METALS FOCUS

SILVER SCRAP:
THE FORGOTTEN FUNDAMENTAL

PREPARED FOR

THE SILVER INSTITUTE

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ABOUT METALS FOCUS

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1. EXECUTIVE SUMMARY

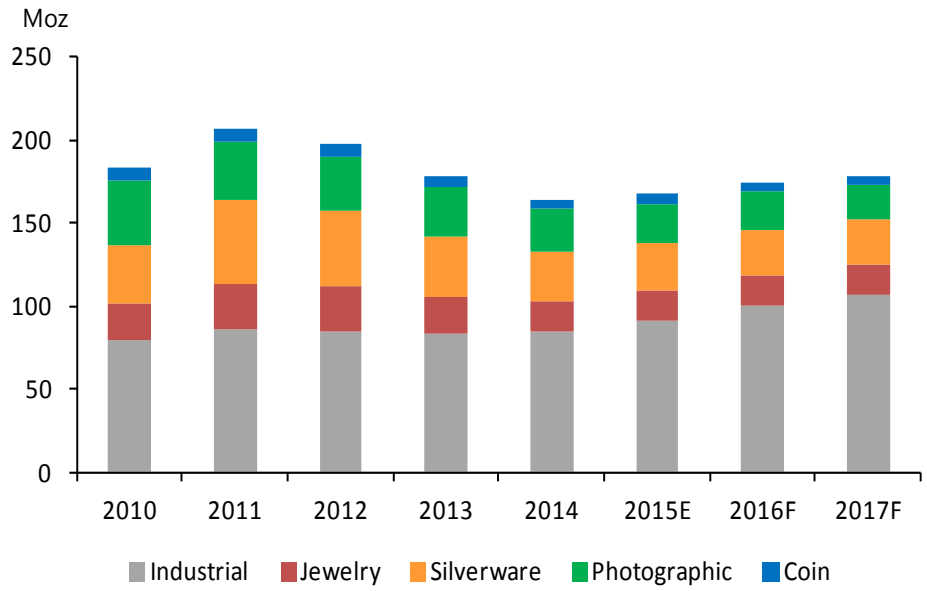
1.1 INTRODUCTION

The recycling of silver is one of the most opaque and complex areas of all the precious metals' fundamentals. This has the potential to create a disconnect between current statistics and the true volume recovered. It was therefore felt that a thorough investigation of silver scrap was needed and we are delighted to have been commissioned by the Silver Institute to carry out the research required. This concern over the accepted scale of recycling has been justified by this report as our findings point to some recent years' volumes being more than 10% lower than we once thought, and this obviously impacts on projected volumes. The timing of the study is also opportune, as the end of the silver bear market appears to be in sight and so we can properly judge how scrap has fared in an era of lower prices and how it might behave looking ahead.

As for the outlook, it is worth noting that structural factors almost guarantee a continued fall in photographic scrap and this, combined with a depleted pool of near-market silverware, leads us to forecast that total recycling will stagnate out to 2017, even with a price recovery. This report therefore provides concrete evidence for a positive development in the fundamentals.

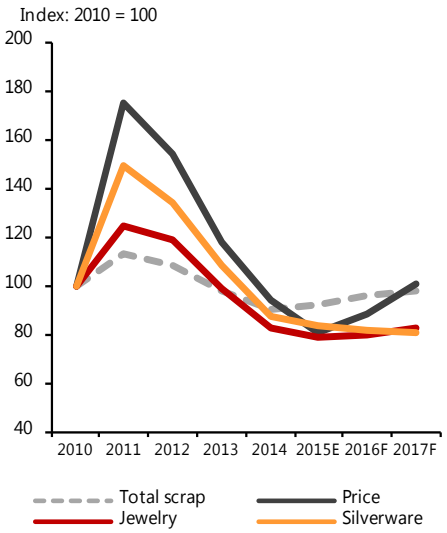
This report includes a chapter on the division by region and also one by sector, or source material, which we classify as industrial end-uses, jewelry, silverware, photography and coins. This sectoral analysis is perhaps the most important as it provides the key insights needed for a robust forecast. The study also provides for the first time ever, to our knowledge, data on the division by sector at the regional level. Lastly, we review the key drivers behind the scale of scrap.

The Recycling of Silver by Sector



Source: Metals Focus

Price Sensitive Scrap



Source: Metals Focus

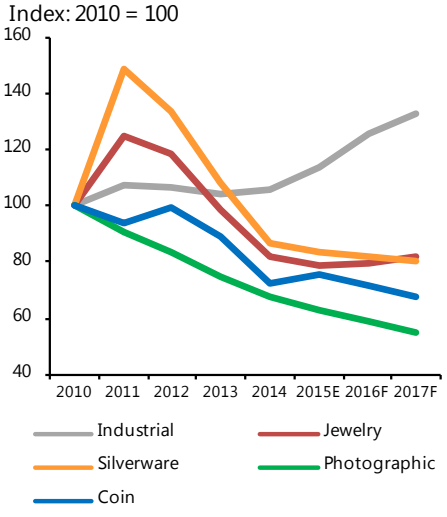
1.2 RECYCLING IN RECENT YEARS

Our period under review began with robust growth, as scrap in 2011 rose by 13% to 206.7 Moz (6,430t). Volumes then fell steeply to just over 164 Moz (5,100t) in 2014, a combined drop of 21%. Much was driven by the rise and fall of the silver price, and in particular its impact on silverware and those elements within industrial scrap where profitability of recovery is price sensitive. Economic distress also boosted scrap, not just by hard pressed consumers disposing of old pieces, but also via the trade's melt of slow selling jewelry and silverware. Background forces boosting volumes included growth in the above-ground stock of fabricated goods, in particular industrial end-uses, and environmental legislation tending to become tighter. Countering that were other factors such as the historic decline in photographic fabrication due to digital inroads.

By sector, silverware was the largest driver of the above trends. This might surprise given its modest fabrication today, but that only highlights other factors important for scrap, namely the large above-ground stock of the product and a high value per piece (compared to jewelry). The West and India were the prime drivers of the rise and fall in scrap, whereas Chinese recycling rose every year, largely as a result of growing scrap from the ethylene oxide (EO) sector.

Our figures for this period have been notably trimmed as a result of the research done for this report, with the largest being 2011's cut of 23.5 Moz (730t). Much was due to the lack of evidence for any substantial recycling from electrical applications, and photographic scrap having fallen faster than expected.

Forecast Scrap Index



Source: Metals Focus

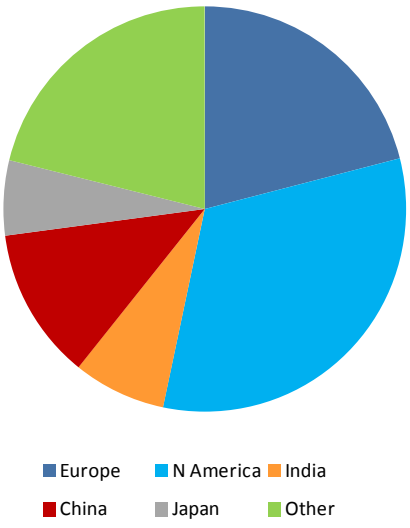
1.3 THE OUTLOOK FOR RECYCLING

Following three consecutive years of losses, silver recycling is projected to increase at the margin, to 168 Moz (5,210t) in 2015. Further modest gains are then expected in the next two years. This relatively steady performance is premised on assumptions that higher industrial recycling will be partly offset by uninterrupted losses in photographic, silverware and coin scrap.

The rise in industrial scrap should primarily come from the silver recovered from EO catalysts as capacity expansions, centered on China, continue. Growth in silver recovered from electronics and electrical sources, however, is expected to be muted, as rising gross volumes and tighter waste disposal legislation will be countered by falling silver grades per unit. Jewelry scrap should also ultimately rise, if only modestly, as price-led gains in emerging markets, especially India, counter ongoing falls in the West.

In contrast, heavily depleted near-market stocks and the absence of distress selling in the West mean that silverware recycling should fall out to 2017, even with India's price-led gains. A larger decline is forecast for photographic scrap, as the knock-on effects of earlier fabrication losses continue, chiefly through declining recovery from x-rays. Lastly, coin scrap should also fall as we see recent years' high level of old circulating coin melt as unlikely to continue.

Recycling by Region, 2014



Source: Metals Focus.

1.4 RECYCLING BY REGION

The West is the main source of recycled silver, accounting for just over half the global total right through from 2010 to 2015. Within that, North America contributes most, but that is mainly a function of the large volumes of silver recovered from imported and domestic EO catalysts. Europe in contrast has unusually large contributions from silverware and coins, respectively making up around 30% and 70% of the global total in those categories. These sizable and usually price sensitive sectors also largely explain why European scrap fell heavily in 2013 and 2014, cutting the latter year to 34.5 Moz (1,072t) from the 2012 high of 46.0 Moz (1,430t).

A high volume of recycled silverware also meant India was the largest supplier within Asia over 2010-2013, yielding then an annual average of 18.9 Moz (588t). However, it slipped behind China in 2014, due to a slump in volumes from its price sensitive stock of silverware and, to a lesser extent, jewelry. Scrap from the latter is important because of its scale (India accounts for the largest share of the global total) and of interest because most scrap comes from individuals, not the trade as is the case in the industrialized world.

India and China are good examples of countries where the adoption of further environmental legislation and rising compliance could lift industrial scrap. However, that is only a minor factor in the relentless gains that China sees, with its silver recycling more than doubling from 13.3 Moz (415t) to a forecast 34.2 Moz (1,063t) in 2017. A far more potent factor is the marked growth in its EO sector. Indeed, if we remove that, China would have seen price-led losses like the rest of the world in 2013 and 2014 and only modest gains for 2015-2017. Japanese scrap is also dominated by its industrial component, with that accounting for 76% of the country's total on average for 2010-2017.

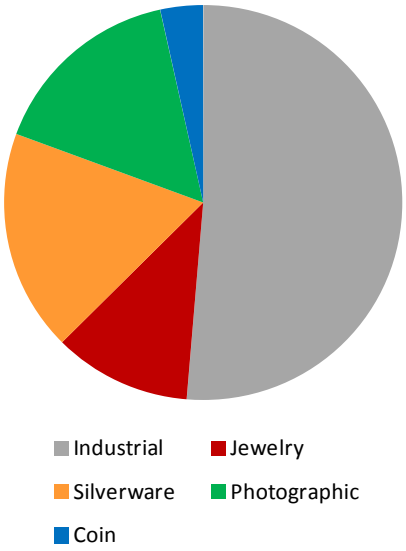
Recycling elsewhere in the world largely concerns the Middle East in conjunction with North Africa, Russia and the rest of East Asia; each contributed 8-9 Moz (250-280t) last year. Within East Asia's second tier, the largest two are Taiwan and then Thailand, while in the Middle East, the most important is Turkey.

Silver Recycling by Region

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	39.9	45.6	46.0	39.1	34.5	33.7	32.4	31.3
N America	55.6	67.0	58.2	54.8	53.1	51.9	54.1	52.0
India	16.4	19.3	22.2	17.7	12.2	12.8	13.6	14.2
China	13.3	15.3	15.5	17.3	19.9	25.1	29.1	34.2
Japan	10.4	10.7	9.9	10.1	9.8	10.0	10.4	11.0
Other	47.2	48.7	45.5	39.2	34.7	34.0	34.6	35.4
Total	**182.9**	**206.7**	**197.4**	**178.2**	**164.2**	**167.5**	**174.3**	**178.0**

Source: Metals Focus

Recycling by Sector, 2014



Source: Metals Focus.

1.5 RECYCLING BY SECTOR

Industrial scrap is the most important sector, comprising 51% of all scrap in 2014. Within that, North America accounts for the largest share, at around 40% of the global total. That is mainly due to the large contribution from EO scrap, which globally accounts for nearly 50% of industrial scrap. EO scrap is primarily a function of catalyst changeouts, while its growth is mainly due to capacity expansion. That makes it very different to the rest of industrial scrap, which is chiefly driven by the silver price, environmental legislation (which is tending to strengthen with time) and the pool of product (which is growing in most segments). Within this mix, it was largely the price rally that fueled scrap's 7% rise in 2011 but, when prices eased, the other two were sufficient for industrial recycling to essentially plateau at 83-85 Moz (2,580-2,640t) through to 2014. These three key forces and ongoing growth in EO scrap should then combine to lift industrial scrap to around 106 Moz (2,800t) by 2017.

The second largest portion of scrap comes from **silverware**, with its average share of the total for 2010-2014 standing at 21%. This might surprise given today's modest demand, but this highlights the importance of above-ground stocks and a relatively high price per piece. Silverware scrap is price sensitive, and this helps explain its 49% surge to over 50.7 Moz (1,577t) in 2011 and its slump to 29.6 Moz (922t) last year. With a depleted pool of near-market product and less distress selling, volumes should continue contracting, if only slowly, out to 2017. **Jewelry** scrap is smaller than for silverware, despite far larger consumption. This largely reflects the low value per item, which limits consumers' incentive to sell in its key western markets. It can also be price responsive and it too grew strongly in 2011 before retreating through to 2014. Volumes are forecast to stagnate out to 2017, despite a forecast of firmer prices.

Photographic scrap is experiencing structural decline as a lagged result of the deep inroads that digital technologies made into photographic fabrication. This largely explains the relentless decline in this scrap from 38.6 Moz (1,202t) in 2010 to 21.0 Moz (653t) by 2017, a trend that cuts its share of the global total from 21% to 12%. That just leaves the small segment of **coin** scrap. This is primarily derived from the melt in the West of unsold commemorative coins and old circulating coins and is therefore not classified as disinvestment.

Silver Recycling by Sector

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	79.8	85.6	85.2	83.2	84.3	91.1	100.1	105.8
Jewelry	22.4	27.9	26.5	22.1	18.4	17.7	17.9	18.4
Silverware	34.1	50.7	45.5	37.0	29.6	28.5	27.9	27.4
Photographic	38.6	35.1	32.2	28.8	26.1	24.3	22.7	21.0
Coin	7.9	7.4	7.9	7.1	5.7	6.0	5.7	5.3
Total	**182.9**	**206.7**	**197.4**	**178.2**	**164.2**	**167.5**	**174.3**	**178.0**

Source: Metals Focus

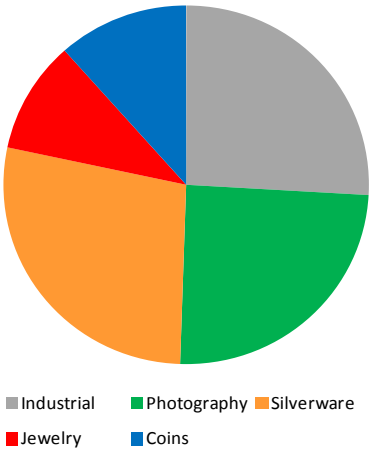
The Regional Breakdown of Silver Recycling by Sector

Moz		2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial									
	Europe	8.6	10.2	10.5	9.5	8.9	9.2	9.4	9.7
	N America	32.2	33.6	33.6	33.7	34.0	34.3	37.4	36.1
	India	3.8	4.5	5.1	3.6	3.6	4.0	4.3	4.7
	China	10.0	11.6	12.2	14.1	16.6	21.8	25.6	30.5
	Japan	7.6	7.9	7.2	7.5	7.4	7.7	8.3	8.9
	Others	17.5	17.8	16.5	14.8	13.8	14.1	15.0	15.9
	Sub-total	**79.8**	**85.6**	**85.2**	**83.2**	**84.3**	**91.1**	**100.1**	**105.8**
Jewelry									
	Europe	3.3	4.3	5.2	4.1	3.5	3.3	3.1	3.0
	N America	3.0	5.8	3.8	3.1	2.7	2.5	2.4	2.3
	India	5.2	5.9	6.4	5.3	3.5	3.4	3.6	3.8
	China	1.2	1.4	1.1	1.1	1.1	1.0	1.1	1.2
	Japan	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.7
	Other	8.8	9.6	9.2	7.7	6.9	6.7	6.9	7.4
	Sub-total	**22.4**	**27.9**	**26.5**	**22.1**	**18.4**	**17.7**	**17.9**	**18.4**
Silverware									
	Europe	9.2	14.1	13.9	11.0	9.6	8.9	8.5	8.0
	N America	8.5	16.8	10.9	8.9	7.9	7.3	7.0	6.7
	India	6.4	7.7	9.3	7.7	4.5	4.7	4.9	5.2
	China	0.9	1.1	0.9	0.8	0.7	0.7	0.8	0.8
	Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Other	8.9	10.9	10.4	8.5	6.8	6.8	6.7	6.6
	Sub-total	**34.1**	**50.7**	**45.5**	**37.0**	**29.6**	**28.5**	**27.9**	**27.4**
Photographic									
	Europe	13.3	11.9	10.8	9.6	8.5	7.7	7.0	6.4
	N America	10.1	9.2	8.2	7.4	7.1	6.7	6.4	6.0
	India	1.0	1.1	1.4	1.0	0.6	0.7	0.7	0.5
	China	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7
	Japan	1.8	1.8	1.7	1.7	1.6	1.4	1.3	1.2
	Others	11.3	9.8	8.8	7.7	6.8	6.2	5.7	5.2
	Sub-total	**38.6**	**35.1**	**32.2**	**28.8**	**26.1**	**24.2**	**22.7**	**21.0**
Coin									
	Europe	5.5	5.1	5.6	4.8	4.0	4.6	4.4	4.2
	N America	1.7	1.7	1.7	1.7	1.4	1.0	1.0	0.8
	India	-	-	-	-	-	-	-	-
	China	-	-	-	-	-	-	-	-
	Japan	-	-	-	-	-	-	-	-
	Others	0.7	0.6	0.6	0.5	0.4	0.3	0.3	0.2
	Sub-total	**7.9**	**7.4**	**7.9**	**7.1**	**5.7**	**6.0**	**5.7**	**5.3**
Grand Total		**182.9**	**206.7**	**197.4**	**178.2**	**164.2**	**167.5**	**174.3**	**178.0**

Source: Metals Focus

2. SCRAP BY COUNTRY/REGION

European Scrap by Sector



Source: Metals Focus. Data for 2014.

2.1 EUROPE

After rapid growth to over 45 Moz (1,400t) in 2011 and 2012, silver recycling in Europe has contracted sharply and is expected to reach just 33.7 Moz (1,048t) this year. Looking ahead, scrap is forecast to continue falling, if at a slower pace, to 31.3 Moz (975t) in 2017.

The key driver of the above initial rise and fall was silver's price rally and retreat, especially through its impact on silverware. This was most marked in southern Europe and in particular Italy; that country's silverware made up over 10% of total European silver scrap at its peak in 2012. Such figures also reflect changing cultural attitudes; Italy used to have a strong tradition of gifting flatware for weddings and the like, but this has largely faded. As a result, there was a large pool of inherited and dated items that quickly came back to the market, when the silver price and any economic distress encouraged this. The impact of this still sizable pool remains visible in that silverware scrap is forecast to account for 26% of the European total versus a global average of 15% in 2017.

Despite the above, it is normally Germany that supplies the largest amount of scrap in Europe. In addition to the size of its population and economy, it is worth highlighting a second factor here – the boost to recycling derived from a greater degree of environmental law enforcement and citizens' willingness to comply. This tendency is yet stronger in northern Europe's smaller countries, be that in terms of e-scrap collection per capita or photographic liquids being properly processed. For instance, some 99% of all silver in these liquids is recovered in the Netherlands, compared to 50-70% in southern Europe.

Another manner in which European scrap differs from the global norm is coin melt, as the region accounts for around 70% of the global total. Much of the metal comes from old circulating and unsold commemorative coins, which leads us to classify the supply as scrap rather than disinvestment.

Silver Recycling by Region

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	39.9	45.6	46.0	39.1	34.5	33.7	32.4	31.3
N America	55.6	67.0	58.2	54.8	53.1	51.9	54.1	52.0
India	16.4	19.3	22.2	17.7	12.2	12.8	13.6	14.2
China	13.3	15.3	15.5	17.3	19.9	25.1	29.1	34.2
Japan	10.4	10.7	9.9	10.1	9.8	10.0	10.4	11.0
Other	47.2	48.7	45.5	39.2	34.7	34.0	34.6	35.4
Total	182.9	206.7	197.4	178.2	164.2	167.5	174.3	178.0

Source: Metals Focus

European Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	8.6	10.2	10.5	9.5	8.9	9.2	9.4	9.7
Jewelry	3.3	4.3	5.2	4.1	3.5	3.3	3.1	3.0
Silverware	9.2	14.1	13.9	11.0	9.6	8.9	8.5	8.0
Photographic	13.3	11.9	10.8	9.6	8.5	7.7	7.0	6.4
Coin	5.5	5.1	5.6	4.8	4.0	4.6	4.4	4.2
Total	**39.9**	**45.6**	**46.0**	**39.1**	**34.5**	**33.7**	**32.4**	**31.3**

Source: Metals Focus

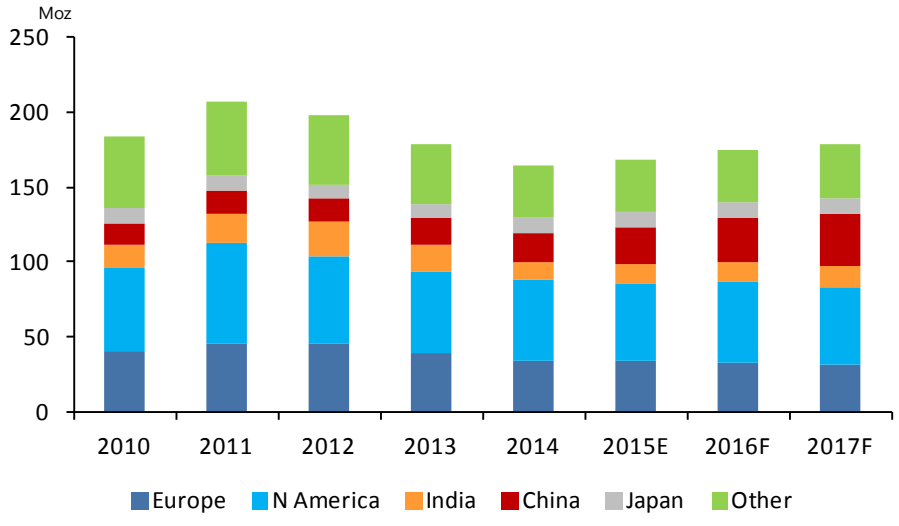
When discussing Europe, it is important to note that it imports large volumes of low grade scrap. Much arrives in pre-treated form and so a true source is difficult to establish, but a big portion is thought to come from industrial end-uses. It will be interesting to see how volumes here fare in the next year or so as the cut off for viable recovery is often around the $15/oz mark.

2.2 NORTH AMERICA

North America represents the largest region for silver recycling, accounting for roughly one-third of the global total this year. This in turn is dominated by the US, which accounts for over 90% of North American silver scrap supply. In terms of recent trends for this region, after surging by 21% in 2011 to 67.0 Moz (2,085t), largely because of a jump in silverware and jewelry scrap, total volumes have since fallen back; the rate of decline, between 2012-2015, averages 6% per annum, leaving the forecast total for this year at 51.9 Moz (1,614t).

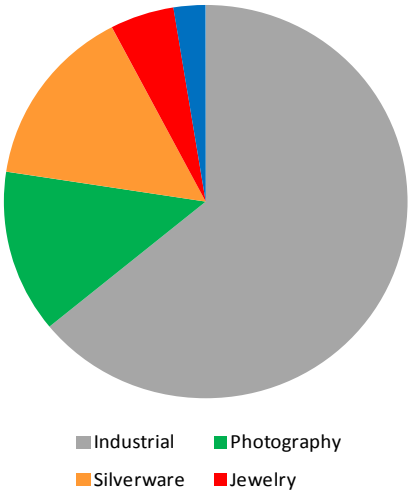
Looking first at jewelry and silverware recycling, as noted above, this accounted for much of the jump in 2011. Despite the high retail markups that characterize these products, the dramatic surge in silver prices led to a massive increase in old silverware, and to a lesser extent, jewelry being sold back. This meant that,

Silver Recycling by Region



Source: Metals Focus

N American Scrap by Sector



Source: Metals Focus. Data for 2014.

for one year, silverware in isolation, became the second largest area of North American scrap supply. As covered in Chapter 3, silverware and jewelry recycling have since fallen back, with scrap from both now not only below the 2011 peak but also below the more ordinary levels seen in 2010.

Turning to industrial scrap, this represents the largest segment of scrap supply in the region. It includes two quite distinct recycling segments, electrical and electronic waste and the recovery of silver from spent ethylene oxide (EO) plants. The latter accounts for the largest share of industrial waste, but represents an anomaly in terms of our analysis of global scrap supply. For all other areas, recycling is captured where the silver-bearing scrap is generated, not where the metal is recovered. For the EO market, with over 400 plants operating globally, it makes sense, barring certain exceptions, to capture the silver where it is treated.

In contrast, electrical/electronic scrap is measured where it is generated. For North America, the majority of end-of-life material is treated overseas, whereas an important share of process (or production) scrap is reclaimed in North America. In terms of the overall industrial scrap series, this sees a period of modest growth, covering 2011-2017. Although weak silver prices and falling grades of reclaimed e-scrap have impacted this segment, the weakness in electrical/electronic recycling is offset by rising EO volumes, principally because of an expanding base of EO capacity.

Finally, turning to photography, this has declined to such an extent that it now contributes a smaller share of North American recycling than silverware. The bulk of photographic waste is generated from the supply of old x-rays released over time by hospitals, where the mandatory period to hold archive material has expired. (The US health system is now digital-based and, although the US still manufactures silver-bearing x-rays, this is largely consumed overseas.)

In contrast, paper, film and motion picture together account for only a small share of the recovered silver from photo recycling, given the extent to which traditional silver-based technologies have been replaced by digital solutions.

North American Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	32.2	33.6	33.6	33.7	34.0	34.3	37.4	36.1
Jewelry	3.0	5.8	3.8	3.1	2.7	2.5	2.4	2.3
Silverware	8.5	16.8	10.9	8.9	7.9	7.3	7.0	6.7
Photographic	10.1	9.2	8.2	7.4	7.1	6.7	6.4	6.0
Coins	1.7	1.7	1.7	1.7	1.4	1.0	1.0	0.8
Total	**55.6**	**67.0**	**58.2**	**54.8**	**53.1**	**51.9**	**54.1**	**52.0**

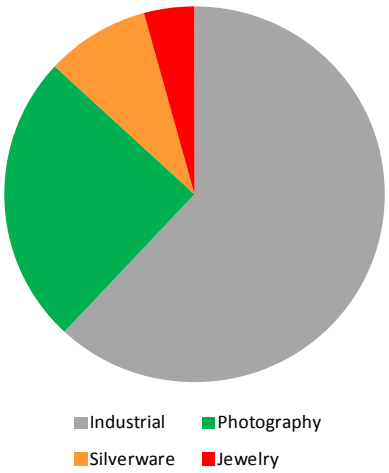
Source: Metals Focus

Chinese Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	10.0	11.6	12.2	14.1	16.6	21.8	25.6	30.5
Jewelry	1.2	1.4	1.1	1.1	1.1	1.0	1.1	1.2
Silverware	0.9	1.1	0.9	0.8	0.7	0.7	0.8	0.8
Photographic	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7
Total	**13.3**	**15.3**	**15.5**	**17.3**	**19.9**	**25.1**	**29.1**	**34.2**

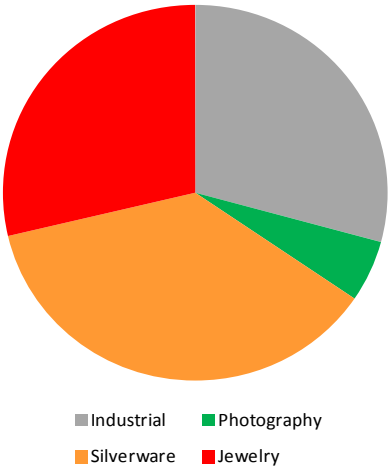
Source: Metals Focus

Chinese Scrap by Sector



Source: Metals Focus. Data for 2014.

Indian Scrap by Sector



Source: Metals Focus. Data for 2014.

2.3 CHINA

Silver scrap in China has grown in the past few years, mainly due to rising ethylene oxide (EO) capacity and, to a modest extent, increased recovery from the electronics sector. Chinese EO capacity is expected to rise by 1.3Mt in 2015. By extension, we expect EO recycling to continue rising, given not only the fact that more than 4Mt of new capacity has been installed over the past five years, but also that much of this features a higher silver content. Turning to electronics recycling, this initially surged following the introduction in 2009 of the country's "Old for New Program". However, the formal waste collection rate appeared to peak in 2011, as subsidies were removed. In the current market, most electronic waste is therefore treated though informal channels, which are characterized by far lower recovery rates of silver. As a result, even though e-waste generation in China continues to rise, this is offset by silver lost by the informal sector.

The recovery of silver from photography is also expected to rise, a trend that runs counter to most other countries. This is chiefly due to there being little sign of the volume of archived x-rays that are being de-stocked slowing down. This in turn partly reflects a later peak in its photographic consumption, although the pace of switching from analog to digital formats in the medical sector has quickened more recently.

Finally, the recycling of old jewelry and silverware both saw a pick-up in 2011 as silver prices rose but the increase in scrap supply was not that significant. This reflects the fact that a large portion of silver jewelry purchased in China is acquired by young people paying high markups for fashion-oriented pieces. As a result, this jewelry is unlikely to come back to the market. As for silverware, the low level of recycling reflects the fact that instead of recycling silverware, people tend to sell unwanted pieces in second-hand markets, where the items are sometimes refurbished before being sold again.

2.4 INDIA

Last year, Indian scrap supply recorded its largest fall since the start of the decade. The near one-third decline left the total at just 12.2 Moz (380t), compared with its recent high in 2012 of 22.2 Moz (690t). Both the surge that year and the sharp fall in 2014 (and 2013) owed much to the trend in silverware and, to an extent, jewelry scrap. This was in turn mainly due to the trend in

Indian Recycling

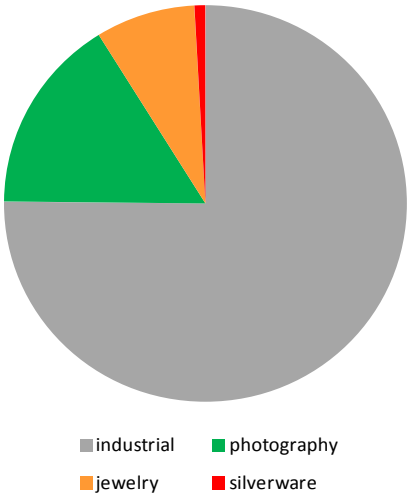
Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	3.8	4.5	5.1	3.6	3.6	4.0	4.3	4.7
Jewelry	5.2	5.9	6.4	5.3	3.5	3.4	3.6	3.8
Silverware	6.4	7.7	9.3	7.7	4.5	4.7	4.9	5.2
Photographic	1.0	1.1	1.4	1.0	0.6	0.7	0.7	0.5
Total	**16.4**	**19.3**	**22.2**	**17.7**	**12.2**	**12.8**	**13.6**	**14.2**

Source: Metals Focus

rupee silver prices, which fell 16% last year and so curtailed these price elastic areas of scrap. Even so, both still dominate Indian recycling, with their combined two-thirds share of the total unlikely to change much going forward. Their modest growth also largely explains our forecast of slow gains for total scrap.

Faster growth is forecast for industrial recycling, chiefly coming from electrical and plating materials, both of which have seen increased flows of late. Another supportive factor is the buoyant tone for Indian economic prospects. This is likely to boost flows of scrap, as companies invest in new plants and as consumers increase the rate at which they upgrade their electronic devices.

Japanese Scrap by Sector



Source: Metals Focus. Data for 2014.

2.5 JAPAN

Being home to a number of base metal smelters, Japan is naturally a major center for e-scrap processing. In turn, this means that there is sizable silver production from secondary sources by local plants. However, a large share of the e-scrap processed in the country is imported, largely from Europe and North America, but also parts of Asia. Metals Focus' estimates suggest that at least half of the silver supply from electronic as well as electrical finished products comes from imported raw materials and for some plants this share is much higher.

Moving to locally generated old scrap, Metals Focus' review suggests that secondary silver production amounted to a little over 9.8 Moz (306t) last year and we expect this will increase at the margin to 10.0 Moz (311t) in 2015. We estimate that three quarters of this came from industrial sources, including electrical, electronic, dental and all other materials outside jewelry, silverware

Japanese Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	7.6	7.9	7.2	7.5	7.4	7.7	8.3	8.9
Photography	1.8	1.8	1.7	1.7	1.6	1.4	1.3	1.2
Jewelry	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.7
Silverware	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**10.4**	**10.7**	**9.9**	**10.1**	**9.8**	**10.0**	**10.4**	**11.0**

Source: Metals Focus

and photographic applications. The latter are estimated to have generated 1.6 Moz (49t) of silver supply last year, primarily coming from shredded old x-rays, but this volume is on the decline. The balance is accounted for by jewelry and silverware. It is finally worth noting that local plants are also refining sizable volumes of process scrap, as well as slimes and other scrap emerging from primary processes.

2.6 THE REST OF THE WORLD

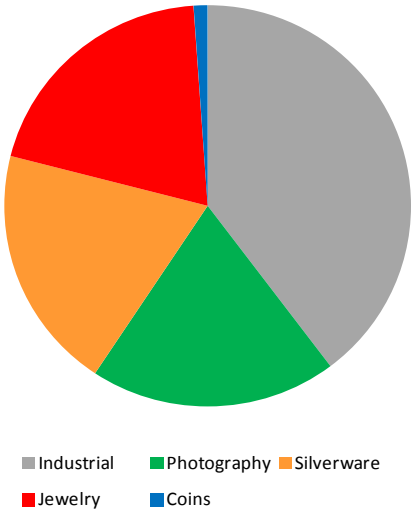
Silver recycling volumes from the rest of the world (ROW) are on a par with those emerging from Europe. Specifically, in 2015 the ROW is expected to generate 34.0 Moz (1,059t). This compares with 47.2 Moz (1,468t) in 2010. On a regional basis, the key markets behind this total are the Middle East (mainly Turkey), the CIS (principally Russia) and East Asia (outside of Japan and China).

Scrap emerging from the Middle East and North Africa fell heavily in 2012 and 2013, and slid again in 2014 but only by 2% to 8.2 Moz (256t). These losses were mainly due to lower Turkish recycling, which in turn was chiefly the result of digital inroads into the demand for x-rays and photographic papers and the long-term decline in silverware consumption. These two factors and weak silver prices mean Turkish scrap could fall by as much as 20% this year.

Turning to the CIS, as noted above, recycling is dominated by the Russian market. On a sectoral basis, silver generated from industrial scrap appears sizable. However, this is difficult to estimate, not least because very little of the contained silver in these end-of-life products is recovered there. This contrasts with old jewelry and silverware, both of which are processed domestically.

Broadly similar themes play out in East Asia (outside of the earlier discussed China and Japan). In other words, the industrial scrap generated in the region will typically either go to landfill (and so will not feed into these industrial scrap series), or will be shipped to an operation most likely in Japan or Europe. Jewelry and silverware recycling, on an individual country basis, tends to be extremely modest. This reflects the lack of silverware consumption in most countries in East Asia. In addition, although East Asian silver jewelry fabrication can be sizable, the bulk of this is exported, notably to the US and Europe.

Rest of World Scrap by Sector



Source: Metals Focus. Data for 2014.

Rest of World Recycling

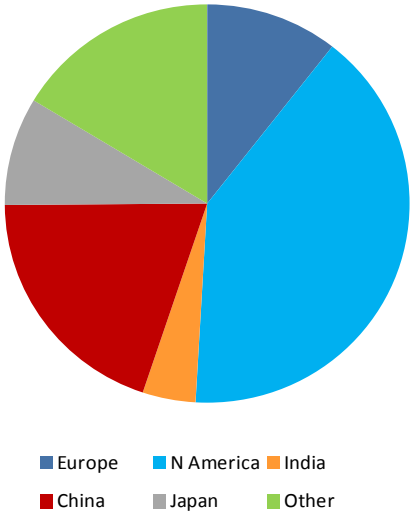
Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial	17.5	17.8	16.6	14.8	13.8	14.1	15.0	15.9
Jewelry	8.8	9.6	9.2	7.7	6.9	6.7	7.0	7.4
Silverware	8.9	10.9	10.4	8.5	6.8	6.8	6.7	6.6
Photographic	11.3	9.8	8.8	7.7	6.8	6.2	5.7	5.3
Coin	0.7	0.6	0.6	0.5	0.4	0.3	0.3	0.2
Total	**47.2**	**48.7**	**45.5**	**39.2**	**34.7**	**34.0**	**34.6**	**35.4**

Source: Metals Focus

3. SCRAP BY SECTOR

3.1 INDUSTRIAL

Industrial Scrap by Region



Source: Metals Focus. Data for 2014.

INTRODUCTION

Industrial scrap is perhaps the most difficult of all to monitor as its end-uses are extremely varied and as the distribution chain for products can be complex. In addition, the chance of silver being recovered varies greatly, depending in the main on the weight of silver per item, the presence of other materials of value (usually gold) and the degree to which ownership is fragmented. At one extreme would be EO catalysts where a significant weight of silver is found per item and the material is held by a limited number of players. Here, almost all the silver would be recycled. At the other extreme are products like memory sticks in the hands of consumers, where recycling is close to zero as silver weights are trivial and dispersion high. Other factors complicating the statistics include the blurred line between process and old scrap and the fact that recovery can move in and out of profitability within the price range that we have seen in the last few years.

Despite these difficulties, it has been possible to assemble solid statistics on industrial recycling, which we estimate to rise this year to just over 91 Moz (2,833t). Growth should then continue to around 106 Moz (3,300t) by 2017 due mainly to a larger pool of product, tighter legislation and firmer prices.

The commentary below provides detail on four key areas that were selected for varying reasons. Electrical and brazing alloy scrap are both opaque fields with limited scrap, but we have focused on the former since it is the largest end-user. Recovery is also limited from electronics goods but a fair portion of this is relatively easy to measure. We have also selected EO scrap, as this is the best example of closed-loop recycling. Lastly, there are several areas of industrial uses where scrap is zero, such as from the silver in nuclear plants' spent absorber rods or the foils in Indian food, but we have chosen to focus on the growth area of photovoltaics and assess if the current absence of recovery could change.

Industrial Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	8.6	10.2	10.5	9.5	8.9	9.2	9.4	9.7
North America	32.2	33.6	33.6	33.7	34.0	34.3	37.4	36.1
India	3.8	4.5	5.1	3.6	3.6	4.0	4.3	4.7
China	10.0	11.6	12.2	14.1	16.6	21.8	25.6	30.5
Japan	7.6	7.9	7.2	7.5	7.4	7.7	8.3	8.9
Others	17.5	17.8	16.5	14.8	13.8	14.1	15.0	15.9
Total	**79.8**	**85.6**	**85.2**	**83.2**	**84.3**	**91.1**	**100.1**	**105.8**

Source: Metals Focus

ELECTRICAL SCRAP

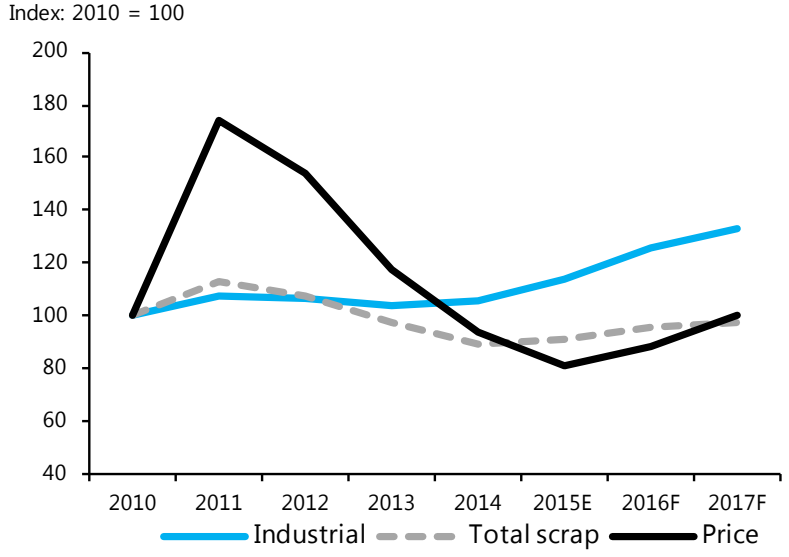
Electrical scrap is derived from a broad range of end-uses such as connectors in wind turbines, paste residues in containers or switchgear in manufacturing plants. Most are industrial in nature and often deal with higher voltages, but exceptions exist here, for example contacts in light switches. It excludes the recycling of silver from consumer goods (which is electronics scrap).

This range means the amount of silver per item can vary from trivial, for example in fuses, to significant, as in cellphone transmitter masts. Ownership dispersion varies hugely too, from say a handful of owners for the above transmitters to millions for light switches. Dispersion can also vary for the same product; a factory could easily send an individual switchgear block to landfill but an OEM might well recycle a batch of faulty blocks. There is also the complication of the blurred boundary between process and old scrap (see Chapter 5 for detail).

Silver prices can also have an important bearing on recovery as the low grades found in many waste materials mean recycling can become uneconomic if prices dip below a certain level. These levels vary greatly but it is likely that several areas are unprofitable below $20/oz and yet more are uneconomic below $15/oz. This means that in an era of low prices the analyst has to make a near impossible estimate of how rigorously an end-user might comply with environmental legislation.

As a result, electrical scrap is the most difficult area to assess within the industrial sphere. Unfortunately, it is also the largest user of silver, being roughly four times greater than brazing alloy demand for example. That said, we can be fairly certain that its scrap volumes cannot be truly significant as refiners' awareness of the flows would be that much greater. Nor are they trivial; the recycling from cellphone transmitter masts in Europe alone for instance has been reported to generate 0.5 Moz (15t) of silver a year.

Silver Recycling from Industrial End-Uses



Source: Metals Focus

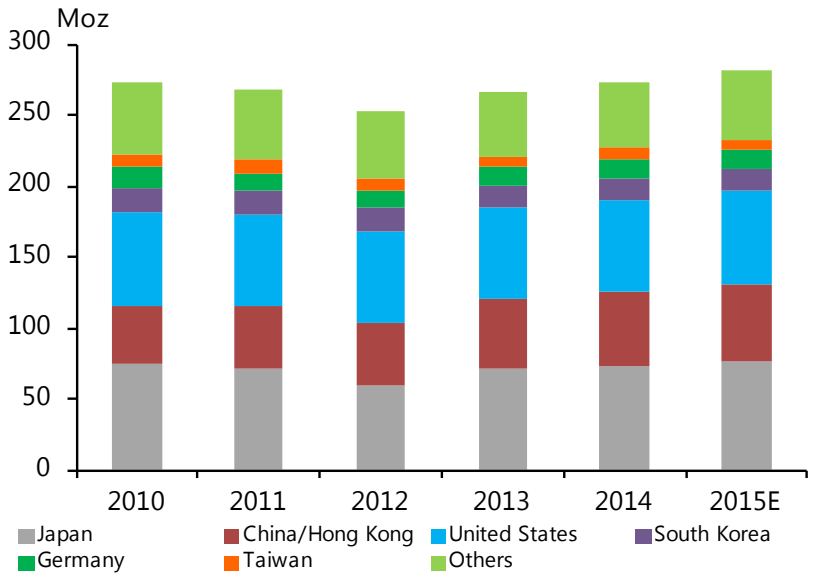
The volumes are also likely to be highest in those areas where legislation is tightest and compliance strongest, for example Scandinavia, and lower where legislation has yet to be fully developed or implemented. As a result of all the above, we believe volumes in emerging markets are likely to be far smaller than the yield from electronics whereas in the developed world they should be on a par, if not larger than electronics scrap. Electrical scrap's sensitivity to the silver price, lacking the 'insulation' that electronics scrap enjoys through its gold content, means that volumes are likely to have fallen in 2013 and 2014, but should grow from 2015 onwards.

ELECTRONIC SCRAP

This segment of scrap relates to the recovery of silver from electronic items, which are dominated by consumer goods and so meaning a wide variety of products such as PCs, tablets or games consoles. Silver's use in these products has grown substantially over the last few decades and this has fed through into strong growth in the volume of electronic waste. According to a UN study, the global volume of e-waste has increased by almost 25% over the past five years from 33.8Mt in 2010 to 41.4Mt in 2014; further growth of 4-5% a year is expected going forward. The fastest growing reported streams of household waste are cell phones, computers, air-conditioners and television sets. All this means that these products now represent a major source for silver recycling.

In addition to the historic silver fabrication that these discarded products contain, recycling volumes in this category are affected by other factors such as government legislation, consumers' and companies' willingness to comply with the rules and subsidies for recovery. The silver price itself can also be important. However, the economics of e-scrap is normally determined by the value of its gold content, with any income from silver and other materials, such as copper and palladium, often just a nice by-product. The impact of precious metal prices

Electronic & Electrical Fabrication



Source: Metals Focus

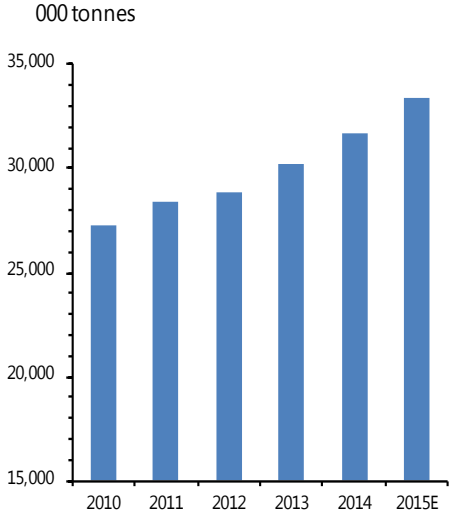
on recovery is complicated by a long term trend towards a lower metal content in most devices, which can threaten the economic viability of recycling. This is invariably the result of manufacturers always striving for cost savings and other contributory developments, such as many devices now having a far shorter shelf-life, which enables precious metal use to be reduced or eliminated.

Recent industrial developments that are feeding this trend include the adoption of flip chips, which continue to take market share from die-attached paste processes. Another are 3D stacked packages, which contain no silver due to having no die-attached paste and are increasingly being used in portable electronics. Pastes with a lower silver content and reduced features in die-size also help to reduce silver consumption in each unit.

A final trend that will influence the volume of silver recovered is the split between the formal and informal refining sectors. This matters as recovery rates in formal plants are far higher than for informal operations, with some estimates claiming that the amount of silver the latter would recover from an identical item being a third of what a formal unit might achieve. Estimates vary widely but it is clear that a large share of e-waste is processed by informal treatment systems due to the lack of a recycling and regulatory infrastructure in many markets. As a result, there is a large portion of potential scrap that is lost through the e-waste that is treated by "backyard" operations.

We estimate that the volume of silver recovered from electronic sources grew from 2010-2014, even with recent silver price weakness, and it seems fairly certain that this will continue through to 2017. This is primarily the result of growing volumes of e-waste, strengthening legislation, rising compliance and capacity expansions by formal operators.

EO Capacity*



Source: PCI Xylenes & Polyesters
* annual production capacity of ethylene oxide plants

ETHYLENE OXIDE CATALYSTS

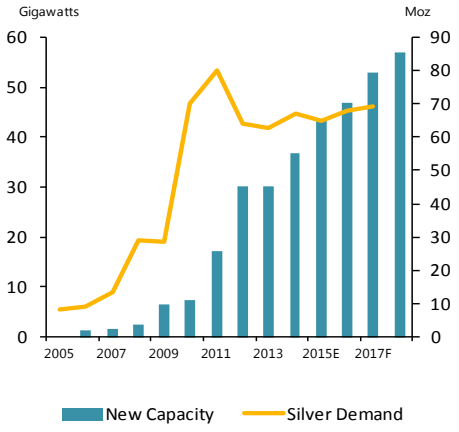
The recovery of silver from ethylene oxide (EO) catalysts is largely a closed loop process. However, it is included here because the recovered silver must be refined before it can be re-used; the amount of silver lost during recycling is trivial, at around 1%. Our estimate for the installed base (globally) of silver is over 100 Moz (3,100t) as at end-2015, which is spread across some 400 plants. Three countries account for over half the total, namely China, Saudi Arabia and the US. It might surprise to see the US included here, given that the bulk of new EO capacity is being installed in China and the Middle East. However, EO plants were first installed in the US in the 1970s. At that time, silver demand averaged around 250 koz (or 8t) per plant. Today, a typical plant size is dramatically higher at over 2 Moz (60t). However, this does not materially affect the dynamics of recovering the contained silver.

As for the frequency of recycling silver, an EO plant will typically be shut down and changed out every 2.5 years. At that point, the decommissioned catalyst will be shipped out, for example to North America or Europe, to be stripped down. In total, around 50 Moz (1,500t) is treated each year globally from EO catalysts.

There are, however, a few exceptions where the export of silver contained in EO catalysts is prohibited and the metal must be recovered locally. Russia and India are notable examples of this, although the combined installed capacity is modest at around 6 Moz (180t). In both cases, the silver will then flow into the market to be consumed, for example in the silverware or jewelry industries. Also, our understanding is that plants in China are similarly affected, although there have been some reports of decommissioned plants being treated elsewhere.

Looking ahead, EO changeouts, and with it the recovery of silver, are set to rise gradually over the coming years. The key factor will be the growth in new capacity, which is quite modest at around 4-6 Moz/year (120-180t). Other issues also come into play, such as the strength of glycol demand (a key output in the EO industry). During periods of high demand, plants can be "run hard", which will see their life extended. However, given the large number of plants around the world, some of these trends can be smoothed out and so, on a year-to-year basis, there might be little variation in the volume of silver recovered. Another consideration is the fact that much of the recently installed capacity has a higher silver content (to improve reaction selectivity and help deliver an extended life cycle).

PV Installations & Silver Demand



Source: European Photovoltaic Industry Association, Metals Focus

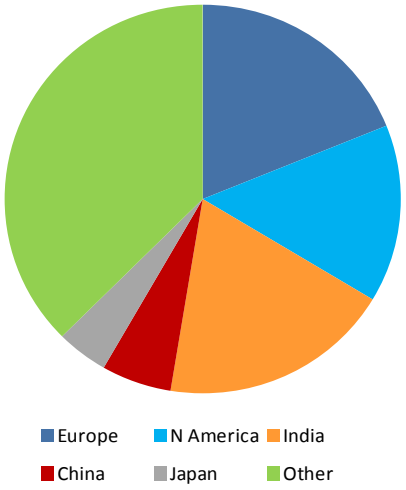
PHOTOVOLTAICS

Over the past decade, the dramatic rise in the use of silver in photovoltaics (PV) has been one of the success stories in the silver industrial landscape. To put this into perspective, in 2005, the sector's silver demand was estimated at just 8 Moz (240t), before surging to a record high of 80 Moz (2,450t) in 2011. The estimate for this year is a more modest, but still noteworthy, 65 Moz (2,020t). On a cumulative basis, over 500 Moz (15,000t) of silver has been consumed by PV since the early 2000s.

However, the volume of silver recovered from old PV cells is believed to be trivial (in contrast to substantial volumes of process scrap). Here, there are three stages in the manufacturing chain where silver can potentially be recovered. The first two are where the silver powder and paste are manufactured, although the level of wastage, in percentage terms, is extremely modest in each case. Third, at the point the cell is finally assembled, there is often a level of breakages, which can range between 10-15% of total production.

Turning to the recycling of old products, the extremely low level of silver recovery reflects two factors. First, the bulk of cells that have been installed have a long shelf life and so the majority are still in use. Second, and more importantly, the volume of contained silver per cell is generally too small and also difficult to separate from the rest of the cell to make the recovery of the metal economically viable (the focus now is on recovering aluminum from spent PV cells). As a result, unless government subsidies emerge to fund silver recycling, it appears unlikely that silver contained in end-of-life PV cells will find its way back into the supply chain.

Jewelry Scrap by Region



Source: Metals Focus. Data for 2014.

3.2 JEWELRY

The recycling of silver from old jewelry makes up the second smallest category of silver scrap supply. Its limited scale is also marked in comparison to gold; silver jewelry fabrication may be more than double gold by weight, but its jewelry scrap is less than half gold's. These modest numbers for silver are largely due to the small amounts typically sold back by consumers as the low value per item means there is little incentive to sell. Not only are volumes comparatively slight, but they have also been falling in recent years; forecast scrap for 2015 at just 17.7 Moz (551t) pales against its 2011 high of 27.9 Moz (868t), when volumes were boosted by the rally in silver prices and distress selling.

The 2011 gains were especially strong in western markets, which saw a 60% rise in silver jewelry scrap in 2011. Since then, western jewelry scrap has seen four years of successive declines. As a result, the 2015 total has broadly returned to 2010 levels. Looking ahead, even though there are significant above-ground consumer stocks, there is little to suggest that these will be teased out and so western jewelry recycling is likely to contract further. As for structure, western scrap is dominated by the supply from the trade. In 2011 for example, it was common to see wholesalers and fabricators melt slow selling stock. Economic uncertainty also led some retailers to de-stock, in part so that they could replace sterling silver products (where retail margins were being squeezed) with silver plated pieces and, in some cases, non-precious metal items.

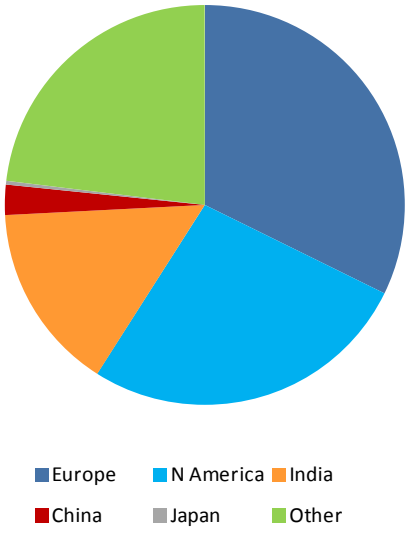
Turning to emerging markets, it is perhaps surprising to see limited levels of recycling in India, given that scale of its jewelry fabrication, which is expected to exceed 42 Moz (1,300t) this year. In addition to a relatively low price per piece, we also need consider recent years' rising demand for fashion jewelry, where making charges are much higher. Volumes have also fallen greatly in the last few years; Indian jewelry scrap supply in 2014 at 3.5 Moz (109t) was more than 30% down on 2013's 5.3 Moz (166t), chiefly as a result of lower rupee silver prices. The continued fall in silver prices in 2015 should also lead to a marginal drop in jewelry scrap, but rising prices in 2016 and 2017 should lead to an increase in recycling. Elsewhere, jewelry scrap in China is smaller than India's due to a yet higher share going to higher margin fashion pieces, while large fabricators like Thailand yield little as most output is for export to the West.

Jewelry Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	3.3	4.3	5.2	4.1	3.5	3.3	3.1	3.0
N America	3.0	5.8	3.8	3.1	2.7	2.5	2.4	2.3
India	5.2	5.9	6.4	5.3	3.5	3.4	3.6	3.8
China	1.2	1.4	1.1	1.1	1.1	1.0	1.1	1.2
Japan	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.7
Other	8.8	9.6	9.2	7.7	6.9	6.7	7.0	7.4
Total	**22.4**	**27.9**	**26.5**	**22.1**	**18.4**	**17.7**	**17.9**	**18.4**

Source: Metals Focus

Silverware Scrap by Region



Source: Metals Focus. Data for 2014.

3.3 SILVERWARE

Silverware recycling represents the second largest area of global scrap supply, accounting for a forecast 17% in 2015. This is a relatively recent development; prior to 2011, this sector ranked third behind photography, but the structural weakness in the latter, with an estimated 37% decline from 2010 to 2015, has seen photographic scrap fall much more sharply, even though silverware recycling has fallen by a still sizable 16% over the same period.

Falling silverware scrap has been far from a constant story as the ramp-up in silver prices in 2011 led to a dramatic surge in silverware being sold back. This was concentrated in Europe and North America, which together saw the recycling of old silverware products jump by almost 75% in 2011 to 30.9 Moz (960t). What may appear surprising is that the jump in silverware (known as flatware in North America) scrap far exceeded that of jewelry, even though the latter boasts a far larger above-ground stock. There are three main reasons for this apparent disparity.

First, the weight of individual silverware items is far higher than for jewelry and so western consumers have little incentive to liquidate their holdings of jewelry, given the low value they will be able to realize. This is reinforced by the fact that western jewelry typically attracts an even higher retail markup compared with silverware. Secondly, silverware has largely fallen out of fashion in many western markets and so consumers were often quite prepared to take advantage of high silver prices during 2011 to sell back, for example, an unwanted piece of inheritance. Thirdly, even if silverware consumption today is modest, that was not the case historically, and this means a large pool of these products.

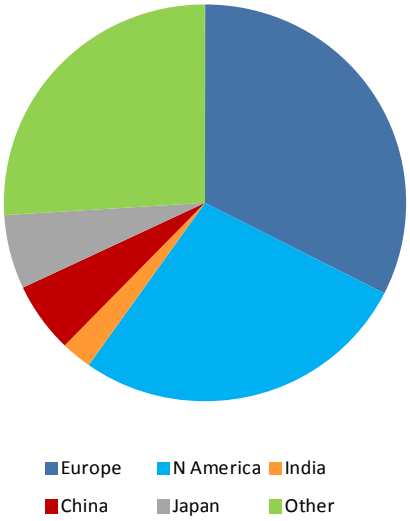
Since 2011, western silverware scrap has fallen back, with 2015's estimated total now below 2010's level. Although silver's price action has clearly played an important role, the erosion of western above-ground stocks of silverware has also been significant. This explains why, even though we expect silver prices to rise in the coming years, it seems unlikely that western silverware recycling will deliver a strong, positive response. A final factor explaining the earlier rise and fall in scrap was distress selling and our forecast for further declines rests in part on a belief that future distress selling will prove slight.

Silverware Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	9.2	14.1	13.9	11.0	9.6	8.9	8.5	8.0
N America	8.5	16.8	10.9	8.9	7.9	7.3	7.0	6.7
India	6.4	7.7	9.3	7.7	4.5	4.7	4.9	5.2
China	0.9	1.1	0.9	0.8	0.7	0.7	0.8	0.8
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other	8.9	10.9	10.4	8.5	6.8	6.8	6.7	6.6
Total	**34.1**	**50.7**	**45.5**	**37.0**	**29.6**	**28.5**	**27.9**	**27.4**

Source: Metals Focus

Photographic Scrap by Region



Source: Metals Focus. Data for 2014.

Emerging market recycling is dominated by India, which is estimated to reach 4.7 Moz (146t) this year, or 16% of global silverware recycling. Looking at recent levels, what stands out is the heavy drop in India's silverware scrap over the last two years; this fell by a dramatic 42% in 2014 alone to 4.5 Moz (140t). These losses were chiefly due to the reduction in silver prices, especially if the piece had been recently acquired at a higher price. It is worth pointing out here that the majority of recycled silverware that comes out in India is largely from more functional utensils, rather than more decorative articles.

Given the fact that price movements often determine return rates and the sensitivity of scrap supply to prices, we expect to see a rise in Indian scrap over the next couple of years. Having said that, this is unlikely to be strong, only reaching 5.2 Moz (162t) by 2017. Most of this should still come from the return of utensils despite recent growth in the pool of high-end silver articles.

3.4 PHOTOGRAPHIC

Photographic scrap has fallen fast of late, with last year's 26.1 Moz (812t) some 32% lower than 2010's 38.6 Moz (1,202t). Nor is the decline finished, with a figure of 21.0 Moz (653t) forecast for 2017. That would give photographic scrap a modest 12% of the 2017 total, compared to a more significant 21% in 2010.

The key reason for the above is the penetration of digital technologies in all realms of photography and the consequential decline of around 80% in photographic fabrication since its peak in the late 1990s. This fed through into immediate falls in recovery from liquids (such as fixers and developers) as this mostly occurs in the year of fabrication, irrespective of whether the liquids came from say consumer film or x-ray processing.

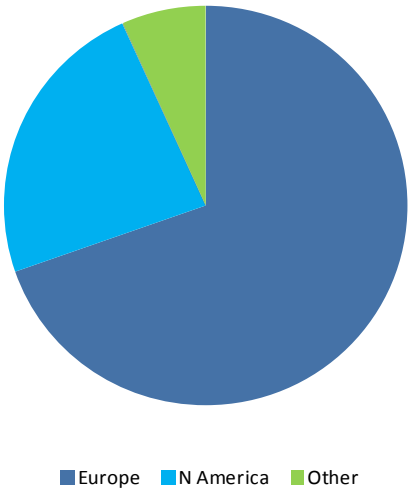
The same can apply to the recovery from film; the recycling from consumer film for example usually occurs soon after fabrication but, for x-rays, there can be a delay as hospitals are obliged to hold on to records. This retention can vary hugely; in Japan, for example, hospitals must keep records for 10 years, whereas in Germany an x-ray for a work-related injury must be kept for 35 years. We are now therefore recycling x-rays dating back to the years either side of the

Photographic Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	13.3	11.9	10.8	9.6	8.5	7.7	7.0	6.4
North America	10.1	9.2	8.2	7.4	7.1	6.7	6.4	6.0
India	1.0	1.1	1.4	1.0	0.6	0.7	0.7	0.5
China	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7
Japan	1.8	1.8	1.7	1.7	1.6	1.4	1.3	1.2
Others	11.3	9.8	8.8	7.7	6.8	6.2	5.7	5.2
Total	**38.6**	**35.1**	**32.2**	**28.8**	**26.1**	**24.3**	**22.7**	**21.0**

Source: Metals Focus

Coin Scrap by Region



Source: Metals Focus. Data for 2014.

fabrication peak and this explains why these are understood to account for 80-90% of total photographic scrap, or perhaps even more in the US.

Perhaps the second most important driver of the recent drop in scrap was the surge in silver prices to their 2011 highs boosting recoveries at that time. This encouraged collectors then to persuade hospitals to search archives for old x-rays but, with these easy pickings gone and the profit from any remaining old x-rays much less, recycling has unsurprisingly fallen considerably since. It is not thought that silver prices of around $15/oz are too low to discourage most photographic recycling, although there are niches where that might be the case. The silver in old movie theater film for instance is often not recovered now (even if the plastics are) as this would require a silver price well over $30 for this to become economic. A final price impact is that collectors sometimes warehouse old film in anticipation of higher future prices, but the volumes involved and the duration of this withholding are not thought great.

Europe and North America dominate here, supplying around 60% of global photographic scrap, largely due to their large pool of old x-rays. A second factor boosting this share is the tendency for x-rays to be kept at hospitals, which facilitates recycling. In contrast, x-rays are often given to patients in countries such as India and China, thereby dispersing supplies and making recycling more difficult and less likely.

In our forecast period, we expect little slowdown in the drop in scrap, and an acceleration is not impossible, as we reach the tipping point when the move to digital in x-rays a decade or two back really starts cutting into volumes available for recycling now. China, by contrast, could even see rising scrap as its peak for photographic consumption occurred many years after the industrialized world. Even with that, losses elsewhere are almost guaranteed to give falling global totals, irrespective of what the silver price does.

Our figures for photographic scrap have been cut by roughly 4-8 Moz (130-260t) a year from our earlier estimates as a result of the detailed work done for this report. Much relates to lower estimates for China, although figures for all regions have been lowered as a result of research in such areas as the declining silver yield of recycled x-rays.

3.5 COINS

Not all melt of silver coins is classified as recycling, as some is best categorized as disinvestment. However, if the metal came from an unsold coin, it never enjoyed investment and so cannot be disinvested. In addition, circulating coins are not true investments and so the melt of these coins is best treated as scrap. These volumes, however, are not large; global coin scrap is estimated at just 5.7 Moz (178t) in 2014 and, as a result, represents by far the smallest category of global silver recycling. Moreover, that volume is considerably lower than recycling levels seen as recently as 2010-13; during that time, silver coin scrap

averaged 7.6 Moz (236t) per annum. We may see a slight rise in volumes this year, but beyond that coin scrap is expected to trend gently downwards.

A key reason for this is the behavior of the European market, which accounts for around 70% of the global total. Much of this in turn comes from Germany, which has a long history of producing commemorative coins for the local market and so the volume of unsold coins (or even coin blanks) can be sizable. There was some link between the trend in silver prices and silver coin recycling as the incentive to clear out slow selling stocks grew in line with the earlier rise in prices, and there was a need to melt those coins where the value of the silver content exceeded the face value. With these near-market stocks greatly reduced, coin scrap understandably fell back in 2013 and 2014.

Establishing the level of true coin scrap in North America is difficult because of the blurred line between scrap and what is best viewed as disinvestment. We would, for example, certainly exclude from scrap the (limited) melt of modern era bullion coins, such as the US Eagle or Canadian Maple Leaf. However, it is understood that sizable volumes of old circulating coins are still being melted down. Even though massive volumes of these coins were struck, relatively few examples now find their way into the market, simply because of the quantities that had already been sold back during the 1980s and 1990s. In terms of the pieces that are liquidated, the 40% coins are also popular with brazing alloy manufacturers, given the coins' significant copper content.

Coin Recycling

Moz	2010	2011	2012	2013	2014	2015E	2016F	2017F
Europe	5.5	5.1	5.6	4.8	4.0	4.6	4.4	4.2
North America	1.7	1.7	1.7	1.7	1.4	1.0	1.0	0.8
India	-	-	-	-	-	-	-	-
China	-	-	-	-	-	-	-	-
Japan	-	-	-	-	-	-	-	-
Others	0.7	0.6	0.6	0.5	0.4	0.3	0.3	0.2
Total	**7.9**	**7.4**	**7.9**	**7.1**	**5.7**	**6.0**	**5.7**	**5.3**

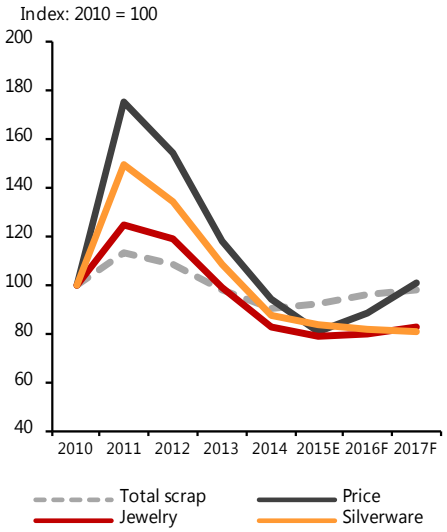
Source: Metals Focus

4. DRIVERS

Introduction

This chapter brings together the analysis found across earlier chapters specifically on the drivers that influence the volume of scrap. Price is undoubtedly a key factor, something that was clear during the bull market of 2008-2011. Above-ground inventories of fabricated products are also important, while the extent to which ownership is fragmented can play a significant role. Finally, legislation encouraging or even forcing consumers as well as the supply chain to recycle end-of-life products, rather than dispose of them in landfill, are also boosting silver recoveries.

Price Sensitive Scrap



Source: Metals Focus

The Silver Price

The impact of the silver price on recycling varies across different sources. As illustrated in the accompanying chart, silverware scrap is the most price-sensitive. This relates to the fact that silver accounts for a relatively high portion of the final product's price and the high unit value. As a result of these factors, during the bull market, Metals Focus noted a dramatic increase in returns of old silverware to the market from consumers and the trade. While the price of the metal also accounts for a sizable part of finished jewelry, the far lower unit value means that the incentive for individuals to sell back old pieces is limited. Indeed, the bulk of jewelry scrap tends to come from the supply chain, namely manufacturers, wholesalers and retailers, liquidating old or unsold inventory. Jewelry scrap is also restricted by the fact that silver jewelry is still considered fashionable, unlike many silverware items. Unsold commemorative coins and old circulating coins are another price elastic source.

The impact of prices on industrial scrap in total is less pronounced. Having said this, changing silver prices do heavily affect the economics of recovery from certain low yield niches within waste material. The viability of recycling electronic waste is typically a function of the value of its contained gold, which by and large in most products has remained high enough over the last decade or so to be profitable, as lower prices in the 2000s were countered by much higher yields. Lastly, scrap from ethylene oxide catalysts is relatively price insensitive. This is due to the high value of silver contained in the catalysts, the relatively straightforward recovery process and the limited number of industrial players involved.

The price can have an impact on photographic scrap as it affects the viability of recovery from certain end-uses, such as movie-theater film or consumer-film liquids. The bulk of scrap these days, however, typically comes from old x-rays, which despite a low yield are still profitable to process at relatively low silver prices. However, changes in the price can be important as they alter the enthusiasm with which collectors will seek supplies from medical facilities, or even individuals.

The Pool of Product

The impact of above-ground inventories of fabricated products containing silver on scrap is more straightforward. If the amount of silver contained in finished products increases over the years, the pool of material that is available to be recycled also increases and, by implication, so does potential supply. Not all categories show ever rising stocks however, as would most certainly be the case with old x-rays. In addition, after periods of heavy scrappage, the above-ground inventory of near–market product can be depleted, resulting in constrained supplies, even if prices are favorable. Silverware is a very good example, illustrating the importance of stockpiles for scrap. Although annual fabrication demand has been relatively low in recent years, scrap supply from old silverware rocketed during the bull market of 2008-2011. This was only possible due to the legacy of decades of consumption having resulted in a sizable stockpile of silverware held by consumers, which was "teased out" by the high silver price. In contrast, looking ahead, it is recent years' decline in this near-market stockpile that we believe will cap supplies, in spite of any possible price increases.

Ownership Concentration

The degree to which holdings are concentrated can also have a bearing on silver scrap as it can impact on the profitability or desirability of recycling. A single piece of jewelry for instance might not come back from an individual, but 1,000 unsold examples of the same piece in the hands of a fabricator could easily get recycled. Photographic scrap can also be materially affected; x-ray recycling for example plummets if the image is handed over to the patient. Its impact on industrial scrap is hugely varied, but, by contrast, this factor is of little importance for silverware, as a consumer might readily recycle just one piece, and for coin scrap as so much comes from state mints and the like.

Environmental Legislation

Legislation primarily is important for industrial fabrication, chiefly as it is here that the profitability of recycling varies. Specifically, there are numerous initiatives around the world to encourage or even force, in certain cases, the recycling of waste electrical and electronic equipment, rather than facilitate its disposal in landfill. Such policies are fueled by environmental concerns, related both to efforts to limit the release of contaminants into the environment through landfill and also to make use of what has been dubbed as an "urban mine", in other words materials that are recoverable without further exploitation of natural resources. Development of such legislation, particularly in emerging markets, has been instrumental in fueling increases in recovery from industrial applications over the past decade, as an ever-increasing share of discarded products has been recycled.

Legislation on its own may prove ineffective in securing volumes for processing, as this needs the support of government enforcement and consumers' and companies' compliance. Trends here, however, also tend to be supportive of rising scrap; for example many governments have woken up to the illegal export of e-waste and are taking ever more measures to crack down on this trade.

5. DATA COMPILATION & QUALIFICATIONS

5.1 METHODOLOGY

The research for this report centered on interviews with contacts in the refining industry. What struck us here is that detailed information on old versus new scrap and materials' origins was often not readily available. One factor behind this is the value of these silver streams often being far less than for gold flows. Secondly, the material received by refiners has normally received pre-treatment, such as the burning of cleaning rags or the commingling through the melt of jewelry and silverware. As a result, the refiner cannot respectively tell from where this ash or high grade block originally came. This therefore required the re-visiting of existing contacts in a position to do further 'digging' and the search for new contacts at the collector level who could see pre-treatment origins.

A new angle that was pursued for greater confidence in the absolute scale of old silver scrap was to review that in the context of refineries' total volumes. This proved useful as the calculations for this report of process scrap could then be compared to research contacts' estimates of the split between their process and old scrap.

Another novel approach was the assessing of recycling as a function of the pool of product, which to our knowledge has never been done before for silver. Where feasible, estimates of stocks in each category were calculated and then these were compared to annual scrap flows. This top-down exercise highlighted outliers, which in turn prompted revisions or the justification of these outliers.

A final new approach concerns electronic scrap. Here, where possible (chiefly for the industrialized world), we took known refinery throughputs and multiplied that by known yields of silver in e-scrap. A related analysis was to take the known volume of silver contained per piece in electronics goods and multiply that by known sales of each within a country to see if our estimates for the recovery of silver from electronic scrap were reasonable. This was particularly useful in Asia as the opacity of some countries' refining sectors made the first of these two methods unworkable.

5.2 DEFINITIONS – OLD VERSUS PROCESS SCRAP

Our published figures on recycling only include old scrap and never process (or production) scrap. The latter is the silver that never becomes part of a final item and instead quickly returns to a refinery, often in a fairly unadulterated form. A good example of this occurs with coin blanks; these are stamped from a sheet and the discs created equate to fabrication, while the gaps between are process scrap. Such material does not count as old scrap, chiefly as no metal is sold back into the market and so it cannot influence the price.

Old scrap, by contrast, is the silver derived from an item that has left the fabricator's premises for its intended use. This recycling can occur quickly (the norm for photographic liquids), or many years later (such as the melting down today of silverware from the 1950s). It can also include unused or unsold pieces, such as slow selling jewelry returning from a wholesaler. Old scrap is the critical component to measure here as its scale and timing can have an important bearing on silver prices.

There is, however, the complication of process scrap stopping should recovery become uneconomic and then restarting should prices rise. One such example is the rags used in the cleaning up of industrial silver pastes; recovery here is understood to fall away below around $20/oz, but become rigorous above say $30/oz. Since this is a change in the supply of silver coming back onto the market, it should arguably be treated as 'old' scrap and so, in those instances where this has proved appropriate and measurable, we have done so.

5.3 REVISIONS TO THE STATUS QUO

The research conducted for this report confirms our initial expectation that the market's current take on silver recycling is overestimated. This is particularly true for the recent past; our figure for 2011 for example has been cut by a significant 11% or 23.5 Moz (730t), although our 2014 total has still been cut by a notable 6% or 10.5 Moz (328t).

At the sectoral level, one important driver of this revision was the lack of evidence for any substantial recycling from electrical applications. Another was the silver yield in recycled electronics having fallen faster than once thought. Photographic scrap has also declined more quickly than expected due to such factors as the recycling of old movie theater film in some countries going to zero in the last year or two. Europe, North America and China were the locations of the greatest downward revisions. In contrast, our rest-of-the-world number was actually increased as peer group benchmarking suggested higher recycling.

Silver Recycling by Sector & Region

By Sector (Tonnes)	2010	2011	2012	2013	2014	2015E	2016F	2017F
Industrial								
Europe	269	318	328	297	278	285	294	303
N America	1,003	1,046	1,045	1,049	1,057	1,068	1,162	1,124
India	119	140	160	112	111	124	135	146
China	311	360	378	438	517	677	797	948
Japan	235	245	224	235	230	240	258	278
Other	545	553	515	459	429	439	467	494
Sub-total	**2,482**	**2,663**	**2,650**	**2,589**	**2,622**	**2,833**	**3,113**	**3,292**
Jewelry								
Europe	102	134	162	127	108	102	98	93
N America	93	179	118	96	84	78	75	71
India	161	185	198	166	109	107	111	118
China	38	44	35	33	33	32	34	36
Japan	30	28	27	26	24	24	23	23
Other	274	298	285	241	215	208	216	230
Sub-total	**697**	**868**	**825**	**689**	**573**	**551**	**557**	**572**
Silverware								
Europe	287	438	432	342	298	276	264	249
N America	264	521	338	278	246	228	217	207
India	200	240	290	240	140	146	152	162
China	29	34	27	24	23	22	23	26
Japan	3	4	3	3	3	3	3	3
Other	277	340	325	263	213	211	208	206
Sub-total	**1,059**	**1,577**	**1,415**	**1,150**	**922**	**886**	**868**	**853**
Photographic								
Europe	414	370	335	299	264	240	218	198
N America	315	285	256	230	222	208	198	188
India	30	35	42	32	20	22	23	15
China	37	39	42	44	46	49	51	52
Japan	56	57	54	52	49	44	40	37
Other	350	306	273	239	211	192	177	162
Sub-total	**1,202**	**1,092**	**1,002**	**896**	**812**	**755**	**706**	**653**
Coin								
Europe	171	159	173	150	124	144	136	132
N America	53	53	53	53	42	31	31	26
India	-	-	-	-	-	-	-	-
China	-	-	-	-	-	-	-	-
Japan	-	-	-	-	-	-	-	-
Other	22	18	19	17	12	9	9	7
Sub-total	**246**	**230**	**246**	**220**	**178**	**185**	**176**	**166**
Total	**5,687**	**6,430**	**6,138**	**5,542**	**5,107**	**5,210**	**5,420**	**5,536**

By Region (Tonnes)								
Europe	1,242	1,419	1,430	1,215	1,072	1,048	1,009	975
N America	1,729	2,085	1,811	1,705	1,651	1,614	1,683	1,617
India	510	600	690	550	380	399	422	441
China	415	477	483	539	619	780	905	1,063
Japan	324	334	309	315	306	311	325	341
Other	1,468	1,515	1,416	1,218	1,079	1,059	1,077	1,100
Total	**5,687**	**6,430**	**6,138**	**5,542**	**5,107**	**5,210**	**5,420**	**5,536**

Source: Metals Focus

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