRTs from Florida?
- What are the current capacities of existing disposal and recycling facilities for CRT components, and will they be able to handle future volumes?

To help answer these questions, the research objectives of this study are to:

1. Consolidate data on CRT waste volume and current management practices in Florida.
2. Develop a model to predict future CRT quantities in Florida and analyze management options.
3. Analyze CRT disposal management options for Florida.

This paper summarizes the results of the study, focusing on information related to the first two objectives.

## **CRT RECYCLING SURVEY**

### **Background**

Recent information on the volume of CRTs disposed and management practices and identify past and recent trends in Florida was collected to provide a snapshot of the current conditions in Florida. Currently there exist approximately 20 facilities in Florida that demanufacture and recycle televisions, computers, and electronics (FDEP, 2009) and 9 organizations in Florida that accept donations of electronic equipment (FDEP, 2008b). In June 2008, the Florida Department of Environmental Protection issued a memorandum that provided the regulatory guidelines for unwanted electronics (FDEP, 2008c). However, each county has individual e-scrap management practices.

### **Methodology**

Surveys were distributed in February-March 2008 to obtain information on the status of unwanted CRT disposal in Florida. The surveys were sent to three different groups: county household solid waste managers, electronics recycling facilities, and donation centers. Each group was asked similar questions regarding disposed CRTs. In particular, the surveys included questions on the following topics:

- Collection method

- Amount of CRTs received in 2007 and 2008 and distribution between televisions (TVs) and computer monitors
- Recent changes in quantities received
- Source of the CRTs
- Fees charged to dispose of CRTs
- CRT processing methods
- Capacity constraints
- Cost of recycling or processing

### **Results**

The results of the surveys provide a snapshot of recent and current trends on the volume, and disposal rate of CRTs in Florida, as well as current management options. Responses were provided by 11 counties, 4 electronics recyclers, and 1 donation center organization.

**Counties:** Of the 11 counties that responded to the survey, 3 have relatively small populations (70,000-150,000 residents), 6 have mid-size populations (225,000-450,000 residents), and 2 have large populations (1-2 million residents). The most common method used by the counties for collecting discarded CRTs was drop-off locations at the main solid waste facilities and at satellite locations. Some counties held collection events, with a frequency ranging from once to 14 times a year. Only two counties have specific curbside pick-up collection, one for the entire county and another for one city within the county. As expected, the majority of the CRTs received are from households (65-100%) while some counties accept items from businesses. Counties do not charge residents for the disposal of CRTs, although a few counties impose a limit on the number of items, while most counties charge a disposal fee for businesses that may vary depending on the type of item. Table 1 summarizes the quantity and distribution of CRTs received by the counties, recycling facilities, and donation centers; note that not all counties that responded provided data and that some counties reported quantities in number of items while others reported total pounds of CRTs received. The change in quantities received varied from county to county, with some reporting no or slight increases and a few reporting 50% or more increases in the recent months preceding the survey.

For the counties responding, all store and prepare the CRTs for shipment to a recycling facility, with most using in-state recyclers, and no counties demanufacture the CRTs themselves. The costs for CRT recycling varies for each county, ranging from \$1-10 per unit, with the costs typically higher for TVs compared to computer monitors. A few counties have established agreements with the recyclers to not pay for disposal, with one receiving \$0.01/lb for monitors sent to the recycler, since computer

monitors often have a higher recycling value compared to TVs. Counties in general do not have capacity constraints for the storage and processing of CRTs for recycling.

**Electronics Recyclers:** Recyclers receive their CRTs from municipalities, government offices, and businesses. Most also hold collection events in coordination with individual counties. The quantity of CRTs received by the recycling facilities responding to the survey varied significantly (Table 1) due to the size of the facilities. Because business contracts account for a large portion of the recyclers' businesses, they receive a larger amount of computer monitors compared to TVs. Recent trends varied among the responses, from no recent changes in the number of CRTs received to a 15-25% estimated increase; one recycler observed a "noticeable" decrease in the number of monitors received. Some recyclers charge \$3-7 per monitor or TV received, while others charged by weight, \$0.15-0.50/lb. The two recyclers who do not demanufacture on-site the CRTs charge more to receive TVs compared to computer monitors. The recyclers who demanufacture CRTs send components to various parts and materials recyclers in the eastern and Midwestern U.S. and Canada. With the exception of one facility, the recyclers who responded did not have capacity constraints for the processing of CRTs.

## **CRT QUANTITY ANALYSIS TOOL**

### **Background**

A CRT materials flow model was developed to help answer the questions: "What are the trends in the volume of CRTs discarded in Florida expected in the near future; and will existing disposal and recycling facilities for CRT components be able to handle projected future volumes?" While the focus is on the trends in Florida, this tool may be used for other states or for the United States in general.

### **Methodology**

The overall approach is to track CRTs throughout their life cycle, from production to usage to recycling and disposal. A spreadsheet-based model using materials balance and flow modeling and analysis was developed to track the life cycle of CRTs. The methodology was based on the approaches used in US EPA (2007) and US EPA (2008). The model tracks CRTs from when a consumer purchases a monitor or television to when the consumer decides the item is no longer of use. Then the CRT may go into storage, to a second user (from donations or resellers), recycling, incinerator, or landfill, or may be exported. Of the quantity that is reused or stored, the CRT can later be recycled, landfilled, incinerated, or exported; these are second life quantities. Figure 1 shows the potential life cycle for a CRT modeled in this tool. This flow of CRTs was modeled over a 35-year period, from 1985-2020.

Estimates on the existing number of CRT television sets

and computer monitors was made based on recent data from the U.S. census and Florida-specific sources. US EPA (2007, 2008) estimated disposal rates of electronics in the U.S. using data from two sources, market research data for sales and government statistics for sales, and found that resulting estimates are similar. Government sales data was used as the default input information for this model. The duration the product is used, which also is known as the time for the product to reach end-of-life (EOL), was estimated based on published information from the literature. A range of EOL times was used in this model so that a CRT. The model provides suggested default values for the above described input data but also allows for the user to change any or all of the information.

The model can be used to predict the overall future quantities of CRTs disposed as well as the distribution of future waste streams (for example to recycling, reuse, export). The tool also allows the user to analyze the effects of potential policies, such as banning landfill disposal of CRTs or mandating a specific of recycling rate.

### **Results**

The results for an example case are presented here for demonstration purposes. The values and trends shown are not intended to be formal predictions of the quantities of CRTs disposed in Florida, and some of the assumed values used for this example problem may not be representative of the actual conditions.

The example case uses the default input data provided in the model, which are based on information reported in the literature. Sales data for CRT computer monitors and TVs (for both units <19" and >19") was from U.S. government statistics for 1985-2007. For the years 2008-2020, it was assumed that sales would be same as for 2007 to provide a conservative, worst-case scenario. The average weight of computer monitors, TVs < 19", and TVs >19" was assumed to be 50.5, 41, and 73 pounds, respectively; this is based on US EPA (2008). Florida's share of the total U.S. CRT sales was based on published data on the state's share of the US economy for 2004-2008; for 1985-2003 a value of 4.5-5.1% was assumed, and an average based on the previous 5 years' data was used for 2009-2020. For this example, the first EOL time for CRT computer monitors was assumed to 3 years for the entire modeled period and 6-12 years for CRT TVs. At the first EOL, it was assumed that of the total CRT computer monitors that are disposed during a given year, 25.9% will go to landfills, 8.7% are recycled, 0.7% are incinerated, 0% are exported, and 64.7% are stored or reused. For CRT TVs at the first life EOL, it was assumed that 29.4% go to landfills, 4.7% are recycled, 0.8% are incinerated, 0% are exported, and 65.10% are stored or reused. The values for second life (after reuse or storage) are different from those for first life. The second EOL duration was assumed to be 1-22 years for monitors and 1-

19 years for TVs. At the second EOL, 73.4% of monitors are assumed to be sent to landfills, 24.5% are recycled, and 2.1% are incinerated; for TVs, it was assumed that 84.2% are landfilled, 13.4% are recycled, and 2.4% are incinerated. In this example, it is assumed that the EOL durations and disposal distributions are the same for all years of the model. However, the model has the capability to use different input values for each year included in the model.

Figure 2 summarizes the total weights (in thousands of tons) of CRT computer monitors and TVs that would be disposed during 2005-2020 for this example case. Because the amount of CRT computer monitors sold has decreased in recent years, it is expected that less will be seen in the waste stream. Figure 3 shows the weights of monitors and TVs that would be recycled based on the assumed values described above. For this example, based on the assumed values used, the trend for the recycling for monitors is similar to the total amounts (Figures 2-3), while the weight of TVs recycled would be a smaller proportion compared to monitors (Figure 3).

### CONCLUDING REMARKS

This paper highlighted the results of a study that collected information about the current status of CRT disposal and recycling and management practices in Florida. A follow-up survey is planned in spring 2010 to assess any changes to CRT disposal rates or practices after the transition digital television broadcast.

This paper also presented a materials flow model that tracks computer monitor and TV CRTs from sales to first EOL disposal, recycling, and reuse to second EOL disposal and recycling across a 35-year duration. This model was developed into a spreadsheet tool that may be used to predict disposed CRT amounts through the waste stream for any region or state. The model also may be used to analyze the impacts of management policies on disposed CRT amounts.

Additional details and results of the study will be available in future reports and publications. The CRT quantity analysis tool is available from the authors upon request.

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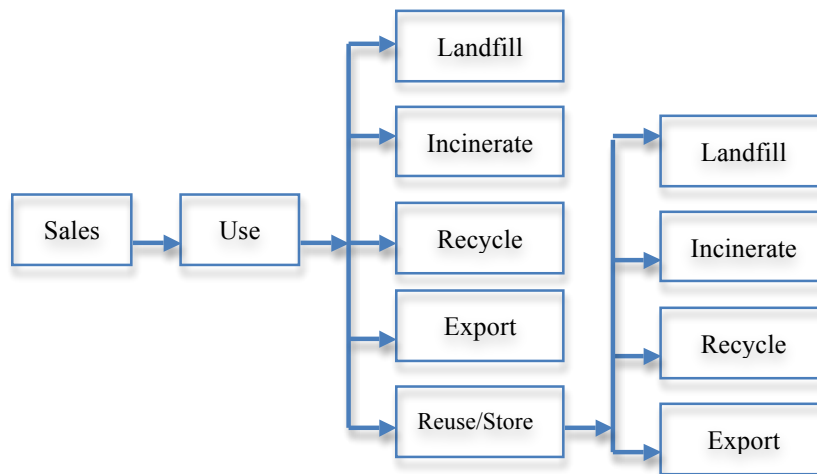
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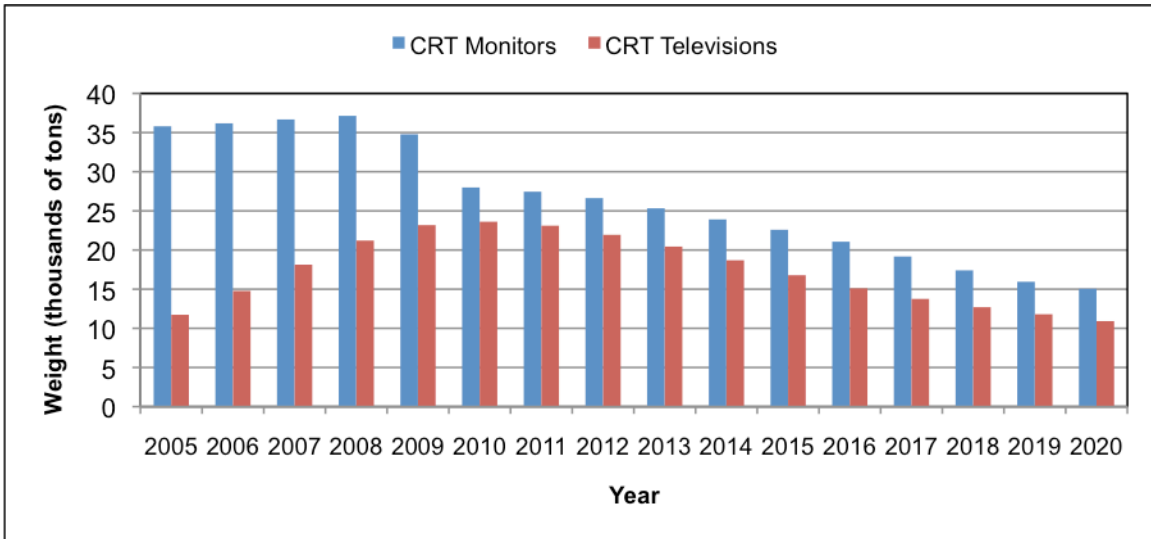
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**TABLE 1. QUANTITIES OF CRTs RECEIVED – SURVEY RESULTS**

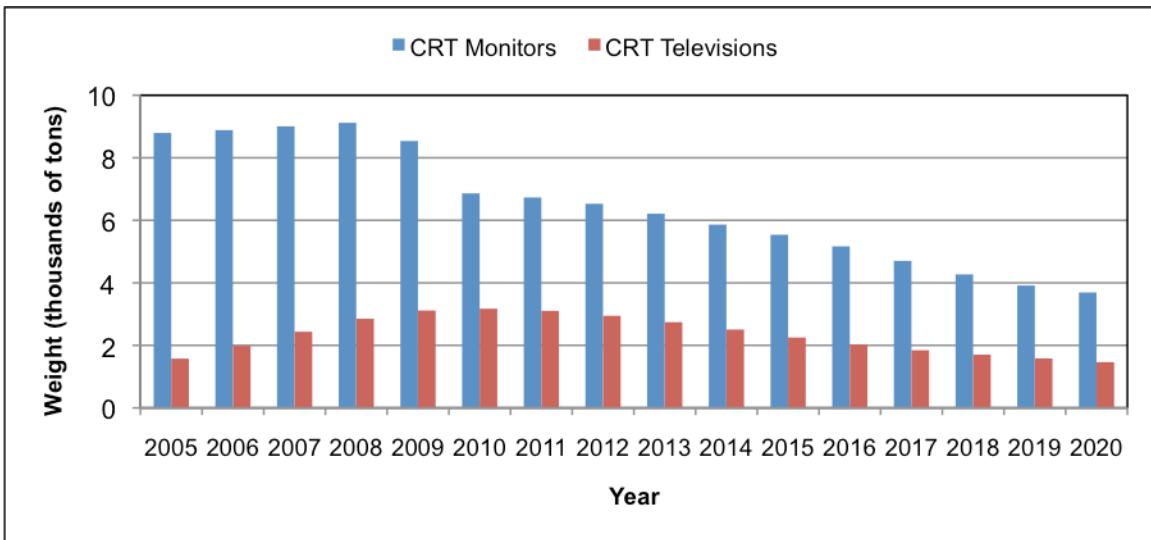
Group	2007 CRTs Received	2008 CRTs Received	Distribution
Counties	3,500 - 25,000 units 117,000 - 550,000 lbs	6,000 - 25,000 units 155,000 - 550,000 lbs	20-70% monitors, 30-80% TVs
Electronics recyclers	6,500 - 365,000 units	7,500 - 174,000 units	60-99% monitors, 1-40% TVs
Donation centers	1.25 million lbs	1.75 million lbs	35% monitors, 65% TVs



**FIGURE 1. CRT PRODUCT LIFE CYCLE FLOW MODEL**



**FIGURE 2. EXAMPLE RESULTS FOR TOTAL WEIGHT OF CRTs DISPOSED TO ALL WASTE STREAMS**



**FIGURE 3. EXAMPLE RESULTS OF THE WEIGHT OF CRTs RECYCLED**