

The Vanadium Market

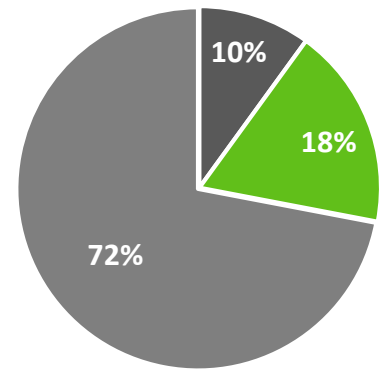
MAIN USES

- **Steel (89% of demand):** Production of high-strength, low-alloy steel and other high-performance steel
- **Chemical and Aerospace (8%):** Creating titanium alloys for the aerospace end market and as an oxidation catalyst in pollution control and chemical production processes
- **Batteries (3%):** Grid and portable energy storage applications

Source: TTP Squared, Credit Suisse research.

TYPES OF PRODUCTION

- Secondary Vanadium Production
- Primary Vanadium Production
- By-product of Steel Production



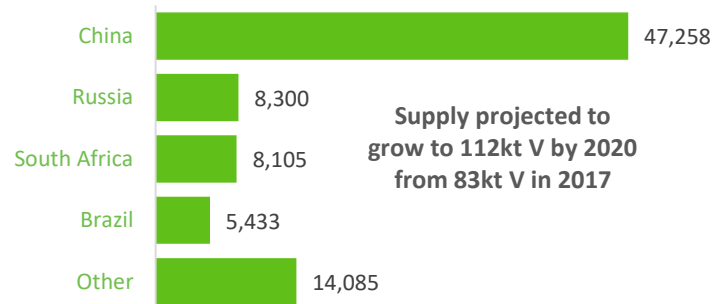
Source: TTP Squared, Credit Suisse research.

AREAS FOR DEMAND GROWTH

- **Increasing steel quality:** It is expected that world steel production growth will level, but that consumption will still increase due to increased quality standards out of China
- **Growth in vanadium redox battery (“VRB”) market and grid scale storage:** Demand from VRBs is currently a small % of the market, but future adoption can shift demand dramatically
 - VRBs have a few advantages over other batteries, including the ability to offer near unlimited capacity for use in larger storage tanks, the ability to be discharged for long periods of time, and the ability to be recharged through the placement of electrolyte

2017 SUPPLY AND PRODUCTION

- 77% of vanadium raw material supply comes from China, Russia, and South Africa

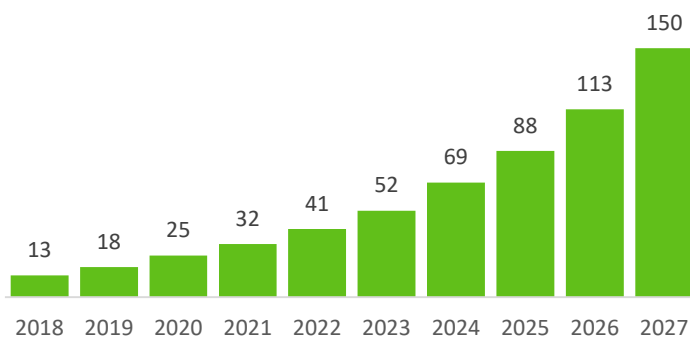


Source: TTP Squared, Credit Suisse research.

GROWTH SEGMENTS TO WATCH

Global Battery Storage Deployment Forecast (GWh)

Key focus: What share of this market will VRB technology take?



Source: Bloomberg New Energy Finance.

Incremental China Vanadium Demand (kt Vanadium)

Key focus: Will rebar strength standards continue to increase?



Source: BMO Research.

