Primer

No time to waste - global waste primer

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Bank of America Merrill Lynch

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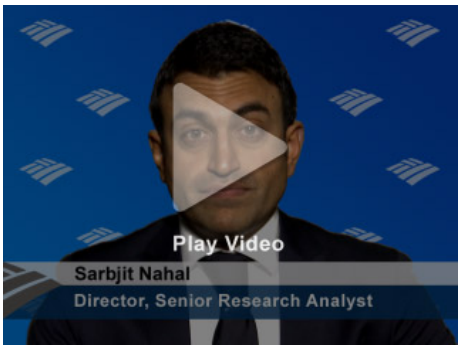

Click the image above to watch the video.

Waste: a global thematic megatrend

As part of our ongoing work on thematic megatrends, we turn our attention to global waste. Poor waste management is a global reality, with only 25% of the 11bn tonnes collected annually recycled or recovered – and 3.5 bn people lacking access to basic waste management services. The situation will get worse with waste volumes growing faster than urbanisation rates and GDP growth – and waste volumes set to double to 2025 (vs. 2005), and double again from 2025-50.

US$1tn+ market today

Waste management is a US$1tn market today that includes municipal solid waste (MSW), industrial waste, waste-to-energy (WtE), and sustainable packaging, among other areas. Growth drivers are increasing volumes, changing variety and complexity of waste streams, urbanisation, income growth (GDP-waste link), reducing environmental and social risks and costs, resource scarcity, commodity prices, growing private sector involvement, stakeholder pressure, and tightening regulation.

From "trash to cash"

We are seeing a shift away from waste as a mandatory public service to waste management as a sustainable business opportunity. We see the fastest growth in the next decade coming from diversion, recycling, recovery of valuable secondary raw materials, waste-to-energy, e-waste, and sustainable packaging – as well as from EMs. We see considerable low hanging fruit potential given that 70%+ of global waste is currently landfilled. "Greening" waste management will require increasing MSW recycling by a factor of 3.5x and doubling industrial waste recycling.

Multiple entry points for US$2tn market (2020E)

We believe that the global dynamics of waste management mean that the sector offers numerous growth opportunities for those with exposure to the value chain. By 2020, we estimate that the waste industry could be worth up to US$2tn, with Europe facing the toughest strategic challenges, and Asia and South America seeing the fastest growth. We see opportunities across waste management, industrial treatment, WtE, wastewater & sewage, E&C, recycling, and sustainable packaging among other areas.

BofAML Global Waste Exposure Stock List & Primer Picks

Together with our sector analysts, we have compiled a list of c80 global stocks covered by BofAML that have exposure to waste and waste-management-related products, services, technologies, themes, and solutions. We examine the role that these could play in driving long-term growth based on our estimates of their current exposures. Our Buy rated stocks with material exposure to the theme, and full stock list fare detailed in an accompanying Primer Picks document

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Refer to important disclosures on page 87 to 89. Link to Definitions on page 86.

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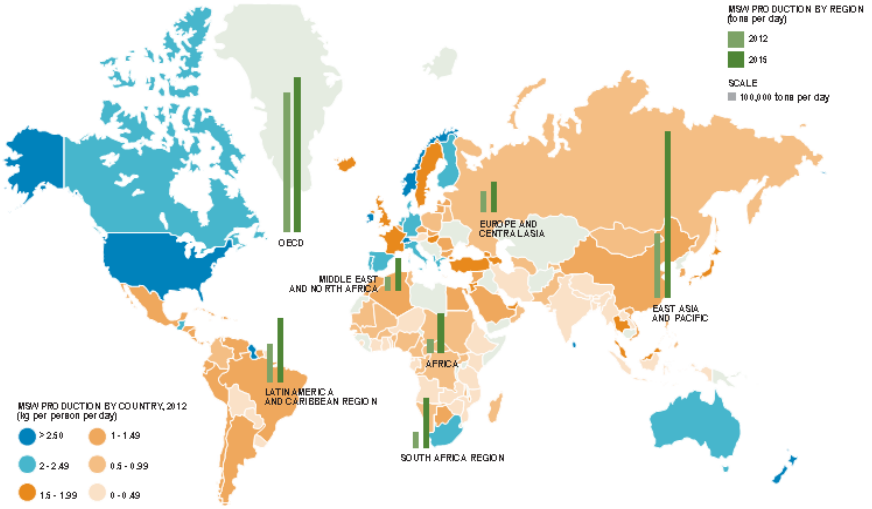
See also BofAML Global Waste Management Stock List & Primer Picks

Thematic Investing, 05 April 2013

No time to waste

Waste poses some of the toughest challenges of any megatrend – with growing volumes and increasing complexity and a variety of waste streams on the one hand and, on the other, poor management, with c.70% of waste ending up in landfill and only 25-30% being recycled or recovered. The situation will likely deteriorate with waste volumes growing faster than urbanisation and GDP growth rates.

Chart 1: Municipal solid waste (MSW) production by country: 2012 vs. 2015



Source: The Economist, BofA Merrill Lynch Global Research

We believe that the global dynamics of waste volumes mean that waste management offers numerous opportunities for those with exposure to the value chain. The market is currently estimated at US$1tn and could grow to US$2tn in the next decade.

Chart 2: Waste management in a nutshell

Source: Suez, BofA Merrill Lynch Global Research

BofAML Global Waste Management Exposure stock list

The BofAML Global Waste Exposure stock list is not a recommended list either individually or as a group of stocks. Investors should consider the fundamentals of the companies and their own individual circumstances / objectives before making any investment decisions

We have mapped the global waste sector's value chain and believe that a number of stocks are well placed to benefit from the theme of waste and waste management through their involvement in areas such as municipal solid waste (MSW), industrial treatment, waste-to-energy (WtE) or energy-from-waste (EfW), wastewater & sewage, engineering and consulting (E&C), recycling, scrap, recovery, and sustainable packaging among other areas.

Together with our BofAML Global Research sector analysts, we estimate the level and materiality of companies' exposure to waste and waste management-related themes, and the role of waste as a long-term growth driver. We characterise each company's exposure as follows:

- **Low** – Waste- and waste-management related products, technologies, services, and solutions are not material to global revenues and/or growth but are one factor, among others, for the business model, strategy and R&D of the company.
- **Medium** – Waste- and waste-management related products, technologies, services, and solutions are an important factor for the business model, strategy and R&D of the company; material to sales and/or growth.
- **High** – Waste- and waste-management related products, technologies, services, and solutions are core to the business model, strategy and R&D of the company; material sales and/or growth driver; pure play (i.e., 100% of sales).

Although it is difficult to accurately gauge the link between such exposure and share price performance (as many factors outside the scope of this analysis are likely to play a role in short- and long-term price development), we still consider waste-related exposure an important and positive point to track given that waste is a sustainability megatrend with a 25-50-year lifespan.

Table 1: BofAML Global Waste Management Exposure stock list

Ticker	Name	Country	BofAML Ticker	Waste sub-sector	Waste Management exposure
TREATMENT					
8422 TT	CLEANAWAY	Taiwan	XNVDF	Treatment	High
9793 JP	DAISEKI	Japan	DSKIF	Treatment	High
ACS SM	ACS	Spain	ACSAF	Treatment	Medium
ECL US	ECOLAB INC	United States	ECL	Treatment	Medium
KRA1V FH	KEMIRA	Finland	KMRAF	Treatment	Medium
ALFA SS	ALFA LAVAL	Sweden	ALFVF	Treatment	Low
BAS GR	BASF	Germany	BFFAF	Treatment	Low
034020 KS	DOOSAN HEAVY	Korea, Republic Of	DOHIF	Treatment	Low
DOW US	DOW CHEMICAL	United States	DOW	Treatment	Low
DD US	DUPONT	United States	DD	Treatment	Low
GE US	GENERAL ELECTRIC	United States	GE	Treatment	Low
ICL IT	ICL	Israel	ISCHF	Treatment	Low
3405 JP	KURARAY	Japan	KURRF	Treatment	Low
LXS GR	LANXESS	Germany	LNXSF	Treatment	Low
MEO1V FH	METSO	Finland	MXTOF	Treatment	Low
6988 JP	NITTO DENKO	Japan	NDEKF	Treatment	Low
OTE1V FH	OUTOTEC	Finland	OUKPF	Treatment	Low
SCI SP	SEMBCORP INDS.	Singapore	SCRPF	Treatment	Low
SIE GR	SIEMENS	Germany	SMAWF	Treatment	Low
SPX LN	SPIRAX-SARCO	United Kingdom	SPXSF	Treatment	Low
3402 JP	TORAY	Japan	TRYIF	Treatment	Low
WTE					
257 HK	CHINA EVERBRIGHT	Hong Kong	CHFFF	WTE	High
PNN LN	PENNON	United Kingdom	PEGRF	WTE	High
ABB US	ABB	Switzerland	ABB	WTE	Low
FER SM	FERROVIAL	Spain	FRRVF	WTE	Low
FUM1V FH	FORTUM	Finland	FOJCF	WTE	Low
KEP SP	KEP	Singapore	KPELF	WTE	Low
Wastewater & Sewage					
AGUAS/A CI	AGUAS ANDINAS	Chile	XXSGF	Wastewater & Sewage	High
257 HK	CHINA EVERBRIGHT	Hong Kong	CHFFF	Wastewater & Sewage	High
CSMG3 BZ	COPASA	Brazil	CSAOF	Wastewater & Sewage	High
IAM CI	AGUAS METROPOLIT	Chile	XVNFF	Wastewater & Sewage	High
PNN LN	PENNON	United Kingdom	PEGRF	Wastewater & Sewage	High
SVT LN	SEVERN TRENT	United Kingdom	SVTRF	Wastewater & Sewage	High
SEV FP	SUEZ ENVIRONNEMENT	France	SZEVF	Wastewater & Sewage	High
UU/ LN	UNITED UTILITIES	United Kingdom	UUGWF	Wastewater & Sewage	High
SBS US	SABSEP-ADR	Brazil	SBS	Wastewater & Sewage	High
VE US	VEOLIA	France	VE	Wastewater & Sewage	High
MWC PM	MANILA WATER	Philippines	MWTCF	Wastewater & Sewage	Medium
ANA SM	ACCIONA	Spain	ACXIF	Wastewater & Sewage	Low
392 HK	BEIJING ENTERPRISES	Hong Kong	BJINF	Wastewater & Sewage	Low
659 HK	NWS HOLDINGS	Hong Kong	NWSZF	Wastewater & Sewage	Low
SCI SP	SEMBCORP INDS.I	Singapore	SCRPF	Wastewater & Sewage	Low
363 HK	SHANGHAI INDUS	Hong Kong	SGHIF	Wastewater & Sewage	Low
E&C					
VATW IN	VA TECH WABAG	India	XVWBF	E&C	High
ACM US	AECOM TECHNOLOGY	United States	ACM	E&C	Low
GBF GY	BILFINGER	Germany	BFLBF	E&C	Low
5471 JP	DAIDO STEEL	Japan	DADSF	E&C	Low
STR AV	STRABAG	Austria	XSTBF	E&C	Low
UGL AU	UGL	Australia	UGLLF	E&C	Low
URS US	URS CORP.	United States	URS	E&C	Low
Recycling					
NUE US	NUCOR	United States	NUE	Recycling	High
SCHN US	SCHNITZER	United States	SCHN	Recycling	High
SGM AU	SIMS METAL MGMT	Australia	SMUPF	Recycling	High
STLD US	STEEL DYNAMICS	United States	STLD	Recycling	High
CMC US	COMMERCIAL METALS	United States	CMC	Recycling	Medium
LKQ US	LKQ CORP.	United States	LKQ	Recycling	Medium
034020 KS	DOOSAN HEAVY	Korea, Republic Of	DOHIF	Recycling	Low

Table 1: BofAML Global Waste Management Exposure stock list

Ticker	Name	Country	BofAML Ticker	Waste sub-sector	Waste Management exposure
Sustainable Packaging					
SMDS LN	DS SMITH PLC	United Kingdom	DITHF	Sustainable Packaging	High
KLBN4 BZ	KLABIN	Brazil	KLBNF	Sustainable Packaging	High
2314 HK	LEE & MAN PAPER	Hong Kong	LMPMF	Sustainable Packaging	High
RKT US	ROCK-TENN	United States	RKT	Sustainable Packaging	High
AMC AU	AMCOR	Australia	AMCRF	Sustainable Packaging	Medium
GPK US	GRAPHICPACKAGING	United States	GPK	Sustainable Packaging	Medium
MND SJ	MONDI LIMITED	South Africa	MODLF	Sustainable Packaging	Medium
PKG US	PACKAGING CORP	United States	PKG	Sustainable Packaging	Medium
SKG LN	SMURFIT KAPPA	Ireland	SMFTF	Sustainable Packaging	Medium
STERV FH	STORA ENSO	Finland	SEOJF	Sustainable Packaging	Medium
SEE US	SEALED AIR CORP	United States	SEE	Sustainable Packaging	Medium
UPMKY US	UPM-KYMMENE	Finland	UPMKY	Sustainable Packaging	Medium
REX LN	REXAM	United Kingdom	REXMF	Sustainable Packaging	Low
Management					
SEV FP	SUEZ ENVIRONNEMENT	France	SZEVF	Management	High
VE US	VEOLIA	France	VE	Management	High
SRCL US	STERICYCLE	United States	SRCL	Management (Medical)	High
5714 JP	DOWA HOLDINGS	Japan	DWMNF	Management	Medium
RTO LN	RENTOKIL INITIAL	United Kingdom	RKLIF	Management	Medium
FER SM	CSX CORPORATION	United States	CSX	Management (Transport)	Low
MTO LN	FERROVIAL	Spain	FRRVF	Management	Low
SRP LN	MITIE GROUP	United Kingdom	MITFF	Management	Low
CSX US	SERCO	United Kingdom	SECCF	Management	Low
O&G					
ECL US	ECOLAB INC	United States	ECL	O&G	Medium
KRA1V FH	KEMIRA	Finland	KMRAF	O&G	Medium
BHI US	BAKER HUGHES	United States	BHI	O&G	Low
CAM US	CAMERON	United States	CAM	O&G	Low
HAL US	HALLIBURTON	United States	HAL	O&G	Low
SLB US	SCHLUMBERGER	United States	SLB	O&G	Low
WFT US	WEATHERFORD	United States	WFT	O&G	Low
TIC, Life Sciences, HCA Distribution & Tech					
ALQ AU	ALS LTD	Australia	CPBLF	TIC	Medium
BVI FP	BUREAU VERITAS	France	BVRDF	TIC	Low
IDXX US	IDEXX	United States	IDXX	Health Care	Low
PLL US	PALL CORP	United States	PLL	Life Sciences	Low
SGSN VX	SGS	Switzerland	SGSOF	TIC	Low
TMO US	THERMO FISHER	United States	TMO	Life Sciences	Low

Source: BofA Merrill Lynch Global Research

Global waste, a 4-11bn ton challenge & a US1tn+ opportunity

The average American discards 2.01 kg (4.43lb) of garbage every day

Annual global production of waste is commonly estimated at between 4bn and 6bn tons (Source: World Bank, UNEP, ISWA) – with the UN estimating that it is as high as 11.2bn tonnes of solid waste collected annually (Source: UNEP). The combination of income growth, urbanisation, the changing variety and complexity of waste streams, environmental and social challenges, and secondary raw material recovery – means that volumes should continue to increase in the coming years. The highest levels of consumption are in developed markets – which consume and dispose of 2-3x more than EMs. However, EMs will present the greatest waste generation and waste management challenges and opportunities going forward.

Only 25% of global waste is recovered or recycled

Waste management offers large margins for improvement and business growth. Only 25% of global waste is recovered or recycled, but this falls as low as 7% for industrial waste, 10% for municipal solid waste (MSW) and 15% for e-waste (Source: UNEP). While there is no one size fits all approach to waste – with the market local or national in nature – the general waste management goals are the same: minimising waste, recovering materials and/or energy from waste, and recycling waste into reusable products. The biggest shift from an opportunity perspective is the transition from recovery and disposal to recycling and resource recovery.

The fastest growth is coming from EMs and emerging “trash from cash” opportunities around the world

Current estimates for the MSW market alone are US$410-433bn pa (Source: World Waste Survey, ISWA). Our estimates for the total global waste management market are as high as US$1tn given a wider scope (e.g. industrial waste, wastewater and sewage, sustainable packaging, and e-waste), the lack of consistent data from EMs, the informal waste management sector, and new and emerging streams of waste. We see the fastest growth coming from EMs (China, India and LatAm) and the emerging “trash from cash” opportunities around secondary raw material and energy recovery from waste.

Chart 3: Waste management in a nutshell

Source: Suez, BofA Merrill Lynch Global Research

The many functions of the waste industry include waste collection/transport, waste treatment, waste disposal, recycling, re-use, waste minimisation, secondary raw materials recovery, energy production from waste, wastewater and sewage treatment and disposal, and sustainable packaging

Defining waste

Defining waste can be a challenge as the waste and waste management industry's boundaries with other sectors are often hard to clearly delineate - and overlap with industry, energy, water, forestry, agriculture, buildings, and transport among many other areas. In addition, industry definitions are often not standardised, meaning that international data must be examined carefully for consistency (e.g. "municipal", "industrial", "hazardous" "e-waste" etc.) (Source: IPCC). Some commonly accepted definitions of waste are outlined below:

- **United Nations Basel Convention**: "*Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded.*"
- **Organization for Economic Cooperation and Development's Glossary of Statistical Terms**: *"Waste refers to materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose."*
- **European Union's Waste Framework Directive (2008/98/EC):** *Waste is "an object the holder discards, intends to discard or is required to discard."*

Breakdown by types of waste

We add further insight by breaking down different types of waste. The waste sector has traditionally encompassed municipal solid waste (MSW) at its core – i.e. trash, garbage, refuse or rubbish or waste types consisting of everyday items that are discarded by the public. Recent years have also seen a growing focus on industrial waste streams and special waste streams – a number of which are outlined in the table below. We believe a comprehensive breakdown of wastes also includes wastewater and sewage and packaging.

Table 2: Other types of waste (ex-MSW)

Type	Importance	Overview
Biomass	140bn tonnes of agricultural residue is generated every year	Includes agricultural and forestry waste.
Construction and Demolition (C&D)	10-15% of total waste generated in developed countries Up to 55% of the total waste reported in Germany	Can be classified as high-volume waste with relatively low impact compared with other types of waste.
Electronic waste (e-waste)	20-50 million tonnes globally in 2005	Growing global demand for electronic and electrical goods.
End-of-life Vehicles	8-9mn tonnes of waste in the EU 0.7mn tonnes of Automobile Shredder Residues (ASR) p.a. 5mn tonnes of ASR p.a. in U.S.	Materials such as plastic, rubber, foam, paper, fabric, glass, etc. that remain to be recycled after the reusable parts of the automobile are removed from shredded EoLV
Hazardous	8.5mn tonnes of hazardous waste have been crossing international boundaries every year	Requires special handling and treatment – even in low quantities may mix up with the stream of waste generated in the municipal or agricultural sector (e.g. used batteries, spent paints, residual chemical pesticides, ozone depleting substances).
Health-care / medical	No global estimates High-income countries: <6kg per person p.a. Low-income countries: 0.5-3.0 kg per person p.a.	Sometimes classified as a subcategory of hazardous waste, but also includes non-hazardous components from healthcare activities.
Marine	103,247,609 pieces of waste in the world's seas between 1989 and 2007	Material discarded directly or indirectly from recreational/shoreline, ocean/waterway, smoking-related, dumping and medical and personal hygiene-related activities and sources. Cigarettes and cigarette filters accounted for almost a quarter of the material.
Packaging	179 kg per capita in the EU15 in 2004	Major issue in high-income countries & expanding rapidly in Ems.

Source: UNEP, OECD, Eurostat, Kiyotaka & Itaru, US EPA, Nakamura, WHO

End goal is the same; a closed loop / circular economy

The underlying objective of waste management is to establish a global circular economy in which material use and waste generation is minimised, any unavoidable waste is recycled or remanufactured, and any remaining waste is treated in a manner least harmful to the environment and human health, or even in a way that generates new value, such as energy recovered from waste (Source: UNEP). This aim is increasingly in line with stakeholder and regulatory sentiment on waste prevention and recycling.

Japan shows a move to a circular economy can be done

Japan is on its way to double resource productivity (i.e. tons of material used per Yen of GDP) by 2015 (vs. 1990 levels) - and the recycling rate over the same period

Japan is a good example of a country that has made progress on the circular economy concept, which it made a national priority in the early 1990s. Since then, it has doubled resource productivity (i.e. tons of material used per Yen of GDP) by 2015 (vs. 1990 levels), doubled the recycling rate over the same period, and reduced total material sent to landfills by about a fifth (Source: Worldwatch Institute).

An essential service, critical infrastructure

The total volume of MSW produced in the US pa is equal to the weight of 5,600 Nimitz Class aircraft carriers, 247,000 space shuttles, or 2.3m Boeing 747 jumbo jets. If all of the solid waste collected in the US was put in a line of average garbage trucks, that line would extend from NYC to Los Angeles, over 100x (Source: R.W. Beck, Inc.).

Waste is regarded as an essential "public service" by local communities and stakeholders. It plays a key role in protecting the environment and public health – and MSW is often the most important service a city provides and/or the largest single budget item for EM cities, and one of the largest employers. MSW management is also regarded as one of the most effective ways of strengthening overall municipal management and a proxy for management quality of other social services such as health, education, or transportation (Source: World Bank).

More efficient waste management is key for governments

The economic costs of waste management are high and most often borne by cash-strapped municipal governments. However, there is a strong long-term incentive to invest in waste management as it:

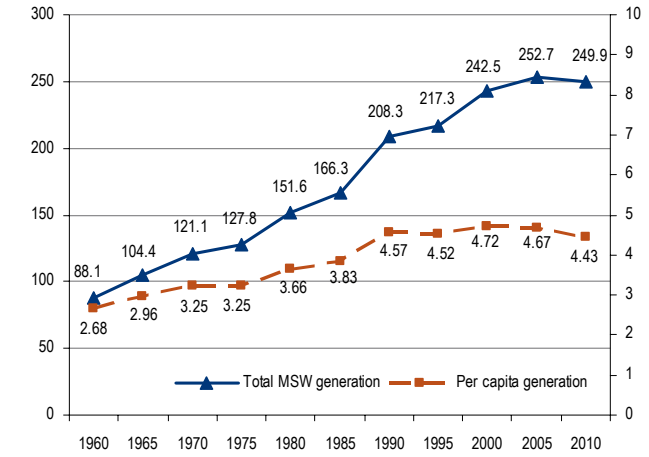
1. reduces environmental and social risks;
2. saves money via more efficient collection (from more efficient collection routes to public education on the 4Rs); and

3. reduces volumes via policies such as "pay as you throw" and landfill taxes/tipping fees; and focuses attention on economic opportunities rather than costs by extracting cash from trash, including valuable secondary raw materials and energy.

Clear incentive to improve efficient waste management

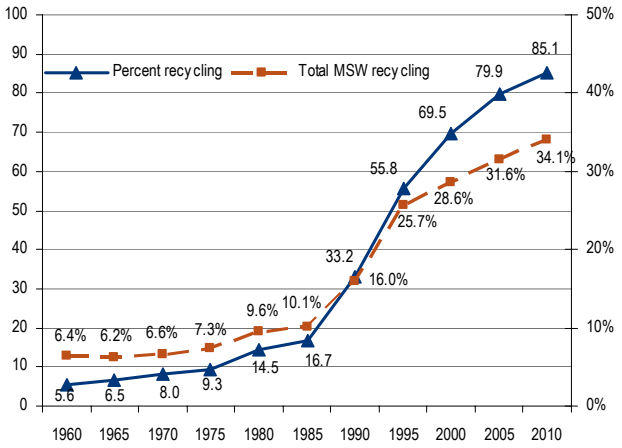
In the US alone, the average American discards 2.01kg (4.43lb) of garbage every day. That said, MSW recycling rates have skyrocketed over the past 50 years, and the waste industry managed 250m tons of household and other MSW and recycled and composted 85m tons of the material in 2010 (Source: US EPA). When construction and demolition waste and non-hazardous industrial waste is included, the industry manages nearly 545m tons of solid waste each year (Source: R.W. Beck, Inc).

Chart 4: US MSW generation rates 1960-10



Source: U.S. EPA, BofA Merrill Lynch Global Research

Chart 5: US MSW recycling rates



Source: U.S. EPA, , BofA Merrill Lynch Global Research

Increasing volumes, 4-11bn t of waste per year

Amounts of waste are largely determined by: i) population; and ii) consumption patterns, which are controlled by GDP per capita

Estimates of annual global production of waste commonly range from 4bn to 6bn tones per year. These figures include an estimated 3.4 to 4bn tonnes of municipal solid waste (MSW) and industrial waste, of which non-hazardous industrial waste accounts for 1.2bn tonnes (Source: World Waste Survey, ISWA). If we include other categories of waste – construction and demolition, e-waste, automotive waste, agricultural and forestry waste - the figures would be even higher. The United Nations Environment programme (UNEP) estimates that up to 11.2bn tonnes of solid waste are produced or collected annually.

Growing faster than GDP & urbanisation rates

Solid waste is the most visible and pernicious by-product of a resource-intensive, consumer-based economic lifestyle (Source World Bank)

A 1% increase in national income creates a 0.69% rise in municipal solid waste generated (Source: Mazzanti Massimiliano, Roberto Zoboli, 2009, Municipal Waste Kuznets curves)

Waste generation is linked to both population and income growth – with the latter considered the more powerful driver. By 2025, average global GDP per capita will be 1.5x the current rate, and 4x by 2050 in a business-as-usual scenario (Source: ISWA). Rising living standards and consumer-based lifestyles mean greater consumption of more resource-intensive goods and services and thus greater waste generation. In view of this combination of factors, global waste volumes have and continue to increase faster than both increases in GDP and rates of urbanisation. It is estimated that global waste production will double by 2025 (vs 2005) and again from 2025 to 2050 (Source: ISWA, EPEM SA)

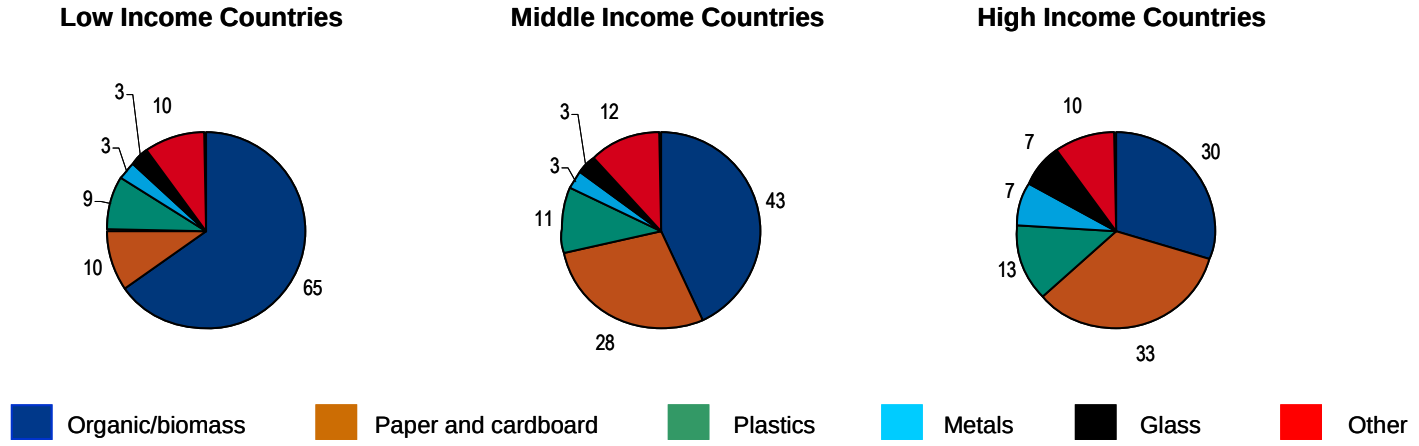
Boost for more efficient waste management

The positive flipside is that as GDP levels rise, waste management tends to become more effective in terms of product design, technologies, infrastructure, recycling rates and secondary raw materials recovery. In addition, regulation and stakeholders' social and environmental concerns are taken on board.

Changing variety & complexity of waste streams

The combination of countries becoming wealthier means increasing resource use, consumer spending and waste. Combined with broader socio-economic changes such as IT and nano-technology, means that waste streams are becoming increasingly varied and complex.

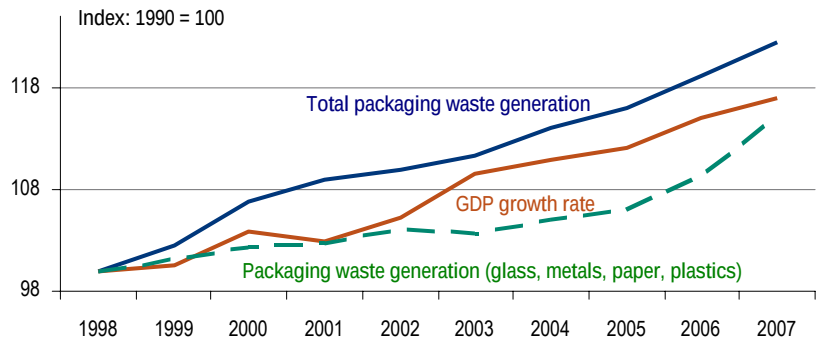
Chart 6: Composition of MSW by national income



Source: UNEP, BofA Merrill Lynch Global Research

- **Inorganic waste** – Urbanisation and rising income levels tend to mean more inorganic materials in waste streams (e.g. paper, plastics, aluminium, nano-materials). For instance, organic waste constitutes 40-85% of waste in rural areas, 65% of MSW in low-income countries, but only 30% of waste in high-income countries (Source: UNEP, Worldwatch Institute)

Chart 7: Packaging waste growth in EU 15



Source: UNEP, BofA Merrill Lynch Global research

- **Electronic or e-waste** – An estimated 20-50m tonnes of e-waste are disposed of each year, which accounts for 5% of all MSW (Source: UNEP and the United Nations University) (see further below on e-waste).
- **Food waste** – Growing agricultural (feeding 9bn by 2050), changing EM consumption patterns (more protein and meat) and urban food waste are set to increase by 44% to 2025 (vs 2005 (Source: ISWA) (see further below on food waste).

40% of food in the US goes uneaten (Source: Natural Resources Defense Council)

Urbanisation, cities produce more waste

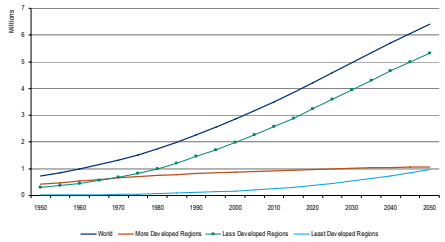
By 2050, as many people will live in cities as the population of the whole world in 2000 (Source: World Bank)

A large proportion of MSW is generated from urban areas; urban dwellers tend to have higher living standards and consumption levels than their rural counterparts, with shortened product life spans (Source: UNEP). According to the UN, the world population will increase by 20% to reach 8bn by 2025 and 9.5bn by 2050. This growth will be accompanied by increasing urbanisation. By 2025, 5bn people will be living in urban areas while 70% of the world's population will be living in cities by 2050 according to the UN. Upwards of 90% of this growth will come from Africa and Asia.

Megacities = megawaste

We will also see "mega-cities" with 10-20m+ inhabitants, stretching hundreds of kilometres across countries. This development will have significant waste impact as urban residents produce 2x as much waste as rural inhabitants, and produce more inorganic waste (e.g. paper, plastic and aluminium). Moreover, the combination of urbanisation and rising living standards is usually accompanies by growing interest in critical public services and environmental protection.

Chart 8: Global urban population 1950-2050 (bn people)



Source: Unpopulation

Table 3: Top 10 megacities 2011-2025 (population in millions)

City	Country	Population – 2011	City	Country	Population – 2025
Tokyo	Japan	37.2	Tokyo	Japan	38.7
Delhi	India	22.7	Delhi	India	32.9
Mexico City	Mexico	20.4	Shanghai	China	28.4
NYC	USA	20.4	Mumbai	India	26.6
Shanghai	China	20.2	Mexico City	Mexico	24.6
São Paulo	Brazil	19.9	NYC	USA	23.6
Mumbai	India	19.7	São Paulo	Brazil	23.2
Beijing	China	15.6	Dhaka	Bangladesh	22.9
Dhaka	Bangladesh	15.4	Beijing	China	22.6
Kolkata	India	14.4	Karachi	Pakistan	20.2

Source: UN Population Division, BofA Merrill Lynch Global research

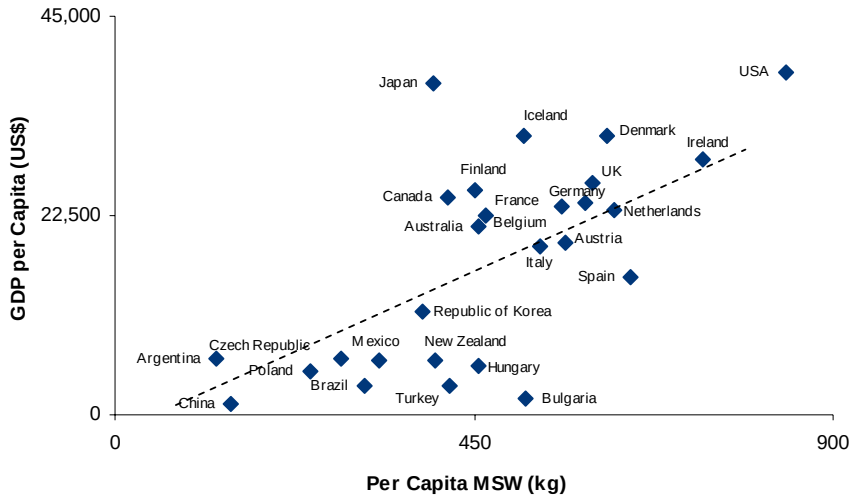
Waste generation per capita can be correlated to:

1) GDP per capita;
2) Energy consumption per capita;
3) Private final consumption per capita.

Income growth, the GDP-waste link

In high-income countries, the urban population generates approximately 0.8kg of MSW per capita per day, compared to 0.2kg per capita per day in low-income countries (Source: UNEP). Developed countries tend to produce more waste per capita because they consume more. Long term, the biggest challenges and opportunities will arise in EMs on the back of: i) the growing linkage between affluence and waste generation and management and; ii) the relative lack of municipal waste treatment facilities and investment, and inability to deal with new, complex and emerging types of waste.

Chart 9: GDP per capita (US$) vs. MSW per capita (kg)



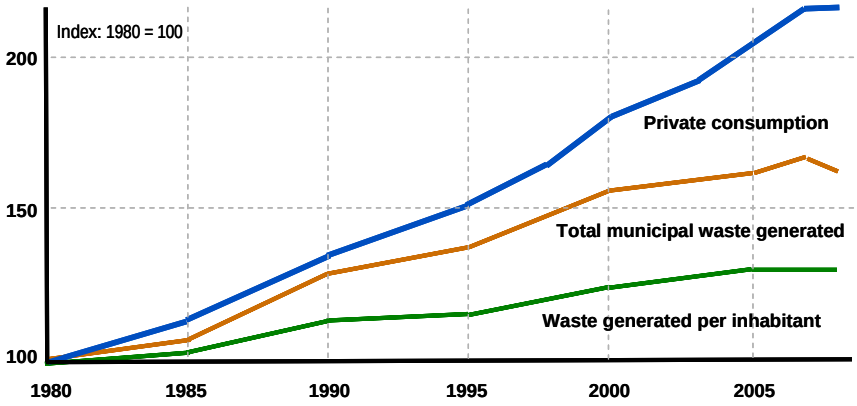
Source: UNEP

Factors behind decoupling include: PAYT ("pay as you throw"), EPR ("extended producer responsibility"), taxes, separate collection of recyclables, "circular economy", "green" products & packaging, LCA (life-cycle analysis) (Source: IPCC)

Developed markets, decoupling in last decade

Per-capita MSW generation is increasing in high-income countries; for e.g., +35% in OECD countries since 1980, and +21% in the US and +14% in the EU from 1995 to 2007. However, increasing awareness and regulations, better waste management and the shift of waste-intensive production to EMs have meant that the rate of MSW generation has stabilised or slowed, especially in the EU and, to a lesser extent the US, over the past 10 years (Source: UNEP, OECD).

Chart 10: Relationship between private consumption and municipal waste in OECD countries



Source: OECD (2008b), BofA Merrill Lynch Global Research. Index shows waste generation intensities expressed per capita and per unit of private final consumption expenditure (ex-public expenditure on education, health etc) since 1980

Fastest growth in EMs - China, Asia, Eastern Europe and MENA

MSW growth rates are growing fastest in markets where affluence is on the rise – China, other parts of East Asia, and parts of Eastern Europe and the Middle East (Source: World Bank). The biggest waste management opportunities also arise in these markets with collection rates lower than 70% in low-income EMs and over 50% of collected waste disposed through uncontrolled landfills (Source: World Waste Survey, UNEP).

Waste, geographic and geopolitical shifts

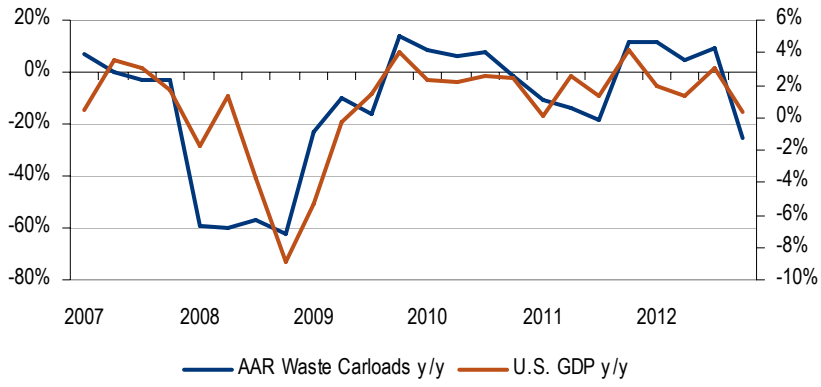
EM waste will also influence geopolitical shifts – with Asia becoming the key market for recycled materials – which will be a defining trend for the industry in the coming years (Source: Diplomatic Courier). For example, China is emerging as the #1 producer of waste after the OECD and the #1 importer, with more than 7.4m tonnes of plastics and 28m tonnes of paper entering the PRC each year (Source: Diplomatic Courier).

The sharp drop during the start of the financial crisis in late 2008 to 2009 was reflected in both waste carloads and GDP

Waste may be a positive economic indicator

There has been some debate as to whether waste may be a positive economic indicator – with a chart of U.S. American Association (AAR) "waste carloads" vs. GDP showing a potential correlation. Peaks and troughs in waste carloads were followed shortly after, or at the same time, as corresponding moves in GDP.

Chart 11: Waste generation per capita vs. economic growth



Source: Bloomberg, BofA Merrill Lynch Global research

From "trash to cash", the business case

Companies are rethinking waste, considering it a resource and assigning it a value

We are seeing a shift away from waste as a mandatory public service to waste management as a business opportunity. In particular, we are seeing a growing focus on the traditional 3Rs (Reduce, Reuse, Recycle) as well as a '4thR", Recover – as a means of reducing raw material demand and cost and making profits (e.g. materials recovery, energy recovery, composting). There is also an increasing focus on prevention or avoiding generating waste in the first place. This is done with a business rationale, with the European Commission estimating that full implementation of EU waste legislation would save €72bn a year, increase the annual turnover of the EU waste management and recycling sector by €42 billion and create over 400,000 jobs by 2020.

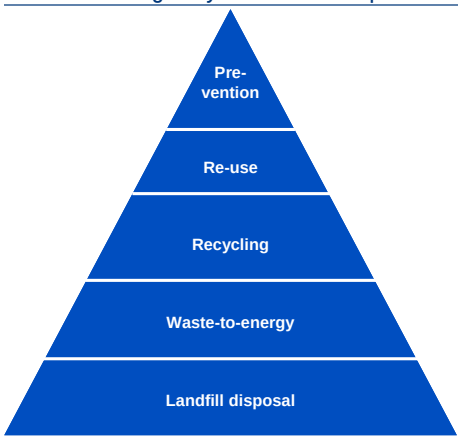
Full implementation of EU waste legislation would save €72bn a year, increase the annual turnover of the EU waste management and recycling sector by €42 billion and create over 400,000 jobs by 2020 (Source: EC)

Waste is linked to broader resource scarcity challenges

We consumed the equivalent of 1 earth in 1976 and 2 earths in 2010. This is expected to grow to 3 earths by 2050 (Source: BASF)

We believe that rapid economic growth, population growth and urbanisation are posing increasing long-term challenges for food, water and energy security – and increasing demand for industrial commodities and consumer goods. An average European, for instance, consumes c50 tonnes of resources a year, around 3x the amount consumed per capita by EMs (Source: Wuppertal Institute). This has knock on impacts on waste – with the average Europeans disposing 2x as much as citizens from EMs (Source: Bleischwitz).

Chart 12: Moving away from landfill disposal

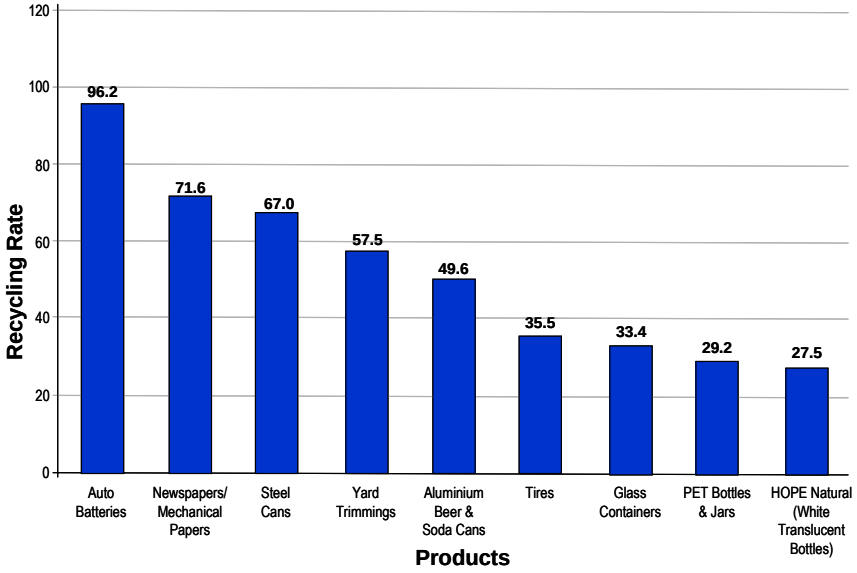


Source: Covanta, BofA Merrill Lynch Global Research

Greater focus on recycling, recovery & prevention

There is an increasing focus on the traditional "3Rs" – reduce, reuse, recycle – and on recovery of valuable secondary raw materials ("4R") and prevention. In Western developed markets, up to 35% of the waste stream is currently recycled, with residential / commercial, metals, and organics all growing at the expense of traditional disposal alternatives such as landfilling. As a result, per-capita waste generation in the US has fallen since 2005 while recycling has grown more than 2x faster than waste generation (Source: Republic Services)

Chart 13: US recycling rates of selected products (2010)



Source: US EPA, BofA Merrill Lynch Global Research. * Does not include combustion (with energy recovery).. ** Mechanical papers include directories, newspaper inserts, and some advertisement and direct mail printing

Recycling rates vary widely by country. In the United States, the recycled share of MSW grew from <10% in 1980 to 34% in 2010, and similar increases have been seen in other industrial countries (Source: Worldwatch Institute)

Large scope, only 25-30% of waste is recycled or recovered

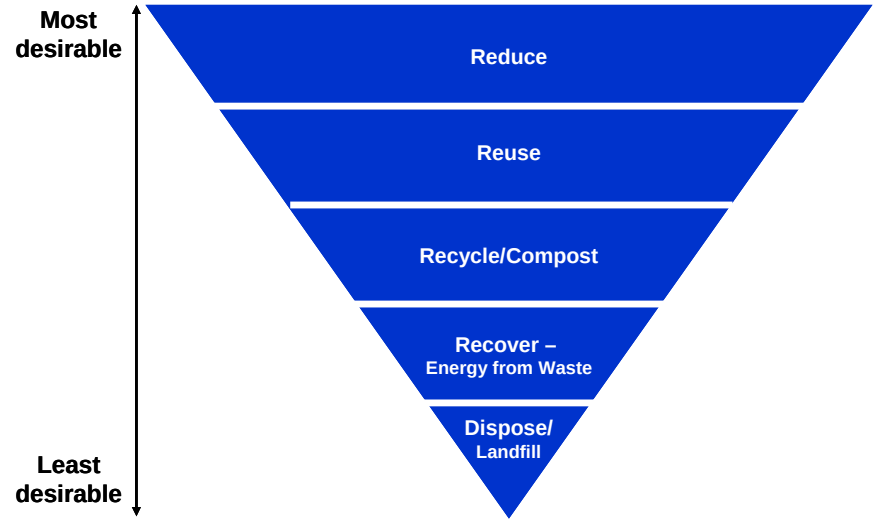
Some 70% of global waste ends up in landfills. Only 25-30% of global waste is diverted to recycling, composting or digestion or recovered as materials or energy or recycled – with levels even lower for industrial waste at 7%, MSW at 10%, and e-waste at 15% (Source: UNEP). Of the 25-30% that is recovered or recycled, two-thirds is either recycled or subject to mechanical and biological treatments (MBT) like composting, while the remainder is converted into energy through thermal and other waste-to-energy (WtE) systems. While there will always be some waste that cannot be prevented and that will require proper handling, we need to move to a greener scenario – with short -to medium-term global targets of upping MSW recycling by a factor of 3.5x and doubling industrial waste to 15% (Source: UNEP).

Medium- and long-term focus is on new revenue opportunities: offering diversion solutions, increasing recycling as a percentage of total revenue, and identifying opportunities to create value from the materials collected

Moving up the value chain

The waste hierarchy identifies five waste management activities in descending order of preference – the preferred activity is waste reduction; the least desirable is landfill disposal. Waste collection will continue to be the largest contributor to industry revenues, on the back of increasing volumes and rising fuel and labour costs. However, it will grow at a slower pace than waste diversion – with recycling and material recovery driving revenue streams. Medium term, the key to returns will be having a critical mass of recycled material volumes. Longer term, it will be companies facilitating waste prevention or reduction.

Chart 14: Waste hierarchy / value chain



Source: Covanta, BofA Merrill Lynch Global Research

Brownfield restoration & redevelopment opportunities

Cleaning up and reinvesting in brownfield properties protects the environment, reduces blight, and takes development pressure off green spaces and working lands (Source: US EPA)

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (Source: US EPA). One of the traditional concerns with Brownfield restoration and development is the cost of cleaning up the area. However, there is a growing business case for restoration and redevelopment:

- **Economic benefits of US$17.79 for every EPA Brownfield US$1 expended** on average through FY12 (Source: US EPA). Brownfield sites also tend to have greater location efficiency than alternative development scenarios resulting in a 32-57% reduction in vehicle miles travelled, thus reducing pollution emissions including greenhouse gasses.
- **Lower investment in infrastructure** – Brownfields usually have infrastructure in place so there is a cost saving in building and maintaining infrastructure relative to alternative new/sprawl development. Some analysis pegs the savings at as much as US$1/brownfields vs. US$10/greenfields.

The US Brownfield Redevelopment Tax Credit offers: a) 10%-22% of site and groundwater remediation costs; and b) 10-22% of redevelopment costs (Source: US EPA).

- **Government grants, loans and incentives** – For instance, in the US, important regulation includes the Resource Conservation and Recovery Act (RCRA), the Community Reinvestment Act (CRA), Superfund, and the Small Business Liability and Brownfields Revitalization Act.
- **Employment and investment** – the US EPA estimates that on average 7.30 jobs are leveraged per US$100,000 of EPA Brownfields funding expended –and that over 20Y, 3.7m jobs could be created.

Table 4: Brownfield redevelopment tax credits, 2009

Area	Site Preparation Component		Tangible Property Component		On-site Groundwater		Total Costs	Total Credit
	Investment	Credit	Costs	Credit	Costs	Credit		
Capital Region	$3,722,346	$670,022	$33,055,066	$5,949,912	$0	$0	$36,777,412	$6,619,934
Finger Lakes Region	$745,026	$74,503	$13,394,009	$2,250,453	$127,189	$12,719	$14,266,224	$2,337,675
Hudson Valley	$0	$0	$14,987,852	$2,996,741	$0	$0	$14,987,852	$2,996,741
New York City	$10,374,902	$2,019,210	$513,415,133	$81,495,701	$494,256	$59,311	$524,284,291	$83,574,222
Southern Tier	$134,833	$13,483	$2,840,481	$284,048	$14,610	$1,461	$2,989,924	$298,992

Table 4: Brownfield redevelopment tax credits, 2009

Area	Site Preparation Component		Tangible Property Component		On-site Groundwater		Total Costs	Total Credit
Central New York	$21,373	$2,554	$19,503	$1,950	$2,739	$329	$43,615	$4,833
Western New York	$6,157,131	$915,955	$1,074,662	$202,978	$0	$0	$7,231,793	$1,118,933
Total	$21,155,611	$3,695,727	$578,786,706	$93,181,783	$638,794	$73,820	$600,581,111	$96,951,330

Source: The Business Council of New York State based on data from NYS Department of Taxation and Finance, BofA Merrill Lynch Global Research

Reducing environmental & social risks

Understanding of the environmental, social – and knock-on economic – risks of not managing waste has increased over the past 20 years

Waste management is intertwined with environmental and social risks, particularly in many EMs, where open, uncontrolled, and unsecured dumps are the most commonly-used method of managing waste. Basic human needs, such as clean water, clean air, safe food, and fair paying jobs are all jeopardised by poor waste management practices, with severe consequences for human health and safety. The environmental and social burdens are borne disproportionately by EMs – including via the growing trans-boundary movement of waste – and relatively marginalised groups including the poor, minorities and women.

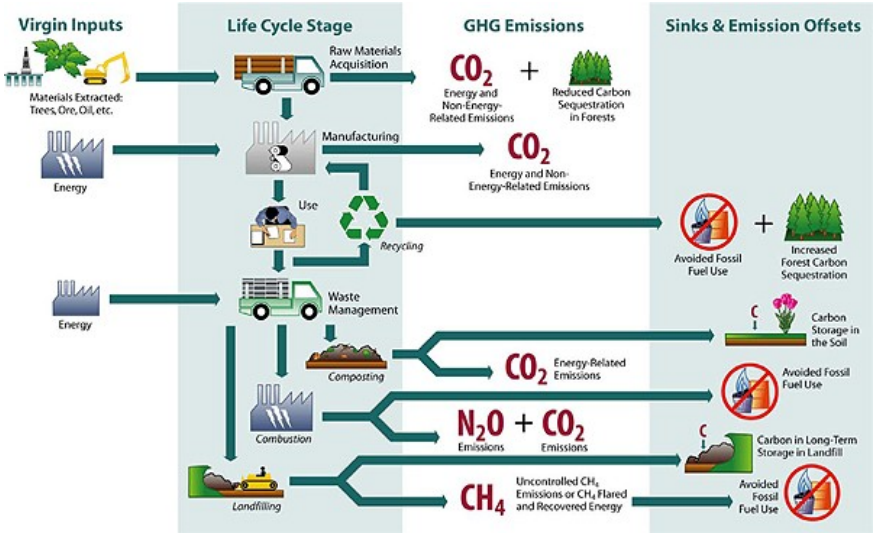
Environmental risks & opportunities

Poor waste management can contaminate surface water, groundwater, soil and air, which causes knock-on problems for human health and biodiversity. Waste treatment and disposal also produces significant greenhouse gas (GHG) emissions, notably methane, which are contributing significantly to global climate change:

Emissions from waste (including disposal, landfill sites and water treatment) represent 5% of global GHG emissions

- **GHG emissions, landfill methane is the #1 concern** – Post-consumer waste-generated GHG emissions were equivalent to approximately 1,300 $MtCO_2$-eq in 2005 (Source: IPCC) or c.5% of global GHG emissions (Source: UNEP) and 2.8% in the EU (Source: Eurostat). Landfill methane is the largest source of GHG emissions (landfill gas is 50-60% methane). It is caused by the anaerobic degradation of organic material in landfills and dumps and is 20x more potent than CO2 when it comes to climate change. Other ozone depleting substances in landfill (air conditioners, refrigerators, building materials, industrial waste) contribute to ozone-layer depletion. Other sources of emissions include fossil fuel electrical production, recovering metals for recycling, and transport.

Table 5: Life-cycle of waste and opportunities for GHG emissions or offsets



Source: U.S. EPA

Savings from recycling 1t of aluminium: 1.3t of bauxite residues, 15 m3 of cooling water, 0.86 m3 of process water, 2t of CO2 and 11kg of SO2

- **Considerable resource and energy savings potential** from substituting virgin materials with resources recovered from waste streams: Recycling is the most energy conserving of all waste management strategies – unlike "1-shot" incineration, providing energy savings through several production cycles. For instance, recycling 1t of aluminium and steel saves the equivalent of 37bbl and 2.7bbl oil, respectively (Source: NRDC) and using recycled blast furnace slag to make cement saves up to 42% of the embodied energy required to manufacture concrete and its constituent materials (Source: World Steel Association). Aluminium is one of the best examples – global aluminium recycling rates are c.90% for transport and construction appliances and 60% for beverage cans. The lower cost of recycled aluminium results from lower energy consumption than is required to smelt it from the raw material, bauxite. Recycled aluminium can be used in all its traditional applications and industry has been able to significantly step up output because of the recycling activity of smelters (Source: European Aluminium Association and Organization of European Aluminium Refiners and Remelters)

- **Resource conservation** – US recycling and composting prevented 85.1m tons of material being disposed of in 2010 (vs. 15m tons in 1980). This prevented the release of approximately 186m metric tons of CO2eq, equivalent to taking 36m cars off the road for a year (Source: US EPA).

Social risks & opportunities

Poor waste collection and improper waste disposal can lead to significant negative impacts in terms of human health and safety as well as for local stakeholders and biodiversity. In contrast, formalised waste management can reduce HSE risks and offers significant prospects for job creation.

Recycling creates more jobs than it replaces (Source: UNEP)

- **Job creation potential** – The labour force involved in waste management is thought to be one of the largest in the environmental solutions space. Recent estimates suggest that up to 15m people are involved across the chain in EMs (Source: Medina), with up to 10m involved in China (Source: UNEP), and >1m in the US (Source: EPN, Institute of Local Self Reliance). For EMs in particular, the informal waste sector is predominant – with up to

1% of the urban population involved in informal scavenging – which sustains up to 10x more jobs than landfilling or incineration on a per tonne basis (Source: ILSR). While some stakeholders argue that there may be potential threats to jobs from formalising waste management activities or reduced resource consumption from the 4Rs, UNEP argues that recycling creates more jobs than it replaces, employing 12m people in Brazil, China and the US alone.

Table 6: EU27 potential new direct, indirect, induced and displaced jobs as a result of 70% recycling rate by 2020

Key recyclable material	Extra recycling of key materials each year by 2020 ('000 tonnes, relative to 2004)	Potential new jobs associated with recycling			
		Direct	Indirect Multiplier: 1.5	Induced Multiplier: 1.75	Total Net New Jobs
Glass	4882	3661	1831	915	6407
Paper	13202	23763	11882	5941	41586
Plastic	9955	92582	46291	23145	162018
Iron and Steel	17838	96326	48163	24081	168570
Aluminium	1270	13973	6987	3493	24453
Wood	28471	21353	10677	5338	37368
Textiles	5231	26154	13077	6538	45769
Biowaste	33779	43913	21956	10978	76847
Total	114628	321725	160862	80431	563019

Source: Estimates based on 2004 baseline (Prognos et al, 2008)

- **Reducing human health & safety risks** – The clear downside to the informal sector is the significant concerns over health and safety, and working conditions. Frequently open, uncontrolled, and unsecured dumps sit alongside agriculture and villages, with significant gas and leachate leakages, and water pollution. Research links uncontrolled dumps, for instance, with higher skin and eye infections, respiratory problems, vector-borne diseases like diarrhoea, dysentery, typhoid, hepatitis, cholera, malaria and yellow fever, plague and flea-borne fever, as well as cancer incidence, mortality, birth defects and low birth weight (Source: UNEP, WHO). Formalising waste management even by landfill and incineration helps to minimise risks by reducing direct exposure to waste

Regulations & legislation going one way

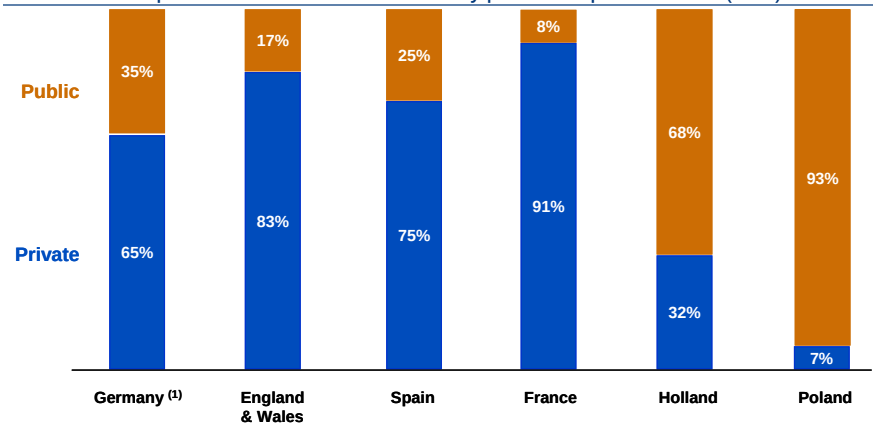
A combination of scientific evidence, public awareness and cost and opportunities have seen governments worldwide implementing more stringent and taxing waste management regulations and legislation. Examples include: the EU Landfill Diversion Directive; landfill taxes / tipping fees; recycling targets; and climate change regulations. The end goal is usually to facilitate a move from landfilling to recycling and recovery – while encouraging and promoting prevention.

Growing role for private sector

"During a time when municipalities are facing declining revenues and severe budget shortfalls, waste collection, recycling, and disposal are among the services most ideal for privatization" – US National Solid Wastes Management Association (NSWMA)

The waste sectors has significant public and private sector participation. We are seeing increasing rates of privatisation of waste management, especially in EMs. Moreover, with public funding increasingly under financial pressure, it is difficult to imagine that municipalities and local governments will be able to meet the needs for service provision and infrastructure investment via government capex. The role of private companies operating waste management will only grow in the coming years.

Chart 15: Municipal solid waste volumes treated by public and private sector (2010)



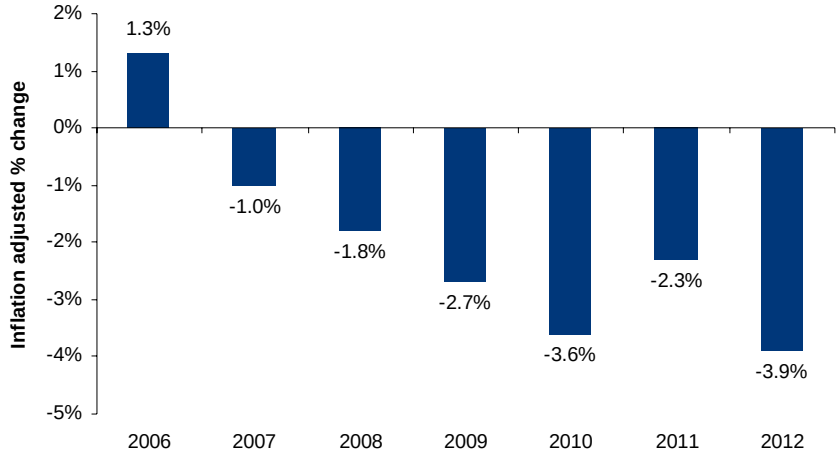
Source: Suez Envirronnement, BofA Merrill Lynch Global Research

"Waste management is one of the most complex and cost-intensive public services, absorbing large chunks of municipal budgets even when organised and operated properly." (Source: UNEP)

Cash-strapped municipalities looking to private sector

Positively, there are growing signs that municipalities are willing to contract with the private sector on the back of financial constraints and insufficient public funding – neither of which looks likely to improve in he near term. Weakened municipal fiscal conditions – with US spending down between -1.0 and -3.9% over the last five years - should provide for municipal privatisation opportunities and public-private growth opportunities.

Chart 16: General funds of US municipalities



Source: Repiublic Services based on National League of Cities 'City Fiscal Conditions in 2012' survey

Increasing focus for M&A

The focus on M&A both via private equity (e.g. Roark Capital Group closed on a US$1.5bn PE fund and Kinderhook Industries portfolios include several smaller waste companies) and listed companies has increased in recent years. .

Table 7: Recent industry M&A

Company	Acquired	Year	Paid (US$mn)
Waste Management Inc	Oakleaf	2011	432.0
Waste Connections Inc	R360	2012	1,330.0
Macquarie	WCAA	2012	526.0
Highstar Capital (Advanced Disposal)	Veolia	2012	1,910.0
Cheung Kong Infrastructure	Barra Topco (Batop)	2013	HK$3.2bn

Source: Company, press sources

Private sector role can lower cost & improve 4Rs

While waste is clearly a local matter and contingent on local conditions, there is an increasing body of evidence (admittedly often from industry organisations) that the private sector can play a role in generating cost savings and reducing financial risks for municipalities – as well as reducing environmental and health and safety risks:

- **Lowers costs** – Competitive delivery of solid waste services can generate cost savings of 20-40% because of economies of scale on investment, procurement, and environmental protection across multiple contracts (Source: Reason Foundation).
- **Promotes recycling rates** – Private sector recyclers have more experience and better ability to assume and manage risks in volatile commodities market – as well as leading the way on innovation such as single-stream recycling – which have helped to double American recycling rates in the past 20 years. The US cities with the highest recycling rates, including San Francisco and Seattle, have fully privatised recycling (Source: NSMWA).
- **Better health & safety records** – US MSW services operated by local governments have an injury rate >4x greater than the private sector, with the latter also missing fewer work days than public sector employees due to injury (Source: US Department of Labor).

Strategic challenges facing the industry

Cross Reference

French Utilities: Water & Waste, 10 January 2013

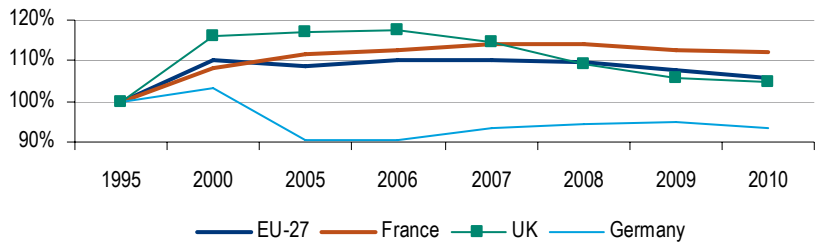
The waste management industry is facing a number of structural changes which are transforming the industry. These will be particularly challenging in a number of developed, mature waste markets; for instance, our European Utilities team argues that the EU waste business is undergoing structural transformation that will not end any time soon, hitting both waste and business mix volumes in the waste value chain.

In a nutshell, the challenges for developed and mature markets include: the progressive decline of landfilling and waste volumes (and increase in recycling), developing expertise and/or partnerships for recovering valuable secondary raw materials and energy (WtE), integrating new “smart collection” technologies, managing materials and energy price fluctuations, commoditisation of MSW collection, low barriers to entry, strong pricing pressure, and the need for greater consumer awareness and incentives.

Declining municipal volumes

European municipal waste output has declined, not only because of the financial crisis, but also owing to structural changes in consumption habits and more environmentally friendly behaviour driven by new regulation (Grenelle de l’Environnement in France) and incentive billing methodologies. Thus, residential volumes per capita continue to slide across Europe on the back of macro and waste prevention measures and the long-lasting effects of the crisis.

Chart 17: Municipal Waste generation per capita in Europe



Source: Eurostat

Pricing pressure

The adoption of new billing systems (e.g., the pay-per-weight system in France) also means downward short-term pricing pressure as it could incentivise customers to consume less and/or recycle more, i.e., hitting the treatment part of the waste value chain with lower volumes available to saturate industrial treatment tools. Longer term, it could enable large and innovative players to gain market share and improve margins at their collection business (fixed services paid for by the customers).

EU waste management industry hit hardest by recession

Exposure to economic cycles

Waste management is closely correlated to economic cycles, with the market driven by a combination of industrial output and revenue growth, and domestic consumption. The industry has been hit by the recession with the EU most affected in terms of industrial production and GDP forecasts. The difficult macro situation in 2012 meant lower visibility from customers, pricing pressure, and a decrease in treated waste volumes and landfill, although this was partially offset by the recession's "less is more" focus on recovery with an increase in WtE (Source: Suez Environnement).

Developed market municipal fiscal conditions remain weak, which may provide privatisation opportunities

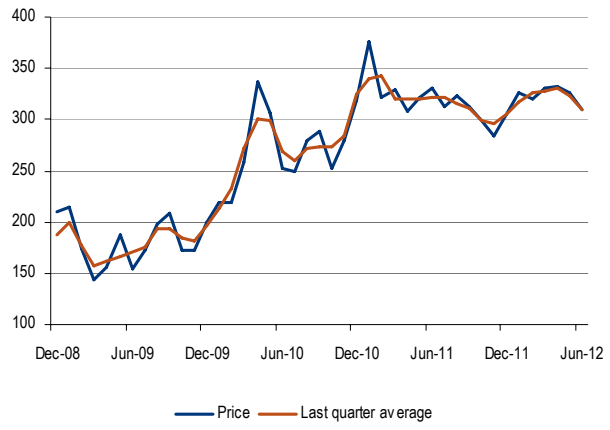
Municipal finances strained, especially developed markets

MSW is often one of the largest single budget items for cities – and the industry has thus been hit by falling municipal revenues; particularly in developed markets. For instance, in the US, 2012 marked the sixth straight year of general revenue decline (Source: Republic Services). Positively, strained municipal finances have meant privatisation and public-private partnership growth opportunities.

Exposure to fluctuating materials and energy prices

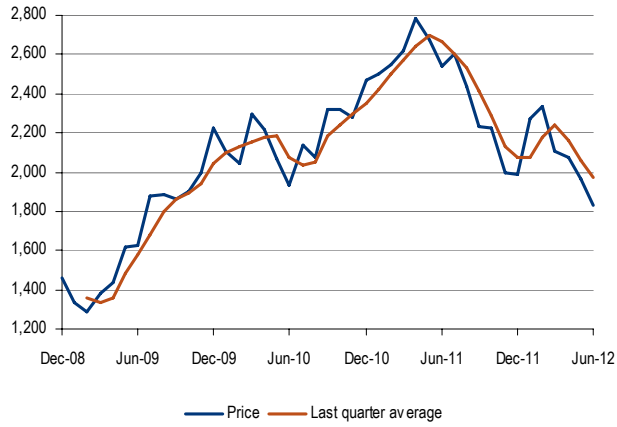
Many companies with exposure to waste management are also implicitly becoming sizeable materials and energy suppliers (e.g. via secondary raw materials recovery, waste-to-energy etc.). Increasing commodity prices are clearly an opportunity, but volatility in prices has to be managed – with some companies having a significant sensitivity of adjusted operating cash flow to recycled materials price fluctuations.

Chart 18: Commodity price evolution - Price of non ferrous metal E40



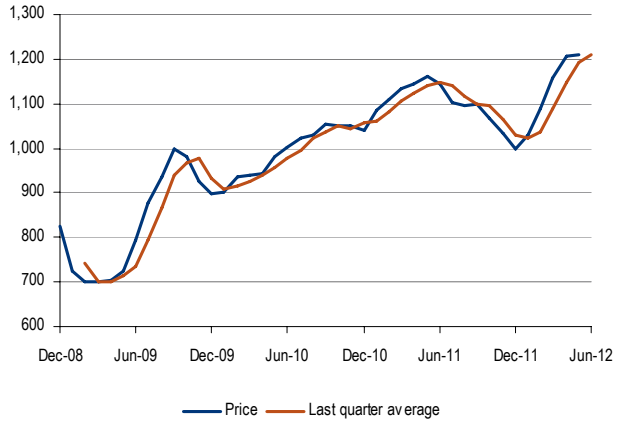
Source: UCFF, BofA Merrill Lynch Global Research

Chart 19: Commodity price evolution - Aluminium Price (raw material)



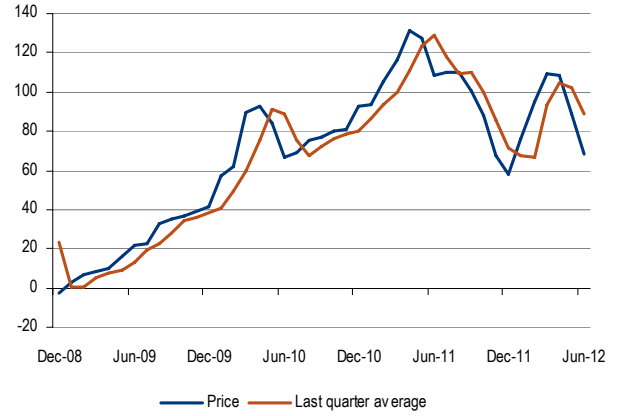
Source: Suez Environnement, BofA Merrill Lynch Global Research

Chart 20: Commodity price evolution - PVC (plastic, raw material)



Source: Suez Environnement, BofA Merrill Lynch Global Research

Chart 21: Commodity price evolution - Price of 1.02 paper



Source: Revipap, BofA Merrill Lynch Global Research

Recovery in recyclate prices remains uncertain

The business of sorting and recycling secondary raw material accounts for a significant part of many companies' waste management business. Any sustained increase in recyclate prices would be positive for EBITDA (but dilutive to margins). We believe that the Chinese economy remains an important driver of secondary raw material prices and therefore expect prices to be relatively strong, at least in 1H13, as our economists forecast that GDP and industrial growth will peak in 1H in China. Following the drop in paper and non-ferrous metal prices in 2012, we expect a modest pick-up from 2013.

Profitable landfilling business hit by legislation

Industrials and municipalities are being incentivised to rely less on landfill when treating waste volumes. Overall in Europe, landfill taxes (also on incineration) have been introduced over the past few years with a significant impact on landfill treatment's share of total waste treatment.

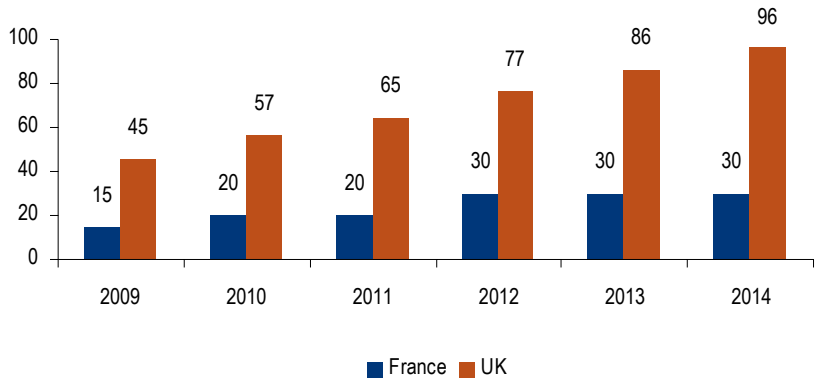
Table 8: % of Waste landfilled in Europe

	2006	2007	2008	2009	2010
EU-27	43	41	40	38	38
UK	60	57	54	50	49
France	35	34	36	32	31
Germany	9	1	1	0	0
Netherlands	2	2	1	0	0
Belgium	5	4	5	5	1
Sweden	4	4	3	1	1

Source: Eurostat

As France and the UK especially are rather late to the game compared with their European peers, both – which represent above 60% of both SEV and VIE waste sales – have implemented aggressive landfill tax policies.

Chart 22: General landfill tax, EUR/t



Source: ETC/SCP

Though this policy is having little effect on sales for now, as the landfill tax is billed by the utility and collected for the authorities, the impact on profitability is far from neutral as landfill (and incineration) activities command the highest margins in the waste value chain.

Table 9: Indicative EBIT margin along the waste value chain

Municipal collection	4-7%
C&I collection	5-9%
Industrial services and HW collection	2-8%
Sorting and Recycling	7-20%
Treatment of Hazardous waste	11-19%
Incineration O&M	5-10%
Incineration BOT	20-30%
Landfill	15-35%

Source: Company data

SEV is most exposed to the landfill business in both the UK and France as it enjoys a market leading >30% share in France of non-hazardous landfilling (it has twice as many landfill sites as second player Veolia) and is the second-largest landfill player in the UK (after FCC/WRG) with more than 80m cubic metres of landfill void capacities (close to twice the size of fifth player Veolia).

Emerging transboundary issues

Waste is shipped between countries for disposal and this can create problems in the importing country from a health, safety and environmental (HSE) perspective – as well as posing trade issues. As we shall see later in the report, e-waste is

commonly shipped to developing countries for recycling, reuse or disposal. While the Basel Convention is designed to prevent problematic waste disposal in countries that have weaker environmental protection laws, it has not prevented the formation of e-waste villages in EMs.

Working conditions & safety

Waste management remains one of the most worrying sectors from a social perspective internationally. Much of the focus is on the informal sector in EMs where child labour, occupational health and safety, social protection and freedom of association issues are not infrequent. Nevertheless, in developed markets, such as the US., trash and recyclable collecting is the fourth deadliest job there, behind only commercial fishing, logging and flying an airplane (Source: Bureau of Labor Statistics).

Need more education and incentives

Despite the ongoing increase in governmental and consumer awareness and action on waste management, further efforts are needed including:

- **public education** to inform people about their options to reduce waste generation and increase recycling and composting;
- **pricing mechanisms** (e.g., product charges) to stimulate consumer behaviour to reduce waste generation and increase recycling;
- **user charges** tied to the quantity of waste disposed of (e.g., consumers separating recyclables paying a lower fee for waste disposal); and
- **preferential procurement policies and pricing** to stimulate demand for products made with recycled post-consumer waste (Source: World Bank).

Municipal solid waste; a looming crisis & a US$400bn+ opportunity

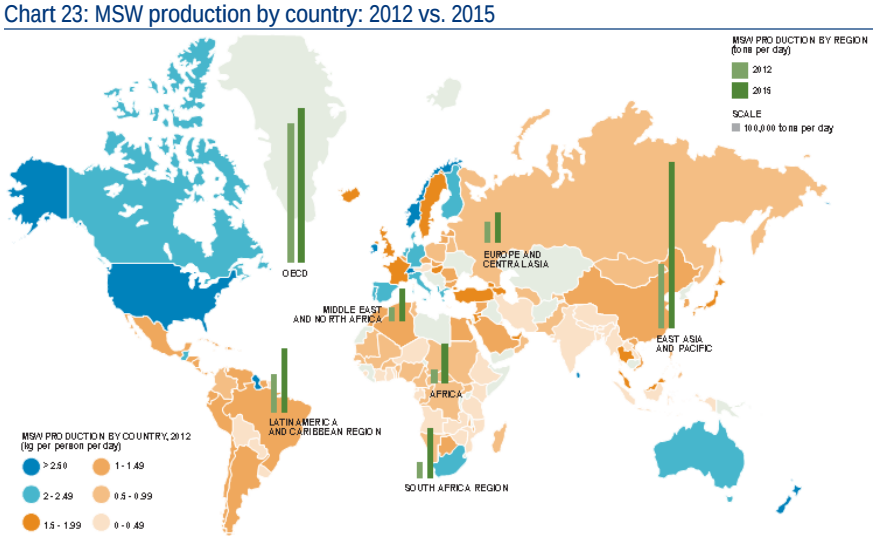
"The challenges surrounding municipal solid waste are going to be enormous, on a scale of, if not greater than, the challenges we are currently experiencing with climate change. This… should be seen as a giant wake-up call to policy makers everywhere." - Dan Hoornweg, co-author of the World Bank's "What a Waste" report

Municipal solid waste (MSW) is commonly known as trash, garbage, refuse or rubbish, and consists of everyday items that are discarded by the public and managed via formal municipal collection programmes. The world is facing a looming MSW crisis as rising income levels, particularly in EMs, mean that MSW volumes are growing faster than GDP or urbanisation rates. Ten years ago, there were 2.9bn urban residents generating 0.64kg/person/day (0.68bn tonnes pa), while today there are 3bn producing 1.2 kg (1.3bn tonnes pa) and, by 2025, this will increase to 4.3bn creating 1.42kg (2.2bn tonnes pa) (Source: World Bank)

Annual MSW management costs for cities vary from <US$2 to c.US$250 per capita pa depending on the technology. While landfill remains the preferred/cheapest option in many countries, we are seeing an increasing focus on recycling and recovery of secondary raw materials; including via WtE. The global MSW market grew 37.3% in 2007-2011 (Source: UNEP). The total annual cost of MSW is projected to rise from the current US$205bn to US$375bn by 2025, with costs increasing most sharply in low-income countries (Source: World Bank).

We anticipate two-tier growth in MSW: 1) Many developed markets, particularly in Europe, are facing structural changes in the waste business on the back of lower municipal waste volumes and the continued shift in the waste treatment mix (more recycling, less landfilling/incineration), which is having a sustained impact on profitability. 2) The EM MSW market is expanding fastest on the back of government support, a growing addressable market, solution attractiveness, market accessibility, five-year growth expectations, and profit opportunities. We see Asia and LatAm as the most attractive regions, with China and Brazil the biggest growth markets.

Chart 23: MSW production by country: 2012 vs. 2015



Source: The Economist, BofA Merrill Lynch Global Research

The US, EU and China represent 60% of global MSW

>1.9bn tonnes of MSW a year

MSW accounts for 1.7-1.9bn tonnes or c.46% of the 3.4-4.0bn tonnes of municipal and industrial waste produced every year (Source: UNEP 2010). While these figures refer to formalised MSW, largely in urban areas, the actual figures are likely to be far higher, given frequent levels of 50%+ uncollected waste in many EMs.

End goals are recycling, composting, landfilling and recovering secondary raw materials including waste-to-energy

Defining MSW & MSW management

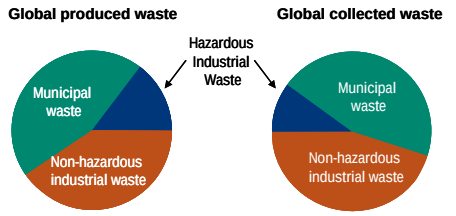
MSW is commonly known as trash, garbage, refuse or rubbish and consists of everyday items discarded by the public. The composition varies by country and according to GDP per capita but typically includes organic material, paper, plastic, glass, metals, and other refuse collected by municipal authorities, largely from homes, offices, institutions, and commercial establishments. MSW typically occurs via formal municipal collection programmes. Most definitions of MSW do not include industrial waste, construction and demolition waste, agricultural waste, medical waste, radioactive waste or sewage sludge. As for MSW management, it typically comprises the following major steps:

- **Collection** including the gathering of solid waste and recyclable materials, post-collection transport to a materials-processing facility, a transfer station or a landfill disposal site.
- **Waste handling and separation, storage and processing at the source** – i.e., to the point of collection
- **Separation and processing and transformation of solid wastes** including via curb-side collection, drop-off and buy-back centres, as well as materials-recovery facilities, transfer stations, combustion facilities and disposal sites.
- **Transfer and transport** including transfer from collection vehicle to larger transport equipment, and transport to a processing or disposal site.
- **Disposal** at engineered facilities on land without creating social or environmental risks.
- **Secondary raw materials recovery & energy generation** – see further Waste-to-Energy section.

US, EU & China - 60% of MSW

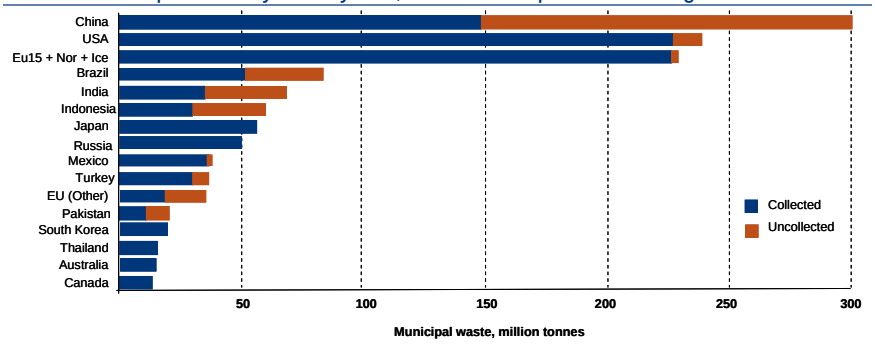
Together, the US, the EU and China account for 60% of global MSW (Source: Waste Management World). The US leads the way in terms of MSW output at some 621,000 tons per day with China a close second, at some 521,000 tons (Source: Waste Management World).

Chart 24: Municipal solid waste – produced and collected (%)



Source: Clean West Capital

Chart 25: Municipal waste by country - US, EU & China represent 60% of global MSW

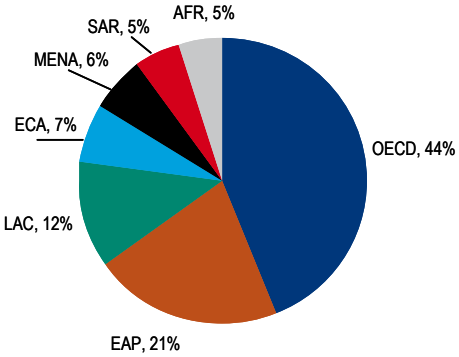


Source: Clean West Capital

Significant regional & country variations

There are significant regional and country variations, as well as within the same cities. Globally, OECD countries generate 572m tonnes of solid waste per year vs. 270m for East Asia and the Pacific Region, with China accounting for 70% of the regional data, 160m for Latin America and the Caribbean; 93m for Eastern and Central Asia; 63m for MENA; and 62m for Sub-Saharan Africa. Even in developed countries, the differences among top 10 are significant – with the US generating nearly 7x more urban refuse than France (Source: Worldwatch Institute).

Chart 26: Waste generation by region



Source: World Bank, BofA Merrill Lynch Global Research

Table 10: Waste generation by region (kg/per capita/day)

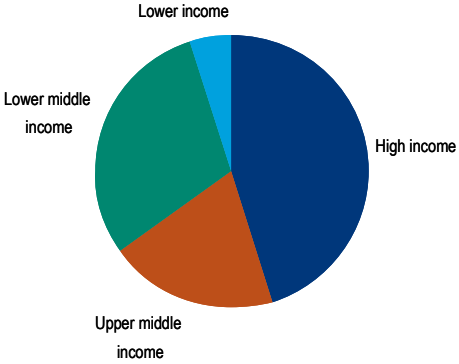
Region	Lower boundary	Upper boundary	Average
OECD	1.10	3.7	**2.2**
Eastern & Central Asia	0.29	2.1	**1.1**
LatAm & Caribbean	0.11	14	**1.1**
MENA	0.16	5.7	**1.1**
East Asia & Pacific	0.44	4.3	**0.95**
Africa	0.09	3.0	**0.65**
South Asia	0.12	5.5	**0.45**

Source: World Bank, BofA Merrill Lynch Global Research

Affluence, #1 driver for higher MSW

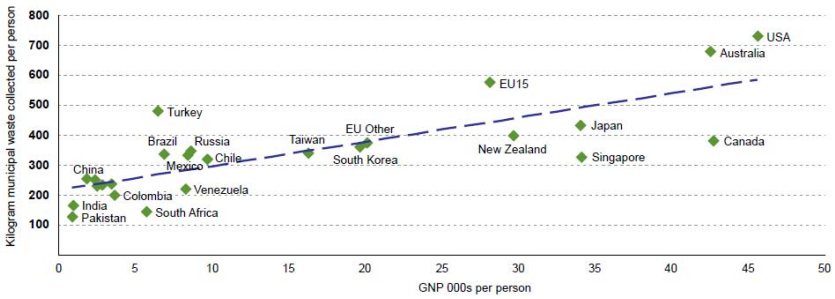
There is a strong affluence-MSW generation link with OECD countries, for example, leading the world in MSW generation at c.1.6m tons per day. In contrast, sub-Saharan Africa produces <200,000 tons per day.

Chart 27: Waste generation by income level



Source: World Bank, BofA Merrill Lynch Global Research

Chart 28: Municipal waste collected by country : greater affluence = higher levels of MSW



Source: Clean West Capital, BofA Merrill Lynch Global Research

On average, each urban resident generates 1.2kg of waste per day

On a per-capita basis, OECD nations generate the greatest quantities of MSW at >2kg per person per day. In South Asia, the rate is less than 0.5kg (Source: Worldwatch Institute).

Table 11: Current waste generation by income level (kg/per capita/day)

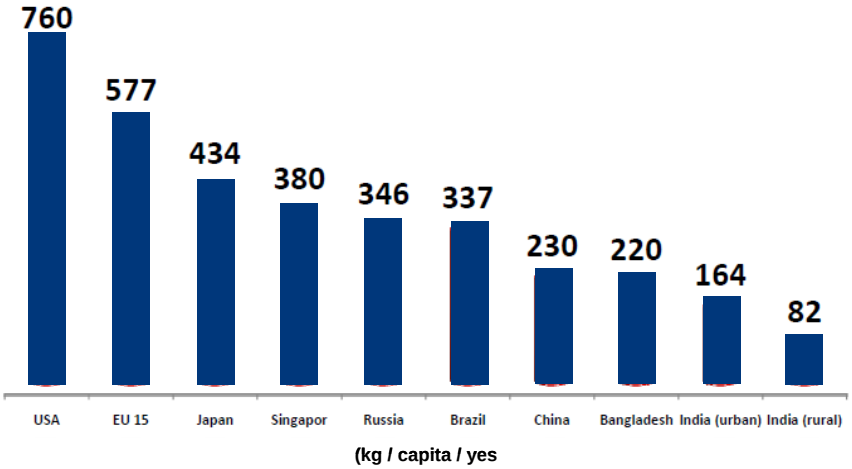
Income level	Lower boundary	Upper boundary	Average
High	0.70	14	2.1
Upper Middle	0.11	5.5	1.2
Lower Middle	0.16	5.3	0.79
Lower	0.09	4.3	0.60

Source: World Bank, BofA Merrill Lynch Global Research

Four EMs in the top 10 & catching up fast

The list of top-10 MSW-generating countries includes four EMs – China, Brazil, India, and Mexico – off the back of their large urban populations and rising levels of affluence/consumer lifestyles and ensuing waste generation.

Chart 29: Municipal waste in kg per capita per year

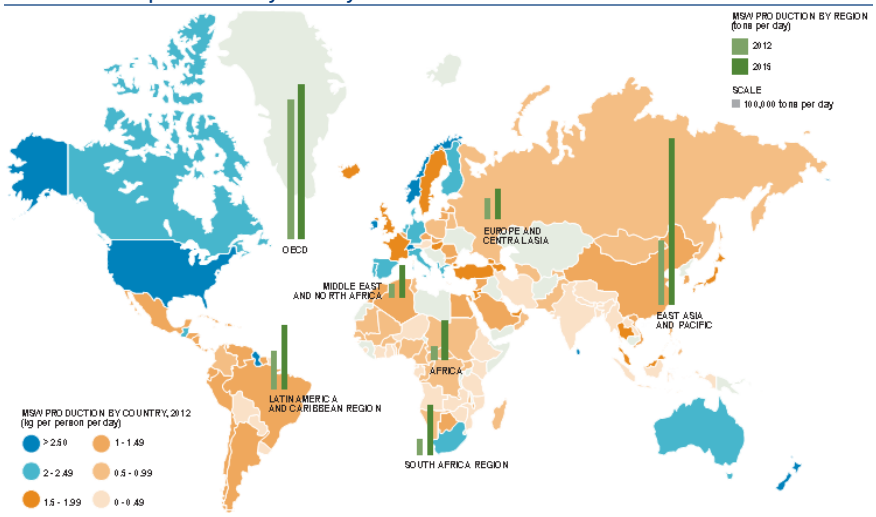


Source: World Waste survey based on Ministries of the Environment, OECD, EurostatVeolia Environmental Services estimates, CyclOpe, UN statistics, UNESCAP and the World Bank

MSW to double to c.3bn tonnes/year by 2025E

Rising prosperity and the increasing urbanisation of the world population could lead to a doubling in the volume of municipal solid waste (MSW) created annually by 2025 (Source: Worldwatch Institute).

Chart 30: MSW production by country: 2012 vs. 2015



Source: The Economist, BofA Merrill Lynch Global Research

The amount of MSW is expected to rise from current levels of 1.3-1.9bn tonnes/year to between 2.2bn and 2.6bn tonnes/year by 2025, with much of the increase coming from rapidly growing cities in EMs (Source: World Bank, Worldwatch Institute).

Table 12: Current & projected urban waste generation

		Urban waste generation (2010)		Projected population (2025)		Projected urban waste (2025)	
Region	Total urban pop. (mn)	Per capita (kg/pc/day)	Total (t/day)	Total pop. (mn)	Total urban pop. (mn)	Per capita (kg/pc/day)	Total (t/day)
Africa	260	0.65	169,119	1,152	518	0.85	441,840
East Asia & Pacific	777	0.95	738,958	2,124	1,229	1.5	1,865,379
E. & Central Asia	227	1.1	254,389	339	239	1.5	354,810
LatAm & Caribbean	399	1.1	437,545	681	466	1.6	728,392
MENA	162	1.1	173,545	379	257	1.43	369,320
OECD	729	2.2	1,566,286	1,031	842	2.1	1,742,417
South Asia	426	0.45	192,410	1,938	734	0.77	567,545
TOTAL	**2,980**	**1.2**	**3,532,252**	**7,644**	**4,285**	**1.4**	**6,069,703**

Source: World Bank, BofA Merrill Lynch Global Research

MSW costs; from US$205bn to US$375bn by 2025E

Everything has a price; it costs between US$2 and US$250 to treat a tonne of MSW

The annual cost of solid waste management is projected to rise from US$205bn currently to US$375bn, rising most sharply in low-income countries (Source: World Bank). As MSW is generally seen as an essential part of public service/critical infrastructure, the bulk of costs are borne by municipal funding, although there has been growing interest from the private sector, particularly since the downturn.

Substantial budget outlay for EMs

Dhaka spends US$ 0.9/capita pa (0.2% of GDP) on MSW management vs. Vienna which spends US$137 (0.4% of GDP) (Source UNEP)

While MSW spending as a percentage of GDP may ne similar – there are large differences between developed and EMs in terms of per-capita spending. For EMs, as much as 20-50% of recurring municipal budgets are spent on MSW, although coverage only averages 50%. In low-income EMs. Collection alone accounts for 80-90% of total waste management budgets, with labour and fuel being the largest costs. Spending on treatment, recycling, recovery and disposal remains low (Source: UNEP). That said, low and lower middle-income countries will see MSW costs increase by a factor of 4-5x to 2025E (Source: World Bank)

Table 13: Estimated Solid Waste Management Costs 2010 and 2025

Country Income Group	2010 Cost	2025 Cost
Low Income Countries	$1.5 billion	$7.7 billion
Lower Middle Income Countries	$20.1 billion	$84.1 billion
Upper Middle Income Countries	$24.5 billion	$63.5 billion
High Income Countries	$159.3 billion	$220.2 billion
Total Global Cost (US$)	$205.4 billion	$375 billion

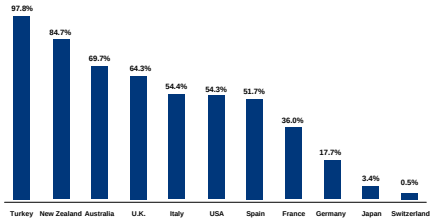
Source: World Bank

Choice of treatment methods

"Greening" the waste sector would need a 3.5x increase in MSW recycling globally (Source: UNEP)

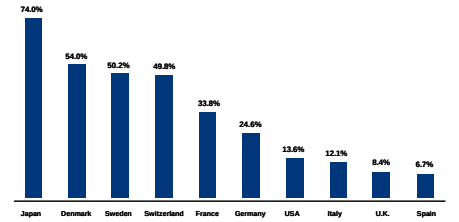
Local treatment methods for MSW are influenced by a variety of factors including cost, urban population density, waste quantity and stream characteristics, availability of space, policy/planning guidance, collection and transport issues, regulatory constraints and enforcement capacity – and stakeholder preferences.

Chart 31: Use of landfill



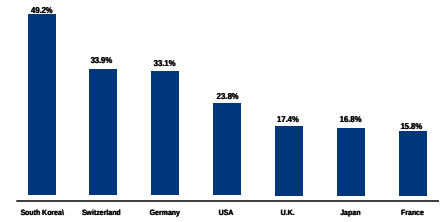
Source: World Waste survey based on OECD, BofA Merrill Lynch Global Research

Chart 32: Use of incineration



Source: World Waste survey based on OECD, BofA Merrill Lynch Global Research

Chart 33: Use of recycling



Source: World Waste survey based on OECD, BofA Merrill Lynch Global Research

In places with high population density and limited space, most waste is incinerated (e.g., Japan and northern EU), while areas with low population density and greater space use landfilling more often (e.g., Australia). For many EMs or even developed market regions with a lack of policy enforcement capacity, open landfills and incineration without energy recovery remains common practice (Source: UNEP).

Table 14: Some regional distinctions for MSW

Country / Region	Waste Management
U.S., Canada, Australia, New Zealand	-Sanitary landfilling
	-Recycling
	-Low rates of incineration, MBT, anaerobic digestion
EU	-Incineration
	-MBT
	-Recycling
	-Anaerobic digestion
	-Evolving toward limited landfilling
Japan	-Incineration
	-Recycling
	-Landfilling of residuals
EMs	-Evolving toward sanitary landfilling
	-Evolving toward controlled composting
	-Limited incineration (China), MBT, anaerobic digestion

Source: UN IPCC, BofA Merrill Lynch Global Research

A triple bottom-line cost analysis becoming key

A total cost-benefit analysis that addresses economic, environmental and social perspectives is necessary in making the right choice of management

Among MSW treatment options, there is growing global interest in recycling and recovery. This is partly based on regulators' focus on increasing command-and-control targets for better management of landfill sites and incinerators, and diversion of waste away from these facilities via the introduction of landfill fees and taxes (Source UNEP). It is also based on the growing market for secondary raw materials.

Table 15: Estimated MSW costs by disposal method

	Low Income Countries	Lower-mid income countries	Upper-mid Inc Countries	High Income Countries
Income (GNI/capita)	<$876	$876-3,465	$3,466-10,725	>$10,725
Waste generation (tonnes/capita/yr)	0.22	0.29	0.42	0.78
Collection Efficiency (percent collected)	43%	68%	85%	98%
Cost of Collection and Disposal (US$/tonne)				
Collection	20-50	30-75	40-90	85-250
Sanitary Landfill	10-30	15-40	25-65	40-100
Open Dumping	2-8	3-10	NA	NA
Composting	5-30	10-40	20-75	35-90
Waste -to-Energy Incineration	NA	40-100	60-150	70-200
Anaerobic Digestion	NA	20-80	50-100	65-150

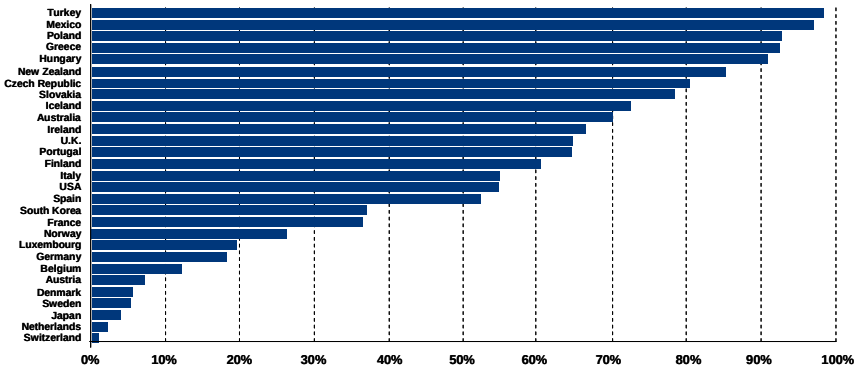
Source: World Bank, BofA Merrill Lynch Global Research

For non-hazardous MSW, the objective is to confine the waste to as small an area as possible, compact it to reduce volumes, and cover it with layers of soil

Landfill – most common method of waste treatment

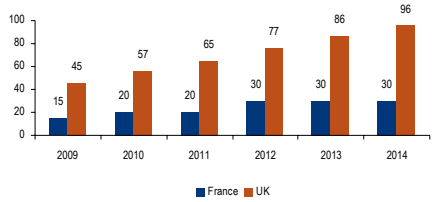
Landfill sites are for the disposal of MSW by burial and are the most common method of organised waste treatment globally. They account for upwards of 50% of MSQW treatment in the US and the UK, one-third in the EU and up to close to 100% in a number of EMs. Usage and landfill rates are contingent on waste composition, land availability and the type of soil.

Chart 34: Proportion of MSW disposd in landfill sites



Source: Clean West Capital , BofA Merrill Lynch Global Research

Chart 35: General landfill tax, €/t



Source: ETC/SCP

Profitable landfilling business hit by legislation

Industrials and municipalities are being incentivised to rely less on landfill when treating waste volumes. For instance, in Europe, landfill taxes (also on incineration) have been introduced over the past few years with a significant impact on landfill treatment's share of total waste treatment. While the US has no national landfill tax, many state and local governments collect ("tipping") fees and taxes on the collection and disposal of MSW.

Table 16: % of Waste landfilled in Europe

	2006	2007	2008	2009	2010
EU-27	43	41	40	38	38
UK	60	57	54	50	49
France	35	34	36	32	31
Germany	9	1	1	0	0
Netherlands	2	2	1	0	0
Belgium	5	4	5	5	1
Sweden	4	4	3	1	1

Source: Eurostat

Increasingly subject to public policy & stakeholder backlash

Public policy is also a key determinant with challenges posed by 'NIMBY' ('not in my backyard') backlash in local communities, as well as pollution, soil contamination, GHG and biodiversity concerns, which often make it difficult to locate new landfills. Moreover, regulators are stepping up their scrutiny; for e.g., via the EU's Landfill Directive (1999/31/EC) which imposes a tax on biodegradable waste which is put into landfills.

Opportunities from landfill, secondary raw material recovery

Landfills are widely seen as an opportunity for secondary raw materials recycling, as is evidenced by waste-picking in many EMs. They are also being targeted at the commercial level via efforts to harvest materials and energy (e.g., gas recovery, waste incinerators with built-in material recovery).

Composting – increasingly common alternative to landfill

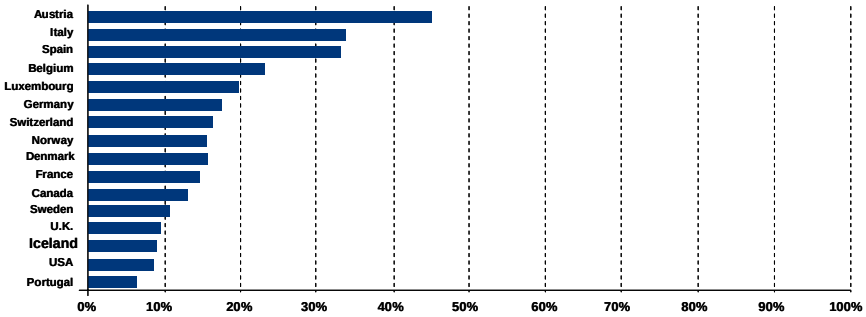
Composting involves decomposing and recycling organic waste into useful stable products, such as fertiliser and soil amendment for re-use in gardens, landscaping, agriculture etc . Its usage is more prevalent in Europe than in North America – and is as high as 10-20% in some countries (Austria, Italy, Spain, Belgium, Germany, Switzerland and Canada).

Composting is much more prevalent in the EU than in the US

Growing concern over landfilling benefits composting

Industrial scale composting – via in-vessel composting, aerated static pile composting and anaerobic digestion – and mechanical biological treatment (MBT combines mechanical sorting of mixed waste streams with anaerobic digestion or in-vessel composting) have gained traction since the mid-1980s. It is now often mandated or regulated by laws controlling the amount of organic matter allowed in landfills. Such treatment is key to reducing landfill gas, which contains methane, a powerful GHG.

Chart 36: Proportion of MSW concvberted into compost



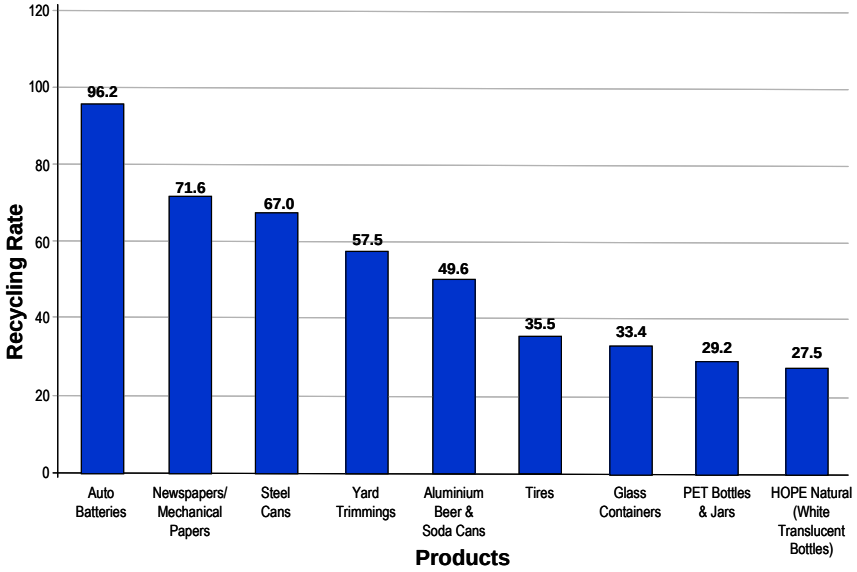
Source: Clean West Capital , BofA Merrill Lynch Global Research

Recycling

Most developed countries recycle between 10% and 33% of their waste

There has been a growing focus on recycling and recovering valuable secondary raw materials. In developed Western markets, 10-35% of the waste stream is currently recycled, with residential/commercial, metals, and organics all growing at the expense of traditional disposal alternatives, such as landfilling. As a result, per-capita waste generation in the US has fallen since 2005 and recycling has grown more than 2x faster than waste generation (Source: Republic Services). While EM figures are much lower, the informal recycling sector can be extremely efficient and improve the figures significantly – even if up to 40% of MSW in India, for instance, still goes uncollected (Source: OECD).

Chart 37: US recycling rates of selected products (2010)



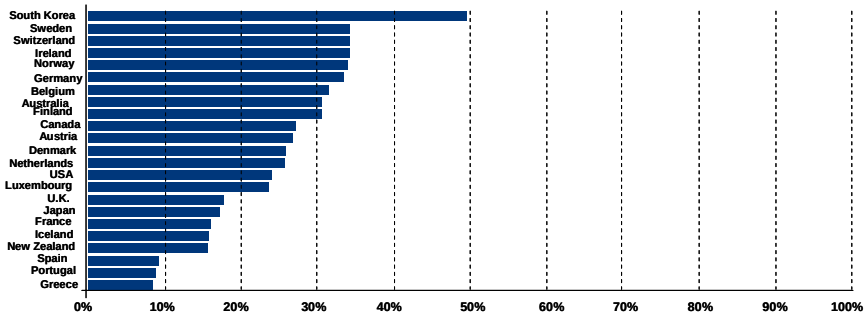
Source: US EPA, BofA Merrill Lynch Global Research. * Does not include combustion (with energy recovery).. ** Mechanical papers include directories, newspaper inserts, and some advertisement and direct mail printing

Recycling rates vary widely by country. In the United States, the recycled share of MSW grew from <10% in 1980 to 34% in 2010, and similar increases have been seen in other industrial countries (Source: Worldwatch Institute)

Considerable scope, only 25-30% of waste is recycled or recovered

Some 70% of global waste ends up in landfills. Only 25-30% of global waste is diverted to recycling, composting or digestion or recovered as materials or energy or recycled and levels are even lower for industrial waste at 7%, MSW at 10%, and e-waste at 15% (Source: UNEP). Of the 25-30% which is recovered, two-thirds is either recycled or subject to mechanical and biological treatments (MBT) like composting, while the rest is converted into energy through thermal and other waste-to-energy (WtE) systems. While there will always be some waste that cannot be prevented and will require proper handling, we need to move to a greener scenario to deal with the ballooning growth in waste; short- to medium-term global targets are to increase MSW recycling by a factor of 3.5x and double industrial waste recycling to 15% (Source: UNEP).

Chart 38: Proportion of MSW recycled



Source: Clean West Capital , BofA Merrill Lynch Global Research

Incineration

Incineration involves combusting organic substances contained in waste materials in furnaces at high temperatures, which converts waste into ash, flue, gas and heat. It is most common in countries which are short on space, such as Japan and some EU countries (Luxembourg, Netherlands, Germany and France).

Waste to energy (WtE)

Incineration with energy recovery via gasification, plasma arc gasification, pyrolysis and anaerobic digestion is gaining increasing traction – as the electricity and heat generated can be used for power plants, the district heating grid or industry. In the EU, energy generated from biogenic waste is considered as non-fossil renewable energy (see WtE focus below).

Stakeholder concerns

The safe limit for human oral consumption of dioxins and furans is 17 billionths of a gram for a 68kg (150lb) person per year (Source: US EPA)

There remains significant stakeholder concern over the environmental and human health impact of incinerators – including pollution from flue gas, dioxin and furan emissions, CO2 emissions (incineration of 1 ton of MSW produces approximately 1 ton of CO2). Improvements in emissions controls and a ramping up of regulations have, however, significantly lessened these risks – and the potential impact on health of modern, well-managed incinerators is "small and not detectable" (Source: UK Health Protection Agency).

Table 17: Estimated MSW costs by disposal method

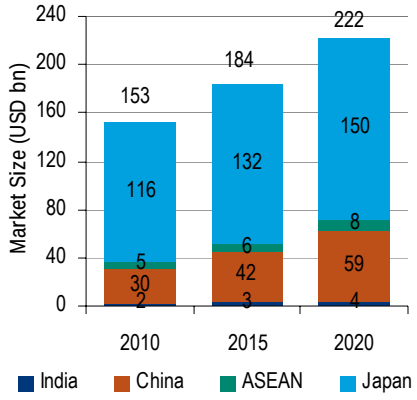
	Low Income Countries	Lower-mid income countries	Upper-mid Inc Countries	High Income Countries
Income (GNI/capita)	<$876	$876-3,465	$3,466-10,725	>$10,725
Waste generation (tonnes/capita/yr)	0.22	0.29	0.42	0.78
Collection Efficiency (percent collected)	43%	68%	85%	98%
Cost of Collection and Disposal (US$/tonne)				
Collection	20-50	30-75	40-90	85-250
Sanitary Landfill	10-30	15-40	25-65	40-100
Open Dumping	2-8	3-10	NA	NA
Composting	5-30	10-40	20-75	35-90
Waste -to-Energy Incineration	NA	40-100	60-150	70-200
Anaerobic Digestion	NA	20-80	50-100	65-150

Source: World Bank, BofA Merrill Lynch Global Research

Attractiveness of key MSW markets

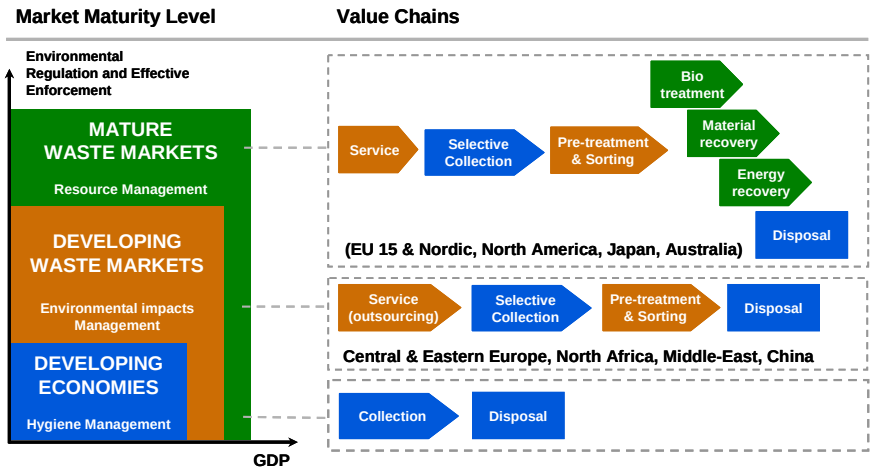
The growing interest in MSW recovery is driven by increasing and maturing regulations and of the growing market for secondary raw materials recovery. The US$400bn industry is set to grow in the coming decade with the biggest investments being made in waste to energy and mechanical and biological treatment. Over the next decade, it is estimated that US$87bn in investments will be made in the global MSW sector (Source: Symmetry).

Chart 39: Asian MSW market to 2020



Source: MEC Intelligence Analysis

Chart 40: Waste market maturity level and evolution of value chains



Source: Suez, BofA Merrill Lynch Global Research

North America, Europe and Japan are the key mature markets in terms of MSW. However, growth in these markets, particularly Europe, has been lowed by the downturn. Going forward, in terms of government support, addressable market, solution, attractiveness, market accessibility, profitability, and 5Y market growth potential – we see the greatest growth potential coming from emerging Asia and Latin America.

Table 18: Attractiveness of MSW markets

Assessment Criteria	Attractiveness						Explanation
	Africa	Asia	Australia	Europe	North America	South America	
Government Support	○	◐	○	◔	◐	◔	• European Union has a strong focus on managing solid waste and environment under the EU directive to regulate the sector • The US policy for waste management is primarily driven by the states • The high income Asian markets have strong government policy support on reducing and managing the amount of waste generation in the sector which is lacking in the low income countries • Majority of South American markets do not have a policy focus on the management of solid waste
Addressable Market	○	●	○	◔	◔	◔	• Asia has the highest market owing to the strong expenditure in Japan, Korea and China • The Market in Europe is also mature with high expenditure in addition to the investments in the Eastern European countries • The North American market primarily comprises of the US market • The South American market is emerging with increasing policy awareness and support
Solution Attractiveness	○	◔	○	●	◔	◐	• Waste management through advanced technologies has become a mainstream solution in most of the Europe while it is in the process of being adopted increasingly in Asia and North America • The Waste Management Technologies in South America are emerging
Five Year Market Growth Potential	○	◐	○	◔	◔	◐	• Growth potential is highest in the Latin American and Asian Economies which will grow close to 10% over the coming years due to the early stage of the market in emerging economies of the regions • The markets in Europe and North America are mature. However, Eastern European Markets will grow close to 10%
Market Accessibility	○	◔	○	●	●	◐	• The participation of the private sector is restricted through laws in the Asian and South American markets
Profit Opportunity	○	◐	○	◔	◔	◐	• Due to the emerging nature of the market the Asia, Eastern Europe, and South American markets represent superior profitable opportunities for payers as they develop the market

t

Source: THE GLOBAL CLEANTECH REPORT 2012, Sliding scale: Full circle = highest priority, very large, advantaged, very rapid, fully open, superior vs. empty circle = no priority, niche, unavailable, very slow, restricted, challenging

Emerging markets – exciting opportunities

Brazil – still bullish on the US$180bn opportunity

For further information on Brazilian water & sewage, see the ongoing work of Diego Moreno & team

LatAm Water Utilities, 01 February 2013

The Brazilian sanitation sector requires substantial investment. With dismal coverage levels (81% in water, 46% in sewage collection and 38% in sewage treatment), Brazil requires investments of R$288bn (US$180bn) to reach 100% coverage, especially on sewage. At the current rate of investment, this would take 60 years to achieve. In addition, the loss levels of the water utilities in Brazil are very high versus the world average (37.4% in Brazil versus 13% on average for the world).

Main features of new Sanitation Law:

- All sanitation companies in Brazil must have a tariff regime established and regulated by a regulatory agency (state or municipal)

- Companies must have concession contracts for all cities where they provide services – different from electricity, water and sewage concession belong to municipalities, or to the state in metropolitan region

- New regulatory framework must be implemented by the end of 2014 (originally it was 2010, it was postponed to 2012 and now it is 2014; we would not discount further postponements)

- All cities in Brazil must target a date to implement universal water and sewage services until 2014; otherwise they will not have access to federal subsidise funds

New sanitation law is a game changer

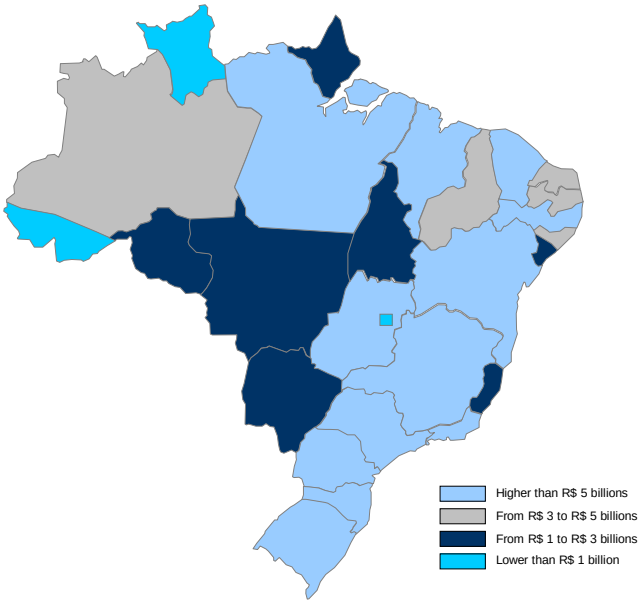
The new sanitation law approved in 2007 requires all sanitation companies in Brazil to have a tariff regime established and regulated by a regulatory agency (state or municipal) by the end of 2012. A regulatory framework that adequately remunerates investments should provide the key missing element to attract private investment. We expect this to take place via partnerships with state-owned companies or privatisations over the long term as most of the state-owned companies do not have the necessary investment capacity to fulfil expansion requirements. This would be similar to what occurred in the electricity, telecom, gas distribution and toll road sectors (and what is currently being planned for airports).

New tariff will align shareholders & stakeholders interests

The new regulatory framework will align minority, political and company interests as the proposed tariff methodology would be ROA-based, whereby regulators will establish a regulatory asset base (RAB) that will be remunerated by a regulatory WACC, similar to Brazilian electricity distribution regulation. Thus, EBITDA will start to grow cycle by cycle as capex will be incorporated into the RAB. Given its magnitude it will offset the probable WACC reduction over cycles.

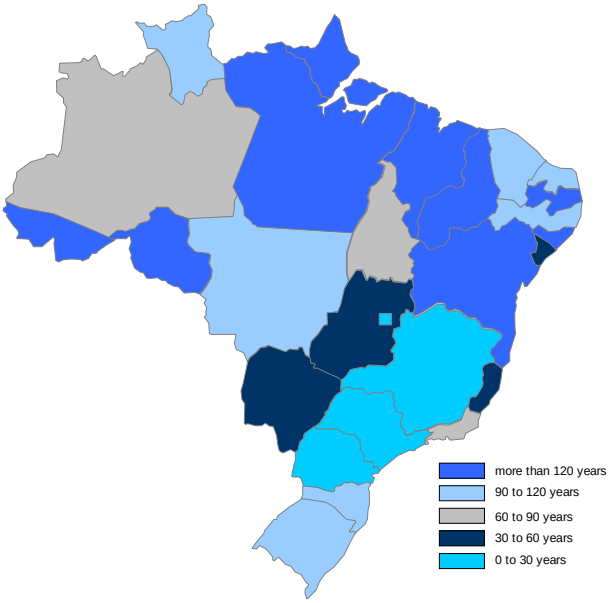
With greater regulatory visibility, we believe the Brazilian water sector is entering a new era as: (1) capex will start to be remunerated, strengthening state-owned companies' balance sheets and bringing a growth component to the investment cases, and (2) the solid and consistent regulations will attract private players to the sector.

Figure 1: Annual investment needs to achieve universal coverage



Source: BofA Merrill Lynch Global Research, Instituto Trata Brasil

Figure 2: Estimated time to achieve universal coverage



Source: BofA Merrill Lynch Global Research, Instituto Trata Brasil

For further information on Chinese water & sewage, see the ongoing work of Xiao Bing Wang & Angello Chan

China Everbright International, 28 September 2012, Investing in China's Water Sector, 11 October 2012

China – waste a big beneficiary of 5YP

With the largest population and one of the fastest-growing economies in the world, China's demand for wastewater treatment and sewage collection and treatment is intense and municipal waste output has grown over the over the past 30 years, from 31m tonnes in 1980 to over 210m tonnes in 2010, the largest figure of any country in the world (Source: Norton Rose Group). By 2030, China is expected to produce 2x as much waste as the US (Source: World Bank). To cope with this, the Chinese government has launched a number of initiatives to reform the severely under-resourced waste and water sector. Companies that stand to benefit from this deregulation process present an interesting investment opportunity, in our view.

Under the 12th Five-Year Plan, China aims to raise WWT, solid waste treatment capacities at CAGRs of 11% and 13.8%, respectively

12th FYP environmental policy beneficiary

We believe China is providing supportive policies for the environmental protection industry in the form of tariffs and subsidies and that the environmental protection targets of the 12 FYP will be maintained. The FYP is looking to move away from landfill, which accounts for c.80% of waste, towards greater recycling, a target of comprehensive utilisation for industrial solid waste of 72%, specialised waste management infrastructure, and waste to energy.

11-14% CAGR for WWT and solid waste per year

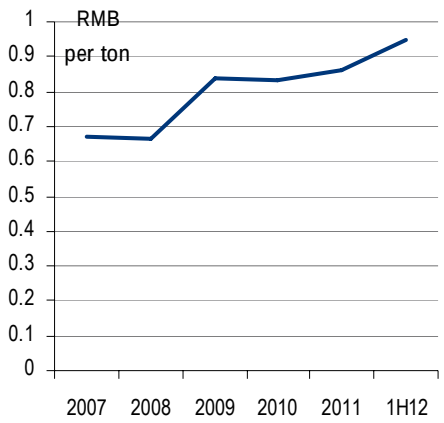
Under the 12th Five-Year Plan, China aims to raise WWT, solid waste treatment capacities at CAGRs of 11% and 13.8%, respectively. We believe local governments will conduct WWT and WTE treatment tariff reviews every 2-3 years. It is also raising grid power tariffs for power generated from waste from WTE operators. Local governments' finances are healthy, especially in regions with dense populations and high waste needs, such as Jiangsu, Zhejiang, Guangdong and Shandong. This should make the government(s) more tolerant of higher treatment tariffs (without delays or defaults).

Table 19: 12th FYP for solid waste treatment solutions in areas where CEI has projects

	2010 actual						2015 target					
	Capacity (ton/day)			%			Capacity (ton/day)			%		
Region	Landfill	Incineration	Others	Landfill	Incineration	Others	Landfill	Incineration	Others	Landfill	Incineration	Others
National Average	352,038	89,625	15,254	77	20	3	513,748	307,155	50,588	59	35	6
Jiangsu	24,168	15,192	-	61	39	-	26,598	31,242	1,000	45	53	2
Zhejiang	22,062	18,535	755	53	45	2	22,614	37,085	755	38	61	1
Shandong	31,835	8,580	1,302	76	21	3	38,283	31,280	5,552	51	42	7
Guangdong	22,373	11,743	-	66	34	-	33,043	41,493	-	44	56	-

Source: NDRC, BofA Merrill Lynch Global Research estimates

Chart 41: CEI's average WWT tariff

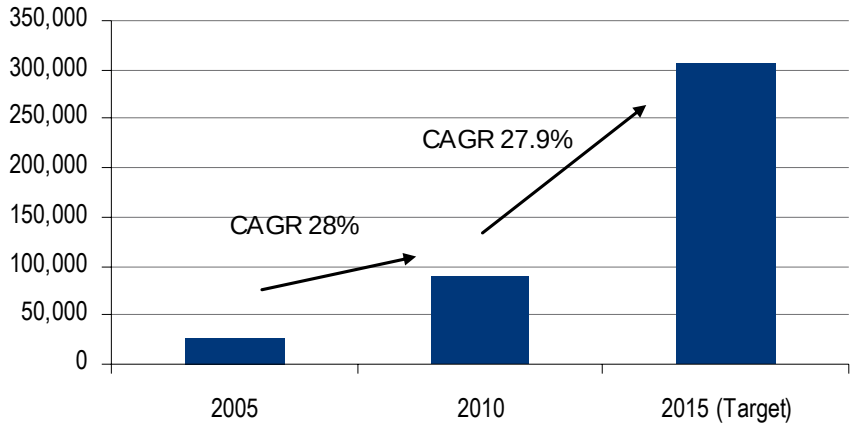


Source: BofA Merrill Lynch Global Research

28%+ CAGR growth for waste to energy (WtE)

China is on course to register a CAGR of 28% in waste-energy (WTE) project capacity during the 12th FYP, with some companies, such as CEI, anticipating a CAGR in capacity of as high as 45.6%. According to China's 12th FYP for solid waste treatment published on 19 April 2012, the proportion of WTE projects to total solid waste treatment in Jiangsu, Zhejiang, Guangdong and Shandong provinces will rise from 21-45% at end-2010 to 42-61% by end-2015, vs the corresponding national averages of 20% and 35%. CEI's WTE business has a higher IRR (10-15%) than its wastewater treatment (WWT) business (IRR: 10-12%).

Chart 42: National WTE capacity addition (tons/day)

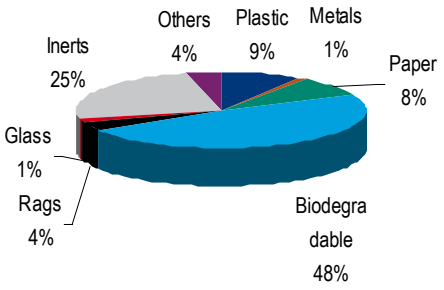


Source: BofA Merrill Lynch Global Research

India – a low starting point but some signs of movement

India is facing a growing MSW challenge with per-capita waste generation increasing by 1-1.3% pa, while the urban population is growing by 3.0-3.5% pa and yearly waste generation is rising by 5.0% (Source: Ministry of New and Renewable Energy, UN). While the biodegradable portion dominates the bulk of MSW, rising urbanisation and changes in lifestyle and food habits mean increasing volumes and complexity of waste streams. Over 160,000 metric tons of MSW is produced annually – which is expected to grow to 260m tons by 2047E (Source: European Business and Technology Centre). It is estimated that if the waste is not treated in a more systematic manner, more than 1,400km² of land would be required by 2047 for its disposal (Source: European Business and Technology Centre). As a result, we are seeing growing signs of tackling MSW, with the market expected to post a 7% CAGR from 2011-15E (Source: Research and Markets).

Chart 43: Composition of MSW in India



Source: National Solid Waste Association of India

Need to shift focus from collection to treatment & disposal

Indian municipal agencies spend 5-25% of their budget on MSW (Source: National Solid Waste Association of India). 60-70% of this is on collection alone and 20-30% on transportation – meaning that hardly any funding is devoted to treatment and disposal. This frequently results in crude dumping in most cities.

Table 20: Finance Commission MSW funding

Segment	Amount (INR mn)
Collection & transportation	3,864
Compost plants	10,012
Development of sanitary landfills	10,569
Total	24,445

Source: The National Environmental Engineering Research Institute (NEERI)

Stepping up investment from a low level

The Indian Government is focusing more on MSW and the Finance Commission has earmarked INR 25,000mn (US$582mn). The most significant initiative has been the move by the Ministry of Development to set up the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) with its promise of INR12,500mn (US$291mn) to 63 cities.

2009-13E CAGR of 9.7% in WtE

WtE in India is expected to post a 2009-13 CAGR of 9.7%, (Frost and Sullivan). The Ministry of New and Renewable Energy (MNRE) estimates that MSW and sewage offer the potential to generate 1,700MW of power, although the technology is nascent and generation stood at only 100MW in January 2013. However, in the 2013 financial budget, the Indian government said explicitly that it will support municipalities implementing WtE projects through different means, such as viability gap funding, repayable grants and low-cost capital.

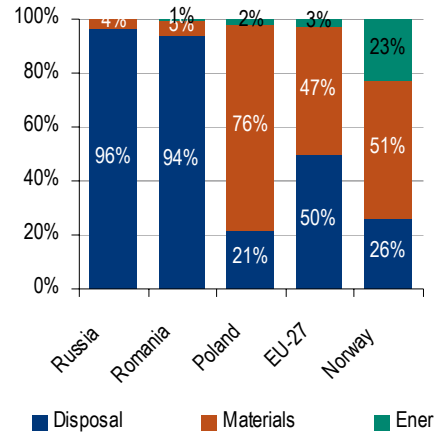
Russia - €40bn required to improve low recovery levels

The volume of MSW in Russia has been increasing steadily in recent years. In 2010, MSW generated per capita was more than 330kg pa. By 2025, MSW generation should reach 450kg to 500kg per capita pa, bringing it close to current EU levels. At present, the level of waste recovery is very low with around 95% of all MSW sent for disposal (Source: IFC).

Need to move away from landfilling

The overwhelming majority of MSW (some 32bn metric tons) is landfilled – partly the result of inadequate legislation and lenient enforcement. Other factors include the lack of a national waste management strategy, inadequate and obsolete infrastructure, and low levels of stakeholder awareness. The remaining capacity of landfills is estimated to be 30-35%, meaning that Russia will need to double capacity to accommodate growing volumes of waste by 2025E. Worryingly, the high dependence on landfilling means Russia is the world's third-largest methane emitter (Source: International Finance Corporation).

Chart 44: Waste recovery: Russia vs. EU



Source: EBRD

Increasing waste service tariffs

Waste service tariffs are increasing, driving market revenues every year. In 2009, tariffs rose by approximately 10%, directly affecting revenues for incumbent market participants. Heightened government and public awareness, coupled with initiatives and programmes attracting Russian and international investors, could create opportunities in this market.

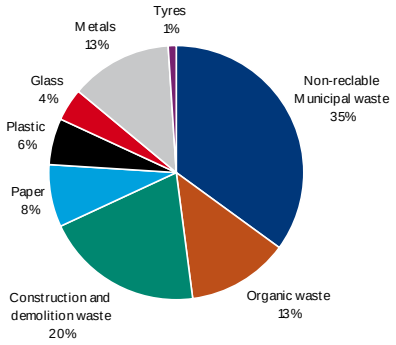
Significant potential for WtE

If Russia optimises its MSW management policy and implements modern technologies, it has the potential to recover up to 45% of waste by 2025E – notably via WtE. This would require investing up to €40bn but could generate an additional €2bn in revenues from recoverable materials (Source: IFC).

South Africa - only 10% of MSW recycled

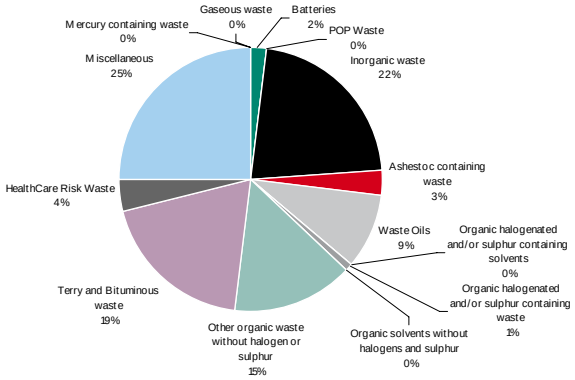
South Africa generated approximately 108m tonnes of waste in 2011, of which 98m were disposed of at landfill. Only 10% of waste was recycled (Source: Department of External Affairs (SA)). The biggest challenge facing South African MSW is the move away from landfilling – its relatively low cost renders alternative technologies and practices financially unsustainable (e.g., recycling). This will require significant capacity building in full-cost accounting of waste management at municipality level (Source: UNEP)

Chart 45: General waste 2011 – South Africa



Source: Department of External Affairs(Republic of South Africa), BofA Merrill Lynch Global Research

Chart 46: Unclassified Waste 2011 – South Africa



Source: Department of External Affairs(Republic of South Africa), BofA Merrill Lynch Global Research

Becoming a focus for government

South Africa has developed more extensive waste policy and regulatory frameworks for MSW in recent years. For instance, it has set a national target to reduce by 70% the amount of 'Big Five' waste products (plastics, cans, paper, glass and tyres) going to landfills by 2022, and has plans in place to minimise and treat the remaining 30%. Along with this goal, the National Waste Management Bill is designed to ensure that waste management is approached in an integrated way – from the point of generation to final disposal. The key challenge is policy/regulation implementation and enforcement.

Table 21: MSW goals set by South African National Waste Management Strategy (NWMS)

Goal	Targets (2016)
Promote waste minimisation, re-use, recycling and recovery of waste.	25% of recyclables diverted from landfill sites for re-use, recycling or recovery. All metros, municipalities, 2ndary cities & large towns have initiated separation–at-source programmes Achievement of waste reduction and recycling targets set in IndWMPs for paper and packaging, -pesticides, lighting (CFLs) and tyres industries.
Ensure the effective and efficient delivery of waste services.	95% of urban households & 75% of rural have access to adequate levels of waste collection service 80% of waste disposal sites have permits.
Grow the contribution of the waste sector to the green economy.	69,000 new jobs created in the waste sector. 2,600 additional SMEs and cooperatives participating in waste service delivery and recycling.
Ensure that people are aware of the impact of waste on their health, well-being and the environment.	80% of municipalities running local awareness campaigns. 80% of schools implementing waste awareness programmes.
Achieve integrated waste management planning.	All municipalities have integrated their IWMPs with their IDPs, and have met the targets set in IWMPs. All waste management facilities required to report to SAWIS have waste quantification systems that report information to WIS.
Ensure sound budgeting and financial management for waste services.	All municipalities providing waste services have conducted full-cost accounting for waste services and have implemented cost reflective tariffs
Provide measures to remediate contaminated land.	Assessment complete for 80% of sites reported to the contaminated land register. Remediation plans approved for 50% of confirmed contaminated sites.
Establish effective compliance with and enforcement of the Waste Act.	50% increase in the number of successful enforcement actions against non-compliant activities. 800 EMIs appointed in the three spheres of government to enforce the Waste Act.

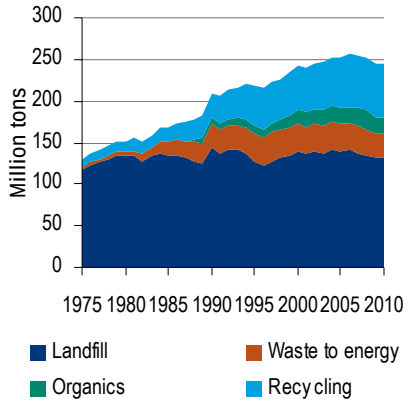
Source: National Waste Management Strategy (South Africa)

Developed markets – downturn slowing growth

USA, US$55-85bn market

The US solid waste industry grew 2% in 2011 to US$55bn in sales (Source: Environmental Business Journal). The entire waste management industry may be as large as US$85bn (Source: Research and Markets). Municipalities represent 23% of the fragmented solid waste management market, with anywhere up to 18,000 companies participating (Source: Environmental Business Journal, Research and Markets). This is equally split between publicly traded companies on the one hand and private companies and municipalities on the other.

Chart 47: The evolving ton of U.S. waste



Source: Repiublic Services, BofA Merrill Lynch Global Research

Despite increased harvesting, actual waste expressed in pounds per person will increase

- **Waste Management and Republic Services are leaders,** accounting for c.40% of market share (Source: Environmental Business Journal). Up to US$70bn of the Nam industry is concentrated among the top-four players (Source; Progressive Waste). Further consolidation opportunities may exist.
- **Solid waste is a commodity business** where the lowest price provider wins, customers have a basic level of service expectation, scale matters locally, and market share is determined by route density. Success tends to be driven by a combination of market selection (customer density, asset mix), asset and contractual positioning, and execution at the local level.
- **Per-capita waste volumes continue to grow:** despite increased recycling, composting and recovery, the waste stream (lb/person/year) is expected to increase.
- **Material recovery growth driven by recycling & recovery.** While waste collection continues to be the largest revenue generator off the back of volumes and labour and fuel costs, the focus for returns will be adopting recycling and material recovery revenue streams.

Table 22: U.S. waste volumes expected to grow

Item (US$bn)	2010	2015	2020	CAGR 2010-15
GDP	14,650	18,400	23,400	4.7%
Waste collection	47.7	58.5	71.3	4.1%
Waste treatment & disposal	16.6	19.2	22.0	3.0%
Material recovery & other	3.3	4.7	6.4	7.3%

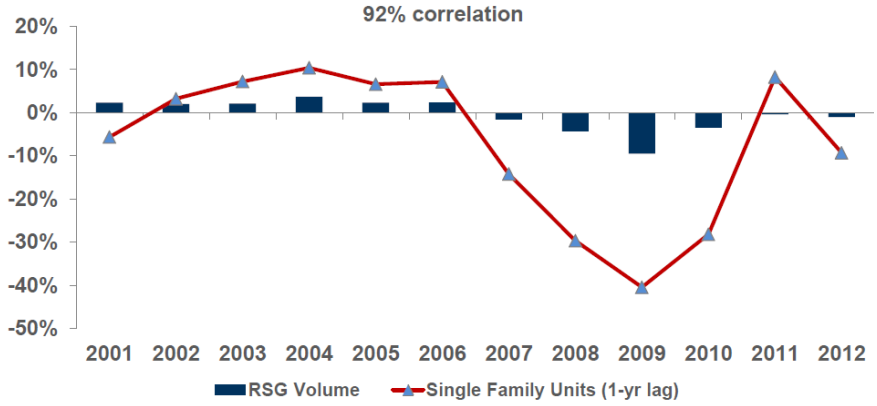
Source: Progressive Waste Solutions

- **Late-cycle performer.** The industry is typically late cycle (i.e., recession resistant with operating leverage to recovery due to high fixed cost infrastructure, slow to reflect economic recovery because the basis of its revenue stream: waste reflects consumption and construction & demolition). But while pricing remains under pressure because of municipal budgets, volumes are holding or growing.
- **Essential service with multi-year contracts**. Up to 80%+ of revenues are contracted with a length of three years or more. Contracts also typically have inflation escalators. Approximately 50% of service revenues include contractual-based pricing restrictions – the remaining 50% are open market where prices increase annually (Source: Republic Services). Industry believes that the core price hit the trough in the first half of 2012 (Source: Republic Services). As for volumes, they are driven by population growth, household formation and new business formation (se below). The leading actors in the sector have a churn rate for commercial and industrial customers of 10% and the typical customer stays for 10 years on average with municipal customers averaging 12 years (Source: Waste Management).

Table 23: Core price trend for Republic Services

Source: Republic Services

Table 24: % change Republic Services volumes vs. single family units



Source: Republic Services based on US Census Bureau and Department of Housing and Urban Development

Table 25: Waste Management's minimum internal rate of return by business type

Business	%
Collection & landfill	12%
Recycling	15%
Waste-to-energy	11%

Source: Waste Management

- **The "evolving ton": focus on extracting value from waste.** Industry growth is driven by price and volume improvements. The percentage of solid waste ending up in landfill fell to 54% in 2010 (vs. 94% in 1960) (Source: EBJ). Going forward, there will be an increasing move away from landfill as capacity is reached and in favour of investments that optimise the value of the waste stream such as waste diversion, recycling and generation of resources and energy from organic and inorganic waste (e.g. gasification, plasma arc gasification, hydrolysis, pyrolysis, and anaerobic digestion et. al.)

Table 26: Nam MSW generation, recovery & disposal

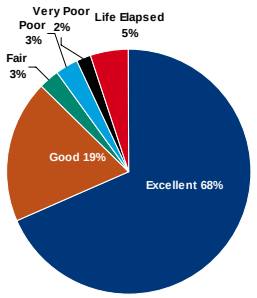
Item (Mn tons)	2010	2015	2020
Population (mn)	309.1	324.3	340.1
Pounds/capita	1,643	1,696	1,735
MSW generated	254.0	275.0	295.0
Landfill disposal	136.0	144.0	151.0
Recycling	65.0	74.0	83.5
Composting	24.0	29.5	35.5
Combustion & incineration	29.0	27.5	25.0
Pounds/person per day	4.50	4.65	4.75

Source: Progressive Waste

Ageing pipes lead to discharge of c900bn gallons of untreated sewage every year (Source: AWK)

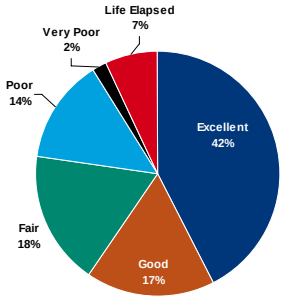
- **Ageing wastewater & sewage infrastructure**. The US's ageing water systems have been under-funded for many years and require substantial investment – as much as U$S1tn over the next 25 years (Source: American Water Works Association). The American Society of Civil Engineers currently ranks both the nation's drinking water and wastewater infrastructure as D-. Without renewal or replacement, 44% of pipes will be classified as poor, very poor or life elapsed by 2020.

Chart 48: Percentage of water pipes in the US by classification (1980)



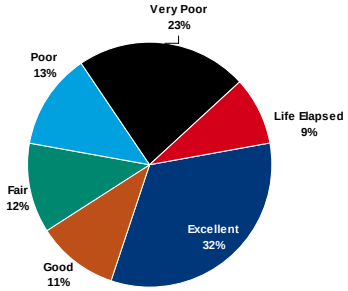
Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

Chart 49: Percentage of water pipes in the US by classification (2000)



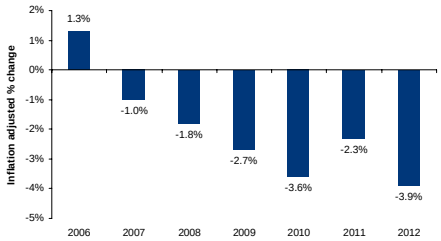
Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

Chart 50: Percentage of water pipes in the US by classification (2020)



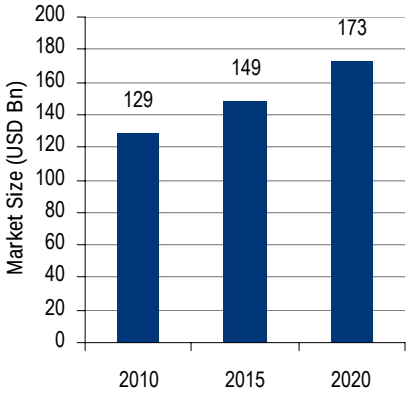
Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

Chart 51: General funds of U.S. municipalities



Source: Repiublic Services based on National League of Cities 'City Fiscal Conditions in 2012' survey

Chart 52: EU MSW market size



Source: MEC Intelligence Analysis

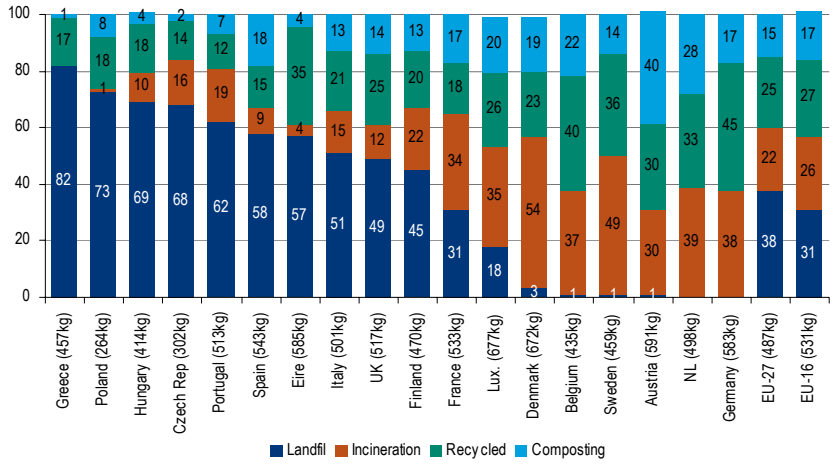
- **Cash-strapped municipalities looking to private sector.** Positively, there are growing signs that municipalities are willing to contract with the private sector on the back of financial constraints and insufficient public funding – neither of which looks likely to improve in the near term. Weakened municipal fiscal conditions should provide for municipal privatisation opportunities and public-private growth opportunities.

- **Growing focus on energy efficiency.** Measures include CNG fleet conversion (lower fuel costs, conversion of folder trucks), fleet automation (converting routes to increase productivity) and standardising maintenance practices (extend vehicle lives), among others.

EU, under structural pressure

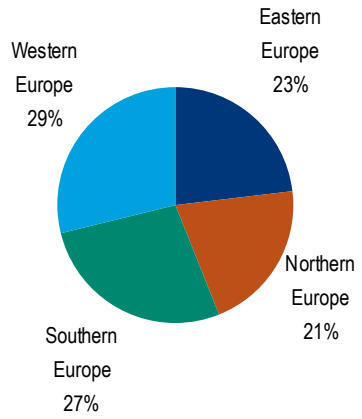
While the EU does not generate as much waste as the U.S., the average European consumes about 50 tonnes of resources a year, around 3x the amount consumed per capita by EMs, and disposes of 2x as much as EM citizens (Source: Wuppertal Institute). The EU has been at the forefront of reducing landfill and incineration and promoting recycling and recovery – and the Waste Framework Directive targets a 50% rate of recycling on average in the EU – with some member states already having exceeded the target.

Chart 53: Municipal waste treatment mix in Europe (% and waste per capita)



Source: Suez Environnemenbt based on Eurostat (2010 data updated in April 2012)

Chart 54: Split of Investment Requirements in Europe



Source: Investing In Resources & Waste Management: Policy Context & Challenges, UNCRD, 2011

Cross Reference

French Utilities: Water & Waste, 10 January 2013

Britain's waste and recycling sector was valued at over £12bn in 2010-11, employing between 104,000-150,000 people (Source; Environment Minister Richard Benyon to Parliament, 11 December 2012)

US$70bn MSW market growing at 1-2% CAGR

The market size for EU waste management and recycling market was estimated at $125 billion in 2009 – out of this the market for MSW was estimated at $70bn growing at a CAGR of 1%-2% annually largely driven by environment regulations. While waste has been strictly regulated by the EU for many years, local characteristics still dominate in waste management. That said, MSW management is well developed across northern, western and most of southern Europe. The key markets in Europe are France, the UK, Germany, and Italy. The fastest growing markets are in Eastern Europe. Given the well advanced nature of the industry, EU companies account for nearly 50% of the market share of waste management and recycling equipment technologies.

France, structural pressure

Local authorities' contracts are typically for 3-7 years for collection and 20-30 years for treatment. With industrial operators, contracts are generally shorter (2-7 years). There is a tender process with a public authority. Renewal should be less of an issue than for water mainly because contracts are less controversial and less profitable. Another reason is that there was no perpetual or *quasi* perpetual contract still running in the waste business as is the case in French water.

Contrary to the German market for instance, the French one is significantly concentrated as SEV and VIE have done some M&A buying of small recycling operators. Regulatory requirements have also lead some small family driven businesses to close. The continuous needs for investments in recycling and sorting facilities and the more sophisticated way of collecting waste should further enable dominant players to gain market share in the long term.

There is a correlation between GDP and industrial production although not perfect especially as countries' GDP profiles have changed over the years. Yet, we indentify two counter running trends: the consumption/production of waste per capita is decreasing while the treatment mix is changing favouring recycling over landfilling and thus hitting profitability.

The dismantling of nuclear reactors and the storage needs of radioactive waste fuel should offer opportunities in the long term. In France alone, the total market could be worth €32bn over the long term.

UK, moving to recycling & waste to energy

The UK waste market is evolving from previously being dependent on landfill to now becoming more reliant on recycling and energy from waste. While UK still lags behind the rest of Europe on this evolution, UK government policies (which are largely driven by EU regulations) are aimed at facilitating this change. Waste is generated from usual streams such as municipal waste, industrial/commercial and mining/construction. The waste is handled largely by private companies, either via long term contracts with local councils in the case of municipal waste or shorter term contracts with other waste generators (such as industries and commercial enterprises). The UK waste market is fragmented with some large players (Veolia, Suez Environnement, Pennon), some medium sized companies (Biffa, WRG, Shanks, Cory) and numerous smaller players.

The main regulatory support for the shift away from landfill is the landfill tax which currently stands at £64/t and is set to rise to £80/t by 2014/15. UK followed the example of other countries such as Belgium and Netherlands (these two countries are well ahead in terms of landfill diversion and recycling). The landfill tax also acts as a support for recycling and energy from waste given it sets the price for landfill as an alternate waste disposal option. The philosophy is to increase recycling as much as possible and then utilise any residual waste to generate energy.

- **Landfill:** As mentioned, UK is still much more dependent on landfill than many other European countries. The landfill tax is designed to incentivise waste volumes away from landfill. Given the significant fall in volumes seen since 2008 (not just due to the tax but also due to the economic downturn), profitability at landfill operations of UK waste player has been under pressure. The residual value of landfill assets is being impacted by potential volume declines expected in future and low profitability. The main value in landfill currently is the power generation from landfill gas which lasts much longer even after a landfill is closed. Some landfill sites could be more valuable than others due to location advantages.

- **Recycling:** Investments into recycling increased significantly in the last 5 years or so. Private operators built recycling centres either as part of contracts signed with local councils or on their own. The industry outlook was boosted by significant price recovery seen since 2009 to 2011, mainly driven by Chinese demand for recycled waste products such as paper, plastics and metals. However, as the Chinese economy slowed down since late 2011, prices for recycled material fell significantly and affected profit margins for waste recyclers in the UK. The impact was exacerbated by increasing competition (for example, even traditional paper producers entered general recycling to access paper). Operational costs were also rising (recycling operations consume a lot of power, for example). The proportion of recycling will continue to increase in the UK, mainly to meet targets. But the profitability of the sector now largely depends on volatile commodity prices.

- **Waste to Energy (WtE) or Energy from Waste (EfW):** These terms are used interchangeably and this is the new area of growth for UK waste. The country currently has capacity to incinerate around 5m tonnes of waste. But capacity is set to increase by 5-7m tonnes in the next 5 years due to projects announced by various player (mainly via contracts with local councils). These new Energy from Waste (EfW) plants are much more environmentally friendly (with advanced scrubbing technologies, for example) than old incineration plants. Profitability is underpinned by the landfill tax (at least £80/t from 2014/15) and power sales into the grid. The main risks are whether enough waste will be available locally to support large-scale EfW plants as the underlying waste volumes continue to fall due to the economic slowdown and a push to reduce waste. Recent newsflow suggests that more waste is being diverted from UK in to Europe given there is incineration overcapacity in Europe at the moment. Pennon is investing over £1bn plants in new EfW plants while other players like Veolia and Suez Environnement are also building plants.

- **Anaerobic Digestion (AD):** These plants mainly process biodegradable waste to generate electricity and produce a by-product which can be utilised as a fertiliser for agriculture. EU regulations on biodegradable waste diversion away from landfill are even more strict than the overall targets. Thus, AD is important to meet this end. Shanks has a big presence in AD and some local councils are encouraging AD plants.

- **Collection:** A low margin activity requiring investments in assets (garbage trucks) and with high manpower costs. Collection faces high competition given low barrier to entry.

Table 27: Solid Waste Market Opportunities

Opportunity	Region	Key "government" stakeholders	Growth (2012-16)
Collection and Transfer in Asia: The total investment needed in the collection and transfer sector of waste management in Asia is estimated at nearly $38 billion during the period 2011-20. Out of this 65% of the investment is expected to come from the East Asia and South East Asia on up gradation of existing infrastructure and new investments	Asia (China, Malaysia, Indonesia, Vietnam, India, Kuwait), Cyprus, Georgia	Urban Local Bodies of Key Commercial Hubs	10%
Waste To Energy Market in China: The increased requirement for energy along with reduction of suitable landfills are driving the demand for incineration facilities in China	China (Shanghai, Beijing, Guangzhou)	Urban Local Body	20%
Recycling of Waste in Europe: The Waste Framework Directive targets a 50% rate of recycling on average in the EU. Some member states of the European Union already exceed the target. The opportunity particularly lies in new members and candidate countries of the European Union.	Eastern Europe (Poland, Romania, Czech Rep.), Estonia, Latvia	Urban Local Body	12%
Increasing Efficiency of the Incineration Equipment: The EU directive mandates the reduction of landfills in the EU. In addition to recycling the use of incineration equipment to manage waste is expected to continue to grow. Most importantly, the incinerators need to have high efficiency below which they will attract taxes equivalent to landfills.	EU (Denmark, Germany, Norway, Sweden, France, Italy, Switz.)	Urban Local Body	NA
Thermal Waste Management in the US: The key focus on the market is to develop recycling as an option. Waste to Energy is a significant opportunity in the market as the increasing costs of energy have made the option favourable. At the same time, Waste to Energy Market is favoured in some states as a renewable energy source and is supported by incentives due to lack of space for landfills, high density population, and possibility of water pollution through landfills.	25 states classify WTE as a renewable energy source, 19 states provide incentives	Urban Local Body	15%
Landfill and Transfer Stations in Brazil: The new policy passed by the National Government of Brazil abolishes open air disposal of waste requiring proper disposal of waste	Brazil (Rio De Janeiro Sao Paulo)	Urban Local Body	10%

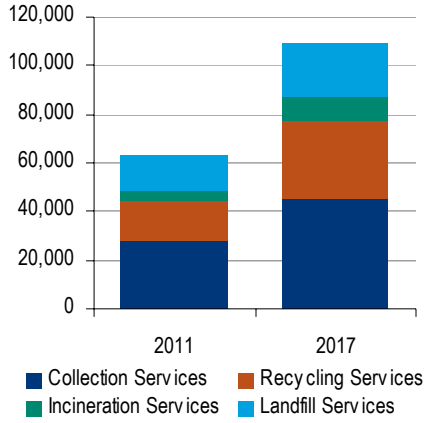
Source: THE GLOBAL CLEANTECH REPORT 2012

Industrial waste & recycling - US$1.1tn+ by 2020E

Industrial waste is produced by industrial operations such as manufacturing, and chemical, power and production plants, among others. Increasing HSE concerns have seen a significant rise in regulation, penalties and fees as enforcement actions to ensure that industrial companies are better managing their waste.

The industrial waste market was estimated to be worth around US$600bn in 2011 and is expected to grow at a CAGR of 7-13% to 2017 to become a US$1.1tn market (Source: Frost & Sullivan). Growth is coming off the back of rapid economic growth in Ems, such as China, and increasing regulation and targets for recycling in developed markets in North America and the EU. Moreover, as discussed throughout the report, there is an increasing business case for recycling and recovery of secondary raw materials and energy via WtE.

Chart 55: Global industrial waste recycling & services market 2011-17



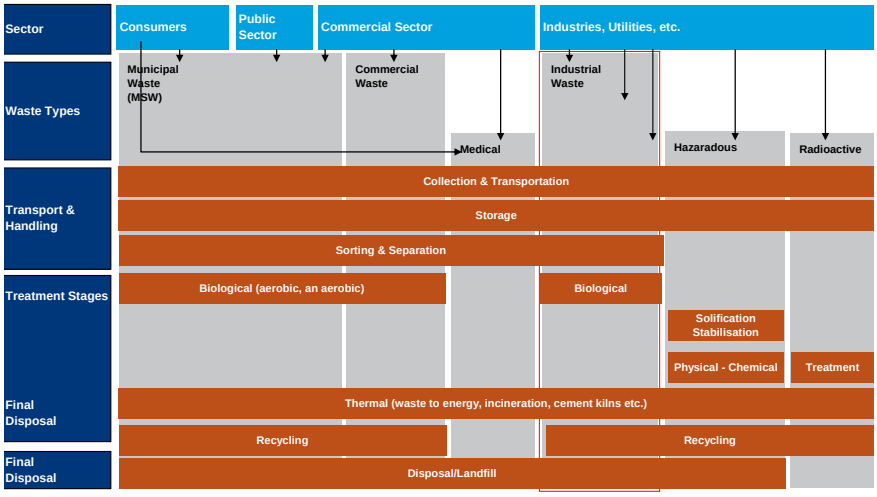
Source: Frost & Sullivan, BofA Merrill Lynch Global research

Table 28: Global industrial waste recycling & services market 2011-17

	2011	2017	CAGR '11-'17
Landfill services	151.16	222.87	6.7%
Incineration services	49.30	96.68	11.9%
Recycling services	158.26	322.58	12.6%
Collection services	278.39	450.35	8.3%
TOTAL	637.11	1,092.48	9.4%

Source: Frost & Sullivan, BofA Merrill Lynch Global Research

Chart 56: Industrial waste

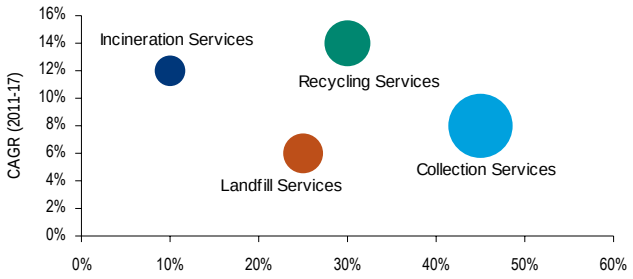


Source: Frost & Sullivan, BofA Merrill Lynch Global Research

Most attractive segment, recycling & recovery

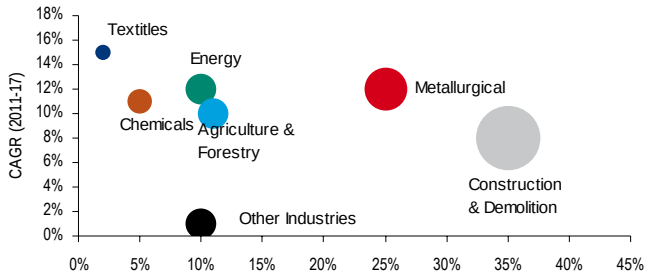
Although collection services continue to dominate the market because of high fuel and labour costs, recycling and recovery are set to grow at the fastest pace and benefit from regulation on limiting landfilling – and business opportunities around secondary raw materials recovery and WtE.

Chart 57: Market attractiveness by waste disposal & service type



Source: Frost & Sullivan, BofA Merrill Lynch Global Research. Bubble is proportionate to market size

Chart 59: Market attractiveness by waste type

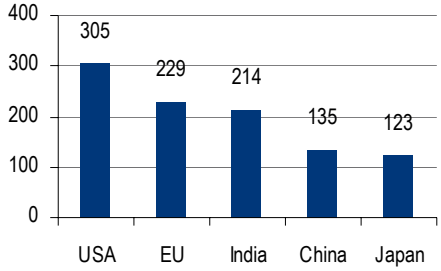


Source: Frost & Sullivan, BofA Merrill Lynch Global Research. Bubble is proportionate to market size

Biggest producers

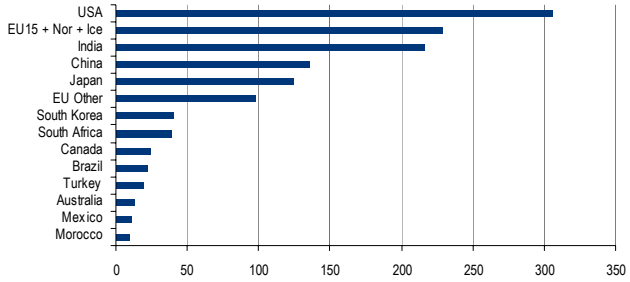
The US is the biggest producer of industrial hazardous and non-hazardous waste, followed by the EU, China and India. Off the back of rapid economic development and under-reporting, figures for EMs may actually be higher.

Chart 60: Industrial waste (mn metric tons)



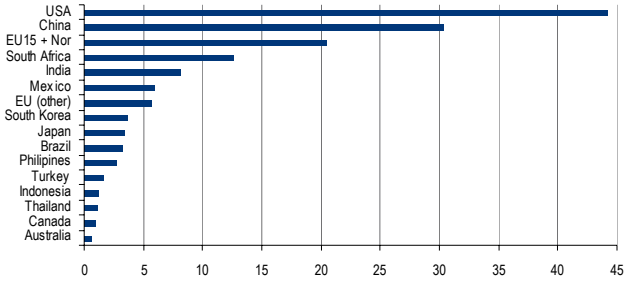
Source: World Waste Survey based on Ministries of the Environment, OECD, EurostatVeolia Environmental Services estimates, CyclOpe and UN Statistics

Chart 61: Industrial non-hazardous waste (mn tonnes)



Source: Clean West Capital

Chart 62: Industrial hazardous waste (mn tonnes)



Source: Clean West Capital

Numerous opportunities for recovery across sectors

Opportunities for waste recycling and recovery exist across agriculture, chemicals, construction and demolition, electronics, food, forestry, metals & mining, nuclear, oil & gas, textiles, among others.

Table 29: Opportunities for industrial waste materials recycling

Type of waste	Type of waste	Opportunities for material recycling	Key countries
Metallurgical	Mineral waste, combustion waste (from blast furnace and steelmaking plant that generate dusts, fumes, slags, sludges and tailings), metallic waste	Aluminium, copper, iron, zinc, cadmium, steel	Germany, UK, France, Bulgaria, Russia, China, Japan, India, South Korea, Australia
Energy	Combustion waste - coal ash (fly ash and bottom ash) and boiler slag, mineral waste	Construction material - bricks, concrete and wallboard reused as clinkers, roofing granules, aggregates for paving materials, and asphalt filler	USA, Germany, UK, Bulgaria, China, India, South Africa, South Korea, Australia
Construction & Demolition	Mineral waste, dredging spoils, metallic waste, glass, plastic resins, rubber, paper and cardboard waste, asbestos	Glass, metal, plastic, rubber elements, paper, bricks, road construction, clinkers, roofing granules, aggregate for paving materials, and asphalt filler	Germany, UK, France, China, Japan, India, South Korea, Australia
Chemicals	Chemical compound waste, chemical preparation waste, acid, alkaline or saline waste, chemical deposits and residues, chemical by-products	Carbon dioxide, catalysts, electrical and electronic chemicals (including battery recycling), functional fluids	Germany, UK, France, Russia, China, Japan, India, South Korea, Australia
Textile	Various fibres	Cotton and linen with good prospects for recycling but petroleum-based fibres such as polyester have little chance for reuse	Germany, France, Russia, China, India
Agriculture & Forestry	Animal and vegetal waste, food preparation and products, animal faeces, urine and manure, soil, wood waste, tree bark twigs and stumps, dredging spoils as well as non-natural wastes, sawdust, charcoal dust, paper and dust, animal health products, machinery and building waste	Fertilizers, bio-fuels (biodiesel, bio-ethanol and heavy fuel oils), briquettes production, packaging, and plastic films	Germany, UK, France, Bulgaria, Russia, China, Japan, India, Australia

Source: Frost & Sullivan, for Tekes, BofA Merrill Lynch Global Research

Chart 63: Sample of leading industrial waste recycling companies

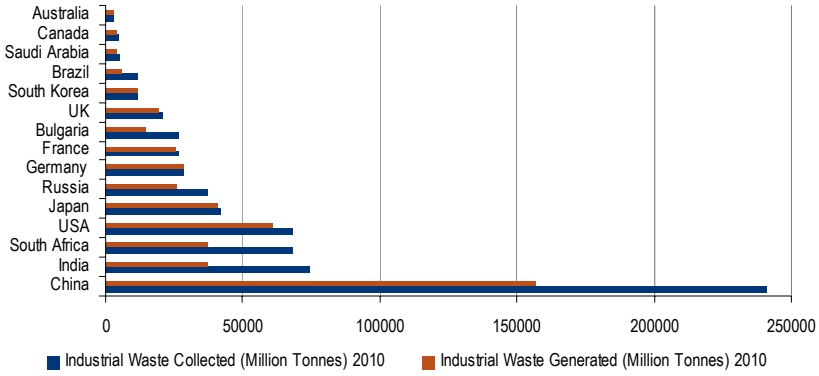
Company	Service Coverage				Market Coverage						
	Collection	Recyling	Incineration	Land filling	Metallurgical	C&D	Energy	Chemicals	Textile	Agriculture/ Forestry	Key Highlights
Veolia Environment	●	●	●	●	●	●	●	●	●	●	Will target industrial clients in emerging regions and australia
Suez Environment	●	●	●	●	●	●	●	●	●	●	Significant waste volume growth in Australia
Waste Management	●	●	●	●	●	●	●	●	◕	●	Very focused on its home market, North America
Befesa	●	●	◑	●	◔	●	◑	◕	◔	●	Strong presence in metal recycling in Europe
Remondis	●	●	●	○	●	●	●	●	●	●	Focused on strengthening its supply chains
Progressive Waste Solutions	●	●	●	●	●	●	◑	◕	◑	●	Formerly BFI and serves a main base in Canada but is making US expansions
EnviroServ	●	●	●	●	●	●	●	●	◔	◔	One of South Africa's largest waste businesses, with mining strenghts
	Low ○				◑	◔	● High				

Source: Frost & Sullivan, for Tekes, BofA Merrill Lynch Global Research

Attractiveness of regional markets

High collection rates in the developed markets present readily accessible markets. In contrast, low collection rates in EMs indicate greater potential for recycling and recovery opportunities.

Chart 64: Top 15 country markets - waste volumes generated vs. collected



Source: Frost & Sullivan, for Tekes, BofA Merrill Lynch Global Research

Table 30: Global industrial waste recycling & services market by region (2011)

		Europe	Americas	MENA	Asia-Pac	Global
Industrial waste (mn t)	Generated	1,933.2	914.7	971.2	5,357.5	9,176.7
	Collected	1,531.7	765.8	270.9	3346.0	5,914.5
Ind. waste recycling & disposal svc.	Mkt. size ($mn)	210.5	112.8	28.6	296.9	637.1
	CAGR 2011-17	7	4.9	12.4	11.6	9.4
Revenue by waste service type (US$bn)	Collection	107.7	22.3	5.3	143.2	278.4
	Recycling30.6	61.1	20.0	3.2	89.2	158.3
	Incineration	7.1	6.2	2.1	33.8	49.3
	Landfill	34.6	64.4	18.0	30.6	151.2

Source: Frost & Sullivan, BofA Merrill Lynch Global Research

Table 31: Europe – industrial waste recycling & disposal services market (2011)

Industrial waste*	Generated	1,933.2mn tonnes
	Collected	1,531.7mn tonnes
Ind. waste recycling & disposal services mkt.	Market size	US$210.5bn
	CAGR 2011-17	7.0%
Revenue by waste service type	Collection	US$107.68bn
	Recycling	US$61.08bn
	Incineration	US$7.1bn
	Landfill	US$34.6bn

Source: Tekes / Frost & Sullivan. * Includes construction & demolition waste

Europe - US315bn by 2017E

According to Tekes, the industrial waste recycling and disposal services market is expected to post a CAGR of 7.0% from 2011 to 2017, with the market growing from US$210.5bn in 2011 to US$315.5bn by 2017E. Western Europe is already very advanced in waste management – Germany, France and the UK account for c.65% of the market. The highest levels of growth will come from new areas like secondary raw materials recovery and growth in CEE countries and Russia. (Source: Tekes / Frost & Sullivan). Growth drivers for the region include:

- **Strong waste and environment regulation** with a strong focus on recycling and recovery and waste prevention both at the European Commission (e.g. 50% target of recycling of household waste, and 70% for recycling of C&D waste in all member states by 2020) and national levels.
- **High dependence on raw material imports** mean an increasing emphasis on a circular economy (i.e., closed loop recycling),
- **Scarcity of land for disposal**, with 150,000 landfills already in place (c.30-50bn m3) and landfill taxes on the rise, the focus is on recycling and prevention.
- **Reducing industrial footprint** via extended producer responsibility, deposit systems, segregated waste collection, cleaner production, recovery and reuse of secondary raw materials (Source: Tekes / Frost & Sullivan).

Table 32: Europe – market drivers & constraints for industrial waste recycling & disposal services market

	Market drivers					Market constraints			
Rank	Driver	1-2Y	3-4Y	5-7Y	Rank	Driver	1-2Y	3-4Y	5-7Y
1	ENV and waste regulation	High	High	High	1	High initial investment cost	High	High	Med.
2	Dependence on raw materials imports	High	High	High	2	Financial crisis	High	Med.	Low
3	Scarcity of land for disposal	Med.	High	High	3	Dependence on landfill disposal	High	Med.	Low
4	Reducing industrial footprint	Med.	Med.	High		Slow technology adoption	Med.	Med.	Low
						Industrial production shifting to other regions	Low	Med.	Med.

Source: Tekes / Frost & Sullivan

Main markets for EU: construction & demolition (55%), metallurgical (29%), ag/forestry (6%), energy (3%), chemicals (3%) (Source: Tekes / Frost & Sullivan)

Key markets & actors, fragmented landscape

The EU market is fragmented – few companies have a significant pan-continental presence. Suez and Veolia are the leading regional players, while Remondis and FCC have strong positions. While consolidation and concentration of bargaining power among the top actors have increased in the past few years, there remains significant competition with key factors being technical expertise, legislative compliance, competitive pricing, industry-specific solutions and local presence (Source: Tekes / Frost & Sullivan).

Table 33: Waste recycling & disposal services companies in top 5 EU markets

Country	Company	Service Coverage				Market Coverage					
		Collection	Recycling	Incineration	Landfilling	Metallurg.	C&D	Energy	Chems.	Textile	Agri/Forest
AUST	.A.S.A	✱			✱	✱	✱	✱	✱	✱	✱
AUST	Saubermacher	✱	✱		✱	✱	✱	✱	✱	✱	✱
FIN	Lassila & Tikan.	✱	✱			✱	✱	✱	✱	✱	✱
FRA	CNIM			✱		✱	✱	✱	✱	✱	✱
FRA	Nicollin	✱	✱		✱	✱	✱	✱	✱	✱	✱
FRA	SAUR	✱				✱	✱	✱	✱	✱	✱
FRA	SITA (Suez)	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
FRA	Vauche		✱	✱			✱	✱			✱
FRA	Veolia	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
GERM	Alba	✱	✱		✱		✱				
GERM	Buhck Group		✱		✱	✱	✱	✱	✱	✱	
GERM	Jackob Becker	✱	✱		✱	✱	✱	✱	✱	✱	✱
GERM	Lobbe	✱			✱	✱	✱	✱	✱	✱	✱
GERM	Remondis	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
BULG	Ecobulpack	✱	✱				✱				✱
RUSS	NED	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
SPAIN	FCC	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
UK	Biffa	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
UK	Shanks	✱	✱		✱	✱	✱		✱	✱	✱
UK	Viridor	✱	✱	✱		✱	✱			✱	✱

Source: Tekes / Frost & Sullivan, BofA Merrill Lynch Global Research

Table 34: Americas – industrial waste recycling & disposal services market (2011)

Industrial waste*	Generated	914.7mn tonnes
	Collected	765.8mn tonnes
Ind. waste recycling & disposal services mkt.	Market size (US$bn)	US$112.8bn
	CAGR 2011-17	4.9%
Revenue by waste service type	Collection	US$22.25bn
	Recycling	US$19.98bn
	Incineration	US$6.19bn
	Landfill	US$64.38bn

Source: Tekes / Frost & Sullivan. * Includes construction & demolition waste

Americas, US$150bn by 2017e

The industrial waste recycling and disposal services market is expected [according to Tekes] to post a CAGR of 4.9% from 2011 to 2017, with the market growing from US112bn in 2011 to US$150.1bn by 2017E. The US is dominant in the region, accounting for c.85% of the market, followed by Canada with c.6% – Brazil will overtake Canada by 2017E (Source: Tekes / Frost & Sullivan). Growth drivers for the region include:

- **Large reserves of natural resources**, including agricultural, metals and minerals, which drive the development of waste-generating industries including high-waste producing metallurgy and constriction and demolition activity.
- **Strong construction industries**, with healthy growth in North America and strong growth n LatAm, meaning additional construction and demolition waste.
- **Increasing waste and environment regulation** with North America continuing to push in favour of recycling and LatAm stepping up top-level frameworks (e.g. Brazil's National Policy on Solid Waste (Source: Tekes / Frost & Sullivan).

Table 35: Americas – market drivers & constraints for industrial waste recycling & disposal services market

	Market drivers					Market constraints			
Rank	Driver	1-2Y	3-4Y	5-7Y	Rank	Driver	1-2Y	3-4Y	5-7Y
1	Large natural resources	High	High	High	1	Variable implementation of regulation	Med.	Med.	Low
2	Strong construction inds.	High	High	High	2	Lack of developed recycling infrastructure	Med.	Med.	Low
3	ENV and waste regulation	Med.	High	High	3	Higher cost than landfilling	Med.	Med.	Med.
4	Encourage business investment	High	High	High					

Source: Tekes / Frost & Sullivan

Main markets for US: construction & demolition (40%), metallurgical (30%), energy (12%), chemicals (5%) (Source: Tekes / Frost & Sullivan)

Key markets & actors – US is #1

While there are c.27,000 public and private actors involved in the market – Waste Management and Republic (Allied) are the largest in the US market, handling over half of total solid waste; Waste Connections, Clean Harbors and Veolia Environmental Services all having strong market shares. Key actors in other Americas markets are outlined in the table below.

Table 36: Waste recycling & disposal services companies in top 5 AMRS markets

Country	Company	Service Coverage				Market Coverage					
		Collection	Recycling	Incineration	Landfilling	Metallurgic.	C&D	Energy	Chemicals	Textile	Agri/Forest
US/CAD	Waste Manage.	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
US/CAD	Republic Srvcs.	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
US	Waste Connect.	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
US	Clean Harbors	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
US	Veolia Enviro.	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
CAD	Progressive Wa.	✱	✱	✱	✱	✱	✱		✱		
CAD	GFL Enviro.	✱	✱		✱	✱	✱	✱	✱	✱	✱
CAD	Miller Waste Sy.	✱	✱		✱		✱			✱	✱
BRA	Abengoa	✱	✱		✱	✱	✱				
BRA	Titech	✱	✱		✱		✱			✱	✱
BRA	WAP Ambientals	✱	✱		✱						
BRA	Boone Comenor	✱	✱				✱			✱	✱
BRA	SAS Sist. Amb.	✱	✱								
BRA	Haztec	✱	✱		✱						
BRA	Ess. Solu. Amb.	✱	✱	✱	✱						
CHI	Befesa	✱	✱		✱	✱	✱				

Table 36: Waste recycling & disposal services companies in top 5 AMRS markets

Country	Company	Service Coverage				Market Coverage					
		Collection	Recycling	Incineration	Landfilling	Metallurgic.	C&D	Energy	Chemicals	Textile	Agri/Forest
CHI	Gr. Urbasser-D.	✱	✱			✱	✱			✱	✱
CHI	Recycla		✱			✱					
CHI	Stericycle	✱	✱		✱						
CHI	Gerdau Aza		✱			✱	✱				
CHI	Cristalerias Ch.		✱								✱
CHI	Cementos Polp.		✱				✱				

Source: Tekes / Frost & Sullivan, BofA Merrill Lynch Global Research

Table 37: Asia Pac – industrial waste recycling & disposal services market (2011)

Industrial waste*	Generated	5,357.5mn tonnes
	Collected	3,346.0mn tonnes
Ind. waste recycling & disposal services mkt.	Market size (US$bn)	US$296.85bn
	CAGR 2011-17	11.6%
Revenue by waste service type	Collection	US$143.2bn
	Recycling	US$89.2bn
	Incineration	US$33.8bn
	Landfill	US$30.6bn

Source: Tekes / Frost & Sullivan. * Includes construction & demolition waste

APAC, US$569bn by 2017E

The industrial waste recycling and disposal services market is expected to register a CAGR 12.2% from 2011 to 2017, with the market growing from US$285bn in 2011 to US$569bn by 2017E, (Source: Frost & Sullivan). It will be two-track growth with countries like Australia, Japan and South Korea already very advanced in waste management. The highest levels of growth will come from increasing affluence, waste generation, industrialisation, formalisation of waste management and increasing levels of waste recovery in rapidly industrialising APAC EMs (Source: Tekes / Frost & Sullivan). China and India face the greatest waste management challenges, dominating the region in terms of volumes, but with low collection rates. China (c.42% of the market) and Japan (c.26%) are the largest markets for waste management services in the region, followed by India and South Korea (8% apiece) (Source: Tekes / Frost & Sullivan). Growth drivers for the region include:

- **Growth in industrial waste**, on the back of increasing industrialisation and industrial diversification;
- **Increasing waste and environment regulation** with countries like Japan leading the way on the circular economy approach / 4Rs and APAC EMs starting from a low(er) level:
- **Demand for formal waste management** on the back of a lack of land space, degradation of the environment, growing industrial waste levels, and the lack of national policy;
- **Growing environmental awareness** with open dumping causing biodiversity degradation and environmental and human health problems.

Table 38: APAC – market drivers & constraints for industrial waste recycling & disposal services market

Market drivers					Market constraints				
Rank	Driver	1-2Y	3-4Y	5-7Y	Rank	Driver	1-2Y	3-4Y	5-7Y
1	Growth in industrial waste production	High	High	High	1	Lack of national policy	High	High	Med.
2	Waste regulation	Med.	High	High	2	Landfill is preferred method	High	High	Med.
3	Demand for proper waste management	Med.	Med.	High	3	Informal waste sector	High	Med.	Med.
4	Environmental awareness	Low	Med.	High					

Source: Tekes / Frost & Sullivan

Main markets for APAC: construction & demolition (23%), metallurgical (19%), ag/forestry (18%), energy (15%), chemicals (7%), textiles (4%) (Source: Tekes / Frost & Sullivan)

Key markets & actors, local players dominate

Waste management in APAC is dominated by regional players with most companies operating in the domestic markets. In markets like China and Japan, strict licensing requirements create high barriers to entry for foreign companies. That said, we are seeing some Japanese companies developing a pan-Asian presence and there is also a growing presence of waste multinationals (Source: Tekes / Frost & Sullivan).

Table 39: Waste recycling & disposal services companies in top 5 APAC markets

Country	Company	Service Coverage				Market Coverage					
		Collection	Recycling	Incineration	Landfilling	Metallurg.	C&D	Energy	Chems.	Textile	Agri/Forest
China	China Boqi Env.			✱		✱	✱	✱	✱	✱	✱
China	China Ind. Was.	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
China	China Metal re.		✱			✱					
Japan	Daiei Kankyo		✱	✱			✱				✱
Japan	Daiseki		✱				✱				
Japan	DOWA Eco	✱	✱	✱	✱	✱					
Japan	Amita Holdings		✱			✱	✱		✱		
Japan	JFE Kankyo	✱	✱	✱			✱				
Japan	Miyama Inc		✱			✱			✱		
Japan	Takeei Co.	✱	✱		✱	✱	✱	✱	✱	✱	✱
India	IL&FS Waste	✱	✱		✱		✱	✱	✱		
India	Ramky Enviro	✱	✱		✱	✱	✱	✱	✱	✱	
India	Upl Enviro. Eng.		✱	✱	✱			✱	✱		✱
India	EcoWise Waste	✱	✱			✱	✱			✱	
India	Effwa	✱	✱	✱	✱						✱
S. Korea	Gumsung Tech.		✱			✱	✱				
S. Korea	Insun Enviro.		✱	✱	✱		✱				
S. Korea	The Resour. Co		✱			✱					
S. Korea	Kore. Envi Tech.			✱	✱		✱				
Australia	Clean Teq Hold.		✱			✱					
Australia	CMA Corp		✱			✱					
Australia	Env. Clean Tech		✱			✱		✱			
Australia	Transpacific		✱			✱	✱	✱	✱	✱	✱

Source: Tekes / Frost & Sullivan, BofA Merrill Lynch Global Research

Table 40: MENA – industrial waste recycling & disposal services market (2011)

Industrial waste*	Generated	971.2mn tonnes
	Collected	270.9mn tonnes
Ind. waste recycling & disposal services mkt.	Market size (US$bn)	US$28.6bn
	CAGR 2011-17	12.4%
Revenue by waste service type	Collection	US$5.3bn
	Recycling	US$3.2bn
	Incineration	US$2.1bn
	Landfill	US$18.0bn

Source: Tekes / Frost & Sullivan. * Includes construction & demolition waste

MENA – US$58bn by 2017E

The industrial waste recycling and disposal services market is expected to post a CAGR 12.4% from 2011 to 2017, with the market growing from US$28.6bn in 2011 to US$57.7bn by 2017E, according to Tekes. Growth is driven by the region's rich natural resources and increasing collection and recycling rates (and the shift away from landfill), with South Africa's mining industry the leading producer of industrial waste. The key markets are South Africa, Saudi Arabia, United Arab Emirates, Egypt and Tunisia (Source: Tekes / Frost & Sullivan). Growth drivers for the region include:

- **Entry of foreign actors**, especially European players, has brought in waste management expertise, formalisation, and faster take-up of industrial recycling practices;
- **Growing lack of landfill space**, especially in South Africa, will make recycling a cost-effective necessity;
- **Increasing waste and environment regulation** with South Africa and Tunisia the most advanced and other countries stepping up efforts, although implementation is erratic (Source: Tekes / Frost & Sullivan).

Table 41: MENA – market drivers & constraints for industrial waste recycling & disposal services market

	Market drivers					Market constraints			
Rank	Driver	1-2Y	3-4Y	5-7Y	Rank	Driver	1-2Y	3-4Y	5-7Y
1	Growth in industrial waste production	High	High	High	1	Lack of national policy	High	High	Med.
2	Waste regulation	Med.	High	High	2	Landfill is preferred method	High	High	Med.
3	Demand for proper waste management	Med.	Med.	High	3	Informal waste sector	High	Med.	Med.
4	Environmental awareness	Low	Med.	High					

Source: Tekes / Frost & Sullivan

Main markets for MENA: metallurgical (36%), construction & demolition (31%), energy (10%), chemicals (6%), ag/forestry (5%), textiles (1%) (Source: Tekes / Frost & Sullivan)

Key markets & actors - small regional actors

The region is dominated by smaller players with specialised waste markets, such as in South Africa and the GCC states (Source: Tekes / Frost & Sullivan). Key actors in other MENA markets are outlined in the table below.

Table 42: Waste recycling & disposal services companies in top 5 MENA markets

Country	Company	Service Coverage				Market Coverage					
		Collection	Recycling	Incineration	Landfilling	Metallurg.	C&D	Energy	Chems.	Textile	Agri/Forest
South Africa	EnviroServ	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
South Africa	Interwaste	✱	✱	✱	✱	✱	✱	✱	✱	✱	✱
South Africa	Wasteman	✱	✱	✱	✱	✱		✱			
South Africa	Waste Giant	✱	✱	✱	✱		✱		✱		
South Africa	Multiwaste	✱	✱		✱						
Saudi Arabia	Saudi Env. Work	✱	✱		✱	✱	✱	✱	✱		
Saudi Arabia	GEMS	✱	✱						✱		
Saudi Arabia	Averda	✱	✱				✱				
Saudi Arabia	Dragados Gulf		✱				✱				
Saudi Arabia	Nesma Recycl.	✱	✱			✱					
Saudi Arabia	Tyre Recycling		✱				✱				
UAE	ME Env. Protec	✱	✱				✱				
UAE	Dulsco	✱	✱		✱	✱	✱			✱	✱
Egypt	Veolia-Onyx	✱	✱		✱						
Egypt	AMA Egypt	✱	✱		✱						
Egypt	Urbaser	✱	✱		✱						
Egypt	FCC	✱	✱		✱						
Egypt	Jacorossi	✱	✱		✱						
Tunisia	Veolia	✱	✱		✱						
Tunisia	AfRec	✱	✱		✱	✱	✱	✱	✱	✱	✱
Tunisia	Segor	✱	✱	✱	✱						
Tunisia	North. Reycl.	✱	✱		✱						
Tunisia	Nehlsen AG	✱	✱		✱						

Source: Tekes / Frost & Sullivan, BofA Merrill Lynch Global Research

A focus on medical waste

US$15bn global market

There is a growing global trend to regulate medical waste owing to safety and security, and environmental issues. The goal is also to reduce cross-contamination risk and the spread of infection. This has meant a growing business for disposal services for medical and bio-hazardous waste for hospitals, laboratories, physician practices, dental clinics, long-term care facilities, as well as numerous other businesses, facilities, and healthcare providers that generate sharps or potentially infectious material. The medical waste market has become a US$15bn market worldwide. Stericycle leads with 13% market share (Source: Stericycle). Growth drivers include:

- **Highly regulated industry** – e.g. in the US market: the industry is covered by a combination of the EPA, DEA, FDA, OSHA, DOT, and State/local agencies.

Predictable revenues: over 95% of Stericycle revenues are under long term contracts with automatic renewal (Source: Company)

- **Insulated from economic cycles** – revenue retention tends to be high as it is a necessarily regulated service for hospitals, blood banks, pharma manufacturers, medical and dental offices, offsite and alternate care providers, biomedical/biotech companies, labs/pharmacies, corporates, retail locations, and veterinary offices among others (Source: Stericyle).

- **Increasing outsourcing of services** – because of stakeholder pressure and regulation, we are seeing a move away from cheap(er) on-site

incineration with 3,600 closed in the US from 1995-2007 (Source: ReportsnReports). This means a greater focus and opportunities for outsourcing of capex-intensive investments to service companies.

- **Global growth prospects** - Medical waste is on the rise globally with increasing numbers of patients, expanding waste generating sources, growing service fees and rising number of service providers.

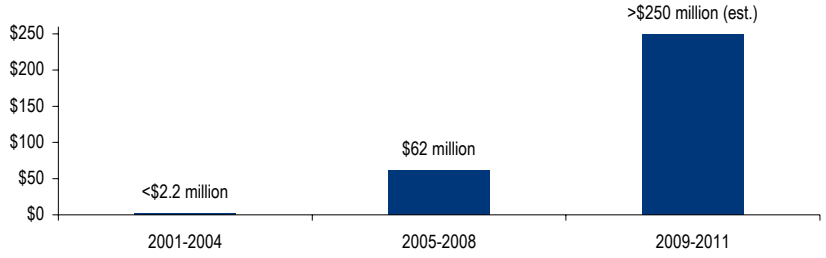
Increasing costs of non-compliance

Cross Reference

Stericycle, 21 March 2013

There is increasing regulatory scrutiny on medical waste. For instance, in the US pharmacy space in January, CVS Caremark announced a US$800,000 settlement with Connecticut's Department of Energy and Environmental Protection, following the mismanagement of hazardous waste at seven pharmacies. Also, California has reported a series of hazardous waste cases at national retail chains, including Walgreens, Target, Wal-Mart, Home Depot and Costco, and state and federal fines have become exponentially burdensome over the past decade. According to the California Waste Association, the state spends >US$1bn pa disposing of hazardous materials and state-level enforcement has intensified.

Table 43: U.S. State & Federal fines at retailers for improper management of hazardous waste



Source: Company reports; EPA

A focus on O&G

There is a growing O&G waste and wastewater treatment market – off the back of increasing basins; increased drilling in unconventional areas (higher waste intensity per well); environmental regulations and enforcement; and heightened stakeholder and corporate awareness of waste stream management.

Waste types and amounts

The US petroleum industry generates around 150,000m3 (260,000 metric tons) of waste every year

Each year, the US petroleum industry generates around 150,000m3 (260,000 metric tons) of waste – including produced water, scales, sludges and contaminated equipment. The amount produced at any one oil reserve varies and depends on several factors including geological location, formation conditions, type of production operation, and the age of the production well (Source: US EPA):

Over 18bn barrels of waste fluids from oil and gas production are generated annually in the US

- **Produced Waters** – The radioactivity levels in produced waters are generally low, but the volumes are large. The ratio of produced water to oil is approximately 10 barrels of produced water per barrel of oil (Source: US EPA). More than 18bn barrels of waste fluids from oil and gas production are generated annually in the U.S. (Source: American Petroleum Institute). Produced waters contain levels of radium and its decay products that are concentrated. In general, produced waters are re-injected into deep wells or are discharged into non-potable coastal waters (see further below).

- **Scale** – is composed primarily of insoluble barium, calcium, and strontium compounds that precipitate from the produced water due to changes in temperature and pressure. Radium is chemically similar to these elements and as a result is incorporated into the scales. Scales are normally found on the inside of piping and tubing (Source: US EPA).

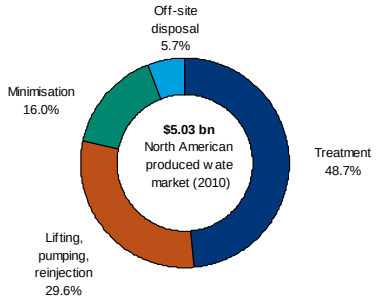
- **Sludge** – is composed of dissolved solids which precipitate from produced water as its temperature and pressure change. Sludge generally consists of oily, loose material often containing silica compounds, but may also contain large amounts of barium. Dried sludge, with a low oil content, looks and feels similar to soil. Oil production processes generate an estimated 230,000 MT or five million ft3 (141 cubic metres) of TENORM sludge each year (Source: US EPA).

- **Contaminated equipment** – According to an API industry-wide survey, approximately 64% of the gas producing equipment and 57% of the oil production equipment showed radioactivity at or near background levels. TENORM radioactivity levels tend to be highest in water handling equipment (Source: US EPA).

Growing focus on produced water market

The oil industry is an indirect water industry, producing water as a by-product ("produced water"). The water to oil ratio (WOR) for the industry as a whole is around 2.5x, with some segments, such as North American onshore oil, producing 8x more water than oil. By 2025, the sector could be producing 5x more water than oil, with onshore crude oil having a ratio of up to 12x, largely on the back of ageing wells and increased unconventional O&G such as EOR, shale gas and oil sands – all of which have thirsty water needs. This produced water is often highly saline and contaminated by hydrocarbons: it is a hazardous waste which requires treatment, disposal, and – with advances in desalination – potentially on- or off-site recycling (Source: GWI).

Chart 65: North American produced water market 2010



Source: GWI, BofA Merrill Lynch Global Research

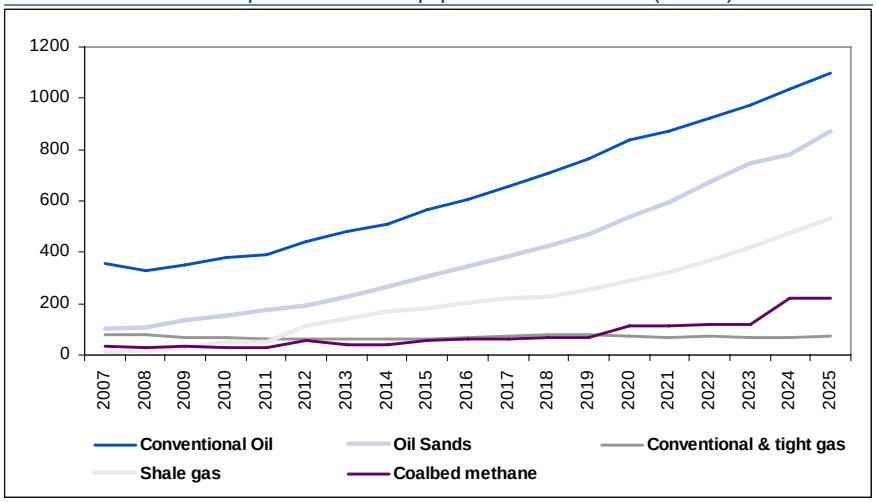
Produced water market to post 5% CAGR over 20Y

The increased WOR and growing environmental concerns and regulation will, we estimate, see the market for water treatment technologies, such as membrane and thermal desalination technologies, filtration systems and biological treatment systems, grow at close to 5% pa over the next 20 years. Enhanced oil recovery (which needs water with a precise salinity) and highly water-intensive oil sands and shale gas will create the largest opportunities, in our view.

Disposing of produced water off-site can cost as much as US$10 per barrel ($63/m3) (Source: GWI)

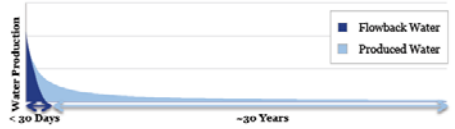
Water treatment in the North American oil sector alone (of produced water) could grow from an estimated US$5bn in 2010 to US$10bn by 2025, a CAGR of 4.7%. Within the sector, the US-produced water treatment equipment market is set to grow from US$693mn in 2010 to US$2.9bn during that time, an annual growth rate of 10.1%. The desalination technologies market, currently worth US$59mn, should enjoy the fastest growth rate, averaging 20.4% per year (Source: GWI).

Chart 66: North American produced water equipment market 2007-25 (US$mn)



Source: GWI, BofA Merrill Lynch Global Research

Chart 67: Water use in shale wells



Source: Heckmann, BofA Merrill Lynch Global Research

Shale gas remains under pressure, US$9bn market by 2020

Shale gas remains controversial in many circles because the industry's process of fracking uses large volumes of water withdrawals from ground and surface water, which some believe could impair drinking water resources, as well as posing a contamination risk because of the chemicals used. An average of 6.3m gallons of water are used per well in the US (Source Heckmann), and with companies drilling up to 16 wells per well pad, this means huge water treatment needs. Chemical and toxin-laced flowback water, which returns to the surface after the well is completed (over c.30 days), accounts for 20% of water. Produced water or water which flows over the lifecycle of a well after it has been drilled (over c.30 years) accounts for 80%.

The water needing to be treated poses challenges including salinity, hydrocarbons, chemicals and heavy metals

The large amount of water needing to be treated is creating a frack water treatment industry, which is expected to exhibit a 28% CAGR to become a US$9bn market by 2020 (Source: Lux Research). The US EPA's likely move on water treatment should provide a fillip over the next two years. Technologies used by players in this field include bag filters, chemical precipitation, electric coagulation, distillation, membrane filtration or a combination (e.g., adding ozone, ultrasound, electricity and pressure).

A focus on nuclear waste

Whilst volumes of nuclear wastes produced are very small, managing waste is a key challenge for the industry's licence to operate

Nuclear power generation facilities worldwide produce about 200,000 m3 of low- and intermediate-level radioactive waste, and about 10,000 m3 of high-level waste including used fuel designated as waste. A typical 1000MW light water reactor will generate (directly and indirectly) 200-350 m3 low- and intermediate-level waste per year. It will also discharge about 20 m3 (27 tonnes) of used fuel per year, which corresponds to a 75 m3 disposal volume following encapsulation if it is treated as waste. Where that used fuel is reprocessed, 3 m3 of vitrified waste (glass) is produced, which is equivalent to a 28 m3 disposal volume following placement in a disposal canister. This compares with an average 400,000 tonnes of ash produced from a coal-fired plant of the same power capacity (Source: World Nuclear Association).

90% of the volume but only 1% of the radioactivity of all rad-waste

- **Low-level waste** is generated from hospitals, labs, industry and the nuclear fuel cycle, e.g., paper, rags, tools, clothing, filters etc. which contain small amounts of mostly short-lived radioactivity). It comprises 90% of the volume

but only 1% of the radioactivity of all rad-waste and is usually buried in shallow landfill sites.

- **Intermediate-level waste** contains higher amounts of radioactivity and may require special shielding (e.g. resins, chemical sludges and reactor components, contaminated materials from reactor decommissioning). It makes up 7% of the volume and has 4% of the radioactivity of all rad-waste – and is landfilled with long-lived waste from reprocessing nuclear fuel is disposed of deep underground.

3% of the volume of all radwaste, it holds 95% of the radioactivity

- **High-level waste** comes from used fuel itself, or the principal waste separated from reprocessing this. It accounts for 3% of the volume of all radwaste, but holds 95% of the radioactivity (25-30 tonnes of used fuel for a typical large nuclear reactor). It generates a considerable amount of heat and requires cooling, as well as special shielding during handling and transport

The US has 108 sites designated as areas that are contaminated and unusable

- **Legacy Wastes** from power - military programs, a legacy of the Cold War. In the UK, some £70bn is estimated to be involved in addressing these wastes, principally from Magnox and some early AGR developments, and about 30% of the total wastes can be attributed to military programs. In the US, Russia, and France the liabilities are also considerable (Source: World Nuclear Association).

Table 44: Nuclear waste services companies

Company	Country	BBG ticker	Specialised nuclear services	Spent fuel recycling	Decontamination & decommissioning	Logistics processing & disposal
Areva	France	AREVA FP	☑	☑		
Babock & Wilcox	United States	BWC US				
Bechtel	United States	Private		☑	☑	
Cameco	Canada	CCO CN				
EnergySOLUTIONS	United States	ES US	☑	☑	☑	☑
Fluor	United States	FLR US		☑	☑	
Jacobs Engineering	United States	JEC US			☑	
Shaw Group (CB&I)	United States	CBI US	☑		☑	
URS	United States	URS US	☑	☑	☑	
USEC	United States	USU US	☑		☑	☑

Source: EnergySOLUTIONS

Costs of radioactive waste management

Waste management represents about 5% of the total cost of electricity generation

Financial provisions are made for managing all kinds of civilian radioactive waste. The costs of managing and disposing of wastes from nuclear power plants represents about 5% of the total cost of electricity generation. Most nuclear utilities are required by law to put aside a levy (e.g., US$0.10 per kWh in the US, €0.14/kWh in France) to provide for management and disposal of their wastes. So far, some US$28bn had been committed to the US waste fund by electricity consumers (Source: World Nuclear Association).

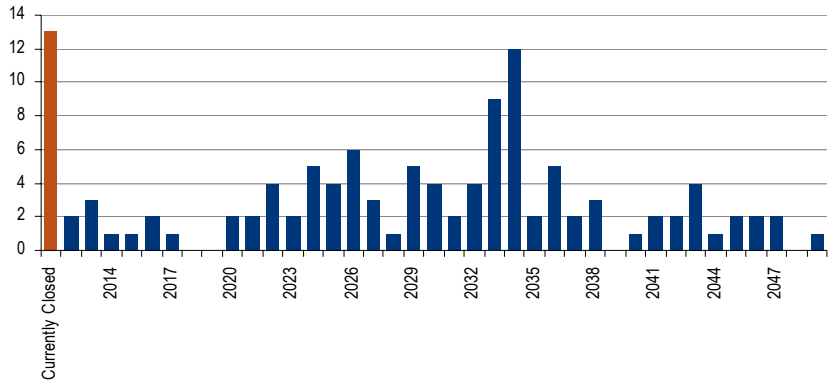
Growth from decommissioning

The dismantling of nuclear reactors and the storage needs of radioactive waste fuel should offer opportunities in the long term. In France alone, the total market could be worth €32bn over the long term.

The shutdown of nuclear plants – after their lifespan of 40-60 years – involves the decommissioning of reactors and the disposal of related low-level radioactive waste. This entails dismantling, safe storage or entombment – and site remediation. Since it may cost US$300mn or more to shut down and decommission a plant – operators are usually required to build up a fund to cover these costs while the plant is operating, to limit the financial risk from operator bankruptcy. In France, the law requires that 100% of provisions for end-of-lifecycle operations be covered by earmarked assets. In the US, the Nuclear

Regulatory Commission requires plants to finish the process within 60 years of closing.

Chart 68: Planned U.S. nuclear plant closures

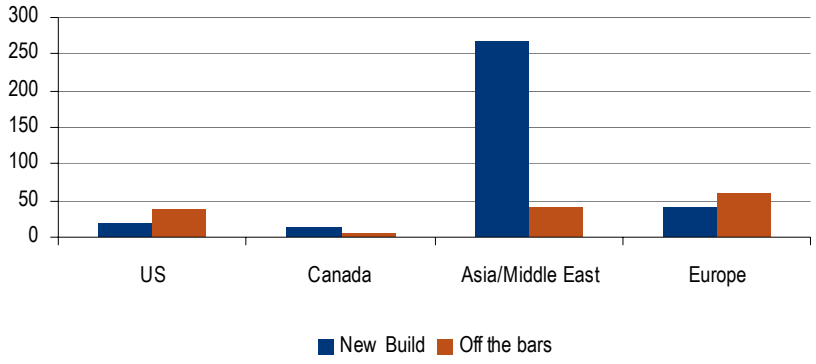


Source: EnergySOLUTIONS.; Data as of December 2010; do not include current extension applications or anticipated extension applications

Growth from EM nuclear

Increasing nuclear power around the world, especially Asia, will mean an increasing focus on helping utilities maintain the efficiency and safety of their existing fleet of nuclear power plants through major component replacement projects, Fukushima-related modifications, major component replacement, life cycle services and ultimately waste management.

Chart 69: Nuclear reactors to 2030e



Source: EnergySOLUTIONS

Solar, growing hazardous waste

More than 21mn kg (46mn lb) of waste was generated by California solar companies from 2007 and mod-2011 (Source: California Department of Toxic Substances Control)

While solar energy is one of the cleanest forms of energy, panel makers are increasingly having to struggle with hazardous waste, including transporting and treating polluted sludge (e.g. when metals and other toxins are removed from water used in the manufacturing process) and contaminated water (e.g. carcinogenic cadmium-contaminated water). The transport of waste has a knock-on impact on solar's full lifecycle carbon footprint. The waste from manufacturing is raising growing reputational concerns within the industry over its green image and will need to move in two directions.

After installing a solar panel, "it would take one to three months of generating electricity to pay off the energy invested in driving those hazardous waste emissions out of state" (Source: Dustin Mulvaney, San Jose State University in AP)

- **Investing in on-site waste treatment** to recycle waste rather than sending it off-site;
- **Improving disclosure on waste –** only 17/41 California solar makers, for instance, reported on hazardous waste production (Source: AP based on California Department of Toxic Substances Control). California state data show the 17 companies (with 44 manufacturing facilities in California), produced 21m kg (46.5m lb of sludge and contaminated water from 2007 through the first half of 2011). Around 97% was taken to hazardous waste facilities throughout the state, and 3% transported out of state for treatment.

Waste to Energy (WtE), an emerging US$29-81bn solution

One ton of MSW can create 500-750 kWh of power

Waste-to-energy (WtE) or energy-from-waste (EfW) is a form of energy recovery via incineration/combustion, pyrolysis and gasification, and anaerobic digestion. It is also possible to recover energy from waste after it has been disposed of in a landfill. One ton of MSW can create 500-750 kWh of power, c50 lbs. of recycled metal, and ash (10% of original volume) (Source: Covanta Energy). Globally, c130mn tonnes of MSW are combusted annually in over 800 WtE facilities – representing c11% of total MSW (Source: Pike Research).

Rationales: growing waste volumes, reducing pressure on landfills, lack of space, energy independence, meeting renewable energy targets, disposing of non-recyclable wastes, and reducing GHG emissions

While WtE remains more expensive than low-cost landfilling, governments are increasingly incentivising take-up. Rationales include growing waste volumes, reducing pressure on landfills, lack of space, energy independence, meeting renewable energy targets, disposing of non-recyclable wastes, and reducing GHG emissions including from landfill gas. From an environmental perspective, less waste to landfill means a significant reduction in landfill-related methane emissions (a greenhouse gas which is up to 25x more potent than CO2).

WtE could treat 261-396mn tons p.a., producing 283-429 TWh of power – a potential US$29-81bn market by 2022e

The global WtE market is estimated at US$7.4bn in 2013 (Source: Visiongain). Over the coming decade, it is estimated that WtE systems could treat over 261mn tons of MSW p.a. by 2022, with a total estimated output of 283TWh of electricity and heat generation. Under a more optimistic scenario, WtE could potentially treat 396mn tons p.a., producing 429 TWh of power. This could see the global WtE market grow to US$29bn by 2022 – and US$81bn under the optimistic scenario (Source: Pike Research). While Europe and developed Asia are the most mature market, we see the greatest growth coming from Asia-Pac and China.

WtE in a nutshell

WtE recovers energy from residual waste using incineration/combustion, pyrolysis and gasification, and anaerobic digestion. It is also possible to recover energy from waste after it has been disposed of in a landfill. Globally, c130mn tonnes of MSW are combusted annually in over 600 WtE facilities that produce electricity and steam for district heating (Source: Themelis, N.J., 2003. An overview of the global waste-to-energy industry. Waste Manage). The knock-on effect is less waste to landfill and a reduction in potential landfill-related methane emissions (a greenhouse gas which is up to 25x more potent than CO2).

Incineration/combustion is the most common method

Modern incinerators reduce the volume of the original waste by c95%, depending upon composition and degree of recovery of materials such as metals from the ash for recycling

Incineration - the combustion of MSW with energy recovery - is the most common WtE method and is also known as EfW (energy from waste). Such facilities combust waste at high temperatures (c850°C) in specially designed boilers that generate steam for a turbine. The turbine runs a generator to create electricity for sale for use in homes and businesses – providing a steady and controllable output or “baseload” power. Excess heat can also be use for heating and any metals recovered from the process and sold to recyclers. These plants typically use between 50,000 to 300,000 tonnes per year of fuel:

- **Typical fuels** – MSW, Commercial & Industrial Waste (C&I), Refuse derived fuel (RDF) or Solid Recovered Fuel (SRF);
- **Outputs** - Electricity or heat or both together if a Combined Heat and Power Plant (CHP); bottom ash (left after combustion and typically landfilled; any

metals removed pre-combustion are recycled); fly ash (material collected by the pollution control equipment).

"Many times more dioxin is now released from home fireplaces and backyard barbecues than from incineration" – New York Times (April 12, 2010)

Not "old school" incineration, environmental concerns

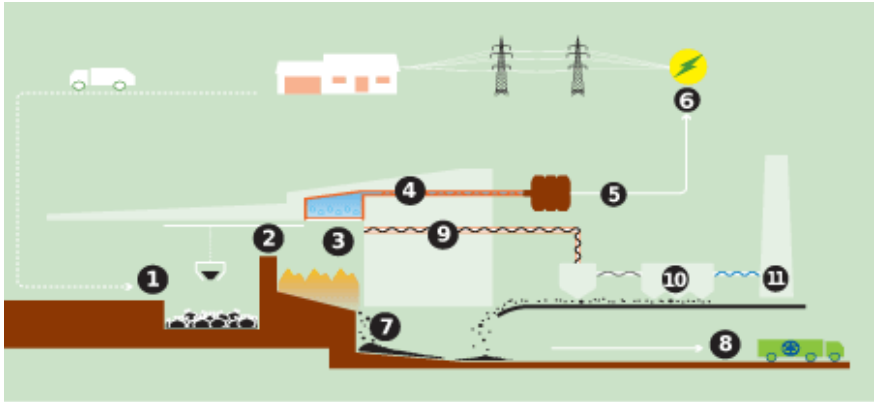
Strict emission standards, including on NOx and SOx, heavy metals and dioxins are in place in most developed countries, and increasingly in EMs (i.e. use of the use of lime scrubbers and electro-static precipitators on smokestacks). However, on-going environmental concerns over incineration include fine particulate, heavy metals, trace dioxin and acid gas emissions – as well as toxic fly ash and incinerator bottom ash (IBA) management.

Table 45: WtE in a nutshell

1) MSW is delivered to WtE facility and stored in a bunker
2) Waste is transferred to a combustion chamber where self-sustaining combustion is maintained at extremely high temperatures
3) Heat from the combustion process boils water
4) Steam from the boiling water is used directly, or the steam drives a turbine that generates electricity
5) Steam from the boiling water is used directly, or the steam drives a turbine that generates electricity
6) Electricity is distributed to the local grid
7) Ash from combustion is processed to extract metal for recycling. It is then combined with residue from the air pollution control process (see 9 and 10).
8) Combined ash is either disposed of in a monofill (where only ash is stored) that receives only that waste, used as cover material at a conventional landfill, or landfilled with other waste
9) All gases are collected, filtered & cleaned before being emitted into the atmosphere (e. g. air pollution control technology)
10) Control emissions of particulate matter primarily through a baghouse (fabric filter)
11) Monitor criteria and other pollutants and operating parameters to ensure compliance with permit conditions

Source: Covanta

Table 46: WtE via incineration/combustion in a nutshell



Source: Covanta; BofA Merrill Lynch Global Research

Other WtE technologies

There are a number of emerging WtE technologies that do not use direct combustion, but which can produce greater amounts of energy as they separate corrosive components (ash) from the converted fuel, thereby allowing higher combustion temperatures and/or efficiently convert the energy into liquid or gaseous fuels.

ATT plants tend to be smaller and more flexible than incineration/combustion plants

Advanced thermal treatment (ATT)

ATT includes gasification (produces combustible gas, hydrogen, synthetic fuels); thermal depolymerization (produces synthetic crude oil, which can be further refined); pyrolysis (produces combustible tar/biooil and chars); and plasma arc gasification or plasma gasification process (PGP) (produces rich syngas including hydrogen and carbon monoxide usable for fuel cells or generating electricity to drive the plasma arch, usable vitrified silicate and metal ingots, salt and sulphur). Plants tend to be smaller and more flexible than incineration/combustion plants and consume between 25,000 and 150,000 tonnes of waste per year.

Anaerobic/biogas plants are much smaller than incineration/combustion plants and are best suited for wet organic waste

Non-thermal technologies – anaerobic digestion & biogas

Non-thermal treatment alternatives include anaerobic digestion (biogas rich in methane); fermentation production (examples are ethanol, lactic acid, hydrogen); mechanical biological treatment (MBT); MBT and Anaerobic digestion; and MBT to refuse derived fuel. These plants operate at low temperatures and use microorganisms to turn the feedstock into biogas (a mix of CO2 and methane) with a biofertiliser as another output. Plants are much smaller than incineration/combustion plants and are best suited for wet organic waste (e.g. food waste, sewage sludge, agricultural residue).

A 3MW landfill gas project producing electricity generates the environmental equivalent of removing 25,000 cars from the road; planting 35,000 acres of trees; or preventing the use of 304,000 barrels of oil (Source: US EPA)

Landfill gas recovery

At landfill disposal sites, as waste decomposes anaerobic conditions develop as available oxygen is consumed. A by-product of anaerobic decomposition is methane, a combustible gas. Combined with other gases, primarily CO2, these gases, known as landfill gas, can be captured from a disposal site. Generally, methane comprises around 50% of landfill gas. The captured gas can be used as an energy source, commonly, for power (electricity) generation. Excess landfill gas at an energy recovery facility may be flared. Flaring of all the captured landfill gas may occur at disposal sites with low energy values or are too small to justify an energy recovery operation. Even though the combustion process results in the generation of CO2, it is considered carbon neutral as it is derived from biomass. (Source: World Bank)

US$7.4bn today and US$29-81bn+ by 2022e

The global WtE market is estimated at US$7.4bn in 2013 (Source: Visiongain). Over the coming decade, it is estimated that WtE systems could treat over 261mn tons of MSW p.a. by 2022, with a total estimated output of 283TWh of electricity and heat generation. Under a more optimistic scenario, WtE could potentially treat 396mn tons p.a., producing 429 TWh of power. This could see the global WtE market grow to US$29bn by 2022 – and US$81bn under the optimistic scenario (Source: Pike Research).

Cost remains a barrier but Increasing incentives

WtE is more expensive than low-cost landfills, but the increasing global focus on the 4Rs - reduce, reuse, recycle and recover – is seeing regulators place an increasing focus on WtE.

Table 47: Two approaches to waste

	U.S.	Denmark
Recycled	33%	42%
Landfill	54%	4%
WtE	13%	54%

Source: US EPA, Eurostat

EU & developed Asia leading the way

Globally, the majority of WtE are located in the EU and the sector continues to remain an attractive opportunity for investment. The key driver in the EU is the Waste Framework Directive requiring focus on recycling of waste and reduction of landfill. An important opportunity exists in increasing the efficiency of the waste to energy plants in Europe – (23% vs 21% for existing plants, and 25% vs. 24% for new plants) – failing which they might be subject to taxes similar to applied on landfills (Source: Global Cleantech Report). In developed Asia, Japan processes up to 70% of its MSW via WtE – and there has been significant take-up in Singapore and Taiwan.

US, held back by policy and regulation,

Currently, there are 87 WTE facilities in the USA processing up to 30 million tons (27.2 million tonnes) of waste every year and converting it into approximately 2,572MW of generating capacity and 15 billion kWh of energy (Source: Waste Management World). The relatively limited take-up of WtE is partly the result of the lack of an enabling policy and regulatory framework necessary to encourage investment.

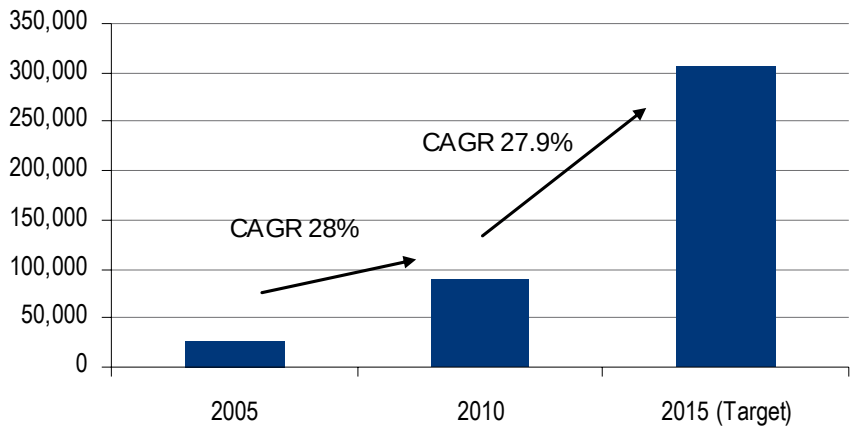
Cross Reference

China Everbright International, 28 September 2012

China, WTE a 12th FYP environmental policy beneficiary

China is becoming an WtE champion and is calling for the construction of 200+ plants by 2020/ We believe China is on course to add 28% CAGR increase in waste-energy (WTE) project capacity during the 12th FYP.

Chart 70: National WTE capacity addition (tons/day)



Source: BofA Merrill Lynch Global Research

Covanta Energy is present in the space and China Everbright plans to focus on developing WTE business, which has a higher IRR (10-15%) compared to its waste-water treatment (WWT) business (IRR: 10-12%). We project CEI's WTE capacity to rise at 45.6% CAGR in 2011-14.

Table 48: Waste to energy and waste water treatment plant comparison for China

	Waste to energy plant	Waste water treatment plant
Leveraged IRR (1/3 equity; 2/3 project loans)	10%-15%, some above 15%	10%-12%
Construction Cost Structure	40%: construction and installation, 45%: equipment 10%: admin. + other expenditures (incl. prep. stg.)	60%: construction and installation, 25%: equipment, 10%: admin. + other expenditures (incl. prep. stg.), 5%: interest expenditure
Construction Period	18 months	10 months
Gross Margin for Construction Revenue	15%-20%	10%-15%
Gross Margin for Operation Revenue	50%-70%	30%-50%
Gross Margin for Finance Income	100%	100%
Sources of Revenue	Feed-in-tariff (60% of total revenue of a plant) Waste Treatment Fee (40% of total revenue of a plant)	Waste Water Treatment Fee
Payback Period	7-10 years	10-12 years

Source: BofA Merrill Lynch Global Research

Environmentally, best solution after recycling

The U.S. government and nearly all states with renewable energy laws have included WtE within the definition of renewable energy

WtE facilities offer a relatively safe, technologically advanced means of waste management which is a good fit in an increasingly zero landfill focused environment. It reduces waste volumes by up to 90% - and also generates constantly replenishable "renewable" energy, reduces GHG emissions (notably methane) and promotes recycling:

- **Strong biomass component** - c65 percent of the combustible portion of MSW comprises renewable biomass materials (e.g. paper, wood and food scraps) (Source: Covanta).
- **Constantly replenished fuel source** as MSW is constantly replenished (for the foreseeable future) and all of the energy recovered by WtE preserves natural resources and avoids secondary impacts from extraction and combustion of these resources.
- **Promotes energy security** as the energy generated is reliable, baseload power and located near residential and business demand centres – thus promoting energy independence goals.

Waste companies are working to promote the use of combined ash as a construction material

- **By-products are relatively safe** with combined ash considered non-hazardous in the U.S. and re-used in the EU and other countries for road construction and fabrication of blocks. Approximately one-third of the combined ash is approved for use as landfill cover in the U.S., with the rest landfilled with MSW or sent to a monofill where only ash is stored.

1:1 CO2 offset for each ton of waste processed

- **Avoided CO2 emissions** with the U.E. EPA estimating that c. one ton of GHG emissions are avoided for every ton of MSW waste processed at an WtE facility because of avoided methane emissions from landfills (methane is 20-25x more powerful than CO2), avoided CO2 emissions from fossil fuel combustion, and avoided CO2 emissions from metals production (because of metals recovered for recycling).

Creating renewable energy at an WtE facility is preferable to landfilling waste both for economic and environmental reasons

- **Supports recycling efforts** – Even with the best recycling efforts, millions of tons of MSW are still sent to landfills (c250mn tons in the U.S. every year). Moreover, U.S. communities with WtE facilities having a higher recycling rate than the national average (Source: Covanta)

Sustainable packaging, a US$200bn+ market (2015-18E)

In recent years, sustainable packaging is on the rise. It seeks to reduce the environmental footprint of packaging from cradle to grave and across the full supply chain – without hindering functional aspects. Packaging has a key role to play in reducing waste but is also responsible for up to 30% of waste in developed markets. The market for sustainable packaging is growing off the back of increasing regulation and consumer demand, and lower costs for FMCG and retail companies. For corporates, the supply-chain cost savings could be as high as 3-5% (Source: Accenture). It also presents a key business opportunity for packaging companies. While the EU and North America are the largest markets, EMs – particularly China and India – represent the fastest-growing markets.

The global sustainable packaging market was worth almost US$109bn in 2011 (Source: Transparency Market Research) – and is expected to grow to US178-US$212bn by 2015-18 based on varying estimates (Source: Transparency Market Research, Freedonia Group). Recycled content packaging has the highest market share and should maintain that position off the back of increased collection activity and processing capacity. But the highest growth is expected for reusable and degradable packaging given high energy costs incurred in the production processes of recycled packaging. The latter could see double-digit growth in the coming years albeit from a very low starting point (Source: Transparency Market Research, Freedonia Group).

Sustainable packaging in a nutshell

Recent years have seen a growing increase in green or sustainable packaging which seeks to reduce the environmental footprint of packaging from cradle to grave and across the full supply chain – from raw materials to packaging to retailers to consumers to end of life – without hindering functional aspects. Typically, this involves using life-cycle inventory (LCI) / life-cycle analysis (LCA), more recycled materials, reusing more packaging components, working with suppliers, packagers, and distributors, and reducing the carbon footprint.

Key role in preventing waste

Food waste has at least 10x the environmental impact of packaging waste

Primary packaging is designed to prevent waste and to get products efficiently and safely into consumers' hands. Clearly a balance has to be struck between under- and over-packaging, but research estimates that food waste has at least 10x the environmental impact of packaging waste. In Europe, less than 3% of food goes to waste between farm/factory and retail depot thanks to the benefit of effective packaging, whereas in EMs at least 30-35% of food never reaches consumers (Source: Rexam).

Packaging waste - 30% of waste

Waste generated by the production and transportation of packaging materials represents c30% of waste generated in developed markets.

Table 49: US packaging waste (1960-2007)

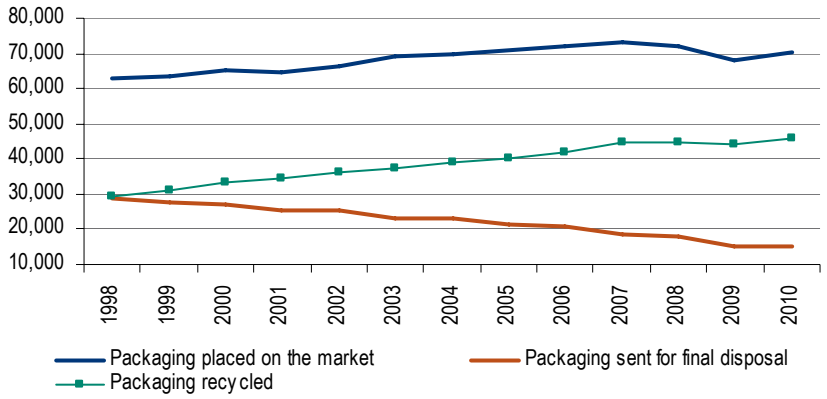
	1960	1970	1980	1990	2000	2005	2007	2008	2009	2010
Total MSW generated –Weight (000's tones)	88120	121060	151640	208270	242540	252660	255380	251360	243650	249860
Containers and Packaging	0.311	0.36	0.347	0.31	0.313	0.302	0.307	0.301	0.293	0.303
Recovery of Containers & Packaging Waste (% of Containers & Packaging)	0.105	0.077	0.161	0.26	0.381	0.413	0.433	0.45	0.48	0.485

Source: EPA,

Between 1998 and 2010, the tonnage of packaging placed on the market in EU-15 rose by 11.1% but the tonnage recycled rose by 53.5% (Source: EUROPEN).

Positively, the amount of developed-market packaging hitting the market has been increasing slower than consumer spending – partly because of a decoupling with economic growth and partly because of increased recovery rates.

Chart 71: EU-15 trends in packaging consumption, recycling and disposal ('000 tonnes)

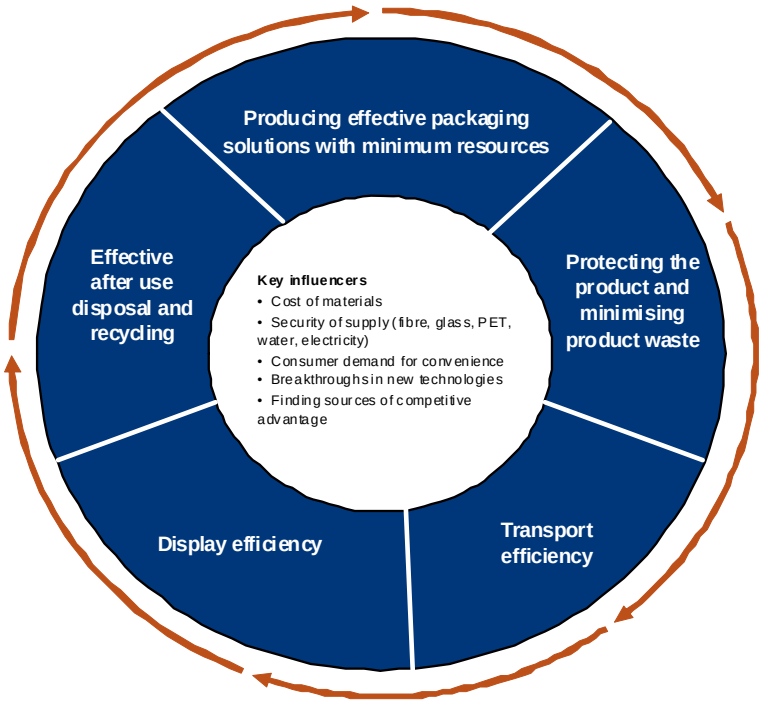


Source: EUROPEN

Sustainable packaging, criteria and factors

Governments, standards organizations, consumers, retailers, and packagers among others have all established green or sustainable packaging goals and targets across the goals of functionality, cost effectiveness, and HSE risk reduction (CEN Packaging Standards, ISO Packaging Standards, Global protocol on Packaging Sustainability et al).

Chart 72: Sustainable packaging



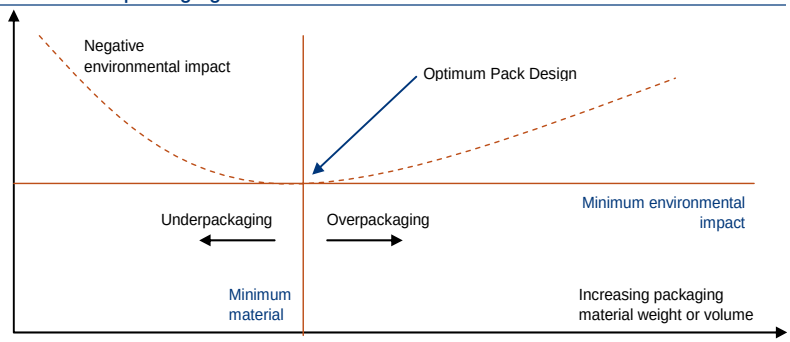
Source: PWC, BofA Merrill Lynch Global Research

SPC membership includes Altria, Best Buy, Campbell Soup, Coca Cola FedEx, General Mills, Kimberley-Clark, McDonalds, Pepsi, Tetra Pak, Unilever, UPS, and the US Postal Service among others – along with many of the largest packaging companies.

Sustainable Packaging Coalition's design factors

Among the specific sustainable design factors considered by the Sustainable Packaging Coalition – an industry working group dedicated to a more robust environmental vision for packaging – are that it: i) is beneficial, safe & healthy for individuals and communities throughout its life cycle; ii) meets market criteria for performance and cost; iii) is sourced, manufactured, transported, and recycled using renewable energy; iv) optimizes the use of renewable or recycled source materials; v) is manufactured using clean production technologies and best practices; vi) is made from materials healthy throughout the life cycle; vii) is physically designed to optimize materials and energy; and viii) is effectively recovered and utilized in biological and/or industrial closed loop cycle (end of life).

Chart 73: Sustainable packaging



Source: Innventia AB

Key roles for FMCG, retail & packaging companies

Companies are reusing and recycling packaging off the back reduced costs, consumer pressure and regulation.

The biggest sustainable packaging challenges arise vis-à-vis FMCG companies and retailers, which are seeing up to double-digit growth (in EMs) for packaging, with a knock-on effect on the packaging industry. They are all in turn influenced by government regulation and retailers and consumer's push for cost-effective, sustainable packaging:

- **FMCG** - Most of the majors have invested heavily in product development and innovation, and there is closer collaboration between retailers, suppliers and packaging manufacturers. Tensions have, however, arisen with regards to sustainability metrics and the impact on cost overheads;
- **Retailers** faced with the ongoing downturn and cost-conscious consumers are focusing on more efficient use of packaging materials. Food and grocery retailers have been leading the way in the US and Europe; and
- **Packaging manufacturers** who are often caught between the conflicting demands of multiple stakeholders are taking a more active role on sustainable packaging – by increasing its communication efforts, its role, and consumers' role in the life cycle. The downturn has seen them step up investments as they focus on the most effective use of resources (i.e. less material, lighter weight material, and more efficient processes for the production, distribution and disposal of products) (Source: PWC).

The EU minimum target of 55% packaging recycling was surpassed or reached by 12 Member States well ahead of schedule, with the remainder including the newer Member States to reach the same target between 2011 and 2015. Challenges remain, however, in making the packaging value chain even more sustainable. (Source: EUROPEN)

Increasing regulation on producers

Beginning with the European Packaging and Packaging Waste Directives, we have seen a concerted move across Europe in particular to ensure that a proportion of the packaging they place on the market is recovered and recycled. The EU is also amending its Emissions Trading Scheme (ETS) to cover transportation; these changes will result in charges being levied based on a product's carbon footprint (through a direct carbon tax or an indirect pass-through cost) (Source: Accenture)

Table 50: UK Packaging waste recovery and recycling targets for 2013-17

Material	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2016 (%)	2017 (%)
Paper/card	69.5	69.5	69.5	69.5	69.5	69.5
Glass	81	81	81	81	81	81
Aluminium	40	43	46	49	52	55
Steel	71	72	73	74	75	76
Plastic	32	37	42	47	52	57
Wood	22	22	22	22	22	22
Total recovery	74	75	76	77	78	79
Of which recycling	68.1	69	69.9	70.8	71.8	72.7

Source: Uk department for Environment, Food & Rural Affairs

Benefits for EMs

In less developed countries, absent or inadequate packaging, combined with weaknesses in distribution infrastructure, cause 30% to 50% of all food to decay before it reaches the end consumer.

Efforts to tackle "greenwash"

Environmental marketing claims sometimes need to be taken with a grain of salt given the lack of standardised or regulated definitions and practices. This has led to allegations of greenwash. Some regulators have moved to tackle the issue with the U.S. Federal Trade Commission (FTC) issuing guidance for the use of environmental marketing claims which tackles issues such as the: distinction between benefits of product, package and service; overstatement of environmental attributes; comparative claims; degradable / biodegradable / photodegradable; compostable; recyclable; recycled content; source reduction; and refillable, among others.

Up to a US$212bn market by 2015-18

The global sustainable packaging market was worth almost US$109bn in 2011 (Source: Transparency Market Research) – and is expected to grow to US178-US$212bn by 2015-18 based on varying estimates (Source: Transparency Market Research, Freedonia Group):

- **EU & North America – the largest markets**: Europe currently accounts for the largest share of the market, with around US$41bn spent followed by North America, which accounted for nearly US$33bn (and the US being the single largest national market). Europe is seeing faster growth than North America off the back of regulatory recycling requirements and less available land for landfills.

- **Asia-Pac is the fastest-growing market** with China, India and Indonesia moving in the area off the back of rising living standards, urbanisation, environmental awareness and growing FMCG and retail sectors. Reusable and degradable packaging is expected to grow at a fast pace from 2013-2018, although nascent consumer demand and regulation and poor recycling

infrastructure will act as brakes on development. Other fast-growing EMs include Brazil, Mexico, Russia and Turkey.

- **Recycled content packaging has the highest market share** and should maintain that position off the back of increased collection activity and processing capacity – along with packaging companies seeking to use greater recycled content including glass. Growth will, however, be slower than other segments because of the relative maturity of the market (e.g., aluminium cans, glass containers).

- **Highest growth is expected for reusable & degradable packaging** given high energy costs incurred in the production processes of recycled packaging. The latter could see double-digit growth in the coming years albeit from a very low starting point (Source: Transparency Market Research, Freedonia Group).

3-5% supply chain cost savings

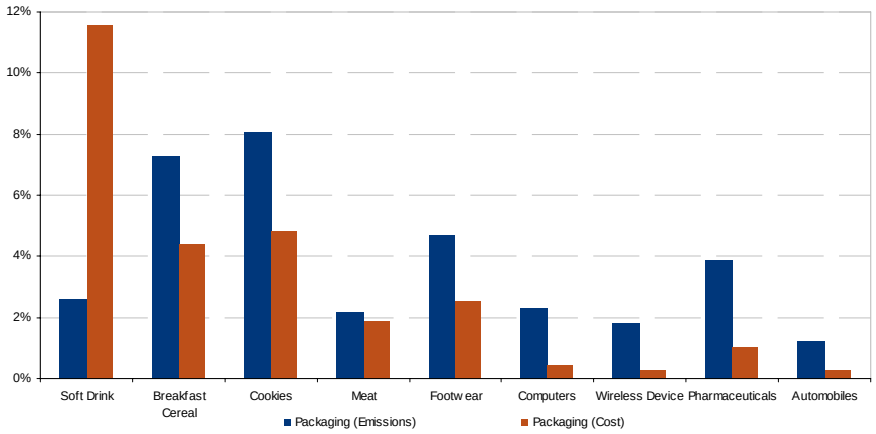
Retailers can realize a 3% to 5% supply-chain cost savings via sustainable packaging initiatives, in addition to potential sales uplift from environmentally or sustainability-oriented consumers (Source : Accenture)

US$3bn in cost savings for WalMart

With more than 100,000 suppliers, Wal-Mart has had pervasive influence on suppliers

In 2006, Wal-Mart mandated a 5% reduction in packaging across all product categories by 2013. As part of that initiative, it rolled out a supplier scorecard to help suppliers calculate their products' carbon footprints and to provide SKU-level detail. In 2012, WMT broadened its initial 15-question scorecard to 100 major categories, with category-specific questions; eg, for cereal, apparel, hardware, toys and electronics. Scorecard items include traditional questions for GHG emissions, energy efficiency and waste, as well as specific ones, for example, on laptops and the energy used during component manufacturing and chemical exposure to workers. For each category, suppliers will be ranked according to sustainability progress and action items. So far, the company estimates that over US$3.4bn of costs has been wrung out of the supply chain via reduced packaging content as a result of this initiative (Source: Accenture, PWC).

Chart 74: Percentage of cost and emissions due to packaging



Source: Accenture, BofA Merrill Lynch Global Research

Key opportunity for packaging companies

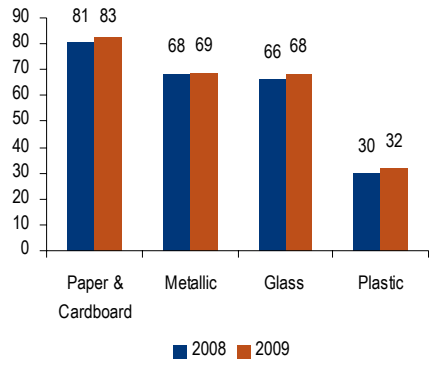
The growth in sustainable packaging presents an opportunity for packaging companies that play a key role in collecting used paper and cardboard, making recycled paper, and then turning it into packaging – the full recycled loop. Clearly, there is also a business interest given that recycling extends the life of natural resources and avoids landfilling costs.

Increasing collection rates is a must

The life cycle of wood fibres can be extended by using recovered (paper) fibres to produce new paper and board. As a result, EU collection rates have reached 80% and global rates are expected to increase off the back of EM potential and energy at the end of life from wood/fibres. In addition to the one-way development of regulation, maintaining and increasing collection rates will, however, be key in the coming years given challenges posed by:

- **Wood fibre availability vs bio-energy** – increasing use of wood for bio-energy with estimates of up to 57% by 2030 (vs. 45% in 20120) poses potential supply challenges (Source: EU). It is notable that in the past 25 years there has been little movement in virgin paper-based capacity in the Western (North American and European) markets (source: Smurfit Kappa), one of the reasons being access to word supply.
- **Growing demand from EMs** notably China, who rely on recovered paper because of low levels of collection rates of recovered fibres, mean increasing competition for fibres. China consumes c.34% of global old corrugated containers, and imports the majority of its requirement (source: RISI). This demand is expected to grow in the medium term given the rapid expansion of waste paper-based paper production capacity.
- **Increasing resource scarcity:** recycling paper will save up to 17 trees and reduce water use by 50% (Source: US Energy Information Administration).

Chart 75: EU packaging recycling rates (%)



Source: Smurfit Kappa

Recycling balanced with other sustainability challenges

Paper and packaging performance, air and water quality, energy required for transportation, sorting and de-inking and natural resource conservation are all factors that need to be weighed in gauging the costs and benefits of new fibre versus recovered fibre content. Moreover, increasing recovered fibre levels can have knock-on water and chemical-use impacts.

Packaging companies playing a greater role

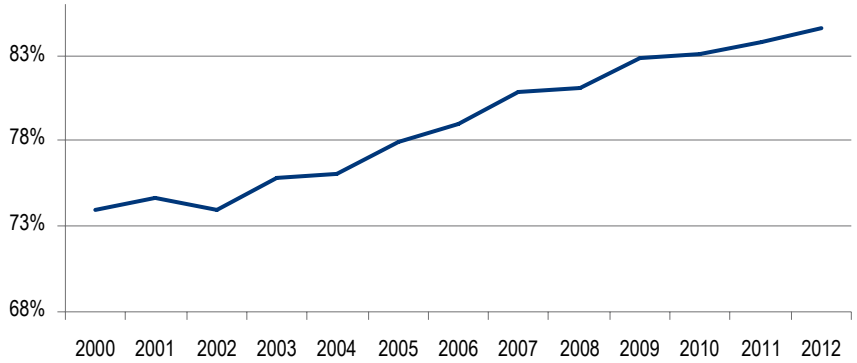
Packaging companies are placing a greater emphasis on recycled fibres including among others: Smurfit Kappa (fibre origin in 2011: 57% recycled pulp produced internally, 18% wood pulp produced internally, 18% recycled paper purchased, 6% virgin paper purchased, 1% market virgin pulp); UPM (recycled fibre represents 32% of fibre raw materials used in paper production), DS Smith (largest collector and recycler of used paper and cardboard in the UK), and International Paper (collect >6mn tons or 12% of U.S. fibre collection) (Source: companies). This was originally due to a combination of cost benefits (production cost lower for recycled material), access to a captive, sustainable, supply of wood (ownership and logistics) and the capital cost of new capacity (virgin capacity is roughly double the cost of recycled capacity).

The combination of wood fibre from sustainably managed forests and high recovery rates make paper one of the most sustainable products in the marketplace

New fibres need to be used sustainably

Paper and packaging cannot be sustained by recovered fibres alone as paper can be recycled only 6-7x before fibres degrade during reprocessing.

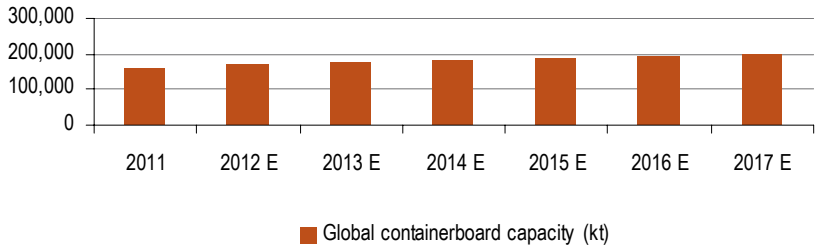
Chart 76: Global OCC recovery rates



Source: RISI

New virgin material (direct from wood pulp) must be introduced into the system in order to replenish fibre content. This is particularly relevant over the medium term as industry specialists (source: RISI) tell us that global waste paper recovery rates are near theoretical maximums (85%) suggesting virgin-based capacity must be added to satisfy demand growth over the medium term.

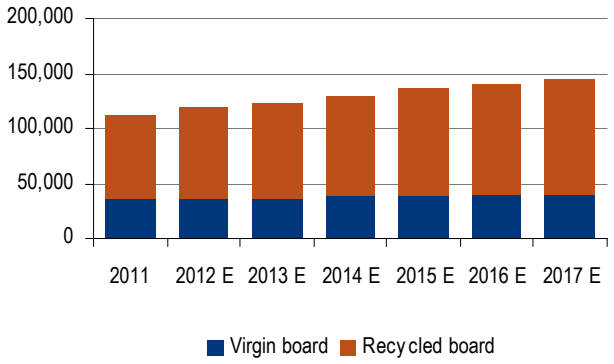
Chart 77: Global containerboard capacity is set to grow by 32mt over the next 5 years



Source: RISI

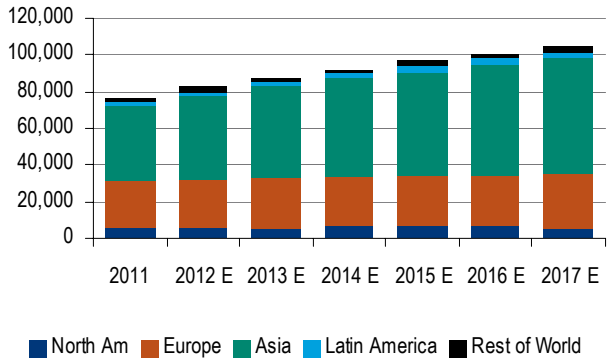
Increased Chinese testliner capacity is expected to be the key driver of global growth, accounting for 80% of the 23mt of growth anticipated in Asia and 56% of global capacity growth over the next five years.

Chart 78: Most new capacity is testliner...



Source: RISI, BofA Merrill Lynch Global Research

Chart 79: ...coming online in Asia



Source: RISI, BofA Merrill Lynch Global Research

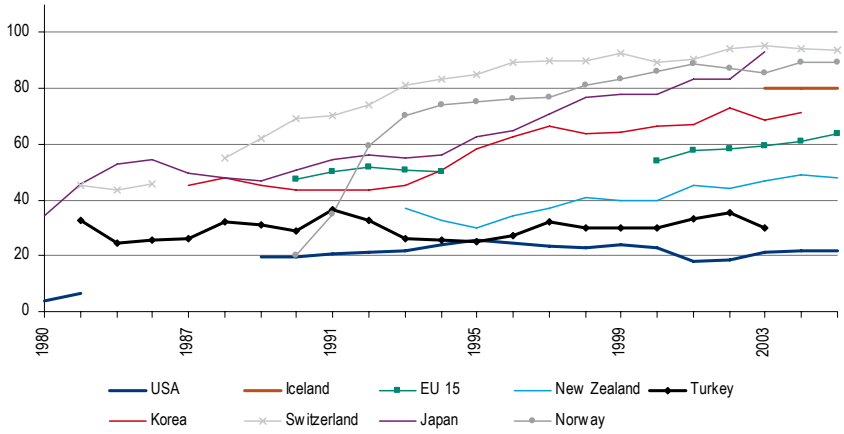
As a result, it is important to ensure that the new fibres used are managed sustainably and in a way that protects the environment – including certifications to recognised standards such as the Sustainable Forestry Initiative (SFI) procurement standard and to the SFI, Programme for the Endorsement of Forest Certification (PEFC) and Forest Stewardship Council (FSC) chain-of-custody Standards.

Beyond recycled fibres, companies are looking to develop lighter-weight solutions which are thinner and reduce CO21 emissions (more boxes per pallet etc), substitution e.g. bag-in-box over rigid plastic containers etc)

Role for glass, highly resource-efficient

There is an important role which can be played by glass given that it is a 100% and infinitely recyclable packaging material. Glass offers a number of advantages including: i) resource efficiency, a returnable glass bottle can be used up to 40x with no loss of quality; ii) energy efficiency, recycled glass (cullet) can substitute up to 95% of raw materials used to manufacture glass, reducing energy consumption as recycled glass has a lower melting point than natural raw materials; and iii) waste management, waste generated in the process can be used to generate energy by use of biomass and for every six tons of recycled glass used, one ton less CO2 is emitted. Along with regulation, this has played a key role in increasing glass recycling levels globally.

Chart 80: Trends in glass recycling



Source: OECD (2008b)

e-waste – US$50-100bn market

e-waste – discarded electrical or electronic devices – is on the rise around the world off the back of greater-take-up, growing production, churn / replacement and shortened life cycles. It is one of the fastest-growing waste segments and accounted for 40-50m tonnes of waste in 2010 (Source: UNEP). The US is the world's leading producer of e-waste with 3m tons each year, followed by China with 2.3m tons (Source: UNEP). According to UNEP; the amount of e-waste being produced, including mobile phones and computers, could rise by as much as 200-400% in China and South Africa and 500% in India (vs. 2007 levels)

It is estimated that only 15-20% of US e-waste is recycled (with rates far lower in EMs), while the remaining electronics go directly into landfills and incinerators (Source: US EPA). However, increasing regulation (e.g., EU's WEEE Directive) and environmental concerns are seeing a market develop for secondary raw materials recovery, with nearly 100% of input materials in e-waste able to be turned into "new" raw materials. For instance, one metric tonne of e-waste contains more gold than is recovered from 17 metric tonnes of gold ore (Source: UNEP). That said, there are significant HSE and trans-border trade issues at stake.

The broad e-waste industry is estimated at US$50-100bn globally (Source: Blumberg Associates, EWaste Systems). The recovery market – recycling/reuse of e-waste components – was estimated at US$13.9bn in 2012 (Source: Transparency and Markets). By 2020, it is estimated that it could grow to between US$25bn and US$44.3bn by 2017-20 (Source: Transparency and Markets, GBI). Recycled metals are the largest revenue generating segment accounting for over 50% of revenues of the e-waste recycled components market. e-waste will be one of the fastest-growing waste management segments globally with EMs set for the highest growth rates.

e-waste in a nutshell

e-waste – also known as electronic waste, e-scrap, or waste electrical and electronic equipment (WEEE) – describes discarded electrical or electronic devices. Depending on the definition, it can encompass the resale, reuse, and refurbishing industries, or only a product that can no longer be used for its intended purpose. It typically covers discarded PCs, office electronic equipment, entertainment device electronics, mobile phones, television sets and refrigerators – as well as associated re-usables and recovered secondary raw materials.

50m tons produced a year, <20% recycled

The US discards 30m computers each year and the EU 100m phones

Rapid changes in technology, changes in media, falling prices, and planned obsolescence have resulted in a growing surplus of e-waste – with an estimated 50m tons produced each year (Source: Sthiannopkao et al 2012).Globally, e-waste generation is growing by 40m tons per year. This is equivalent to filling around 15,000 football fields six feet deep with waste (Source: US EPA). The US is the world's leading producer of e-waste with 3m tons each year, followed by China with 2.3m tons (Source: UNEP). It is estimated that only 15-20% of US e-waste is recycled (with rates far lower in Ems) the rest goes directly into landfills and incinerators (Source: US EPA).

Table 51: What we bought

	US Sales – what we bought			Global Sales – what we bought			
	2010	2011	2012	2010	2011	2012	Future year projections
Computers							
Computers: desktop laptop (ex-tablet)	71.7 mn	68.7mn	23.5mn laptops only	350.9mn	352.8mn	404mn	
Tablets (incl e-readers)		54.8mn	36.4mn	19.5mn	72.7 mn	103.4mn	383.2mn by 2017
- iPads			81 mn				
Servers							
Printers							
Printers, multi's, digital copiers	27.9mn						
Televisions							
All televisions	34.1mn			247mn	248mn	254mn	
LCD TVs				195mn	206mn		
Cell Phones							
All cell phones	235.6mn			1.211bn	1.59bn		
Smart phones	65mn	95mn	108.8mn	304.7mn	491.4mn		>1bn by 2015
iPhones			190mn	47mn	93mn		

Source: Gartner Quarterlies, CEA, Displaysearch, IDC, EPA, iSuppli

Up to 500% growth over next 10 years

According to UNEP; the amount of e-waste being produced – including mobile phones and computers – could rise by as much as 200-400% in China and South Africa and 500% in India (vs. 2007 levels). By that same year in China, e-waste from discarded mobile phones will be about 7x higher than 2007 levels and, in India, 18x higher. By 2020, e-waste from televisions will be 1.5x to 2x higher in China and India while in India e-waste from discarded refrigerators will double or triple (Source: UNEP).

Table 52: US e-waste – trashed or recycled (2010)

Products	Total disposed	Trashed	Recycled	Recycling rate
Computers	423,000	255,000	168,000	40%
Monitors	595,000	401,000	194,000	33%
Hard copy devices	290,000	193,000	97,000	33%
Keyboards & mice	67,800	61,400	6,460	10%
TVs	1,040	864,000	181,000	17%
Mobile devices	19,500	17,200	2,240	11%
TV peripherals	NA	NA	NA	NA
Total	2,440,000	1,790,000	649,000	27%

Source: US EPA, BofA Merrill Lynch Global Research

Valuable secondary raw materials recovery

Nearly 100% of the input waste material can be turned into new raw materials

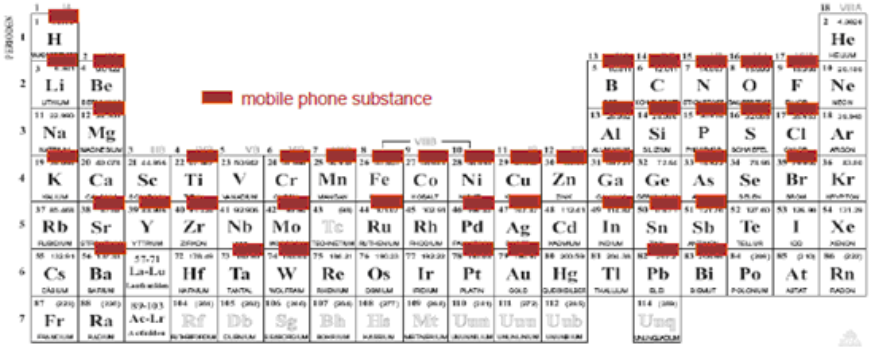
Audiovisual components, TVs, VCRs, DVDs, stereos, mobile phones, tablets, and computer components contain precious metals such as gold, silver, platinum, etc. and base metals such as aluminium, copper, and iron. e-waste recycling is evolving as a business off the back of diversion of such WEEE from energy-intensive downcycling processes (e.g., conventional recycling) to reverting it to a raw material form via sorting, dismantling, recovery of valuable secondary raw materials, reuse and refurbishment. Given sufficient tonnage available as feedstock, the productivity of such engineering has resulted in it being approximately 17x more productive to mine one ton of e-waste than it is to mine one ton of gold ore from the ground (Source: EWaste Sytems)

Recovery can be done via melting circuit boards, burning cable sheathing to recover copper wire, open-pit acid leaching for separating metals of value, mechanical shredding and separation – and emerging solutions such as cryogenic decomposition.

Recycling 1m cell phones can recover about 24kg (50lb) of gold, 250kg (550lb) of silver, 9kg (20lb) of palladium, and >9,000kg (20,000lb) of copper

- **Recycling 1m cell phones** can recover about 24 kg (50 lb) of gold, 250kg (550 lb) of silver, 9kg (20lb) of palladium, and more than 9,000kg (20,000lb) of copper.
- **A ton of electronic scrap from PCs** contains more gold than is recovered from 17t of gold ore (Source: US EPA)

Chart 81: Material content of mobile phones



Source: Umicore based on Nokia

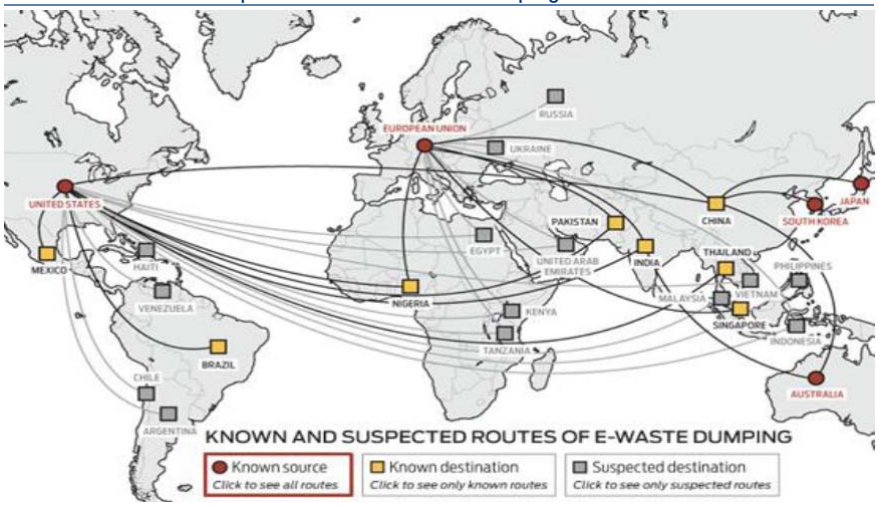
Up to 80% of US WEEE directed to recycling is exported

Guiyu, China is known as the "e-waste capital of the world", employing over 150,000 e-waste workers dis-assembling WEEE and recovering metals and parts

Global trade controversies & EMs

There is growing controversy and trade disputes over the belief in some circles that EMs have become toxic dump yards for e-waste. Cost is key – as it is up to 10 times cheaper to export e-waste to EMs than it is to recycle locally. Though some e-waste exportation is legal, a large portion is illegal or unregulated (e.g. "used" or "second-hand" WEEE are often not subject to any restrictions). For instance, in the US, where federal regulation on e-waste and the export of toxic waste is lacking, as much as 80% of WEEE directed for recycling is not done so domestically (Source: Basel Action Network), but is exported to countries, such as China, India, Pakistan, the Philippines and Africa. In 2011, some 162m tons of e-waste was recycled in China, 2x the amount in 2005, with a total value of RMB571.5bn (US$91.8bn), up by 12.7% compared with 2010 (Source: China Resource Recycling Association). By 2020, it is estimated that up to 70% of global e-waste will be processed in China (Source: Communications Information News).

Table 53: Known and suspected routes of e-waste dumping



Source: ISWA based on Silicon Valley Toxics Coalition, Electronics Take Back Coalition, The Story of Stuff Project

From a trade perspective, there is growing concern over the loss of potential revenues from resource extraction and recycling of materials such as copper, silver and gold, as well as "retained" value creation via refurbishment.

- **Opponents** of the trade point to the lower environmental and social standards in WEEE importing countries – and argue there is a transfer of pollution-generating activities (e.g. open fire melting of WEEE).
- **Proponents** of the trade say it creates jobs, affordable products, and that growth of internet access is a stronger correlation to trade than poverty

Health, safety & environmental (HSE) risks

A typical 15-inch cathode ray tube contains 1.5lb of lead

WEEE scrap components may contain contaminants such as lead, cadmium, beryllium, or brominated flame retardants. Moreover, the processes of dismantling and disposing of WEEE, frequently in EMs, exposes workers to HSE risks and liquid and atmospheric releases to water, groundwater, soil and air. Among the hazardous materials found in WEEE are: Americium (radioactive source in smoke alarms); mercury (fluorescent tubes, switches, flat screens); sulphur (lead-acid batteries); BFRs (flame retardants in plastics in most electronics); cadmium (light-sensitive resistors, corrosion-resistant alloys, ni-cad batteries); lead (solder, CRT monitor glass, lead-acid batteries, PVC); beryllium oxide (filler in some thermal interface materials, magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, gas lasers), perfluorooctanoic acid (electronics); hexavalent chromium. There is also evidence of cytotixic and genotoxic effects of some chemicals.

Table 54: Potential environmental risks from e-waste

E-Waste Component	Process Used	Potential Environmental Hazard
CRTs (cathode ray tubes used in TVs, computer monitors, ATM, video cameras etc)	Breaking and removal of yoke, then dumping	Lead, barium and other heavy metals leaching into the ground water and release of toxic phosphor
Printed circuit board (image behind table - a thin plate on which chips and other electronic components are placed)	De –soldering and removal of computer chips; open burning and acid baths to remove final metals after chips are removed.	Air emissions as well as discharge into rivers of glass dust, tin, lead, brominated dioxin, beryllium cadmium, and mercury
Chips and other gold plated components	Chemical stripping using nitric and hydrochloric acid and burning of chips	Hydrocarbons, heavy metals, brominated substances discharged directly into rives acidifying fish and flora. Tin and lead contamination of surface and groundwater. Air emissions of brominated dioxins, heavy metals and hydrocarbons

Table 54: Potential environmental risks from e-waste

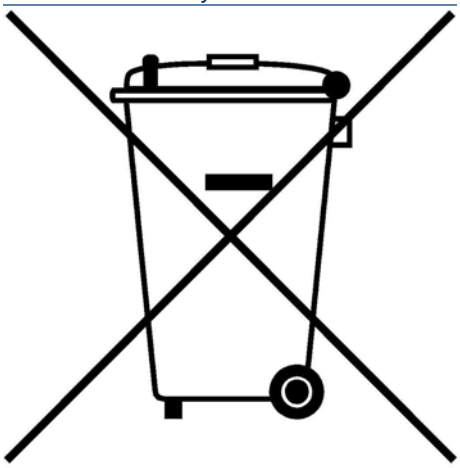
E-Waste Component	Process Used	Potential Environmental Hazard
Plastics from printers, keyboards, monitors, etc.	Shredding and low temp melting to be reused	Emissions of brominated dioxins, heavy metals and hydrocarbons
Computer wires	Open burning and stripping to remove copper	Hydrocarbon ashes released into air, water and soil.

Source: Dutt & Chakrabarti (2011)

Cyber-security concerns

e-waste presents a potential cyber-security threat – both to individuals and exporting countries (i.e., hard drives not properly erased, sensitive information, financial data). It is also becoming a "homeland" security issue – with instances of national security WEEE resurfacing in importing countries.

Chart 82: EU WEEE symbol*



Source: European Commission. * The black line indicates that goods have been placed on the market after 2005, when the Directive came into force

EU's WEEE, highest regulatory standard in world

The EU's Waste Electrical and Electronic Equipment Directive (WEEE) became European Law in February 2003 – and sets collection, recycling and recovery targets for all types of electrical goods, with a minimum rate of 4kg per head of population per annum recovered for recycling. In 2012, the WEEE was amended – with the 4kg goal retained for 4Y followed by a 3Y period where the calculation of collection rates will be revised to 45% of the weight of E&E products entering the market. Once this seven-year transitional period is over, EU member states will individually select the actual collection options they wish to use. The overall aim is for the EU to recycle at least 85% of electrical and electronics waste equipment by 2016 (2021 for new member states).

10 categories of WEEE

The WEEE directive sets a total of 10 categories of WEEE for reporting purposes: large household appliances; small household appliances; IT and telecommunications equipment; consumer equipment; lighting equipment; electrical and electronic tools; toys, leisure and sports equipment; medical devices; monitoring and control instruments; automatic dispensers

Responsibility is on the manufacturers

The directive imposes the responsibility for the disposal of WEEE on the manufacturers or distributors of such equipment. It requires that these companies establish an infrastructure for collecting WEEE, in such a way that "Users of electrical and electronic equipment from private households should have the possibility of returning WEEE at least free of charge". It has seen the formation of national "producer compliance schemes", into which manufacturers and distributors paid an annual fee for the collection and recycling of associated waste electronics from household waste recycling centres.

US Responsible Electronics Recycling Act (RERA)

The bill is publicly supported by electronics companies such as Apple, Best Buy, Dell, HP, LG, Samsung and several environmental groups

A growing number of electronics recyclers have come out in support of a new federal bill, The Responsible Electronics Recycling Act (RERA). The Bill is set to be introduced in Congress and would: i) prohibit the export of restricted electronic waste to developing countries; ii) establish criminal penalties for knowingly exporting restricted electronic waste; iii) increase EPA oversight of electronic waste handling and disposal; and iv) curb fraudulent labelling of refurbished electronics. The underlying goals are to grow the domestic electronic recycling industry, while avoiding social and environmental risks in EMs, fraudulent recycling schemes, and cyber-security threats.

US$50-100bn broad market

The broadly defined e-waste industry encompasses e-waste recyclers – as well as aftermarket electronic equipment brokers, OEMs with internal take-back programmes, non-profit recycling organizations, scrap dealers, warranty and non-warranty repair firms and asset management firms. This broad market is estimated at US$50-100bn globally (Source: Blumberg Associates, EWaste Systems).

US$13bn market for recovery, US$44bn by 2020E

The global e-waste recovery market – recycling/reuse of e-waste components – was estimated at US$13.9bn in 2012 (Source: Transparency and Markets). It is estimated that it could grow to US$25bn to US$44.3bn by 2017-20 (Source: Transparency and Markets, GBI). Recycled metals are the largest revenue generating segment, accounting for over 50% of revenues of the e-waste recycled components market.

Small, regional & fragmented market

The market is extremely fragmented, with the largest processor, a division of Sims Metals, processing less than 3% of worldwide tonnage. Most operators are small and regionally focused, with only a few or limited services (Source: EWaste Systems).

BIllions in cost savings for corporates

For corporates involved with e-waste, WEEE recycling programmes can help them avoid billions in costs. For instance, nearly 90% of the phones collected by Sprint are reused in some capacity. Sprint is looking to get back nine out of every 10 phones it sells by 2017. It is also targeting to collect 100% of its e-waste by 2017, estimating that e-waste recycling avoids US$1bn in costs by 2017.

The average American or European consumer wastes 95-115kg (209-254lb) of food a year vs 6-11kg (13-24lb) in Sub-Saharan Africa, South Asia and South-east Asia (Source: UN FAO)

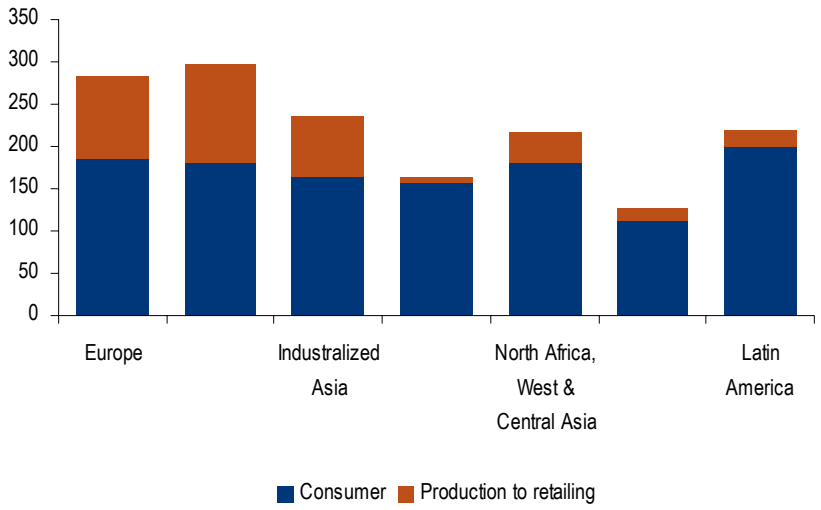
Food – 1/3 lost or wasted

According to the UN's Food and Agriculture Organisation (FAO), one-third of food produced is wasted (about 1.3bn tonnes) – with some stakeholders estimating the amount to be as high as 40-50% in the U.S and UK. Food loss and waste means higher prices for consumers and lost income for small farmers – and comes in the face of close to 1bn people being undernourished globally and increasing risks of crop failure in many countries due to climate change, leading to rising food prices and thus food crisis.

Food waste in a nutshell

Definitions of food waste vary according to factors like what food waste consists of, how it is produced, and where or what it is discarded from or generated by. The US EPA defines it as "uneaten food and food preparation wastes from residences and commercial establishments, such as grocery stores, restaurants, and produce stands, institutional cafeterias and kitchens, and industrial sources like employee lunchrooms". Some stakeholders make further distinctions between food waste and food loss, which refers to supply chain-related losses via production, post-harvest and processing (Source: Swedish Institute for Food and Biotechnology for UN FAO).

Chart 83: Per-capita food losses and waste (kg/year)



Source: UN FAO

Impacts felt at all stages of value chain

Food waste occurs at most stages of the food value chain with the largest losses for fruit and vegetables (percentage, volumes, financial, energy):

- **Production / harvest** – food production (pest infestations, extreme weather), harvesting (ripe vs immature crops, lack of 100% collection), quality regulations and standards / consumer preferences (selective harvesting)
- **Post harvest stage** – storage (extreme weather, pests and microorganisms, EMs), handling, shrinkage
- **Processing** – quality, food safety regulations (especially for meet and dairy),

- **Retail** – packaging (protection and freshness vs), best before / sell by dates, contractual arrangements with suppliers (surplus production to avoid failure to supply agreed quantities)

Food loss and waste has an "immediate and significant" impact on livelihoods and food security in some of the world's poorest countries." – Swedish Institute for Food and Biotechnology

Hits EMs and developed markets equally

Food waste is estimated at 670m tonnes in developed markets and 603m in EMs (Source: AO). That said, both face different challenges with developed countries wasting food at the level of the consumer and food retail vs. EMs, losing it because of poor infrastructure:

- **EMs** – the supply chain is the #1 source of loss/waste, accounting for 40%+ of losses at the post harvest and processing stages (vs. developed markets: 40%+ at the retail and consumer stage). Reasons include poor storage facilities (warm/humid climates, rodents, parasites, fungus); poor infrastructure and transportation, inadequate refrigeration; scarce market facilities (unsanitary, crowded, unrefrigerated; poor packaging).

- **Developed markets** – loss/waste arises via quality standards (photogenic sensors, aesthetic defects = <25-30% (brightness, blend/blemish, broken): food manufacture (sorted-out potatoes <10%, trimming scraps 2-12%, sorted-out French fries 1-10%, transport losses during processing 1-10% ; poor environmental conditions during display (temperature management, 55% of fruit and vegetable waste); lack of waste planning; (central or local kitchen, lack of communication/coordination, storage for next day vs. safety); best-before / use-by dates (55% UK, food still good to eat); leftovers (42% UK households: cooking, preparing, serving) (Source: FAO))

Table 55: Food loss & waste per person/year

Food loss & waste per person/year	Total	Production & retail stages	Consumers
North America and Oceania	295 kg (650 lb)	185 kg (410 lb)	110 kg (240 lb)
Europe	280 kg (620 lb)	190 kg (420 lb)	90 kg (200 lb)
Industrialized Asia	240 kg (530 lb)	160 kg (350 lb)	80 kg (180 lb)
Latin America	225 kg (500 lb)	200 kg (440 lb)	25 kg (55 lb)
North Africa, West and Central Asia	215 kg (470 lb)	180 kg (400 lb)	35 kg (77 lb)
Sub-Saharan Africa	160 kg (350 lb)	155 kg (340 lb)	5 kg (11 lb)
South and Southeast Asia	125 kg (280 lb)	110 kg (240 lb)	15 kg (33 lb)

Source: Swedish Institute for Food and Biotechnology for UN FAO

Food wasted by consumers in developed markets is equal to the entire food production of sub-Saharan Africa

Economic impact of food waste is US$200bn in the US alone

The economic impact of food waste in the US alone is equivalent to US$198bn (Source: Barilla Center for Food & Nutrition). BCFN estimates that waste during the consumption stage in the US is equivalent to US$124bn. The costs on average for a family of four are about US$1,600 a year. In the distribution state, food waste equals US$64.6bn.

Solutions

EM efforts need to focus on producer

With some of the biggest food waste challenges occurring in EMs, the FAO believes that measures should, at the foremost, have a producer perspective, e.g. by improving harvest techniques, farmer education, storage facilities and cooling chains.

Industrialised country efforts need to focus on consumers

In industrialized countries on the other hand, the FAO believes that solutions at producer and industrial level would only be marginal if consumers continue to waste at current levels. Consumer households need to be informed and change the behaviour which causes the current high levels of food waste (e.g. improved communication in supply chains, awareness, consumer power, improved purchase and consumption planning, education (best-before-dates)). Some stakeholders argue in favour of reducing reliance on big food retailers.

Role for sustainable packaging

Food waste has at least 10x the environmental impact of packaging waste

Primary packaging is designed to prevent waste and to get products efficiently and safely into consumers' hands. Clearly a balance has to be struck between under- and over-packaging, but research estimates that food waste has at least 10x the environmental impact of packaging waste. In Europe, less than 3% of food goes to waste between farm/factory and retail depot thanks to the benefit of effective packaging, whereas in EMs at least 30% to 35% of food never reaches consumers (Source: Rexam).

Food retailers & food waste

Retail stores can throw away large quantities of food. Usually, this consists of items that have reached their either their best before, sell-by or use-by dates. Food that passed the best before, and sell-by date, and even some food that passed the use-by date is still edible at the time of disposal, but stores have widely varying policies to handle the excess food. Some stores put effort into preventing access to poor or homeless people, while others work with charitable organizations to distribute food.

Link to Definitions

Industrials

Click here for definitions of commonly used terms.

Macro

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
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