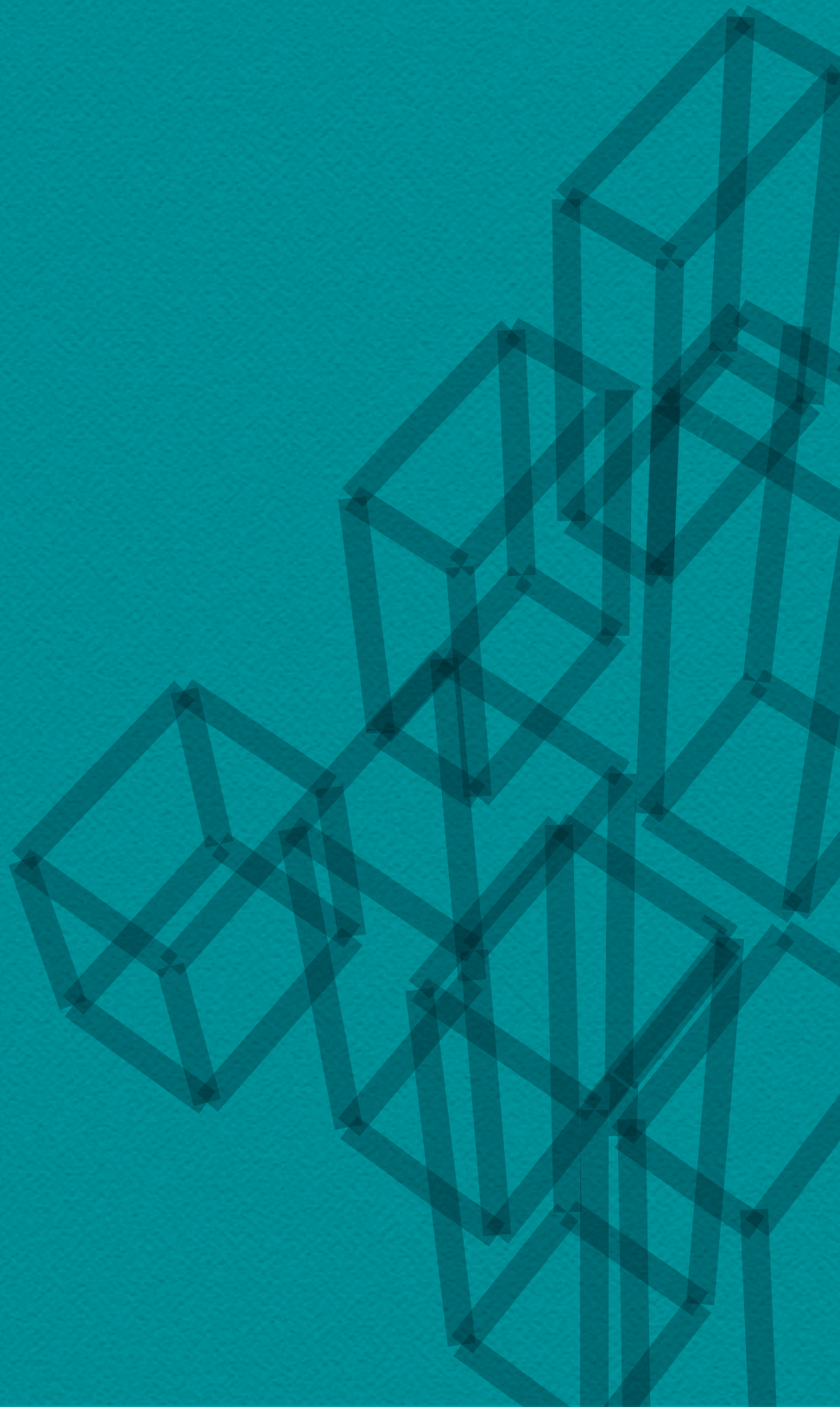


GOOD PRACTICE GUIDE

# Waste to Resources

**C40**  
**CITIES**

CLIMATE LEADERSHIP GROUP



### **C40 Cities Climate Leadership Group**

The C40 Cities Climate Leadership Group, now in its 10th year, connects more than 80 of the world's greatest cities, representing 600+ million people and one quarter of the global economy. Created and led by cities, C40 is focused on tackling climate change and driving urban action that reduces greenhouse gas emissions and climate risks, while increasing the health, well-being and economic opportunities of urban citizens. [www.c40.org](http://www.c40.org)

*The C40 Cities Climate Leadership Group has developed a series of Good Practice Guides in areas critical for reducing greenhouse gas emissions and climate risk. The Guides provide an overview of the key benefits of a particular climate action and outline successful approaches and strategies cities can employ to implement or effectively scale up these actions. These Guides are based on the experience and lessons learned from C40 cities and on the findings and recommendations of leading organisations and research institutions engaged in these areas. The good practice approaches are relevant for cities engaged in C40 Networks as well as for other cities around the world.*

## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>3</b>
<b>1 BACKGROUND .....</b>	<b>4</b>
1.1 PURPOSE .....	4
1.2 INTRODUCTION .....	4
<b>2 WASTE TO RESOURCES SYSTEMS AND CLIMATE CHANGE .....</b>	<b>5</b>
2.1 WHAT IS SOLID WASTE MANAGEMENT? .....	5
2.2 FROM WASTE MANAGEMENT TO RESOURCE MANAGEMENT .....	5
2.3 FROM RESOURCE MANAGEMENT TO A CIRCULAR ECONOMY .....	7
2.4 BENEFITS OF A SOUND WASTE TO RESOURCES SYSTEM .....	8
2.5 CHALLENGES TO DELIVERING A SOUND WASTE TO RESOURCES SYSTEM .....	9
<b>3 DELIVERING A SUCCESSFUL WASTE TO RESOURCES SYSTEM .....</b>	<b>9</b>
3.1 CATEGORIES OF BEST PRACTICE .....	9
3.2 SET AMBITIOUS TARGETS .....	10
3.3 FOCUS ON INTEGRATED PLANNING AND FAST DEPLOYMENT .....	12
3.4 SUPPORT CIRCULAR ECONOMY THROUGH REGULATION AND PUBLIC PURCHASING .....	14
3.5 RAISE AWARENESS TO PROMOTE SOURCE REDUCTION .....	17
3.6 TARGET FOOD AND GREEN WASTE REDUCTION .....	19
<b>4 FURTHER READING .....</b>	<b>21</b>

## EXECUTIVE SUMMARY

Municipal solid waste management strategies can both provide effective mitigation of GHG emissions through landfill gas recovery and improved landfill practices, and can avoid significant GHG generation through controlled composting, integrated waste treatment facilities, and expanded collection services. In addition, waste minimization, recycling and re-use represent an important and increasing field of actions for GHG emission reductions through the conservation of raw materials, improved energy and resource efficiency and fossil fuel avoidance.

There is a significant opportunity for C40 cities to reduce emissions from integrated waste management actions, as cities have the powers to enact change and there is the opportunity for still more actions in this area. Integrated Waste Management systems must be planned, developed, and operated within the framework of local resource availability, economics, and environmental concerns.

This Good Practice Guide focuses on the key elements to deliver successful waste to resources systems, with a survey of best practices leading to better economic, social, and environmental outcomes for cities. These include:

- 1. Set ambitious targets**
- 2. Focus on integrated planning and fast deployment**
- 3. Support circular economy through regulation and public purchasing**
- 4. Promote source reduction and mandatory separation**
- 5. Target food and green waste reduction**

Successful waste management systems aim to extract the maximum practical benefits from products and to generate the minimum amount of waste. The proper application of the waste hierarchy can have several benefits, including GHG emissions reduction, reduction of environmental pollution and energy consumption, resource conservation, jobs creation and stimulation of the development of green technologies.

The C40 Waste to Resources Network was established to support cities in sharing experience and lessons-learned in moving beyond waste management to resource management.

The purpose of this Good Practice Guide is to summarise the key elements of waste to resources good practice for global dissemination, highlighting the success of C40 cities in planning and delivering successful waste to resources systems.

# 1 BACKGROUND

## 1.1 Purpose

The C40 Cities Climate Leadership Group is developing a series of Good Practice Guides in areas critical for reducing GHG emissions and climate risk. The C40 Good Practice Guides provide an overview of the key benefits of a particular climate action and outline successful approaches and strategies cities can employ to effectively scale up these actions. These Guides are based on the experience and lessons learned from C40 cities and on the findings and recommendations of leading organisations and research institutions engaged in these areas. The following Good Practice Guide focuses on the key elements to successfully move beyond waste management to resource management, with a survey of best practices leading to better economic, social, and environmental outcomes for cities. These approaches are relevant for cities engaged in C40's Waste to Resources Network as well as for other cities around the world.

## 1.2 Introduction

Emissions from waste management and disposal represent a growing percentage of urban greenhouse gas emissions, and action to reduce these impacts will be critical as waste generation is growing faster than any other environmental pollutant, including CO<sub>2</sub>, particularly in the developing regions where the contribution from waste to overall emissions is larger<sup>i</sup>.

Solid waste disposal and management activities generate emissions of methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O). Landfills are the third largest anthropogenic source of methane, accounting for approximately 11% of estimated global methane emissions, or nearly 800 MtCO<sub>2</sub>e<sup>ii</sup>.

Municipal solid waste management strategies can both provide effective mitigation of GHG emissions by improving the disposal and treatment operations (through landfill gas recovery and improved landfill practices), and avoid significant GHG generation through controlled composting, state-of-the-art energy recovery systems, and diversion of valuable materials from the waste stream through improved collection services.

Waste minimization, recycling and re-use represent an important and increasing potential for indirect reduction of GHG emissions through the conservation of raw materials, improved energy and resource efficiency and fossil fuel avoidance.

## 2 WASTE TO RESOURCES SYSTEMS AND CLIMATE CHANGE

### 2.1 What is solid waste management?

Waste management comprises the collection, transportation, treatment, recycling, disposal and monitoring of solid waste. Solid waste is managed to avoid its adverse effects on human health and the environment.

Most cities are responsible for waste management, either through direct ownership and operation or through policy setting and enforcement. Waste management representing one of the largest costs to municipal budgets, a successful and sustainable waste management system needs to consider technological solutions along with environmental, socio-cultural, legal, institutional and economic linkages.

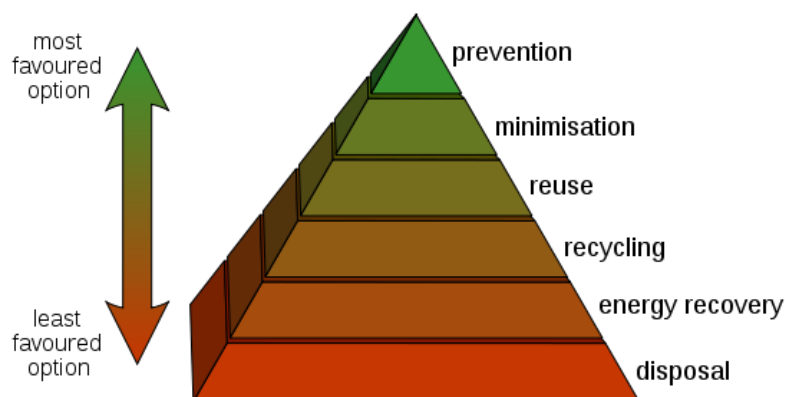
As the world’s population has become more affluent, it has also become more consumption-oriented and wasteful. Waste management challenges are particularly acute in emerging cities, as they face increased consumption and demand for better services.

C40’s research for Climate Action in Megacities 3.0 revealed that C40 cities are taking over 1,039 actions in the waste management sector with almost 50% of them being transformative, meaning that they are being deployed city-wide, and with top actions focusing on source separation policies (>60%), re-use schemes (>60%) and electronic waste recycling (>50%)<sup>iii</sup>.

### 2.2 From waste management to resource management

All products and services have environmental impacts, from the extraction of raw materials for production, to manufacturing, distribution, use and disposal. Following the waste hierarchy will generally lead to the most resource-efficient and environmentally sound choice for managing the product’s lifecycle.

The Waste Hierarchy is the evaluation of processes that protect the environment alongside resource and energy consumption, from most favourable to least favourable actions. This hierarchy establishes preferred program priorities based on sustainability. Generally agreed Good Waste Management systems are those that prioritise actions at the top of the pyramid with the goal of minimizing actions at the bottom.



**Waste prevention and minimisation:** Preventing waste means reducing the amount of waste generated, reducing the hazardous content of that waste and reducing its impact on the environment. It is based on a simple concept: if you create less waste, you consume fewer resources and you don't have to spend as much money to recycle or dispose of your waste. Waste prevention includes strict avoidance of waste generation, and qualitative and quantitative reduction at source.

**Reuse:** Reuse means using a product more than once, either for the same purpose (for example returnable glass milk bottles) or for a different purpose (such as old jam jars for food storage). Repairing products, selling them on or donating them to charity/community groups also reduces waste. Reuse, when possible, is preferable to recycling because the item does not need to be reprocessed before it can be used again.

**Recycling:** Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Recycling is an effective way to manage waste materials once they have been generated and can't be reused. It prevents waste from being sent to landfill and makes waste into new goods or products. This can involve turning the old material into a new version of the same thing or into something completely different. For example, used glass bottles can be recycled into new bottles or they can be recycled into something different, such as road materials for use in construction projects. Effective recycling often requires waste separation according to different materials so that they can be recycled efficiently. Composting of organic materials into a valuable soil amendment to return carbon and nutrients to the soil is also a valuable form of recycling.

**Energy recovery:** Energy recovery from waste is the conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, anaerobic digestion, and landfill gas (LFG) recovery. This process is often called waste-to-energy (WTE). Critics argue that incinerators or other very high temperature processes destroy valuable resources, emit high levels of carbon emissions, are not renewable nor compatible with circular economy, and can reduce incentives for recycling. The question, however, is an open one, as countries in Europe recycling the most (up to 70%) also incinerate their residual waste to avoid landfilling. Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of residue of both solid waste management and solid residue from wastewater management. This process reduces the volumes of solid waste to 20 - 30 % of the original volume.

**Disposal:** Disposal is the processing of waste through landfilling, incineration, and other finalist solutions. Disposal of waste in a landfill involves burying the waste and this remains a common practice in most countries. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Design characteristics of a modern landfill include methods to contain leachate, such as clay or plastic lining material.

## 2.3 From resource management to a circular economy

In a world with growing pressures on resources and the environment, cities have the unique opportunity to become the drivers towards an urgent transition to a resource-efficient and ultimately regenerative circular economy<sup>iv</sup>.

Cities and local governments have demonstrated that they have the ability to drive market changes and to demand better products that are less wasteful<sup>v</sup>. The ultimate goal is to achieve a systemic change in the production and consumption cycle, from a linear system towards a cyclical approach, so that materials, products and resources are produced and used as efficiently as possible. The Circular Economy philosophy of resource management aims to change current practices to emulate sustainable natural cycles, where all materials are designed to become resources for others to use, and to shift to a new practice, where the industry adopts the reuse and service-life extension of goods as a strategy of waste prevention, regional job creation and resource efficiency.

As stated by the European Union manifesto for a resource-efficient Europe<sup>vi</sup>, a circular, resource-efficient and resilient economy can be achieved in a socially inclusive and responsible way by (text directly adapted):

1. Encouraging **innovation** and accelerating public and private **investment** in resource-efficient technologies, systems and skills.
2. Implementing, using and adopting smart **regulation**, standards and codes of conduct that a) create a level playing-field, b) reward front-runners and c) accelerate the transition
3. Abolishing environmentally harmful **subsidies** and tax-breaks that waste public money on obsolete practices, shifting the tax burden away from jobs to encourage resource-efficiency, and using **taxes** and charges to stimulate innovation and development of a job-rich, socially cohesive, resource-efficient and climate-resilient economy.
4. Creating better market conditions for **products and services** that have lower impacts across their life-cycles; inspiring sustainable life-styles by informing and incentivising consumers, and encouraging sustainable sourcing, new business models and the use of waste as raw materials.
5. **Integrating** current and future resource scarcities and vulnerabilities more coherently into wider policy areas, such as in the fields of transport, food, water and construction.
6. Providing clear signals to all economic actors by adopting policy goals to achieve a resource-efficient economy, setting **targets** that give a clear direction and **indicators** to measure progress.



## 2.4 Benefits of a sound waste to resources system

Good waste management and waste to resources systems aim to extract the maximum practical benefits from products and to generate the minimum amount of waste.

Effective waste management systems can provide significant co-benefits beyond addressing emissions, from health and social benefits to economic development and poverty reduction.

**Public health:** Unmanaged waste often ends up on the streets or in water drains, attracting pests and vectors. Waste disposed in unsanitary landfills or dumps can pollute underground water with toxic leachate. Improving waste collection and disposal practices and reducing the overall volume of waste produced can have a direct positive impact on public health, access to water and a cleaner city environment.

**Air quality:** Open burning of waste is a persistent practice in many regions of the world and a major contributor to black carbon, a pollutant that also has an impact on short term global warming. Lack of planning of waste collection routes or the use of old vehicles for waste collection will also have an impact on vehicle emissions, negatively impacting air quality. Waste reduction and recycling can help alleviate both of those challenges.

**Resource and energy efficiency:** Cities face increased pressure for resource efficiency in terms of materials and energy. Energy from waste can help reduce fossil fuel consumption, lowering system costs. Better recycling systems reduce the utilisation of raw materials and provide an incentive to better consumption and production practices. Extended Producer Responsibility programmes help to add value to recyclable materials, lowering the requirements for subsidies from municipal budgets to keep the programs running.

**Economic development and poverty reduction:** By establishing a proper Material Management Process, cities can help to increase the efficiency of resources recovery and integrate any informal recyclers into the formal economy by promoting the creation of cooperatives and improved work conditions<sup>vii</sup>. By enacting policies that promote the proper management of materials from manufacturing to disposal and producer's responsibility, cities can help to increase the value of recyclable materials and the pursuit of those materials by the industry.

**Social perception:** Solid waste management is highly visible and affects people's perception of government and people's perception of society as the driver for consumption and waste generation. Effective planning and sustainable investments in municipal solid waste management systems, promotion of community resources sharing, and education campaigns can contribute to positive perception of the local government and public support for long-term goals.

## 2.5 Challenges to delivering a sound waste to resources system

Sustainable solid waste management is a challenge as well as an opportunity for city governments, primarily due to increasing city populations and waste generation, the burden posed on the municipal budgets as a result of the disposal and management costs, or the lack of understanding of a diversity of factors that affect the different stages of waste management and linkages that need to be established for the system to function effectively.

**Large number of stakeholders:** Waste management involves many stakeholders with different fields of interest, and communication among them is key. Detailed understandings of whom the stakeholders are and the responsibilities they have in the structure are important steps in order to establish an efficient and effective system.

**Complex issue:** Solid waste management is a multi-dimensional issue. Municipalities in general seek for equipment as a path to find solutions to the diversity of problems they face. A successful waste management system must consider technological solutions along with environmental, socio-cultural, legal, institutional and economic linkages.

**Difficulty to recover costs:** Solid waste services have a cost as any other services provided but in general the expenditures are not recovered. Financial resources are required to obtain the skilled personnel, infrastructure, and equipment needed to implement successful waste management systems. Waste to resources can however help recover part of the cost through waste valuation and/or creation of numerous co-benefits.

**Issue beyond municipality's borders:** Waste management often requires cooperation and coordination across different municipality and district borders. It is fundamental to produce reliable data to create proper information channels within and between municipalities and help decision makers develop integrated waste management strategies adapted to the needs of the citizens.

These challenges can often be overcome through innovative solutions, cooperation, planning, and management good practices, addressed in detail in Section 3 below.

## 3 DELIVERING A SUCCESSFUL WASTE TO RESOURCES SYSTEM

### 3.1 Categories of Best Practice

Within the C40 Waste to Resources Network, cities pursue several different strategies to achieve their desired outcomes. Which type of approach a city chooses to deploy to reach its goal depends on each city characteristics, including:

- Powers that the city Mayor has over waste management system and transport

- The legislative context at a regional and national level
- The asset ownership structure
- Relationship with waste management operators and other agencies
- Citizen engagement and buy-in
- Revenue streams and availability of financing

In order to address the above-mentioned challenges and reap the multiple benefits of a sound waste to resources system, a number of key good practice approaches have been identified. These include:

- **Set ambitious targets**
- **Focus on integrated planning and fast deployment**
- **Support circular economy through regulation and public purchasing**
- **Promote source reduction and mandatory separation**
- **Target food and green waste reduction**

We have identified case studies that sit in each of these categories and demonstrate good practices from C40 cities.

### 3.2 Set ambitious targets

Cities and municipalities often face the challenge of shorter administration terms, which may inhibit long term planning. Aggressive long-term goal setting can benefit city governments by providing a unifying target that can be tracked and progressed across administrations. For these long-term strategies to succeed, it is imperative to define objective metrics and milestones that can be communicated and used to evaluate progress.

A citywide goal can also help to unify targets across departments. Waste management planning and service delivery usually involves the departments of finance, environment, labour, public works, and others - often with varying, and sometimes even conflicting, priorities. A common goal can help smooth cooperation across different stakeholders.

#### **Case study: *San Francisco – Zero Waste by 2020*<sup>viii</sup>**

*Summary:* The Zero Waste goal is a policy initiative to eliminate waste in resource and materials management, and move toward a circular economy and therefore, long term true sustainability<sup>ix</sup>. Zero waste is defined by San Francisco as sending nothing to landfill or for high temperature destruction (incineration). Instead of waste being sent to landfill or incineration, products are designed and used according to the principle of highest and best use, and the waste reduction hierarchy: prevent waste - reduce and reuse, recycle and compost (in that order). By becoming a zero waste city, San Francisco aims to achieve three goals: conserve valuable resources, reduce environmental impacts, such as climate change resulting from methane emitted by landfill, and help create green jobs.

*Results:* As a result of this programme, landfill disposal in San Francisco reached its lowest level in decades in 2013, at less than half of its 2000 disposal. The city also exceeded its 2010 goal of 75% diversion with a rate of 80% diversion of waste from landfill (1,593,830 tons in 2010) from 35% in 1990, which has helped the city to set a North American record for recycling and composting<sup>x</sup>. Through the number of measures and initiatives introduced<sup>xi</sup>, including mandatory separation of recyclables and compostables (including all food) for everyone in San Francisco. San Francisco collects more than 600 tons/day of food scraps in what is the largest urban food scraps composting program in the U.S., and has decreased the use of plastic bags by hundreds of millions per year and banned use of expanded polystyrene foodware. Reduction in landfill waste results in GHG emissions savings, contributing towards San Francisco’s carbon reduction goal of 80% by 2050.

*Reasons for success:* With the approaching the tonnage limit in its contract for disposable at the Altamont landfill, San Francisco seized the opportunity to take an alternative sustainable path, taking into account the co-benefits of the 3R approach (reuse-reduce-recycle) and the true costs of landfill and incineration<sup>xii</sup>. From the start, the project has defined an ambitious vision and set of goals, as well as measurable milestones to track progression. Additionally, a clear communication with the citizens<sup>xiii</sup> made the programme seem consistent and easy to participate in, ensuring continuously improving results. San Francisco has made the strong connection between going toward zero waste and reducing carbon emissions and climate change. It has reframed its Climate Action Strategy as 0-50-100-Roots. The 0 means Zero Waste (50 and 100 for sustainable transportation and renewable energy) and Roots means to remove carbon from the air and store it in the soil and plants with aid of compost.

### **Case study: New York City - Zero Waste NYC**

*Summary:* “Every week, the average New Yorker throws out nearly 15 pounds of waste at home and another nine pounds of waste at work and in commercial establishments” (OneNYC, 2015) and New York City spends over \$350 million per year on waste disposal, while trucking garbage to out-of-state landfills generates additional carbon emissions. To tackle this situation, New York City has set the goal to reduce the amount of waste disposed of by 90 % by 2030 from a 2005 baseline (around 3.6 million tons). It will also send zero waste to landfill by that point, which will also contribute to reaching the target of 80% reduction in GHG emissions by 2050 compared with 2005, introduced in 2014 and reaffirmed in OneNYC<sup>xiv</sup> (April 2015), the City’s sustainable and resilient plan.

*Results:* The ambitious zero waste goal has led to development of multiple city-wide initiatives<sup>xv</sup>, a detailed underlying analysis of benefits and co-benefits of the zero waste program, and early engagement of public and local organisations, helping to get diverse stakeholders on board<sup>xvi</sup>. The Zero Waste NYC initiatives aim both at reducing costs and waste generation, including for instance the expansion of New York City’s organics curbside collection (currently available to 100,000 homes<sup>xvii</sup>) and local drop-off site programs to serve all New

Yorkers by the end of 2018. The city also hopes to implement single-stream recycling collection for metal, glass, plastic and paper products by 2020. Other waste initiatives include building a waste-to-energy anaerobic digestion plant to transform up to 500 tons of organic waste a day into methane for heating; reducing the use of plastic bags and other non-recyclable waste (e.g. expanded polystyrene foam); giving every citizen the opportunity to recycle and reduce waste; making all schools zero waste schools; expanding opportunities to reuse and recycle textiles and electronic waste; developing a blueprint for a Save-as-You-Throw program<sup>xviii</sup> to reduce waste through application of the polluter-pays principle; and reducing commercial waste disposal by 90 % by 2030<sup>xix</sup>.

*Reasons for success:* Since the close of the Fresh Kills landfill in 2001, New York City has shipped nearly all of its landfilled waste to out-of-state facilities, which led to rising costs and environmental concerns. Driven also by concerns about the negative impact of waste on neighbourhoods and by the City's GHG emissions reduction target (waste reduction has the potential to contribute to the 80x50 GHG emissions reduction goal with at least 4% or 3.8MMT of CO<sub>2</sub>e<sup>xx</sup>), New York City has developed the ambitious zero waste target and a comprehensive strategy to reduce the amount of waste generated.

*When/why a city might apply an approach like this:* Cities are facing an increasing need for resource optimization as well as constraints for landfill space, fuel consumption and service quality. Cities looking to deploy ambitious long term programmes to reduce waste disposal can learn from San Francisco's and New York City's experience of engaging citizens, producers and service providers, as well as maintaining a consistent participation strategy across the city, measuring progress and delivering on the infrastructure required to match people's participation.

### 3.3 Focus on integrated planning and fast deployment

Large scale infrastructure development for waste management is more likely to succeed when all stakeholder priorities are aligned, which will help avoid delays and conflicting schedules. Cities and municipalities are demonstrating that when there is political will and coordination across government entities, transformational changes in solid waste management can happen in relatively short time.

#### **Case Study: Milan Integrated Waste Collection System 2012-2014<sup>xxi</sup>**

*Summary:* The city of Milan developed an integrated waste collection plan to recycle the largest possible portion of material, including organic waste, since 2012.

Milan ranks very high among European metropolitan areas in its separation and collection rates thanks to the implementation of food waste collection for households citywide. Milan started the residential food waste collection program and transparent bag program for recyclables in

late 2012 and completed the citywide deployment by mid-2014. The city coordinated activities with its municipal waste company and citizens by registering households and ordinances for each step, worked with building managers to raise awareness of the program details and implemented efficiency tracking and field optimization metrics.

*Results:* The integrated waste collection program was able to reduce residual waste from 450,000 tons in 2011 to 316,000 tons by 2015, and achieve a recycling rate of 52.7% of municipal solid waste in 2015, including 136,000 tons of organic waste collected (compared to 40,000 in 2012) , with 0% of landfill disposal . This puts the city on the path to achieving the EU target of reusing or recycling at least 50% of their municipal solid waste by 2020, and the more ambitious Italian target of 65% by 2016.

*Reasons for success:* Milan was able to implement significant improvements to its waste collection system by working with all stakeholders involved in the management chain, including its municipal waste services company, AMSA, building managers, and general public, designing a consistent program, measuring service requirements, and phasing in a gradual deployment strategy, using this approach to optimise subsequent sectors of the city.

#### **Case study: Oslo<sup>xxii</sup> - Waste Management Strategy**

*Summary:* The city of Oslo has set an overall target to reduce its CO<sub>2</sub> emissions by 50% by 2030 and to become carbon neutral by 2050<sup>xxiii</sup> compared to 1990. One of the measures needed to achieve this ambitious target is an integrated waste management system, which Oslo launched in 2006 with its Waste Management Strategy (WMS), aiming to establish a “recycle and reuse” society. The WMS builds on national strategies and promotes the waste management hierarchy (see Section 2.2). Incineration and landfill are seen as the least desirable forms of waste management and represent the last resort within Oslo’s strategy. As such, a large part of the WMS concentrates on the behavioural habits of citizens to make them carry out waste reduction, reuse and recycling. In 2012, Oslo implemented the circular waste management system which includes recycling, producing biogas and bio fertilizer from bio waste, and energy recovery for district heating and electricity production.

*Results:* In the current Oslo’s waste management system household waste is sorted by citizens themselves into various fractions. Since 1997, paper and drink cartons have been collected by the city after separation in households, whereas glass and metal packaging are delivered by households to about 700 local collection sites around the city (in general within a radius of 300 meters). Sorting of food waste and plastic packaging at source started in October 2009, and since June 2012 all households in Oslo are included. Plastic packaging is deposited in blue bags while food waste goes in green bags. A total of 85.5 kg of food waste per person was generated in 2014. And 40% of this was separated into green bags. By making food waste visible, the system also appears to have made residents more aware of the volume of food that is wasted, as the total volume of food waste has reduced by 5% since collections started. Residual waste is

to be discarded in other plastic bags. All bags are discarded into the same waste containers. The coloured bags are separated from each other in optical sorting plants<sup>xxiv</sup>. This system required no changes by the municipality to the existing logistics of waste management and could be implemented rapidly – contrary to the alternative with adding more waste containers and routes for the collection vehicles<sup>xxv</sup>. The plastic packaging is recycled and the food waste is supplied to a biological treatment plant with capacity of 50,000 tons/year, which produces enough biogas and bio fertilizer to run about 150 buses and provide about 100 medium-sized farms with bio fertilizer yearly.

Two waste-to-energy plants incinerate residual waste from the city, with a capacity of 410,000 tonnes of waste per year and the energy used for district heating and electricity generation. The total annual energy production is about 840 GWh heat and 160 GWh electricity. The heat energy meets the need of about 84,000 households through the district heating system, while the produced electricity is delivered to Oslo's schools, together with electricity produced from landfill gas from the city landfill closed in 2007.

In 2011, about 240,000 tonnes of household waste was collected and of this 1% was reused, 33% recycled (37% in 2014), 60% energy-recovered and only 6% went to landfill. The city aims to recycle 50% of the household waste by 2018. Currently, Oslo is drafting a new waste strategy for the 2015-2025 period with enhanced goals and a closer linking to the circular economy.

*Reasons for success:* The city of Oslo has successfully built an integrated waste management system based on adaptation of a legacy waste collection system, upgraded fast through the use of innovative technologies; early recognition of the importance of behaviour change in reducing waste generation and perfecting source separation of waste; and driven by long-term GHG emissions reduction and waste reduction goals. Oslo and Cambi AS received the Norwegian Research Council's innovation reward in 2012 for their approach of system thinking around waste and the biogas/bio fertilizer production plant they have.

*When/why a city might apply an approach like this:* Cities in need of implementing fast transitions in their waste systems can learn from these successful innovative technology solutions in waste separation and disposal reduction, as well as communication strategies, and citizen engagement. Cities planning long-term strategies can also follow the above examples to develop more ambitious plans.

### 3.4 Support circular economy through regulation and public purchasing

The circular economy is a full paradigm shift in societal development that goes beyond solid waste management. However, several cities and municipalities across the world are starting to take actions to advance towards this target.

Governments are usually the largest purchasing entity in most cities, which gives them a unique opportunity to drive market changes and incentivize better product design, which ultimately benefits everyone.

Most cities have the ability to influence the market through material restrictions (single use plastic bans, Styrofoam containers ban, etc.) or by procurement that incorporates environmental and resource efficiency considerations for products and services that have lower impacts across their lifecycles. They can also inspire sustainable life-styles by informing and incentivising consumers, and encourage sustainable sourcing, new business models and the use of waste as raw materials.

**Case study: Berlin – Sustainable public procurement<sup>xxvi</sup>**

*Summary:* Following from the Berlin Closed Substance Cycle and Waste Management Act (1999) and Berlin Waste Management Strategy (2011), whose main objective is to develop a modern, closed-loop waste management system, the city of Berlin has implemented measures and initiatives to help increase the recycled waste quantity from 445,000 tonnes in 1996 (20.9% of total waste) to 624,000 tonnes in 2012 (42.2%)<sup>xxvii</sup>. The Strategy further sets ambitious climate protection targets, including that of additional annual reduction of 1.1 million tonnes of CO<sub>2</sub>e by 2020 (about 25% of the reduction in total Berlin’s GHG emissions over 2010-2020). This is to be achieved not only through high-quality recycling and cleaner recovery of waste, but also through an improved, environmentally responsible public acquisition system, worth every year around EUR 4-5 billion across the official bodies in the city.

In 2010 the Berlin House of Representatives passed the Berlin Public Procurement Act (BerlAVG). This obliges all public purchasing offices in Land Berlin to take environmental criteria into consideration for their procurements, including the lifecycle costs. In 2013, the “Decree on the application of regulations for environmentally-friendly purchases and order placements for deliveries, construction work and services – VwVBU<sup>1</sup>” came into force. It establishes minimum environmental criteria for the acquisition of relevant products, construction work and services in the form of datasheets, constraints on purchases, and specifications for the evaluation of tenders by calculating life cycle costs for electric appliances, vehicles, and buildings.

*Results:* With this administrative regulation in place, municipal bodies have become a driving force for innovation in numerous sectors by promoting the use of durable, energy-efficient products which have a limited lifecycle impact on the climate, the environment and public health, and which are produced under fair conditions. This can also result in increased economic efficiency, as the follow-on costs, which in the past have either been ignored or underestimated, can now be effectively reduced. The city of Berlin has set an example for the rest of Germany. The regulation contains demanding environmental criteria, for example for

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<sup>1</sup> <http://www.stadtentwicklung.berlin.de/service/gesetzestexte/de/beschaffung/vorschrift.shtml>



office materials, office equipment, cleaning agents and cleaning services, road vehicles, large-scale events, tenders for power supplies, the planning of office buildings, and for the recycling of commercial waste.

*Reasons for success:* European cities have inherent challenges to improve resource efficiency and long-term sustainability. Berlin is taking an active role to contribute towards more efficient manufacturing and product design by including sustainability requirements in all government procurements. The size of the Government as the largest purchasing entity makes it a formidable agent of change, which spreads the benefits to all stakeholders in the production chain<sup>2</sup>.

### **Case study: *Oakland Zero Waste Program private-public partnership***

*Summary:* In 2015, the City of Oakland, California, approved new Zero Waste Franchise agreements with its waste collection companies. These two agreements went into effect in July of 2015, and significantly expand the services offered to residents, including recycling and composting options, bulky pickups, illegal dumping collection, and replacement of the entire fleet of collection trucks with Compressed Natural Gas (CNG) fuelled vehicles. The Zero Waste program also includes climate change goals, such as: divert 100 % of compostable and recyclable materials from landfill; implement lower emission transportation and processing of waste; create source reduction and improved customer sorting through a comprehensive education program; and meet the City's goal of reducing GHG emissions from waste management by 36% by 2020.

Some other cities' Zero Waste programs use for example mandatory ordinances and labour intensive compliance programs, which offer a high potential for waste reduction but are infeasible for governments that might lack the resources to dedicate to the effort. The Oakland Zero Waste program is innovative in that it is achieving similarly high levels of diversion and per-capita landfill contributions with far fewer resources by capitalizing on partnerships with a variety of stakeholders. These include StopWaste<sup>xxviii</sup>, the local countywide solid waste authority, East Bay Municipal Utility District<sup>xxix</sup>, the local water provider, and the city's unique and diverse private sector recycling businesses. These partnerships have produced widely expanded outreach and a synergistic process that handles collection, transfer, disposal, and recycling.

*Results:* Oakland's Zero Waste Program is already delivering concrete results, with documented diversion of more than 250,000 tons of materials from landfills annually. Combined with use of natural gas fuelled collection and transfer vehicles (70% of the fleet), the program is reducing

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[http://www.stadtentwicklung.berlin.de/service/gesetzestexte/de/beschaffung/studie\\_evaluierung.shtml](http://www.stadtentwicklung.berlin.de/service/gesetzestexte/de/beschaffung/studie_evaluierung.shtml)

GHG emissions by more than 450,000 tonnes annually. The program has also generated numerous co-benefits, such as training opportunities through partners such as Civicorps<sup>xxx</sup> and East Bay Municipal Utility District; increased options for addressing illegal dumping and improved bulky item pickup resulting in improved streetscapes and accessibility; improved local air quality resulting from gradual change to hybrid diesel electric collection vehicles; increased opportunities for green businesses to lower carbon footprints; and support for the city's private recycling, composting, and associated industries.

*Reasons for success:* Learning from the experience with the Zero Waste Strategic Plan (2007) that set goals and outlined city policy direction but stalled on the implementation side, the city of Oakland has taken into account the multiple challenges it was facing (such as lack of understanding of waste reduction and recycling practices among the local population, high levels of illegal dumping and limited city means to motivate residents' and businesses' behaviour change), and has developed a variety of policies, agreements, and innovative strategies to divert materials from landfills in close cooperation with the private sector, local stakeholders and the public<sup>xxxi</sup>.

*When/why a city might apply an approach like this:* All cities can benefit from long-term strategies for sustainability, resource and waste management. Replicating successful programs and adapting them to local condition will provide the best chances for success while avoiding mistakes or ineffective solutions. It is important to set achievable but ambitious milestones and communicate successes to maintain public support and engagement.

### 3.5 Raise awareness to promote source reduction and mandatory separation

When cities and municipalities take actions that prioritise solid waste reduction and avoidance, they are effectively avoiding usable resources from entering into the waste stream, preventing the energy intensive efforts to recover those resources from waste down the road.

Source reduction and avoidance allows usable resources to remain cleaner by not being mixed with solid waste, enabling them to be used for more efficient purposes like food banks, livestock feed or more efficient recycling.

Waste reduction and avoidance requires clear communication with consumers, producers and society to drive towards better consumption and also requires permanent awareness and information programs, as well as the infrastructure to collect specific materials before they enter the waste stream.

### **Case study: *Houston Reuse Warehouse*<sup>xxxii</sup>**

*Summary:* Construction and building material, from doors, electrical fixtures and equipment, to lighting, lumber, metal, plumbing, plywood, sinks and showers, accounts for 38% of the waste stream in the Houston area. The Building Materials Reuse Warehouse<sup>xxxiii</sup>, launched by a grant from the Houston Galveston Area Council and the City of Houston Solid Waste Management Department, benefits the community by providing space for excess building materials that would otherwise be dumped in local landfills. The Warehouse accepts material from individuals, supply companies and builders, and makes it freely available for reuse by any non-profit organization. The concept is simple, the more they take, the more room the Warehouse has to accept more material<sup>xxxiv</sup>. The Warehouse has also recently built a community center, to create a workshop and meeting space and promote further the ‘reuse’ and sharing resources concept.

*Results:* The City of Houston Building Materials Reuse Warehouse now forms part of a network of Houston local community organizations working to keep reusable building materials out of the landfills and to put them into the hands of those that can use them. While the Reuse Warehouse focuses on providing materials to non-profit organizations, many of the other local organizations also make materials available to individuals. By 2015, the project has diverted 3,000 tons of material from landfill<sup>xxxv</sup> and has given away 90% of that. Apart from helping the waste diversion, the project also brings the Houston community together and allows businesses and individuals donating material to free up their storage space.

*Reasons for success:* Construction and demolition (C&D) waste can represent a major contributor to a city’s waste stream, particularly in rapidly growing cities. Developing simple programs that make it easy for generators to participate to reuse C&D materials is essential to avoid these materials from getting mixed and subsequently being harder to recycle or reuse. Houston’s Reuse Warehouse is an exemplary implementation of a community program that incentivises not just material reuse but also community engagement to exchange ideas and projects for increased sustainability in construction projects.

### **Case study: *Yokohama 3R Dream Plan*<sup>xxxvi</sup> - *Engaging Businesses and Residents in Waste Reduction***

*Summary:* Faced with rapid population growth and constraints on space for depositing ash from waste incineration, Yokohama chose the one option: reduce waste through increased reuse and recycling citywide.

The 3R Dream Plan<sup>xxxvii</sup> 2010 - 2025, adopted in January 2011, aims to “reduce garbage while continuing the separation and recycling of garbage, to deal with global warming and to reduce CO2 emissions; *(and)* to realize comfortable and liveable city where garbage is controlled by pursuing safe, secure, and stable garbage processing” (3R Dream Plan, 2011<sup>xxxviii</sup>). The Plan puts the cooperation between citizens, companies and the city government at the centre and encourages behaviour change in order to increase recycling and to reduce waste. The

Yokohama 3R Dream Plan teaches manufacturers to use recycled and recyclable materials during production and urges businesses to sell eco-friendly products and services, which will lead to less resources imported and used and, ultimately, wasted. Residents are encouraged through an extensive promotion and education campaign to participate by managing their household waste, reusing plastic bags and water bottles, and supporting environmentally friendly businesses. Residents are engaged by invitation to tens of thousands of resident briefings, more than 2,000 campaigns at collection points, and hundreds of campaigns at train stations.

*Results:* Thanks to Yokohama's continued efforts (G30 Plan 2002-2010 and 3R Dream Plan 2010-2025<sup>xxxix</sup>), the city has already reduced waste by 45% from a peak of 1.61 million tons in 2001. The 3R Dream Plan in particular concentrates on expanding waste reduction efforts while the city population is growing. Yokohama thus aims to reduce total generation of garbage by more than 10% by 2025 from 2009 levels (it has already reduced more than 3% in 2013) and to mitigate climate change and reduce greenhouse gas emissions by at least 50% in 2025 compared to 2009 (already reduced more than 10% in 2013). Yokohama thus aims to reduce 71,000 tons of CO<sub>2</sub> annually by 2017 and more than 141,000 tons of CO<sub>2</sub> by 2025. The successful promotion and education campaign has also led to a number of co-benefits, such as converting enough energy to power 170,000 households for one full day thanks to residents collecting their kitchen waste.

*Reasons for success:* Yokohama has been able to progressively reduce waste generation while sustaining economic development by creating a participatory environment for government, industry, commerce, consumers and the general population. This is only achievable when there are transparent mechanisms that avoid conflicts of interest.

*When/why a city might apply an approach like this:* As waste reduction and avoidance becomes a general target for most cities facing diminishing landfill capacities or general demand for better waste and resource management, experiences like the ones developed at Houston and Yokohama will provide useful lessons in driving towards a closed-loop economy and the requirements to engage all sectors of society.

### 3.6 Target food and green waste reduction

From a climate perspective, targeting food and green waste reduction has the largest impact than any other solid waste component.

When food and green waste ends up in a landfill, it decomposes in an oxygen-free environment (anaerobic), which produces carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Methane is a powerful greenhouse gas that is far more devastating to the climate in the short term because of how effectively it absorbs heat in the atmosphere. In the first two decades after its release, methane is 84 times more potent than carbon dioxide.

Even when methane from landfills is captured and destroyed, inherent inefficiencies will not allow a complete capture of the gas, allowing some of it to escape to the atmosphere through leaks.

Diverting organics from landfills allows for them to be used for other purposes, like food banks, livestock feed, or composting and anaerobic digestion. Producing high quality compost from clean organics is one of the best solutions to the climate impact of waste management. Compost has the potential of turning solid waste from an emissions source into an emissions sink by enhancing the soil's ability to store carbon, and offset the use of chemical fertilisers, further reducing indirect emissions.

### **Case Study: Hong Kong - Food and Yard Waste Plan<sup>xi</sup>**

*Summary:* The Food and Yard Waste Plan for Hong Kong (2014-2022) is a comprehensive organic waste management plan launched in February 2014 to map out a comprehensive strategy, targets, policies and action plans for the management of such waste in the coming years with a view to tackling the challenge faced in Hong Kong. The target is to reduce Hong Kong's food waste disposal to landfills by at least 40 % by 2022. To achieve this target, the Hong Kong Government has mapped out four strategies as the backbone of the plan to overcome the challenge of food waste, namely: reduction at source, reuse and donation, recyclable collection, and turning food waste into energy.

*Results:* It is estimated that about 0.46 million tonnes CO<sub>2</sub>e GHG emissions can be avoided annually when the plan is fully implemented in 2022. Additionally, the target is to reduce Hong Kong's food waste disposal to landfills (about 3,600 tonnes per day in 2011) by at least 40 % by 2022. It is estimated that about 20% of food waste would be avoided through the Hong Kong Food Wise Campaign, and the implementation of waste charging.

*Reasons for success:* The success of Food and Yard Waste Plan hinges upon the measures highlighted in the Plan so that citizens, organizations and the Government can each ply their part to reduce, separate and recycle food waste.

### **Case study: London - FoodSave Scheme<sup>xli</sup>**

*Summary:* In the context of 920,000 tonnes or 1.3bn meals of food being thrown away each year in the UK food & hospitality services sector, out of which an estimated 75% could have been eaten<sup>xlii</sup>, London has launched a new voluntary scheme for cafes, pubs, restaurants and wholesalers to reduce food waste, saving thousands of pounds in the process.

FoodSave, launched in November 2013, is a project to help small and medium-size food businesses reduce their food waste, put surplus food to good use and dispose of unavoidable food waste more responsibly, through processes such as composting or anaerobic digestion. It

offers food waste audits and promotes simple measures, such as offering customers different portion sizes, measuring side dishes in cups, using leftover food for its soup of the day and menu specials, and raising staff awareness of what not to throw away<sup>xliii</sup>.

The FoodSave scheme, funded by the European Regional Development Fund, the London Waste and Recycling Board and the Mayor of London, has been run in partnership with the *Sustainable Restaurant Association* that delivered FoodSave for food service and hospitality businesses (including restaurants, pubs, staff canteens, hotels and cafes) and *Sustain: The alliance for better food and farming* that ran the project for retailers, manufacturer and wholesalers.

*Results:* By March 2015, the Food Save scheme has helped around 200 of London's small hospitality businesses manage better their food waste, reduce food waste by over 150 tonnes and divert over 1,000 tonnes of food waste from landfill (estimated equivalent of 3,270 tCO<sub>2</sub>e<sup>xliiv</sup>), while saving businesses over £350,000 associated with waste reduction and disposal. At the same time, the project holds many lessons for the city of London to drive food waste down across the city hospitality sector.

*Reasons for success:* The city of London has seized the opportunity of an external funding to build an innovative public-private partnership with hospitality sector representatives and individual businesses to start addressing food waste through a voluntary food waste reduction scheme, while using the project outcomes as valuable lessons learned for future tackling of food waste city-wide.

*When/why might a city apply an approach like this:* Other cities could be inspired by this approach to start promoting food waste reduction amongst businesses and to derive targets with action plans to tackle food waste and yard waste, and share experiences to tackle source separation, collection and treatment in a dense living environment.

## 4 FURTHER READING

A number of external organisations, including C40 partners, have published best practice guidance for developing waste management projects, including:

- UNEP / IETC Developing Integrated Solid Waste Management Plan – Training Manuals, Jun 2009  
<http://www.unep.org/ietc/InformationResources/Publications/tabid/56265/Default.aspx#iswm1>
- UNEP / IETC The Japanese industrial waste experience: Lessons for rapidly industrializing countries, March 2014  
[http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/UNEP%20TIE Japanese%20waste\\_english\\_web.pdf](http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/UNEP%20TIE%20Japanese%20waste_english_web.pdf)

- World Bank - Results-Based Financing for Municipal Solid Waste Projects  
<http://documents.worldbank.org/curated/en/2014/07/20328140/results-based-financing-municipal-solid-waste-vol-2-2-main-report>
- The World Bank: What a Waste: A Global Review of Solid Waste Management  
<http://go.worldbank.org/BCQEPOTMOO>

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<sup>i</sup> What a Waste: A Global Review of Solid Waste Management, The World Bank, 2012.

<sup>ii</sup> <http://www.unep.org/ccac/tabid/1060441/Default.aspx>

<sup>iii</sup> <http://cam3.c40.org/#/main/home>

<sup>iv</sup> <http://www.theguardian.com/sustainable-business/climate-change-circular-economy-davos>

<sup>v</sup> San Francisco closer to turning zero-waste ambition into reality:  
<http://www.theguardian.com/environment/2014/jun/17/san-francisco-zero-waste-recycling-composting>

<sup>vi</sup> [http://europa.eu/rapid/press-release\\_MEMO-12-989\\_en.htm](http://europa.eu/rapid/press-release_MEMO-12-989_en.htm)

<sup>vii</sup> Buenos Aires embraces “cartoneros” in push for zero waste - <http://citiscopes.org/story/2014/buenos-aires-embraces-cartoneros-push-zero-waste#sthash.y7YU6rje.dpuf>

<sup>viii</sup> [http://www.c40.org/case\\_studies/zero-waste-program](http://www.c40.org/case_studies/zero-waste-program)

<sup>ix</sup> <http://sfenvironment.org/zero-waste/overview/legislation>

<sup>x</sup> <http://bit.ly/1SOEhap>

<sup>xi</sup> Adapted from: [http://archive.epa.gov/jius/web/html/zero\\_waste\\_program.html](http://archive.epa.gov/jius/web/html/zero_waste_program.html)

<sup>xii</sup> <http://bit.ly/1JKARTR>

<sup>xiii</sup> <http://sfenvironment.org/zero-waste>

<sup>xiv</sup> <http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf>

<sup>xv</sup> <http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf> - p.178

<sup>xvi</sup> <http://on.nyc.gov/1Ofg8cF>

<sup>xvii</sup> <http://bit.ly/1F7Ticp>

<sup>xviii</sup> <http://observer.com/2015/11/save-as-you-throw-working-group-will-consider-financial-incentive-for-recycling/>

<sup>xix</sup> <http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf>

<sup>xx</sup> C40 Awards Application 2015

<sup>xxi</sup> <http://bit.ly/1PbCB4E>

<sup>xxii</sup> [http://www.c40.org/case\\_studies/waste-management-system](http://www.c40.org/case_studies/waste-management-system)

<sup>xxiii</sup> [http://carbonn.org/index.php?id=312&tx\\_datareport\\_pi1%5Buid%5D=339](http://carbonn.org/index.php?id=312&tx_datareport_pi1%5Buid%5D=339)

<sup>xxiv</sup> <http://www.recyclingtoday.com/article/stadler-oslo-award-roaf>

<sup>xxv</sup> <http://waste-management-world.com/a/oslos-colourful-solution-to-waste-management>

<sup>xxvi</sup> <http://bit.ly/1TUVywU>

<sup>xxvii</sup> <http://bit.ly/1TUVywU>

<sup>xxviii</sup> <http://stopwaste.org>

<sup>xxix</sup> <https://www.ebmud.com>

<sup>xxx</sup> <http://www.cvcorps.org>

<sup>xxxi</sup> <http://www.oaklandrecycles.com>

<sup>xxxii</sup> <http://www.houstontx.gov/solidwaste/reuse.html>

<sup>xxxiii</sup> <http://www.houstontx.gov/solidwaste/reuse.html>

<sup>xxxiv</sup> <http://www.houstontx.gov/solidwaste/reuse/reuseflyer.pdf>

<sup>xxxv</sup> <http://www.houstontx.gov/solidwaste/reuse.html> (video, 0.48 min)

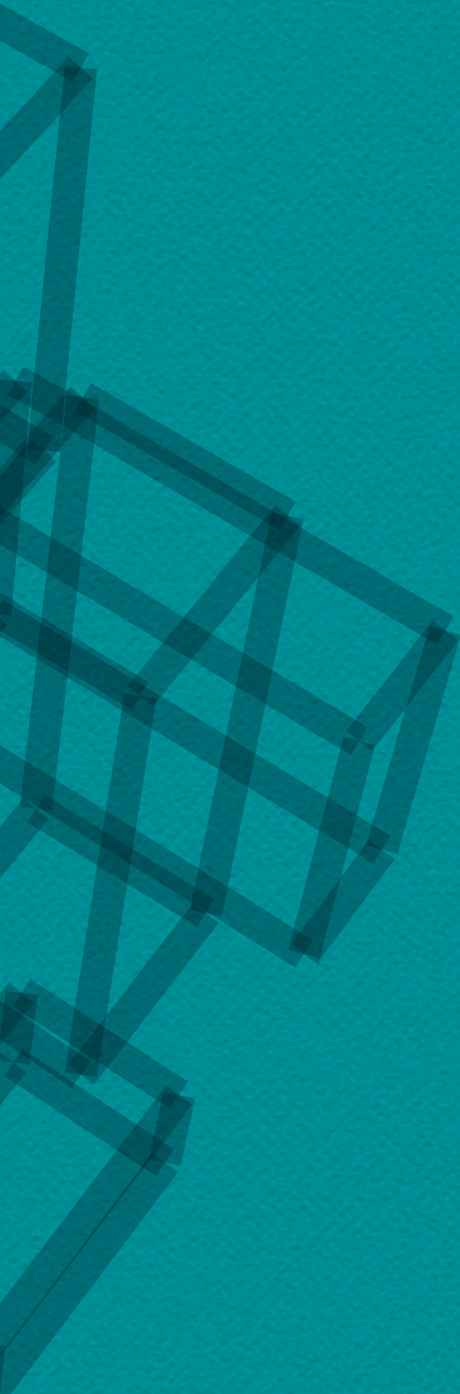
<sup>xxxvi</sup> <http://www.city.yokohama.lg.jp/shigen/sub-keikaku/keikaku/3rm/dai2ki/2ki-english.panhu.pdf>

<sup>xxxvii</sup> <http://www.city.yokohama.lg.jp/shigen/sub-keikaku/keikaku/3rm/dai2ki/2ki-english.panhu.pdf>

<sup>xxxviii</sup> <http://www.city.yokohama.lg.jp/shigen/sub-keikaku/keikaku/3rm/plan/3rmplan/3rmplangaiyo-en.pdf>

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- <sup>xxxix</sup> [http://citynet-ap.org/wp-content/uploads/2011/10/Intergrated\\_solid\\_waste\\_management\\_in\\_Yokohama.pdf](http://citynet-ap.org/wp-content/uploads/2011/10/Intergrated_solid_waste_management_in_Yokohama.pdf)
- <sup>xl</sup> <http://bit.ly/1SOEwCe>
- <sup>xli</sup> <https://www.c40exchange.org/pages/viewpage.action?pagelId=54624404>
- <sup>xlii</sup> <http://bit.ly/1mVzYNK>
- <sup>xliii</sup> <http://www.edie.net/news/5/Boris-Johnson-Food-Save-Scheme-London-restaurants-Food-Waste/>
- <sup>xliv</sup> <https://www.c40exchange.org/pages/viewpage.action?pagelId=54624404>





**London**

North West Entrance, City-Gate House  
39-45 Finsbury Square, Level 7  
London EC2A 1PX  
United Kingdom

**New York**

120 Park Avenue, 23rd Floor  
New York, NY 10017  
United States

**Rio de Janeiro**

R. São Clemente, 360 - Morro Santa Marta  
Botafogo, 22260-000  
Rio de Janeiro - RJ  
Brazil

[www.c40.org](http://www.c40.org)  
[contact@c40.org](mailto:contact@c40.org)

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February 2016