



# Rare Earth Magnet Market Outlook to 2035



Adamas Intelligence

Q2 2022

## Disclaimer and User License Agreement

**This report and its contents are copyright and confidential.** This report is not for public distribution and may not be reproduced or redistributed in part or whole without prior written permission from Adamas Intelligence.

This report is for private internal use of the person or company that licenses it and may not be shared, co-licensed, or distributed among consortiums or multi-company organizations. Apart from any use as permitted by law, all rights pertaining to this publication are reserved by Adamas Intelligence and associated copyrights are strictly and legally enforced. This report is watermarked with the licensee's name, company, and e-mail address to help Adamas Intelligence protect and enforce its copyrights.

This report is provided for information purposes only. It is not a complete survey of every material fact respecting any company, project, resource, reserve, mine, market, end-use, application, product or nation. This report has been prepared in good faith on the basis of information available up to 30 days prior to the date of publication without independent verification, unless specified otherwise.

The information provided in this report is from primary research, secondary research, and other sources, which we believe to be reliable. Efforts have been made to try and ensure the accuracy of the data and information contained in this report, however, Adamas Intelligence does not guarantee or warrant the accuracy, reliability, completeness, or currency of the information in this report.

Readers are responsible for assessing the relevance and accuracy of the contents of this publication. Adamas Intelligence will not be liable for any loss, damage, cost, or expense incurred or arising by any reason of any person or business using or relying on information, statistics, forecasts, estimates, or opinions stated in this publication. Companies, mines, or other facilities may be identified by proprietary or trade names herein to help readers identify particular companies, mines, or facilities but this is not, and is not intended to be, an endorsement or recommendation of the mine, facility, or company referred to, unless explicitly stated.

This report contains "forward-looking statements" – that is, statements related to future events. In this report, forward-looking statements address our expectations of future rare earth production, supply, demand, consumption, and prices within parameters defined by stated scenarios, and often contain words such as "forecast", "project", "expect," "anticipate," "intend," "plan," "believe," "seek," "see," or "will." Forward-looking statements by their nature address matters that are, to different degrees, uncertain.

A number of future uncertainties exist that could cause actual results to be materially different than those expressed in our forward-looking statements. Readers are responsible for assessing the relevance and accuracy of these forward-looking statements. Adamas Intelligence will not be liable for any loss, damage, cost, or expense incurred or arising by any reason of any person or business using or relying on forward-looking statements in this report.

### **Important Notes:**

All prices and values referred to herein are in U.S. dollars unless specified otherwise.

Due to rounding, numbers presented throughout this document may not add up precisely to the totals provided and percentages may not precisely reflect the absolute figures.

## Table of Contents

<b>Executive Summary .....</b>	<b>10</b>
<b>Chapter 1: Introduction .....</b>	<b>11</b>
<b>Rare Earth Elements: Small Market, Big Necessity .....</b>	<b>11</b>
<b>Classification and Abbreviations.....</b>	<b>11</b>
<b>Rarely Enriched in Nature .....</b>	<b>12</b>
<b>Eight End-Use Categories .....</b>	<b>13</b>
<b>Global Rare Earth Consumption in 2021 .....</b>	<b>14</b>
<b>Rare Earth Balance Problem .....</b>	<b>15</b>
<b>Implications of the Balance Problem .....</b>	<b>16</b>
<b>NdFeB Permanent Magnets: Enablers of Modern Technology .....</b>	<b>17</b>
What is NdFeB?.....	17
What is it made of?.....	17
Why is it special?.....	17
<b>NdFeB Alloy is Available in Over 50 Different Grades .....</b>	<b>18</b>
<b>NdFeB Powder is Available in Over 30 Different Grades .....</b>	<b>19</b>
<b>Chapter 2: Value Chain Overview .....</b>	<b>20</b>
<b>Mine to Magnet Overview.....</b>	<b>20</b>
Rare Earth Mining, Separation and Refining.....	20
Rare Earth Metals and Alloys .....	21
NdFeB Alloys and Powders .....	21
NdFeB Magnets.....	21
<b>Value Chain Economics .....</b>	<b>23</b>
<b>Value Chain Market Shares.....</b>	<b>24</b>
<b>Chapter 3: Historical Global Production .....</b>	<b>25</b>
<b>Global Mine Production of Magnet Rare Earths by Oxide .....</b>	<b>25</b>
<b>Global Mine Production of Magnet Rare Earth Oxides by Company .....</b>	<b>26</b>
<b>Global Mine Production of Magnet Rare Earth Oxides by Country .....</b>	<b>27</b>
Neodymium Oxide .....	28
Praseodymium Oxide .....	29
Dysprosium Oxide .....	30
Terbium Oxide .....	31

<b>Global Refined Production of Magnet Rare Earth Oxides by Country .....</b>	<b>32</b>
Neodymium Oxide .....	33
Praseodymium Oxide .....	34
Dysprosium Oxide .....	35
Terbium Oxide .....	36
<b>Global Refined Production of Magnet Rare Earth Oxides by Company .....</b>	<b>37</b>
<b>Global Secondary Production of Magnet Rare Earth Oxides .....</b>	<b>38</b>
Secondary Production from Magnet Swarf .....	39
Secondary Production from End-of-Life Devices .....	40
<b>Global Secondary Production of Magnet Rare Earth Oxides by Country .....</b>	<b>41</b>
<b>Global NdFeB Alloy Production by Country.....</b>	<b>42</b>
<b>Global NdFeB Alloy Production Capacity by Country .....</b>	<b>43</b>
<b>Global NdFeB Powder Production by Country .....</b>	<b>44</b>
<b>Global NdFeB Powder Production Capacity by Country .....</b>	<b>45</b>
<b>Global NdFeB Alloy and Powder Producer Landscape.....</b>	<b>46</b>
<b>Chapter 4: Historical Global Consumption .....</b>	<b>48</b>
<b>Consumption of Magnet Rare Earths .....</b>	<b>48</b>
<b>Consumption of NdFeB Alloys and Powders .....</b>	<b>49</b>
<b>Consumption of NdFeB Magnets .....</b>	<b>49</b>
<b>Consumption of NdFeB Magnets by Region.....</b>	<b>50</b>
<b>Consumption of NdFeB Magnets by End-Use Category.....</b>	<b>51</b>
Passenger EV Traction Motors .....	53
Commercial EV Traction Motors .....	54
Other E-Mobility .....	55
Automotive Micromotors and Sensors .....	56
Wind Power Generators .....	57
Industrial Motors, Pumps and Compressors.....	58
Other Industrial Applications .....	59
Cordless Powertools .....	60
Consumer Electronics .....	61
Consumer Appliances .....	62
Automobile Speakers .....	63
Others .....	64

## **Chapter 5: Historical Production – Consumption Balance ..... 65**

Neodymium and Praseodymium Oxides .....	65
Dysprosium and Terbium Oxides .....	66
Magnet Alloys and Powders .....	67

## **Chapter 6: Historical Prices ..... 68**

<b>Prices of Magnet Rare Earths.....</b>	<b>68</b>
Neodymium, Praseodymium and Didymium Oxide.....	68
Dysprosium Oxide .....	69
Terbium Oxide .....	70
<b>Prices of NdFeB Alloys .....</b>	<b>71</b>
N-Series Alloys .....	71
M-Series Alloys.....	72
H-Series Alloys .....	73
SH, UH and EH-Series Alloys .....	74

## **Chapter 7: Forecasted Demand to 2035 ..... 75**

<b>Forecasted Demand for Sintered and Bonded NdFeB Magnets.....</b>	<b>75</b>
<b>Forecasted Demand for Sintered and Bonded NdFeB Magnets by Region .....</b>	<b>78</b>
<b>Forecasted Demand for NdFeB Alloys and Powders .....</b>	<b>79</b>
<b>Forecasted Demand for Magnet Rare Earths by Oxide.....</b>	<b>80</b>
<b>Forecasted Demand for Magnet Rare Earths by End-Use Category .....</b>	<b>81</b>
Forecasted Demand for Didymium Oxide by End-Use Category .....	82
Forecasted Demand for Dysprosium Oxide by End-Use Category.....	85
Forecasted Demand for Terbium Oxide by End-Use Category .....	88
<b>Forecasted Demand for Passenger EV Traction Motors to 2035 .....</b>	<b>92</b>
Passenger EV Traction Motors .....	94
Passenger BEV Traction Motors.....	95
Passenger PHEV Traction Motors .....	96
Passenger HEV Traction Motors .....	97
<b>Forecasted Demand for Commercial EV Traction Motors to 2035.....</b>	<b>99</b>
Commercial EV Traction Motors .....	101
Light, Medium and Heavy Commercial EV Traction Motors .....	102
Bus and Special Purpose EV Traction Motors .....	103
<b>Forecasted Demand for Other E-Mobility Traction Motors to 2035 .....</b>	<b>105</b>
Other E-Mobility Traction Motors .....	106

Electric Bicycle and Moped Motors .....	107
Electric Motorcycle and Quadricycle Motors.....	108
Electric Micro-Scooter Motors.....	109
Low-Speed EV Traction Motors .....	110
<b>Forecasted Demand for Automotive Micromotors and Sensors to 2035.....</b>	<b>112</b>
Automotive Micromotors and Sensors .....	113
Power Steering Motors .....	114
Power Seat Motors .....	114
Power Window Motors.....	115
Power Lock Motors .....	115
Power Mirror Motors.....	116
Power Sunroof Motors .....	116
Power Liftgate Motors .....	117
Power Tilt Steering.....	117
Fuel Pump Motors .....	118
Cooling Fan Motors.....	118
Crank Angle Sensors.....	119
Ignition Coil Motors .....	119
Water Pump Motors .....	120
Exhaust Gas Recirculation Valves .....	120
Electric Compressors.....	121
Electric Brakes.....	121
Optical Disc Drives .....	122
Other.....	122
<b>Forecasted Demand for Wind Power Generators to 2035.....</b>	<b>124</b>
Wind Power Generators .....	125
Permanent Magnet Direct Drive Wind Power Generators .....	126
Permanent Magnet Hybrid Direct Drive Wind Power Generators .....	127
<b>Forecasted Demand for Industrial Motors, Pumps and Compressors to 2035.....</b>	<b>129</b>
Industrial Motors, Pumps and Compressors.....	130
Fans and Blowers .....	131
Centrifugal Pumps.....	131
Industrial Compressors .....	132
Positive Displacement Pumps.....	132
Other Motors, Pumps and Compressors .....	133
<b>Forecasted Demand for Other Industrial Applications to 2035 .....</b>	<b>135</b>
Other Industrial Applications.....	136
Industrial Robots and Welders.....	137

Elevators and Escalators .....	138
Magnetic Lifters .....	139
Magnetic Separators.....	139
Magnetic Filters .....	140
Magnetic Couplings .....	140
Other Industrial Applications .....	141
<b>Forecasted Demand for Cordless Powertools to 2035.....</b>	<b>143</b>
Cordless Powertools .....	144
Cordless Drills.....	145
Cordless Saws and Sanders .....	146
Cordless Mowers .....	146
Cordless Trimmers .....	147
Cordless Vacuums and Blowers .....	147
Other Cordless Powertools .....	148
<b>Forecasted Demand for Consumer Electronics to 2035 .....</b>	<b>150</b>
Consumer Electronics .....	151
Mobile Phone Vibration Motors .....	152
Mobile Phone Voice Coil Motors .....	152
Consumer HDDs.....	153
Enterprise HDDs.....	153
Laptop Speakers.....	154
Tablet Speakers.....	154
Television Speakers.....	155
Mobile Phone Speakers .....	155
Home Theater Speakers.....	156
Smart Speakers and Displays .....	156
Other Wireless Speakers.....	157
Headphones.....	157
Small Printers and Copiers .....	158
Large Format Printers .....	158
<b>Forecasted Demand for Consumer Appliances to 2035.....</b>	<b>160</b>
Consumer Appliances .....	161
Room Air Conditioners.....	162
Packaged Air Conditioners .....	162
Commercial Fridges and Freezers .....	163
Residential Fridges and Freezers .....	163
Washers and Dryers.....	164
Ovens and Microwaves.....	164

Dishwashers .....	165
<b>Forecasted Demand for Automobile Speakers to 2035 .....</b>	<b>167</b>
Automobile Speakers .....	168
<b>Forecasted Demand for “Blue Sky” Applications to 2035 .....</b>	<b>170</b>
Residential Magnetocaloric Chillers .....	171
Commercial Magnetocaloric Chillers .....	171
<b>Forecasted Demand for Other End-Uses and Applications to 2035 .....</b>	<b>173</b>
Health and Wellness .....	174
Defense .....	174
Aerospace .....	175
All Other .....	175
<b>Chapter 8: Forecasted Global Production .....</b>	<b>176</b>
<b>Forecasted Global Mine Production of Magnet Rare Earths by Oxide .....</b>	<b>176</b>
<b>Forecasted Global Mine Production of Magnet Rare Earths by Region .....</b>	<b>177</b>
Neodymium Oxide .....	178
Praseodymium Oxide .....	179
Dysprosium Oxide .....	180
Terbium Oxide .....	181
<b>Forecasted Global Refined Production of Magnet Rare Earth Oxides by Region .....</b>	<b>182</b>
Neodymium Oxide .....	183
Praseodymium Oxide .....	184
Dysprosium Oxide .....	185
Terbium Oxide .....	186
<b>Forecasted Global Secondary Production of Magnet Rare Earth Oxides .....</b>	<b>187</b>
Secondary Production from Magnet Swarf .....	188
Secondary Production from End-of-Life Devices .....	189
<b>Forecasted Global Secondary Production of Magnet Rare Earth Oxides by Region .....</b>	<b>190</b>
<b>Forecasted Global Production of NdFeB Alloys and Powders .....</b>	<b>191</b>
<b>Forecasted Global Production of NdFeB Alloys and Powders by Region .....</b>	<b>192</b>
<b>Chapter 9: Forecasted Global Production – Demand Balance .....</b>	<b>193</b>
<b>Forecasted Global Production – Demand Balance for Magnet Rare Earth Oxides .....</b>	<b>193</b>
Neodymium and Praseodymium Oxides .....	194
Dysprosium Oxide .....	195
Terbium Oxide .....	196
<b>Forecasted Global Production – Demand Balance for Magnet Alloys and Powders .....</b>	<b>197</b>



<b>Chapter 10: Forecasted Prices .....</b>	<b>198</b>
<b>Forecasted Magnet Rare Earth Oxide Prices .....</b>	<b>198</b>
Neodymium, Praseodymium and Didymium Oxide .....	199
Dysprosium Oxide .....	200
Terbium Oxide .....	201
<b>Upside Price Forecast Scenario .....</b>	<b>202</b>
<b>Downside Price Forecast Scenario .....</b>	<b>203</b>
<b>Implications for Metals, Alloys, Powders and Magnet Prices .....</b>	<b>204</b>
<b>Implications for End-Use Markets.....</b>	<b>205</b>
<b>Chapter 11: Magnet Market Outlook .....</b>	<b>206</b>
<b>Appendices .....</b>	<b>213</b>
<b>A1: Dysprosium and Terbium Thrifting .....</b>	<b>213</b>
<b>A2: Breakdown of Rare Earth Mines by Group in China .....</b>	<b>214</b>
<b>A3: Potential Future Miners of Magnet Rare Earths Outside China.....</b>	<b>215</b>
<b>A4: Potential Future Processors, Refiners and Recyclers of Magnet Rare Earths Outside China.....</b>	<b>217</b>
<b>A5: Production Capacity of Leading NdFeB Alloy and Powder Manufacturers .....</b>	<b>218</b>
<b>A6: Leading EV Traction Motor Manufacturers Globally .....</b>	<b>219</b>
<b>A7: Leading EV Manufacturers Globally.....</b>	<b>222</b>
<b>A8: Leading Wind Power Generator Manufacturers Globally .....</b>	<b>226</b>
<b>A9: Forecasted China Domestic Prices of All Rare Earth Oxides to 2035 (Base Case).....</b>	<b>227</b>
<b>A10: Forecasted China Domestic Prices of All Rare Earth Oxides to 2035 (Upside) .....</b>	<b>228</b>
<b>A11: Forecasted China Domestic Prices of All Rare Earth Oxides to 2035 (Downside).....</b>	<b>229</b>