# RECYCLING, REUSE, AND REMANUFACTURING
**(September 17, 2013)**

## I. INTRODUCTION

This paper focuses on the opportunities, challenges, and potential solutions to achieve greenhouse gas (GHG) reductions from increased capture, reuse, and remanufacture of recyclable materials in the waste stream. For the purpose of this paper, recyclable materials include: recyclable fibers (paper, textiles, and carpet), plastic resins, glass, metals, lumber, wood waste, and inert materials.[1] Source reduction (including reuse) and recycling are at the top of the waste management hierarchy and the preferred approach to reduce GHG emissions from the Waste Management Sector. Both result in decreased GHG emissions from landfills; conserve energy; and reduce environmental impacts associated with the upstream production of materials, products, and packaging.

The sections that follow describe the waste collection and processing infrastructure in California, what happens with the collected recyclable materials, what are California's statewide recycling targets and the associated GHG emissions benefits, what are the challenges in meeting and exceeding these targets, and what actions may be taken to meet these challenges. This paper is one of several papers being prepared to provide information critical to the discussion about the role that the Waste Management Sector can and should play in meeting the goals of Assembly Bill (AB) 32.

## II. GENERAL DESCRIPTION OF THE RECYCLING INFRASTRUCTURE IN CALIFORNIA

### A. Collection

#### How are recyclable materials collected?

Recyclable materials are collected in a variety of ways including: a) collection program offered by a city, town, or county, or by private haulers under contract with a local governmental agency; b) back-hauling by businesses (or private hauling under contract) that develop their own strategies for collecting and handling recyclable materials; c) pickup of source-separated recyclables (e.g., only cardboard, only metal, only plastics) by independent recyclers; or; d) self-haul of recyclables to a recycling center, drop-off facility, or material recovery facility. Unlike traditional recycling materials, construction and demolition debris (C&D) is collected almost exclusively in large containers (e.g., drop-boxes) or in large bodied trucks (e.g., end-dumps) and might be collected by the municipality, private haulers, or independent recyclers depending upon the local collection system.

#### What portion of the collected material is capable of being recycled?

In 2010, about 73 million tons of waste materials were generated in California. Roughly 37 million tons of this material went into landfills and about 36 million tons were recycled. The 37 million tons landfilled includes disposal-related activities (i.e., alternative daily cover, alternative intermediate cover, and beneficial reuse at California landfills, material transformed at California

[1] Organic materials are addressed in the Biomass Conversion and the Composting and Anaerobic Digestion Technical Papers.

transformation facilities, and tire derived fuel). Nearly two-thirds of the paper, plastic, and metal materials found in the disposed waste stream are uncontaminated when they arrive at disposal facilities and could be recycled into feedstock for reuse and remanufacturing facilities with minimal additional preprocessing.

## B. Processing

### How is collected material processed to recover recyclable material?

There are a variety of types of facilities where materials are sorted, consolidated, and prepared for end uses/markets. A material recovery facility (MRF) receives recyclables and sorts the materials by type or grade to meet the commodity specifications of the end use markets. The primary types of MRFs are Multi-Stream and Single Stream, and mixed-waste processing. At a Multi-Stream MRF, incoming recyclables have usually been collected separate from each other, for example through a curbside dual stream program that separates paper from glass, plastic, and metal materials. At a Single Stream MRF, incoming recyclables have been collected in one stream and often have a higher level of contamination than materials received at a Multi-Stream facility. A mixed waste processing facility (sometimes called dirty MRF) receives municipal solid waste which is then processed and sorted to recover recyclable commodities. Another MRF processing method is to collect wet (e.g., food) and dry (e.g., paper, clean containers) materials separately and process them separately at the MRF.

In addition, there are many facilities that focus on construction and demolition (C&D) materials. Aggregate, ready mixed concrete, and asphalt plants collect and recycle inert materials, primarily hardened concrete and asphalt. Mixed C&D processing facilities receive mixed construction and demolition debris which is then sent through a series of manual and automated sorting processes to extract the recyclable commodities. Mixed C&D facilities focus their efforts on recovery of heavy and bulky materials like wood, metal, concrete, asphalt, dirt, and cardboard. Some source separated C&D materials are also processed at MRFs. After the initial processing at a MRF or C&D processing facility, some recyclable commodities go through secondary processing to upgrade the value or utility of the material prior to use as feedstock in a remanufacturing facility.

### What is the current capacity of the processing infrastructure in California?

The current capacity of the processing infrastructure is estimated based on information collected in CalRecycle's Facility Information Toolbox and is shown in Table 1. Not counting the 6.6 million tons per year in secondary processing, approximately 42 million tons of materials are currently processed in California while 36 million tons of materials are recycled annually. The difference between the tons of materials processed and the tons of material recycled is attributed to residues from processing facilities that are landfilled or used for a disposal related activity. As shown in Table 1, there is adequate capacity in the current processing infrastructure to accommodate significant increases in recycling (although this is not the case for utilization of recycled materials).

**Table 1. Number and Throughput of Facilities in the Processing Infrastructure[2]**

| Type of Facility | Number of Facilities | Current Throughput M tons/year | Remaining Capacity M tons/year |
|---|---|---|---|
| Material Recovery Facilities | 137 | 11.9 | 16.9 |
| C&D Processing Facilities | 242 | 29.9 | 30.2 |
| Secondary Recyclables Processing Facilities | 223 | 6.6 | 3.1 |
| **Totals** | **602** | **48.4** | **50.2** |

## III. CURRENT STATUS ON THE UTILIZATION OF RECYCLABLE MATERIALS

### How are the recycled materials used in California?

Once recoverable materials are collected and sorted or processed, they are delivered to recycling/remanufacturing markets, either in California, elsewhere in the United States, or internationally. Significant quantities of glass and some of the metals, plastics, and paper that are collected for recycling in California remain in the state for remanufacturing. However, the majority of recyclable commodities collected in California for recycling are transported out of state by rail or ocean-going vessel. California's recyclable commodities, with a value of about $8 billion, constitute 28% of all California exports by sea[3]. Table 2 illustrates the remanufacturing destination of California's recycled materials.

**Table 2. Remanufacturing distribution of recycled materials in California[4]**

| Material | Remanufacturing Destination |
|---|---|
| Aluminum | 99% Southeastern U.S., 1% Mexico, Europe, Brazil |
| Steel | 90% Pacific Rim, 10% California |
| Glass | 85% California, 8% Texas, Colorado, Washington, Oklahoma, 7% Mexico |
| HDPE | 46% California, 36% in China, 18% Southeast U.S. |
| PET | 77% China, 14% California, 10% Southeastern U.S. |
| Cardboard & Paper | 64% U.S., 36% China |

The number of remanufacturing facilities in operation in California, their throughput and their remaining capacities are tabulated in Table 3. As shown in Table 3, California's

[2] Throughput and capacity estimates from the CalRecycle Facility Information Toolbox (FacIT) and are based on continually-updated data from industry operators, survey results, and self-reported data. http://www.calrecycle.ca.gov/FacIT/ -

[3] http://www.calrecycle.ca.gov/Actions/Documents/85/20132013/906/Export%20Report%20for%202012%20California%20Recyclable%20Materials.pdf

[4] http://www.arb.ca.gov/cc/protocols/localgov/pubs/recycling_method.pdf

remanufacturing facilities handle a total of 2.3 million tons of material with little remaining capacity. Considering that there are 22 million tons of recyclable materials being exported from California and an additional 22 million tons of materials (including organics) currently being disposed in landfills annually that need to be recycled by 2020 in order to meet the AB 341 75% recycling goal (see Section IV), the information shows that there is a lack of recycling manufacturing capacity to handle increased amounts of materials that could be collected and processed. Inert materials from C&D facilities are excluded from Table 3 since additional remanufacture is not required as processing results in final products or commodities. For example, most of the concrete and asphalt is crushed and converted to aggregate during the initial processing for use as road base.

**Table 3. Number and Throughput of Facilities in the Remanufacturing Infrastructure[5]**

| Type of Facility | Number of Facilities | Current Throughput M tons/year | Remaining Capacity M tons/year |
|---|---|---|---|
| Glass Remanufacturing Facilities | 13 | 0.7 | 0.1 |
| Paper Remanufacturing Facilities | 14 | 1.1 | 0.005 |
| Plastic Remanufacturing Facilities | 21 | 0.4 | 0.07 |
| Tire Remanufacturing Facilities | 74 | 0.05 | 0.04 |
| **Totals** | **122** | **2.3** | **0.2** |

With the existing remanufacturing infrastructure only handling a little over 2 million tons and having minimal remaining capacity, there is insufficient capacity to handle the recyclable materials for California to sustainably manage its own waste. This lack of recycling infrastructure for certain commodities and the state's close ties with the Pacific Rim make Asia one of the primary destinations for recyclable commodities. While international markets were a convenient and much-needed outlet for commodities over the past two decades, they are subject to global uncertainties. The 2008 worldwide economic downturn highlighted California's dependence on foreign markets for recycled materials. During the 2008 economic downturn, demand for recycled commodities decreased, commodity prices plummeted, and stockpiles of recycled commodities began to build up at material recovery facilities and ports, highlighting California's precarious reliance on export markets for recycled commodities. California's dependence on foreign markets has been illustrated again in 2013 with China's recent "Green Fence" policy that has adversely impacted export markets for recyclable commodities and re-emphasized the need to develop new, in-state remanufacturing capacity.

## IV. GOALS FOR INCREASING RECYCLING/REMANUFACTURING AND ACHIEVING GHG BENEFITS

Using recycled commodities as feedstock for remanufacturing and energy production will achieve significant GHG reductions. In particular, reintroducing recyclables back into the manufacturing process reduces greenhouse gas emissions from multiple phases of product production including extraction of raw materials, preprocessing, and manufacturing. With the adoption of AB 341 (Chesbro, Chapter 476, Statutes of 2011), a clear mandate was established to achieve a statewide recycling goal of 75% by 2020. Preliminary estimates are that about

[5]Throughput estimates from FacIT may include virgin as well as recycled feedstocks. http://www.calrecycle.ca.gov/FacIT/

22 million tons per year of material will need to be removed from the landfill waste stream and used in non-disposal alternatives by 2020, in order to meet this 75% goal. Achieving AB 341's 75% recycling mandate will result in an estimated 20 to 30 MMTCO2e reduction in 2020 compared to business as usual[6].

When looking at the impact of waste reduction activities on GHG emissions, future life cycle analysis on net environmental impacts will be needed. To estimate the GHG reduction benefits of recycling and remanufacturing, ARB has developed emission reduction factors (ERFs) for a majority of the materials that are recycled. Figure R-1 and Figure R-2 illustrate the amount of material and the corresponding GHG reductions that could be achieved by meeting the 75% recycling goal[7].

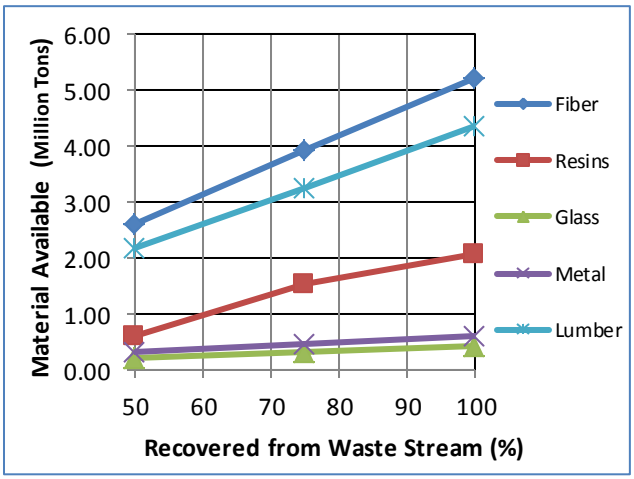


**Figure R-1. Amount of Material Available**

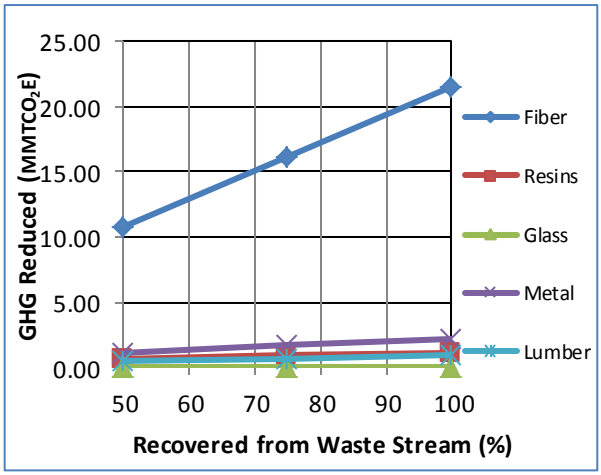


**Figure R-2. Potential GHG Reduced**

Beyond 2020, additional reductions in GHG emissions from the Waste Management Sector will be needed. Staff proposes a 2035 goal of Net-Zero GHG emissions for the Waste Management Sector. As a 2050 goal, staff recommends a reduction of direct GHG emission in California from the Waste Management Sector to 25% below the direct emission associated with meeting the 2035 goal. To achieve these reductions, even greater diversion of organics and other recyclable commodities from landfills and further expansion and enhancement of the alternative non-disposal pathways will be needed to meet the 2020 goals. In addition, greater emphasis will need to be placed on reducing the volume of waste generated, recycling/reusing products at the end-of-life, and remanufacturing these materials into beneficial products.

## A. Existing requirements, programs, and regulatory policies

This section provides a summary of the existing regulations, policies, incentives and permitting requirements that influence the reuse and remanufacturing of recyclable materials.

[6] Includes 5-6 MMTCO2e GHG emissions reduction by recycling organics. See the Composting and Anaerobic Digestion Technical Paper. Methodology for estimating the remaining amount of GHG emission reductions is shown in Appendix A.

[7] Achieving the 75% recycling goal requires recycling organics in addition to these materials as addressed in the Biomass Conversion and Composting and Anaerobic Digestion Technical Papers.

**How are processors and re-manufacturers of recycled products permitted to operate in California?**

Remanufacturing facilities using clean, source separated, feedstock generally do not need a solid waste facilities permit (SWFP) but do require local land-use approval and environmental review under the California Environmental Quality Act (CEQA). Remanufacturing facilities may also require water and air permits and, depending upon facility discharges, environmental impact mitigations may be required. MRFs require a Solid Waste Facility Permit unless the incoming material is source-separated, contains less than 10 percent residuals and is less than 1 percent putrescible.

**What regulations have an impact on recycling and remanufacturing recycled materials?**

Regulations that have either a direct or an indirect impact on recycling and remanufacturing recycled materials are listed below:

- AB 939 - In 1989, the California Integrated Waste Management Act of 1989 (AB 939, Sher) was passed, which required cities and counties to reduce the amount of waste going to landfills by 25 percent in 1995 and 50 percent by the year 2000, through source reduction, recycling, and composting activities.
- AB 341 – In 2011, AB 341 established a policy goal of not less than 75 percent of the solid waste generated be source reduced, recycled or composted by 2020. AB 341 also requires businesses that generate 4 cubic yards or more of waste and multifamily residential dwelling of five units or more to recycle.
- AB 32 – AB 32, signed into law in 2006, established a first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions of GHG. Several measures in the Waste Management Sector have been identified under the AB 32 process for having GHG reduction potential.
- Cap-and-Trade – The Cap-and-Trade program is established under AB 32 to reduce GHG emissions. The program will cover major sources of GHG emissions in the State such as refineries, power plants, and other large industrial facilities which includes some manufacturers using recyclable materials as feedstock. The Cap-and-Trade program includes an enforceable GHG cap that will decline over time. ARB will distribute allowances, which are tradable permits, equal to the emission allowed under the cap.
- California Beverage Container Recycling and Litter Reduction Act (BCRLRA) (AB 2020, Sher, 1986) – This law sets a goal of recycling at least 80 percent of all beverage containers sold in the State by imposing a deposit of 5 or 10 cents per container, depending on size. The program helps ensure a steady supply of recycled aluminum, glass and plastic that can be used to manufacture new products. The law also created several programs to develop or enhance demand for recycled content products (see below).
- The Rigid Plastic Packaging Container (RPPC) law (SB 235, Hart, 1991) requires specified containers to meet one of several compliance options, including 25 percent recycled content. The program helps ensure manufacturing demand for California recycled plastics.
- The State Agency Buy Recycled Campaign (SABRC), a joint effort between CalRecycle and the Department of General Services (DGS), supports markets for recycled materials by requiring State agencies to purchase certain recycled-content products. The program implements several statutes, covering products such as paper, plastics, tire-derived

products, compost and others. The product specifications, minimum recycled content levels, and purchase conditions vary by product.

- Several California "minimum-content" laws require manufacturers (or publishers, in the case of newspapers) to use minimum levels of recycled materials in products made, sold or used in California. These include glass containers (35 percent recycled content), newsprint (50 percent of newsprint used must have at least 40 percent recycled content), fiberglass (30 percent) and plastic trash bags (10 percent). Definitions of "recycled" and other specifications vary by product.
- Certain labeling laws indirectly support recycled-content manufacturing by ensuring truthful claims of recycled content or other environmental benefits. For instance, California law (Business and Professions Code Section 17580) requires product labels and advertisements to document such claims and to comply with the Federal Trade Commission "Green Guides" for environmental advertising. California also requires (Public Resources Code Sections18000 – 18016) rigid plastic containers to be labeled with resin identification codes to facilitate recycling.
- The Construction Demolition Inert (CDI) regulations in Title 14 of the CCR set statewide minimum handling requirements for facilities that transfer and process those materials.
- Caltrans currently has specifications that allow for the use of: up to100% recycled aggregate in road base, recycled and reclaimed concrete aggregate in some concrete applications, 25% reclaimed asphalt pavement (RAP) in hot mix asphalt (HMA), and 5% reclaimed asphalt shingles (RAS). Public Resources Code Section 42704 allows Caltrans to develop a specification for the use of up to 40% RAP in HMA by 2014.
- Public Resources Code Sections 16000-16004 – Authorizes re-use of returned plastic concrete through reference to the Greenbook Standard Specifications for Public Works Construction.
- The California Green Building Standards Code (CALGreen), Title 24, Part 11 of the California Code of Regulations, requires that all construction and demolition residential and non-residential building projects, requiring a permit, must divert a minimum of 50% of construction waste materials generated.

**What are some programmatic funding sources and incentives for recycling and remanufacturing recycled materials?**

Some of the programs that provide funding and/or incentives for recycling and remanufacturing are listed below:

- Recycling Market Development Zones (RMDZ) loans - The intent of the RMDZ loan program is to help California manufacturers increase their processing capabilities and create additional markets for recycled-content products. Eligible applicants are businesses with manufacturing and processing facilities that produce recycled-content materials and products in designated zones in California. Funding for this program currently relies on repayment of principal and interest from prior loans, which typically amounts to only about $5 million or less per year.
- Beverage Container Recycling Program – Beverage containers covered under the Beverage Container Recycling and Litter Reduction Act (BCRLRA) are subject to California Redemption Value (CRV), a cash incentive of 5 cents for containers less than 24 ounces and 10 cents for containers 24 ounces or larger. Beverage producers also pay a "Processing Fee" to the State when the cost of recycling is greater than the scrap value of the recycled containers. CalRecycle disburses these fees and unclaimed deposits to pay for a variety of programs to increase recycling, reduce contamination and encourage use of the recycled materials. These include:

- Direct payments to cities and counties to reduce costs of curbside collection and other local programs;
- Collection and litter reduction grants to local jurisdictions, Conservation Corps and businesses;
- Quality Incentive Payments to processors who sort and clean recycled beverage container material to specified standards;
- Handling Fees and incentive payments to certified recyclers who increase collection;
- Public education; and
- Plastic Market Development Payments (PMDPs – see below).

- Electronic Waste Recycling Program – The Electronic Waste Recycling Act of 2003 and SB 50 (Sher, Chapter 863, Statutes of 2004) established a funding system for the collection and recycling of specified electronic wastes.
- Plastic Market Development Program (PMDP) – The PMDP provides $10 million or more per year to encourage both the processing and remanufacture of recycled beverage container plastics (primarily PET and HDPE) within California rather than outside the State. The payments are split between product manufacturers and reclaimers. Each company receives up to $150 per ton of CRV plastic processed and used to make a new plastic product.
- California Pollution Control Financing Authority (CPCFA) – CPCFA's Tax-Exempt Bond financing Program gives California businesses help with acquisition and installation of new equipment.
- Tax Credits – Federal and State tax credits may be available for green equipment purchases.
- Industrial Development Bond (IDB) Financing Program – California Industrial Development Financing Advisory Commission (CIDFAC) approves the issuance of IDBs, which provide manufacturing and processing companies low-interest financing for capital expenditures.
- Other programs that provide financial and other assistance include the Go-Biz program, Small Business Development Centers (SBDC), Service Corp of Retired Executives (SCORE) and Employment Training Panel (ETP) assistance.

## V. CHALLENGES TO MEETING GOALS

This section discusses the current and future challenges to meeting the recycling and GHG reduction goals by increasing the reuse and remanufacturing of the recyclable materials in California. In general, there are a number of overarching challenges to increased recycling including: lack of sufficient domestic recycling infrastructure to remanufacture recycled materials, insufficient markets for recycled materials, and the relatively low cost of landfilling which adversely impacts the economics of recycling.

The challenges to effectively and efficiently increase the reuse and remanufacturing of recycled materials can further be placed into short-term actions and long-term actions. Overall, California has sufficient capacity to process materials currently collected for recycling, but there is insufficient capacity to remanufacture these materials into products in California. Approximately 2 million tons of recycled materials processed in California are remanufactured into products in California while roughly 22 million tons of recycled materials processed in California are exported for remanufacturing. Furthermore, an additional 22 million tons of material needs to be recycled to meet the AB 341 75% recycling goal and there is insufficient

remanufacturing capacity in California to turn these materials into products. Additional work is also needed to educate Californians to take responsibility for the waste they generate, to empower the public to purchase climate-friendly products, to optimize product packaging, and encourage producer responsibility for recycling.

## A. Short-Term

The first step in meeting the challenges to achieving these goals involves identifying and prioritizing immediate actions that could be taken to meet the 2020 GHG and waste diversion goals for the waste management sector. Some of the challenges to full utilization of the available recyclable materials are addressed below.

*GHG emissions reduction quantification*

- There is an insufficient number of emission reduction factors (ERFs) for alternative waste processing pathways (e.g., aerobic digestion) and materials that can be recycled (e.g., carpet), limiting the ability to quantify some potential reductions.
- Review California-specific data for benchmarking recycling facilities that are subject to Cap and Trade.
- Exported recyclables do not necessarily meet the same commodity standards as in-state markets and consideration of final destination, e.g., closed-loop recycling, downcycling, or incineration, should be included in GHG emission reduction factors.

*Permitting and Siting New and Modified facilities*

- Building new and up-grading existing facilities will face multiple challenges including: multiple permits and regulatory compliance requirements, the length of time for approval processes, CEQA issues, and local community and regional planning and acceptance, including environmental justice concerns.
- Lack of consensus that for California to meet its GHG and waste reduction goals there needs to be greater acceptance of ownership for the waste generated within California.

*Financial limitations*

- The relatively low cost of landfilling and the lack of financial incentives for non-landfilling alternatives may hinder increases in new facilities for remanufacturing.
- The Recycling Market Development Zone (RMDZ) program, which combines recycling with economic development to start new businesses, expand existing ones, create jobs, and divert waste from landfills, only serves half the geographic area of the State of California and has very limited sustainable funding.

*Market Development*

- Insufficient market demand for recycled, reused, and remanufactured materials (such as paper) and for residual waste materials generated from non-disposal alternatives (such as ash).
- Lack of adequate specifications and acceptance of the use of reclaimed or recycled C&D materials (RAS, RAP, etc.) into paving applications at both the state and local levels.
- There is a decreasing quality of collected materials due to trend towards more mixed collection of recyclables.

*Regulatory Development*

- Determine the need to develop additional regulations if necessary to achieve GHG and waste reductions goals.

## B. Long-Term

Some of the long-term challenges include the following:

*Infrastructure Improvements*

- Increase in productions of remanufactured commodities or new remanufacturing facilities will require continuous infrastructure development.

*Quality of recyclable commodities*

- The need to foster collection of cleaner recyclable materials.

*Identify future research*

- How to best identify and fund future research that could be used to further achieve the goals of the program.

*Ultimately take ownership for waste generated in California*

- The need to develop a sustainable, low-carbon waste management system that processes waste in California and minimizes the export of waste-related materials to other states or nations.

# VI. POTENTIAL SOLUTIONS

Building new recycling remanufacturing facilities could help California meet its GHG emissions and recycling goals while at the same time increasing our "ownership" of waste generated in California. Discussed below are some potential solutions to the challenges described above. As with the discussion of Challenges, the potential solutions are organized by short-term and long-term categories.

## A. Short-Term

*GHG Emissions Reductions Quantification*

- Develop new ERFs for alternative pathways for waste processing (e.g., aerobic digestion) and materials that can be recycled (e.g., carpet).
- Amend exiting ERFs as needed.
- Review Cap-and-Trade benchmarks for capped recycling manufacturing facilities (glass, paper, etc.) to ensure use of recycled feedstock is incentivized.
- Consider any additional quantifiable data on end use of exported recyclables and incorporate the information data into future updates to the RERFs as needed.

*Permitting and Siting and Regulatory Compliance*

- Work with other agencies, districts, and jurisdictions to identify and address conflicting permitting and regulatory requirements for recycling and remanufacturing facilities/operators.
- Develop a model permit that could be used to streamline the permitting process across several agencies.
- Create Programmatic EIRs and guidance documents to assist project proponents in the completion of environmental review and compliance with CEQA.

- Foster State, local, and private cooperation in achieving the Waste Management Sector goals and gaining public acceptance through public education outreach programs.

*Financial Limitations*

- Develop new financial incentives for building sufficient infrastructure in-state and ensuring the economic viability of various recycling pathways.
    - Explore potential offset project protocols for applicable recycling processes which may generate ARB offset credits.
    - Establish new incentive payments or loan/grant programs geared for the re-manufacturing of high-GHG commodities, for example through the use of Cap and Trade revenues.
    - Explore options such as tax credits and use of EPIC funds.
- Increase formal partnership with GO-Biz to further expand technical support for recycling and remanufacturing businesses.
- Expand sustainable financing for the RMDZ program and for recycling manufacturers throughout the State of California.
- Develop and implement product stewardship programs.

*Market Development*

- Increase markets for recycled products. This may be accomplished via incentives or requirements for increased recycled products purchasing by the State.
- Maximize recovery potential by establishing grants and/or performance standards for MRFs and C&D facilities to recover higher-quality commodities from mixed waste streams.
- Work with state and local transportation agencies on research, testing, and development of specifications for greater use and acceptance of reclaimed and recycled C&D materials in paving applications.
- Increase education of residents and businesses regarding the collection of cleaner recyclable commodities.
- Educate public on their responsibility to recycle, reuse and minimize their carbon footprint.

*Regulatory Options*

- Develop regulation(s) if needed to achieve GHG and waste reduction goals.

## B. <u>Long-Term</u>

*Infrastructure Improvements*

- Develop a sustainable waste management system that can adequately handle the increase in municipal solid waste that needs to be shifted from landfill to remanufacturing processes to meet GHG and waste reduction goals.
- Foster State, local, and private cooperation in achieving the Waste Management Sector goals.

*Improve the sustainability of the California waste management infrastructure*

- Developing markets for recycled, reused, and remanufactured materials (such as paper) and for residual waste materials generated from non-disposal alternatives (such as ash).
- Evaluate the effectiveness of recycling education efforts and modify as needed to improve the quality of recyclable commodities.
- Develop and implement additional product stewardship programs.

*Quality of recyclable commodities*

- Maximize recovery potential by establishing grants and/or performance standards for MRFs and C&D facilities to recover higher-quality commodities from mixed waste streams.
- Increase education of residents and businesses regarding the collection of cleaner recyclable commodities.

*Identify future research*

- Identify future research (e.g., improved sorting, processing, and re-manufacturing technologies) that could be used to further achieve the goals of the program.

*Reduce the volume of waste generated*

- Maximize recycling of packaging materials.
- Evaluate opportunities to reuse materials.
- Enhance producer responsibilities for hard-to-manage waste materials.
- Continue to educate the public on their abilities to help achieve California's GHG and waste management goals.

*Maximize Recycling*

- Evaluate the effectiveness of the short-term incentives and modify as needed to achieve continuous, measurable increases in the amount of materials recycled, reused, and remanufactured.
- Incorporate recycling and recyclability as a front end design parameter for packaging and products.

# Appendix A: Waste Management Sector Greenhouse Gas Emission Estimates

Appendix A details the initial effort to estimate the greenhouse gas (GHG) emission reductions from the Waste Management Sector that will be realized by meeting AB 341's 75% recycling goal. The GHG emission reductions are presented for the Waste Management Sector as a broad range because they are dependent on many variables including:

1) Reliance on existing emission reduction factors. As noted in the Technical Papers and the Implementation Plan, additional work is needed to improve the emission reduction factors and to develop new ones. Future work will include updating the emission reduction factors for landfills, including avoided methane emissions for organics that are shifted to non-landfill management alternatives. New emission reductions will be developed for anaerobic digestion and for additional recyclable materials such as carpet.
2) The expected composition of disposal related materials and materials recycled in 2020.
3) The variability of different materials within a general material category such as paper, and the variability associated with appropriate emission reduction factors. For example, there are different types of paper (corrugated cardboard, magazines, newspaper, white ledger paper, mixed paper, etc.), each with different estimated tonnages in the waste stream and each with associated emission reduction factors that depend on how much of these materials are recovered and how they are processed into beneficial products.

Thus there is a broad range of potential GHG emission reductions from the Waste Management Sector, on the order of 20 to 30 MMTCO2e. While this range will undoubtedly, due to obtaining new information and subsequent revised calculations, be refined over time, the bottom line is that there are significant GHG emission reductions that will be realized by achieving AB 341's 75% recycling goal.

## 2020 Waste Generation – Business as Usual (BAU) Scenario

In 2010, about 73 million tons of waste materials were generated in California of which roughly 37 million tons were disposal related (i.e. landfilling, alternative daily cover, alternative intermediate cover, beneficial reuse at California landfills, material transformed at California transformation facilities, and tire-derived fuel) and about 36 million tons were recycled. Under a business as usual (BAU) scenario, we estimate that waste generation will grow to 79 million tons by 2020. To estimate waste generation in 2020, CalRecycle selected the long-term average (1990 through 2010) per-resident waste generation rate of 10.7 lbs./person/day[8] multiplied by the 2020 population estimate of 40.6 million from the Department of Finance[9]. Under a BAU scenario, where recycling

[8] http://www.calrecycle.ca.gov/75Percent/Plan.pdf
[9] http://www.dof.ca.gov/research/demographic/reports/projections/P-2/

remains constant at 36 million tons per year, California would generate an estimated 43 million tons of disposal-related material in 2020.

**2020 Waste Generation, Increased Recycling, GHG Emission Reductions – AB 341 Scenario**

In order to reach the 75% recycling goal of AB 341[10], about 22 million tons of the 43 million tons of disposal related materials in 2020 under a BAU scenario will instead need to be recycled. We have applied relevant emission reduction factors[11], including estimates for avoided landfill methane emissions[12] where appropriate, to the 22 million tons of waste recycled to estimate the range of associated GHG emission reductions. The GHG emission reduction calculations are based on the assumption that the composition of the waste recycled is proportionate to the composition of the waste going to disposal-related activities in 2010[13]. For example, paper, which constituted 15% of the disposal-related material in 2010, is assumed to constitute 15%, or 3.2 million tons, of the additional 22 million tons of material that needs to be recycled in 2020 to achieve the 75% recycling goal.

Table 1 below shows the composition of the waste stream and the estimated tons of the various material types that go to disposal-related activities in 2020 under a BAU scenario. The table also shows rough ranges for GHG emission reductions for the various material types if 22 million tons of these materials are diverted from the waste stream and sent to recycling, composting, anaerobic digestion, or biomass conversion facilities instead. By recycling the additional 22 million tons needed to achieve the AB 341 75% goal, we will also achieve roughly 20 to 30 MMTCO2e in GHG emission reductions[14]. Note that these emission reductions are based on best estimates of avoided landfill emissions and use existing Recycling Emission Reduction Factors (RERFs), Composting Emission Reduction Factor (CERF), and in some limited cases (i.e. metals, electronics, and carpet) factors from the USEPA WARM model. The Implementation Plan commits to updating some of these factors as part of the overall Waste Management Sector Plan.

[10] About 22 million tons of additional recycling plus the 36 million tons of existing recycling will be needed to achieve the 75% recycling goal.

[11] http://www.arb.ca.gov/cc/protocols/localgov/pubs/compost_method.pdf; http://www.arb.ca.gov/cc/protocols/localgov/pubs/recycling_method.pdf As noted in the Technical Papers and the Implementation Plan, additional work is needed to develop new and revise some of the existing emission reduction factors.

[12] As noted in the Landfill Paper, additional work is needed to quantify landfill emissions.

[13] We recognize that this composition assumption is not ideal; however, it is the best assumption given available data and is sufficient to provide an estimated range of GHG emission reductions.

[14] Note that GHG emission reductions are presented as a broad range because they are dependent on many variables. For example, there are many different types of paper (corrugated cardboard, magazines, newspaper, white ledger paper, mixed paper, etc.), each with different estimated tonnages in the waste stream and each with associated emission reduction factors that depend on how much of these materials are recovered and how they are processed into beneficial products.

## Table 1: Estimated GHG emission reductions from Waste Management Sector

| Material | % of Material Composition[15] | 2020 BAU Disposal-Related Tons (million) | 2020 GHG Emission Reductions (MMTCO2e) from increased Recycling, Composting, Anaerobic Digestion or Biomass Conversion |
|---|---|---|---|
| Paper[16] | 15 | 6.3 | 8 - 10 |
| Glass[17] | 1.4 | 0.6 | <0.5 |
| Metal[18] | 4 | 1.7 | 3 – 4 |
| Plastics[19] | 8.2 | 3.5 | 2 – 3 |
| Food[20] | 13 | 5.6 | 2 - 4 |
| Green[21] | 10.9 | 4.7 | 2 – 3 |
| Lumber[22] | 12 | 5.2 | 0.5 - 1 |
| Other Organics[23] | 9.5 | 4.1 | 3 - 4 |
| Other Inerts | 17 | 7.3 | |
| Household Hazardous | 0.3 | 0.1 | |
| Special Waste | 6 | 2.6 | |
| Electronics[24] | 0.5 | 0.2 | <0.5 |
| Mixed Residue[25] | 2.5 | 1.1 | < 0.5 |
| **Total[26]** | **100** | **43** | **20-30** |

[15] Differences from the 2008 Waste Characterization are attributable to the inclusion of 7 million tons of disposable related activities which were not included in the 2008 Waste Characterization Study (ADC, AIC, beneficial reuse, transformation, tire-derived fuel).

[16] **Paper:** There are different ERFs for the various types of paper (corrugated cardboard, magazines, newspaper, white ledger paper, mixed paper, etc.) ERF range of 0.54 - 5.53 MTCO2E/ton of material. Lower end of range estimated based on ERF of 0.3 MTCO2e/ton material (RERF) plus adjusted avoided landfill ERF of 0.24 MTCO2e/ton material (adjusted by ARB). Higher end of range estimated based on ERF of 5.0 MTCO2e/ton material (RERF) plus avoided landfill ERF of 0.53 MTCO2e/ton material (CalRecycle).

[17] **Glass:** ERF 0.2 MTCO2E/ton of material.

[18] **Metal:** There are different ERFs for the various types of metal. ERF range of 1.5 - 12.9 MTCO2E/ton of material.

[19] **Plastics:** There are different ERFs for various types of plastic. ERF range of 0.8-1.4 MTCO2E/ton of material.

[20] **Food:** ERF range of 0.66 to 0.95 MTCO2E/ton of material. Lower end of range estimated using (CERF) of 0.42 MTCO2e/ton material plus adjusted avoided landfill ERF of 0.24 MTCO2e/ton material (adjusted by ARB). Higher end of range estimated using (CERF) of 0.42 MTCO2e/ton material plus avoided landfill ERF of 0.53 MTCO2e/ton of material (CalRecycle).

[21] **Green:** IBID

[22] **Lumber:** ERF 0.21 MTCO2E/ton of material.

[23] **Other Organics:** ERF range of 0.66 to 0.95 MTCO2E/ton of material.

[24] **Electronics:** ERF of -2.35 MTCO2E/ton of material from USEPA Waste Reduction Model (Warm).

[25] **Mixed Residue:** ERF of 0.24 – 0.53 MTCO2e/ton material based on avoided landfill emissions.

[26] Numbers do not total exactly due to rounding.