
ILLUMINATING THE QUANTUM COMPUTING SUPPLY CHAIN

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QC IMPORTANCE

The quantum computing (QC) industry is of strategic importance to the Department of War (DoW) as a critical emerging technology. In order to ensure intellectual property protection and continued sustainment of QC programs it is necessary for the DoW to have clear insight into the supply chain.

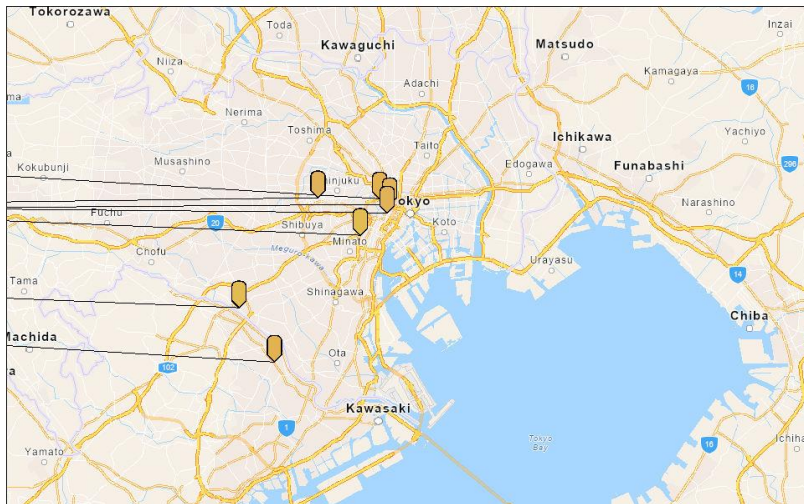
SUPPLY CHAIN IMPORTANCE

- The emerging technology and critical hardware supply chains are notoriously opaque, leaving decision makers without the full scope of information they need. Quantum computing is uniquely complicated as multiple modalities require advanced semiconductors in addition to lab-grade refined minerals and rare earth elements. These layers further complicate the protection of the quantum computing industry from supply chain disruptions to intellectual property theft.
 - As a result of the QC supply chain's complexity and global dispersion, identifying dependencies on specialized materials, concentrations of critical mineral production, and foreign investment networks create challenges for the resilience of the U.S. quantum ecosystem. The dependency on **over 90%** imported rare earths and critical minerals from foreign countries easily leads to supply chain disruptions causing delays in the development of the U.S. quantum industry.
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APPROACH

- While conducting this investigation the RISC team utilized financial data obtained through a Pitchbook license and mapped supplier and investment flows using ESRI's ArcGIS.

Tokyo Investment Origin



4/7/2026

1:318,941
0 2.25 4.5 9 mi
0 3.5 7 14 km
Sources: Esri, DeLorme, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

European HQs



4/7/2026

1:24,371,754
0 130 260 520 mi
0 205 410 820 km
Sources: Esri, DeLorme, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

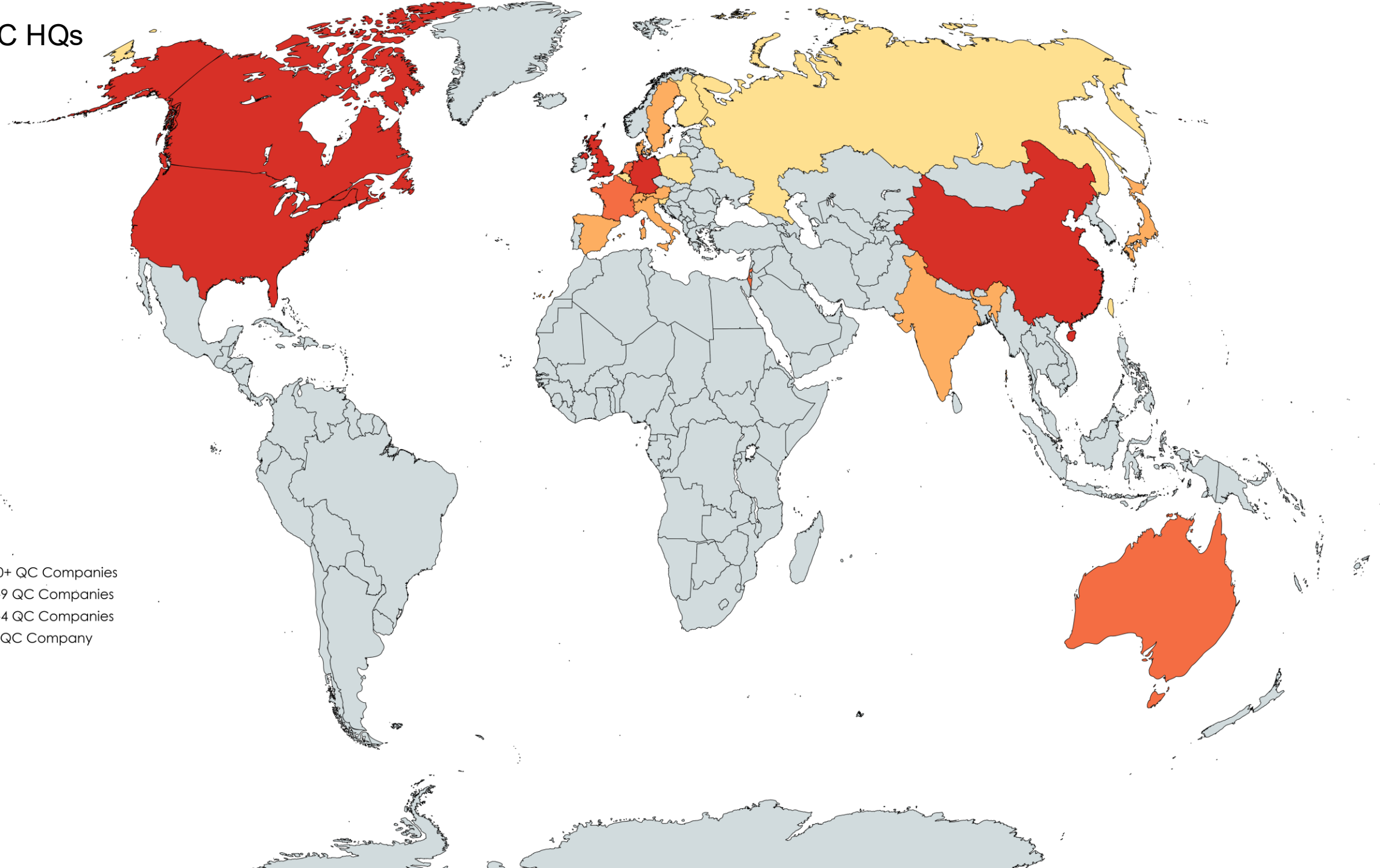
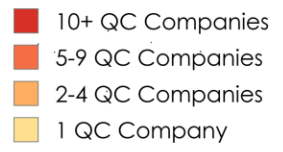
LIMITATIONS

- Due to the nature of innovation and development in the QC sector, capital origin and supply chain connections are difficult to identify. The prevalence of private companies that did not have to disclose financial or partnership information creates complications for supply chain and FOCI analysis.
 - Private companies operating on 'shadow mode,' with no visibility into investment and a lack of specific international headquarter or branch addresses limited the final product. Additionally, it can be difficult to ascertain the nature of corporate partner relationships, leading to a lack of clarity surrounding technology transfer, intellectual property sharing, and research and development collaboration.
 - The majority of QC suppliers do not identify who their critical mineral and rare earth element (REE) suppliers are. Also, companies involved in the mining and supply of critical minerals and REEs provide limited publicly available information (PAI) on the locations of their mining operations which limits the illumination of the QC supply chain.
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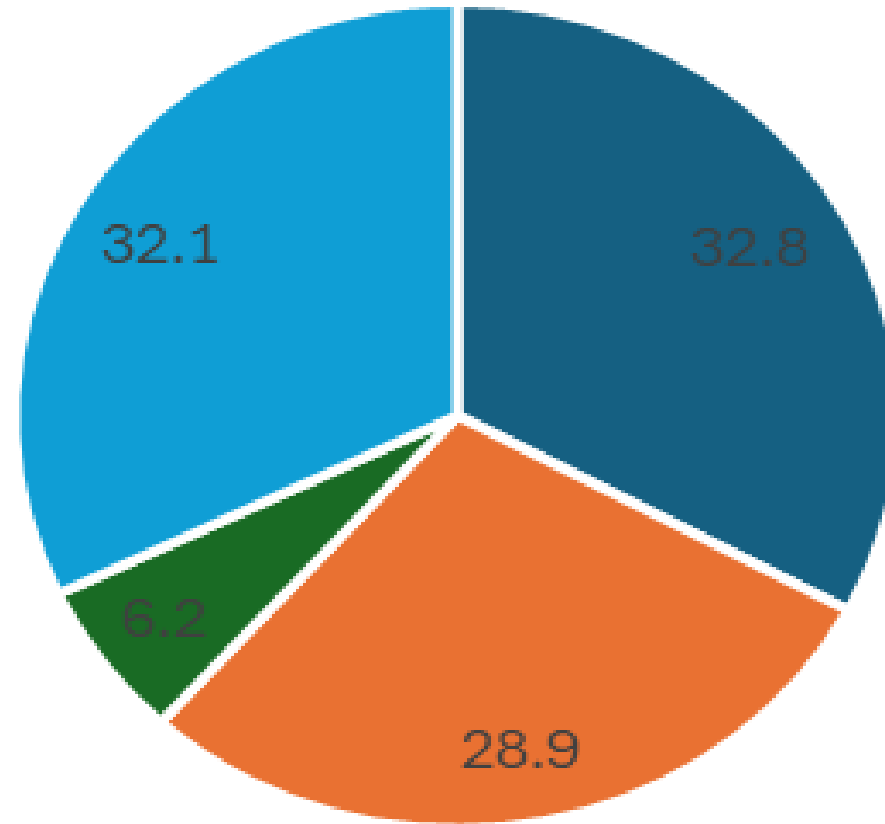
COMPANY LAYERS

- Developed a geographical information system (GIS) to map the domestic and international QC supply chain and its investors to highlight areas of strategic interest and chokepoints. Using ESRI's ArcGIS systems rare earth elements, domestic manufacturers, foreign manufacturers, and foreign investment were mapped.
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GLOBAL QC HQs



Quantum Computing Investment

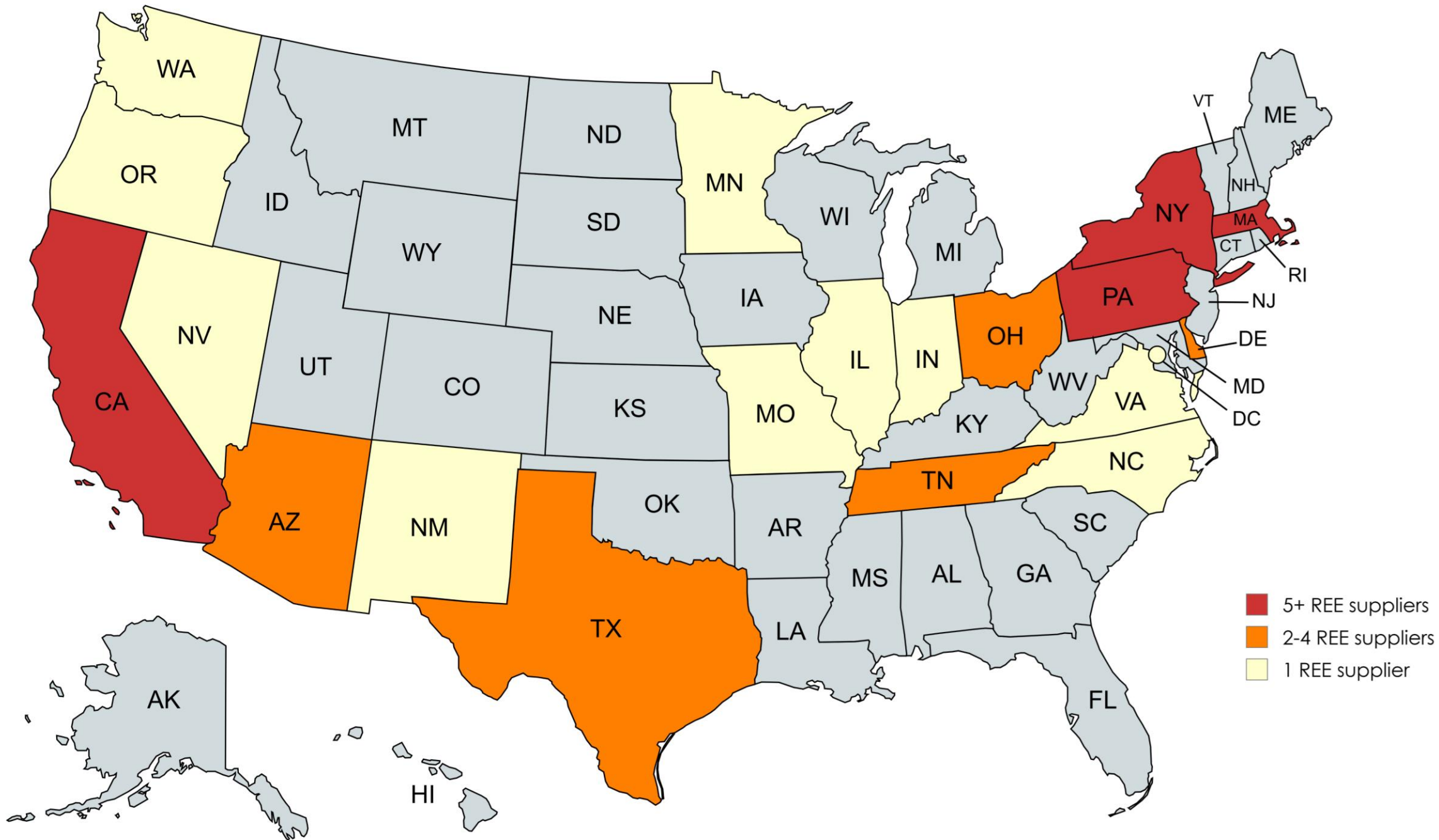


■ Domestic ■ Some Foreign Investment ■ Public ■ Undisclosed

CRITICAL MINERALS & RARE EARTH ELEMENTS

- QC hardware such as superconducting systems and trapped ion systems are essential to the development of quantum computing systems. Critical minerals (ex. Niobium, Tantalum) and REEs (ex. Yttrium, Neodymium) are required for QC hardware to function.
 - Their supply chains have high geographic concentration, limited substitutability, and geopolitical risk. The countries with the highest number of critical mineral and REE suppliers are (1) China, (2) Russia, (3) Japan, (4) U.K., and (5) Germany.
 - Mining is global but rare-earth refining is heavily dominated outside the U.S. which creates dependency
 - Processing and refining these materials creates chokepoints in the QC supply chain:
 - Export control vulnerability
 - Constraints on defense manufacturing and quantum research/development
 - Inability to scale or replace supply quickly slows defense capabilities
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DOMESTIC REE SUPPLIERS



RECOMMENDATIONS

- Monitor the companies identified as at-risk from FOCI and prioritize partnerships with manufacturers that have full investment transparency.
 - Where possible, diversify identified supplier dependencies, ensuring resiliency and redundancy for supporting components. For non-replicable single source chokepoints invest in bilateral relations and public-private partnerships with said source.
 - Implement near-real-time monitoring systems for critical supply chain risks which would significantly impact the QC operational ability. Integration of this proposed monitoring system with current logistics tracking programs would provide greater awareness.
 - Support Bureau of Industry and Security export monitoring and enforcement capabilities to protect domestic innovations.
 - Ensure compliance with Dodd-Frank Act through reporting from QC manufacturers and component suppliers that source rare earth elements to uphold ethical standards for REE suppliers, subsidiaries, and refiners.
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LOOKING AHEAD

- This project focused on physical or hardware inputs into the QC supply chain. Further analysis for software constraints or quantum sensing and quantum key distribution supply chain illumination would be complementary.
 - Outbound investment from the United States to foreign companies is prevalent in emerging technologies and can create FOCI style risks. Research into these trends could result in valuable insight into investment flows. Additionally, an evaluation into the role of angel investors within quantum computing could round out the FOCI analysis.
 - Conducting further research on REE and critical mineral suppliers to identify single-source dependencies would be beneficial to identifying choke points in the supply chain. Developing analysis on geographical areas with the highest natural production of critical minerals and REEs would be complementary to identifying these dependencies.
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THANK YOU!

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