

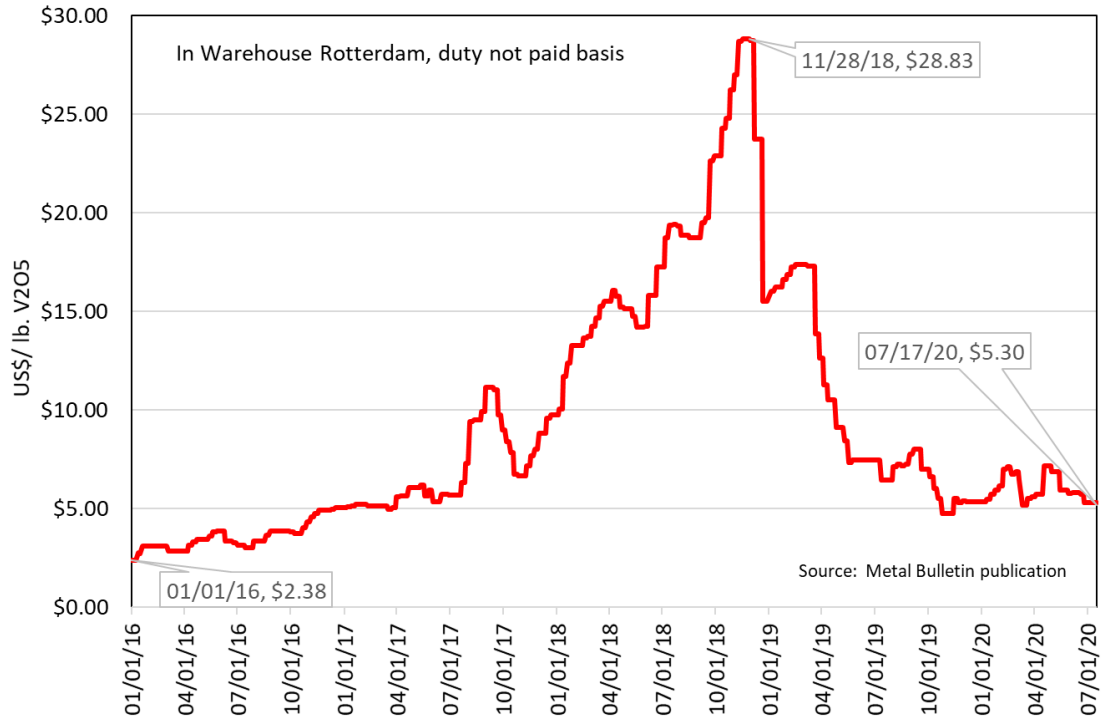
Vanadium Market

July 30, 2020

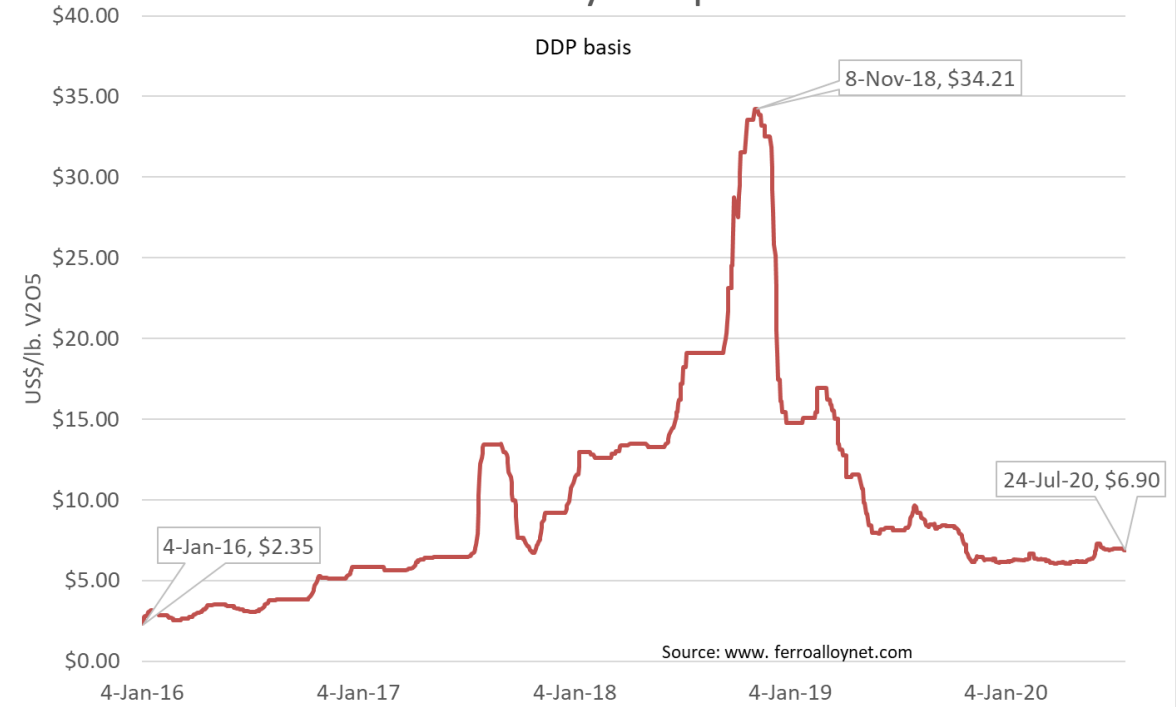
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Historical Price Data

Metal Bulletin V2O5 Daily Average Midpoint Price History



China V2O5 Daily Midpoint Price



V2O5 Published Prices Metal Bulletin Vs China

Monthly average published prices for commodity grade fused flake V2O5



Source: Metal Bulletin Publication and www.ferroalloy.net

— MB — China

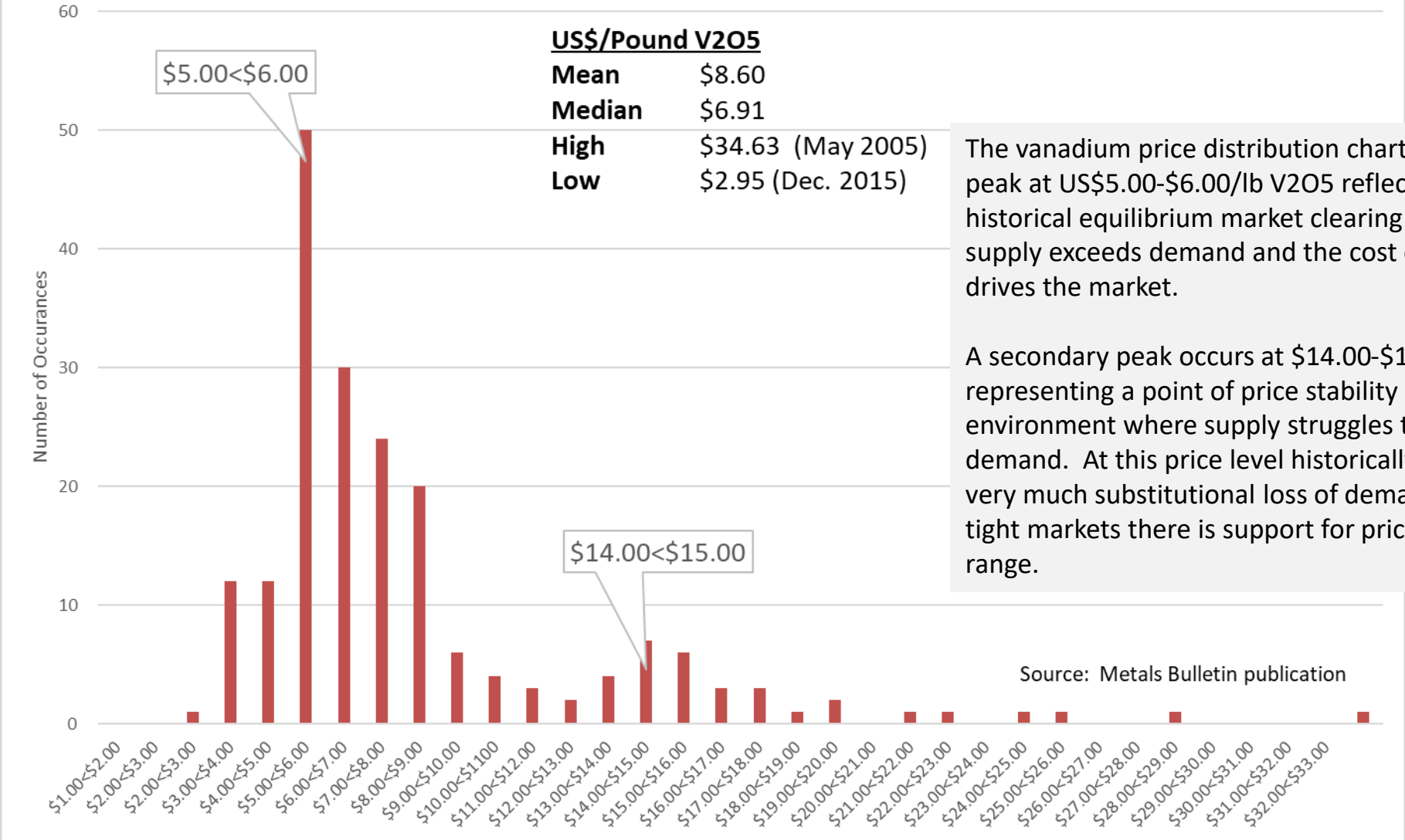
Metal Bulletin V2O5 Monthly Midpoint Average Price Jan. 2004 - June 2020 Inflated to Nov. 2017 US\$



In recent years vanadium prices have been very volatile. The mean inflated price since January 2004 is \$8.60/lb. V2O5 and this mean price is strongly influenced by the intermittent price spikes. The long-term median price of \$6.91/lb. V2O5 is important in terms of defining a "normal" price in this environment.

V2O5 Distribution Chart

Jan. 2004 - June 2020
Inflated to Nov. 2017 US\$



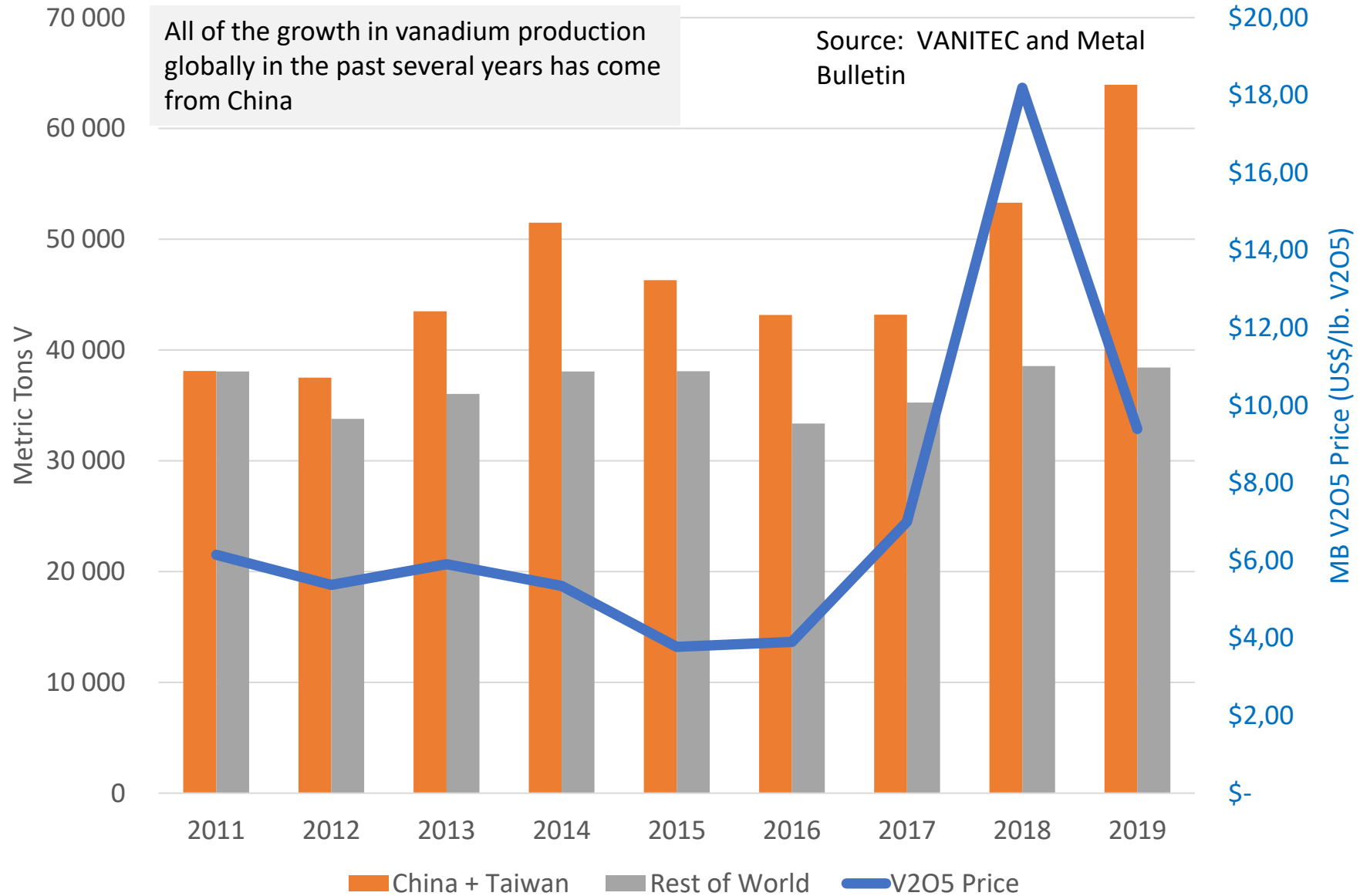
The vanadium price distribution chart shows a clear peak at US\$5.00-\$6.00/lb V2O5 reflecting the historical equilibrium market clearing price when supply exceeds demand and the cost of production drives the market.

A secondary peak occurs at \$14.00-\$15.00/lb V2O5 representing a point of price stability in an environment where supply struggles to meet demand. At this price level historically we don't see very much substitutional loss of demand and so in tight markets there is support for prices in this range.

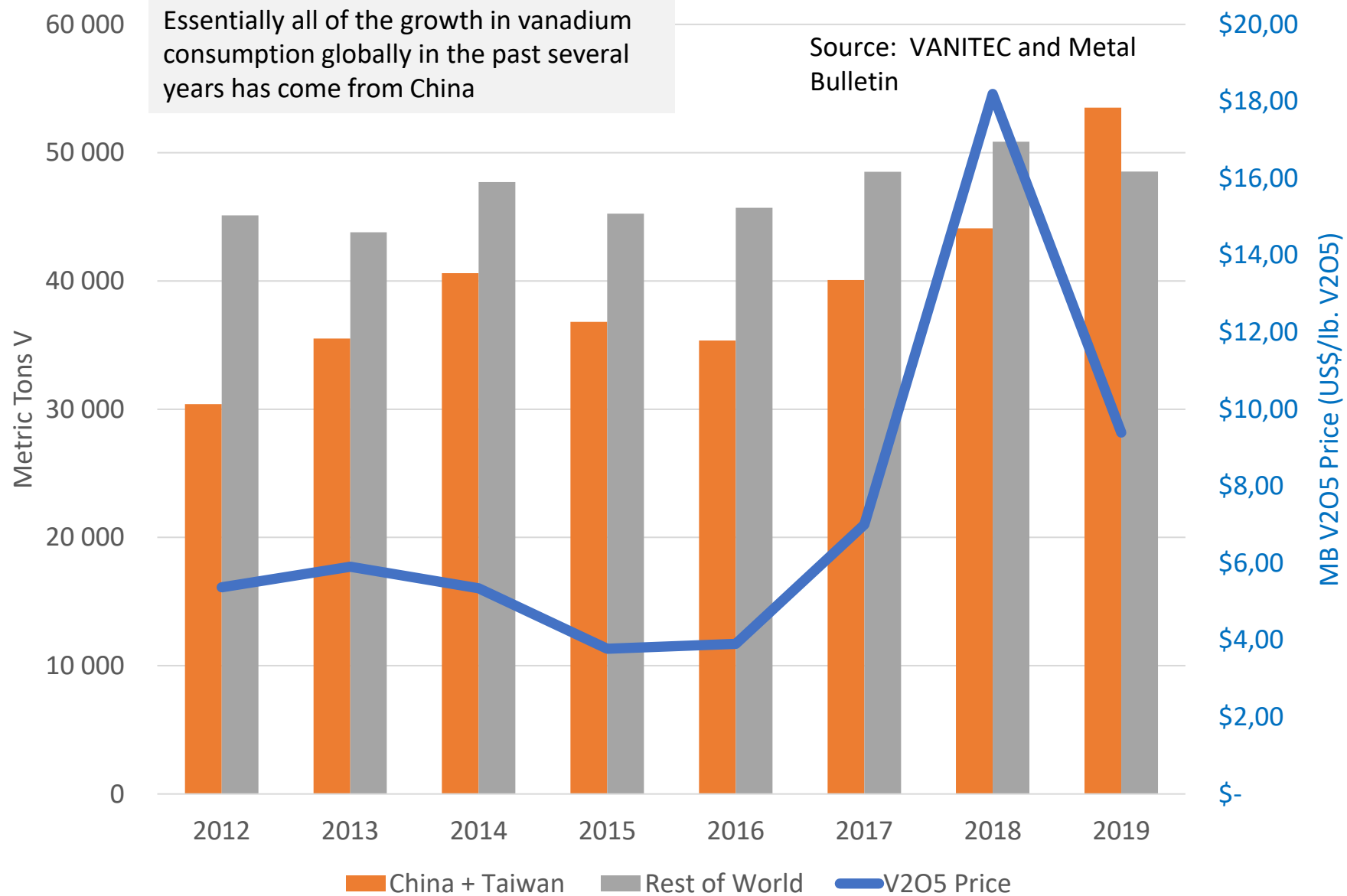
Source: Metals Bulletin publication

Vanadium Production and Consumption

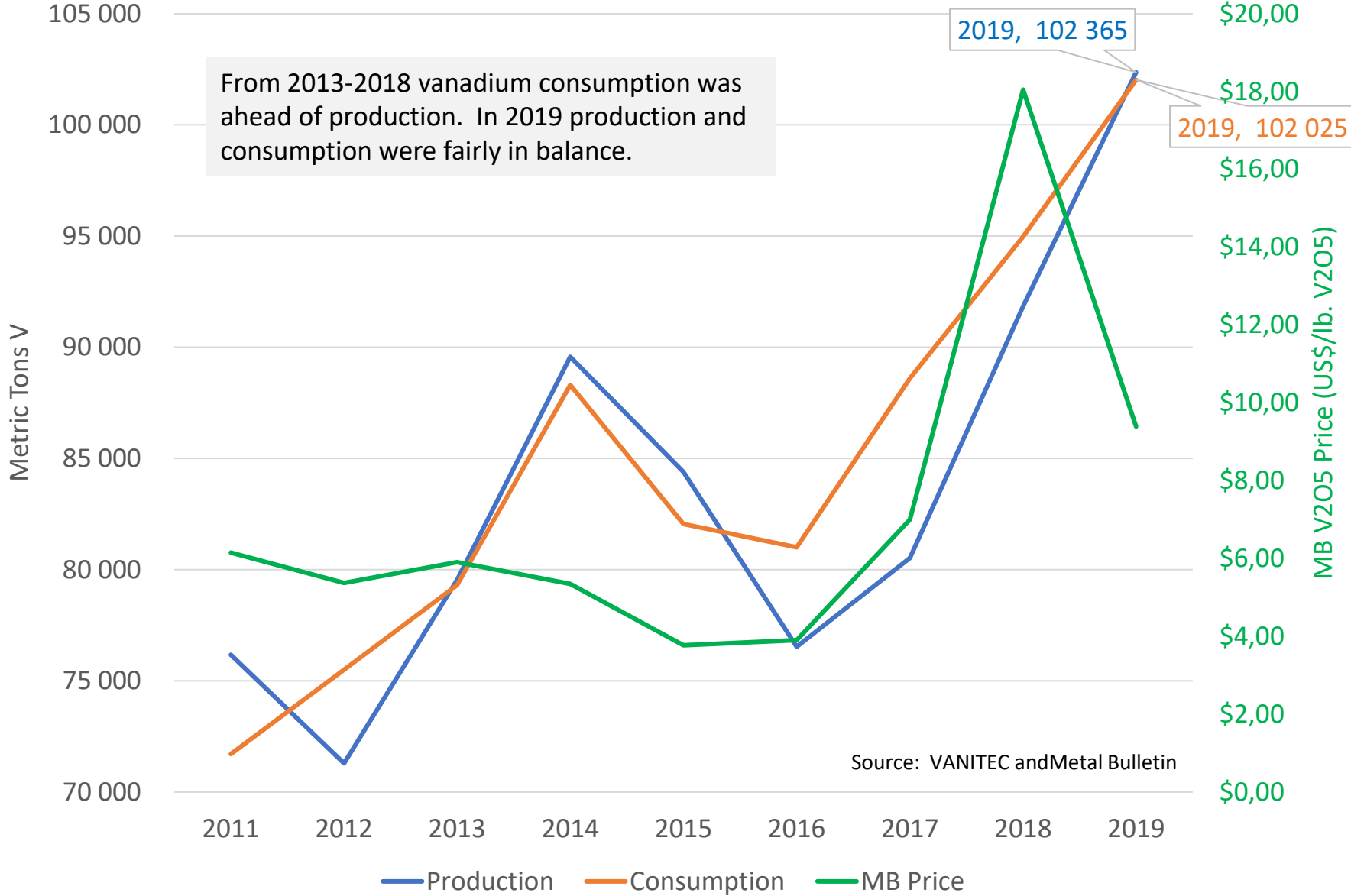
Global Annual Vanadium Production



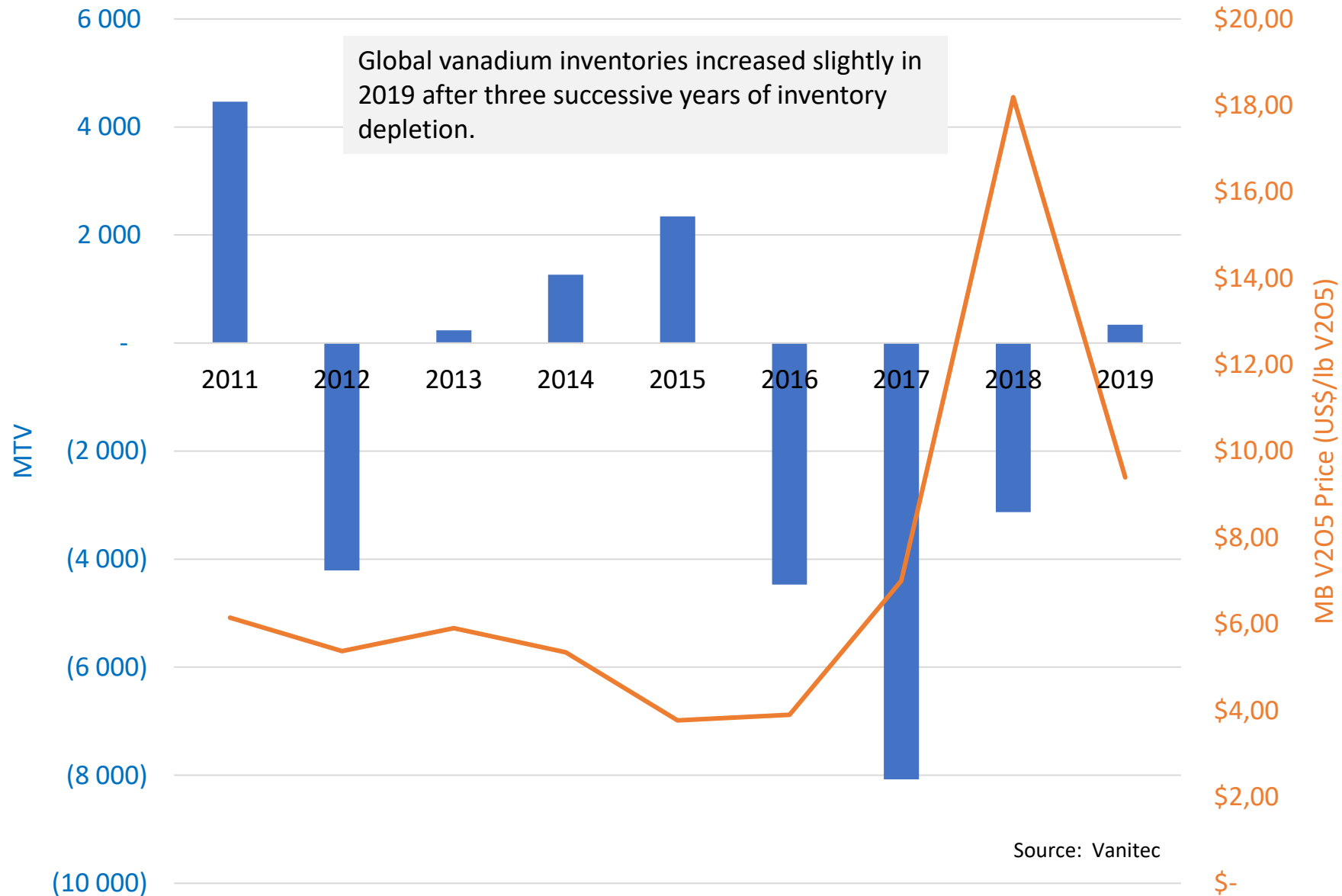
Global Annual Vanadium Consumption



Global Annual Vanadium Production & Consumption

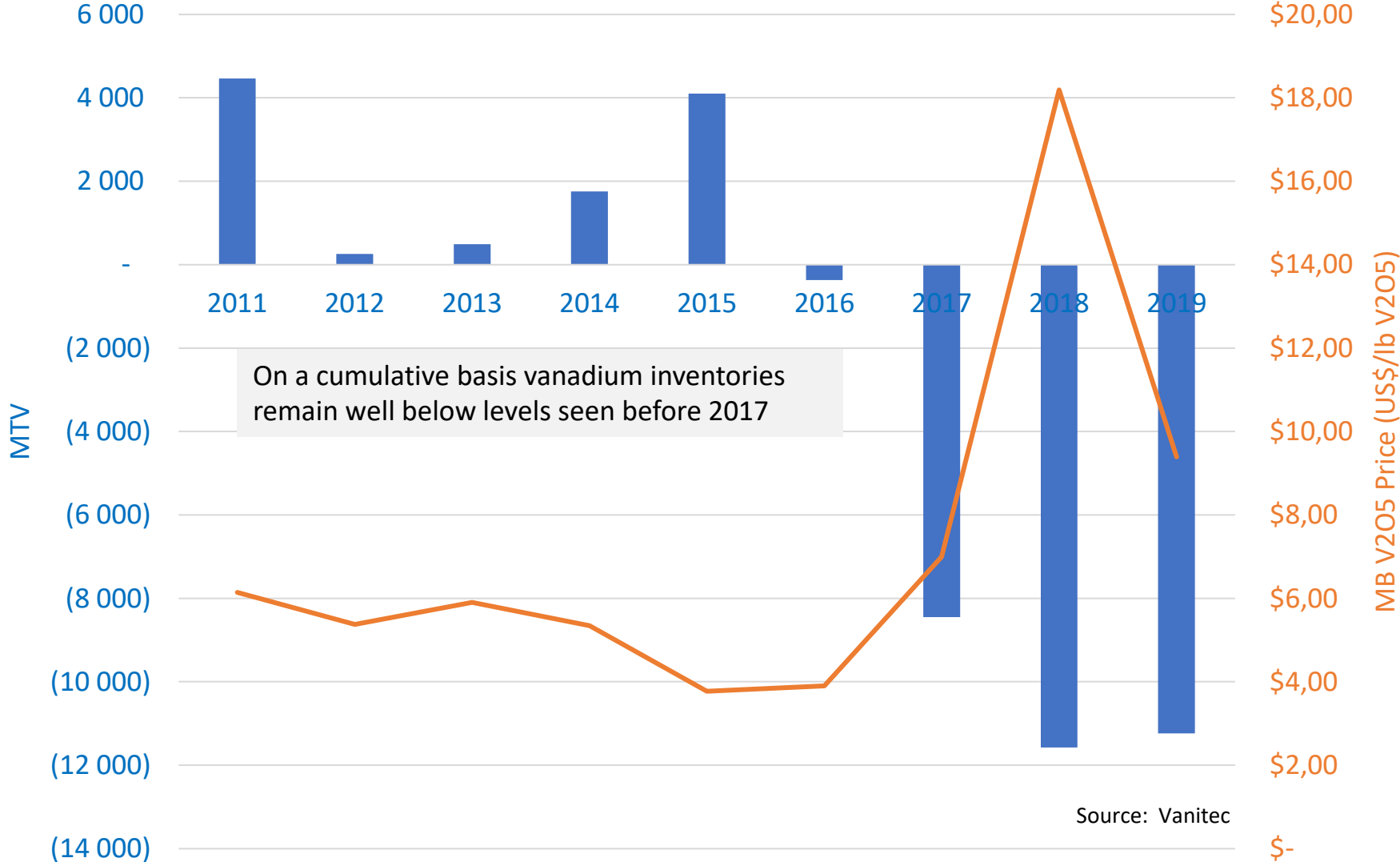


Global annual Vanadium Inventory Change



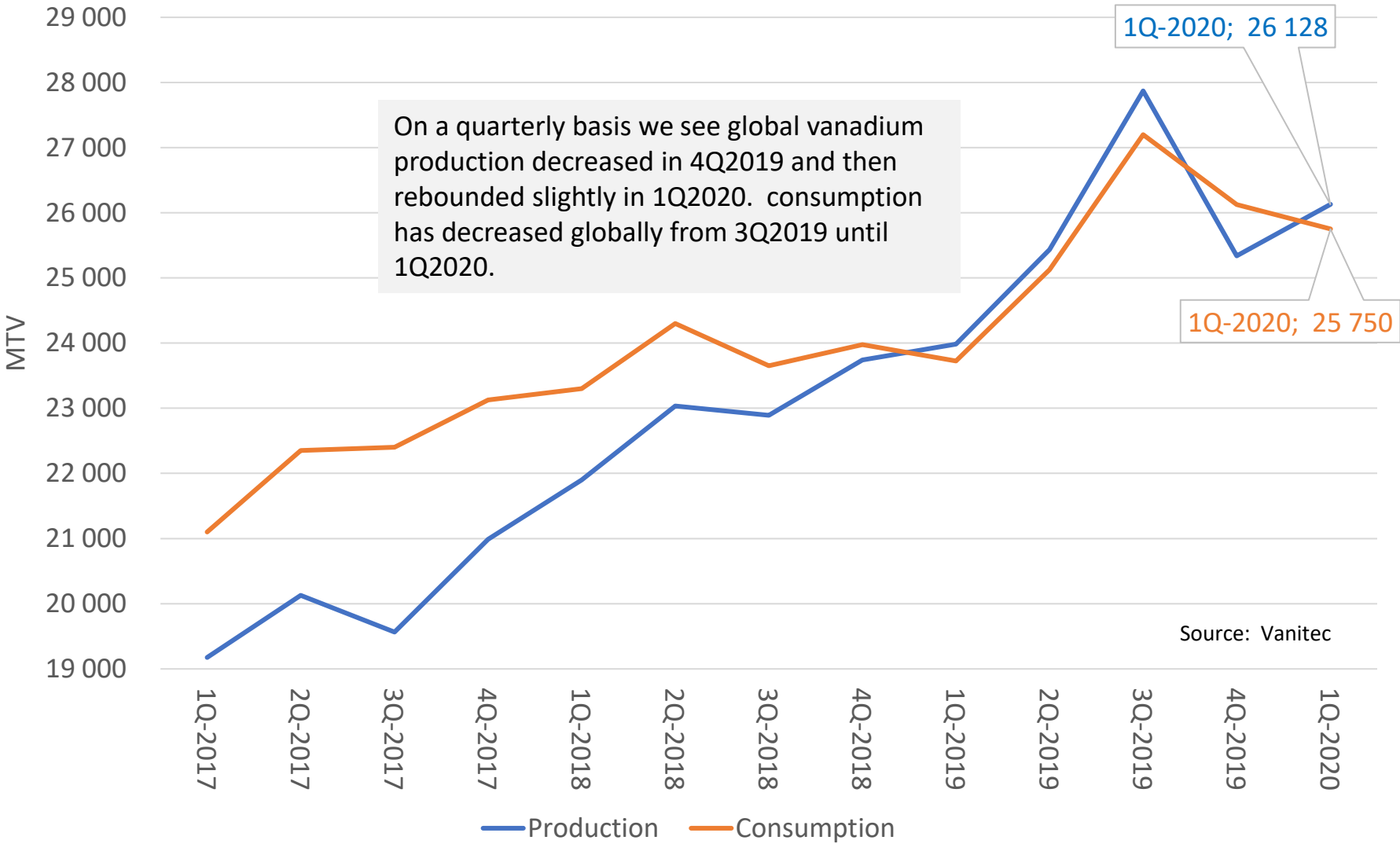
Source: Vanitec

Global Cumulative Annual Vanadium Inventory Change



Source: Vanitec

Global Quarterly Vanadium Production and Consumption

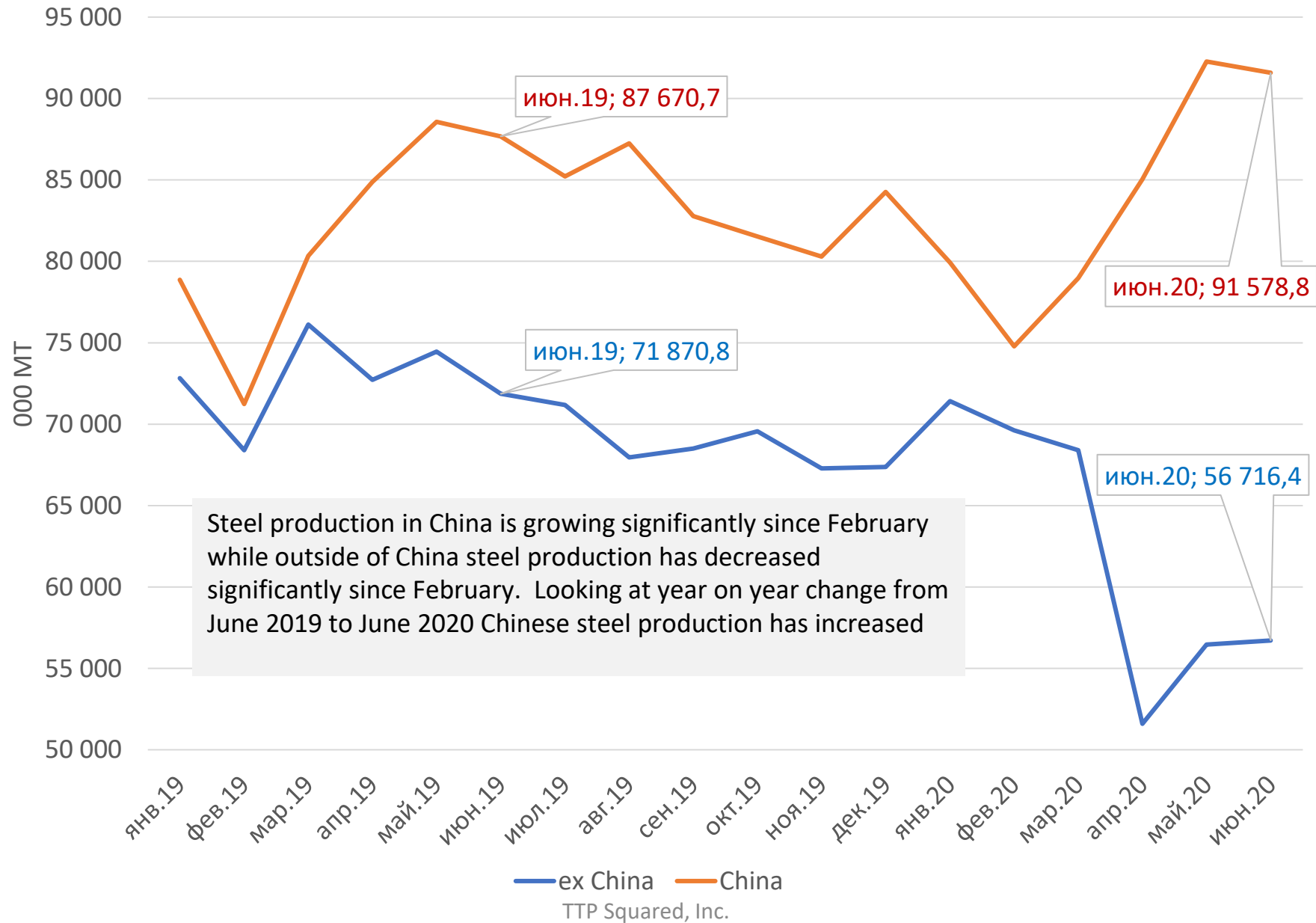


Source: Vanitec

Steel Production

Global steel production ex china has been severely impacted from April 2020.

Steel Production China vs ROW



China Vanadium consumption

- China consumed 53,500 MTV in 2019, an increase of 21% or 9,400 MTV as compared to 2018.
- In China vanadium consumption in the steel industry increased from 41,200 MTV in 2018 to 50,200 MTV in 2019, an increase of 9,000 MTV driven by broader adherence to the new rebar standard.
- World Steel projects that Chinese steel production will grow by 1% from 2019 to 2020.
- In 2019 still about 15% of rebar production does not meet the new standard. We project conformance to the new standard at 95% in 2020
- The combination of slightly increased steel production and broader adherence to the standard will result in Chinese vanadium consumption in the steel industry to increase from 50,200 MTV in 2019 to 58,000 MTV in 2020.

Ex China Vanadium consumption

- Outside of China the steel industry consumed 42,900 MTV in 2019.
- Steel production ex China in the first 5 months of 2020 was 10% lower than the first 5 months of 2019.
- World Steel Association projects ex China steel production in 2020 to decline by 14.2% as compared to 2020.
- The World Steel Association forecast would suggest vanadium consumption in the steel industry ex China in 2020 will be 36,800 MTV, a decrease of 6,100 MTV compared to 2019.
- In 2019 ex China consumption of vanadium in production of titanium alloys was 2,918 MTV. Due to COVID-19 titanium alloy production has collapsed and consumption of vanadium in this application in 2020 is projected to be 1,200 MTV a decrease of 59% or 1,718 MTV
- Ex China the chemical markets consumed 2,400 MTV in 2019. we expect 2020 consumption to decrease by 10% compared to 2019, a decrease of 240 MTV for the year
- In total ex China we expect vanadium consumption in 2020 to decrease from 2019 level of 48,509 MTV to 40,750, a decrease of 7,750 MTV or 16% year on year.

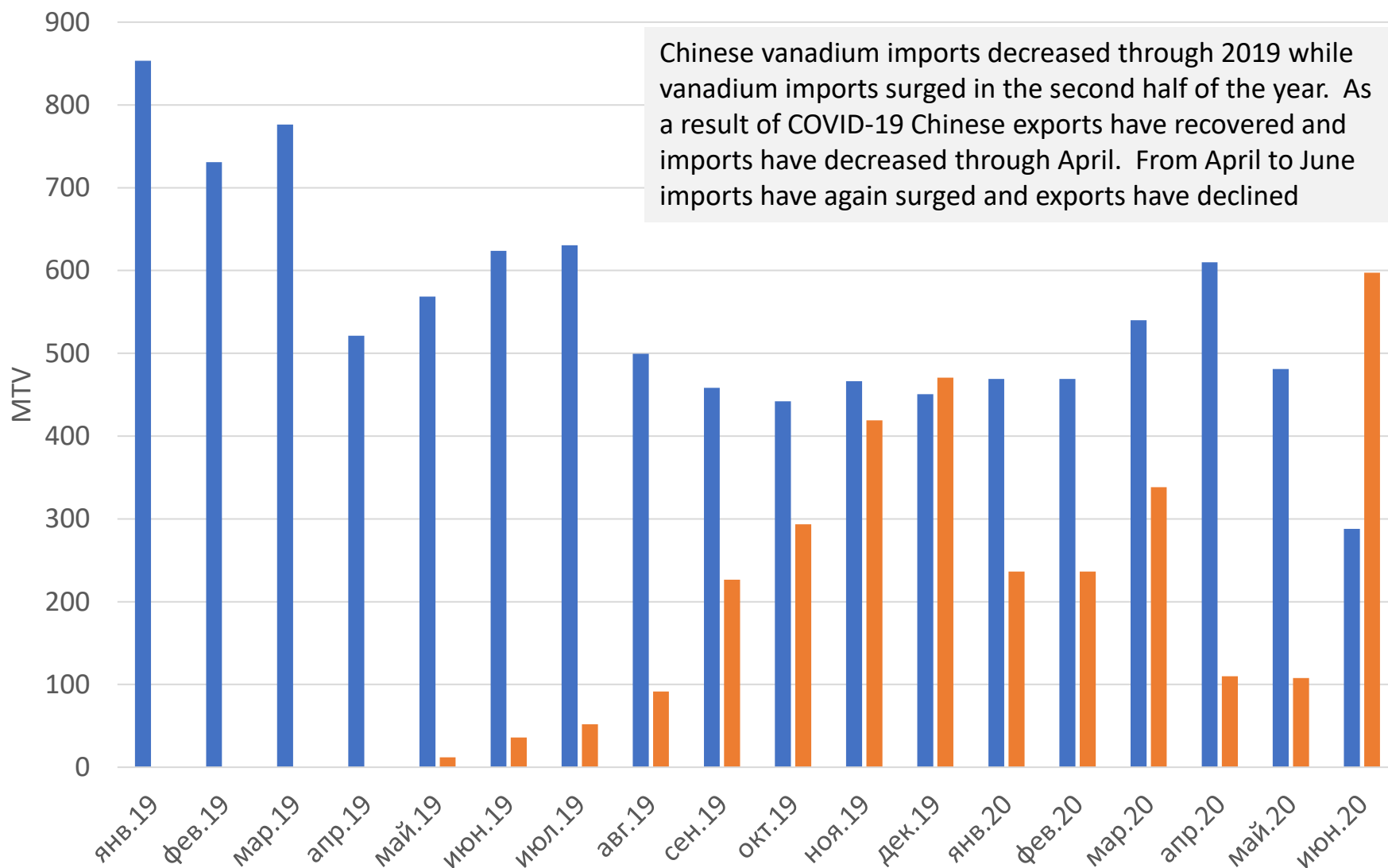
Vanadium Market 2019 vs 2020

	Ex China		China		World	
	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>
Steel Production (million MT)	849	728	907	917	1,756	1,645
V consumed in Steel (MTV)	42,900	36,800	50,200	58,000	93,100	94,800
V Consumed in Ti Alloys (MTV)	2,918	1,200	965	750	3,883	1,950
V consumed in Chemicals	2,400	2,250	1,240	1,100	3,640	3,350
V deployed in Energy Storage (MTV)	291	500	1,094	1,200	1,385	1,700
Total	48,509	40,750	53,499	61,050	102,008	101,800
	Ex China		China		World	
	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>
V Production (MTV)	38,427	40,728	63,938	59,284	102,365	100,012
	Ex China		China		World	
	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>	<u>2019</u>	<u>2020</u>
Surplus (Deficit) (MTV)	(10,082)	(22)	10,439	(1,766)	357	(1,788)

Summary

- In 2019 vanadium production slightly exceeded consumption for the first time in four years.
- The projection for 2020 indicates the global market will show a shortfall in production as compared to consumption.
- The forecast pre COVID indicates western markets would have needed 10,600 MTV exported from China in 2020. With the assumptions now in place as a result of COVID-19 we now project vanadium production and consumption ex China will be in balance.
- Availability and price of exports from China will drive the international market – if China remains a net exporter of vanadium, we have an oversupply in the market. If China requires more than 1,800 MTV per year in net imports, then we see the market becoming very tight.

China Monthly Vanadium Imports and Exports

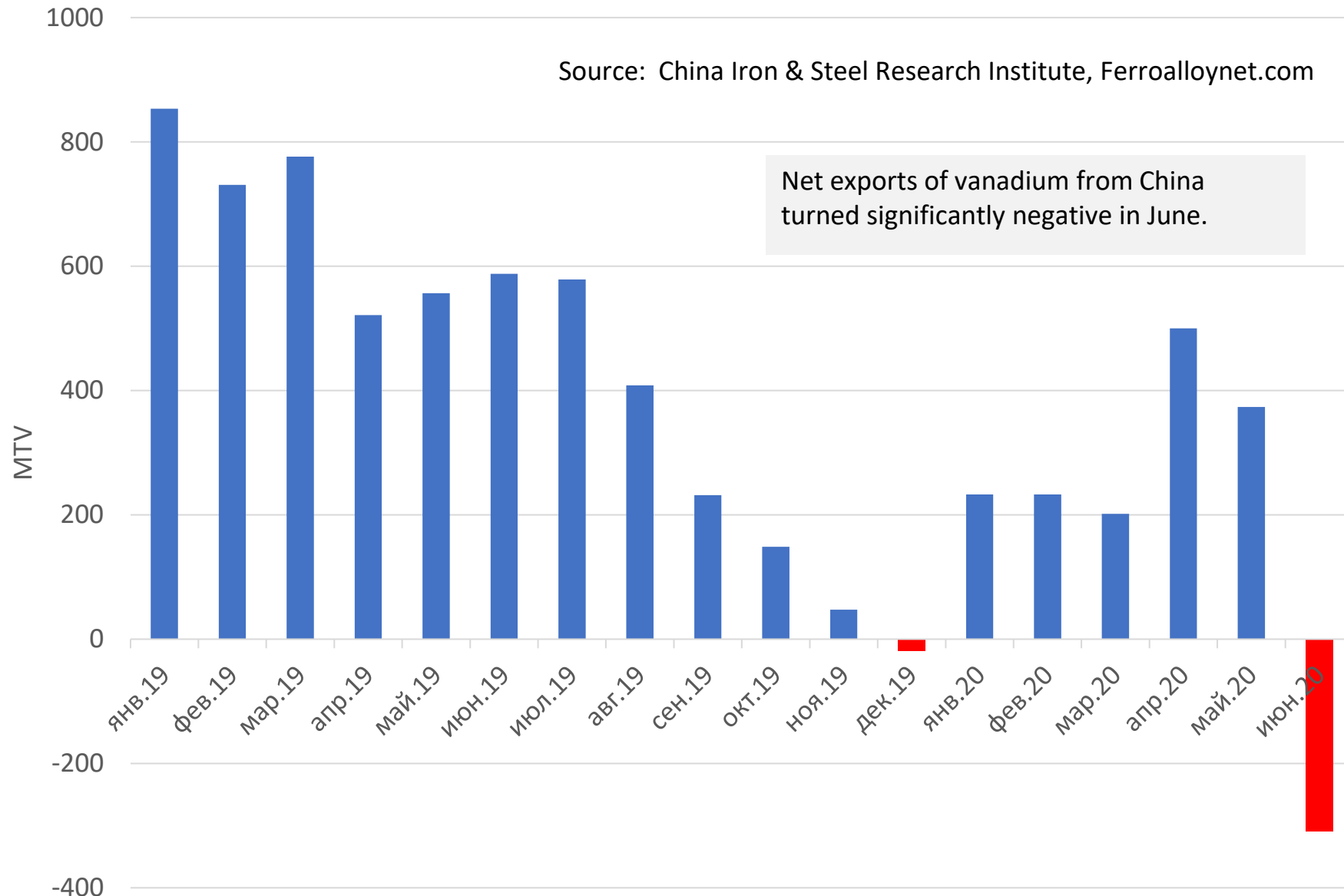


Source: China iron & Steel Research Center, Ferroalloy.net.com

■ Exports ■ Imports

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China Monthly Net Vanadium Exports



2020 V2O5 Cash Cost Curve

