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Experts

Top 10 Circular Materials by mass

– Market study –

About this market study

Since 2011 represents the latest year of which comprehensive accounts of metric calculation entered key flow charts, the reinforcement and need for updated key figures is obvious. Therefore, the aim of this market study was to identify the ten largest material flows by mass from a circular economic perspective based on newest database.

The overall goal was to deliver the big picture for the current status of circular economy in the world. This study didn‘t focus on regional best practice examples but on the coherence of global circularity which is why larger regional units on a cross-country basis were taken in observation. The smallest units were chosen for national levels.

Circularity is part of basic industrial processes for many industry leaders in Global North. In a global world our focus can’t be fixed on industrial leaders though. The global economy is systemic and needs to be examined as one system. How circular are the globally most successful circular systems by mass really?

What we have found is that most material systems are lacking circular comprehensiveness in a global context. 9 million tons are supposed to be managed circular, which is a small amount, taking into account that about 100 million tons are extracted out of this planet earth per year. But by looking deeper into regional mass balance accounts, we find that the results are even worse.

Table of Content

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Methodology

For identification of the TOP 10 circular materials by mass, the Circularity Gap Report was the starting point. The database of the Circularity Gap Report was the largest database for key flows and metric calculations. The year 2011 represents the latest year of which comprehensive accounts for key flows exist. The need for updated key figures was obvious.

By identifying 10 materials with highest circularity scores in 2011, the database had to be verified. Large units of data, which were published by United Nations and World Bank on waste management and material flow, were chosen. The findings could be verified and time-line data sources could be identified. Overall, 12 materials were analyzed coming from 12 primary industries and 12 recycling sectors. The final total number of sources was: 190. The total number of time-line figures used in this study is: 2,800. Additional 9,940 time-line figures were identified as not useful and therefore excluded from the study. 25% of all data and sources researched were identified as appropriate.

As a general challenge according to Haas (2015, p. 790) a **data variance factor of TWO** exists in examined waste and material flow analysis for the EU and it might be even higher for the world.

Methodology

The global inconsistency of statistical figures in material and waste streams can't be ignored. It increases by including domestic extraction figures and trade balances. Therefore, another step of methodologic selection was added.

Using Beigl et. al waste analysis concept enabled the identification of produced material and recycled material and start the deeper dive into data basis. (Beigl et al, Waste Management 28 (2008) p. 200 – 214)

As concepts of waste stream modelling the material streams were defined as to organic materials, paper, glass, plastic metal etc. Further the collection stream is defined as to commingled residual waste, separated waste streams (like glass or paper) and illegal disposals (in landfills or open dumps). Further the fractions of household waste, which are separate for organic material, paper, glass, plastics, metals and others had to be taken in mind.

The findings showed that the TOP 10 materials are not necessarily a fraction of household waste. In some cases, they are.

Methodology

Due to large data bias, large number of regions, mixed structure of good data base and lack of data for a number of reasons the reduction of parameters and simplification of findings had to proceed.

The rating card was invented. It contains general findings according to Circular Economy tool kit objectives. The findings will further have to be validated. The rating generated from the findings of all sources and is a strict simplification in functional form.

In the first step four categories were chosen, which refer to the Circular Economy toolkit by Allen Mac Arthur foundation (2019), it delivered the basis for the Circular Economy intervention types. The four categories are:

1. Legislation for CE – Policy intervention types
2. Acceptance of CE – cognition for CE in people's minds for value of material, collection and recycling
3. Availability of recycling technology
4. Market maturity

The overall rating is the average rating tendency according to expert interview on basis of single results of the rating card scheme.

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Methodology

Definitions:

Collection rate = (production + imports)/consumption

Recycling rate = Material from Waste Stream that enters production = Waste material/production

Circularity rate = Recycling rate / (domestic extraction + imports – exports)

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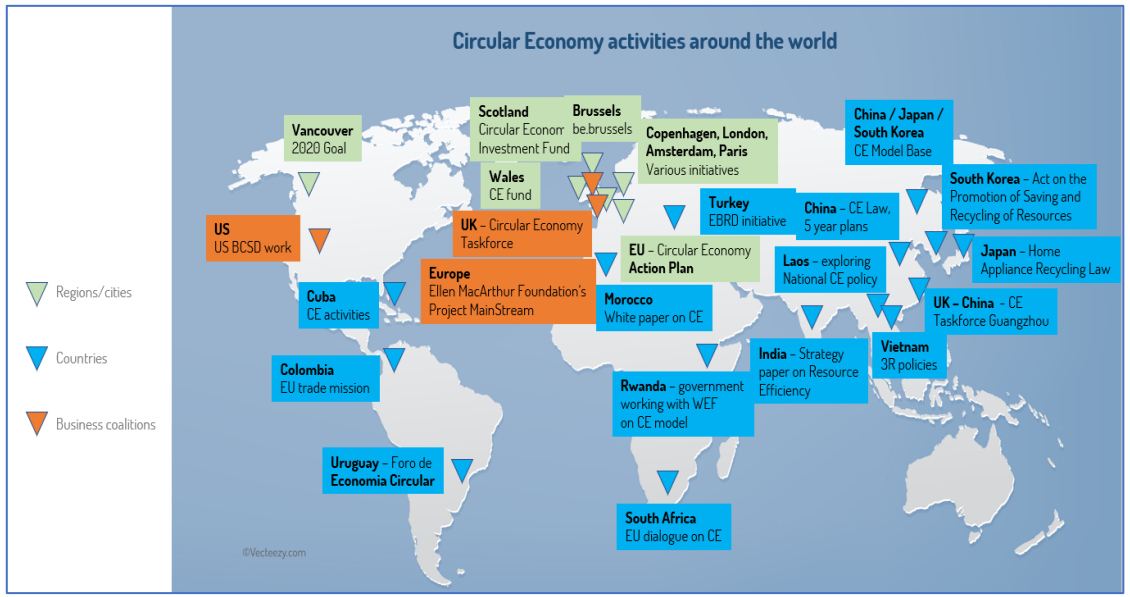
Introduction – Global Circular Economy

Waste culture and concepts are different in Global North and Global South: For Global North, goal is to decouple waste generation from consumption. In Global South, waste grows as income per capita does. Whereas key questions for Global North are about HOW to recycle specific materials, key questions for Global South are about how to recycle AT ALL.

The majority of waste still ends up in open dump or in landfill. In mega cities of Global South incineration has grown up to 26% within 5 years and is substituting landfill. In the industrialized waste sectors incineration makes up for 12-27%.

As the map shows, worldwide more and more circular economy activities get started to move into the right direction:



Circular economy activity around the world. Own illustration based on (Preston & Lehne, 2017, p. 6).

Sources: Kaza et. al (2018, p.p 17-37) - Lu et. al (2017, p. 176) - Sabour et. al (2020, p. 2).

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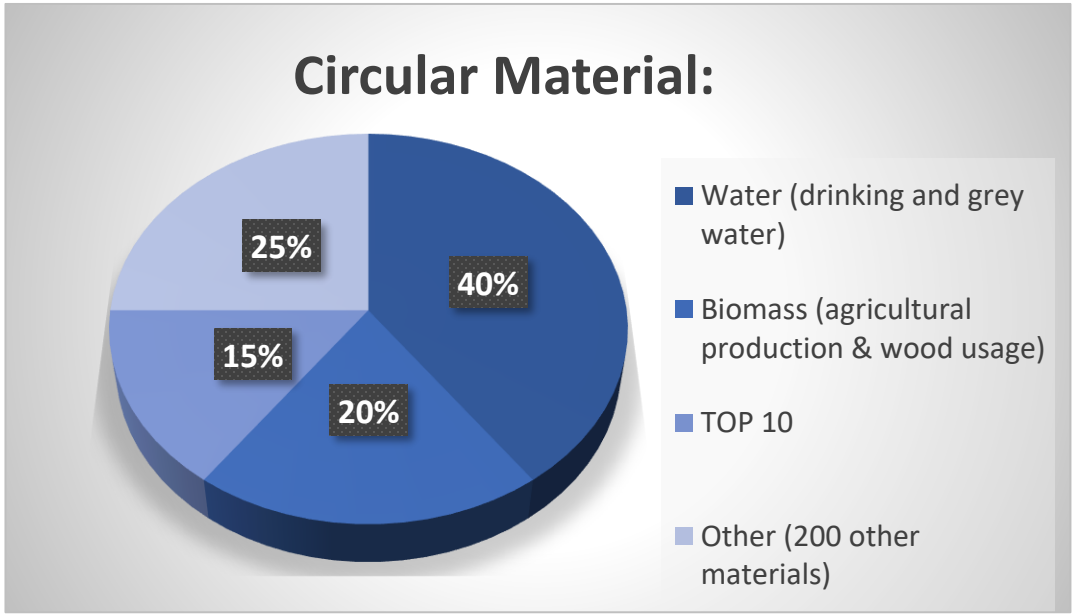
Introduction – Global Circular Economy

To understand the context of this study, it makes sense to look at waste. Globally, waste is composed of 44% wet waste (food, green waste), 38% dry waste (metal, paper, cardboard, plastic) and 18% mixed waste.

Every year, 100 billion tons of planetary material get extracted. Of these 100 billion tons, 10 billion tons p.a. are supposed to be managed circular. 1.5 billion tons of these are the top 10 circular materials described in this study. We are therefore looking at 1.5% of the global material flow.

The individual materials and its readiness for circular economy in the region will be rated through score cards.



Sources: de Wit et. al (2018, p. 6) - Hatfield-Dodds et. al (2017, p. 8) - Kaza et. al (2018, p.p 17-37).

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STEEL

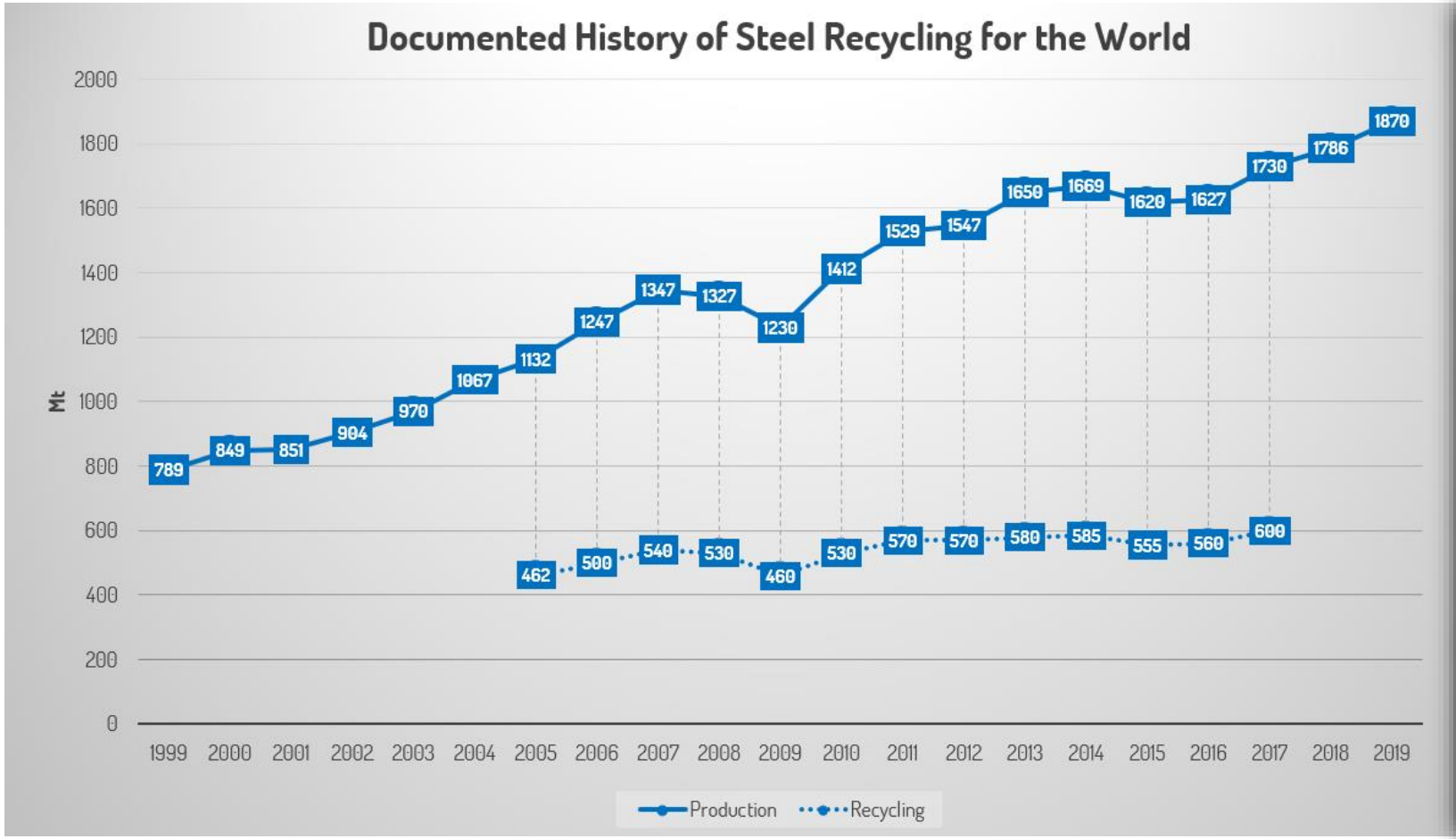
1,730 million tons produced (2017).

600 million tons recycled (2017).

35% global recycling rate.

Photo by Christophe Dion from Unsplash.

Steel – Market study results



Facts

- Material is no fraction of household waste.
- 1,730 million tons globally produced (2017).
- 600 million tons recycled (2017).
- 35% global recycling rate (2017).
- Since 1st industrial revolution the steel market is well-established.
- During the financial crisis in 2008, steel markets globally broke down.
- Global economic growth due to growing Chinese market leads to decoupling from recycling.

Sources: Bureau of International Recycling – Ferrous Division (2010, p. 8) - Bureau of International Recycling – Ferrous Division (2011, pp. 8-9) - Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 11) - Bureau of International Recycling – Ferrous Division (2017, p. 8, pp. 12-13, pp. 22-23) - Bureau of International Recycling – Ferrous Division (2019, p. 8, p. 13, p. 22) - Bureau of International Recycling – Ferrous Division (2020, p. 8) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005a, p. 79, p. 90, p. 96, p. 98, p. 116, p. 118) - Söderholm et. al (2008, p. 64) - World Steel Association (2011, p. 4, p. 6, p. 9, p. 26) - World Steel Association (2013, p. 16, p. 27) - World Steel Association (2017, pp. 15-16, p. 22) - World Steel Association (2018, p. 106, p. 108) - World Steel Association (2019, p. 22) - World Steel Association (2020a, p. 1) - World Steel Association (2020b, p. 6, p. 16, p. 22).

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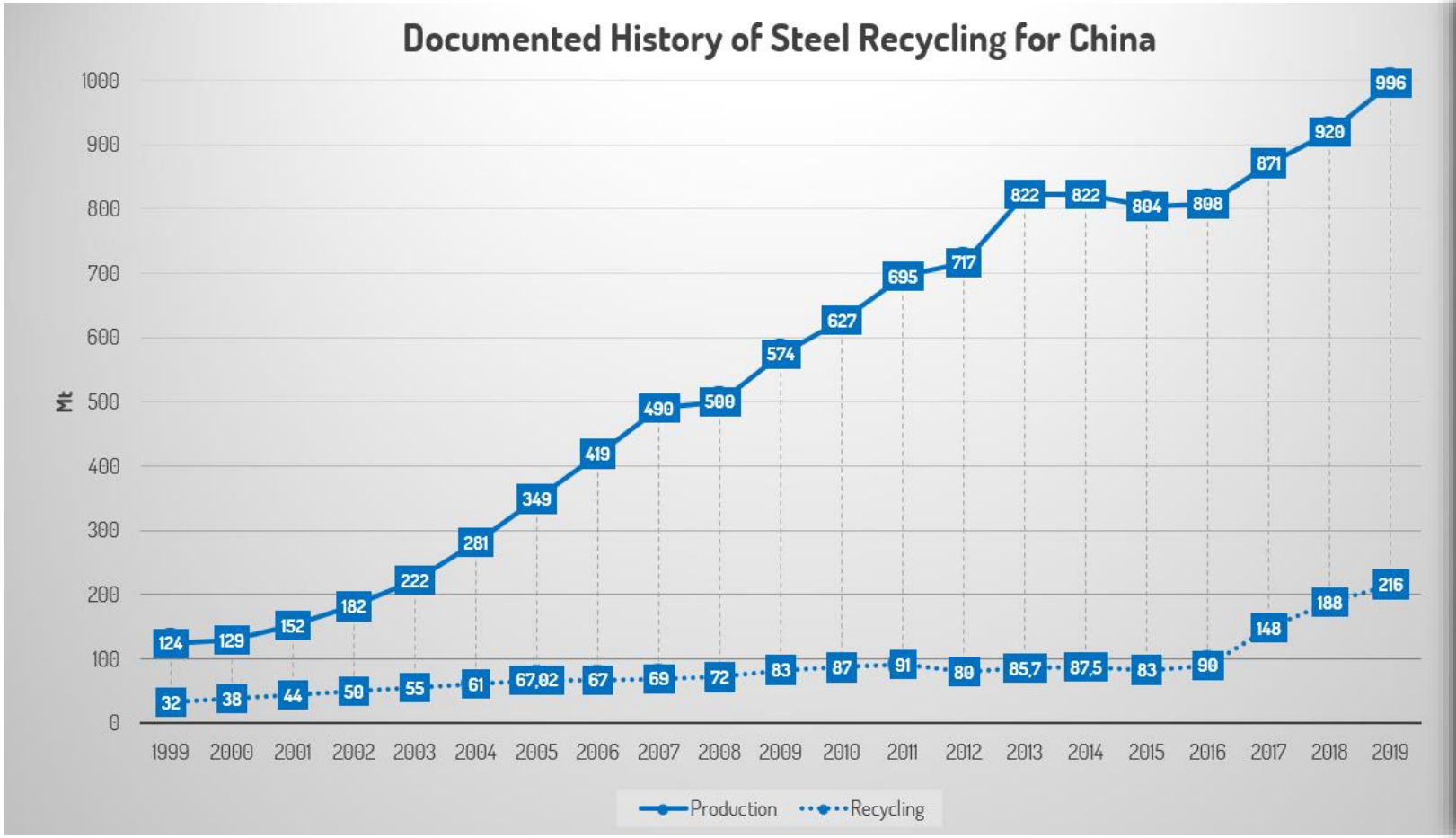
Steel – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Asia.

China:

- 996 million tons produced (2019).
- 216 million tons recycled (2019).
- 22% recycling rate (2019).
- Political announcement for Circular Economy in 2009.
- Recycling demand is increasing.
- No subsistence situation yet; decoupling from recycling.

Sources: Bureau of International Recycling – Ferrous Division (2010, p. 8) - Bureau of International Recycling – Ferrous Division (2011, pp. 8-9) - Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 11) - Bureau of International Recycling – Ferrous Division (2017, p. 8, pp. 12-13, pp. 22-23) - Bureau of International Recycling – Ferrous Division (2019, p. 8, p. 13, p. 22) - Bureau of International Recycling – Ferrous Division (2020, p. 8) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005a, p. 79, p. 90, p. 96, p. 98, p. 116, p. 118) – Söderholm et. al (2008, p. 64) - World Steel Association (2011, p. 4, p. 6, p. 9, p. 26) - World Steel Association (2013, p. 16, p. 27) - World Steel Association (2017, pp. 15-16, p. 22) - World Steel Association (2018, p. 106, p. 108) - World Steel Association (2019, p. 22) - World Steel Association (2020a, p. 1) - World Steel Association (2020b, p. 6, p. 16, p. 22).

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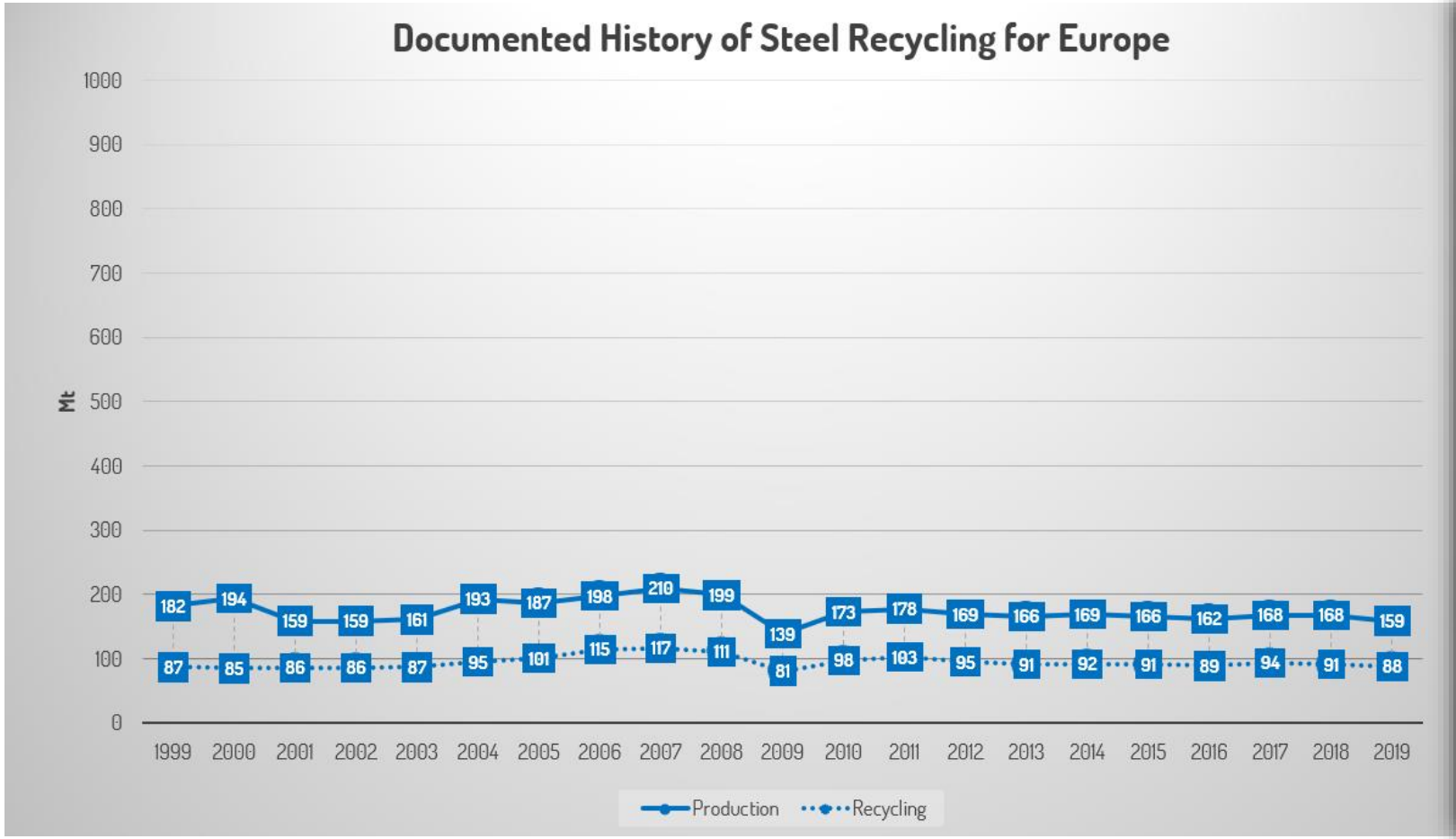
Steel – Market study results



Facts

- Material is no fraction of household waste.
- 159 million tons produced (2019).
- 88 million tons recycled (2019).
- 55% recycling rate in 2019 (which is lower than in the US).
- Legal basis for the disposal of waste electrical and electronic equipment (WEEE) is the Directive 2012/19/EU.
- Market is mature.
- During the financial crisis in 2008, steel markets broke down in Europe.

Sources: Bureau of International Recycling – Ferrous Division (2010, p. 8) - Bureau of International Recycling – Ferrous Division (2011, pp. 8-9) - Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 11) - Bureau of International Recycling – Ferrous Division (2017, p. 8, pp. 12-13, pp. 22-23) - Bureau of International Recycling – Ferrous Division (2019, p. 8, p. 13, p. 22) - Bureau of International Recycling – Ferrous Division (2020, p. 8) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005a, p. 79, p. 90, p. 96, p. 98, p. 116, p. 118) – Söderholm et. al (2008, p. 64) - World Steel Association (2011, p. 4, p. 6, p. 9, p. 26) - World Steel Association (2013, p. 16, p. 27) - World Steel Association (2017, pp. 15-16, p. 22) - World Steel Association (2018, p. 106, p. 108) - World Steel Association (2019, p. 22) - World Steel Association (2020a, p. 1) - World Steel Association (2020b, p. 6, p. 16, p. 22).

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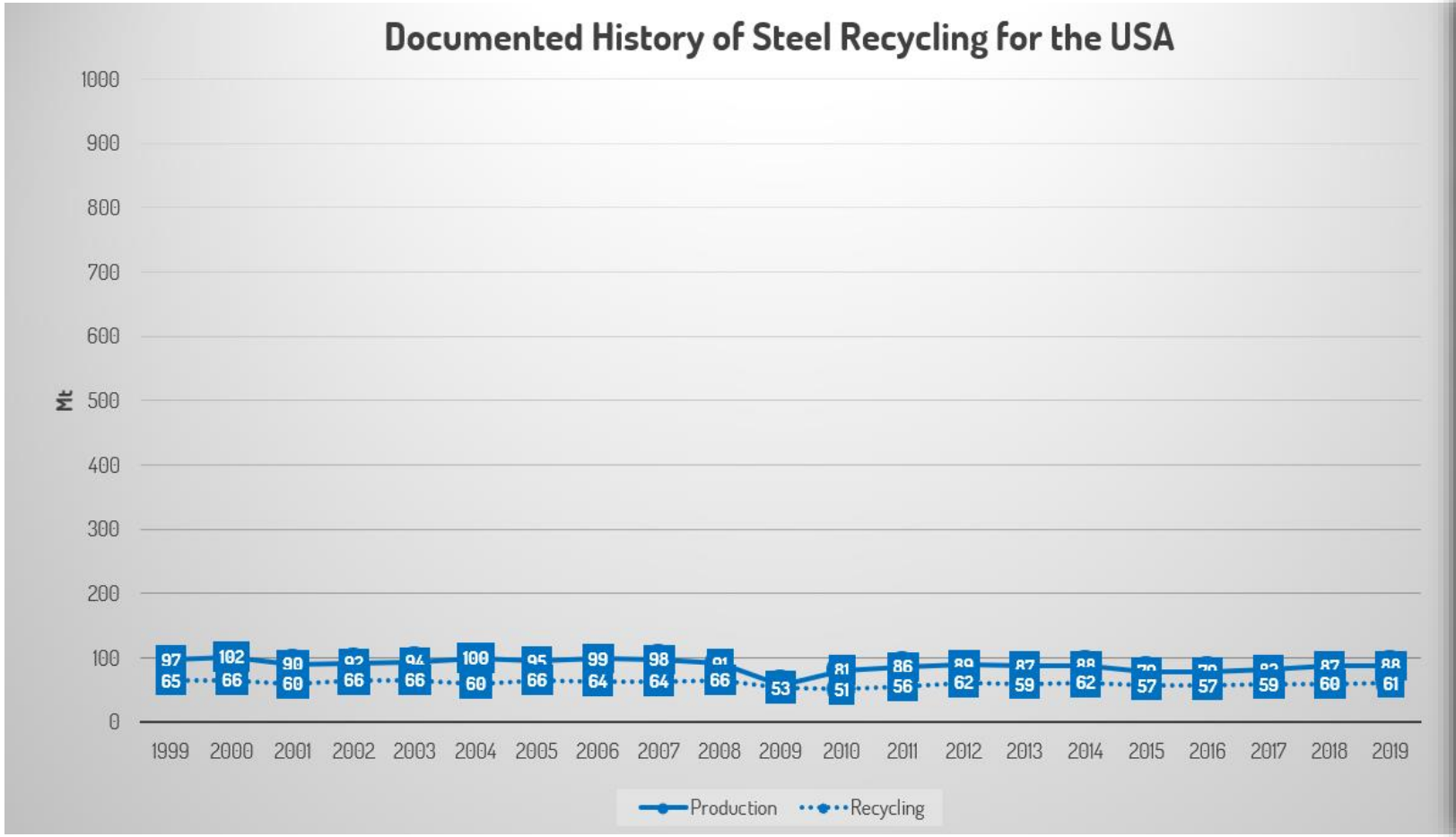
Steel – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole North America.

USA:

- 88 million tons produced (2019).
- 61 million tons recycled (2019).
- 69% recycling rate (2019).

Sources: Bureau of International Recycling – Ferrous Division (2010, p. 8) - Bureau of International Recycling – Ferrous Division (2011, pp. 8-9) - Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 11) - Bureau of International Recycling – Ferrous Division (2017, p. 8, pp. 12-13, pp. 22-23) - Bureau of International Recycling – Ferrous Division (2019, p. 8, p. 13, p. 22) - Bureau of International Recycling – Ferrous Division (2020, p. 8) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005a, p. 79, p. 90, p. 96, p. 98, p. 116, p. 118) – Söderholm et. al (2008, p. 64) - World Steel Association (2011, p. 4, p. 6, p. 9, p. 26) - World Steel Association (2013, p. 16, p. 27) - World Steel Association (2017, pp. 15-16, p. 22) - World Steel Association (2018, p. 106, p. 108) - World Steel Association (2019, p. 22) - World Steel Association (2020a, p. 1) - World Steel Association (2020b, p. 6, p. 16, p. 22).

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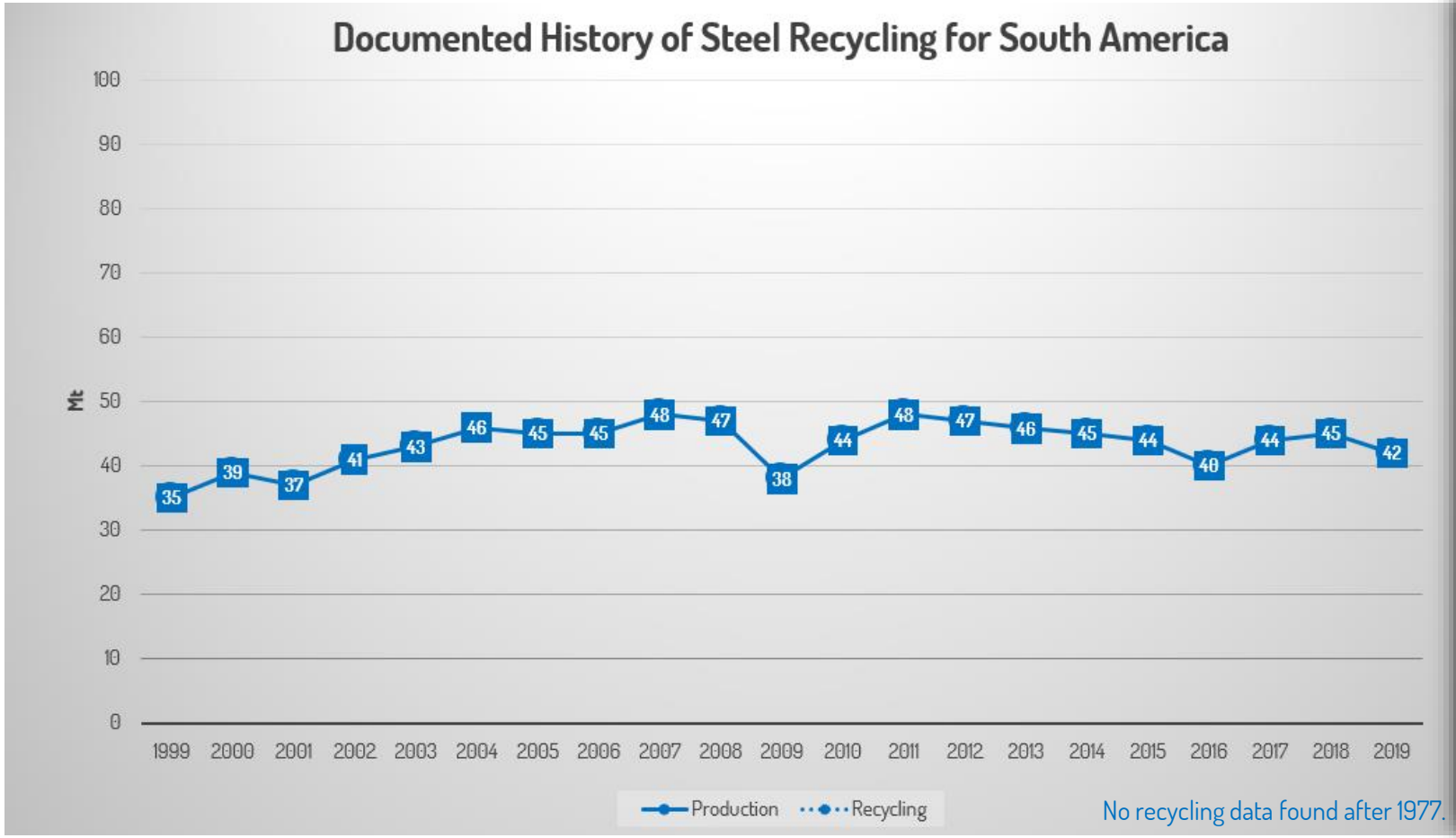
Steel – Market study results



No recycling data found after 1977.

Facts

- Material is no fraction of household waste.

Very limited findings:

- 42 million tons produced (2019).
- 10 million tons recycled (1977).
- Market is mature.

Sources: Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 13, pp. 18-19) - Bureau of International Recycling – Ferrous Division (2017, p. 8, p. 12, p. 23, p. 26) - Bureau of International Recycling – Ferrous Division (2019, p. 8, pp. 12-13) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005a, pp. 10-12, pp. 77-79, pp. 95-99) – International Iron and Steel Institute (2005b, p. 6, p. 17) - World Steel Association (2010a, pp. 3-5, pp. 89-90, pp. 115-118) - World Steel Association (2010, p. 13) - World Steel Association (2011, pp. 5-6, p. 9, p. 14, p. 16, p. 26).

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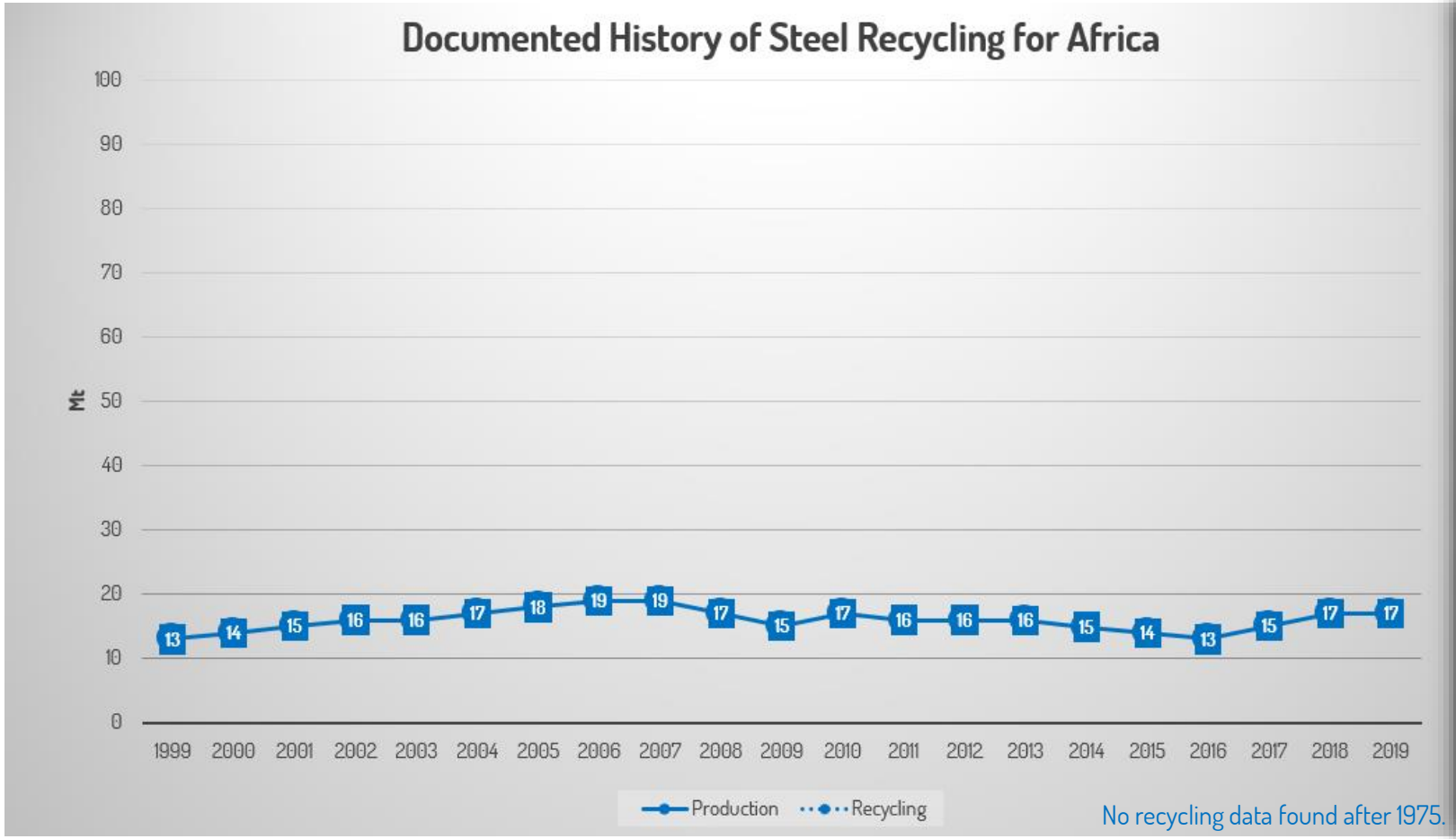
Steel – Market study results



No recycling data found after 1975.

Facts

- Material is no fraction of household waste.

Very limited findings:

- 17 million tons produced (2019).
- 9 million tons recycled (1975).
- Africa is a dumping place for steel with high rates of informality.
- Almost no recycling figures.
- Malfunctioning markets.
- Low institutionalized level, no WEEE-Directive like in Europe.

Sources: Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 19) - Bureau of International Recycling – Ferrous Division (2017, p. 8, p. 26) - Bureau of International Recycling – Ferrous Division (2019, p. 8) - International Iron and Steel Institute (1978, p. 49) - International Iron and Steel Institute (2005, pp. 11-12, pp. 78-79, p. 96, p. 98) - World Steel Association (2010, pp. 4-5, pp. 89-90, p. 116, p. 118) - World Steel Association (2011, p. 5, p. 9, p. 26).

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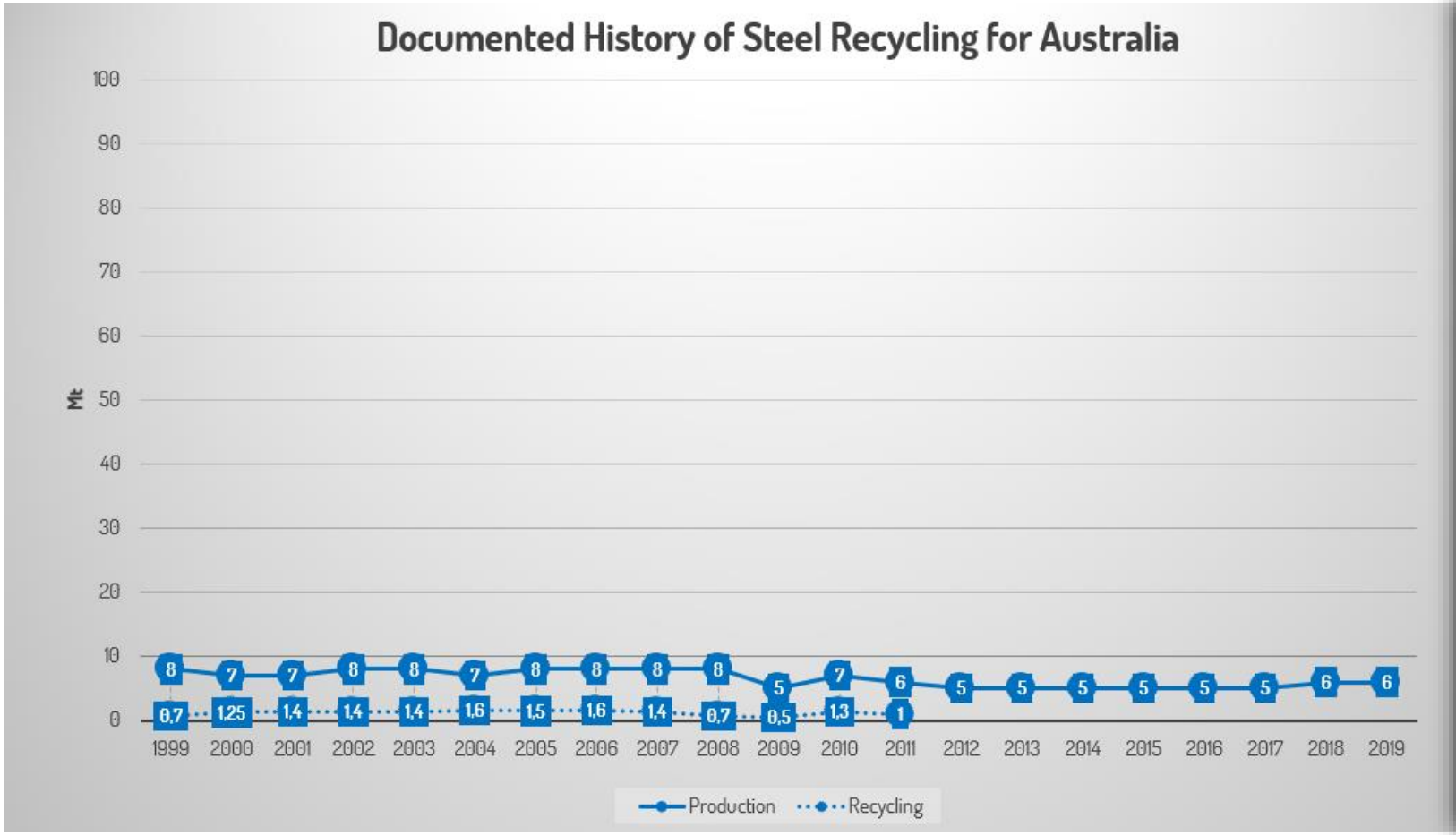
Steel – Market study results



Facts

- Material is no fraction of household waste.
- 6 million tons produced (2011).
- 1 million tons recycled (2011).
- 17% recycling rate (2011).
- Australia is characterized through a geographical decoupling of recycling imports and mining infrastructure.

Sources: Bureau of International Recycling – Ferrous Division (2013, p. 8, p. 19) - Bureau of International Recycling – Ferrous Division (2017, p. 8, p. 26) - International Iron and Steel Institute (2005, pp. 11-12, pp. 78-79, p. 96, p. 98) - World Steel Association (2010, pp. 4-5, pp. 89-90, p. 116, p. 118) - World Steel Association (2011, p. 5, p. 9, p. 26) - World Steel Association (2019, p. 5, p. 10, pp. 21-22) - World Steel Association (2020b, p. 8, p. 10, p. 16, p. 22) – Yellishetty et. al (2014, p. 8).

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SCORE CARD STEEL

		Global North			Global South		
	WORLD	USA	CHINA	EUROPE	AFRICA	AUSTRALIA	SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Steel - Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Steel	600 Mt	1,730 Mt	35%	good	Though technology is available, global recycling rate only reaches 35%. World markets are still growing faster than recycling. Anyhow, CE rating is good due to good circular practice in many countries.	

Steel is characterized through little material degradation. It has been the most important material for the first industrial revolution. Mining and production of steel making characterized this period. The recycling of steel scrap evolved and grew during unsteady times. During 1st and 2nd World War, many countries started campaigning for the collection of steel scrap to ensure supplies for weapon industries. Later, steel was needed to rebuilt destroyed cities and to feed the growing industries.

Therefore, the level of knowledge and cognition for circular economy is high in modern industry. Today, used steel scrap is cheaper than virgin iron ore in the production process. Trading market is developed and steel markets exist globally. Prices depend on global trends.

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ASPHALT

936 million tons produced (2013).
530 million tons recycled (2013).
57% global recycling rate.

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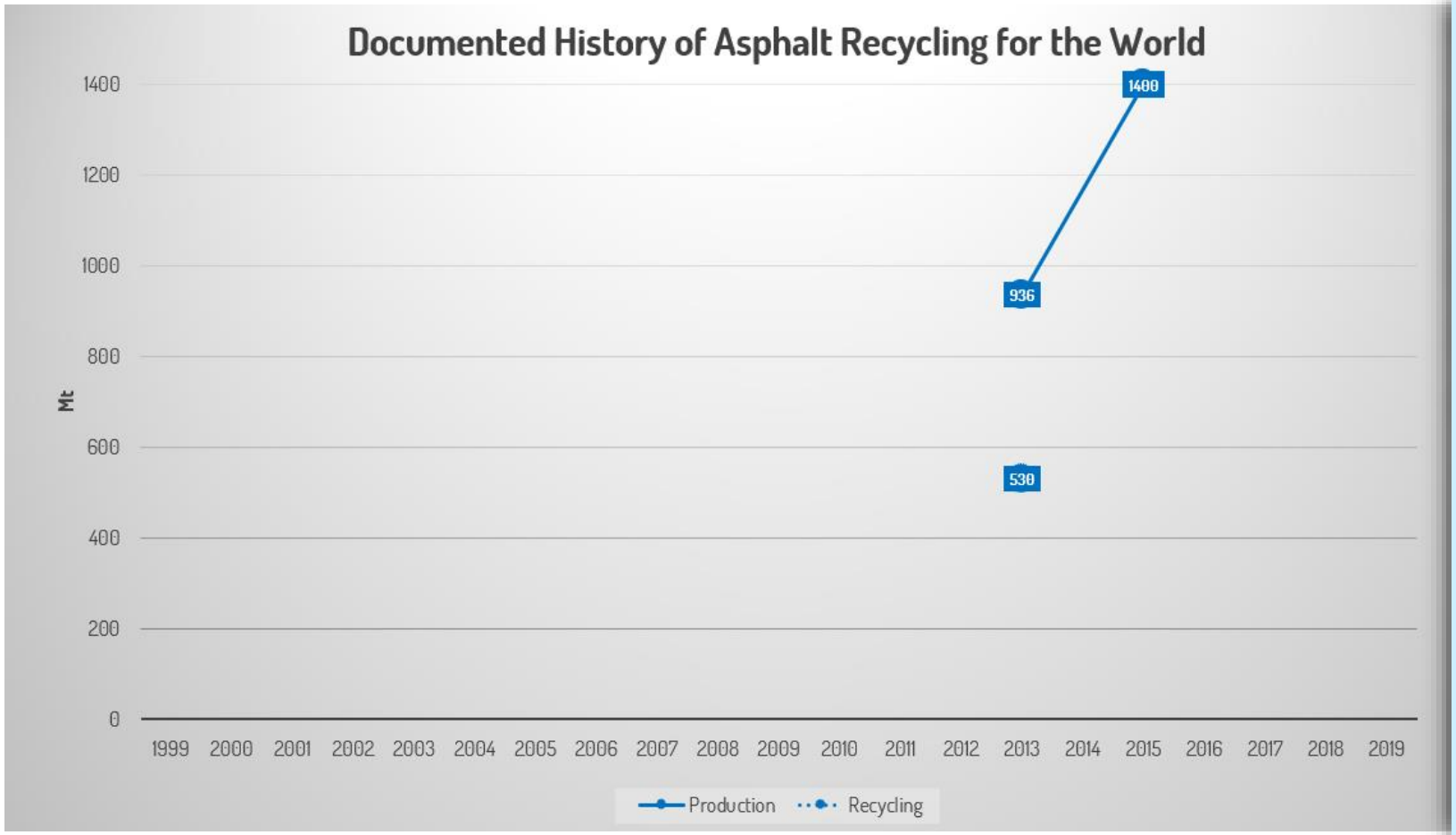
Photo by Nick Fewings via Unsplash.

Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- 936 million tons produced (2013).
- 530 million tons recycled (2013).
- 57% global recycling rate (2013).
- Main data from samples.
- "[...] in situ recycling is already quite high, but quantitative assessments at the global level or for world regions are lacking." [Haas et. al (2015), p. 773]

Sources:Haas et. al (2015, p. 773).

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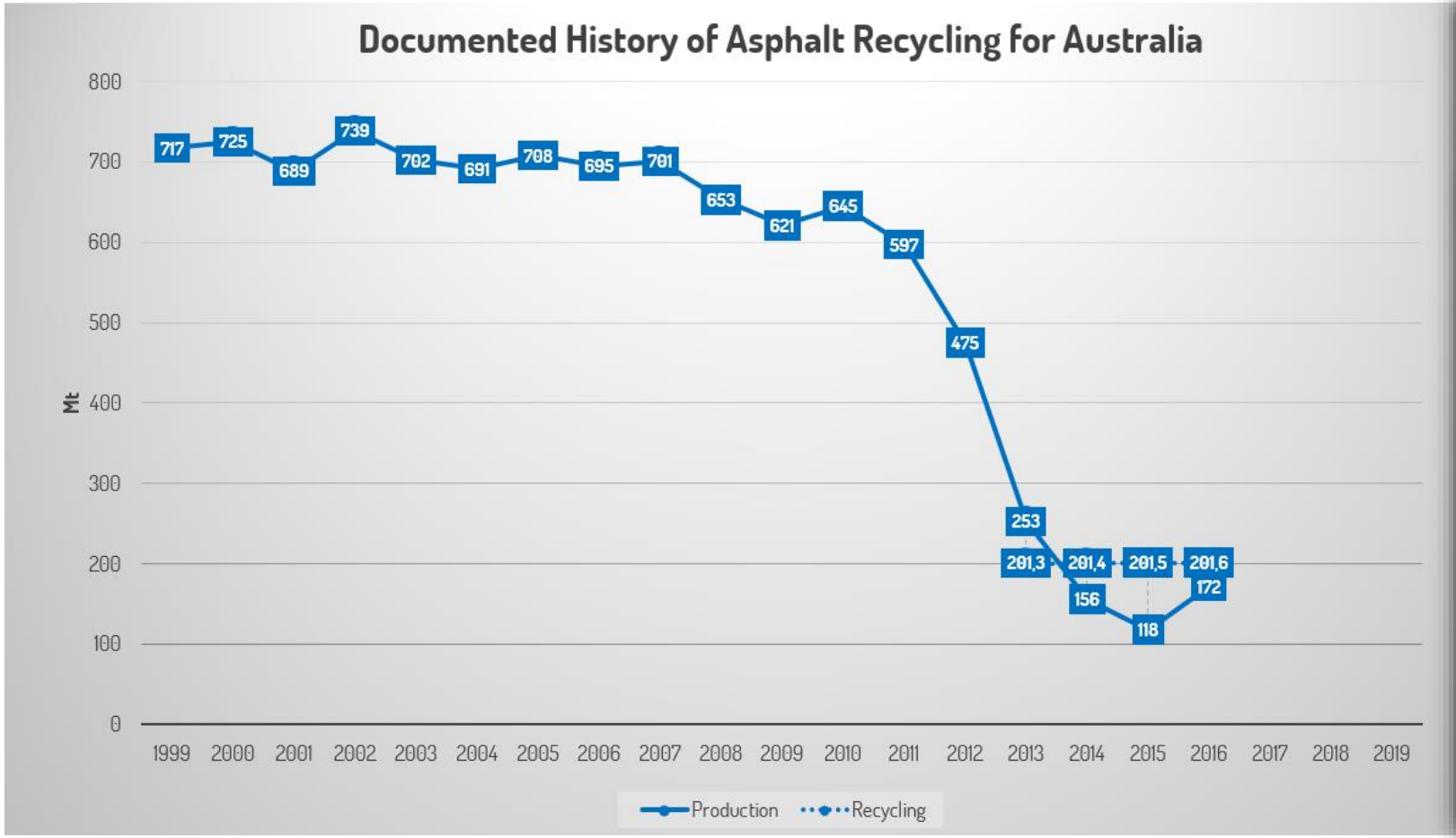
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Oceania.

Australia:

- 172 million tons produced (2016).
- 17 million tons recycled (2016).
- 10% recycling rate (2016).
- Decline in road construction due to fiscal crisis to be seen in road maintenance.
- In 2013, first attempt of systemic collection of recycling data.

Sources: Australian Asphalt Pavement Association (2018, p. 12) – Australian Government – Department of Sustainability, Environment, Water, Population and Communities (2012, p. 13 ff..) – King et. al (2015, p. 3).

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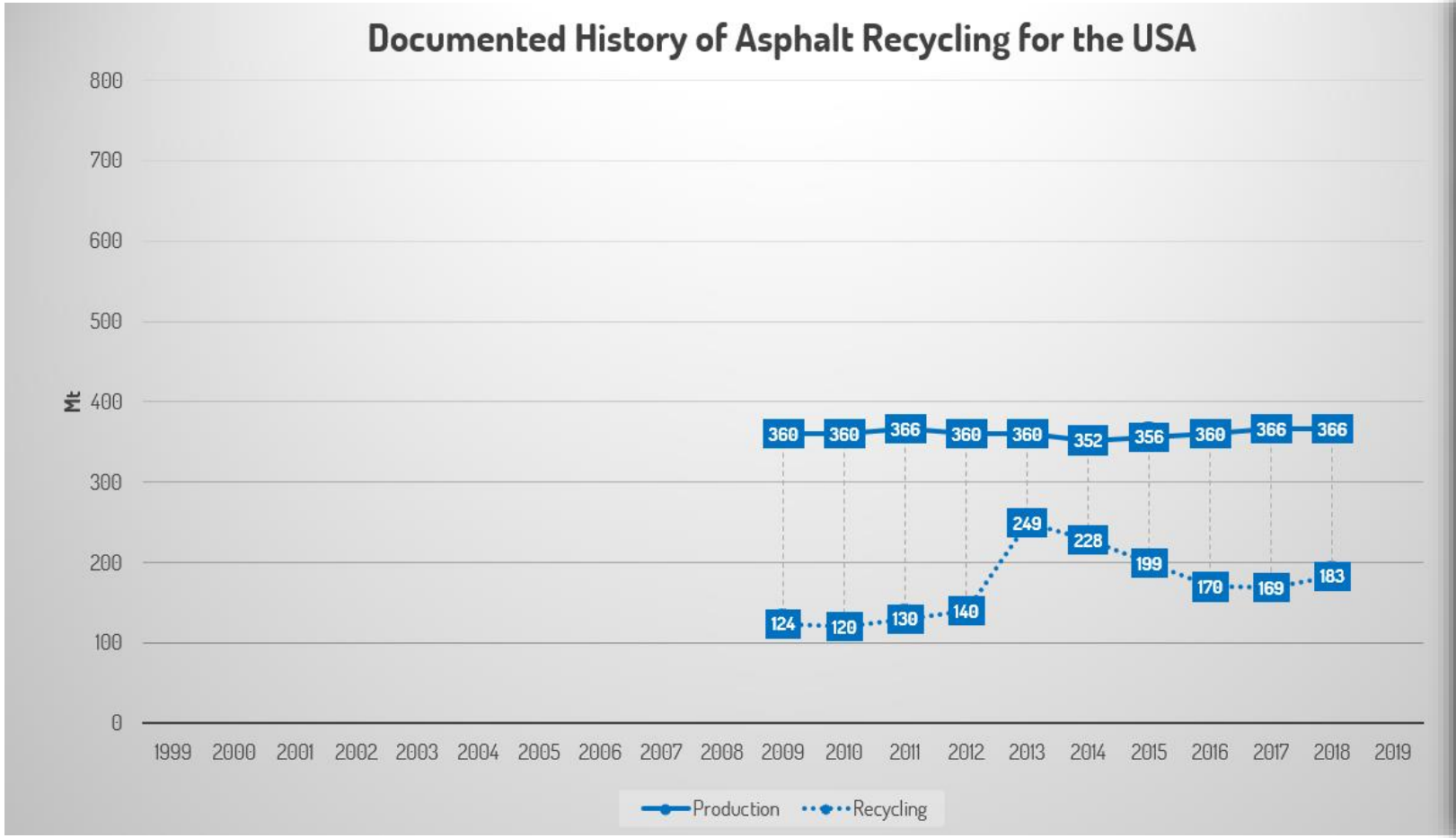
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole North America.

USA:

- 366 million tons produced (2018).
- 183 million tons recycled (2018).
- 50% recycling rate (2018).
- In 2013, federal road construction program, but the federal system was inhibiting factor because federal states have to decide on their own to join recycling programs. Therefore, short-term lifts in recycling are possible. Long-term lifts develop slowly.

Sources: Hansen et. al (2013, p. 8, p. 12) – Hansen et. al (2015, p. 9, pp. 12-13, p. 17, p. 20) - Hansen et. al (2017, p. 10, p. 12, p. 14, p. 21, pp. 28-29, pp. 37-39) - Williams et. al (2018, pp. 6-7, p. 10, p. 13, p. 15, p. 22, pp. 30-31, pp. 40-43) - Williams et. al (2019, p. 12, p. 16, p. 23, p. 31, p. 39, pp. 41-43).

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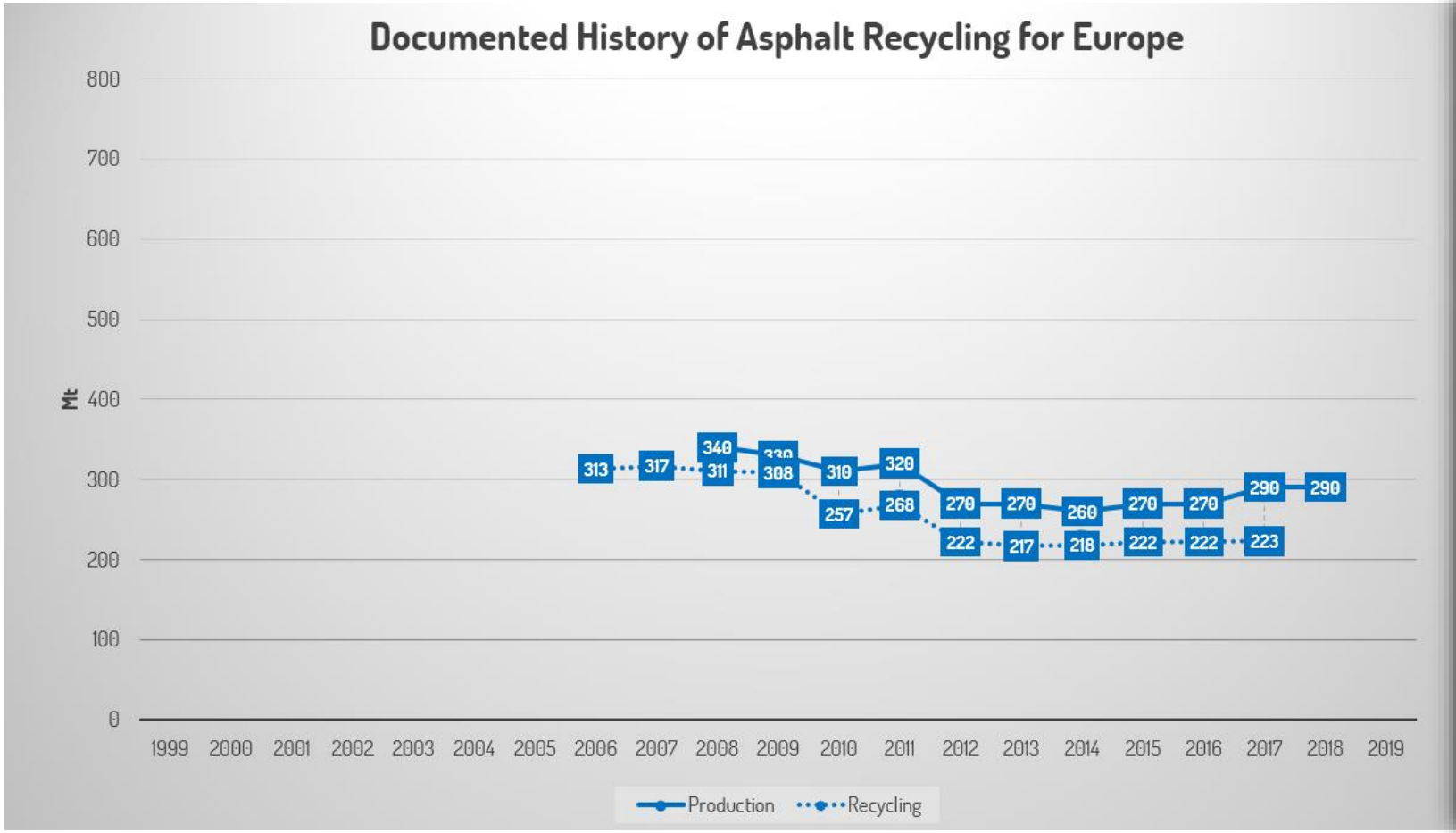
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- 290 million tons produced (2017).
- 223 million tons recycled (2017).
- 77% recycling rate (2017).
- No consistent legislation yet.
- Time lag in recycling development due to consequence of fiscal crisis in 2008.

Sources: European Asphalt Pavement Association (2020, pp. 3-4, p. 6, p. 9) – Mantalovas et. al (2019, p. 11, pp. 13-14).

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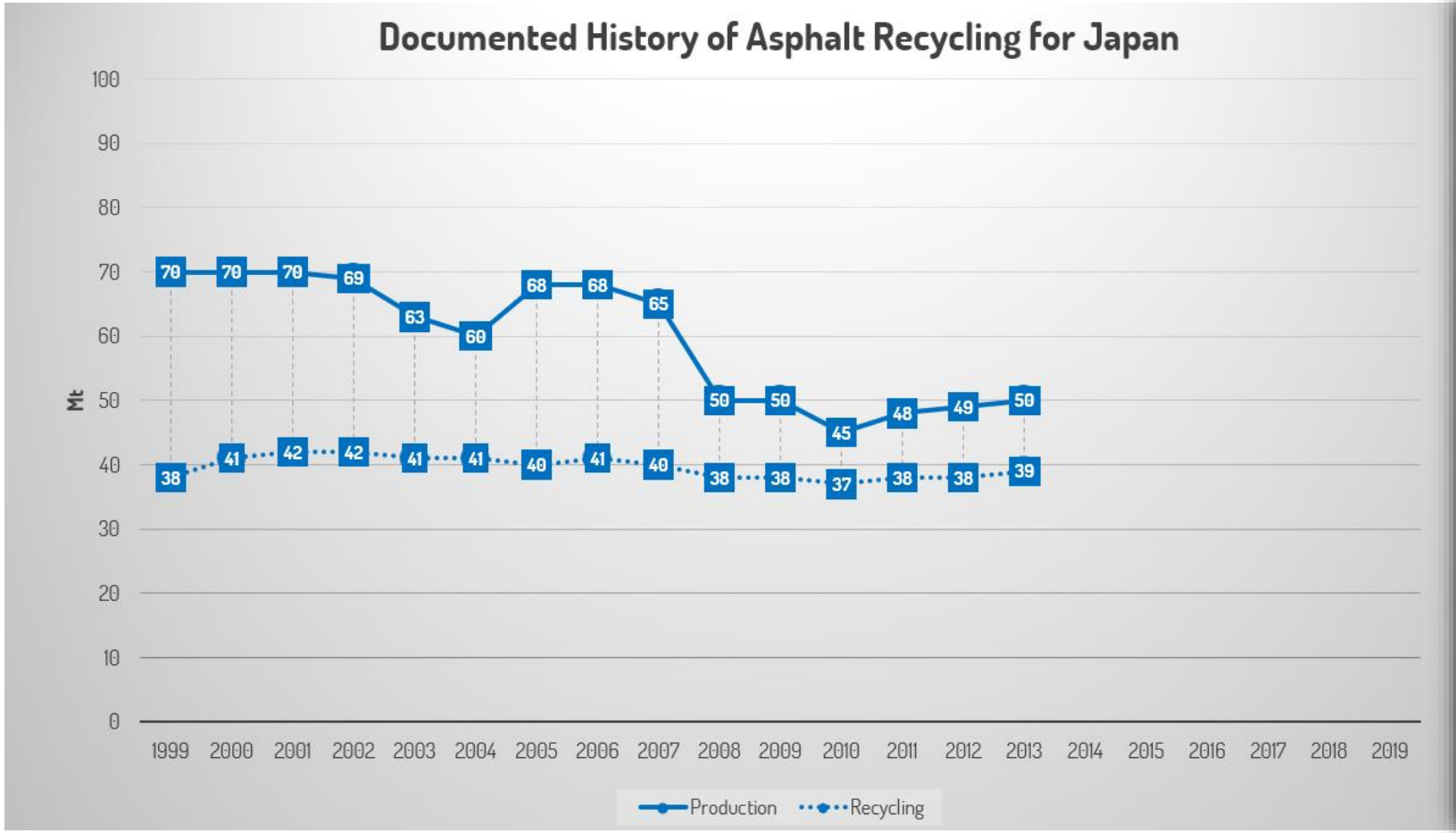
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Asia.

Japan:

- 50 million tons produced (2013).
- 39 million tons recycled (2013).
- 78% recycling rate (2013).
- In 2013, introduction of closed-loop recycling/ circular economy. No longer need for statistical emphasis.
- Consistent governance strategy.
- Early implementation.
- Circular economy performance in asphalt sector 100%.

Sources: Copeland (2015, p. 3, p. 5, p. 8, pp. 46-47) –Kubo (n.d., p. 7) – Kubo (2009, pp. 4-6) – Mantalovas et. al (2019, p. 11, pp. 13-14) –Ministry of the Environment (2014, p. 25) – Qiu et. al (2016, p. 8) – Transportation Research Board (2014, pp. 60-66) – West et. al (2015, p. 14).

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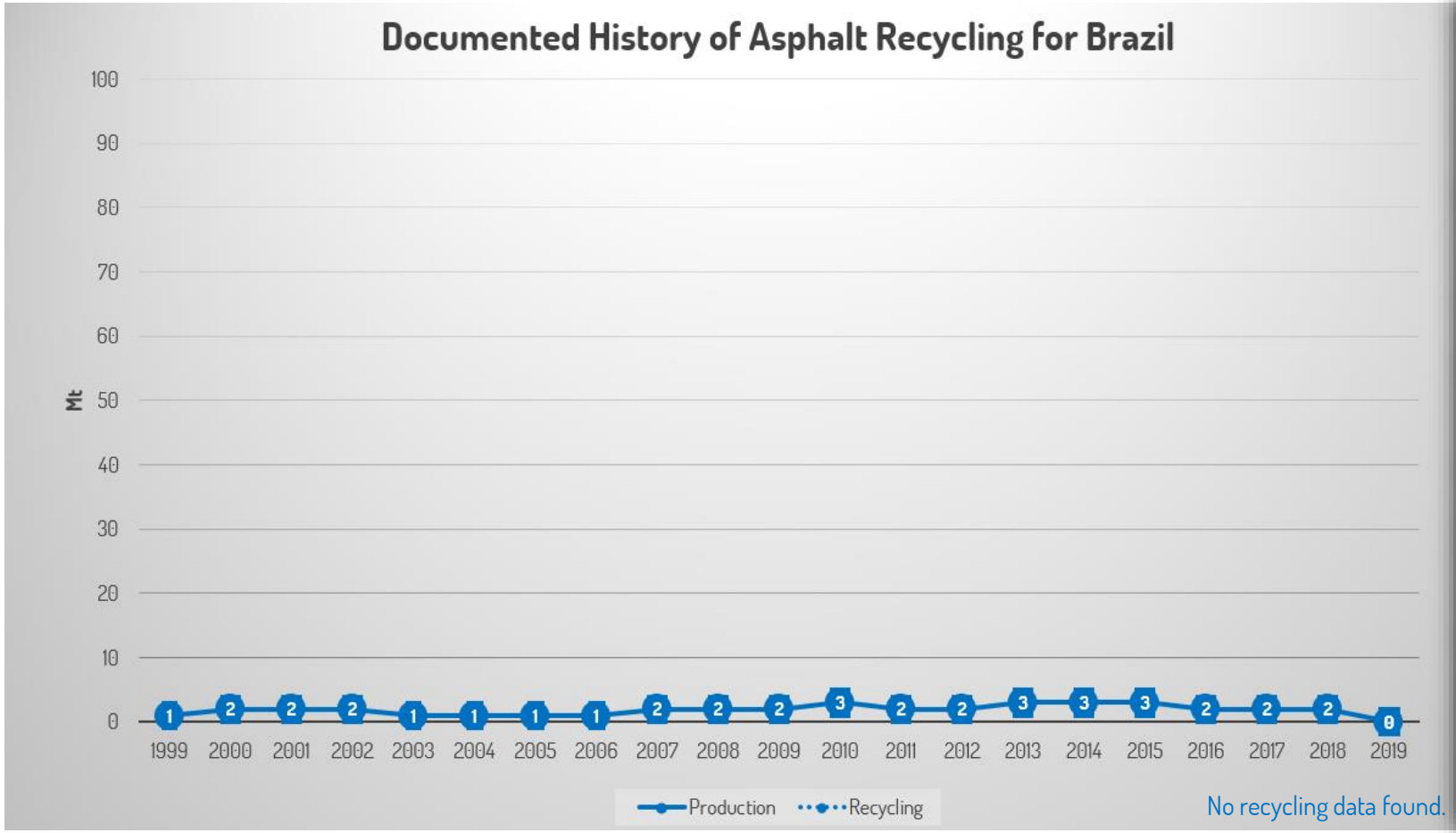
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole South America.

Brazil:

- Almost 0 million tons produced (2019).
- No data available for recycling.
- High share of concrete because asphalt is melting in heat.
- Cold-in place recycling technique.
- Asphalt accounts for ca. 2% of construction and demolition waste.
- Use of recycled construction material is growing and supported by the Brazilian National Council for the Environment.

Sources: Contreras et. al (2016, pp. 594-599) - United Nations Statistics Division (2020).

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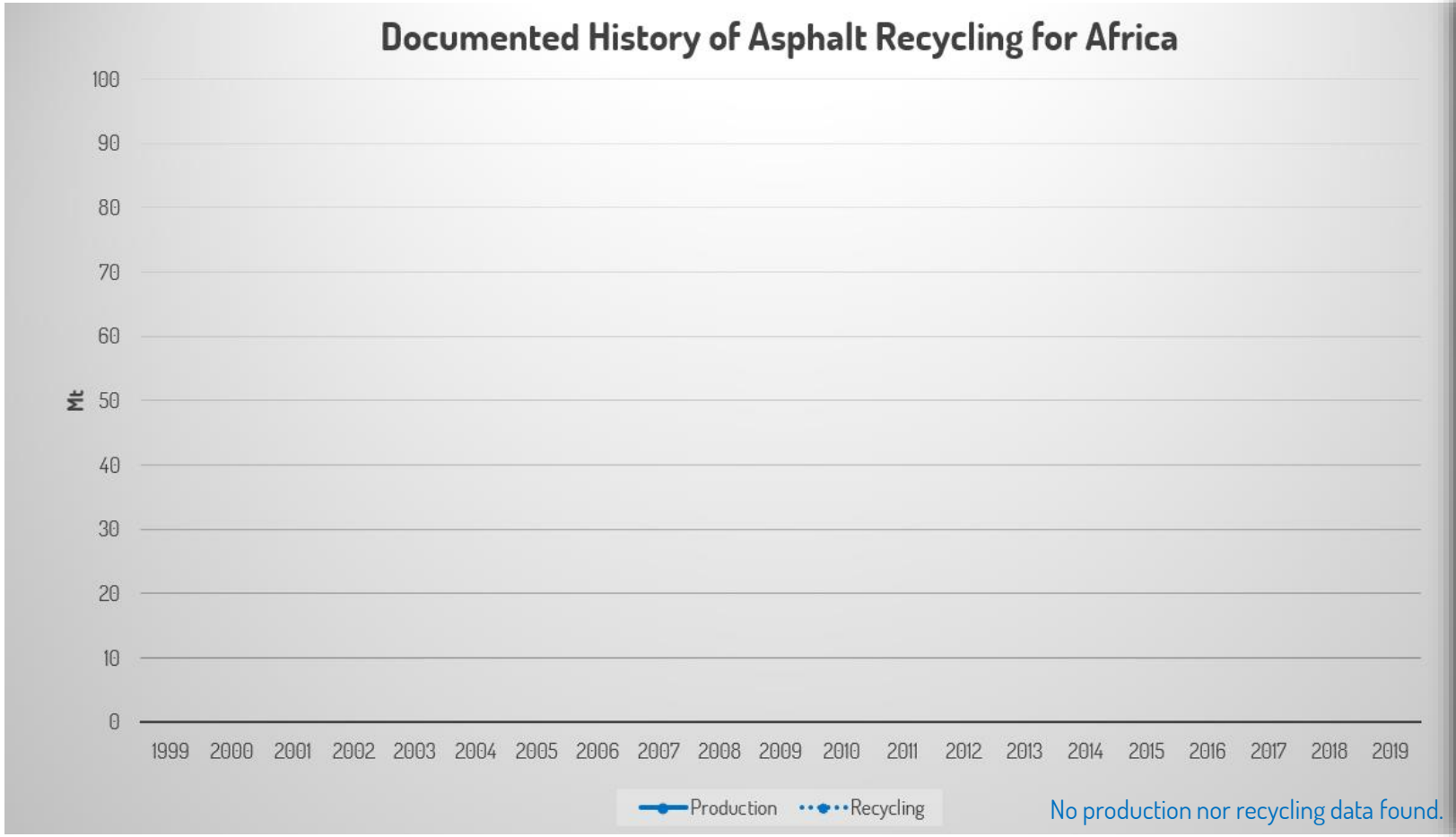
Asphalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for Africa.
- Focus lies on how to build streets at all; not how to recycle them.
- No mega cities.
- Domination of gravel and sand roads; some concrete streets due to heat; little asphalt.

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SCORE CARD ASPHALT

		Global North			Global South		
	WORLD	USA	JAPAN	EUROPE	AFRICA	AUSTRALIA	BRAZIL
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Asphalt – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Asphalt	530 Mt	936 Mt	72%	bad	Beside Japan, no country has circular governance and performance in recycling. Japan is a great role model for closed-loop recycling. Other countries need to adapt understanding of high economic value. CE rating is good anyhow, because technology and knowledge is worldwide available.	

Japan is the most successful country in asphalt recycling, based on a clear legal strategy for circular economy. The basic problem was that Japan as island has no space for landfill of construction and demolition waste. So, a strategic answer to this problem was needed.

In other parts of the world, recycling technology is well developed and available. Virgin material is offered at the same price level as recycled material. Anyhow, the rest of the world is not as successful as Japan because there is a lack for clear compliance for circular economy strategy in many countries in the world.

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PAPER

420 million tons produced (2018).

221 million tons recycled (2018).

53% global recycling rate.

Photo by Pixabay via Pexels

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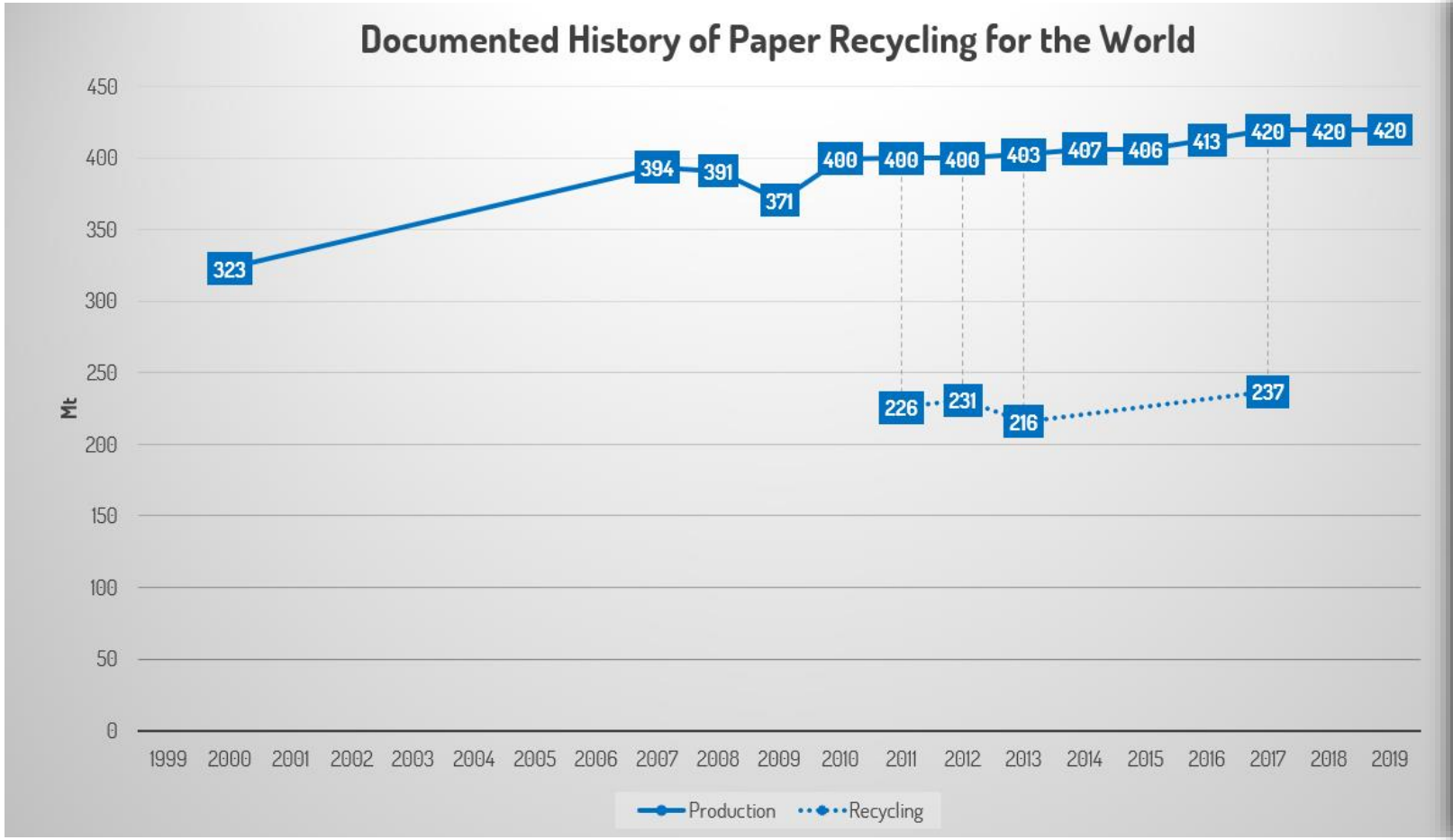
Experts

Paper – Market study results

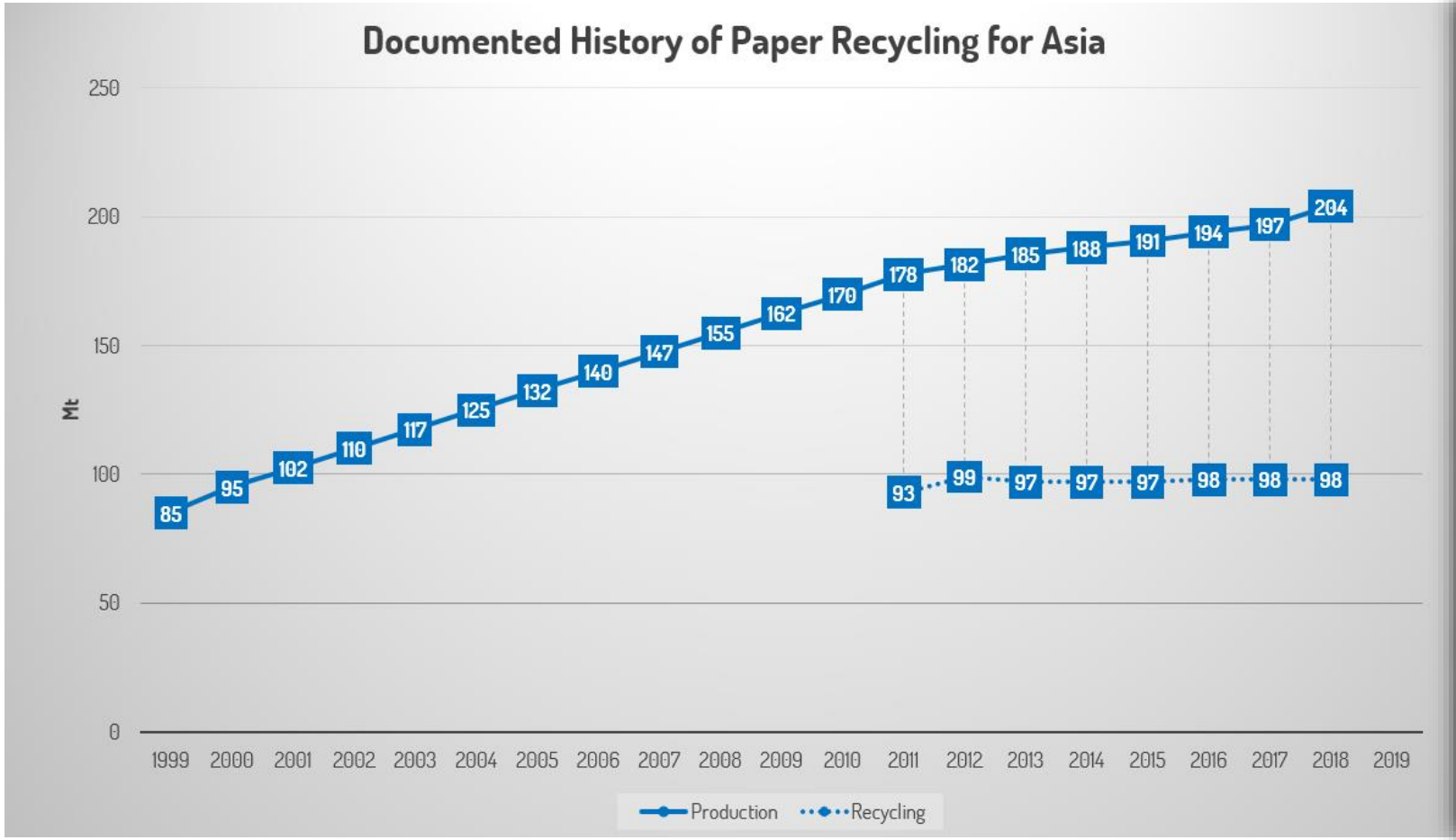


Facts

- Material is fraction of household waste only in some parts of the world.
- 420 million tons produced (2018).
- 221 million tons recycled (2018).
- 53% global recycling rate (2018).
- During the financial crisis in 2008, paper markets globally broke down.
- New data collection since 2009 in many regions.
- Precise solid data base with only 5% statistical uncertainty

Sources: Bureau of International Recycling – Paper Division (2013, p. 2, p. 10) - Bureau of International Recycling – Paper Division (2014, p. 2, p. 10) - Bureau of International Recycling – Paper Division (2015, p. 2, p. 10) - Bureau of International Recycling – Paper Division (2020, p. 5, p. 15, p. 17, pp. 19-20) - Food and Agriculture Organization of the United Nations (2019, pp. 1-3) - Haggith et. al (2018, pp. 10-12, p. 18, p. 21, pp. 34-35) - Verband Deutscher Papierfabriken e.V. (2019, p. 2).

Paper – Market study results



Facts

- Material is no fraction of household waste.
- 204 million tons produced (2018).
- 98 million tons recycled (2018).
- 48% recycling rate (2018).
- Political strategy for CE in China in 2009 leads to statistical research in the following years.
- China has disrupted paper market further: The degree of contamination for imports was reduced to 0.5%. (Rest of the world: 10%.)
- The ban led to imports of contaminated fibers in the USA and filled landfills according to US Trade Commissioner Sarah Scott.

Sources: Berg et. al (2019, pp. 2-3, p. 5) - Bureau of International Recycling – Paper Division (2013, pp. 2-4, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10, pp. 12-12) - Bureau of International Recycling – Paper Division (2020, pp. 5-13, pp. 15-21) - CONFEDERATION OF EUROPEAN PAPER INDUSTRIES (2020b, p. 5, pp. 16-17, pp. 23-24) - Haggith et. al (2018, pp. 3-4, pp. 9-11, p. 18, pp. 20-21) - Lu et. al (2017, p. 7) .

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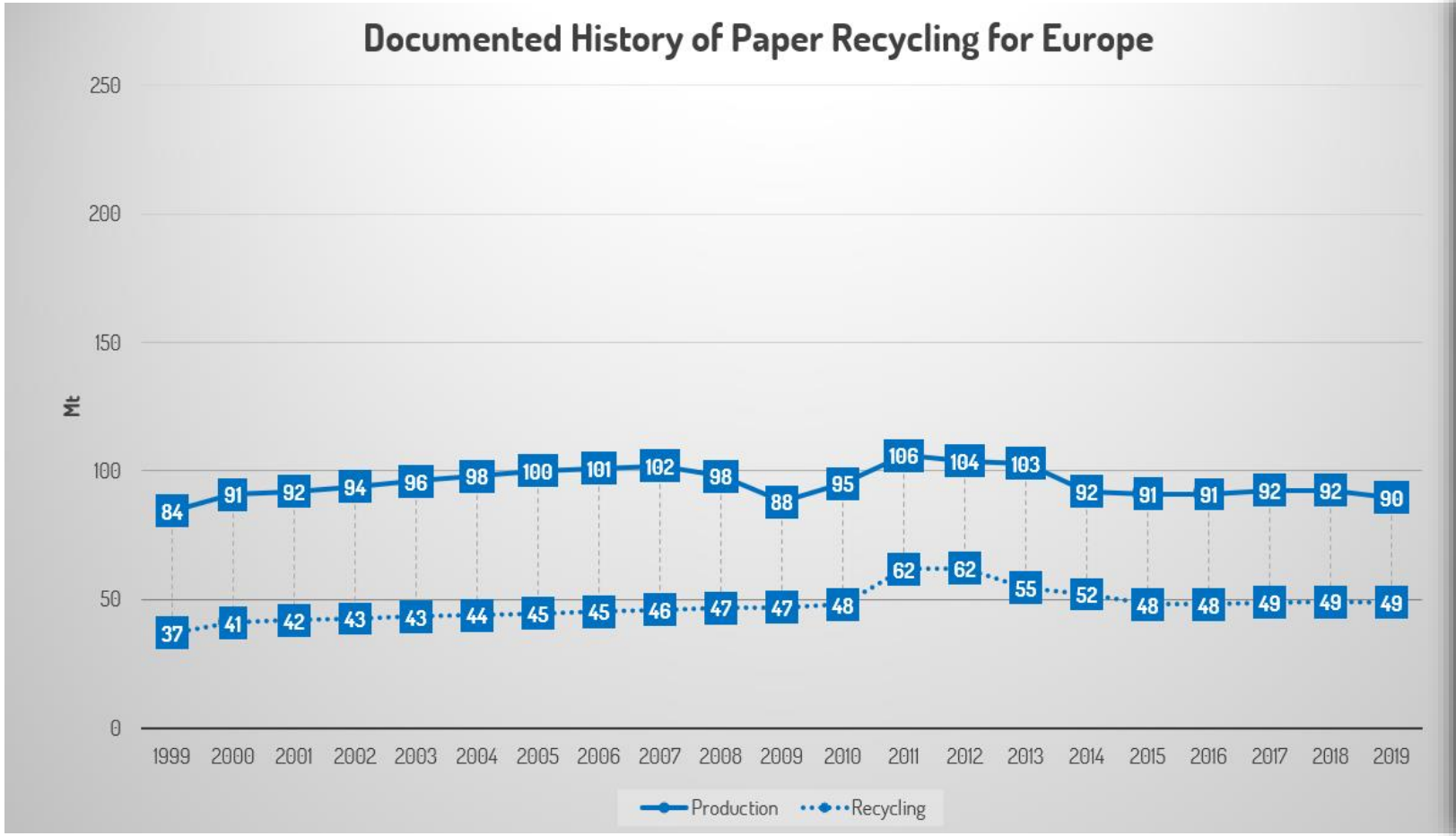
Paper – Market study results



Facts

- Material is fraction of household waste in parts of EU.
- 90 million tons produced (2019).
- 49 million tons recycled (2019).
- 54% recycling rate (2019).
- In 1996, recycling starts due to implementation of the environmental label „Blue Angel".
- During the financial crisis in 2008, paper markets broke down in Europe.
- For recycling market, consequences of fiscal crisis appear later.
- After financial crisis, demand is catching up.
- The down-turn may be influenced by digitization.

Sources: Bureau of International Recycling – Paper Division (2013, pp. 2-4, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10, pp. 12-12) - Bureau of International Recycling – Paper Division (2020, pp. 5-13, pp. 15-21) - CONFEDERATION OF EUROPEAN PAPER INDUSTRIES (2020b, p. 5, pp. 16-17, pp. 23-24) - Eurostat (2020) - Haggith et. al (2018, pp. 3-4, pp. 9-11, p. 18, pp. 20-21) - Verband Deutscher Papierfabriken e.V. (2019, p. 2).

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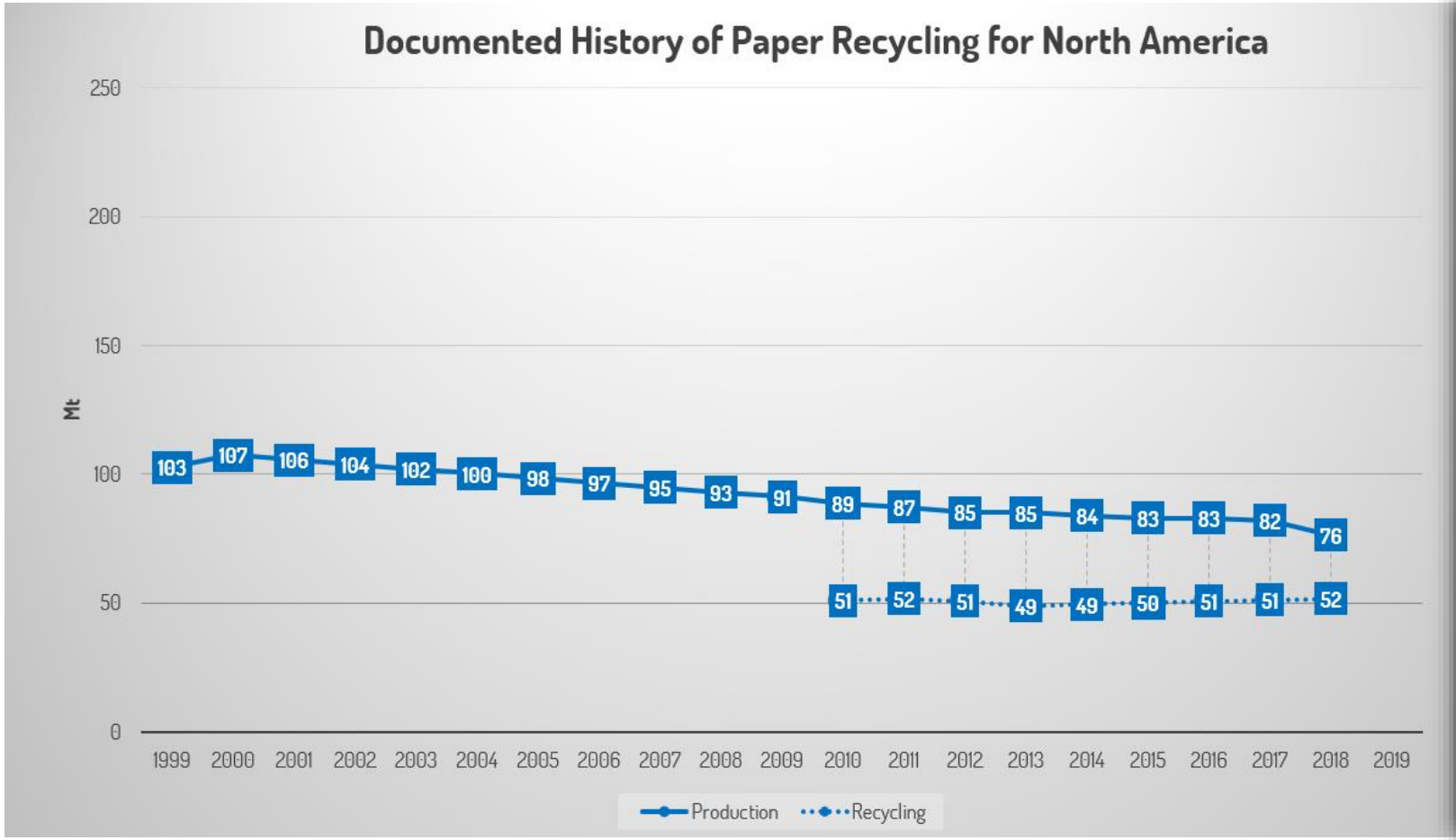
Paper – Market study results



Facts

- Material is fraction of household waste.
- 76 million tons produced (2018).
- 52 million tons recycled (2018).
- 68% recycling rate (2018).
- In 2009, the recycling rate for paper and paper-based packaging starts growing in the USA.
- Federal initiative in 2010: EPA was assigned to collect data to prepare legal regulation on waste.
- In the same year, the American Forest & Paper Association began partnership with the National Paper Trade Association.

Sources: Bureau of International Recycling – Paper Division (2013, pp. 2-4, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10, pp. 12-12) - Bureau of International Recycling – Paper Division (2020, pp. 5-13, pp. 15-21) - CONFEDERATION OF EUROPEAN PAPER INDUSTRIES (2020b, p. 5, pp. 16-17, pp. 23-24) - Haggith et. al (2018, pp. 3-4, pp. 9-11, p. 18, pp. 20-21) - Lu et. al (2017, p. 7).

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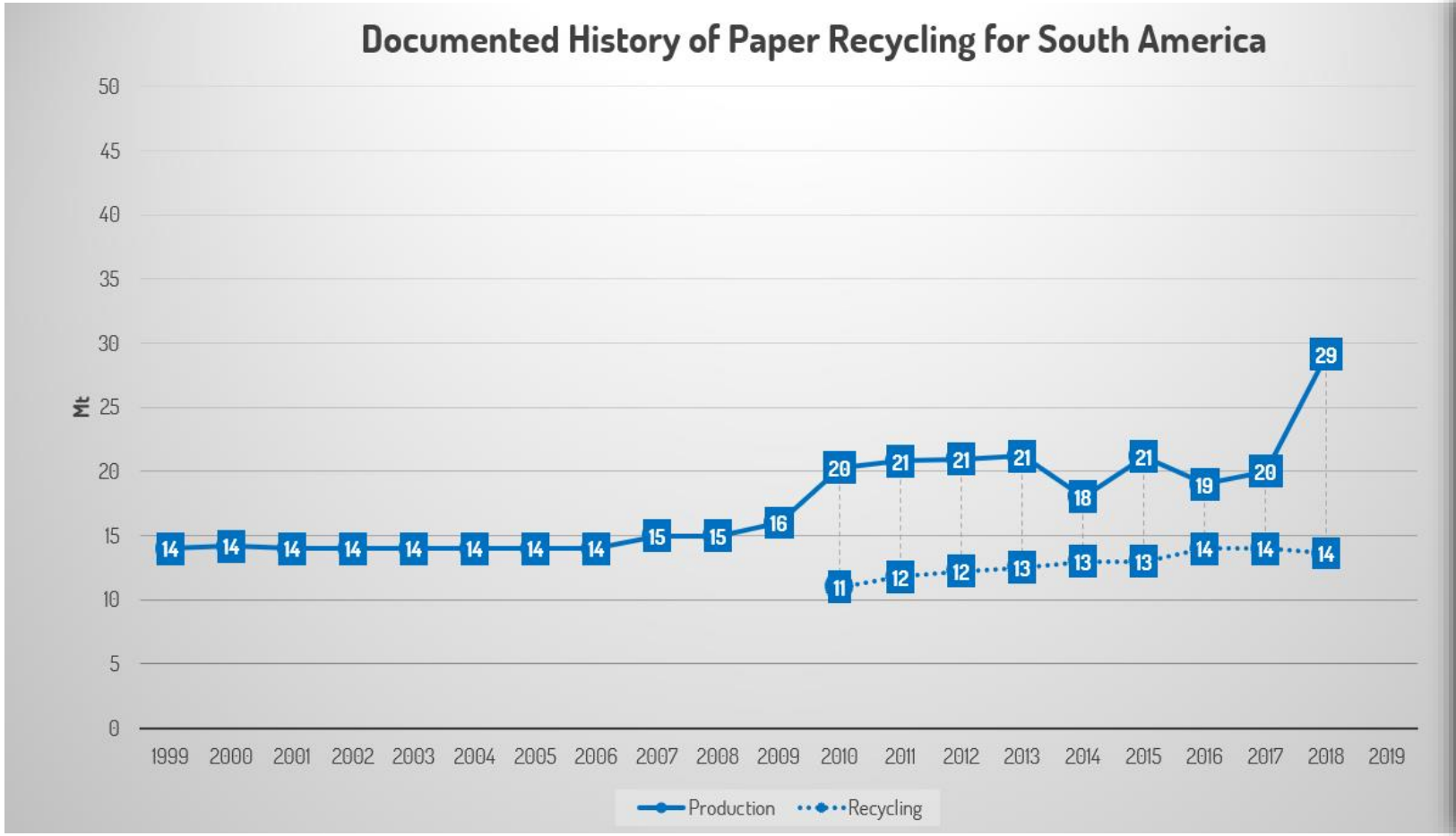
Paper – Market study results

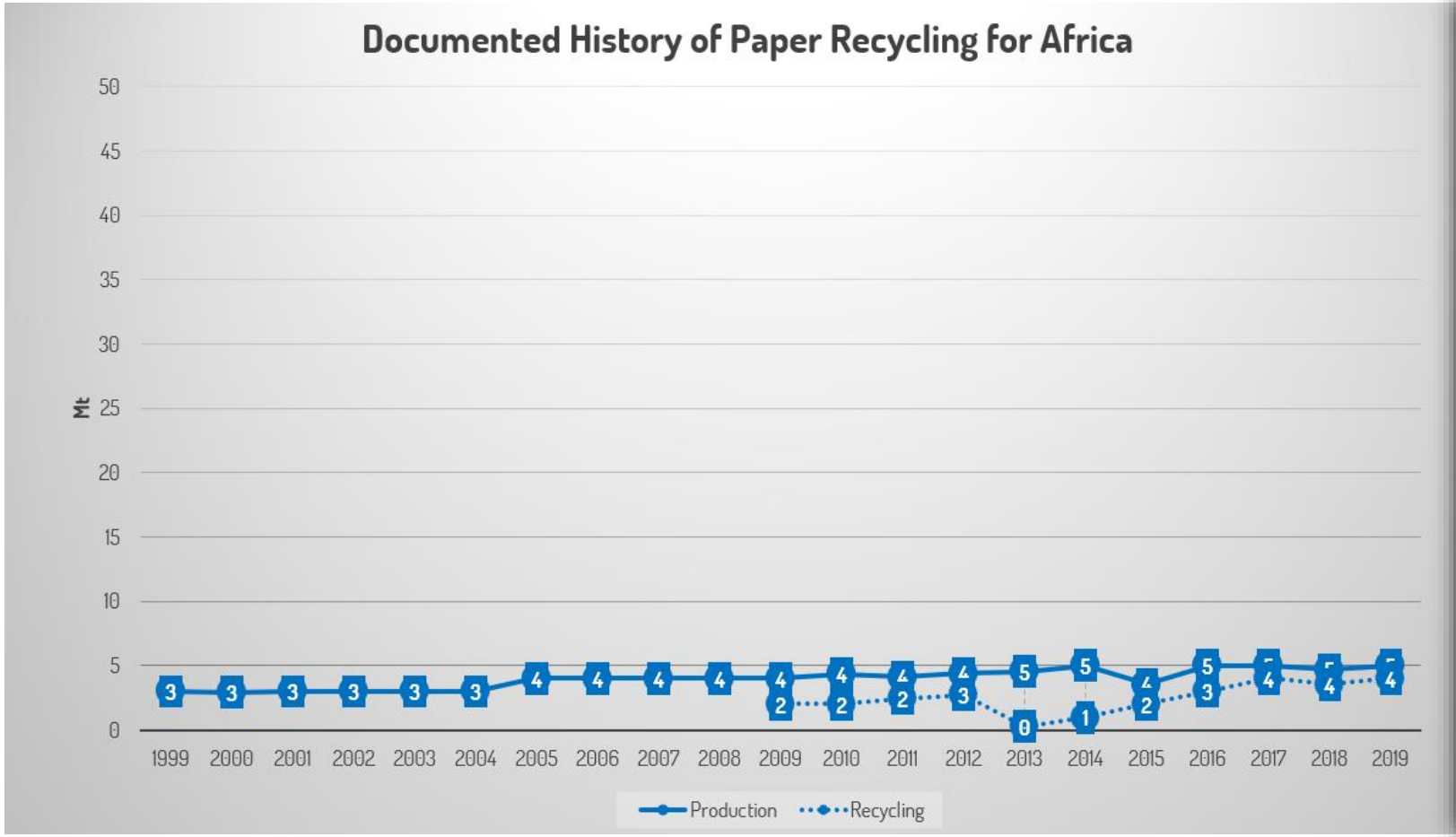


Facts

- Material is no fraction of household waste.
- 29 million tons produced (2018).
- 14 million tons recycled (2018).
- 48% recycling rate (2018).
- **80% informality!**

Sources: Bureau of International Recycling – Paper Division (2013, pp. 2-4, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10, pp. 12-13) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10, pp. 12-12) - Bureau of International Recycling – Paper Division (2020, pp. 5-13, pp. 15-21) - CONFEDERATION OF EUROPEAN PAPER INDUSTRIES (2020b, p. 5, pp. 16-17, pp. 23-24) - Food and Agriculture Organization of the United Nations (2009, p. 66, p. 135) - Haggith et. al (2018, pp. 3-4, pp. 9-11, p. 18, pp. 20-21) - Lu et. al (2017, p. 7).

Paper – Market study results



Facts

- Material is no fraction of household waste.
- 5 million tons produced (2019).
- 4 million tons recycled (2019).
- High recycling rates with 80% (2019).
- Paper as ancient cultural heritage.
- Where paper is produced, it is also recycled.
- Only a small amount consumed.
- Anyhow, data includes blind spots.

Sources: Bureau of International Recycling – Paper Division (2013, pp. 2-3, p. 7, p. 10) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10) - Bureau of International Recycling – Paper Division (2020, p. 7, p. 9, p. 12, pp. 15-16, p. 18, pp. 20-21) - Haggith et. al (2018, p. 3, pp. 9-11, p. 18, p. 21)).

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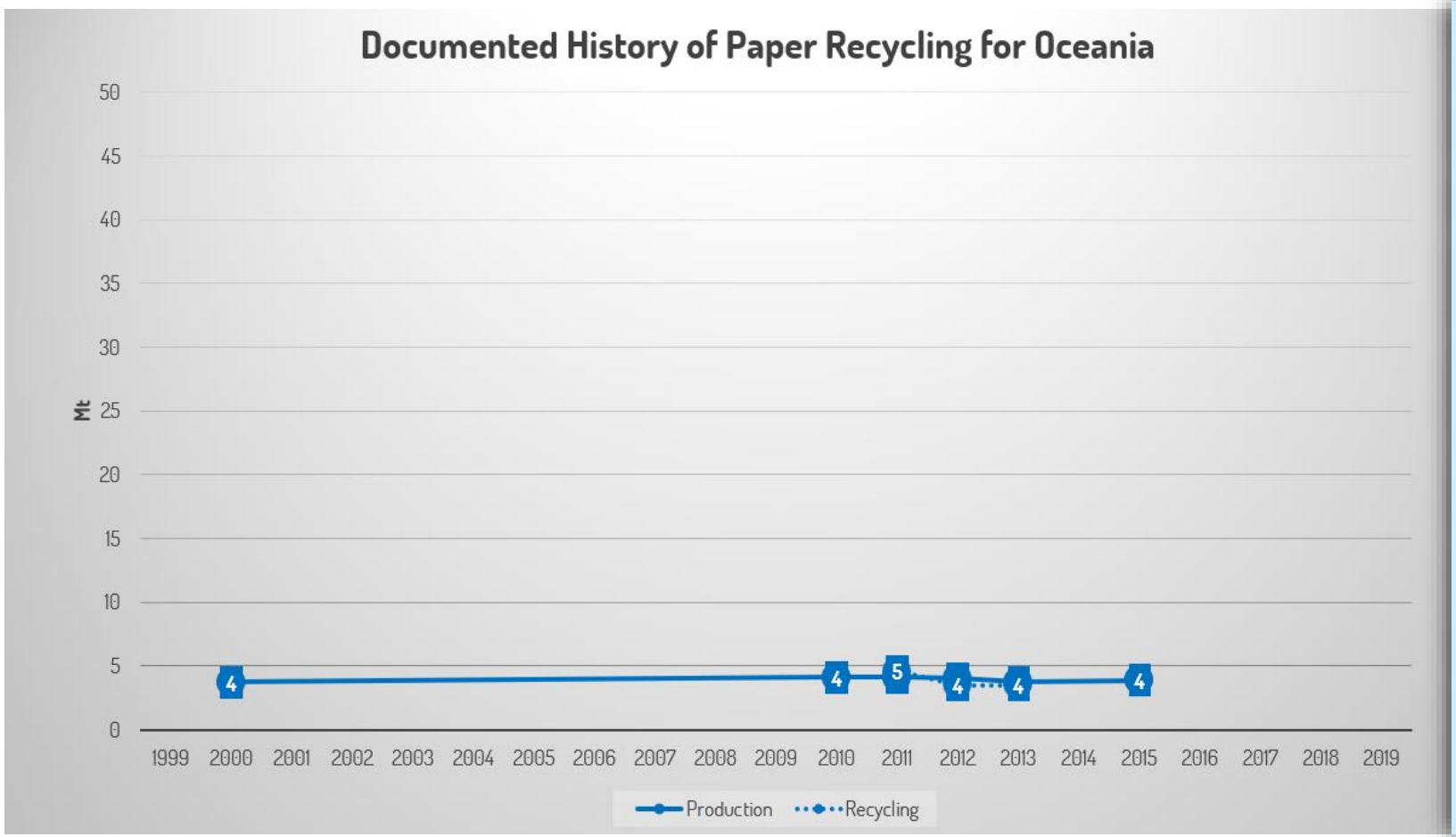
Paper – Market study results



Facts

- Material is fraction of household waste.
- 4 million tons produced (2013).
- 4 million tons recycled (2013).
- 100% recycling rate (2013).
- Strong environmental pressure in Australia.
- Politicians needed to act.
- High investments in recycling infrastructure.
- Oligopoly structure.
- Closed loop recycling is still missing in Australia.
- A lot of paper ends up in landfills.
- Waste strategy not coherent.

Sources: Bureau of International Recycling – Paper Division (2013, pp. 2-3, p. 7, p. 10) - Bureau of International Recycling – Paper Division (2014, pp. 2-3, p. 7, p. 10) - Bureau of International Recycling – Paper Division (2015, pp. 2-3, p. 7, p. 10) - Haggith et. al (2018, p. 3, pp. 9-11, p. 18, p. 21).

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SCORE CARD PAPER

		Global North			Global South		
	WORLD	USA / NORTH AMERICA	CHINA / ASIA	EUROPE	AFRICA	OCEANIA	SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Paper – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Paper	221 Mt	420 Mt	53%	good	The advancement of paper recycling worldwide is worse than expected. Especially countries of Global South are lacking functioning paper markets, legislation, technology, single-stream collection and many paper waste is still dumped. Anyhow, due to the overall good cognition, technology, collection systems and maturity of markets in the rest of the world, CE rating is good.	

The collection of paper is culture-driven. The material has multiple economic and social benefits since its invention: Paper was used for the development of new hygienic standards, for the storage of knowledge, as payment instrument and medium, etc.

Today, paper markets and recycling markets are globally established for numerous qualities. The production of new fibers is more expensive than reusing fibers. Fibers can be used up to seven times.

PLASTIC

390 million tons produced (2018).

50 million tons recycled (2018).

13% global recycling rate (case studies only).

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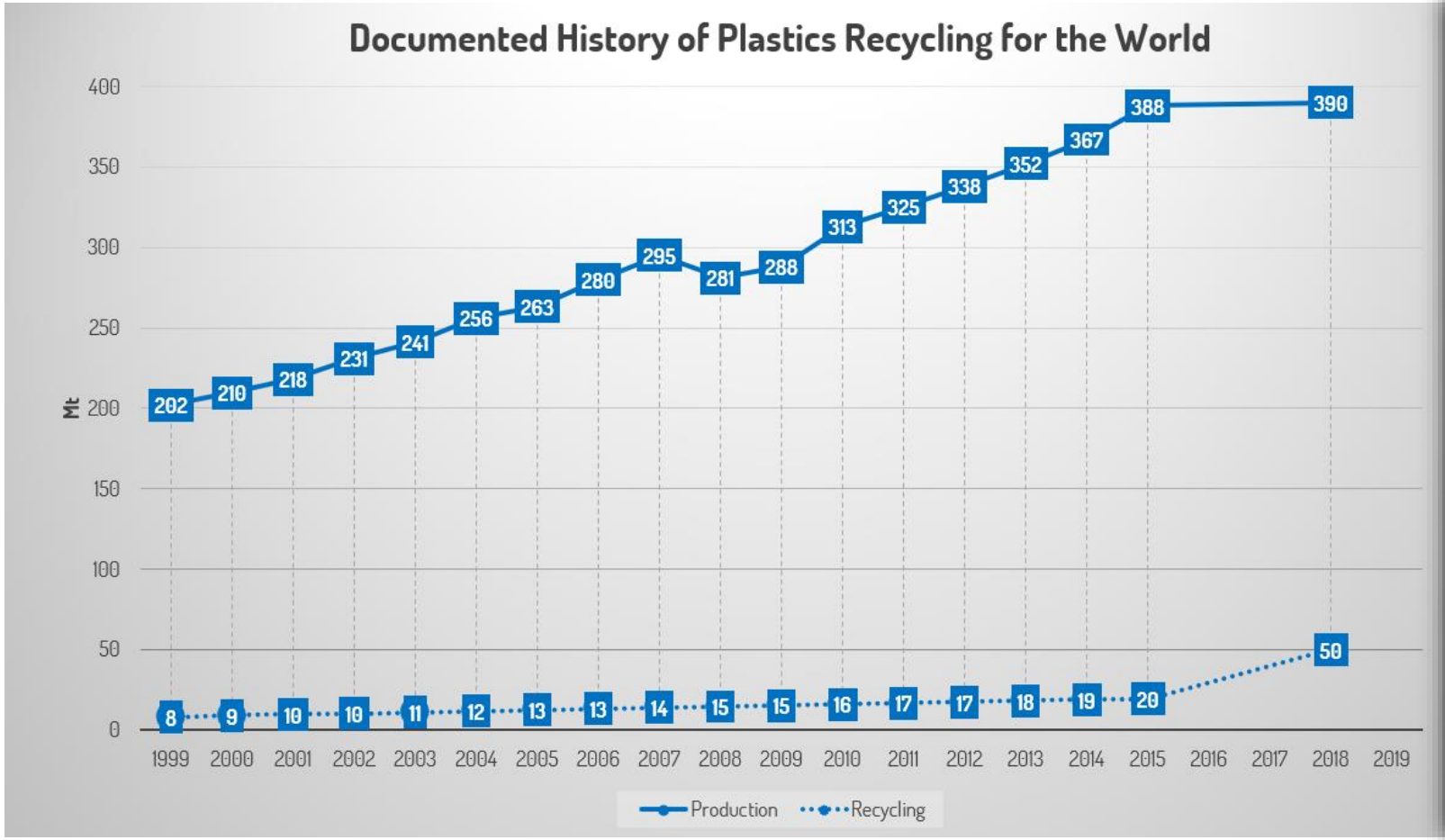
Photo by Naja Bertolt Jensen from Unsplash.

Plastics – Market study results



Facts

- In some parts of Global North, material is fraction of household waste.
- 390 million tons produced (2018).
- 50 million tons recycled (2018).
- 13% global recycling rate in 2018 (case studies only).
- Not scientific, plastic association source for data.
- In 2020, the Bureau of International Recycling has plastics on their list for the very first time.
- During the financial crisis in 2008, plastics markets globally broke down.
- Positive circular development – production decreases, recycling increases.

Sources: Conversio Market & Strategy GmbH (2019, pp. 8-10, p. 16) – Khan (2020) – PlasticsEurope – Association of Plastics Manufacturers (2015, pp. 1-2, p. 8) – Ritchie et. al (2018) – Ryberg et. al (2018, pp. 28-29, p. 93).

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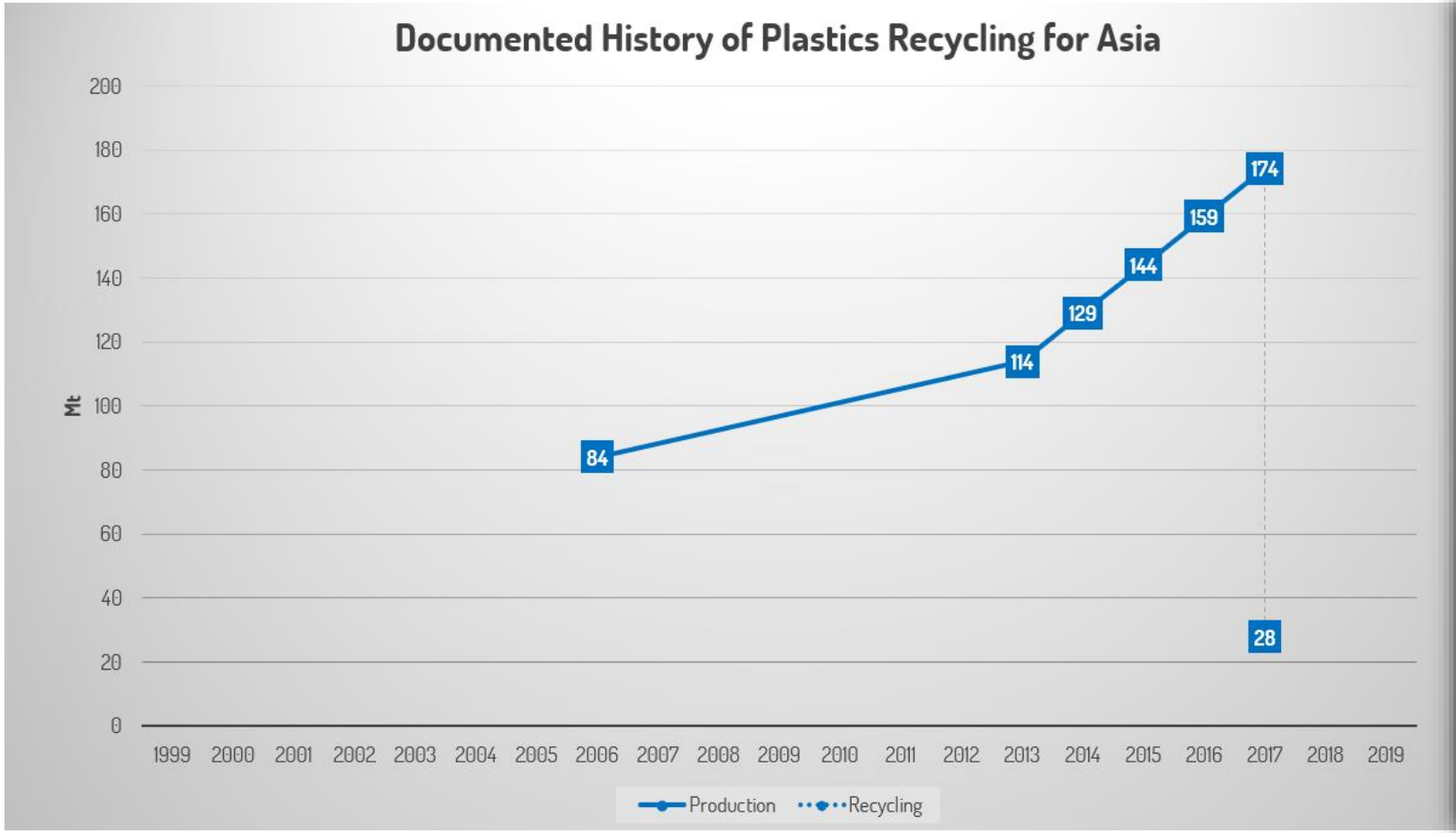
Plastics – Market study results



Facts

- Material is no fraction of household waste.
- 174 million tons produced (2017).
- 28 million tons recycled (2017).
- 16% recycling rate (2017).
- Import ban in China since 2018: China is trying to enforce new ambitious environmental policies.
- Effect on international trade in scrap plastic: a need for change in the players bearing the responsibility of waste management, with transfers to other countries becoming a less viable option.
- Most of the scrap plastic has flowed to South East Asia instead.

Sources: Conversio Market & Strategy GmbH (2019, pp. 11-12, p. 15) – Khan (2020, p. 19) – PlasticsEurope – Association of Plastics Manufacturers (2015, p. 2, pp. 7-8) – PlasticsEurope – Association of Plastics Manufacturers (2018, p. 13, pp. 18-19) – Ryberg et. al (2018, p. 11, p. 28, p. 30, p. 34, p. 39, p. 52, p. 93)..

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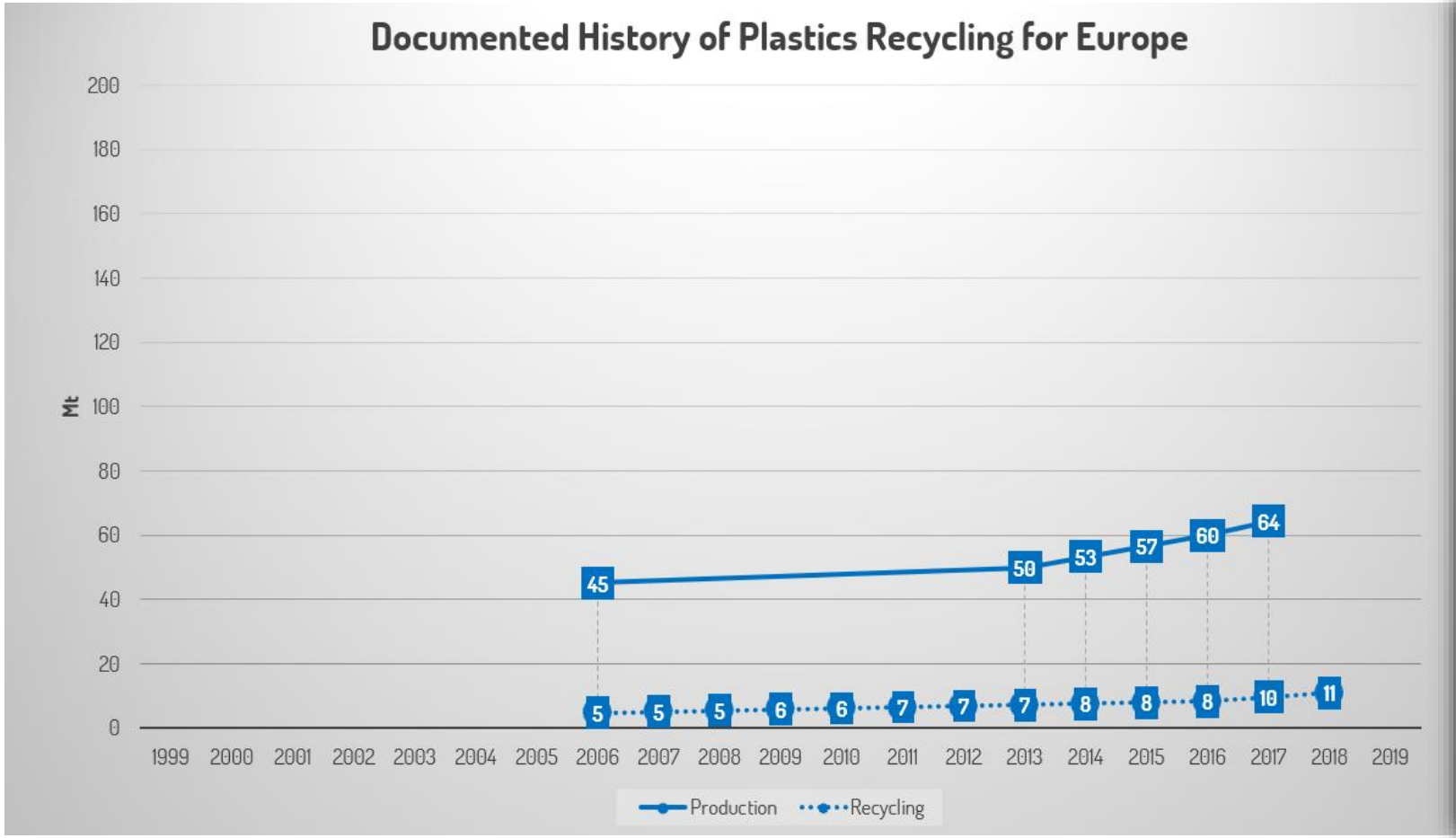
Plastics – Market study results



Facts

- In most EU countries, material is fraction of household waste.
- 64 million tons produced (2017).
- 10 million tons recycled (2017).
- 16% recycling rate (2017).

Sources: Conversio Market & Strategy GmbH (2019, pp. 11-12, p. 15) –PlasticsEurope – Association of Plastics Manufacturers (2015, p. 2, pp. 7-8) – PlasticsEurope – Association of Plastics Manufacturers (2018, p. 13, pp. 18-19) – Ryberg et. al (2018, p. 11, p. 28, p. 30, p. 34, p. 39, p. 52, p. 93)..

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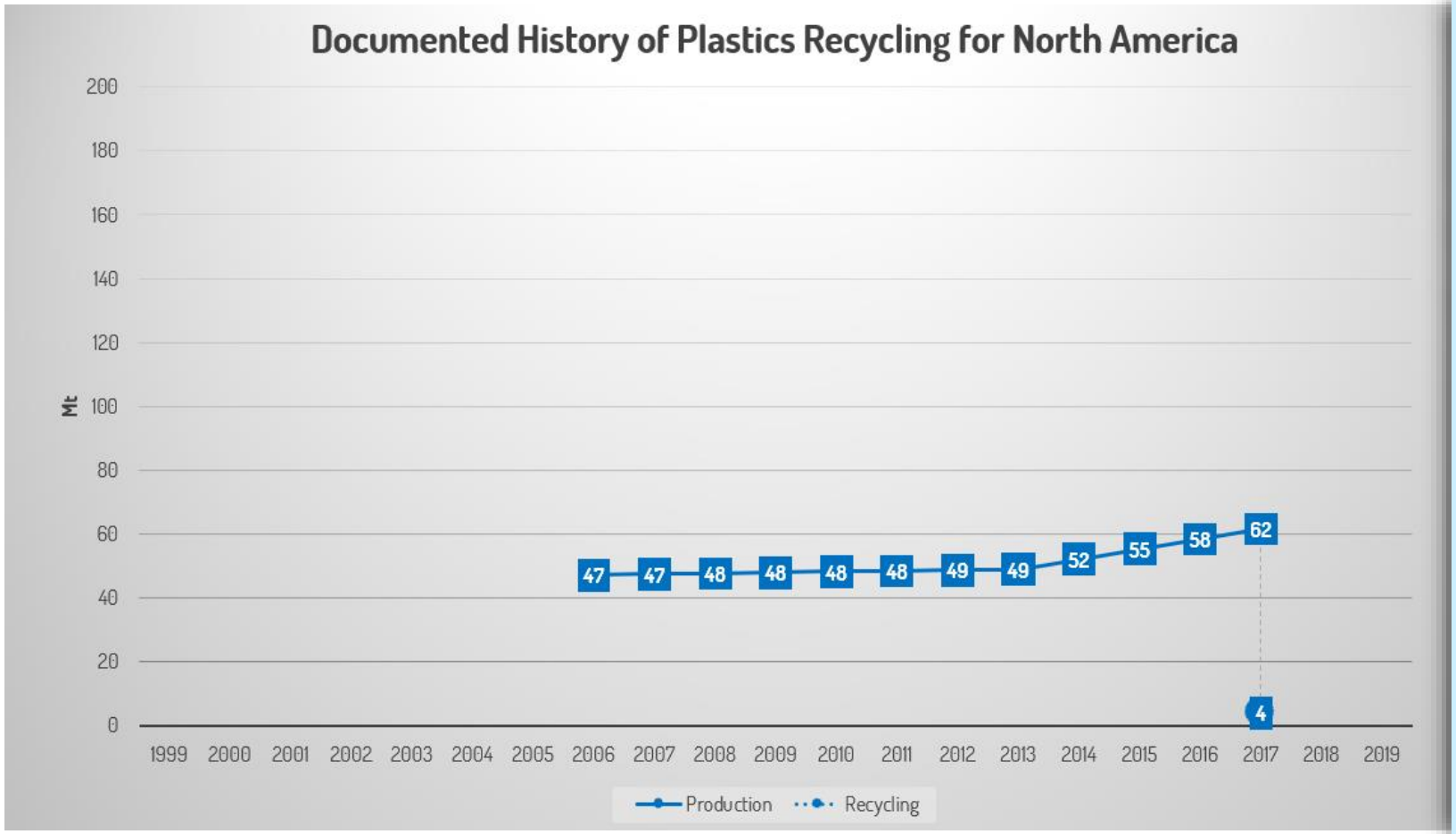
Plastics – Market study results



Facts

- Material is fraction of household waste in a few Federal States.
- 62 million tons produced (2017).
- 4 million tons recycled (2017).
- 6% recycling rate (2017).

Sources: Conversio Market & Strategy GmbH (2019, pp. 11-12, p. 15) - PlasticsEurope - Association of Plastics Manufacturers (2015, p. 2, pp. 7-8) - PlasticsEurope - Association of Plastics Manufacturers (2018, p. 13, pp. 18-19) - Ryberg et. al (2018, p. 11, p. 28, p. 30, p. 34, p. 39, p. 52, p. 93)..

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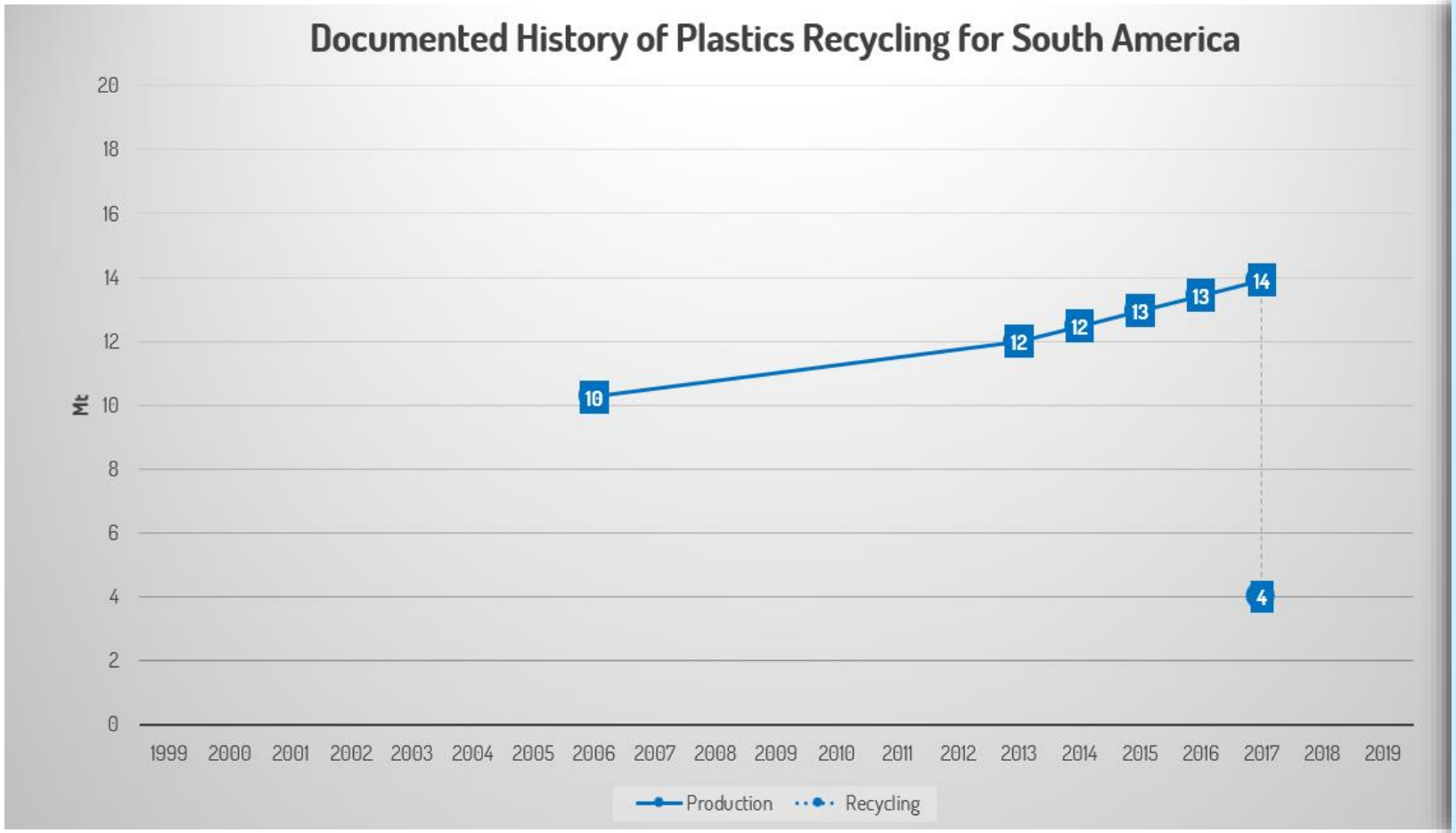
Plastics – Market study results



Facts

- Material is no fraction of household waste.
- 14 million tons produced (2017).
- 4 million tons recycled (2017).
- 29% recycling rate (2017).

Sources: Conversio Market & Strategy GmbH (2019, pp. 11-12, p. 15) - PlasticsEurope - Association of Plastics Manufacturers (2015, p. 2, pp. 7-8) - PlasticsEurope - Association of Plastics Manufacturers (2018, p. 13, pp. 18-19) - Ryberg et. al (2018, p. 11, p. 28, p. 30, p. 34, p. 39, p. 52, p. 93)..

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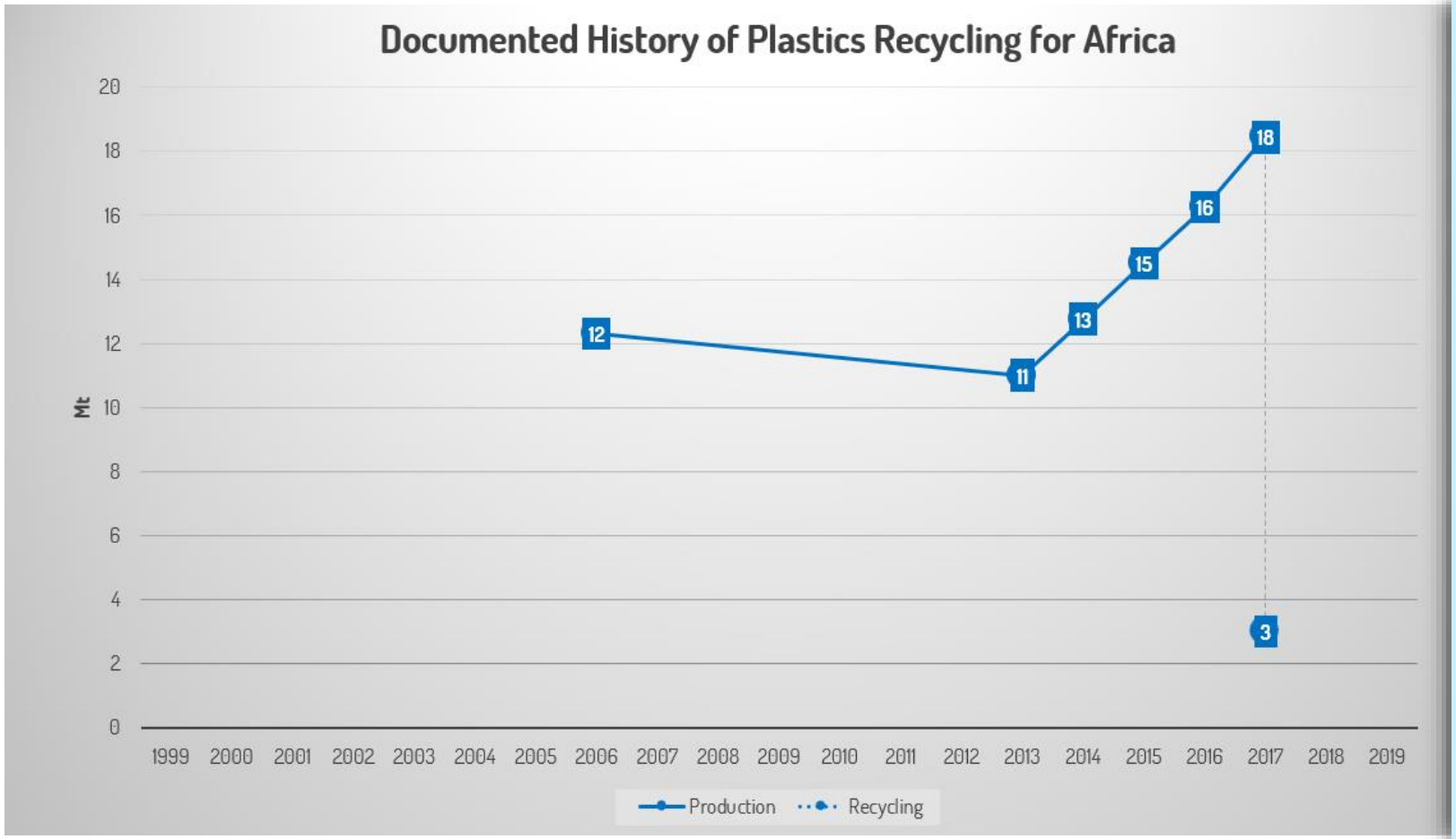
Plastics – Market study results



Facts

- Material is no fraction of household waste.
- 18 million tons produced (2017).
- 3 million tons recycled (2017).
- 17% recycling rate (2017).

Sources: Conversio Market & Strategy GmbH (2019, pp. 11-12) - PlasticsEurope - Association of Plastics Manufacturers (2015, p. 2) - Ryberg et. al (2018, p. 30, p. 34, p. 39, p. 52, p. 93).

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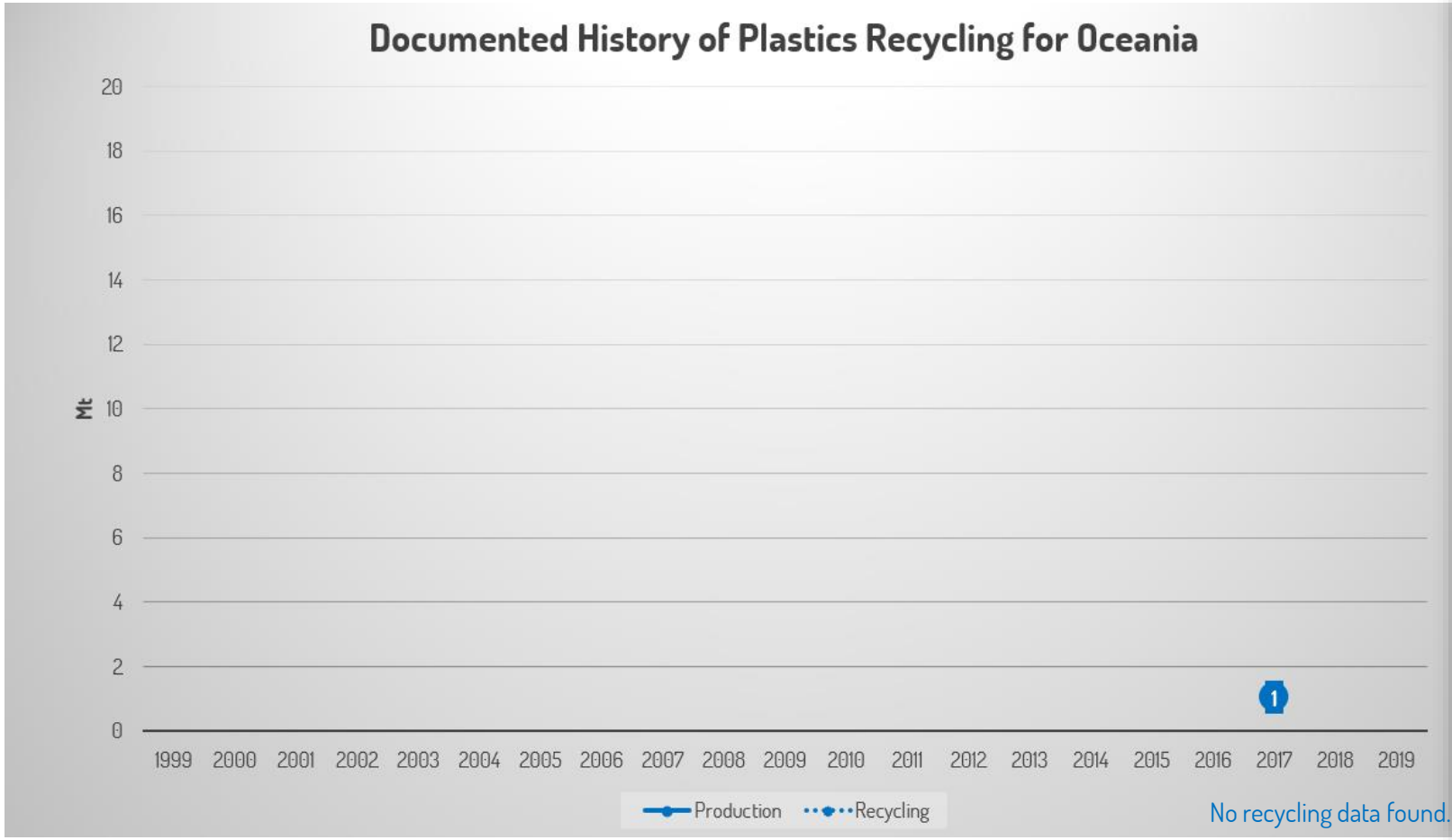
Plastics – Market study results



Facts

- Material is no fraction of household waste.
- 1 million tons produced (2017).
- No data available for recycling.

Sources: Ryberg et. al (2018, p. 30, p. 34, p. 39, p. 52, p. 93).

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SCORE CARD PLASTICS

		Global North			Global South		
	WORLD	USA / NORTH AMERICA	CHINA / ASIA	EUROPE	AFRICA	AUSTRALIA / OCEANIA	SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Plastics – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Plastics	50 Mt	390 Mt	13%	bad	Data basis is not scientifically evaluated. Plastics recycling is entering governance' agendas. But so far, waste management structures and legislative impact has been weak. Technology is available.	

Plastics recycling markets exist. They are functioning and they are having a quick rise in recycling materials as PET recycling material shows. Actually PET recycling material is more expensive than virgin material due to regulation aspects (recycling quota).

Anyhow, so far, the virgin resource crude oil has been so cheap that the development of closed-loop-recycling technologies have had little return on invest. Now, due to environmental pressure, regulation is changing worldwide.

ALU

77 million tons produced (2019).

29 million tons recycled (2019).

38% global recycling rate.

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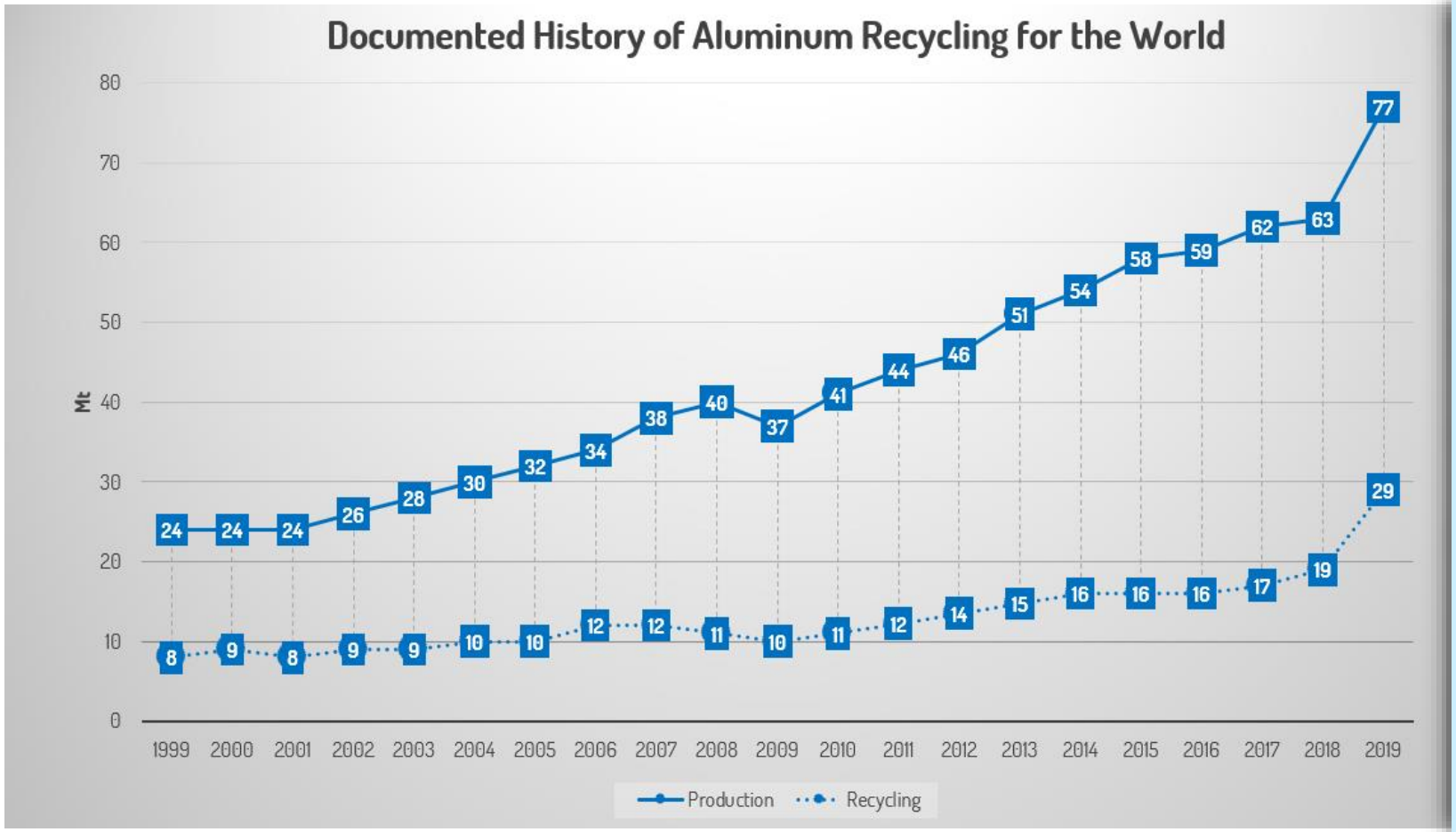
Photo by Karolina Grabowska from Pexels.

Aluminum – Market study results

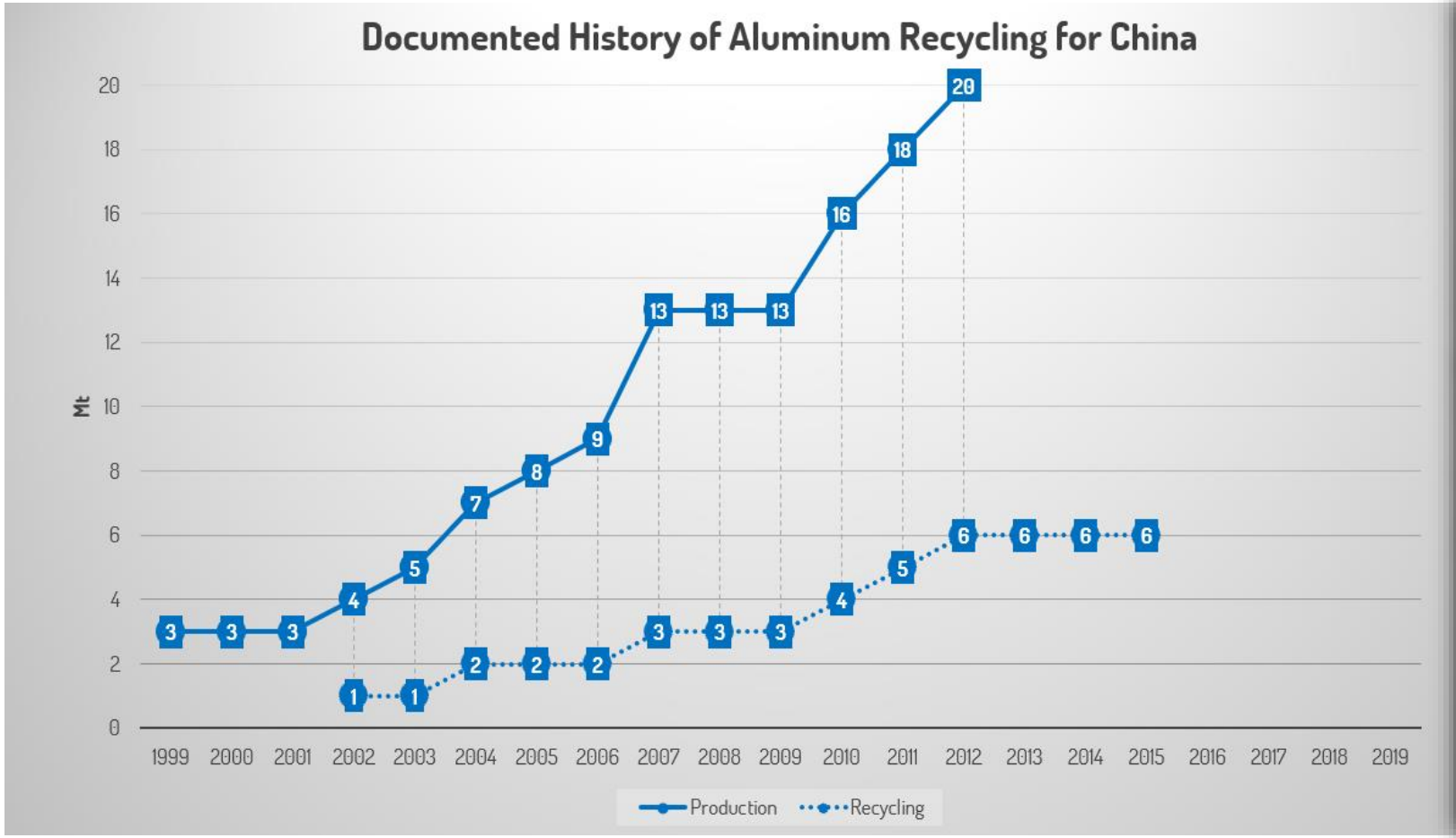


Facts

- Material is no fraction of household waste.
- 77 million tons produced (2019).
- 29 million tons recycled (2019).
- 38% global recycling rate (2019).
- Similar development to other mineral ore, ferrous or non ferrous markets.
- Decoupling of production and recycling due to Chinese market growth.
- During the financial crisis in 2008, aluminum markets globally broke down.

Sources: Barry et. al (2013, Table 4) - Gesamtverband der Aluminiumindustrie e.V. (2019) - Impol Group (2005, p. 22) - Impol Group (2006, pp. 20-21) - Impol Group (2007, pp. 18-19) - Impol Group (2008, p. 16) - Impol Group (2009, pp. 23-24) - Impol Group (2010b, p. 23) - Impol Group (2010b, pp. 23-24) - Impol Group (2012, p. 23) - Impol Group (2013, p. 25) - Impol Group (2014, pp. 27-28) - U.S. Geological Survey (2015).

Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- 20 million tons produced (2012).
- 6 million tons recycled (2012).
- 30% recycling rate (2012).
- In 2020, China imports become regulated.

Rest of Asia:

- 46 million tons produced (2018).
- 11 million tons recycled (2018).
- 24% recycling rate (2018).

Sources: Barry et. al (2013, Table 4) – Hatayama et. al (2009, p. 654–656) – U.S. Geological Survey (2015) – Wei (2015, p. 3, pp. 14–15, p. 17).

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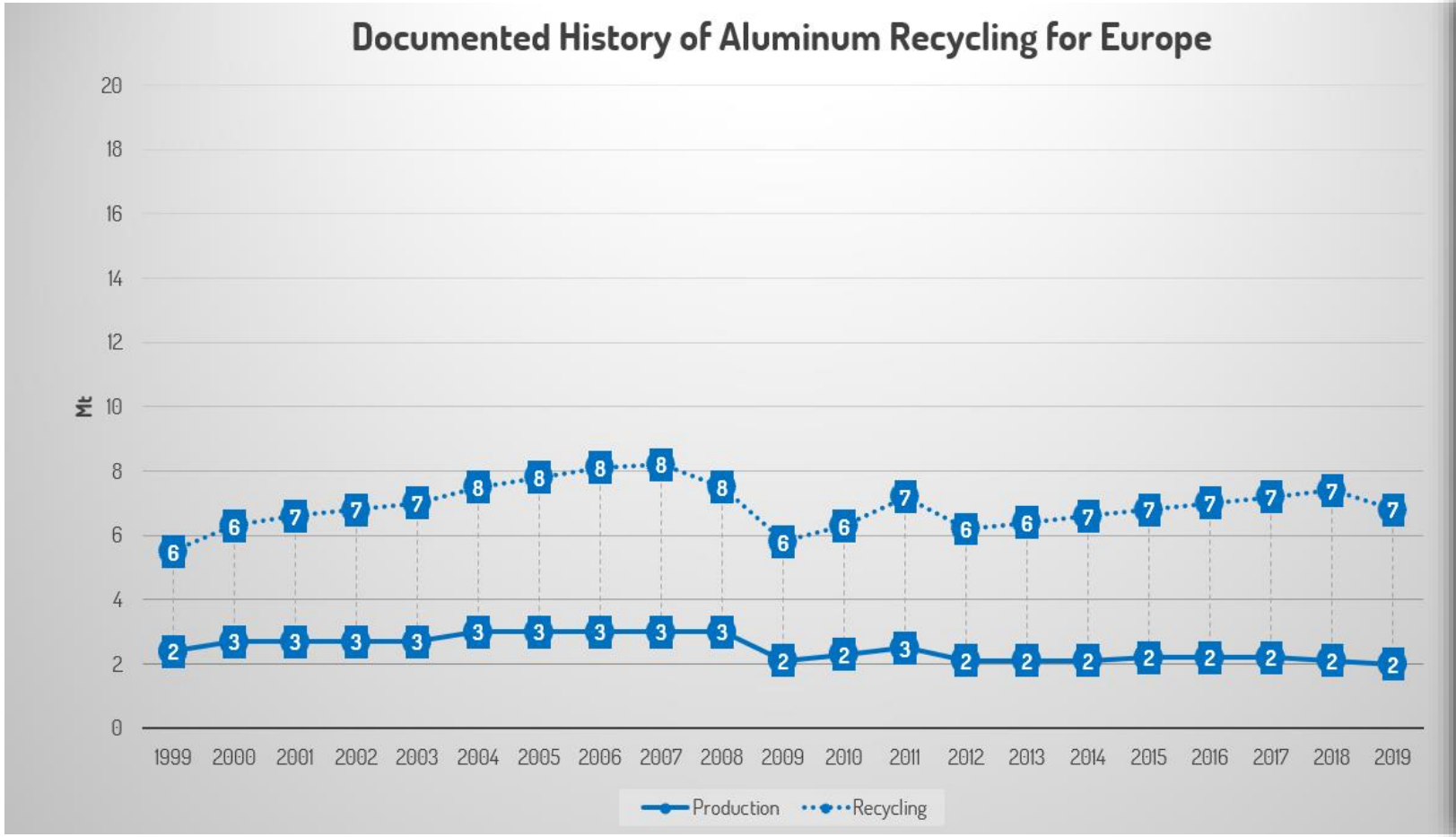
Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- 2 million tons produced (2019).
- 7 million tons recycled (2019).
- 100% recycling rate (2019).
- Scrap quantities are large in Europe, which is why recycling quantities are above production quantities.
- Therefore, Europe is mainly scrap exporter.

Sources: European Aluminum Association (2020a, pp. 8-9) - European Aluminium Association (2020b) - Hatayama et. al (2009, p. 654-656).

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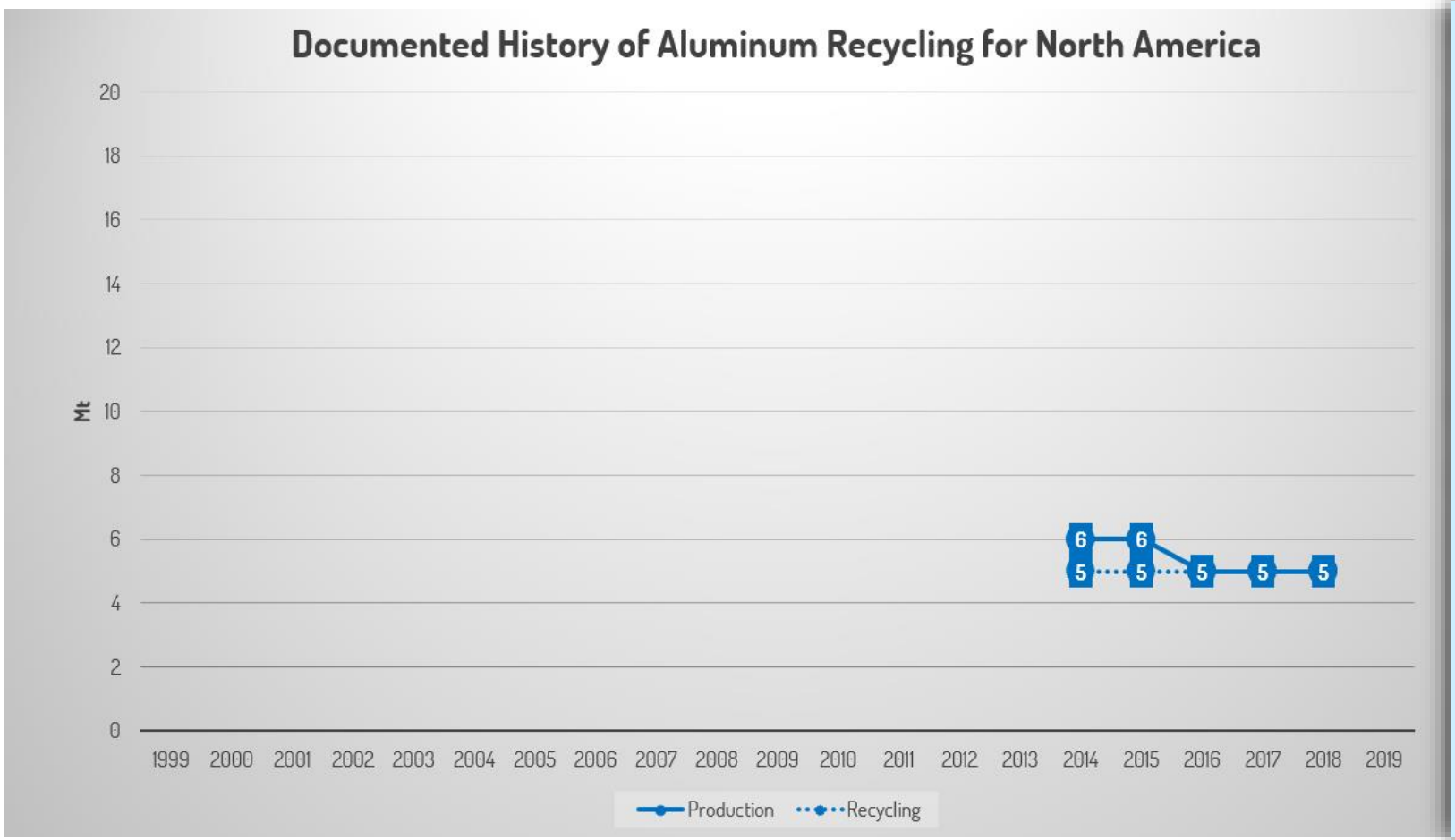
Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- 5 million tons produced (2018).
- 5 million tons recycled (2018).
- 100% recycling rate (2018).
- documentation of recycling in quantities reaches back until 2014
- recycling rate of 83% in 2014
- since then, recycling volumes remained stabled whereas production went down

Sources: Gesamtverband der Aluminiumindustrie e.V. (2019).

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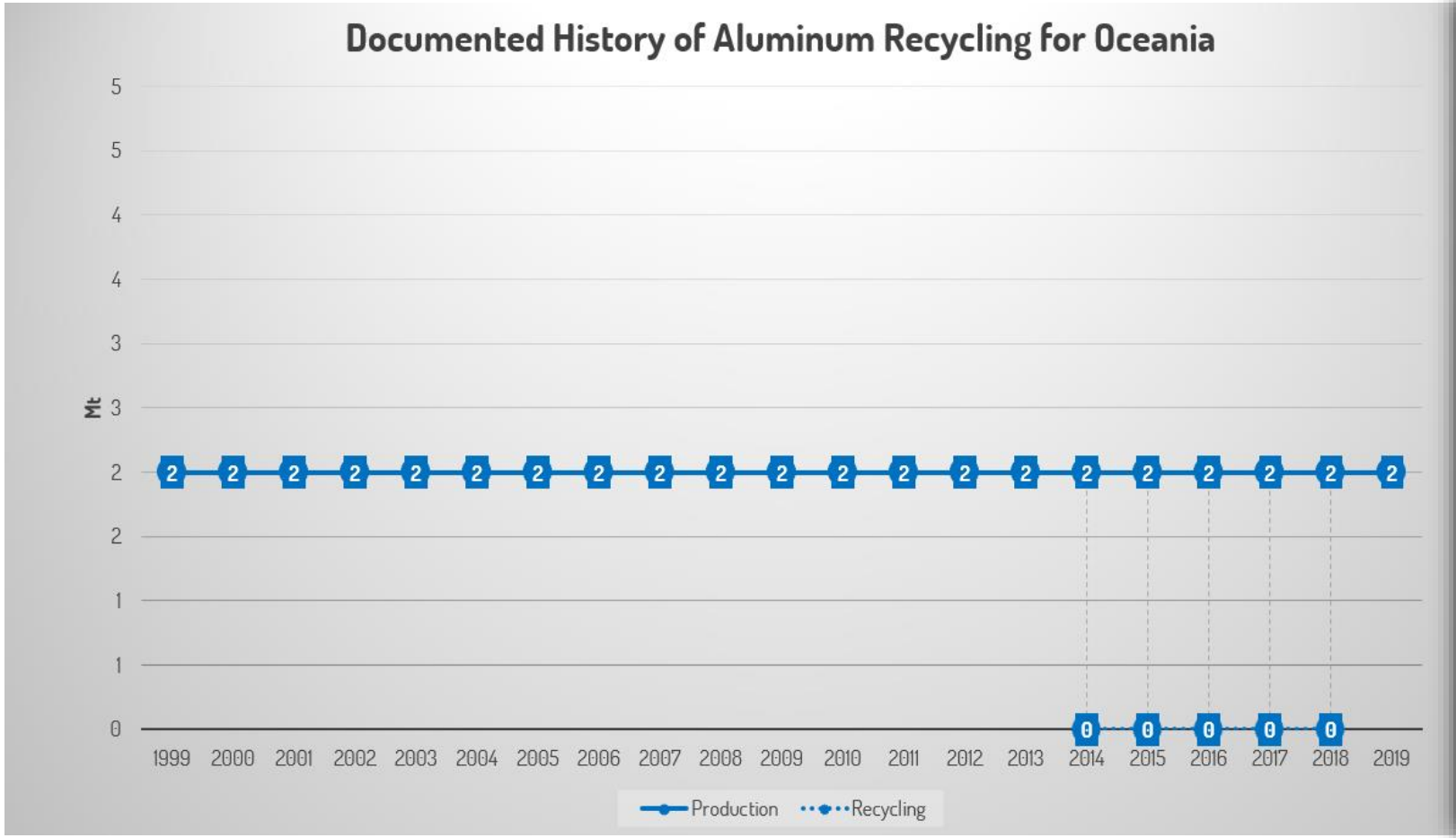
Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- 2 million tons produced (2018).
- Almost 0 million tons recycled (2018).
- Almost 0% recycling rate (2018).

Sources: Gesamtverband der Aluminiumindustrie e.V. (2019) –U.S. Geological Survey (2015).

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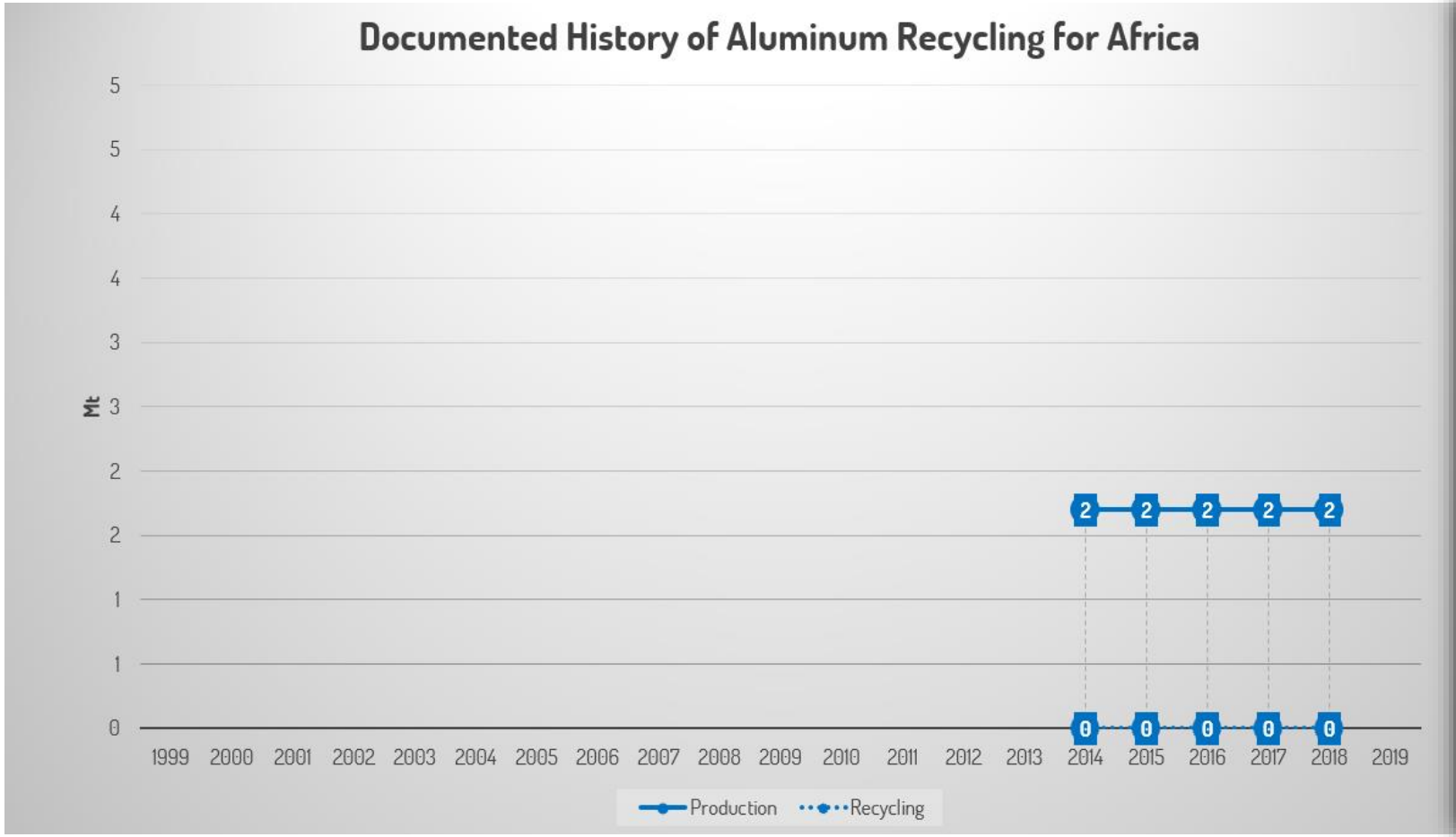
Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- 2 million tons produced (2018).
- Almost 0 million tons recycled (2018).
- Almost 0% recycling rate (2018).

Sources: Gesamtverband der Aluminiumindustrie e.V. (2019).

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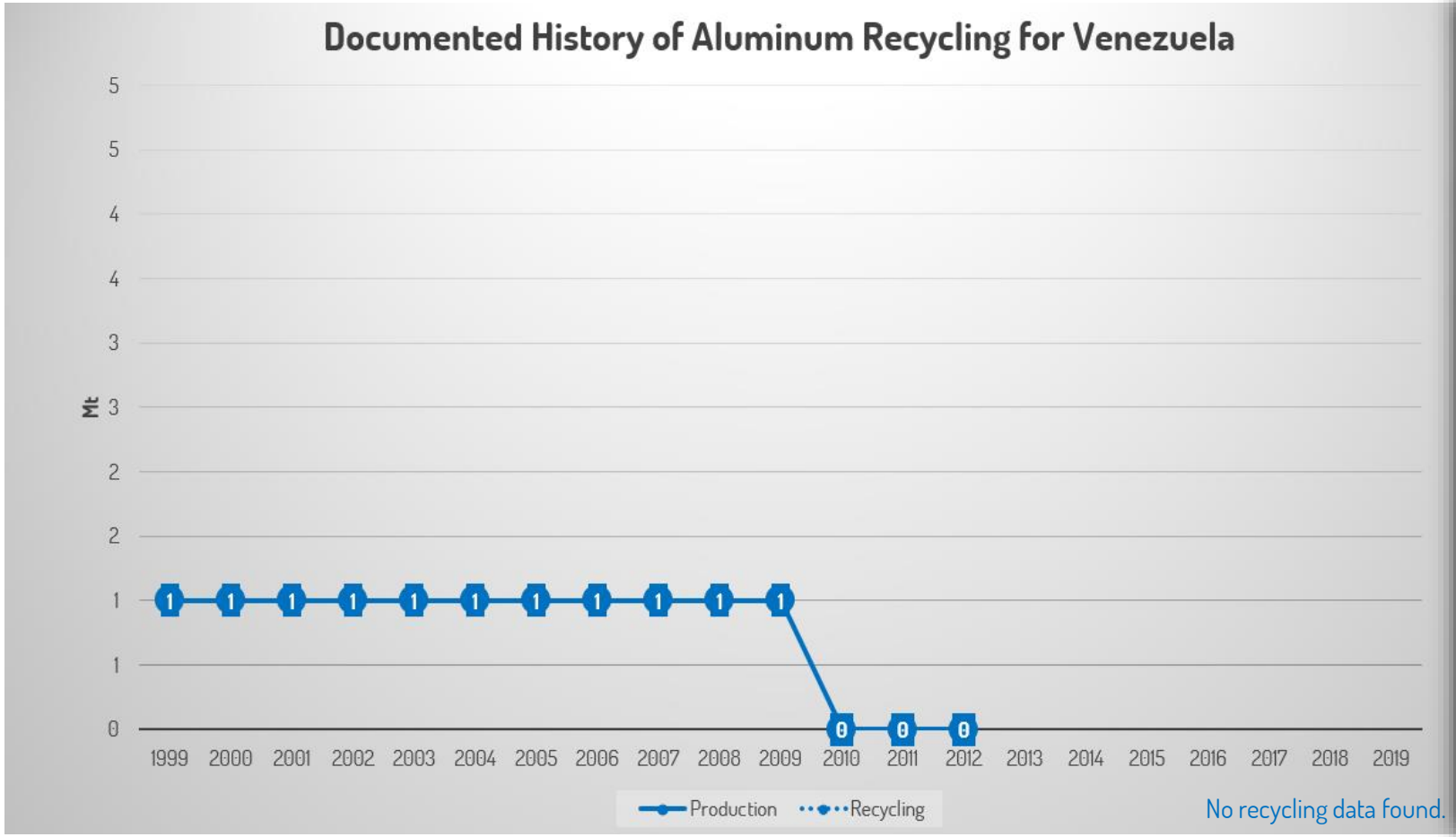
Experts

Aluminum – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole South America.

Venezuela:

- 0 million tons produced (2012).
- No data available for recycling.

Sources: U.S. Geological Survey (2015).

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SCORE CARD ALUMINUM

		Global North			Global South		
	WORLD	USA / NORTH AMERICA	CHINA / ASIA	EUROPE	AFRICA	AUSTRALIA / OCEANIA	VENEZUELA / SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Aluminum – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Aluminum	29 Mt	77 Mt	38%	fair	Though technology is available, global recycling rate only reaches 38%. World markets are still growing faster than recycling. Anyhow, CE rating is good due to good circular practice in many countries.	

Just as steel, aluminum experiences little material degradation. Aluminum industry mainly grew in answer to a growing aeronautics industry during the past 200 years. During world wars, aluminum was declared strategic material which is why today, used aluminum scrap is cheaper than virgin ore in the production process. In modern aluminum industry, developed trading market and aluminum markets exist globally. Prices depend on global trends. Lately, aluminum competes with composites due to the flexible composition of the material. In terms of recycling, mono-materials like aluminum are to be preferred.

Latest trends of China's resource strategy have shaken aluminum market: China's ferrous import ban also addresses imports of aluminum scrap in order to reduce the rate of contaminated aluminum waste and to adapt new quality standards.

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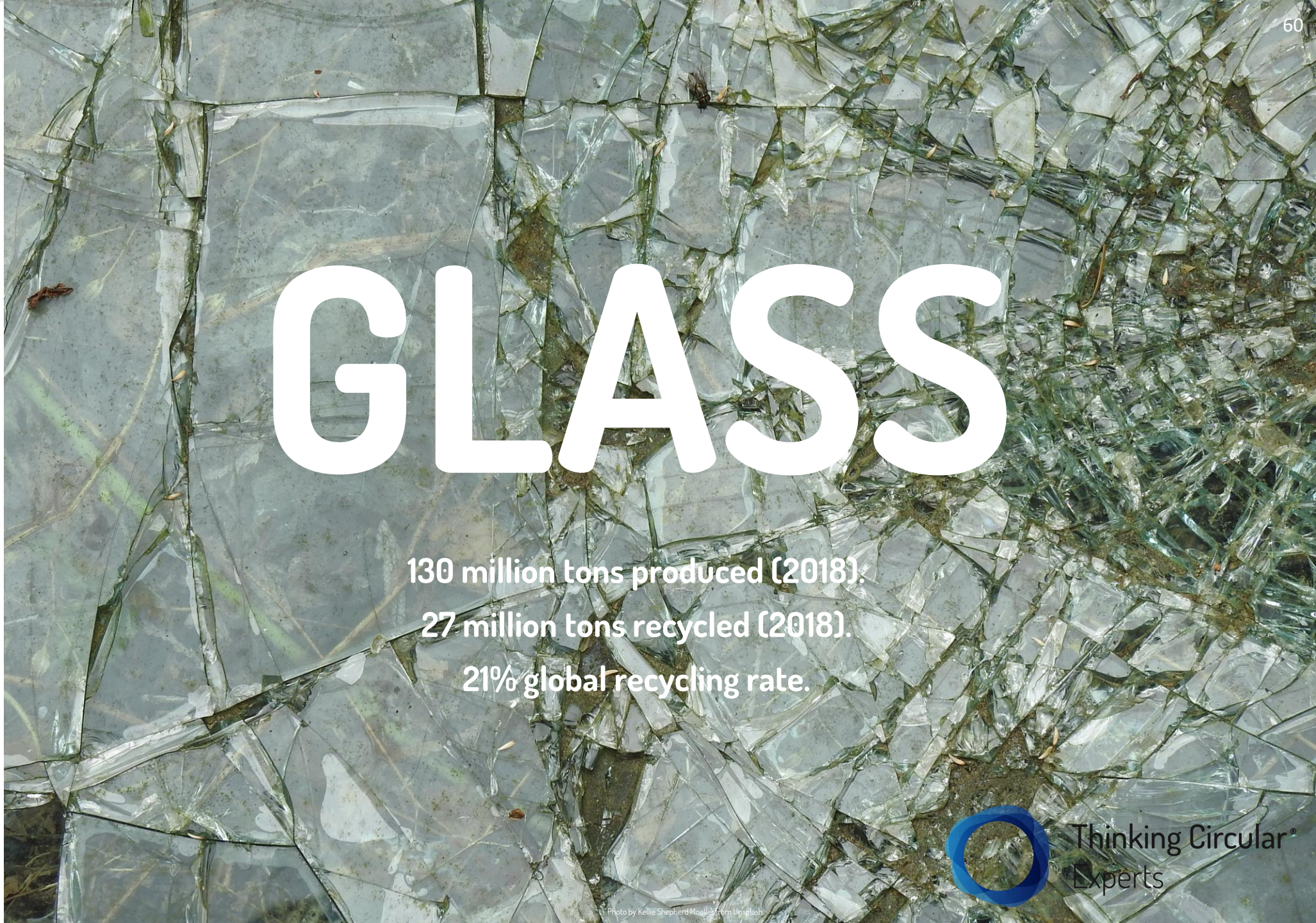
Experts



GLASS

130 million tons produced (2018).

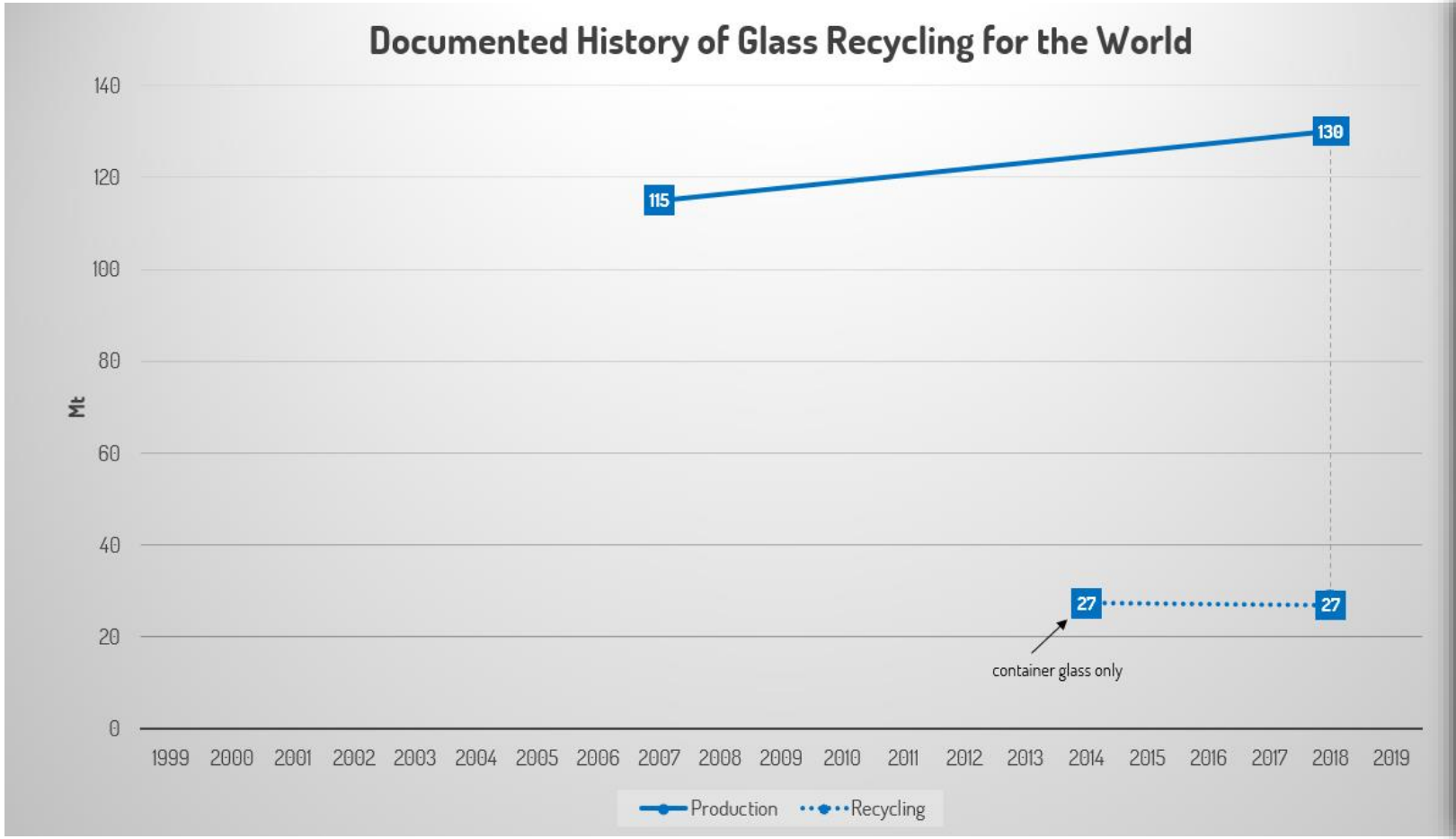
27 million tons recycled (2018).

21% global recycling rate.

Thinking Circular® Experts

Photo by Kellie Shepherd Moeller from Unsplash

Glass – Market study results



Facts

- Material is fraction of household waste only in a few countries of Global North.
- Worldwide almost no data collection.
- Often, statistics include container glass only.
- 130 million tons produced (2018).
- 27 million tons recycled (2018).
- 21% global recycling rate (2018).

Sources: Butler et. al (2019, p. 308, p. 313) - Kaza et. al (2018, p. 25, p. 29) - Wintour (2015, p. 1).

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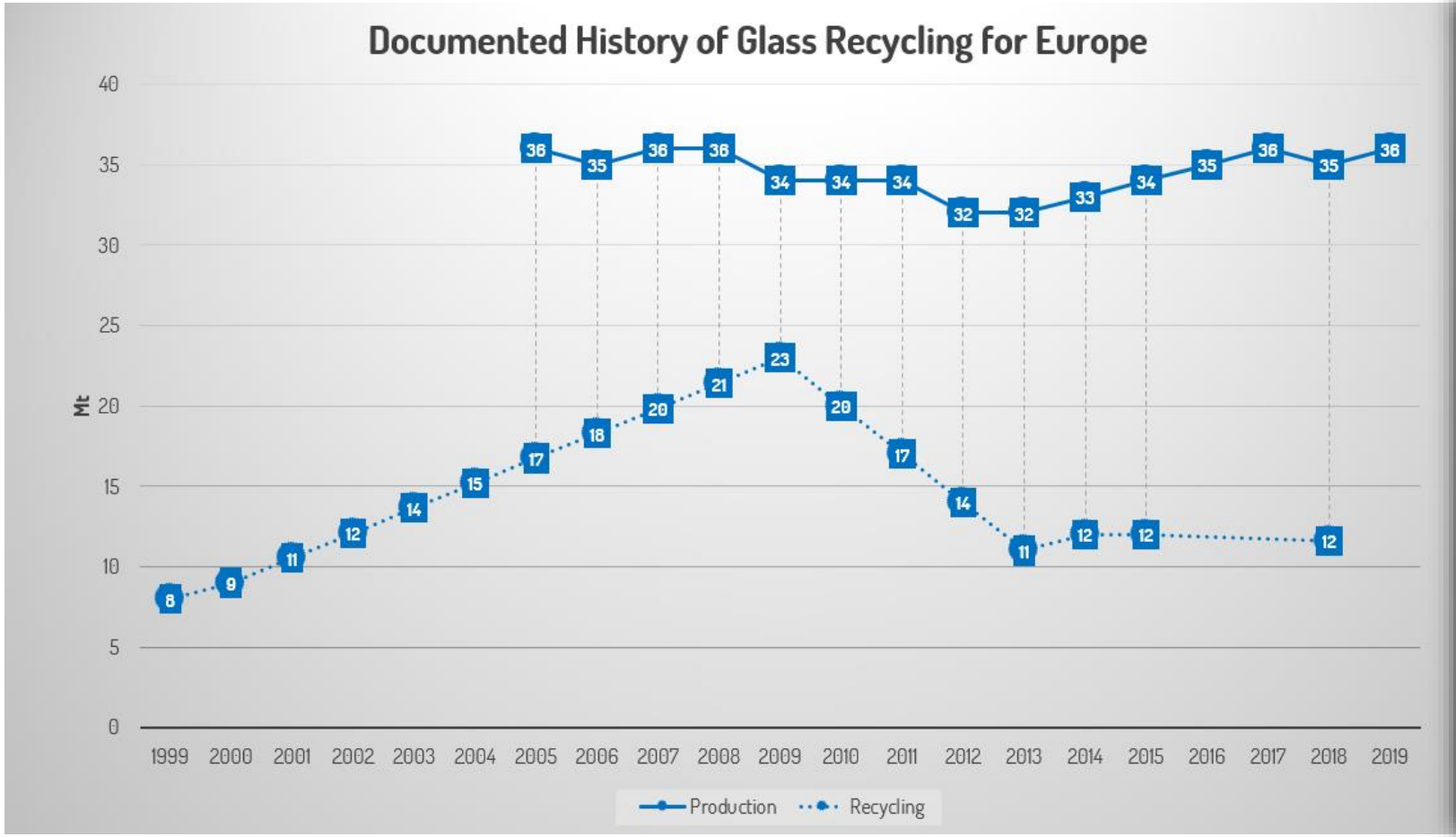
Glass – Market study results



Facts

- Material is fraction of household waste in parts of EU.
- 35 million tons produced (2018).
- 12 million tons recycled (2018; container glass only).
- 74% recycling rate (2018; container glass only).
- Implementation waste legislation in 1999.
- During the financial crisis in 2008, glass markets broke down in Europe.
- Compared to the rest of the world, recycling rates in Europe are very high, especially for container glass.
- High qualities of recycled glass.

Sources: Association of Cities and Regions for Recycling and Sustainable Resource Management et. al (2012, p. 26) - Bundesverband Sekundärrohstoffe und Entsorgung e.V., Fachverband Glasrecycling (2016) - Bundesverband Sekundärrohstoffe und Entsorgung e.V., Fachverband Glasrecycling (2018) - Gonzáles-Torre (2002, p. 3) - Harder (2018) – Hohmann (2020).

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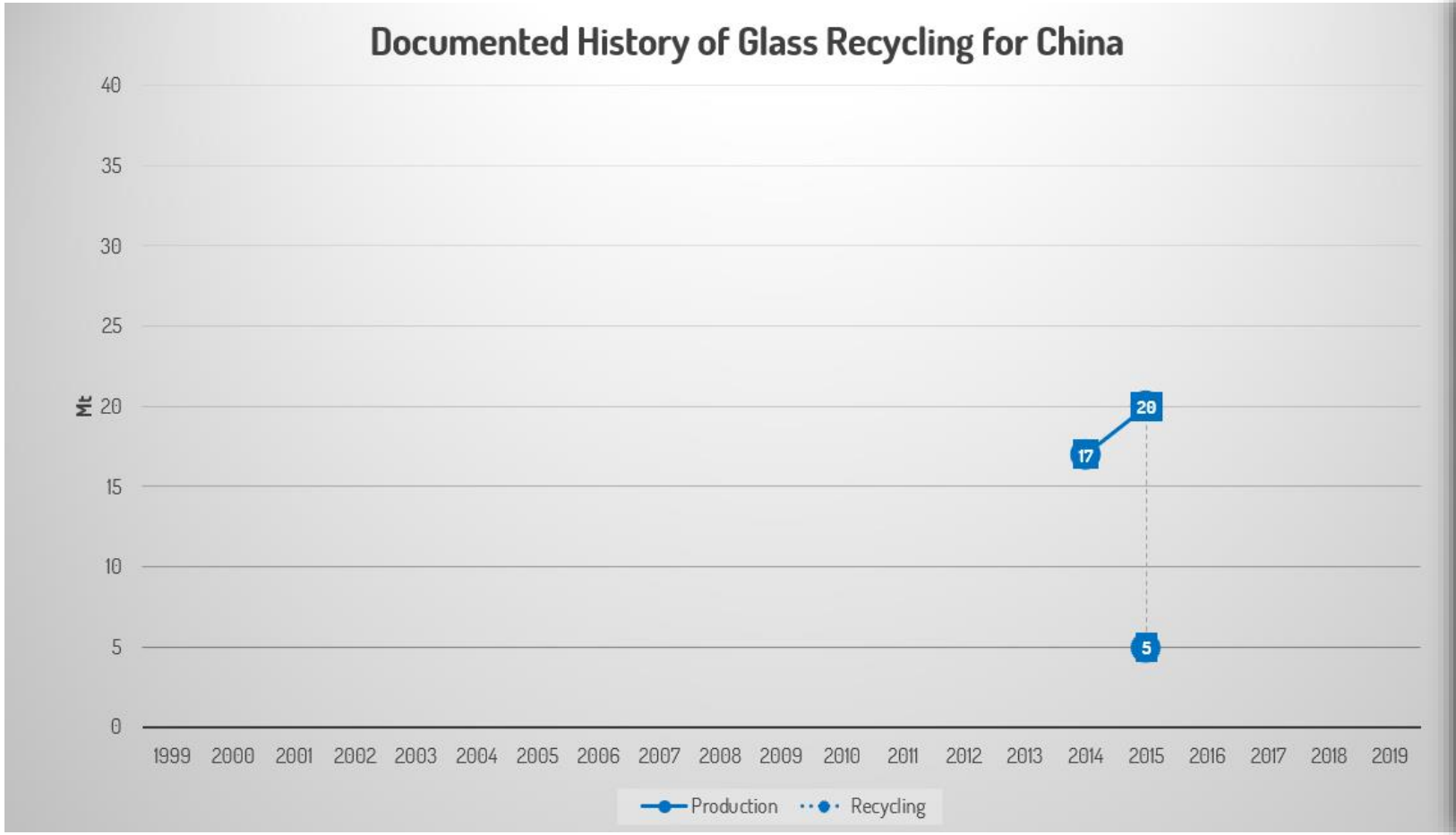
Glass – Market study results



Facts

- Material is no fraction of household waste.
- 20 million tons produced (2015; container glass only).
- 5 million tons recycled (2015; container glass only).
- 25% recycling rate (2015; container glass only).
- In 2018, recycling rate below 20%.
- Recycling lines have been built in the 1950th years, recycled glass doesn't meet quality requirements as for virgin material.

Sources: Butler et. al (2019, p. 308, p. 316) – Harder (2018).

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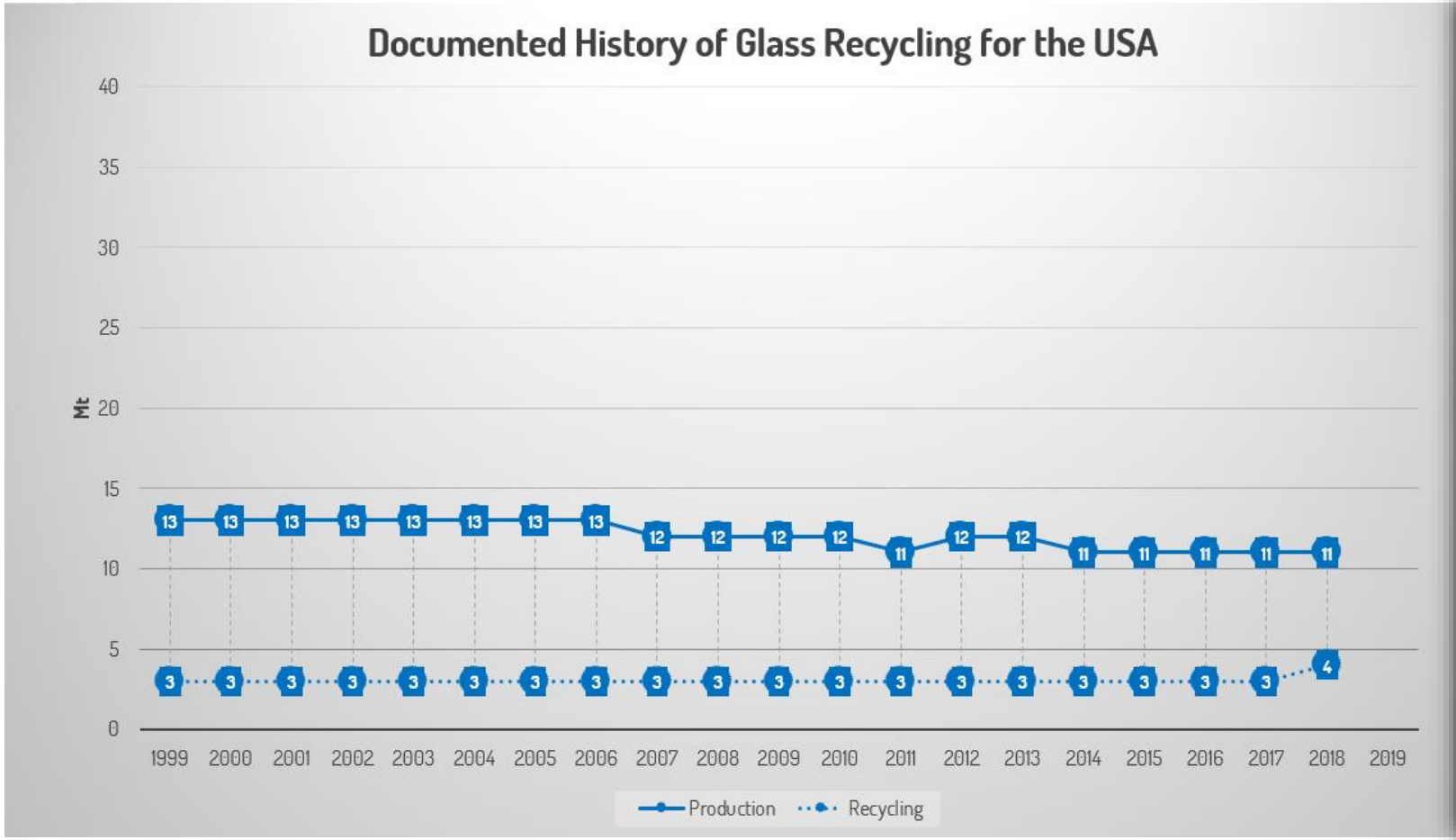
Experts

Glass – Market study results



Facts

- Material is fraction of household waste.
- No data available for whole North America.

USA:

- 11 million tons produced (2018).
- 4 million tons recycled (2018).
- 35% recycling rate (2018).
- Glass collection started early in the 1990s.

Sources: Harder (2018) - United States Environmental Protection Agency (2014, pp. 1-2) - United States Environmental Protection Agency (2016, pp. 1-2) - United States Environmental Protection Agency (2020).

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Glass – Market study results

Facts

- Material is no fraction of household waste.
- No data available for whole South America.

Brazil:

- 3 million tons produced (2011).
- 0.63 million tons recycled (2014).

Sources: Wintour (2015, p. 10).

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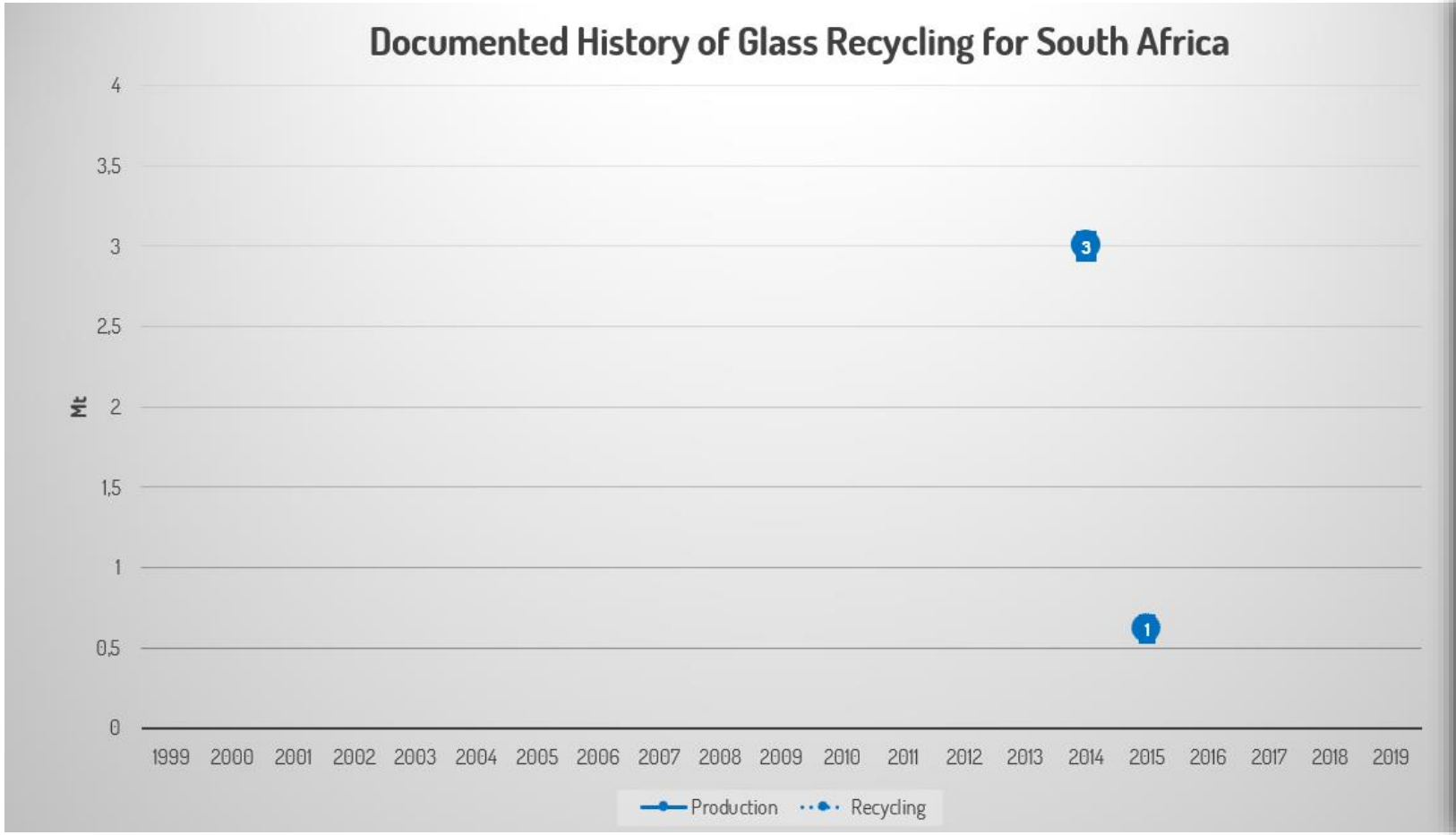
Glass – Market study results



Facts

- Material is no fraction of household waste.
- 3 million tons produced (2014; container glass only).
- 0.62 million tons recycled (2015).
- 41% recycling rate (2018).
- A trend reversal has taken place: More than 4000 „bottle banks“ have been installed for glass collection.

Sources: Butler et. al (2019, p. 308, p. 313) – Harder (2018).

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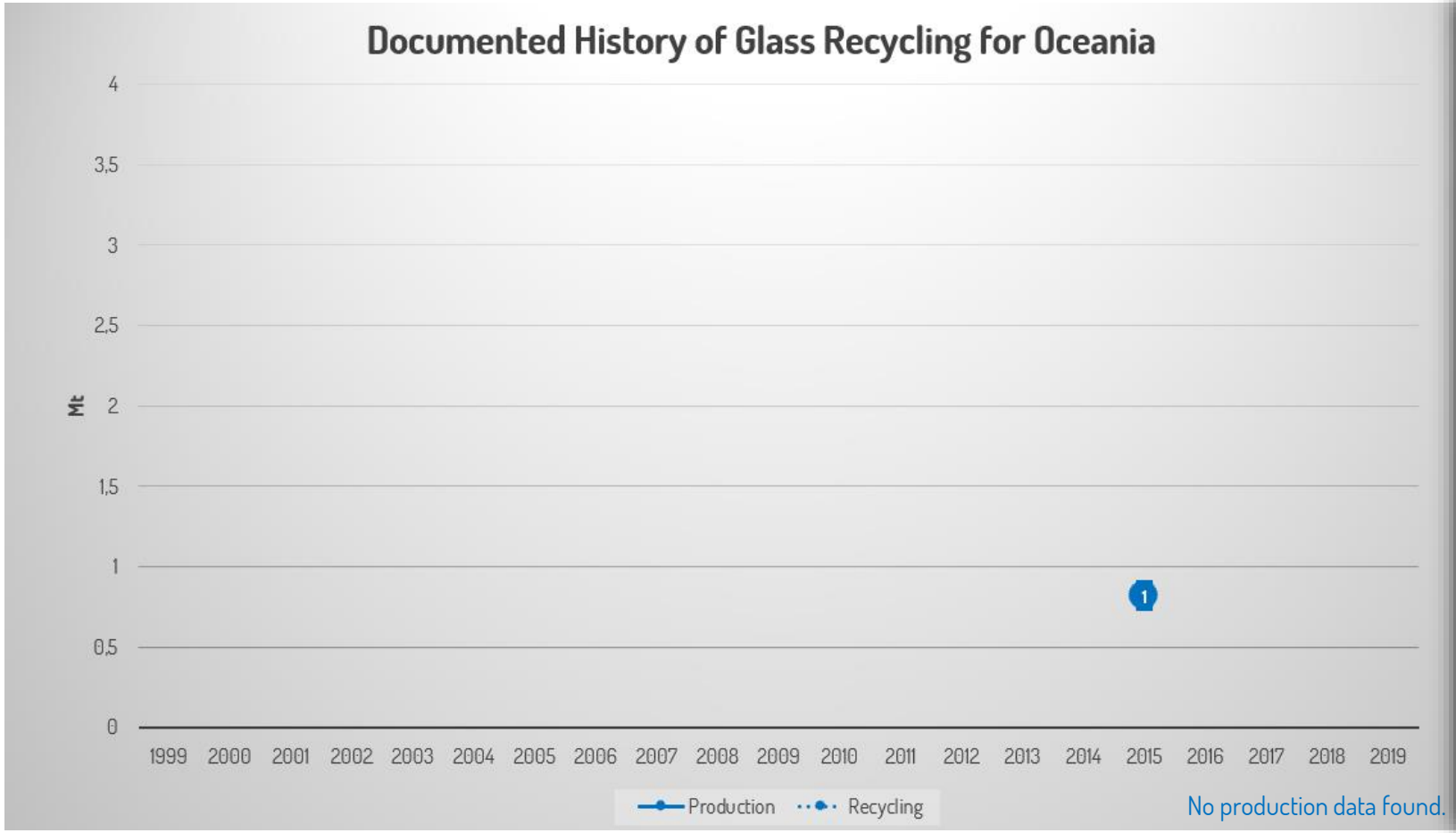
Glass – Market study results



No production data found.

Facts

- Material is no fraction of household waste.
- No data available for production.
- Almost 1 million tons recycled (2015; container glass only).

Sources: Butler et. al (2019, p. 308, p. 313).

Thinking Circular® Experts

SCORE CARD GLASS

		Global North			Global South		
	WORLD	USA	CHINA	EUROPE	SOUTH AFRICA / AFRICA	AUSTRALIA / OCEANIA	BRAZIL / SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

Thinking Circular®
Experts

Glass – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Glass	27 Mt	130 Mt	21%	fair	Glass recycling market is underdeveloped in most parts of the world.	

For Europeans, glass recycling is very common due to the good infrastructure of glass containers for collection.

For North Americans, glass recycling is just as normal as for Europeans. Recycled glass is cheaper than virgin glass production.

In Global South, glass recycling quotes have been low so far.

Sand scarcity has not effected virgin glass production which is the reason why it is cheaper than recycled glass. Sand scarcity is now on the agenda.

Thinking Circular® Experts

RUBBER

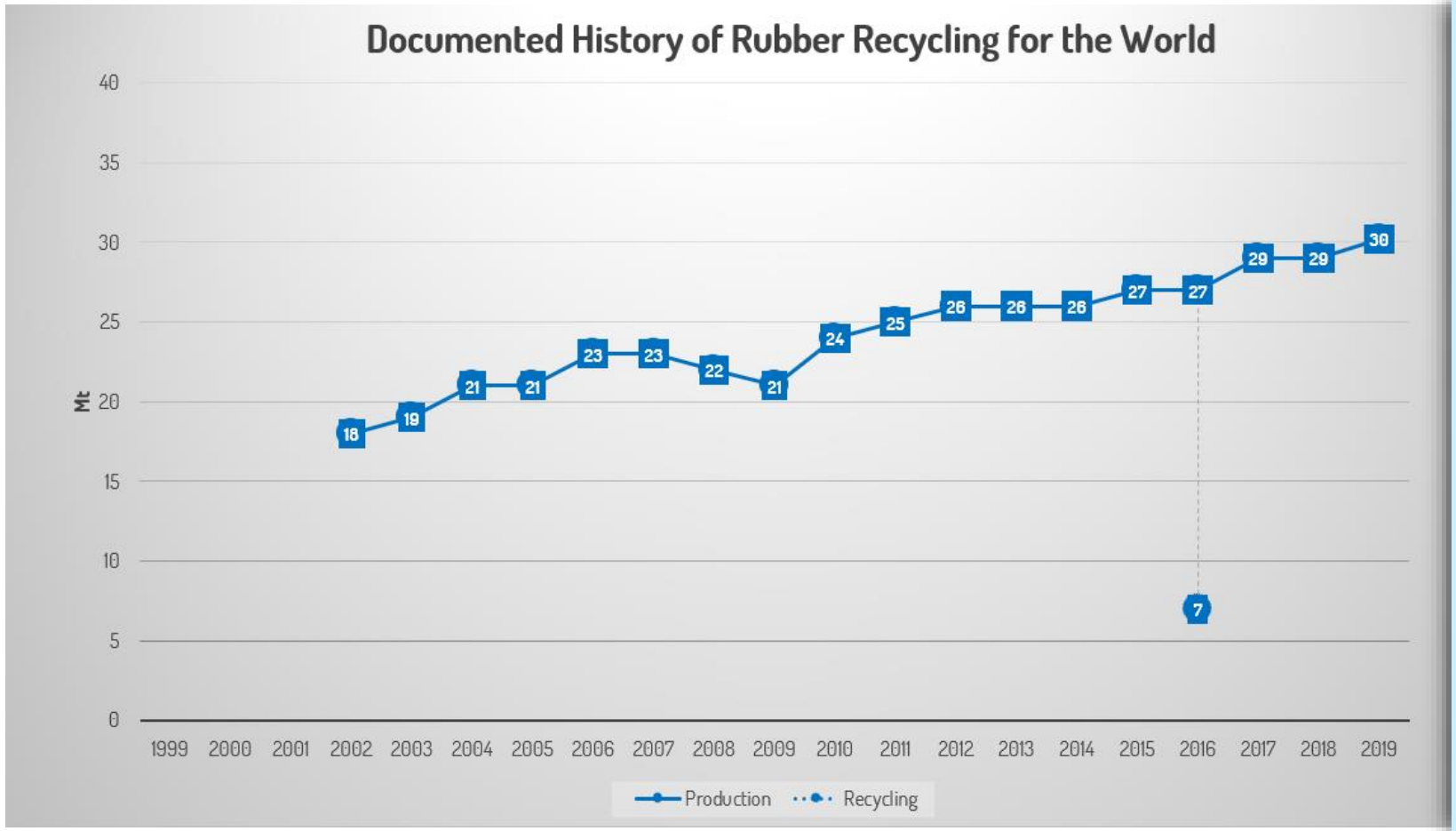
27 million tons produced (2016).

Approximately 7 million tons recycled (2016; extrapolated).

Single case studies show a global recycling rate of 26% from extrapolated data.

Photo by Imthaz Ahamed from Unsplash.

Rubber – Market study results



Facts

- Material is no fraction of household waste.
- 27 million tons produced (2016).
- 7 million tons recycled (2016; extrapolated).
- Single case studies show a global recycling rate of 26% (extrapolated data).
- Only in high-income regions, rubber together with leather accounts for 4% of waste composition. In lower-income regions, rubber and leather waste accounts for less than 1% of waste composition.
- In early 21st century, demand for cars was rising.
- During the financial crisis in 2008, rubber markets globally broke down.

Sources: Garside (2020a) - Grilli et. al (1980, p.19, p.33, p.42, p.80) - Kaza et. al (2018, pp. 29-30) - Lembaga Getah Malaysia, Malaysian Rubber Board (2019, pp. 1-2) - The Rubber Economist Ltd. (2020).

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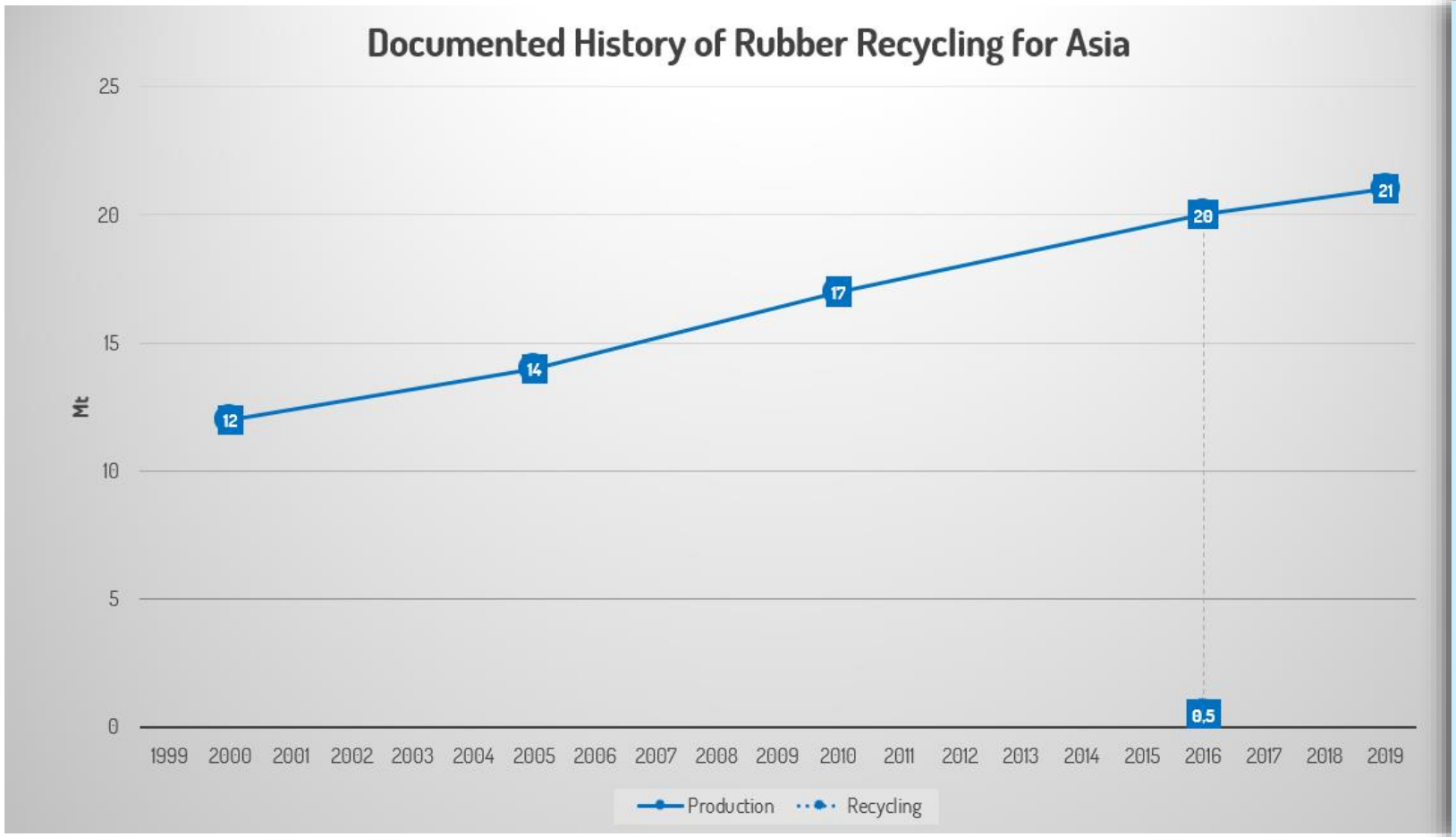
Rubber – Market study results



Facts

- Material is no fraction of household waste.
- 20 million tons produced (2016).
- 0,5 million tons recycled (2016).
- Single case studies show a recycling rate of 3% (extrapolated).
- Rubber and leather account for 1-2% of waste composition.
- A large amount of garbage is still disposed in landfill or dumped; only a small part gets recycled.
- Improvements to collection systems, recycling programs and construction of sanitary final disposal sites are underway.

Sources: Grilli et. al (1980, p.19, p.33) - Kaza et. al (2018, p. 59, p. 61, p. 65, p. 78) - The Rubber Economist Ltd. (2020).

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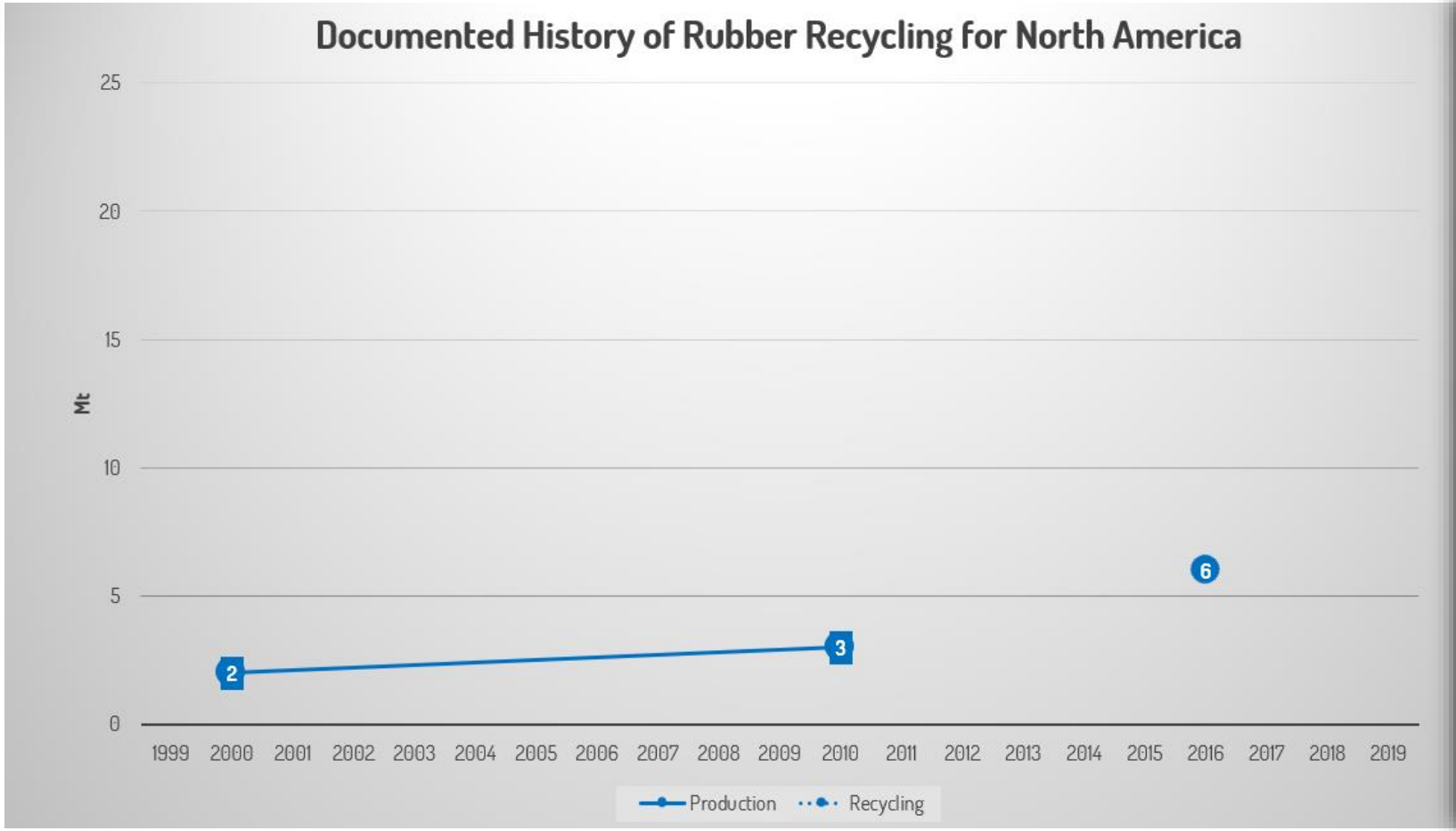
Rubber – Market study results



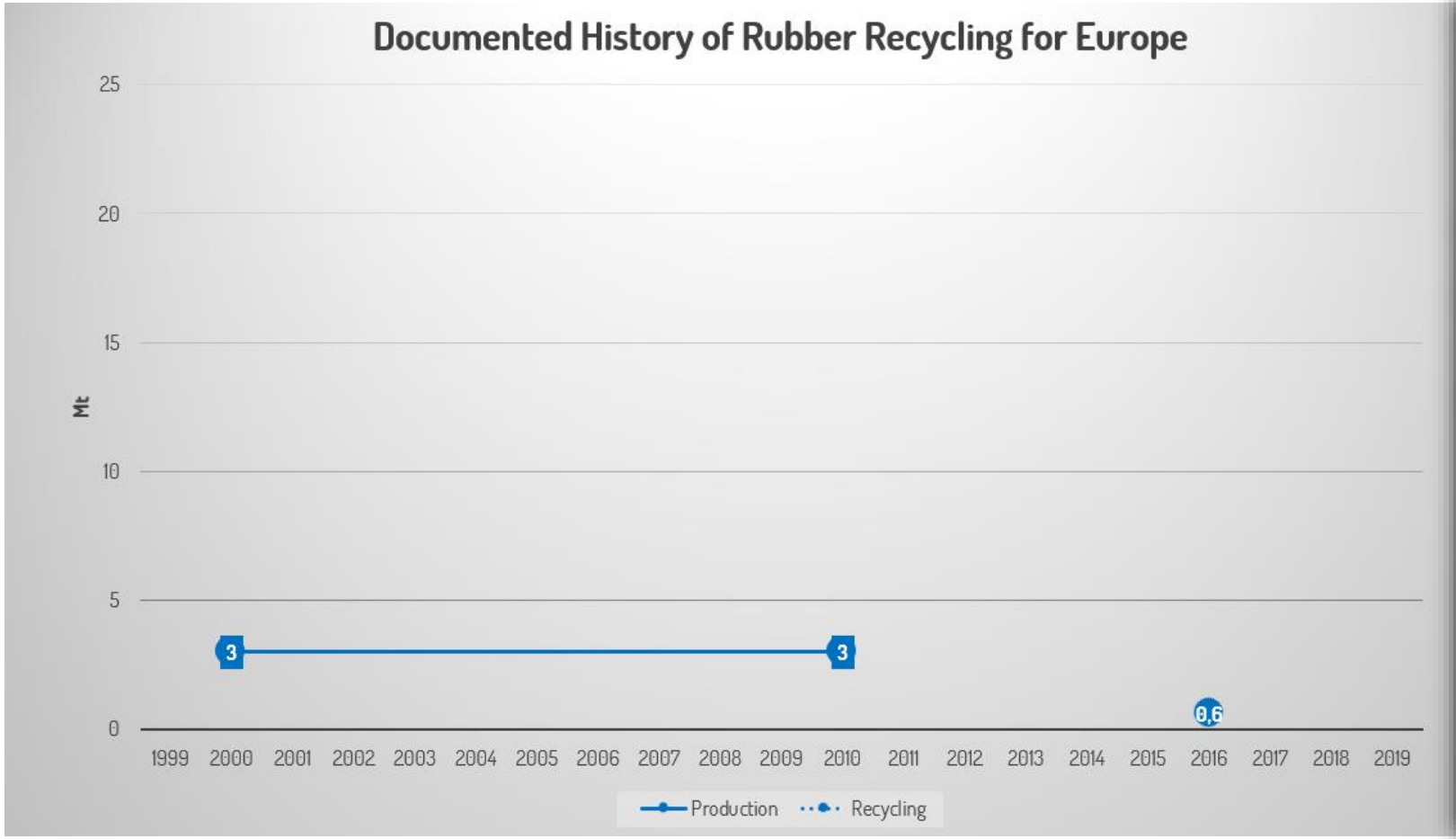
Facts

- Material is no fraction of household waste.
- 3 million tons produced (2010; only synthetic rubber).
- 6 million tons recycled (2016).
- In North America, rubber and leather account for 9% of waste composition.
- In the USA, tire retreading is a self-concept.
- Downcycling is a problem.

Sources: Kaza et. al (2018, p. 59, p. 61, p. 65, p. 78) - Misurelli et. al (1997, p. 14) - The Rubber Economist Ltd. (2020).

Thinking Circular® Experts

Rubber – Market study results



Facts

- Material is no fraction of household waste.
- 3 million tons produced (2010; only synthetic rubber).
- 0,6 million tons recycled (2016).
- Rubber and leather account for less than 1% of waste composition.
- Tire retreading in Europe is confronted with new challenges due to tire imports.

Sources: Centre for Remanufacturing and Reuse (2008, p. 17, p. 19) - Grilli et. al (1980, p.19) - Kaza et. al (2018, p. 59, p. 61, p. 65, p. 78) - The Rubber Economist Ltd. (2020).

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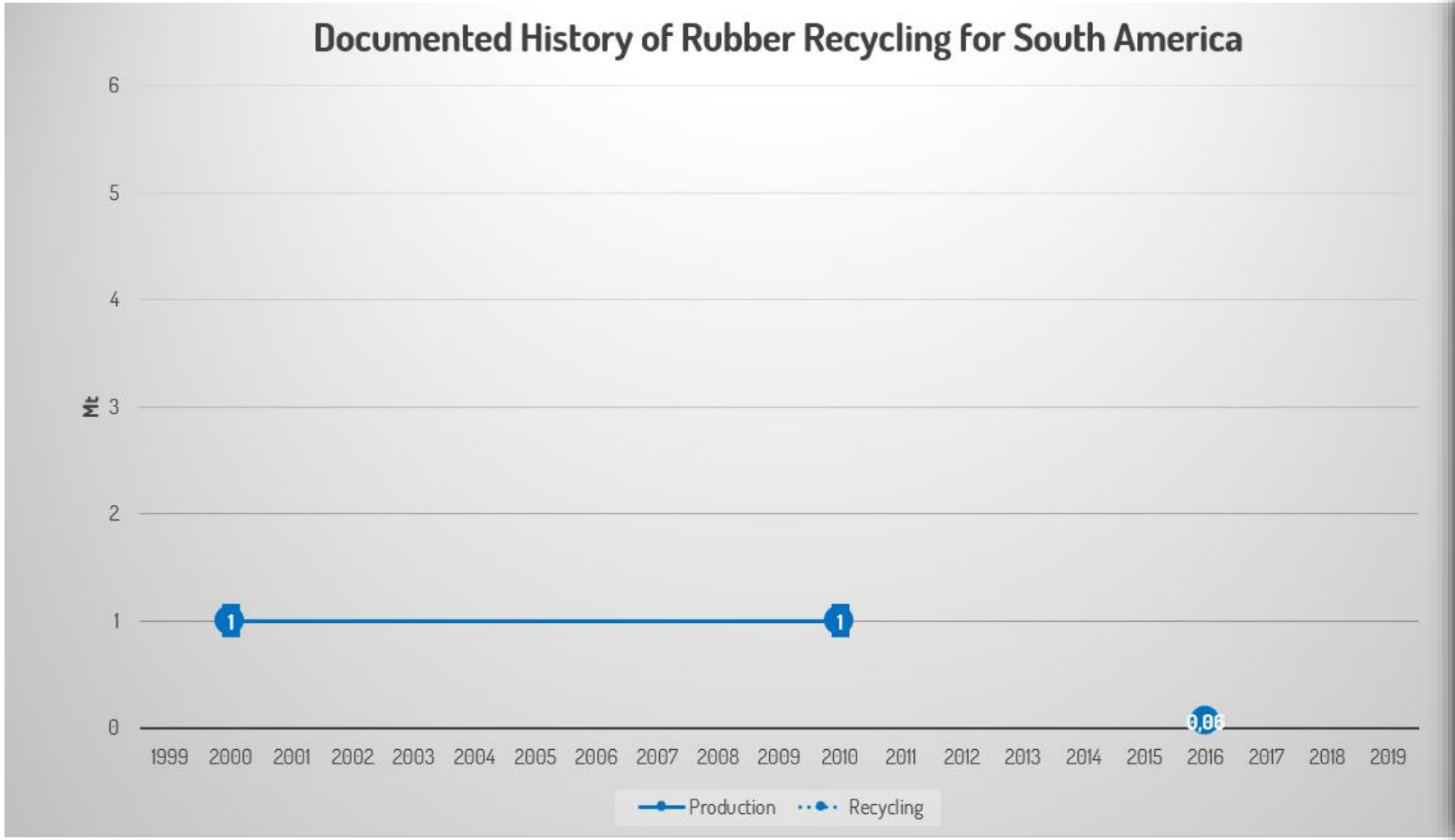
Rubber – Market study results



Facts

- Material is no fraction of household waste.
- 1 million tons produced (2010; only synthetic rubber).
- 0,06 million tons recycled (2016).
- Rubber and leather account for less than 1% of waste composition.

Sources: Kaza et. al (2018, p. 59, p. 61, p. 65, p. 78) – The Rubber Economist Ltd. (2020).

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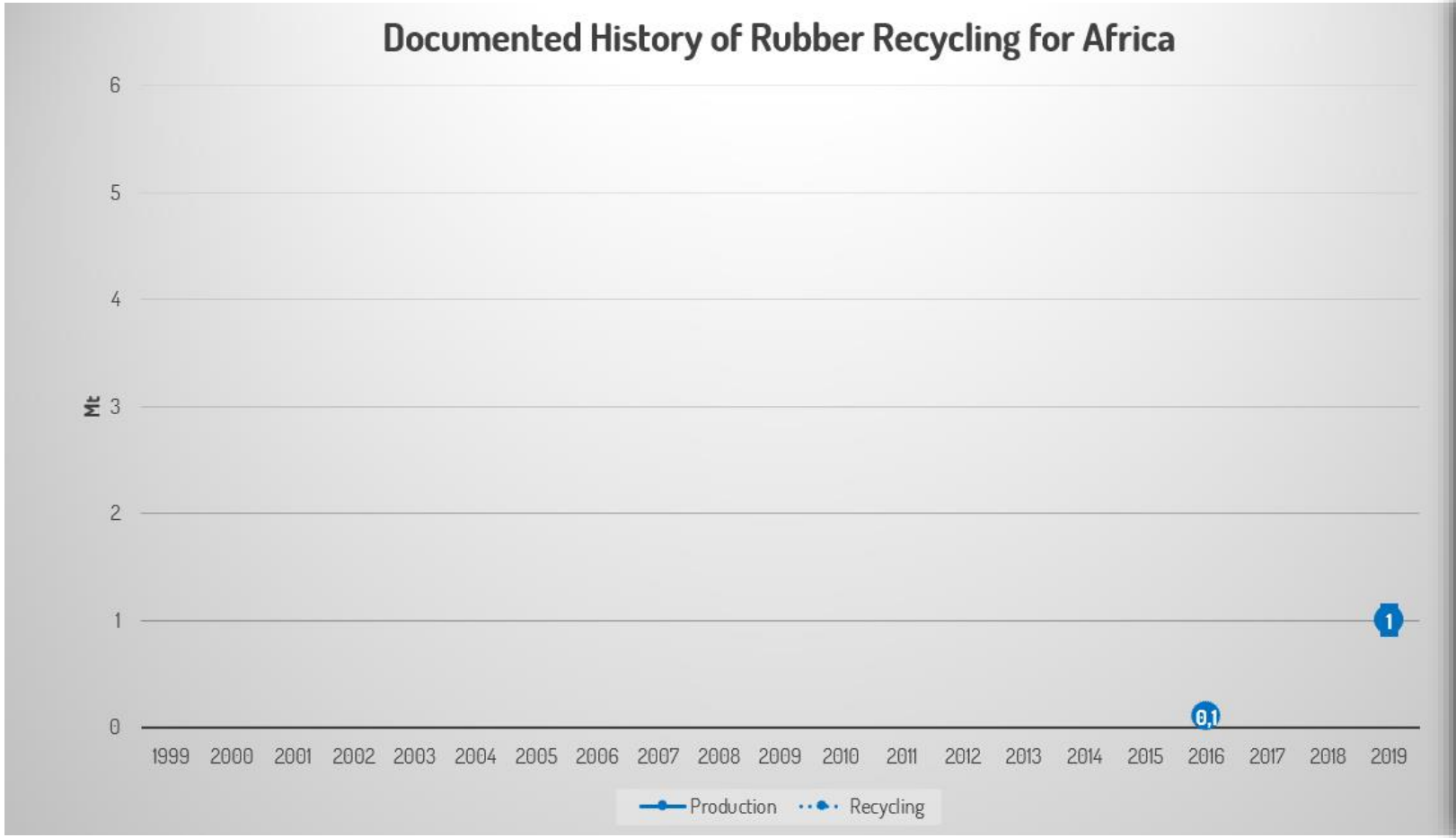
Rubber – Market study results



Facts

- Material is no fraction of household waste.
- 1 million tons produced (2019; only natural rubber; extrapolated).
- 0.1 million tons recycled (2016).
- Rubber and leather account for 0-2% of waste composition.

Sources: Grilli et. al (1980, p.19) - Kaza et. al (2018, p. 59, p. 61, p. 65, p. 78) - The Rubber Economist Ltd. (2020).

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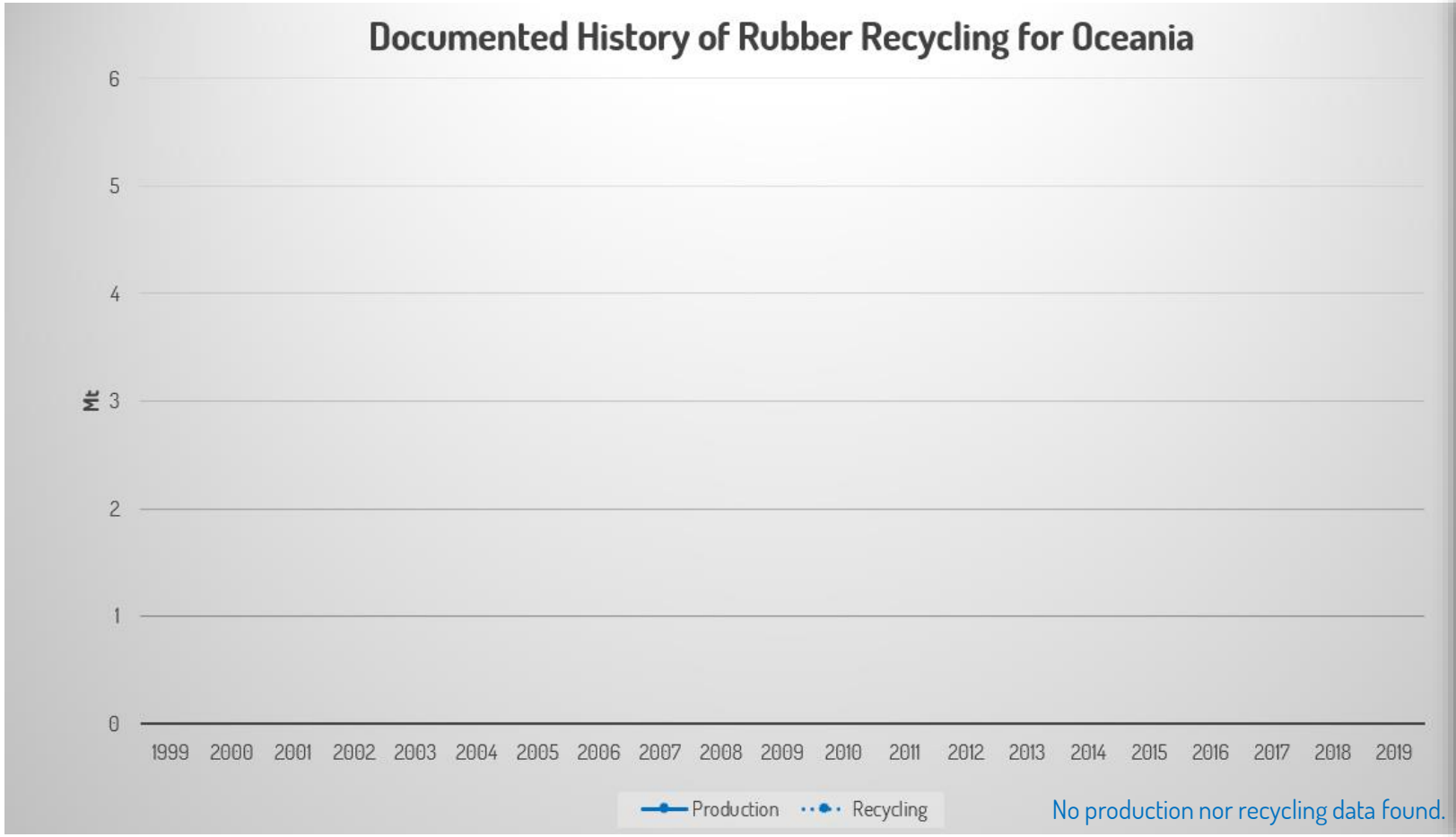
Rubber – Market study results



Facts

- Material is no fraction of household waste.
- No data available for Oceania.

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Experts

SCORE CARD RUBBER

		Global North			Global South		
	WORLD	USA / NORTH AMERICA	CHINA / ASIA	EUROPE	AFRICA	AUSTRALIA / OCEANIA	SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

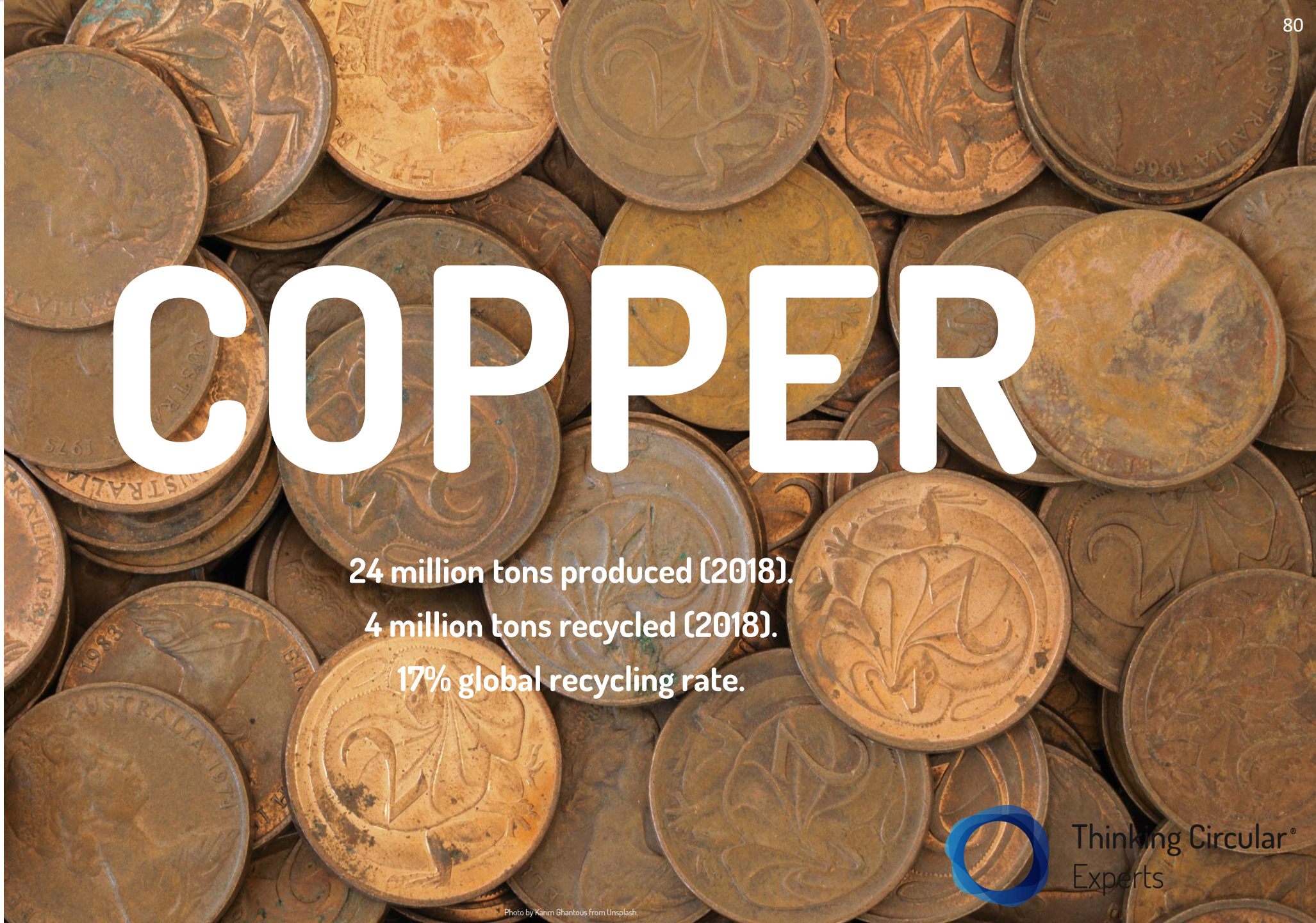
Thinking Circular®
Experts

Rubber – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Rubber	7 Mt	27 Mt	24%	bad	Tire retreading is less expensive in some parts of the world (USA). It lacks image in other industrial countries. Rubber can only be downcycled.	

Rubber is rarely categorized as waste which is the reason why tires are often disposed in open dump. It lacks data collection, infrastructure for collection and acceptance of economic value. This can be seen through the development of the European retreading industry, which is suffering from the import of cheap new tires from Asia. Prices for retreaded tires are at the same level as new quality tires. Low quality tires from Asia undermine the fair prices for retreading tough.

Furthermore, tire retreading lacks image and there is reduced technology for recycling tires. In the USA, tire retreading is common practice, but the material is still down-cycled.



COPPER

24 million tons produced (2018).

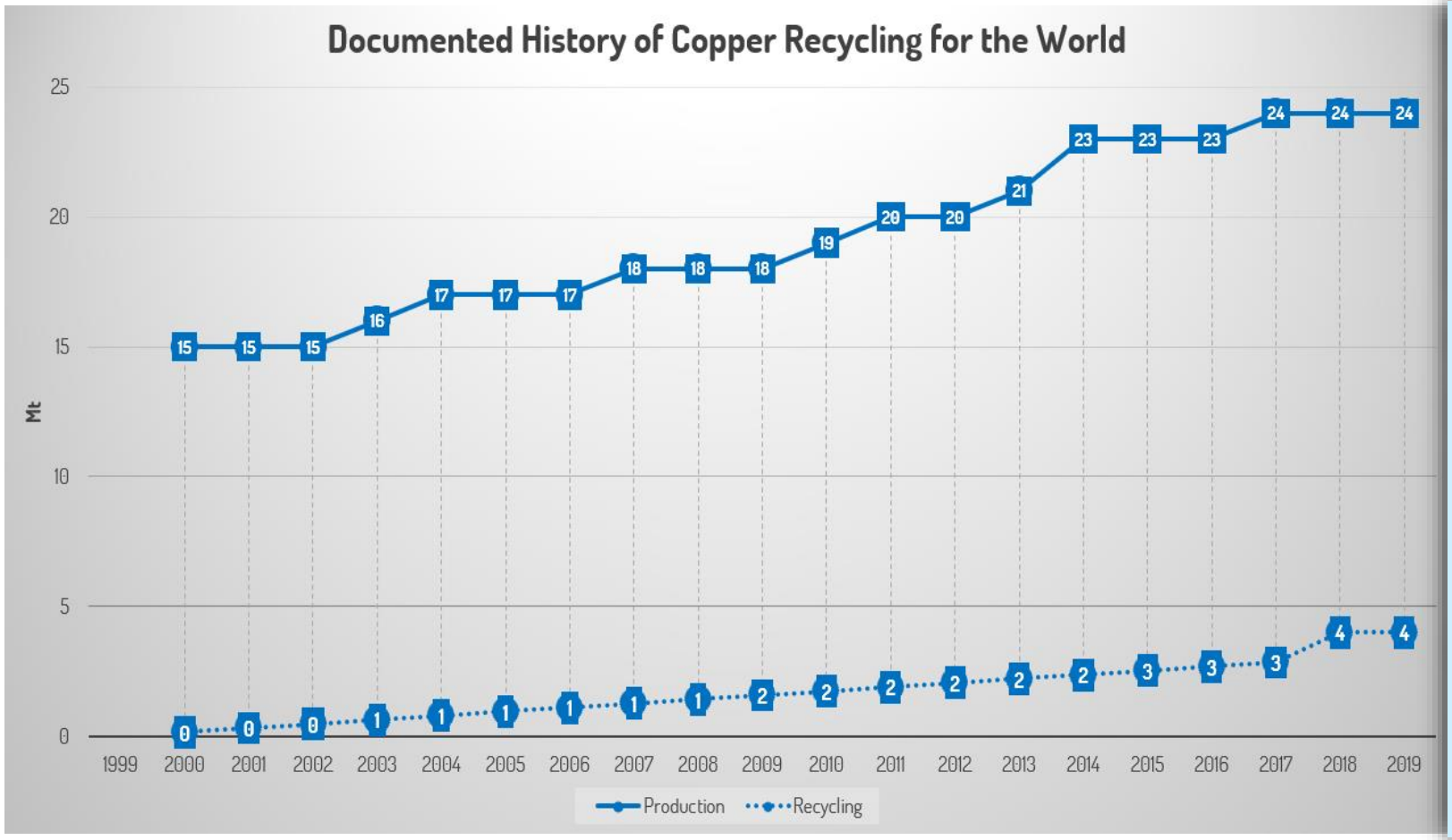
4 million tons recycled (2018).

17% global recycling rate.

Thinking Circular® Experts

Photo by Karim Ghantous from Unsplash.

Copper – Market study results



Facts

- Material is no fraction of household waste.
- 24 million tons produced (2019).
- 4 million tons recycled (2019).
- 17% global recycling rate (2019).
- Similar development to steel; same legislation.
- Key driver of global refined copper usage has been Asia, where - mainly due to China - demand has expanded almost eight-fold over the past four decades.
- Slide and slow recycling development appearing linear due to steady growth.

Sources: Goonan (2009, p. X8) - International Copper Study Group (2019, p. 21, p. 40, p. 59) - International Copper Study Group (2020).

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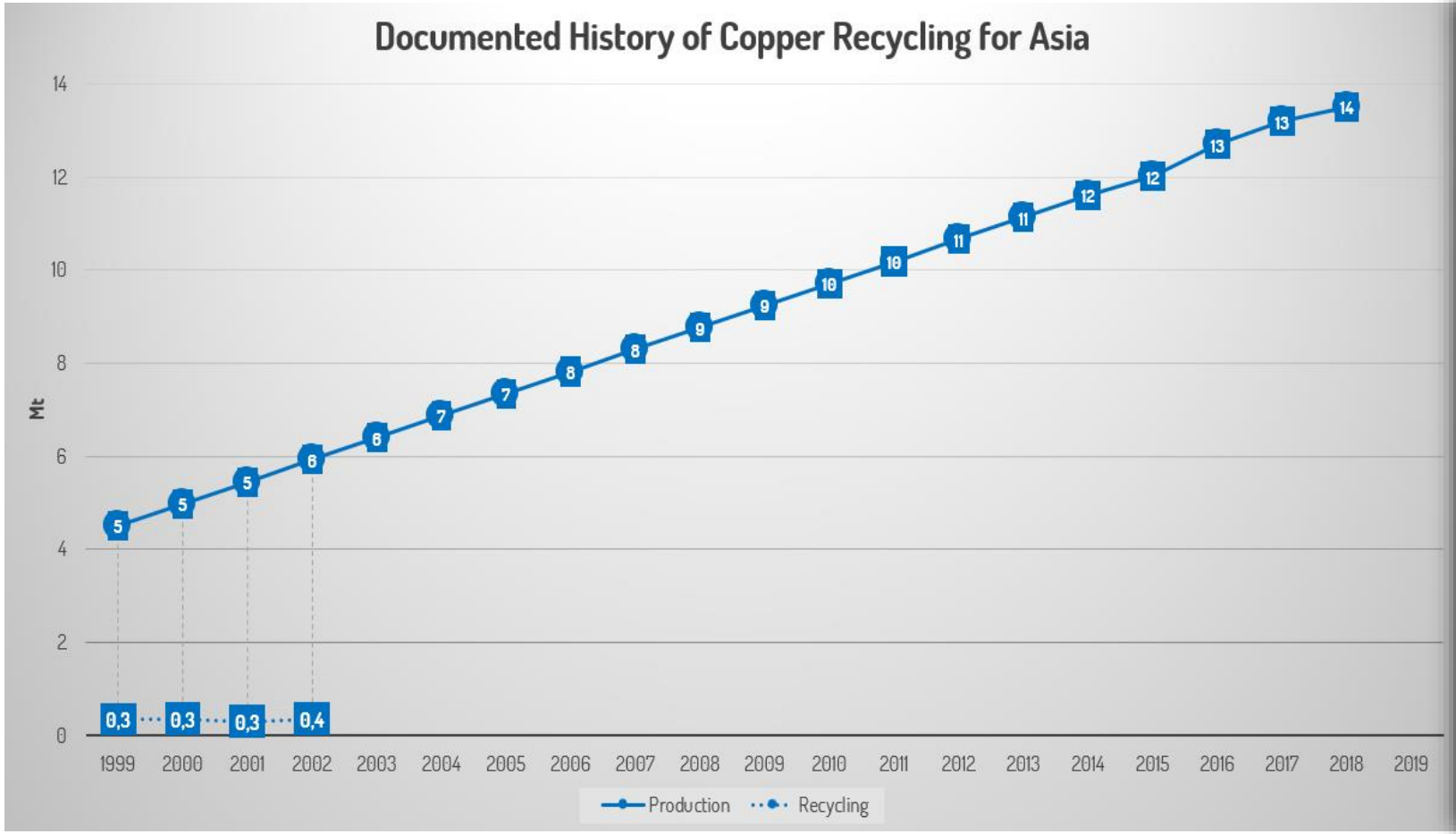
Copper – Market study results



Facts

- Material is no fraction of household waste.
- 13.5 million tons produced (2018).
- Recycling data could only be found for China.
- 0.35 million tons recycled (2002; China only).

Sources: Edelstein (2001, pp. 25-27) - Edelstein (2002, pp. 25-27) - International Copper Study Group (2019, pp. 23-24) - International Copper Study Group (2020a).

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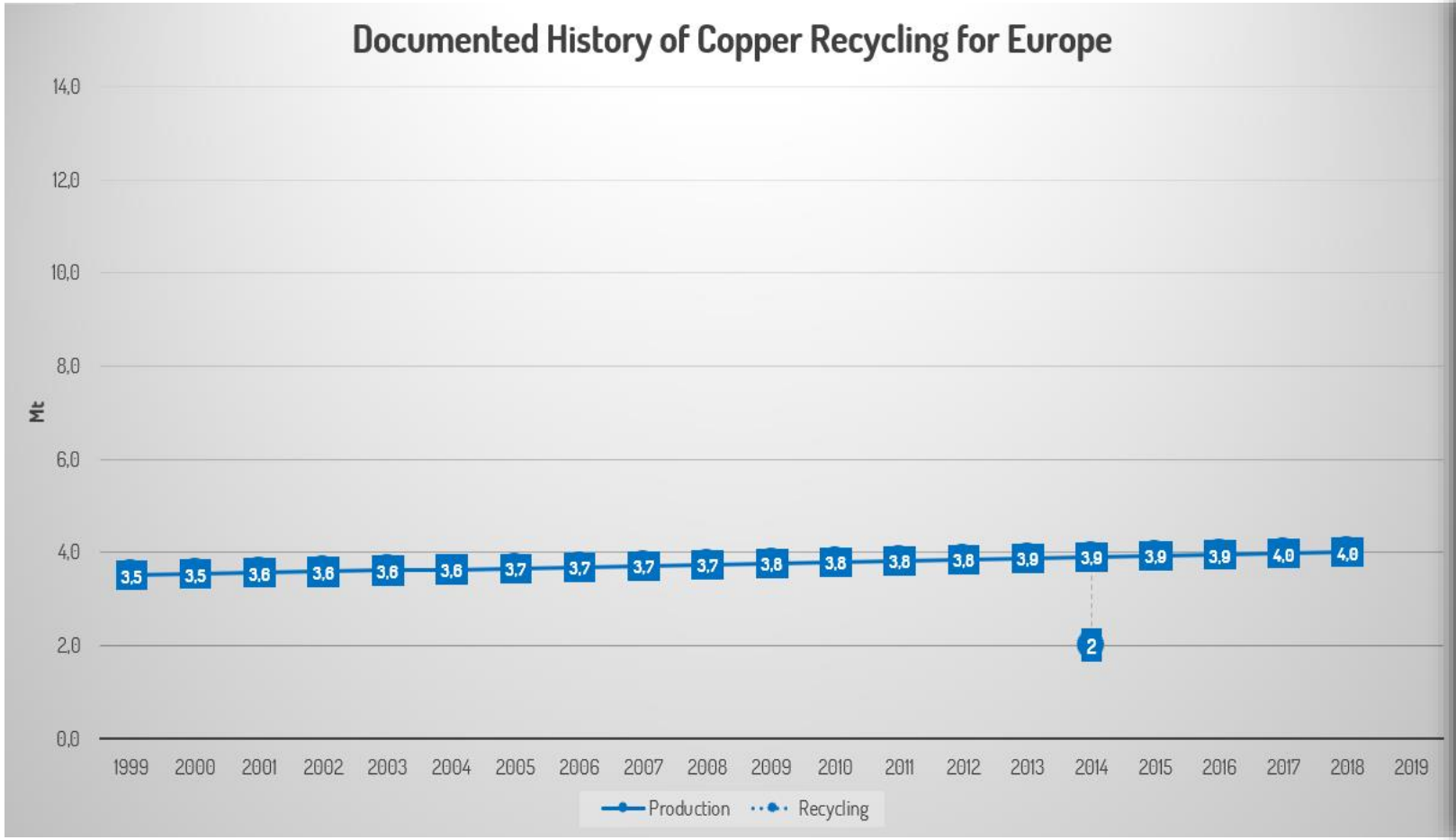
Copper – Market study results



Facts

- Material is no fraction of household waste.
- 4 million tons produced (2014).
- 2 million tons recycled (2014).
- 50% recycling rate.

Sources: European Copper Institute (2018) - International Copper Study Group (2019, pp. 23-24).

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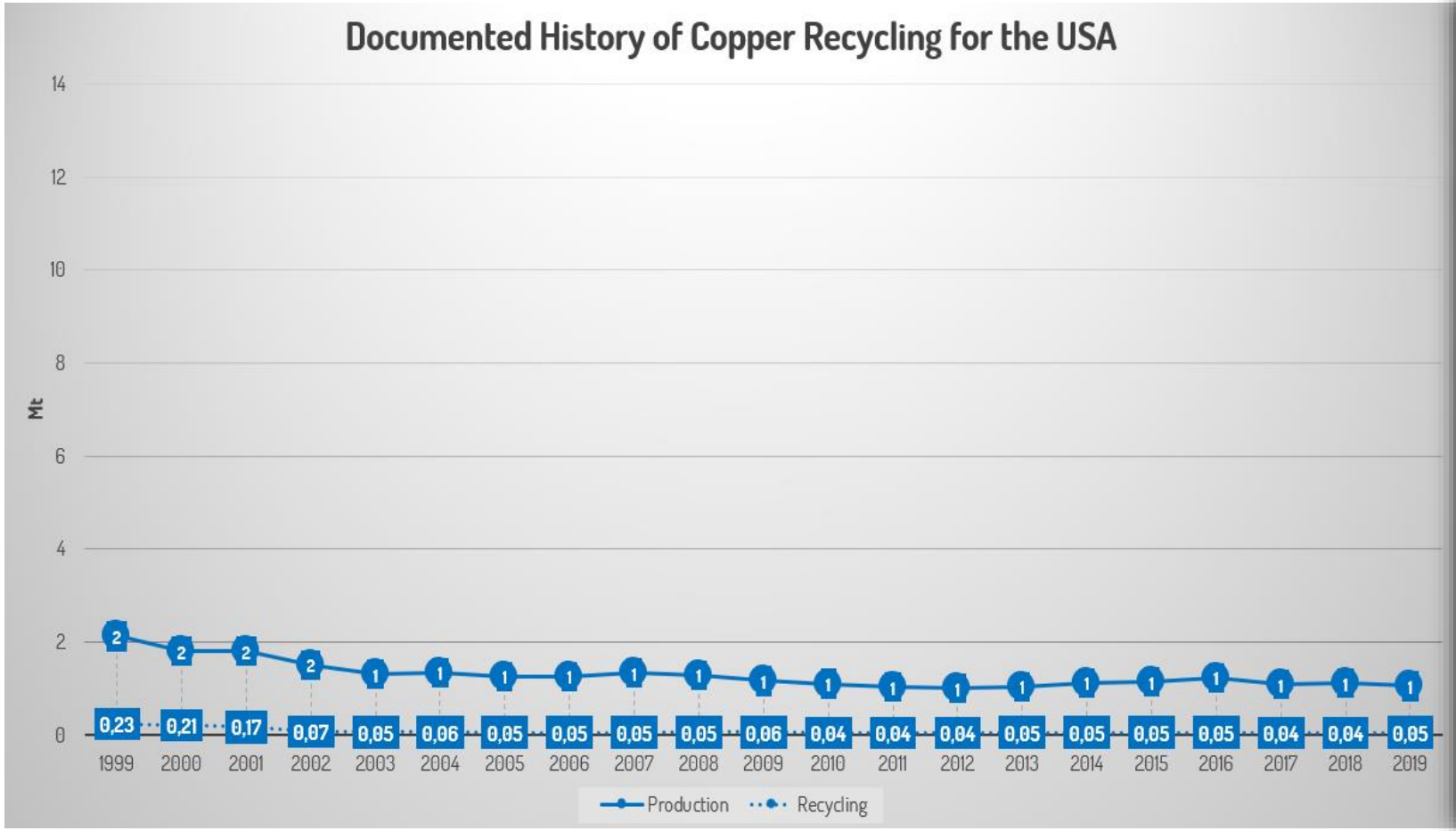
Copper – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole North America.

USA:

- 1 million tons produced (2019).
- 0.05 million tons recycled (2019).
- 5% recycling rate (2019).

Sources: Brininstool (2015, p. 48) - Edelstein (2001, pp. 25-27) - Edelstein (2002, pp. 25-27) - Edelstein (2005, p. 54) - Edelstein (2010, p. 48) - Flanagan (2020, p. 52).

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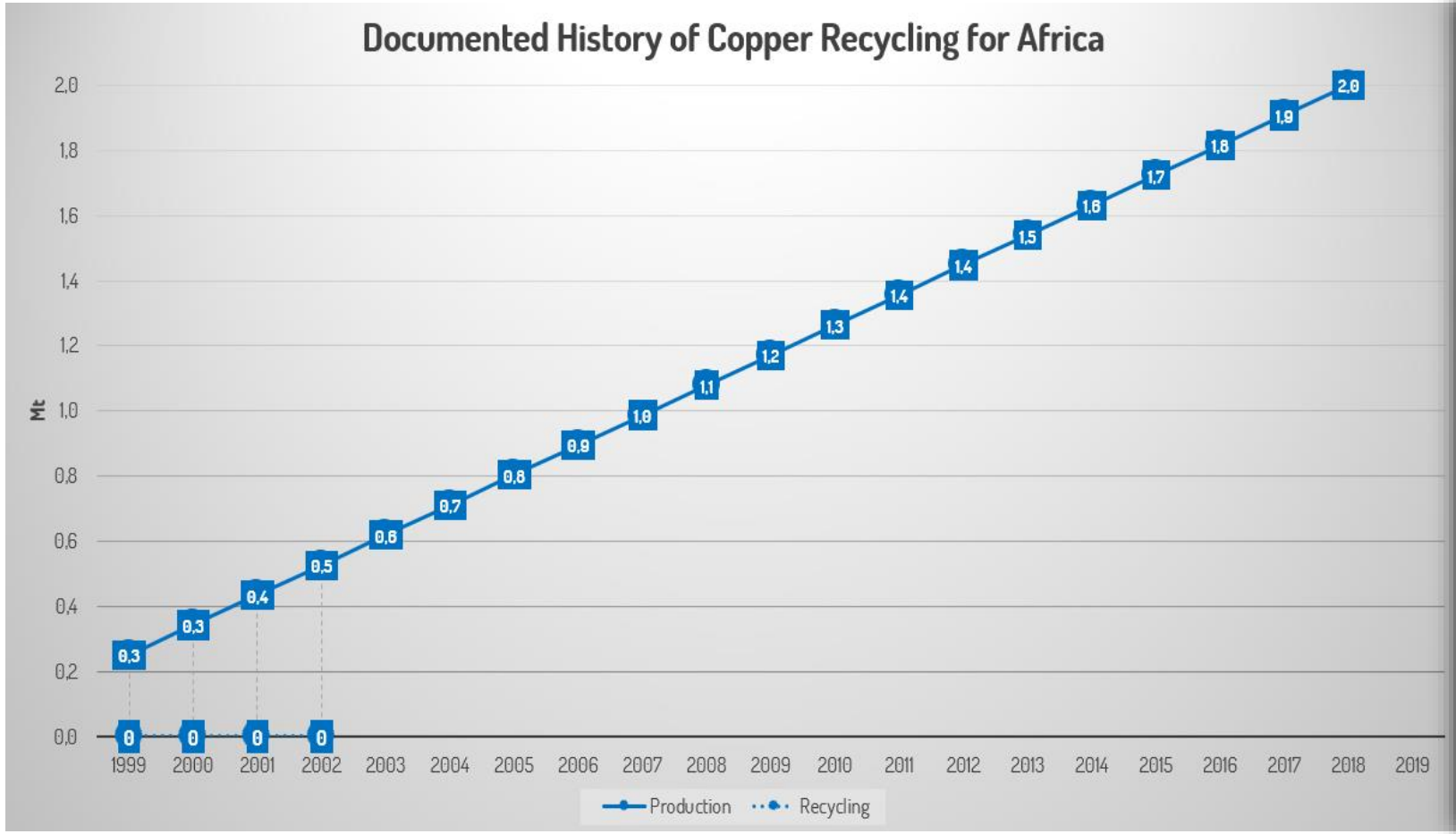
Copper – Market study results



Facts

- Material is no fraction of household waste.
- 2 million tons produced (2018).
- Recycling data could be found for South Africa only.
- Almost 0 million tons recycled in 2002 in South Africa.

Sources: Edelstein (2001, pp. 25-26) - Edelstein (2002, pp. 26-27) - International Copper Study Group (2019, p. 23).

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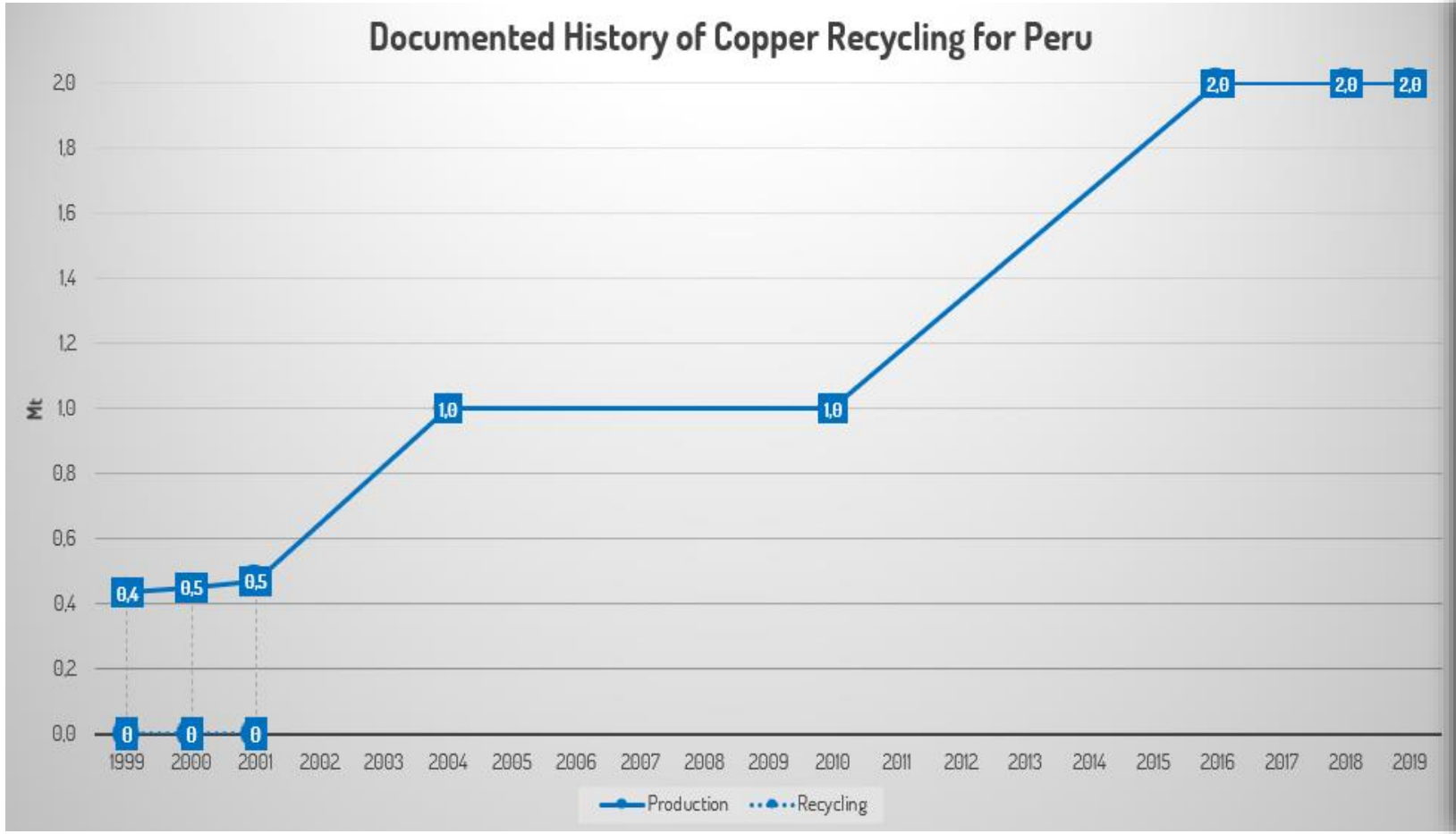
Copper – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole South America.

Peru:

- Almost 0 million tons produced (2001).
- Almost 0 million tons recycled (2001).
- Almost 0% recycling rate (2001).
- In 2013, the second world largest mining project started in Peru leading to higher production capacities.

Sources: Dorner (2020, p. 15) - Edelstein (2001, pp. 25-27) - Edelstein (2002, pp. 25-27) - Goonan (2009, p. X8) - International Copper Study Group (2019, pp. 23-24).

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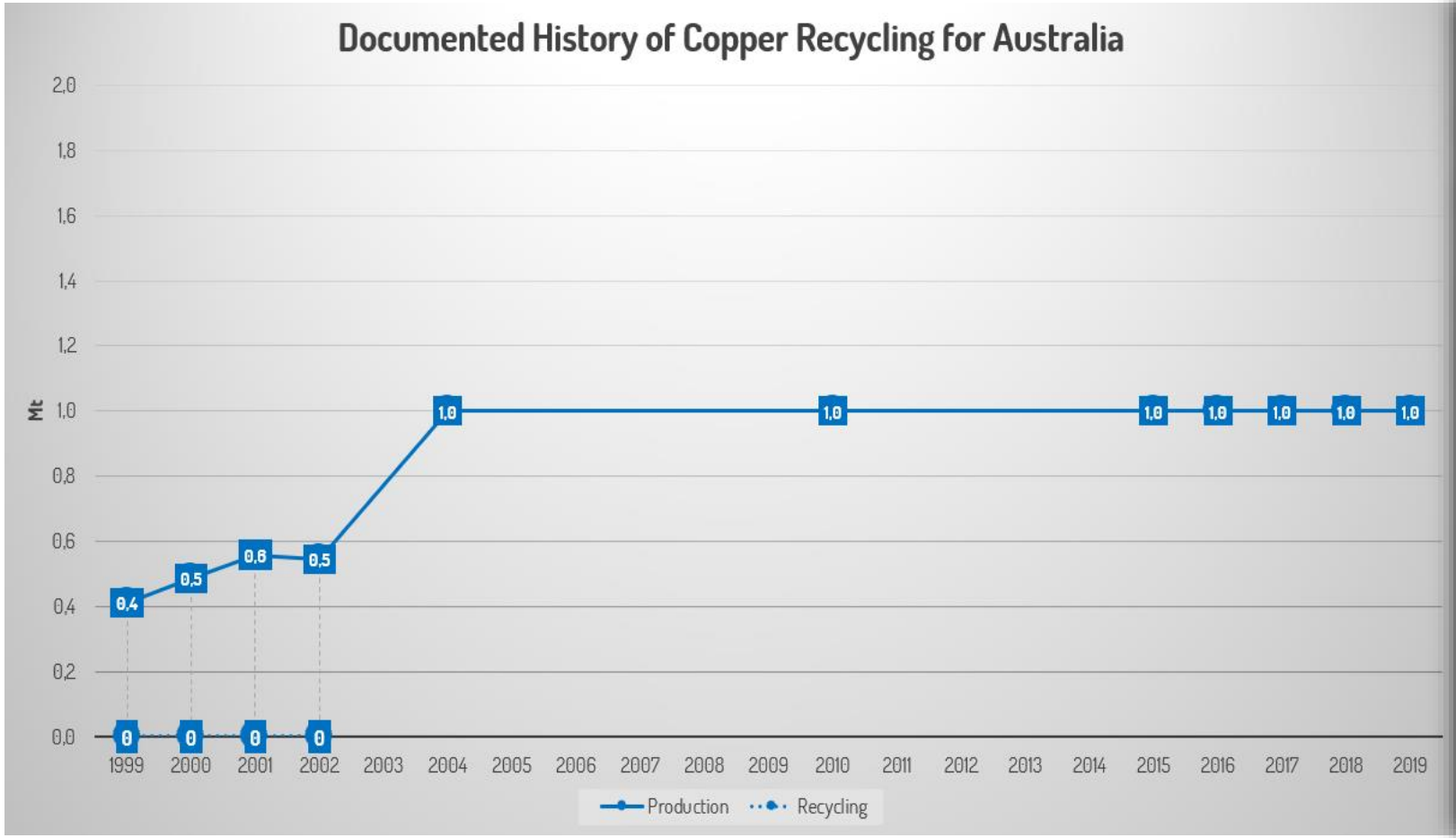
Copper – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Oceania.

Australia:

- 1 million tons produced (2019).
- Almost 0 million tons recycled (2019).
- Almost 0% recycling rate (2019).

Sources: Edelstein (2001, pp. 25-26) - Edelstein (2002, pp. 26-27) - Garside (2020a) - Goonan (2009, p. X8) - International Copper Study Group (2019, p. 23).

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SCORE CARD COPPER

		Global North			Global South		
	WORLD	USA	CHINA / ASIA	EUROPE	AFRICA	AUSTRALIA	PERU / SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

Thinking Circular®
Experts

Copper – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Copper	4 Mt	24 Mt	17%	fair	The electrification is key driver and key problem in copper recycling. Overall CE rating is good due to high market maturity, availability of recycling technology and acceptance of high economic value in most parts of the world.	

Copper is a material that is appreciated for its economic value, its high recyclability and even for its health benefits. Just as glass and paper, copper looks back on a long journey of material history. Archaeological evidence demonstrates that copper was one of the first metals used by humans and was used at least 10,000 years ago for items such as coins and ornaments in western Asia. The discoveries and inventions relating to electricity and magnetism of the late 18th and early 19th centuries and the products manufactured from copper, helped launch the Industrial Revolution. Today, copper continues to serve society's needs. Innovative applications for copper are still being developed as evidenced by the development of the copper chip by the semi-conductors industry. As copper is nowadays part of electronics, recycling is not used to its full potential as it is hard to retrieve.

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TEXTILE

108 million tons produced (2019).

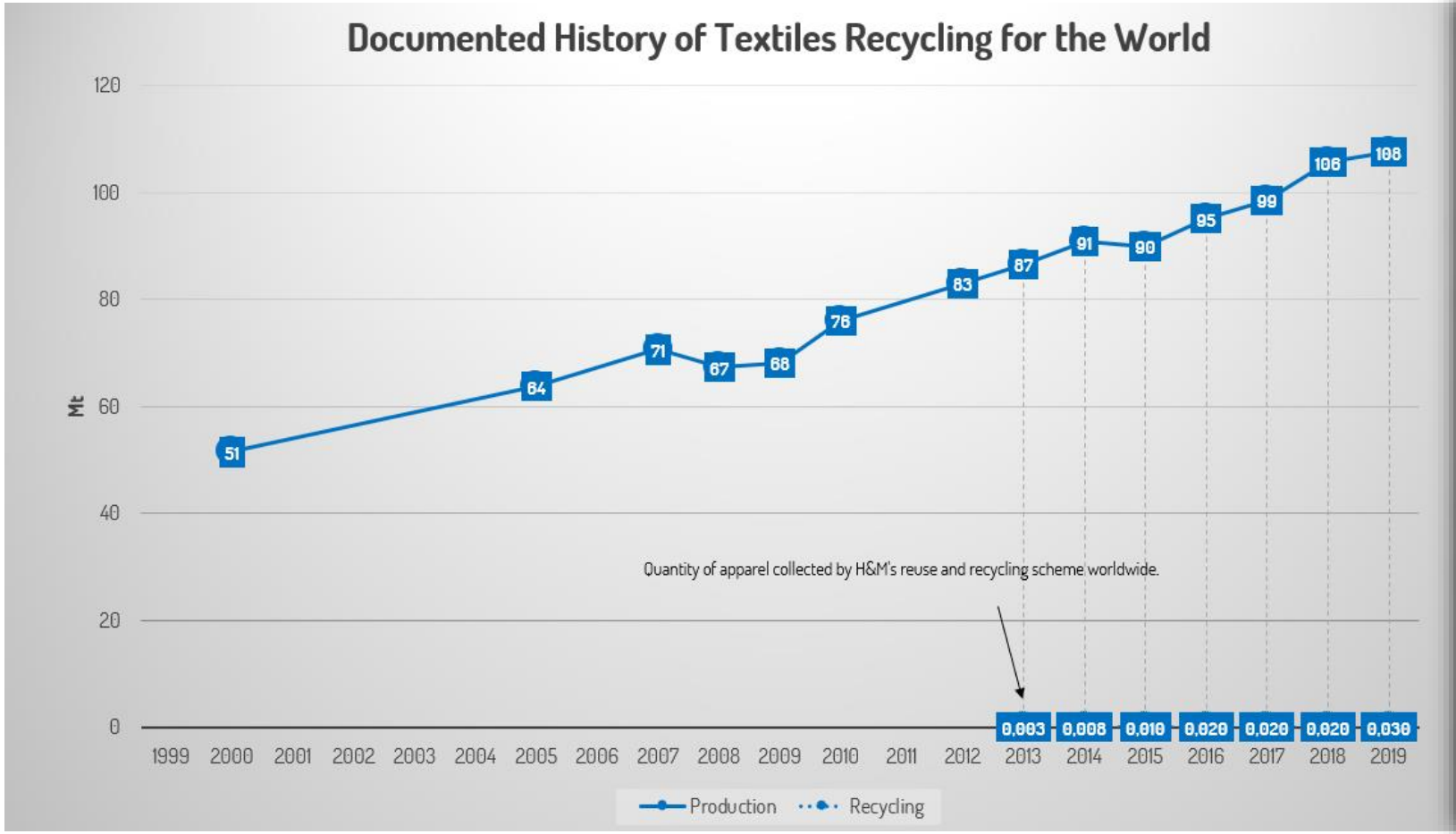
0,03 million tons recycled (2019; only data by H&M).

0,0003% global recycling rate (only data by H&M).

Thinking Circular® Experts

Photo by Ethan Bodnar via Unsplash

Textiles – Market study results



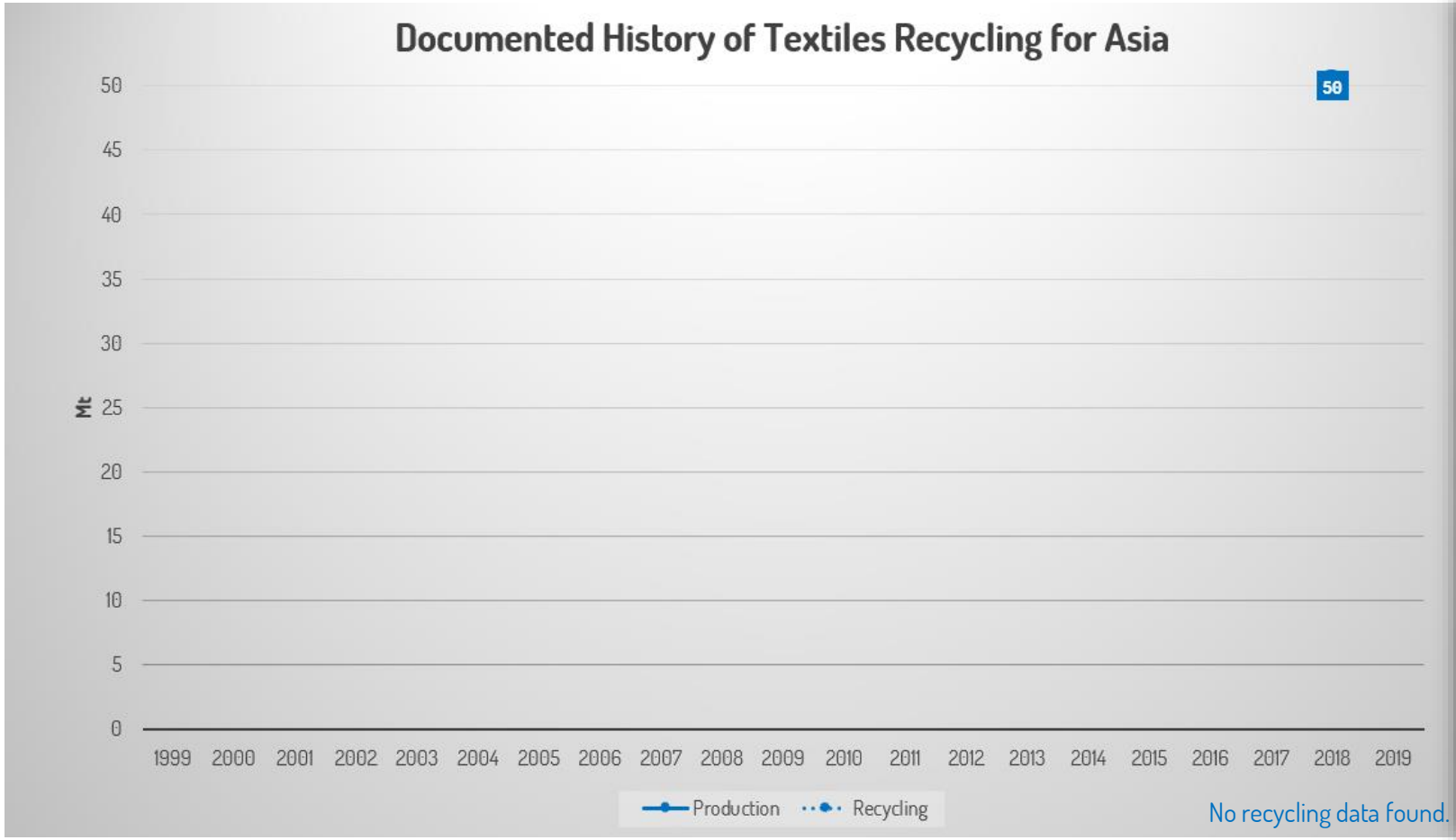
Facts

- Material is no fraction of household waste on a global level, except for a few countries in Global North.
- 108 million tons produced (2019).
- 0,03 million tons recycled (2019; only recycling quantity by H&M which is the only recycling data which could be found for textiles worldwide).
- 0,0003% global recycling rate (only data by H&M).
- Huge data lack! Recycling rate is not significant. Anyhow, statistical basis shows need for improvement.
- Global textile recycling is missing circularity.

Sources: Garside (2020c) – H&M Group (2019b, p. 26) – Shahbandeh (2020).

Thinking Circular® Experts

Textiles – Market study results



No recycling data found.

Facts

- Material is no fraction of household waste.
- No data available for whole Asia.

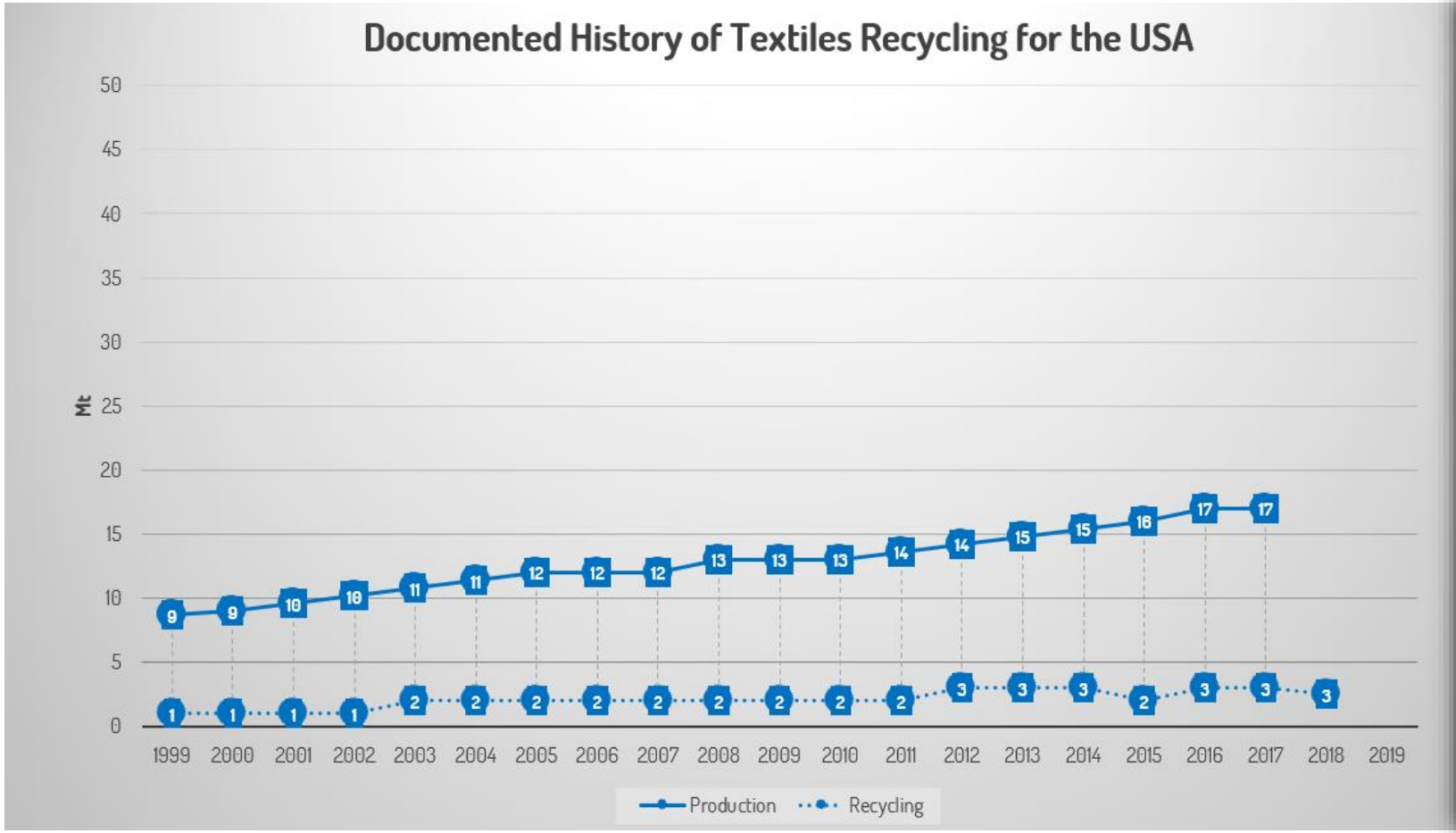
China:

- 50 million tons produced (2018; only chemical textiles).
- No data available for recycling.
- Asia is the main hub for the textile industry.
- Changing consumption patterns lead to growth.
- China is major exporter followed by India and Bangladesh.
- China controls about 40% of the global textile markets.
- Cheap labor is the main reason for the growth in Asian countries.

Sources: Textileworld.com (2019).

Thinking Circular® Experts

Textiles – Market study results



Facts

- Material is fraction of household waste.
- No data available for whole North America.

USA:

- 17 million tons produced (2017).
- 3 million tons recycled (2017).
- 18% recycling rate (2017).
- "It is well established that recycling is economically beneficial, yet much of the discarded clothing and textile waste in the USA fails to reach the recycling pipeline." [Hawley (2004), p. 3]

Sources: United States Environmental Protection Agency (2016, p. 8) - United States Environmental Protection Agency (2019, pp. 1-2) - United States Environmental Protection Agency (2020a, pp. 1-2).

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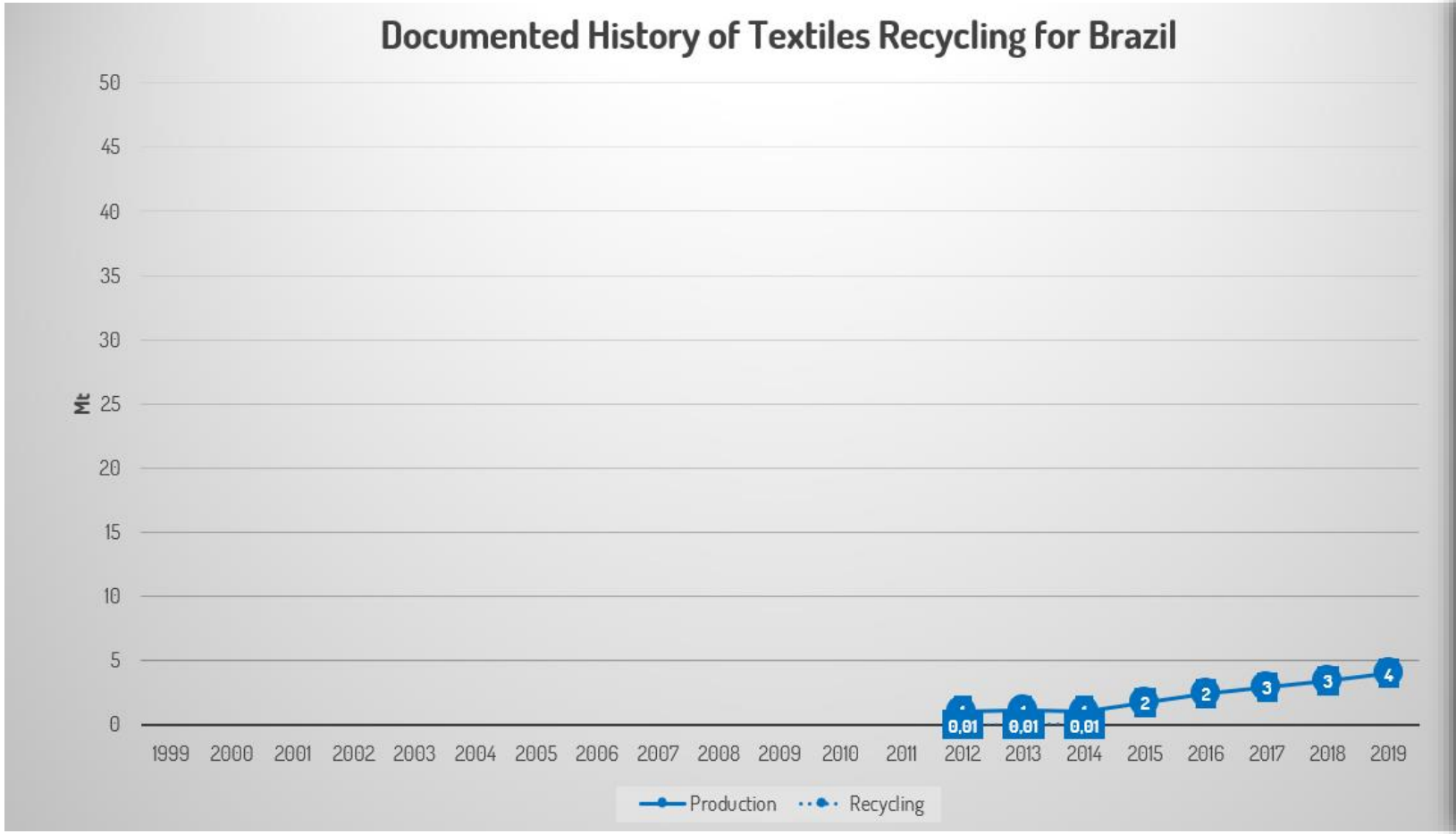
Textiles – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole South America.

Brazil:

- 1 million tons produced (2014)
- 9,000 tons recycled (2014).
- 1% recycling rate (2014).
- Brazil is the third largest cotton exporter.
- Brazil prefers to import rather than to use national textile waste because of dirt, mixture of raw materials, high labor and transportation costs, lack of fiscal and tax incentives.
- The potential is disregarded due to the lack of studies on the possibilities of recycling.

Sources: Do Amaral et. al (2018, p. 2, p. 4, p. 6, pp. 8-9) - Wright (2020).

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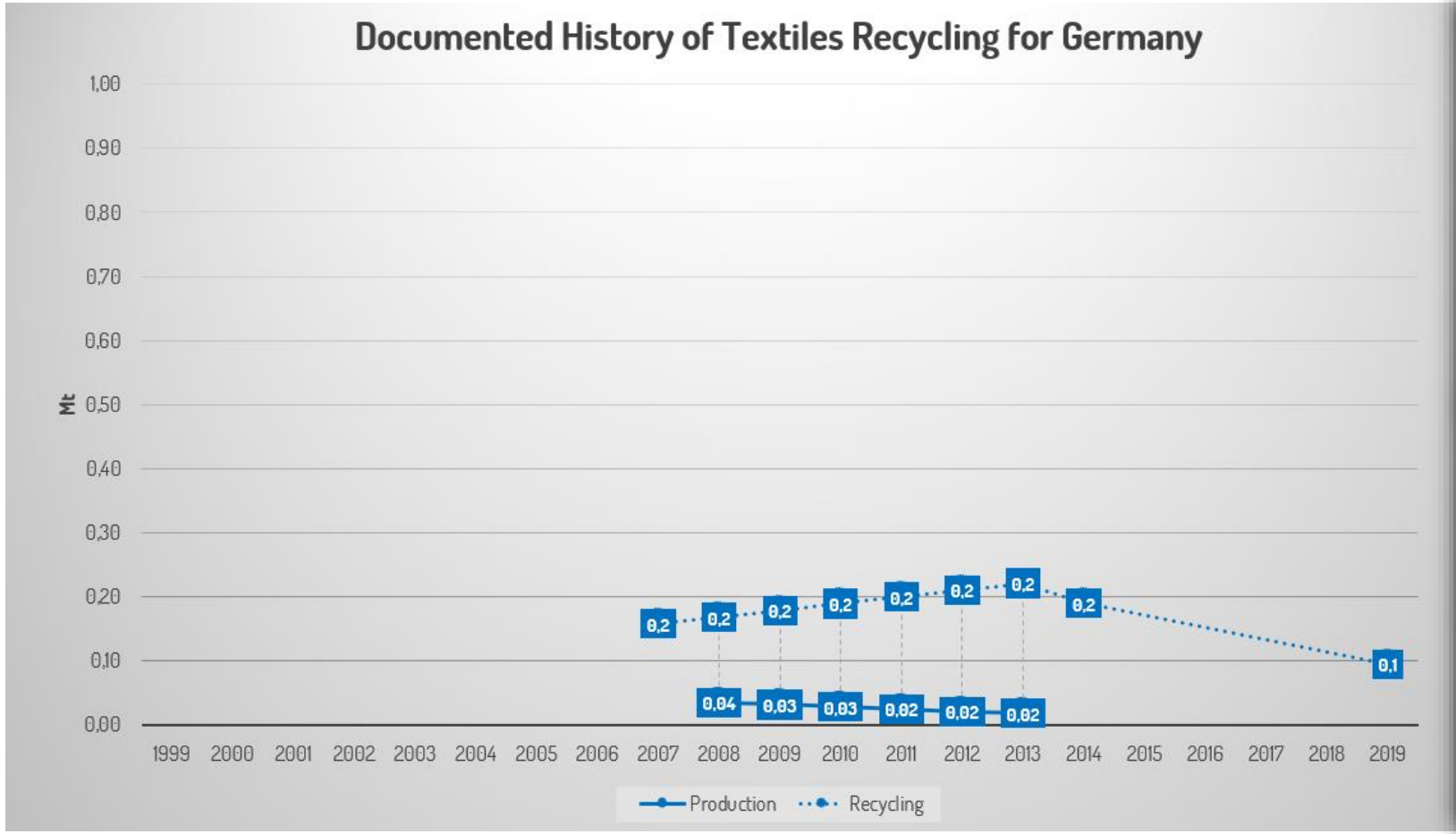
Textiles – Market study results



Facts

- Material is fraction of household waste in some parts of EU.
- No data available for whole Europe.
- Textile recycling differs from country to country.
- Sweden has not even one recycling plant for textile recycling.

Germany:

- 18,000 tons produced (2013).
- 221,000 tons recycled (2013).
- 100% recycling rate.
- There is no noteworthy production in Germany. Anyhow, large quantities get recycled. The BVSE is researching on how textiles get into Germany.

Sources: Bundesverband Sekundärrohstoffe und Entsorgung e.V., Fachverband Textilrecycling (2015, p. 1, p. 20, p. 23, p. 32) - Fairwertung.de (2016).

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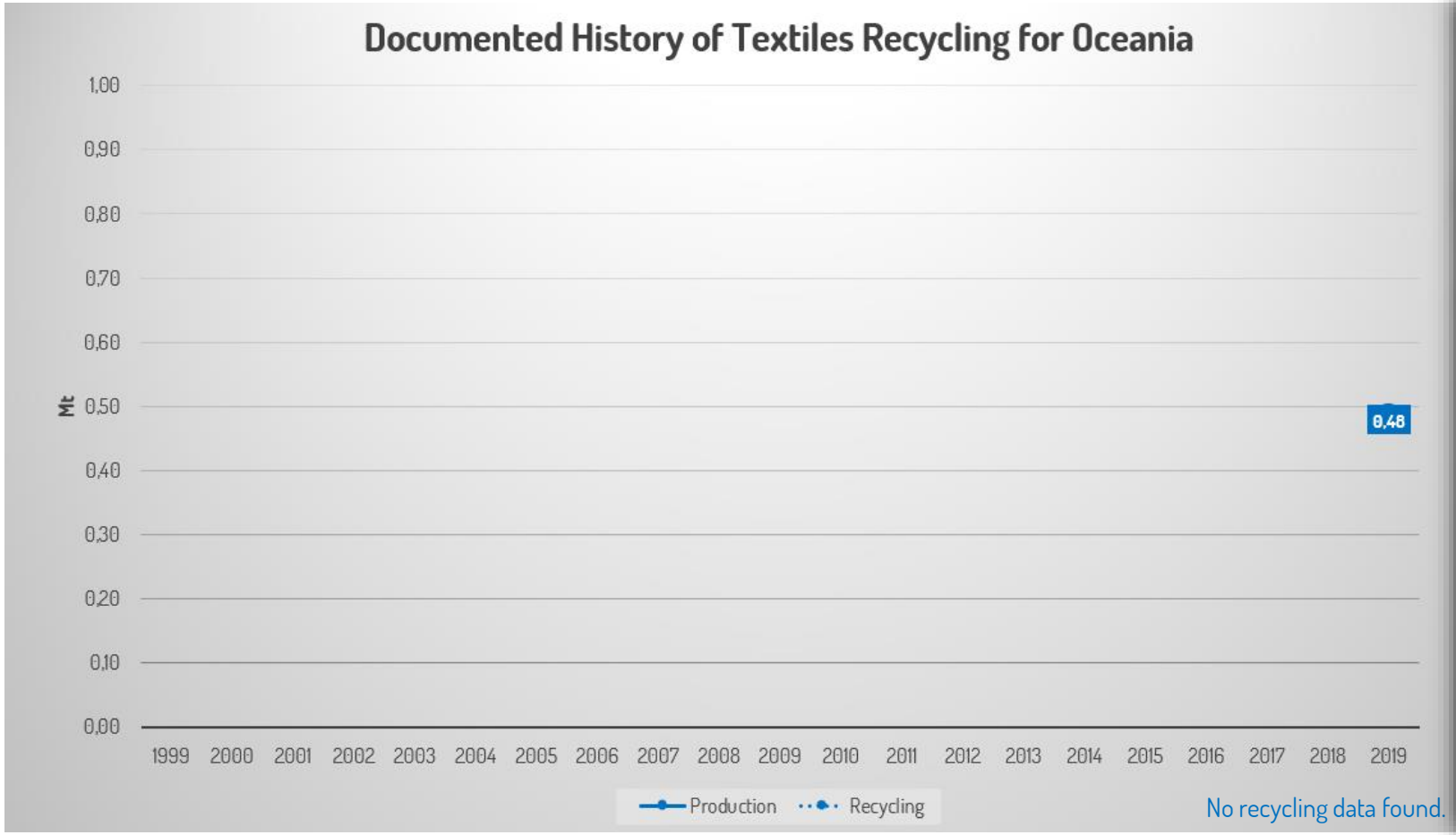
Textiles – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Oceania.

Australia:

- 479,000 tons produced (2019; only cotton).
- No data available for recycling.

Sources: Wright (2020).

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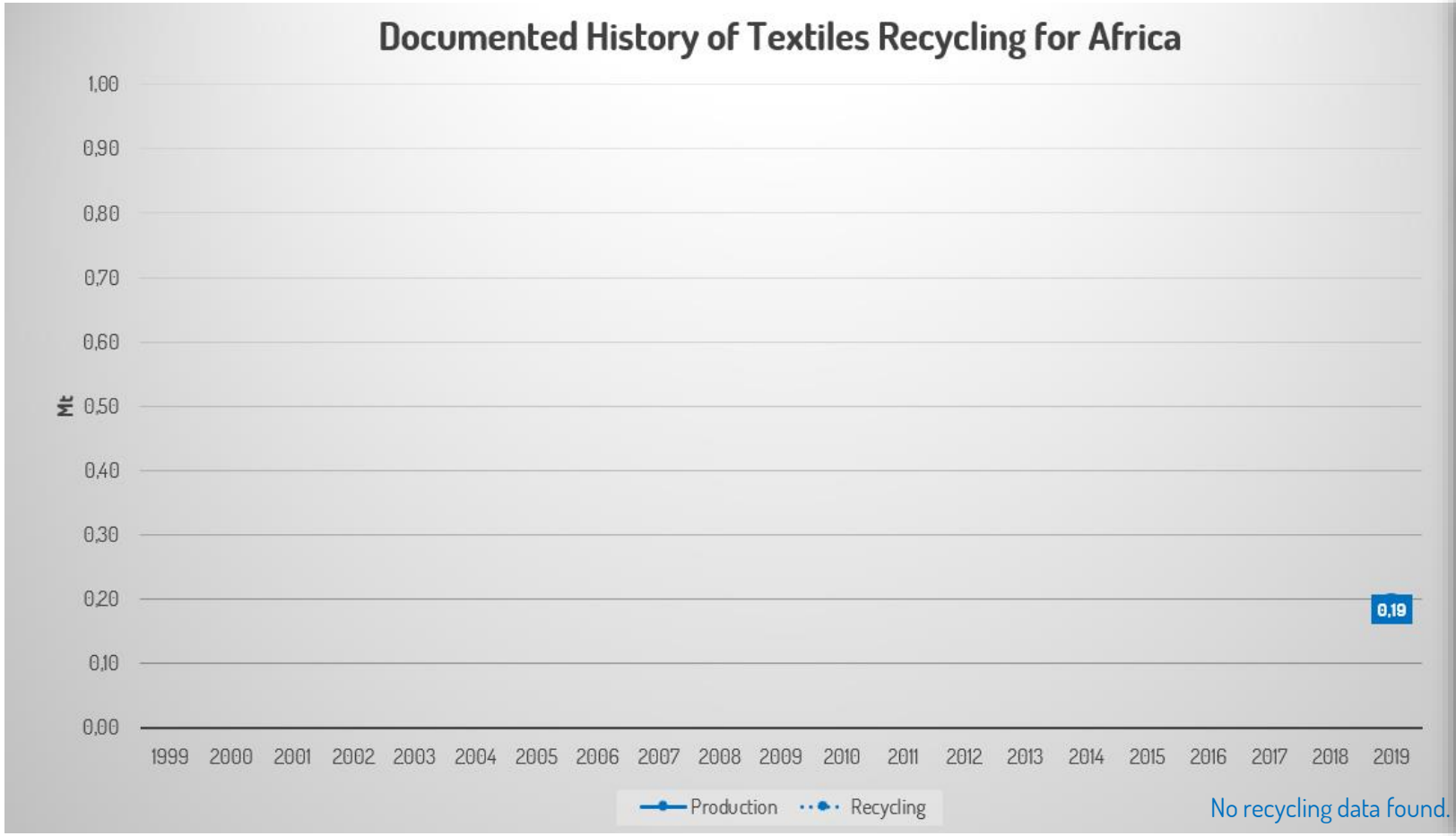
Textiles – Market study results



No recycling data found.

Facts

- Material is no fraction of household waste.
- No data available for Africa.

Burkina Faso:

- 185,000 tons produced (2019; only cotton)
- No data available for recycling.

Sources: Wright (2020).

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SCORE CARD TEXTILES

		Global North			Global South		
	WORLD	USA	CHINA / ASIA	GERMANY / EUROPE	AFRICA	AUSTRALIA / OCEANIA	BRAZIL / SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Textiles – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Textiles	21 Mt	99 Mt	21%	bad	Fast fashion growth and recycling worse than expected. The charity-driven character of collection systems in the Global North is driving the topic, which has been neglected since clothes are status symbol and have a deep cultural meaning. The Global South as poorer part in the world has established second-hand markets. The figures by H&M have not been solicited scientifically.	

Textiles are summarized in a material group that is highly undervalued and underdeveloped. Except for the USA, there is no worldwide interest in the collection and recycling of textiles. Textile collection happens on a voluntary basis. There is a lack in regulation and moreover, virgin production is cheaper than recycling.

Globally fashion symbolizes status. Secondhand textiles are still identified with a low social level.

COBALT

117,000 tons produced (2017).

15,000 tons recycled (2017).

13% global recycling rate.

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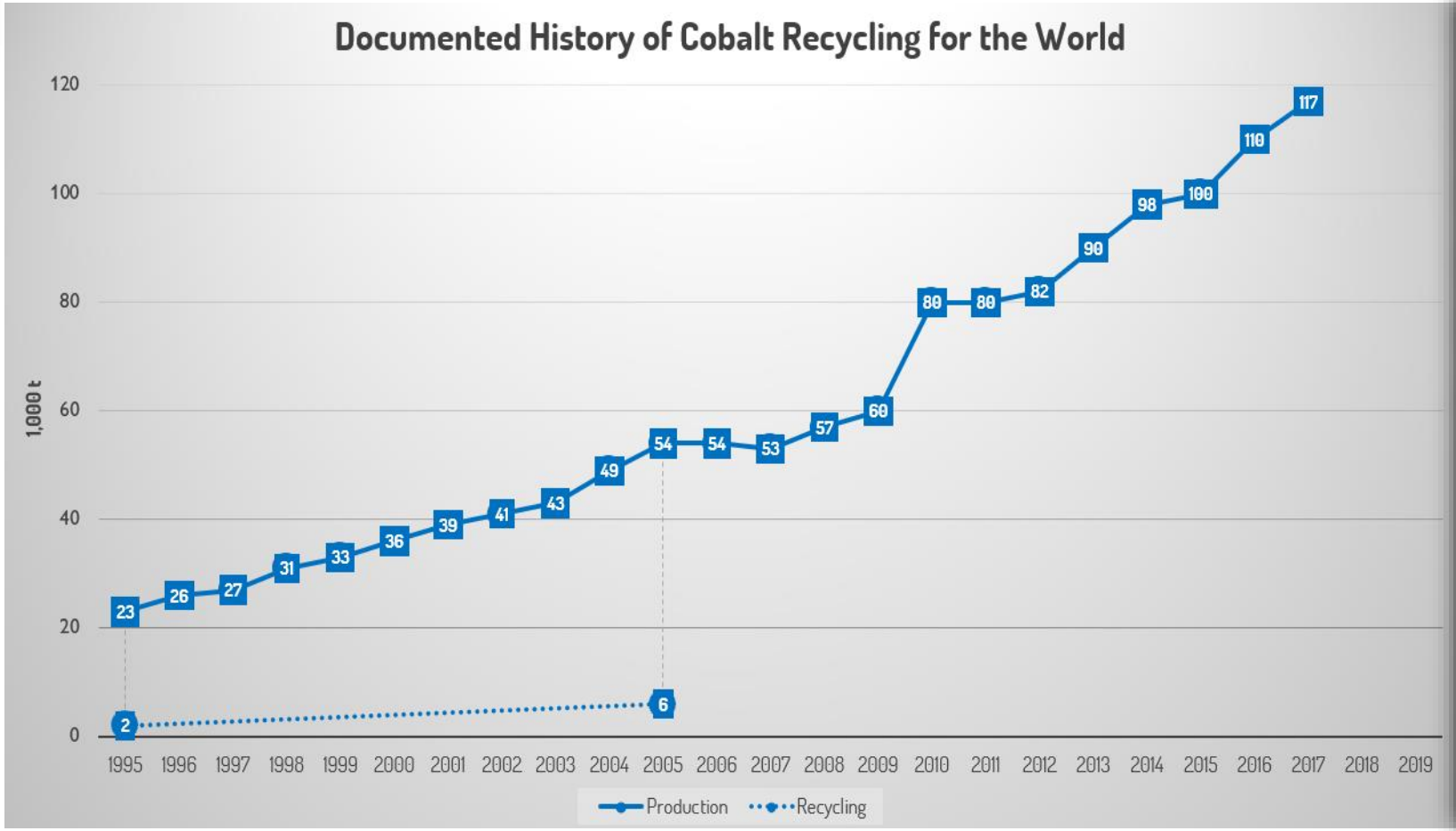
Photo by Alberto Sorin from Unsplash.

Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- 117,000 tons produced (2017).
- 15,000 tons recycled (2017).
- 13% global recycling rate (2017).
- Cobalt markets are globally existing.
- Demand for cobalt is strong.

Sources: Al Barazi et. al (2018, p. 45, p. 53, p. 59) – Barry et. al (2013, Table 17) – Sun et. al (2019, p. 48).

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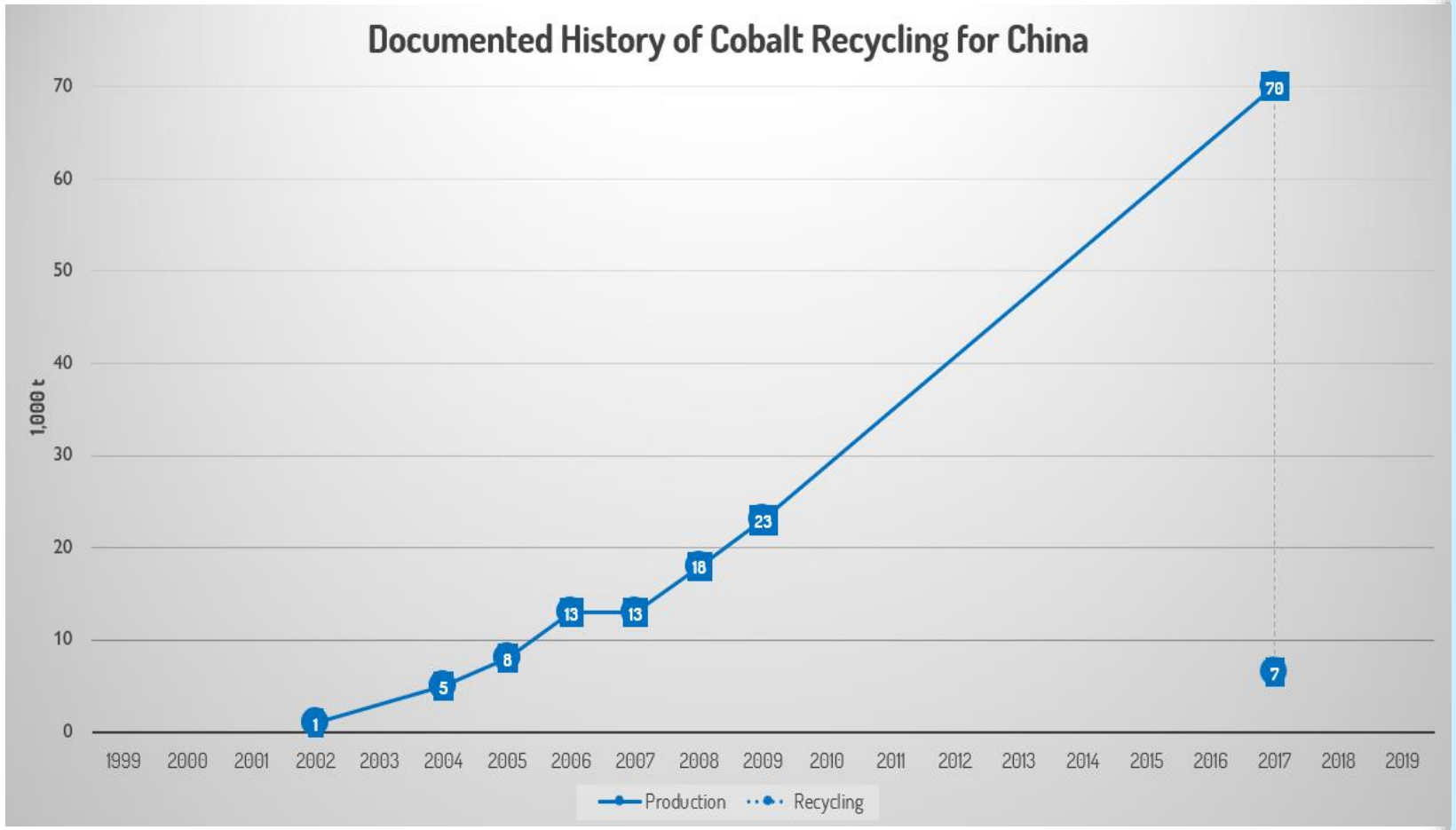
Cobalt – Market study results



Facts

- No data available for whole Asia.
- Material is no fraction of household waste.

China:

- 70,000 tons produced (2017).
- 6,500 tons recycled (2017).
- 9% recycling rate (2017).
- China has the highest recycling capacity in the world with over 36,000 tons per year.

Sources: Al Barazi et. al (2018, p. 45, p. 50, p. 53, p. 55) – Barry et. al (2013, Table 17).

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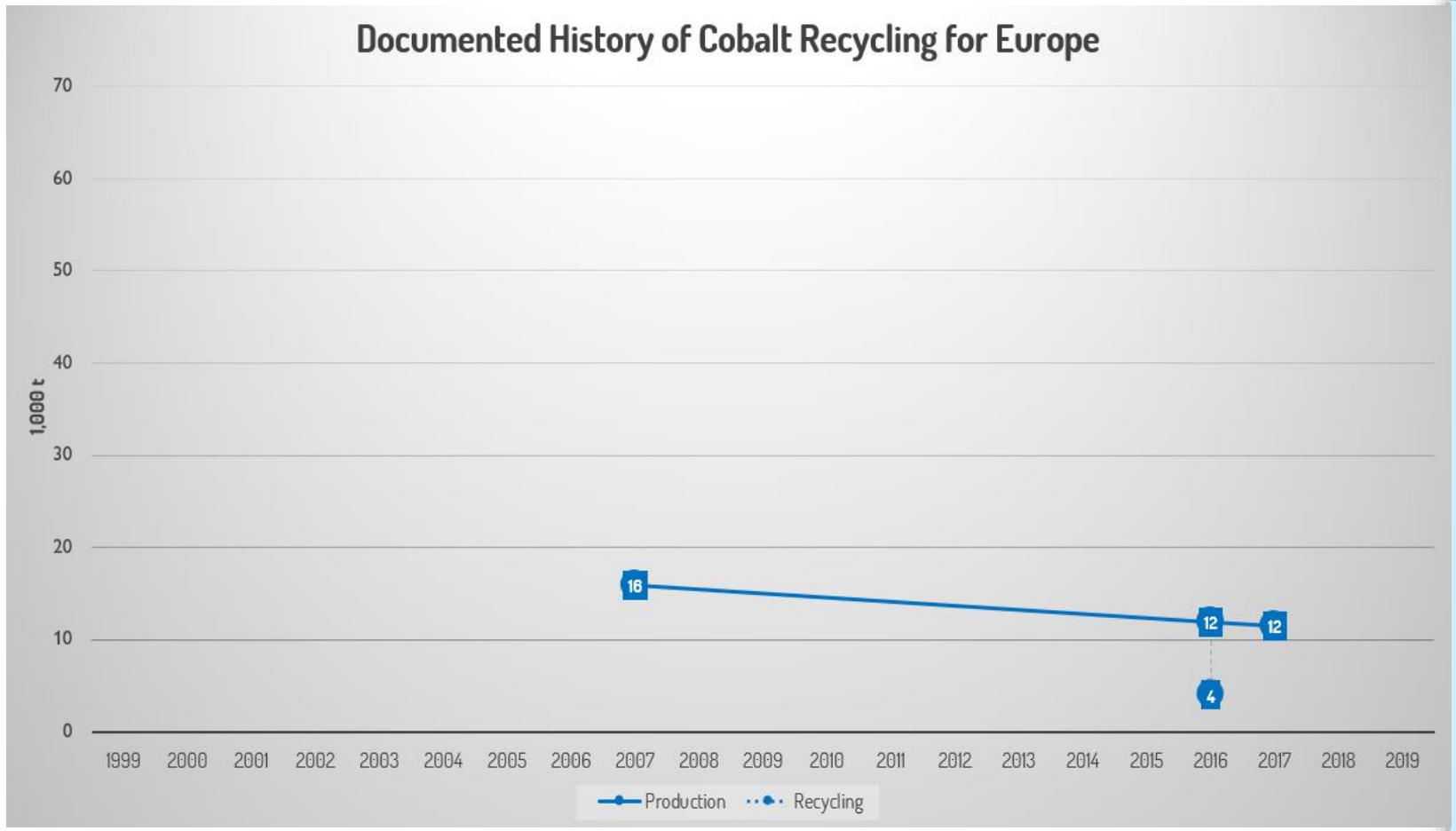
Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- 12,000 tons produced (2016).
- 4,025 tons recycled (2016).
- 34% recycling rate (2016).
- Technology is available through Umicore in Belgium.
- Recycling rates in Belgium are 100%.
- France has the second highest recycling capacity worldwide with 20,460 tons per year.

Sources: Al Barazi et. al (2018, p. 45, p. 50, p. 53, p. 55) - BIO by Deloitte (2015, p. 108).

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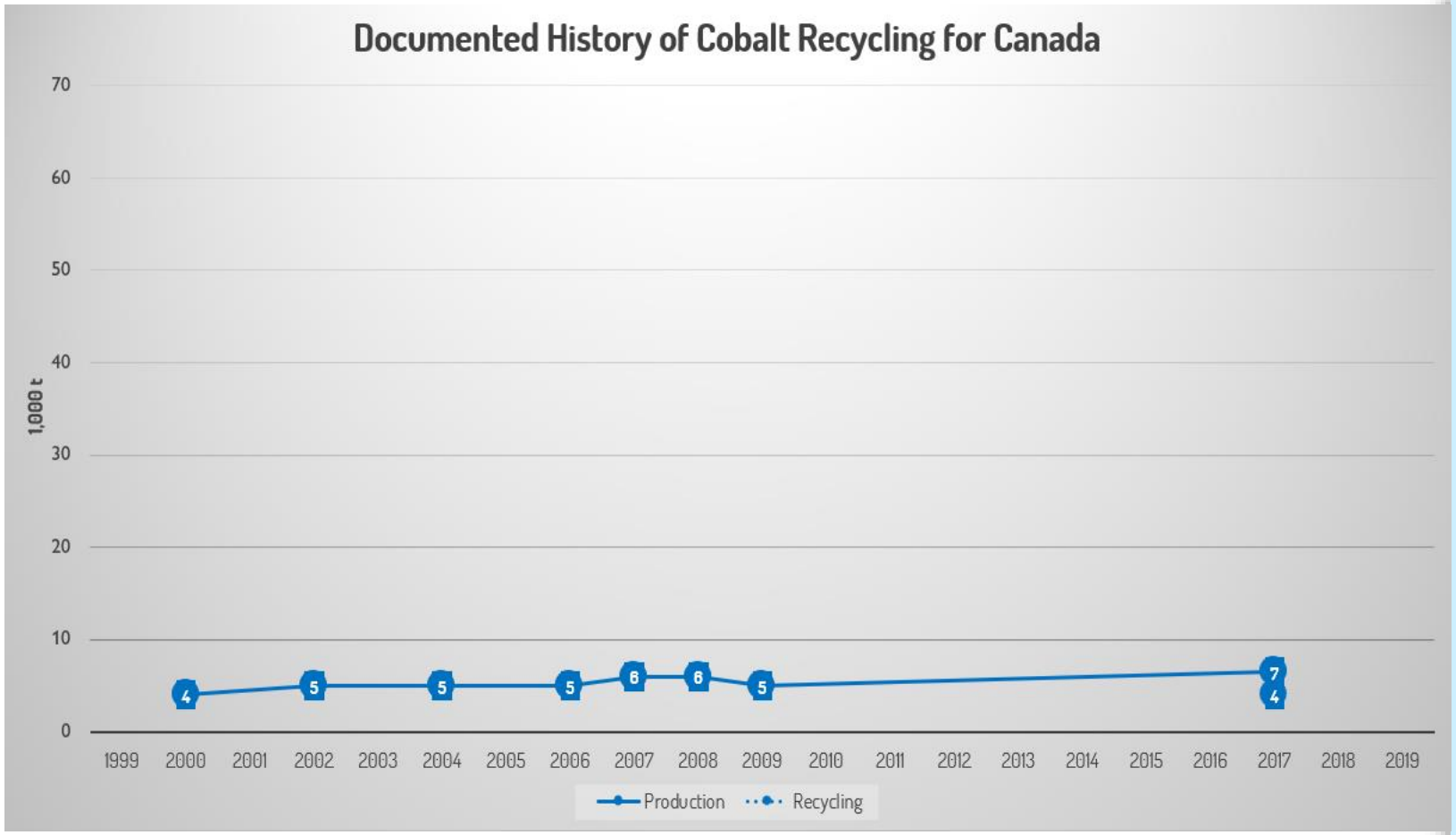
Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole North America.
- Only one recycling company in the USA

Canada:

- 6,500 tons produced (2017).
- 4,000 tons recycling capacity (2018).
- Two recycling companies in Canada.

Sources: Al Barazi et. al (2018, p. 45, p. 50, p. 53, p. 55) - Barry et. al (2013, Table 17).

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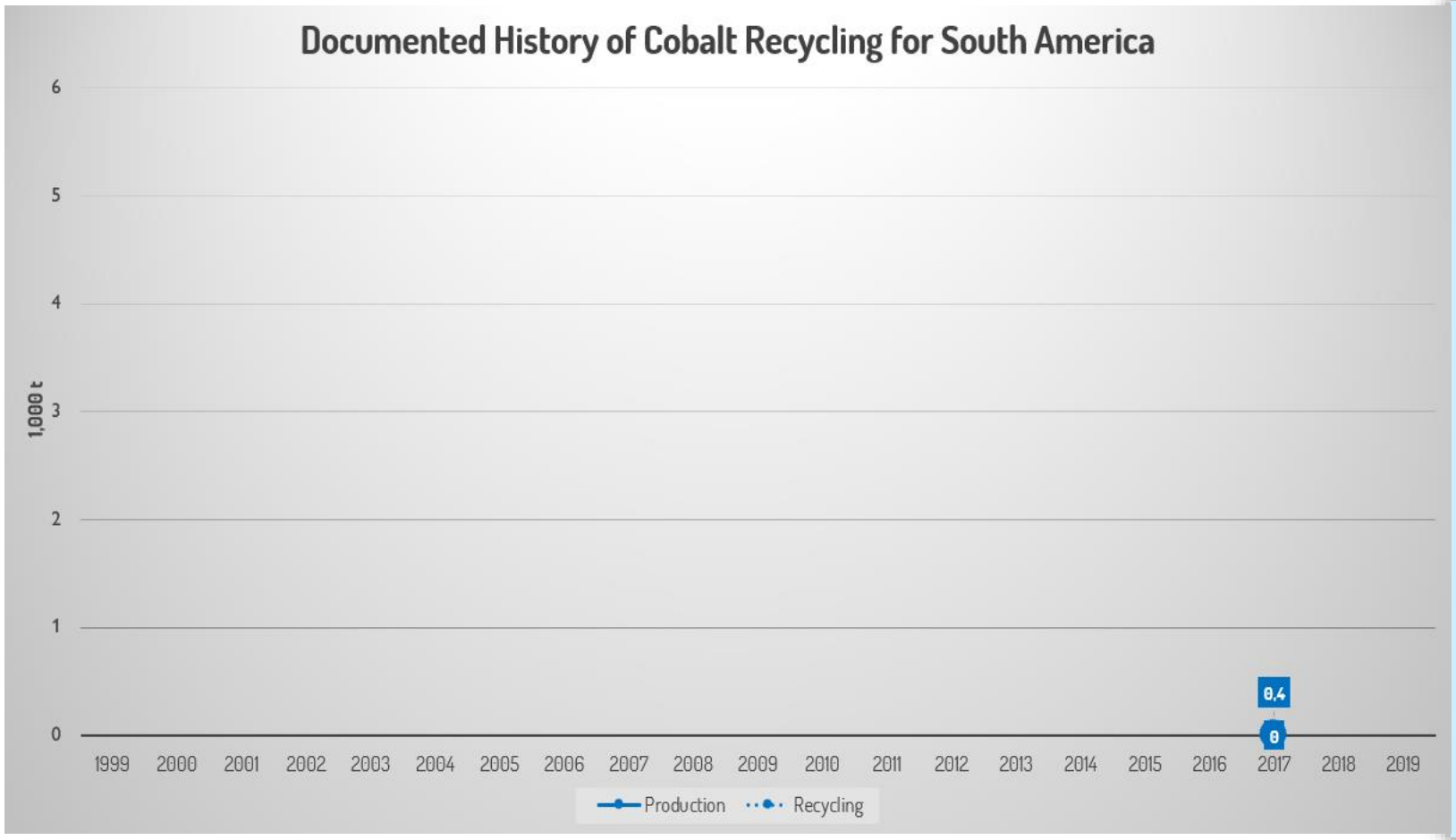
Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- Below 420 tons produced (2017).
- 0 tons recycled (2018).
- No recycling companies.

Sources: Al Barazi et. al (2018, p. 45, p. 50, p. 53, p. 55).

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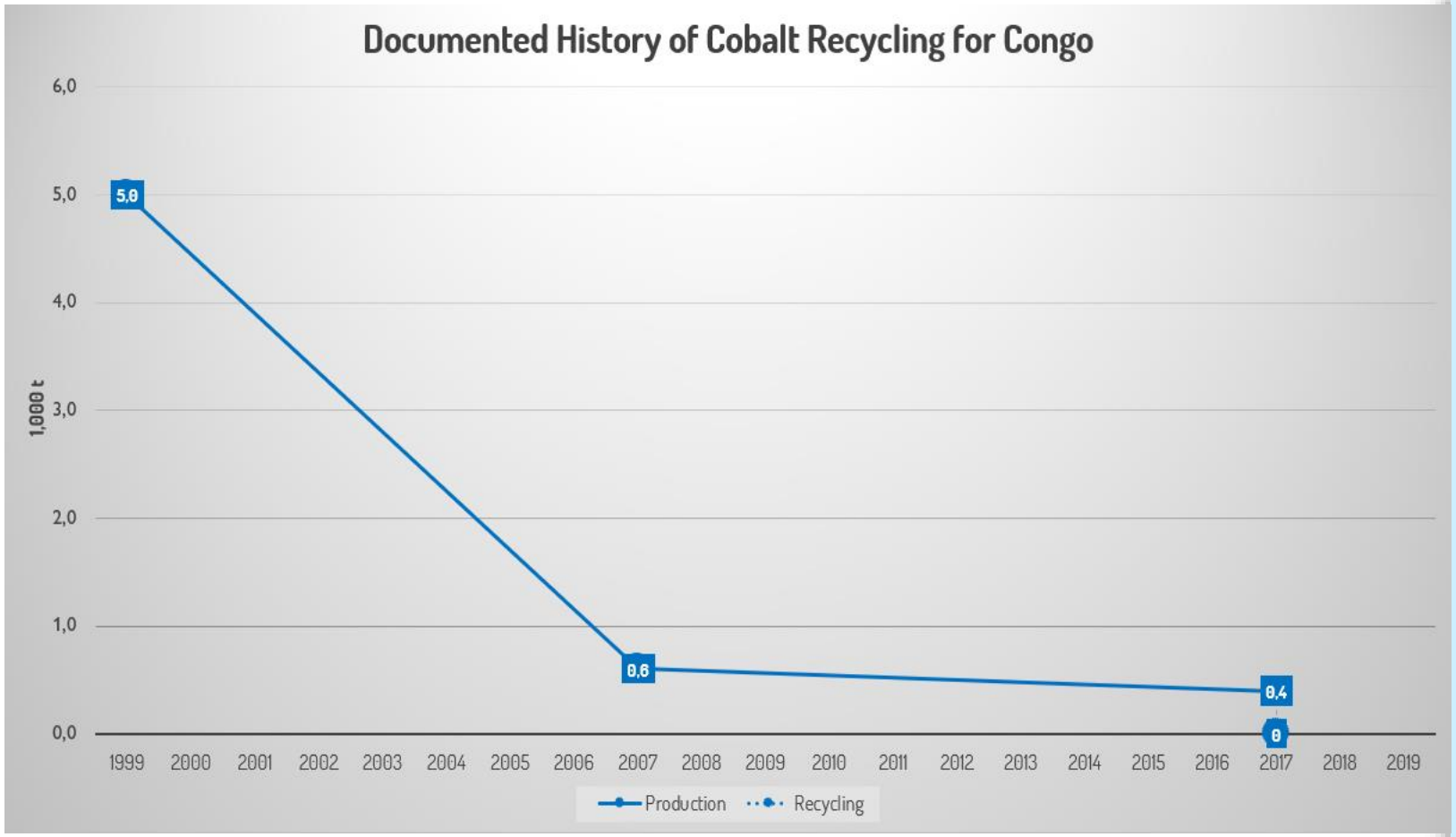
Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Africa.

Congo:

- 400 tons produced (2017).
- Almost 0 tons recycled (2017).
- Almost 0% recycling rate.
- Congo is suffering from imperialistic structures, leading to civil war and violation of human rights.

Sources: Al Barazi (2018, p. 45, p. 55) - Barry et. al (2013, Table 17).

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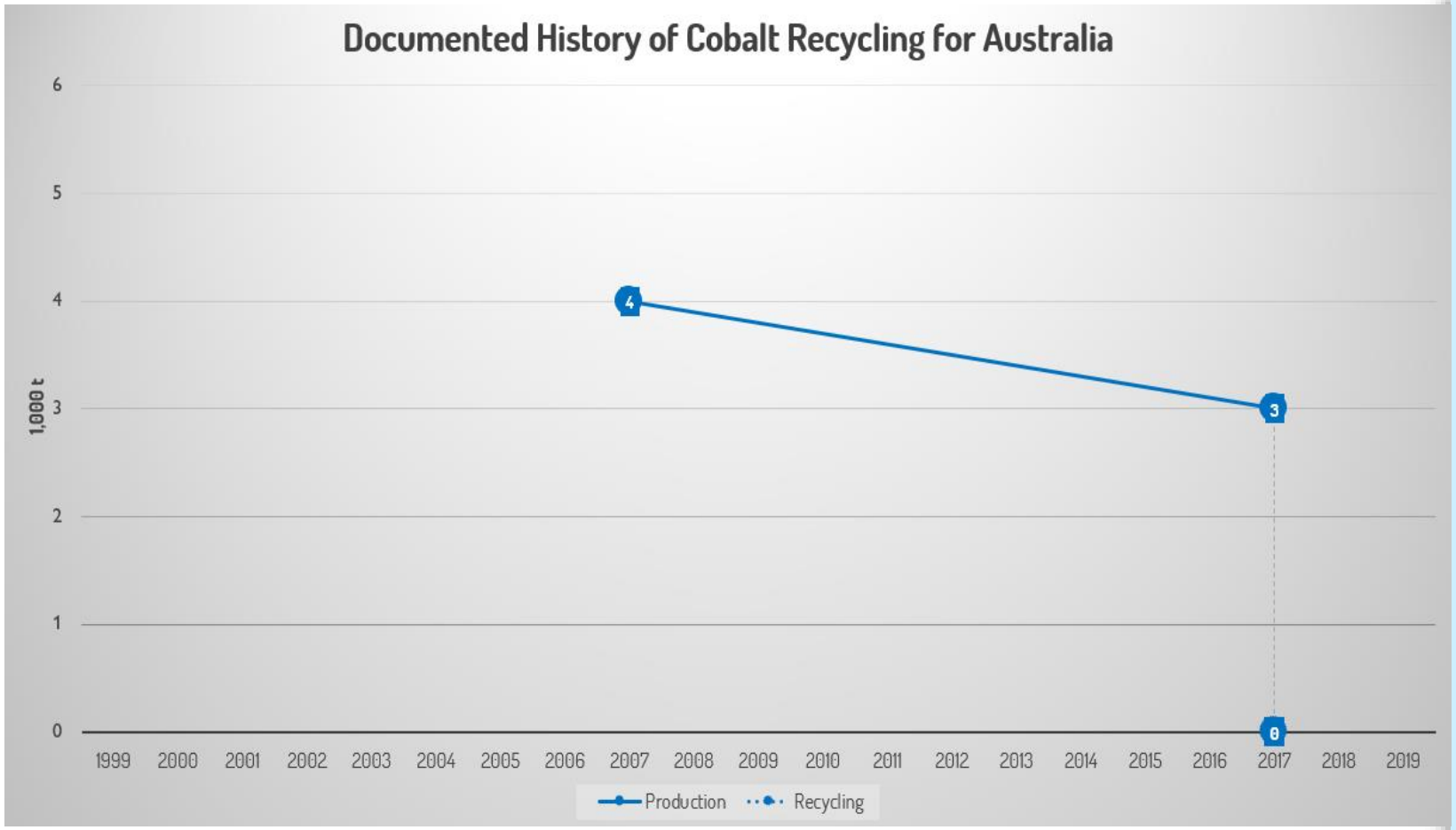
Cobalt – Market study results



Facts

- Material is no fraction of household waste.
- No data available for whole Oceania.

Australia:

- 3.000 tons produced (2017).
- 0 tons recycled (2018).
- 0% recycling rate.
- No recycling companies.

Sources: Al Barazi (2018, p. 45, p. 55).

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SCORE CARD COBALT

		Global North			Global South		
	WORLD	CANADA / NORTH AMERICA	CHINA	EUROPE	AFRICA	AUSTRALIA	SOUTH AMERICA
Maturity of market							
Design 4 CE Legislation							
Recycling Technologies							
Acceptance CE							

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Cobalt – Summary

Material	Recycling in million tons (Mt)	Production in Mt	Recycling Rate in %	Reliability of data	Major challenges for circularity in the field	CE Rating
Cobalt	0,015 Mt	0,117 Mt	13%	fair	No cobalt stocks available. Handling of small amounts. Resource scarcity.	

Just as copper, cobalt is a systemically relevant material today. Its recycling is of economic value. The material is especially important for the e-mobility industry and the renewable energy sector.

As e-mobility becomes more widespread, recycling and reuse will be important to the future raw material cycle of cobalt. Technologies for recycling are already available.

Cobalt is recovered through the recycling of lithium-ion batteries. Anyhow, data gaps prevent to find out details on how much cobalt is actually recycled in regions worldwide.

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About Thinking Circular®

About the multiverse of Thinking Circular

At Thinking Circular, we're creating a multiverse for green progress by helping green innovation to prosper. We use the concept of a circular economy and the Cradle-to-Cradle (C2C) design principle to support business, science and politics on the path to a more sustainable society. Consultancy, networking, partners, political positioning, events, expert advice, influencers, speakers – Thinking Circular offers all of this and much more. This is where ideas for securing the future are forged: We develop green innovations and make them a reality.

What we mean by circular economy

The more consciously and harmoniously we interact with nature, the less waste will be produced. Waste as a product of excess and unfair distribution is attributable to the mismanagement of our economic systems. As long as we fail to produce and consume goods in such a way that they are compatible with and cause no harm to humans and the natural environment, we will need to use green technologies to compensate for the flaws in our system. Treating and decontaminating our air, water and soil will remain a necessity until the green transformation is brought to a successful conclusion.

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