

# Worldwide Production, Trade and Consumption of Cadmium

## 1 Introduction

Cadmium is produced as a by-product from mining, smelting, and refining sulphide ores of zinc, and to a lesser degree, lead and copper. Cadmium minerals do not occur in concentrations and quantities sufficient to justify mining them. As it is a by-product of zinc, the production of cadmium is more dependent on production of refined zinc than on market demand. The percentage of cadmium in zinc concentrates varies from mine to mine, ranging from 0.07 to 0.83 per cent with an average of 0.23 % while zinc concentration is typically 55%. On average, about 3 kg of cadmium can be produced for each ton of zinc. Currently, China applies a 0.3% Cd threshold on imported zinc concentrate. Zinc concentrates with more than 0.3% cadmium may face difficulties to enter the Chinese market.

The data presented in this report was collected from several sources:

- Production data were collected from different sources:
  - Data reported to ICdA by members. Since some members have asked not to disclose their individual plant data, the production data are consolidated by region.
  - Data from the US and British geological survey, Indian Bureau of Mines: USGS, BGS IBM
  - ILZSG data on zinc plant capacity of zinc refineries that also refine cadmium. Combining this with typical Cd/Zn ratio, an estimate can be made for those plants/regions where no data is available.
  - Company annual reports.
- Trade data were taken from the UN COMTRADE database which contains data until 2018. Data were extracted via Chatham house which has a more user-friendly interface to extract data. (<https://resourcetrade.earth>). Only data reported under HS code 8107 “Cadmium and articles thereof, including waste and scrap” was considered. For cadmium compounds, there is no comprehensive reporting available. For example, Cadmium oxide with tariff code 2825.90.60 is not reported in COMTRADE. The reporting is only up to 6-digit HS code. Therefore, once transformed into oxides or hydroxides, it is not possible to identify the trade flows. Also, 8-digit customs codes are not consistent worldwide. For cadmium oxide, the 7<sup>th</sup> and 8<sup>th</sup> digit can be 20, 60 75 or 90.

## 2 Cadmium production and trade

### 2.1 Cadmium trade

Overview of trade data 2016-2018 as reported in COMTRADE under HS code 8107 “Cadmium and articles thereof, including waste and scrap.” Note that trade of cadmium compounds is not covered by this HS code.

#### 2.1.1 Nett importers of cadmium

rank	Importer	Importer region	2016	2017	2018
1	India	South-Central-North Asia	3894	5302	6571
8	Bangladesh	South-Central-North Asia	2	51	60
10	Pakistan	South-Central-North Asia	80	0	23
17	Others	South-Central-North Asia	1	3	0
2	China	China	9094	7717	3773
5	Malaysia	East Asia	-2	-68	273
9	Singapore	East Asia	8	3	26
15	Indonesia	East Asia	2	31	4
16	Others	East Asia	11	8	3
3	Belgium	Europe	2561	2099	2146
4	Sweden	Europe	1018	1162	963
7	Spain	Europe	20	12	117
11	Italy	Europe	-8	-34	20
14	Others	Europe	9	12	9
6	United States	Americas	53	106	218
13	Others	Americas	4	8	11
19	Others	Oceania	0	6	0
12	Israel	Middle East and Africa	97	193	14
18	Other	Middle East and Africa	23	15	0
20	Other	Other	-218	-5	0

Table 1 List of cadmium nett importer by country. Volumes in metric tonnes. (“-“ = export)

#### Largest cadmium consumers (2018 data)

**China:** 12 000 t/y

- Second largest importer of cadmium is China but imported volumes have dropped by 60% over the period 2016-2018. With an estimated internal production of 8 200 ton, China’s total consumption was about 12 000t in 2018.

Therefore, China is still the largest consumer of cadmium. 2019 import and export reported by the World Bank indicates a further drop of net import to 2 198 t, bringing total Chinese consumption down to 10 400 t. (assuming no change in Chinese production)

**India:** 6 618 t/y

- India is by far the largest and fast-growing importer, taking in 2018 almost 50% of all international cadmium import worldwide.
- Total Indian cadmium consumption in 2018 was 6 618 t. 2019 net imports reported by the World Bank indicate a further increase to 7 722 t.
- Domestic production is low. According to the Indian Bureau of Mines, total domestic production in 2017-2018 was only 47 t and even dropping to zero in 2019. In its 2019-2020 annual report, Hindustan Zinc reported that a cadmium production plant to produce 2,600 MTPA of cadmium from smelter process residues is in the installation phase and is expected to be commissioned in FY 2020-21.
- Rising demand for cadmium from India's unregulated jewellery makers is driving up prices of the metal, despite the fact that it was banned from hallmarking by the Bureau of Indian Standards (BIS) due to its ill effects on health. "Strong demand for cadmium in India, mostly for jewellery alloys, was a major driver for cadmium prices in most of 2017," according to a US Geological Survey report. Indian imports of cadmium, used for soldering and as an alloy in gold and silver jewellery, rose sharply. Only 50% of gold jewellery is hallmarked. Most artisan jewellers do not hallmark. With the upcoming mandatory hallmarking of gold jewellery by June 2021, a significant drop in the use of cadmium for gold jewellery can be expected.

#### **Europe: 2 500 t/y**

- Large volumes imported by Belgium reflect consumption by transformation industry to make Cd compounds for export while imports by Sweden relate to important NiCd battery manufacturing activities.
- Observed variations in trade activities in the UK, Switzerland and Estonia are linked to actions from traders rather than to an actual cadmium consumption.
- Europe consumed 406 t more cadmium metal than it produced in 2018. On top of that, there was an important flow of cadmium metal leaving Europe of about 1 361 t in 2018. Therefore, Europe's total cadmium import was 1 767 t in 2018.

#### **Japan: 900t/y**

- Combining COMTRADE export data and BGS data on production, the Japanese consumption of cadmium is estimated to be 900t in 2018.

#### **USA: 600t/y**

- The US has internal production and recycling of cadmium and is a net importer of cadmium. No data are published on consumption but from estimated production and import, US consumption is likely between 600 and 700t/y.
- There is growth in the US imports, but unclear if this is related to a decrease of local production or an increase of the US consumption.

## 2.1.2 Exporters of cadmium

rank	Exporter	Exporter region	2016	2017	2018
5	Kazakhstan	South-Central-North Asia	1618	1709	852
12	Russian Federation	South-Central-North Asia	1620	681	233
17	Uzbekistan	South-Central-North Asia	227	319	144
15	China, Hong Kong SAR	China	-52	-84	163
1	Korea, Rep.	East Asia	5193	5255	5092
3	Japan	East Asia	1362	1496	1178
19	Korea, Dem. Rep.	East Asia	0	0	31
7	Poland	Europe	538	581	667
8	United Kingdom	Europe	-502	-244	549
9	France	Europe	361	706	485
10	Norway	Europe	333	414	419
11	Switzerland	Europe	6	-4	329
13	Germany	Europe	472	564	215
16	Bulgaria	Europe	209	367	153
20	Netherlands	Europe	396	-101	31
23	Estonia	Europe	160	152	0
2	Canada	Americas	2292	2260	1528
4	Mexico	Americas	1302	1071	1138
6	Peru	Americas	670	806	673
14	Brazil	Americas	80	236	206
18	Australia	Oceania	425	465	128
21	United Arab Emirates	Middle East and Africa	-296	-34	18
24	Bahrain	Middle East and Africa	232	0	0
22	Others	Not specified	-195	10	0

Table 2 List of cadmium nett exporter by region. Volumes in metric tonnes. (“-“ = import)

### Observations

- The republic of South Korea is by far the largest exporter of cadmium metal. Korea Zinc is the largest zinc producer in the world. According to the Korean trade office, the export dropped with more than 25% to 3947,9 t in 2019. Because China was the largest importer of Korean cadmium, it is likely that this has affected Korean export.
- With presence of 2 zinc refineries also producing cadmium, Canada is a top 3 exporter, but export dropped by 33% in 2018.
- Export from the Russian Federation and Kazakhstan and Uzbekistan has dropped as well.
- Export from Central and South America has been fairly stable.
- Although Europe consumed 406 t more cadmium metal than it produced in 2018, there was an important flow of cadmium metal leaving Europe of about 1 361 t in 2018.: 1214 t to India, 129 t to South-Korea and 104 t to China.

### 2.1.3 Regional trade balance

When looking at regional trade balances, the following is observed:

- There is a large deficit in South-Central-North Asia and China which is balanced by an excess cadmium in the Americas and South-East Asia. However, this deficit has decreased by more than 1 400 t in 2018 and impacted mainly the exports from the Americas and South-East Asia.
- In Europe, the cadmium deficit has dropped with 75% since 2016. In 2018, the nett cadmium import was only 406t. (1.5% of world consumption)
- Demand in Africa and middle East has dropped as well as the cadmium export from Oceania but in absolute numbers, these tonnages are rather small.
- Decreased nett imports worldwide have mostly affect exports from the Americas and South-East-Asia. If more stringent rules on Indian jewellery industry are enforced, exports to India will drop significantly.

rank	Importer region	2016	2017	2018
1	South-Central-North Asia	3 386	4 814	6 177
2	China	9 236	8 701	5 393
3	Europe	2 401	2 113	1 767
4	Americas	194	325	275
5	East and South-East Asia	31	263	313
6	Africa & Middle East	328	313	44
7	Oceania	0	7	0

Table 3 Import by region

Trade exclude trade within the region

rank	Exporter region	2016	2017	2018
1	East and South-East-Asia	6 567	7 040	6 308
2	Americas	4 482	4 583	3 591
3	China	89	900	1 783
4	Europe	779	1 303	1 361
5	South-Central-North-Asia	2 873	2 168	751
6	Oceania	425	466	128
7	Africa & Middle-East	144	76	48

Table 4 Export by region

Trade exclude trade within the region

rank	Region*	2016	2017	2018
1	South-Central-North Asia	512	2 646	5 426
2	China	9 146	7 801	3 609
3	Europe	1 623	810	406
4	Africa & Middle East	- 33	237	- 4
5	Oceania	- 425	- 459	- 128
6	Americas	-4 288	-4 259	-3 315
7	East and South-East Asia	-6 535	-6 777	-5 994

Table 5 Overall regional trade balance for world regions: net import (+) and net export (-)

\*Trade excludes trade within the region

## 2.2 Cadmium production

Cadmium production comes mainly from primary zinc smelters. On average, 1 ton of zinc in zinc mineral concentrates is associated with 3 kg of Cd. With an annual production of 14 million tonnes of zinc, there is a potential production of 42 000 tonnes of cadmium. However, not all zinc refiners do refine contained cadmium. In 2018, the cadmium production was estimated to be about 24 000 t.

Region	Country	Company	Zinc capacity	Cadmium production	
				2017	2018
<b>China</b>		all primary smelters	7 236 000	<b>8 200</b>	<b>8 200</b>
<b>East- &amp; South-East-Asia</b>				<b>6 310</b>	<b>7 013</b>
	Korea Rep	Korea Zinc (Young Poong Group)	650 000		
		Young Poong Corp (Young Poong Group)	350 000		
	Japan	Akita Zinc Co Ltd (Dowa Group)	210 000		
		Hachinohe Smelting Co. Ltd. (Mitsui)	118 000		
		Hikoshima Smelting Co. Ltd.	84 000		
		Kamioka Mining & Smelting (Mitsui)	72 000		
<b>South-Central-North Asia</b>				<b>2 560</b>	<b>2 571</b>
	India	Chanderiya, Rajasthan (ISF) (HZL)	105 000		
		Chanderiya, Rajasthan (RLE) (HZL)	453 000		
		Dariba, Rajasthan (HZL)	240 000		
		Debari (HZL)	92 000		
	Russian Fed.	Chelyabinsk (CZP/UMMC)	200 000		
	Kazakhstan	Ridder (Kazzinc/Glencore)	125 000		
		Ust-Kamenogorsk (Kazzinc/Glencore)	190 000		
	Uzbekistan	Almalyk (AMMC)	95 000		
	Iran	all primary smelters	131 000		
<b>Europe</b>				<b>2 017</b>	<b>2 107</b>
	Bulgaria	Plovdiv (KCM 2000 AD)	80 000		
	Germany	Nordenham (NZH Glencore)	175 000		
	Netherlands	Budel (Nyrstar)	295 000		
	Norway	Odda (Boliden)	200 000		
	Poland	Miasteczko Slaskie (HCM)	75 000		
		Bukowno (ZGH-Boleslaw)	100 000		
<b>America</b>				<b>4 490</b>	<b>4 221</b>
	Brazil	Juiz de Fora, Minas Gerais (Nexa)	95 000		
		Tres Marias, Minas Gerais (Nexa)	180 000		
	Canada	Flinflon (Hudbay Minerals Inc.)	110 000		
		Teck Resources Limited	310 000		
	Mexico	San Luis Potosi (Grupo Mexico)	105 000		
		Torreón (Peñoles)	350 000		
	Peru	Cajamarquilla (Nexa)	350 000		
	United States	Clarksville (Nyrstar)	118 000		
		Inmetco			
<b>Oceania</b>				<b>388</b>	<b>342</b>
	Australia	Hobart (Nyrstar)	280 000		
		Sun Metals Corporation (Korea Zinc)	225 000		
<b>World</b>				<b>23 578</b>	<b>24 125</b>

Table 6 Annual production of cadmium from zinc refining (metric tonnes)

Most numbers are verified but there is some uncertainty on the accuracy of the Chinese output. For Uzbekistan, Kazakhstan and Brazil, no recent data from producers were received. Values for these countries are estimates reported by USGS, BGS and IGS.

### 3 Cadmium consumption

Combining the data on trade and production, the regional consumption is calculated. Changes in stocks might affect accuracy of the estimated consumption.

- It should be noted that all conclusions are on cadmium metal. Listed consumption of cadmium in a region does not imply that it is also used in that region. Once transformed into cadmium compounds, flows of cadmium compounds to the users are not traced.
- In 2017, China had a massive 63% share of the total world consumption. In 2018, the share dropped to 46% and in 2019 there is a further drop to 40%. It looks like there is an important shift from China to India. Likely, more stringent environmental and health regulation and enforcement in China are at the origin of this geographical move of activities. With the recent ban on zinc concentrates containing >0.3% Cd, there could be a decrease of Chinese cadmium production as well.
- India has become a major consumer of cadmium in the last years. Main consumer is the jewellery and fashion industry.

A gold-8%Cd alloy (KDM gold) is much used for soldering gold jewellery as it doesn't dilute the gold when the jewellery is remelted. However, the use of cadmium in jewellery making, resulted in health problems to the artisans as well as its wearers, so the Bureau of Indian Standards (BIS) banned it and will not do any hallmarking of cadmium alloyed gold. Solders of Zinc and other metals are being used to replace cadmium. Industry sources say gold jewellery with a purity stamp or hallmarking, that does not contain cadmium, now represent about 40 percent of the industry.

More important is that with recent legislation, hallmarking of gold jewellery and artefacts will now also become mandatory in India from 1 June 2021 to ensure purity of the precious metal. This mandatory hallmarking will make it compulsory for all the jewellers to register with the Bureau of Indian Standards (BIS) and sell only hallmarked gold jewellery and artefacts. However, at the end of 2020, only 10% of the Indian jewellers had registered for hallmarking. Therefore, industry is trying to push back the deadline to January 2022. The mandatory hallmarking is expected to completely bring down the illegal usage of cadmium by small jewellery artisans, which have a 60% market share of gold jewellery industry in India. If this would materialize, Indian cadmium imports can drop significantly. In 2018, India consumed 6 618 t cadmium, mostly in jewellery and fashion.

Cd is also much used in silver alloys. Opposite to gold, silver alloy hallmarking is not and will not become mandatory in India. Cadmium is added in smaller quantities (2% or 4%) to make silver more resistant to tarnish while respecting restriction to keep silver purity at least at 925/1000. However, alternative Cd free solution are now available, and it is expected this use of Cd will diminish and eventually disappear.

Another fast-growing segment in India is the imitation, costume and fashion jewellery, where alloys containing more than 90% cadmium are used. In this segment, cost is a driving factor for using cadmium. It is also the segment with the highest cadmium consumption. The



whole segment of fashion and imitation jewellery represented US\$ 6 billion in 2020 with a 20% annual growth. Annual silver consumption in India was at 2150 t in 2019.

As a conclusion on India, there is uncertainty how the expected sharp decrease of cadmium use in gold jewellery will be balanced by increased use of cadmium in the highly unregulated and fast-growing Indian market of imitation, costume and fashion jewellery.

- South-Central-North Asia, with India as dominant consumer, raised its share in consumption from 20% to 31%.
- In East Asia, with main players Korea and Japan, consumption apparently increased. However, considering the important production volumes in that regions, the observed variations could also be linked with variations in cadmium stocks rather than with variations in consumption. If the average over 2017-2018 would be considered, cadmium use in that region would be around 275 t/y or 1,1% of world consumption.
- In the Americas, a similar variation is seen. On average, the consumption is 700 t/y or 2.75% of world consumption.
- The average consumption in Europe is 2670 t/y or 10.5% of world consumption. The observed decrease from 2017 to 2018 could be related to changes in stock.
- Oceania, Africa and the Middle East have only very little consumption of cadmium.

Region	Import (+)/export(-)		Production		Consumption	
	2017	2018	2017	2018	2017	2018
China	7 801	3 609	8 200	8 200	16 001	11 809
East Asia	-6 777	-5 994	6 310	7 013	- 467	1 019
South-Central-North Asia	2 646	5 426	2 560	2 571	5 206	7 997
Europe	810	405	2 017	2 107	2 827	2 512
America	-4 259	-3 315	4 490	4 221	231	906
Oceania	- 459	- 128	388	342	- 71	214
Africa & Middle East	242	- 4			242	- 4
<b>World</b>			<b>23 965</b>	<b>24 454</b>	<b>23 969</b>	<b>24 453</b>

Table 7 Cadmium trade, production and consumption in main geographical regions.

## 4 Cadmium consumption

The cadmium landscape has changes over the last few years. Changes in environmental and health regulation and enforcement in China has resulted in a drop of 35% of Chinese consumption between 2017 and 2019.

India has balanced this drop in China by a sharp growth in cadmium consumption. With the upcoming mandatory hallmarking of gold jewellery in India by June 2021, cadmium demand for this market segment will drop drastically. It needs to be seen if the use of cadmium in the highly unregulated and fast-growing Indian market of fashion jewellery with illegal use of cadmium alloys will compensate this loss.

The ongoing construction of a new cadmium refining capacity of 2650 t/y at Hindustan Zinc, expected to be commissioned in 2022, will further contribute to changes in today's trade balances.



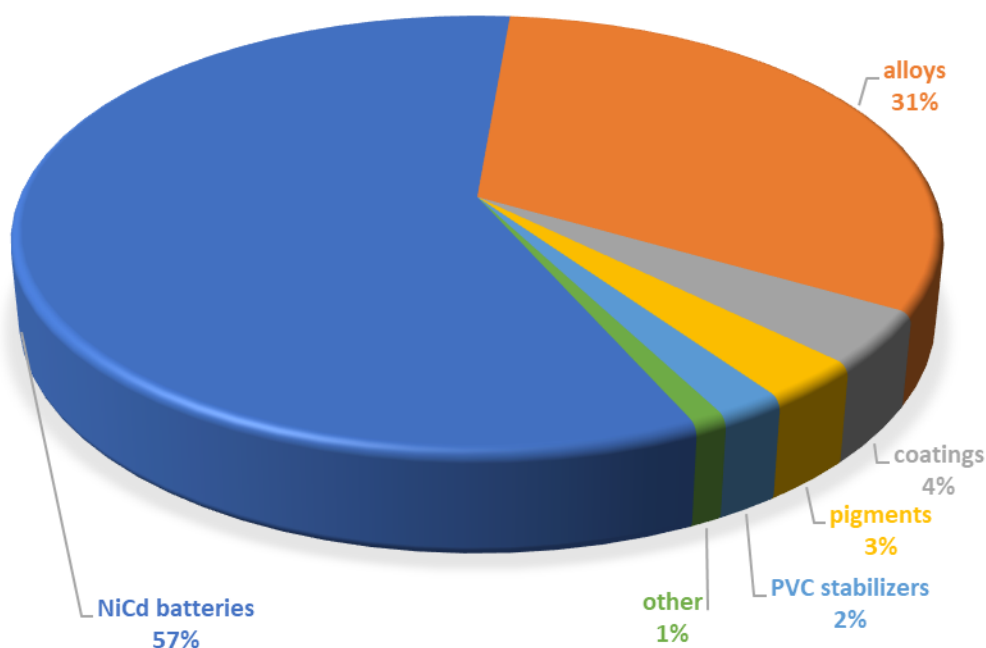
In 2019 the worldwide cadmium consumption was split over a series of applications, listed here below in order of market size:

- NiCd batteries in aviation, public transportation, safety and industrial back-up systems
- Alloys in fashion jewellery, solders, Cu-Cd high conductivity wires with high strength and flexibility, Ag-In-Cd moderator rods in nuclear reactors.
- Anti-corrosion plating in aviation, military and offshore (electrical parts, structural parts and fasteners)
- CdS and CdSe based temperature and UV resistant pigments (yellow, orange, red and brown)
- PVC stabilizers
- Semiconductors: CdTe photovoltaic cells, CdTe X-ray detectors, IR detectors

The size of the alloy market is more difficult to estimate as no data is available on the unregulated and illegal use of cadmium in the fashion jewellery industry, mainly in India. It was estimated as what was left over after the cadmium uses in all other applications where quantified. For NiCd batteries, the top end of different estimates was taken (11 000 – 14 000 t/y).

The only application where there is some growth, is the semiconductor market for CdTe. Cadmium use in all other applications is flat or in slight decline. The highest uncertainty on future evolution comes from the use of cadmium in alloys, and particularly in the Indian gold and fashion jewellery sector.

### WORLD CADMIUM APPLICATIONS (2019)



## 5 References

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