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| **NSF Engine: The New Mexico Quantum Moonshot - Grand Challenges for US National & Economic Security** | **Key to the Application**   * **Blue tables:** Key goals, gaps, activities of Engine * **Grey tables:** Supporting information * **Black boxes:** Deep dives and technical highlights * **Exhibits/graphics:** Other supporting information |

# A. Overview, Vision, and Rationale:

The transistor, atomic clock, and splitting of the atom – three innovations enabling the modern world that each harnesses quantum mechanics. Today, we stand on the brink of another transformative era, again driven by quantum technology.[[1]](#endnote-2) The disruptive potential of the next quantum age will solve challenges across every industry, from sensors for safe navigation and networks that protect our information and critical infrastructure to computational technologies that foster energy abundance and fight life-threatening disease. The Mountain West[[2]](#endnote-3) is leading the way into this future.[[3]](#endnote-4) The region is home to more quantum-focused organizations,[[4]](#endnote-5) 21st-century quantum-focused Nobel Prize winners,[[5]](#endnote-6) and quantum jobsthan anywhere else in the world.[[6]](#endnote-7) Central and northern New Mexico (NM)—the service region for this Engine—has a distinguished history of quantum innovation that reflects its role as the country’s largest quantum research cluster for national security.[[7]](#endnote-8) With China aggressively prioritizing advanced technology development, like AI and quantum,[[8]](#endnote-9) to usurp US national and economic primacy, we must invest in the right ecosystems and strategies to cement America’s leadership.

NM leads the world in deploying quantum solutions for next-generation navigation, drives US government capabilities for protections from vulnerable cyber and infrastructure networks, and invented some of the most promising techniques for quantum computing. Institutions like Sandia National Laboratories (SNL), Los Alamos National Laboratory (LANL), Air Force Research Laboratory (AFRL), and the University of New Mexico (UNM) represent the forefront of quantum science for national security. Nevertheless, NM, the second poorest state in the country,[[9]](#endnote-10) has yet to realize the economic benefits of its pioneering research.

Quantum technologies, NSF Regional Engines support, access to significant existing resources, and historically large new investments will provide New Mexicans a once-in-a-generation chance to right size their economic might with the state’s scientific prowess. **NSF Engine: The New Mexico Quantum Moonshot - Grand Challenges for US National & Economic Security**’smission is to *secure American leadership in quantum technology, including computing, sensing, and networking, while building broad-based prosperity in NM.* The promise of this effort has attracted new and existing resources of $1.65b, including $1.32b in existing resources, including access to key facilities, state support, SIC investments, and $327m in new resources that will be made available by a historic investment by the State of NM, industry partners, and local ecosystem stakeholders.Paired with a unique strategy that combines the best of the public and private sector, we will accelerate commercialization to drive technology and economic development. Based on the Bureau of Economic Analysis’ RIMS II data, this includes supporting over 8k new jobs over the project lifetime. Elevate Quantum will oversee the Engine from its NM Business Unit, based in Albuquerque. A two-pronged strategy (Exhibit 1) supported by rigorous governance and cross-sector partnerships will grow and sustain the Engine. Specifically, we will invest in (1) grand challenges (GCs) and (2) place-based capacity building (PBCB). Combined with NM’s foundational regional strengths, these investments will produce local and global impact.

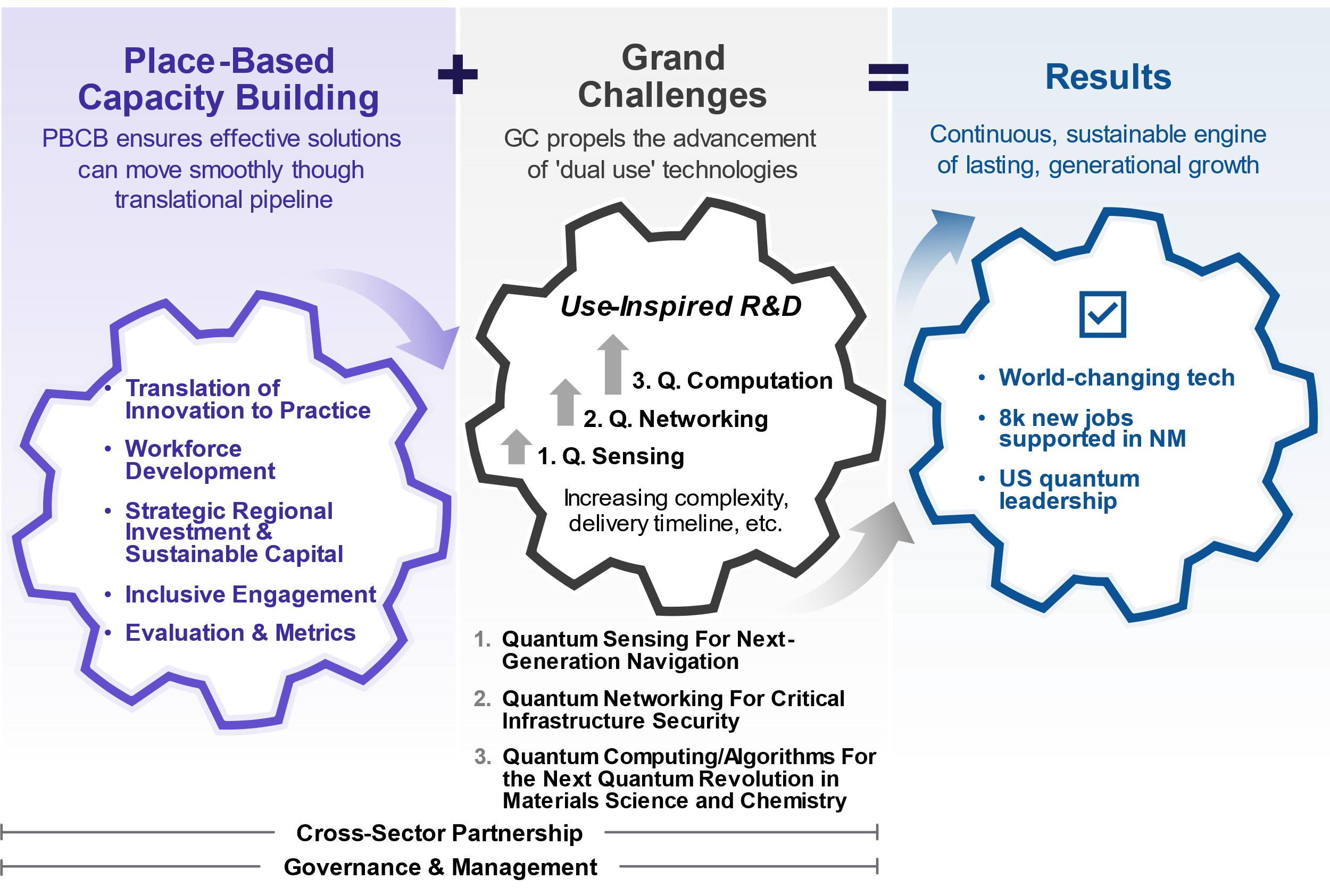
***(1) Grand challenges:*** Leveraging the principles of quantum mechanics to solve real-world problems is perhaps one of the most technologically difficult endeavors humanity has ever pursued. The first prong of the Engine leverages the innovation potential of GCs to accelerate the commercialization of quantum technologies. Elevate Quantum, a 120-member industry-led consortium, in partnership with Engine co-PIs and core partners at SNL, LANL, UNM, Vescent Photonics, and the NM Governor’s office, and industry representatives, selected three major GCs for both their promise of quantum solutions and their market and societal impact: **Quantum Sensing** **For Next-Generation Navigation**, **Quantum Networking For Critical Infrastructure Security,** and **Quantum Computing & Algorithms For the Next Revolution in Materials Science and Chemistry**.These “*dual-use*” challenges leverage regional strengths and infrastructure from national security to catapult technology development for important civilian use-cases.

Solving these GCs would unlock up to $250bn in market value. The societal impact will be no less dramatic, from paving the way for safe and efficient navigation, helping secure water and electrical infrastructure from state and non-state actors, and rapidly advancing materials and energy solutions that can help catapult society into the next technological age.

***Dual-use*:** technologies with national security and civilian applications. Quantum tech is inherently dual-use because of its role in precision sensing, communication security, and high-power computation, enabling capabilities like GPS and radar systems that are the mainstay of civilian markets worth $10’s of billions.

In Engine Phase 1 (Years 1-2) we will (1) provide launch funding and commercial support to bridge the innovation ‘Valley of Death,’ (2) systematically address ecosystem barriers through capacity building, and (3) maintain rigorous evaluation metrics to ensure success. In Phase 2, organizations (both current and new partners) compete for large-scale investment to deploy the highest potential technologies identified in Phase 1).

***2) Place-based capacity building:*** The second prong of the Engine, PBCB efforts, are explicitly tied to the GCs. We bridge research, industry, and defense fields, creating efficient pathways to move quantum technologies from lab to market. We take inspiration from whole-ecosystem models successfully deployed in places like South Korea, Taiwan, Northern Europe, and China to enable their respective dominance in critical technologies.[[10]](#endnote-11) By streamlining technological, entrepreneurial, tech transfer, and workforce resources, the Engine can continuously address bottlenecks to ensure that our ecosystem can iterate and scale quantum technologies faster than any other around the world. PBCB benefits both the teams leading GC efforts and the broader quantum ecosystem. Core partner organizations include UNM, Central New Mexico Community College (CNM), NM Institute of Mining and Technology (NMT), New Mexico State University (NMSU), SNL, LANL, Colorado School of Mines, University of Colorado Boulder (CU Boulder), Infleqtion, Icarus Quantum, Quantinuum, Roadrunner Venture Studios (RVS), and the State of NM.

Our two-pronged approach of tackling GCs and creating a quantum ecosystem through PBCB creates a cohesive Engine for sustainable technological advancement and US leadership. This builds on governance and monitoring systems established through EQ’s successful designation as America’s only Phase 2 Quantum Tech Hub. As an industry-led 501(c)(3), EQ represents a consortium of 120+ organizations united around accelerating quantum commercialization. EQ targets critical bottlenecks that existing labs, academic centers, and industry cannot solve independently, with a financially sustainable model to remain competitive for the long-term. EQ focuses on regional talent, with 90% local member organizations, but the hub’s capability and vision has attracted global leaders like Amazon, Google, Lockheed, Microsoft, and IBM.

EQ’s management team brings over three decades of experience leading complex technology initiatives and will ensure these investments drive meaningful technological, economic, and security outcomes for both the region and the nation. NM played a critical supporting role in the $127m investment focused on strengthening quantum capabilities in Colorado (CO) through the US EDA Tech Hub program that focused on mature industry clusters. Fully realizing quantum’s promise requires leveraging NM’s unparalleled expertise in quantum and national security to develop its nascent industry ecosystem into a global commercial leader.

Exhibit 1: Engine Approach

Next, we address the state of quantum technologies, their timeline to impact our GCs markets, and the unique capabilities of the Mountain West and NM that make it the ideal Engine location.

***State of quantum technologies:*** The first wave of quantum-dependent innovation—Quantum 1.0—delivered breakthroughs such as the transistor, the laser, and the atomic clocks that underpin both GPS and the internet, intrinsic to most advanced technology used today. We are entering the era of Quantum 2.0**,** with the potential to harness the full information-processing power of quantum physics. Innovations like quantum computing and quantum-enhanced sensing promise to unlock new frontiers from medicine and materials to national security and AI.[[11]](#endnote-12)

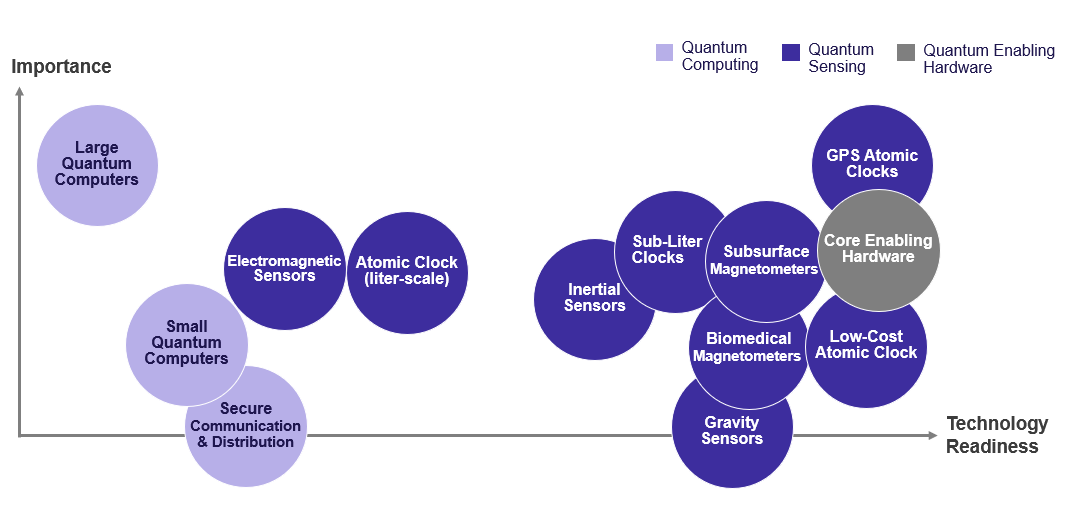
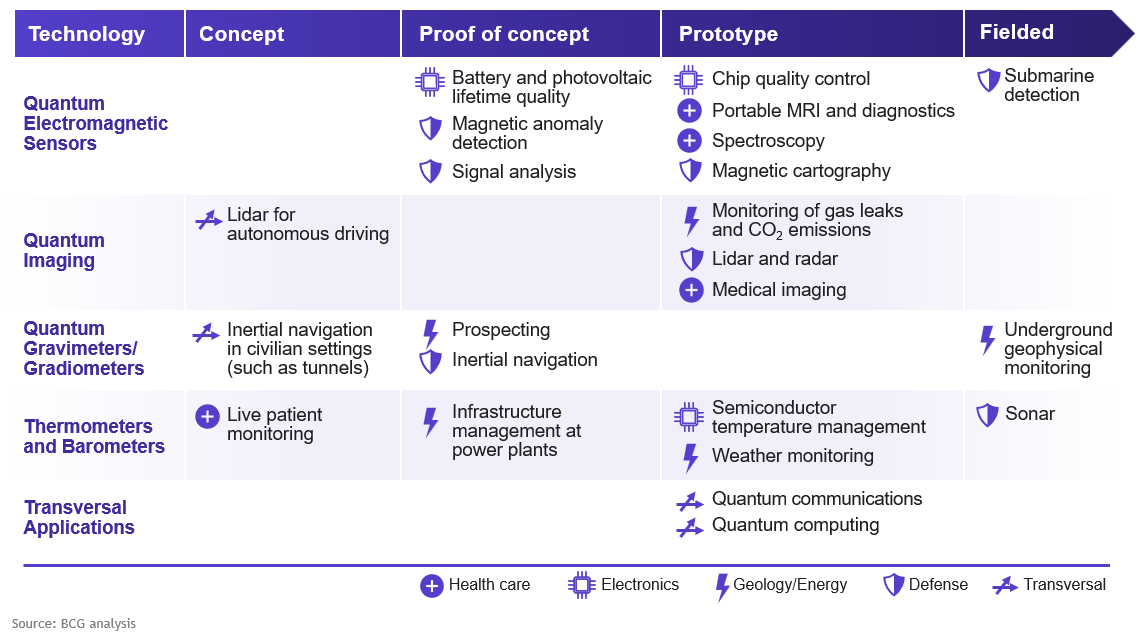
****Quantum sensing** uses the principles of quantum mechanics to measure physical properties with extraordinary precision. Technologies like quantum electromagnetic sensors, imaging, gravimeters and gradiometers, thermometers and barometers enable applications like next-generation GPS and MRI and are forecasted to generate $3–5bn in market value annually by 2030.[[12]](#endnote-13) Position, navigation, and timing (PNT) applications—the focus of the first GC—are some of the most technologically mature elements of Quantum 2.0. The Mountain West is a leader in both developing and deploying these next-generation capabilities.[[13]](#endnote-14)  The table in Exhibit 2 details these technologies.[[14]](#endnote-15) As with AI, putting a precise timeline on wide commercial adoption of quantum computing is difficult, but the potential to harness quantum mechanics to solve previously intractable problems is undeniable and the potential for unprecedented market and national security impacts is clear. Adapted from Department of Defense (DOD) data, Exhibit 3[[15]](#endnote-16) shows the deployment readiness of quantum technologies. Estimates suggest an impact in total GDP from quantum computing of as much as $3.5 trillion by 2040, with $450–850bn in new profits for end-users.[[16]](#endnote-17) Momentum within the quantum computing industry continues to build, with major players and startups driving R&D toward achieving customer utility. Since 2018, the number of physical qubits on a quantum circuit—a critical measure of computing capability—has doubled every one to two years,[[17]](#endnote-18) and in late 2024, Google’s Willow quantum processor demonstrated the potential for exponential error correction capabilities.[[18]](#endnote-19)

Exhibit 3: Deployment Readiness of Quantum Technologies for DOD

Exhibit 2: Commercial Maturity of Quantum Sensing Technology (Source: BCG)

***The Mountain West region is positioned to be the national quantum leader:*** The Mountain West is strategically positioned for US quantum advancements and especially for “existentially important” national security applications identified by DOD.[[19]](#endnote-20) The region boasts an unmatched 3,000+ commercial quantum jobs, 1,000+ researchers,[[20]](#endnote-21) and is home to 4 quantum Nobel laureates[[21]](#endnote-22) and the most quantum-focused organizations[[22]](#endnote-23) in the world (Exhibit 4), including one of the oldest quantum information science (QIS) A picture containing table

AI-generated content may be incorrect.research centers at UNM and 3 of the nation’s top 20 institutions for quantum research publications.[[23]](#endnote-24) The Mountain West also serves as the nation’s primary hub for critical enabling hardware essential to a secure US supply chain; all sub-kelvin cryogenics for quantum systems are either sourced from the Mountain West or imported.[[24]](#endnote-25) As one of only two areas nationwide hosting two combatant commands (Northern and Space Commands) and with the highest concentration of aerospace jobs in the country, the region’s infrastructure and expertise are unmatched. Paired with the world-class national security research conducted at LANL and SNL, the Mountain West is exceptionally well-prepared to advance quantum technologies for US strategic interests.

***The role of New Mexico:*** As the dual-use capital of quantum, NM is the natural fit for this Engine to serve citizens across the state and country. Engine leadership and activities will reside in NM with outside institutions partnering to help the Engine meet its goals.

Exhibit 4: Mountain West boasts 5 of Top 20 US Quantum Company Investments

NM is a vast reservoir of untapped scientific and entrepreneurial potential. Despite being home to more PhDs per capita than any other state[[25]](#endnote-26) and hosting world-class research facilities, it is among the poorest US states. This paradox stems largely from an economy dependent on volatile industries[[26]](#endnote-27) like oil and gas[[27]](#endnote-28) and film[[28]](#endnote-29) combined with limitations on the translation of research now fortunately being addressed.

Following the 2018 National Quantum Initiative (NQI), NM and CO accelerated collaboration in QIS, building on a history of sharing research excellence and intellectual capital since the 1950s. However, the partnerships’ commercial benefits have largely accrued to CO.[[29]](#endnote-30) This imbalance represents a significant inefficiency in America’s quantum innovation pipeline. The Center for Integrated Nanotechnology (CINT) and the Microsystems Engineering, Science and Applications (MESA) facilities at Sandia and Los Alamos national labs exemplify this challenge. Globally unparalleled in their quantum research and prototyping capabilities, historic federal policies make it difficult for these facilities to partner on things like modest commercial production runs.[[30]](#endnote-31) Companies routinely collaborate with MESA and CINT for groundbreaking research only to leave NM to commercialize and scale—taking jobs and economic opportunities with them.

This Engine aims to resolve these inefficiencies by forging pathways to commercialization while preserving the vital national security mission of NM’s research institutions. By working closely with the national labs and academic institutions, we can identify and bring to market promising technologies for commercialization. Through targeted investments in teams, facilities, capital, and administrative capacity, we will build an efficient lab-to-market pipeline to bring leading quantum companies to NM, form and retain top startups, and create thousands of jobs while advancing technologies critical to America’s prosperity.

Building off successful models like JILA—the joint institute between the National Institute of Standards and Technology (NIST) and CU Boulder—UNM, SNL, and LANL are forming a joint quantum effort. Launched in January 2024, the Quantum NM Institute (QNM-I), led by Professor Ivan Deutsch, bridges a world-class academic center of quantum science with national security researchers.[[31]](#endnote-32) QNM-I will foster groundbreaking science, translation of innovation to practice, and workforce development. Further, it offers a unique opportunity for the Engine to capitalize on. This Engine represents an ambitious yet achievable blueprint for unleashing NM’s unrealized potential and securing American leadership in the quantum revolution.

***The right time and place:*** The US stands at a pivotal moment in the global quantum race. For every dollar America is investing in quantum, China is spending over four (Exhibit 5).[[32]](#endnote-33) China has prioritized quantum technology since 2016 and is rapidly gaining ground in computing and sensing technologies while establishing clear leadership in quantum networking and supply chain development.[[33]](#endnote-34)

America faces a historic opportunity to continue its leadership in quantum technology that it missed for the semiconductor industry. Despite inventing the core technologies for semiconductor fabrication (the clean room, for example, was invented at SNL in NM), the US lost its manufacturing leadership to strategic, place-based investments in Asia, Israel, and Northern Europe.[[34]](#endnote-35) The $250bn CHIPS Act, while a bipartisan success and crucial step for US competitiveness, also shows the cost of playing catch up.[[35]](#endnote-36) As China undertakes for quantum the same industrial strategy that secured dominance in technologies like 5G –

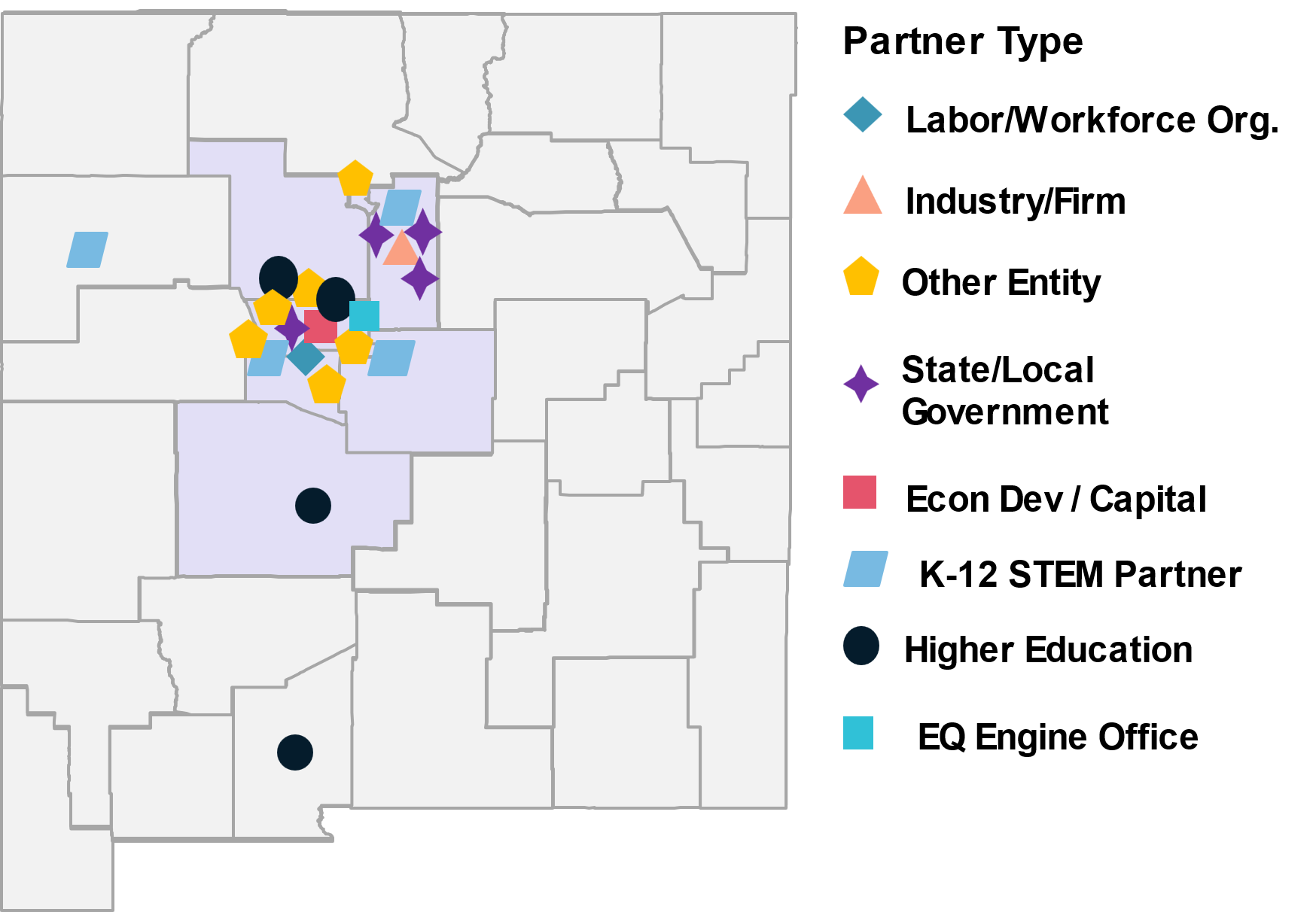
already moving from a non-player in quantum enabling technologies like sub-kelvin cryogenics to producing Graphical user interface, application, Teams

AI-generated content may be incorrect.over half of global research publications and nearly half of the world’s suppliers, as one example – the US must take decisive action to secure its geostrategic role.[[36]](#endnote-37)

Commercialization and market dominance happens fastest in ecosystems that have a seamless transition from use-inspired R&D to the entrepreneurs and industry that take those innovations to market. This Engine has assembled the strategy, the partners, and the resources to fully activate NM’s leading dual-use quantum cluster to transform a region long-overlooked into an engine of future economic vibrancy for all Americans.

***Proposed region of service:*** EQ was born as a region-wide partnership across NM, CO, and WY to cement US leadership in quantum. The organization has capabilities in two locations: a Denver/Boulder site with industry-focused fabrication and lab services and an Albuquerque lab focused on region-wide workforce and national security partnerships. This Engine will expand EQ’s NM Business Unit. Activities outlined in this application will infuse NM’s research ecosystem with translational expertise from CO’s industry, building a world-leading startup cluster with globally unique new and existing resources activated through the course of this Engine. Key metropolitan areas will be the primary focus, including Albuquerque, Santa Fe, and Los Alamos with ties back to the rural communities that form the region’s backbone (Exhibit 6). Strategic positioning along the Interstate-25 corridor – connecting southern NM to Northern WY - builds on decades of regional collaboration, combining NM’s leading R&D institutions with CO’s strong commercial ecosystem.

Exhibit 5: Investment in Quantum by Country

As an EPSCoR state,[[37]](#endnote-38) NM encompasses not just the nation’s highest percentage of Hispanic residents (over 50%) and a significant Native American population (11.2%), but also a substantial veteran community and large rural and working-class populations.[[38]](#endnote-39),[[39]](#endnote-40) NM’s largely rural population has missed out on the investments that have benefitted coastal tech hubs over the past two decades. Despite having the nation’s highest concentration of PhDs per capita, only 16% of NM’s workforce holds a bachelor’s degree[[40]](#endnote-41) (the national average is 34%). As a state, NM has seen limited economic benefits from the tech revolution it helped invent (Microsoft was founded in Albuquerque), highlighting both the challenges and opportunities ahead. Addressing these disparities through targeted economic development and improved infrastructure access is crucial for fostering growth for all Americans.

While historic R&D, technology, and workforce development initiatives have successfully boosted broad participation in urban tech centers, rural states have been overlooked. Our Engine will work closely with minority-serving institutions (MSIs),[[41]](#endnote-42) tribal communities, rural centers, community colleges, leading companies, R1 universities, and national labs to ensure the quantum revolution creates opportunities across NM.

Exhibit 6: Region of Service and Engine Partners

***Current state of practice and major gaps:*** NM’s quantum ecosystem possesses extraordinary research capabilities but remains commercially nascent (Exhibit 7). However, **the confluence of untapped human capital against an extraordinary legacy in technology innovation position NM as the nation’s most promising ecosystem for trajectory-setting investments in quantum technology**. Engine funding will enable the nascent ecosystem to mature over the next 10 years (Exhibit 7). This effort will be further accelerated by the historic commitments from the State of New Mexico. With strong bipartisan support for A picture containing graphical user interface

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Description automatically generatedquantum development, demonstrated through Governor Lujan Grisham’s commitment to introduce legislation to spur $800m of investments and the legislature’s sustained investment in research infrastructure, NM stands ready to transform its historical challenges into strategic advantages. State investments are underpinned by the strong support of the state-controlled $59bn fund, called the State Investment Council (see letter for details). This combination of world-leading technical capabilities, substantial financial resources, and aligned political interest creates an unprecedented opportunity to shape the future of quantum technology while building a more prosperous NM and US.

Exhibit 7: Maturity Assessment of 7 Key Drivers of Ecosystem Change

***Major gaps to New Mexico’s lasting leadership in the Mountain West and America***

While NM today represents one of the world’s great research centers of quantum information science, two historic gaps have held the state back from featuring a thriving industry to match its scientific prowess. The first is **a systemic disconnect from industry-anchored, use-inspired R&D.** This is a result of deliberate historic federal policy to isolate the then-sensitive national security research at LANL and SNL from external access. The second gap is **a lack of capacity—capital, talent, and infrastructure—to sustain a vibrant startup and industry ecosystem.** The co-location of national labs next to leading academic centers in places like San Francisco, Chicago, and Boston forged talent, developed capital, and built the infrastructure to create a vibrant startup ecosystem. New Mexicans missed out on this rising technical and economic tide.

Today, NM is positioned to change this narrative, thanks to evolving federal and lab policies culminating in the Quantum NM Institute. This Engine aims to develop two capabilities to overcome remaining gaps for regional and global excellence: anchoring R&D in commercially compelling GC applications with industry at the table and pairing historically large state investments with PBCB support from the NSF. The GCs are selected for large, significantly de-risked commercial markets and a prize structure incentivizing industry engagement from inception. PBCB represents the critical capital and know-how to develop the talent, culture, and physical infrastructure to make startup creation and industry scaling feasible in NM.

# Broader Impacts

***National and global impacts of quantum technology:*** Bill Phillips, a Nobel laureate from NIST, observed that, "quantum computers are more fundamentally different from current technology than the digital computer is from the abacus."[[42]](#endnote-43) Indeed, quantum technology represents one of humanity’s most transformative inventions with the potential to revolutionize modern life. From enabling breakthroughs in clean energy through improved catalysis and battery technology to accelerating drug discovery through precise molecular simulation, quantum technologies provide unprecedented tools to address our greatest challenges. In healthcare, quantum sensors promise to detect disease earlier through next-generation imaging, and quantum computers could unlock personalized medicine through complex biological systems simulations. Quantum systems could optimize energy grids, improve carbon capture, and even reverse environmental damage through engineered photosynthesis. National security implications are equally significant. According to the DOD, quantum technologies are "existentially important" to maintain America’s strategic advantages.[[43]](#endnote-44) From quantum-secure communications to enhanced sensing capabilities, quantum systems will reshape the security landscape. Leading countries will shape the standards and frameworks that govern quantum technology development and deployment. Conferring unprecedented advantages in cybersecurity, intelligence gathering, and defense, the consequences of falling behind in this technology race are as stark for our nation’s security as they are its economic vibrancy.

***Regional economic resilience and diversification:*** For NM, this Engine represents an unprecedented opportunity for economic transformation. Quantum computing alone is projected to unlock $3.5 trillion[[44]](#endnote-45) in annual economic value by 2040. By capitalizing on our unique quantum assets and expertise in nuclear and materials science, NM can lead this revolutionary industry. Currently reliant on volatile sectors like oil and gas and the film industry, the state can evolve a new high-tech industry to help diversify its core sectors and expand into other areas such as manufacturing. Quantum technology offers the opportunity, promising to generate tens of thousands of high-paying jobs[[45]](#endnote-46) while building lasting economic resilience.

***Workforce development and inclusive growth:*** This Engine will ensure the quantum revolution creates opportunities for all New Mexicans with over 8k jobs generating >$1bn in annual income expected to be generated over the next 10 years from these activities alone. Through partnerships with educational institutions, industry leaders, and community organizations, we will develop workforce training programs from K–12 through career, creating pathways to stable, well-paying careers across the state. Nearly half of quantum industry jobs nationwide do not require advanced degrees.[[46]](#endnote-47) In the Mountain West’s hardware-focused companies, that number approaches 80%.[[47]](#endnote-48) Our full-stack approach creates opportunities across the educational spectrum—PhDs conducting cutting-edge research, software engineers, skilled technicians, and machinists building quantum systems. With average annual salaries across all career levels of $125,000,[[48]](#endnote-49) these jobs offer the economic advancement and upward mobility that has defined America’s greatest technological successes. With the ensuing supplier ecosystem reaching every corner—including rural and tribal areas—EQ’s workforce development strategy ensures that quantum revolution benefits are distributed[[49]](#endnote-50) across the region.

This Engine will also address NM’s historical challenges in commercializing its extraordinary research capabilities. Through targeted support for entrepreneurs and stronger collaboration ties with existing industry partners, we will build robust pathways for translating breakthrough innovations into market impact. Our combination of GCs and PBCB creates a comprehensive framework for nurturing quantum companies from inception through scale-up, supported by unprecedented access to capital and expertise.

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| **Building Tomorrow’s Quantum Workforce: Clara’s Story (Name Changed for Privacy)**  When Clara joined Maybell Quantum as a contract technician, she brought raw talent, determination, and the precision skills that are invaluable in quantum technology, honed through a history of working on wiring systems for satellites. What she didn’t bring was a high school diploma. Six weeks into her contract, Maybell leadership learned that Clara was living in her car to pay down debt after losing housing from an adoptive family. Reflecting her unique skills and exceptional fortitude, the company offered a signing bonus and permanent employment that enabled her to secure housing. Today, Clara is one of a select few worldwide who can fabricate the sophisticated silver nanostructures essential for ultra-low temperature heat exchangers. While pursuing her engineering degree, she plays an integral role in building America’s quantum computing infrastructure. Her journey exemplifies the opportunity quantum offers for economic mobility -nearly 90% of Maybell’s employees come from non-traditional backgrounds. As infrastructure for the quantum revolution is built, so are new pathways to the American dream. |

# Key Drivers of Ecosystem Change

The program solicitation identifies seven key drivers of ecosystem change necessary for success, outlined below. Our dual-pronged strategy of combining GCs with PBCB optimally addresses these drivers in the quantum context. This strategy will accelerate quantum innovation while ensuring quantum revolution benefits strengthen our region and our nation.

*Table 1: Key Goals and 10-Year Outcomes across Pillars and Drivers*

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| Engine Pillars | Key Drivers | Key Goals | Expected 10-Year Outcomes | App Section |
| Crosscutting Initiatives | Governance & Management | Establish effective NM leadership team and governance practices reflective of all state stakeholders | * Clear and effective vision, strategy, and execution of Engine goals * Nationally recognized NM scientific, workforce, and commercial leadership | Proposing Team and Organizational Structure (B) |

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| --- | --- | --- | --- | --- |
| Engine Pillars | Key Drivers | Key Goals | Expected 10-Year Outcomes | App Section |
| Crosscutting Initiatives | Cross-Sector Partnerships | Locally based, globally leading industry cluster infused with NM research and state stakeholders | * 5 of top 10 commercial quantum players by market cap have permanent presence in NM | Strategic and Implementation Plans (C1) |
| Use-Inspired R&D | Successful development of critical dual-use technologies through partnerships between industry, academia, and national labs | * 1–2 GC technologies driven to technology/manufacturing readiness level (TRL/MRL) of 7+ with commercial orders of $500m+ | Strategic and Implementation Plans (C2) |
| Grand Challenges | Translation of Innovation to Practice | Permanent pathways for technology translation from NM research institutions to world leading companies | * 10x+ tech transfer agreements from national labs and local universities * 10 new quantum startups established with 2 major series A/growth round per year | Strategic and Implementation Plans (C3) |
| Place-Based Capacity Building | Workforce Development | Develop diverse, skilled talent for quantum technologies in NM | * 8,000 direct, indirect, and induced jobs * Entrepreneurship training for 50 potential founders per year by year 10 * 4 new degree programs | Strategic and Implementation Plans (C4) |
| Inclusive Engagement | Make NM the home of quantum industry, research, and jobs for all New Mexicans | * Quantum jobs supplied by groups including rural, veteran, tribal, and Hispanic communities * Learning pathways for quantum education core region of service schools. | Strategic and Implementation Plans (C5) |
| Strategic Regional Investment & Sustainable Capital | Secure sustainable capital and quantum infrastructure through public-private partnerships and dedicated funding mechanisms | * $1bn+ committed quantum funds * $500m+ raised by NM-based companies | Strategic and Implementation Plans (C6) |

# B. Proposing Team and Organizational Structure

***Lead Organization:*** The Engine will be led by a dedicated team from EQ’s NM Business Unit based in the state that oversees a broad group of stakeholders. This team will leverage the full resources of the EQ organization—a 501(c)(3) non-profit led consortium of over 120 organizations across the Mountain West—allowing for comprehensive and effective ecosystem alignment, administration, thought leadership, team selection, project evaluation, and integration of all partner organizations in pursuit of a common goal. With prime-age employment gaps as high as 65%, rural territories covering more than 250k square miles,[[50]](#endnote-51) and more than a dozen MSIs, NM, CO, and WY (two as EPSCoR states) are backing EQ. While 90% of EQ’s members are local, industry giants like Amazon, IBM, Google, and Microsoft join the ranks of 32 institutions of higher education, 25 economic development organizations, 5 federal labs, 17 labor and workforce groups, and 10 government entities to *radically accelerate the commercialization of quantum technology*. This powerful alliance bridges research and market needs, aligning regional strategies with unparalleled expertise and infrastructure.

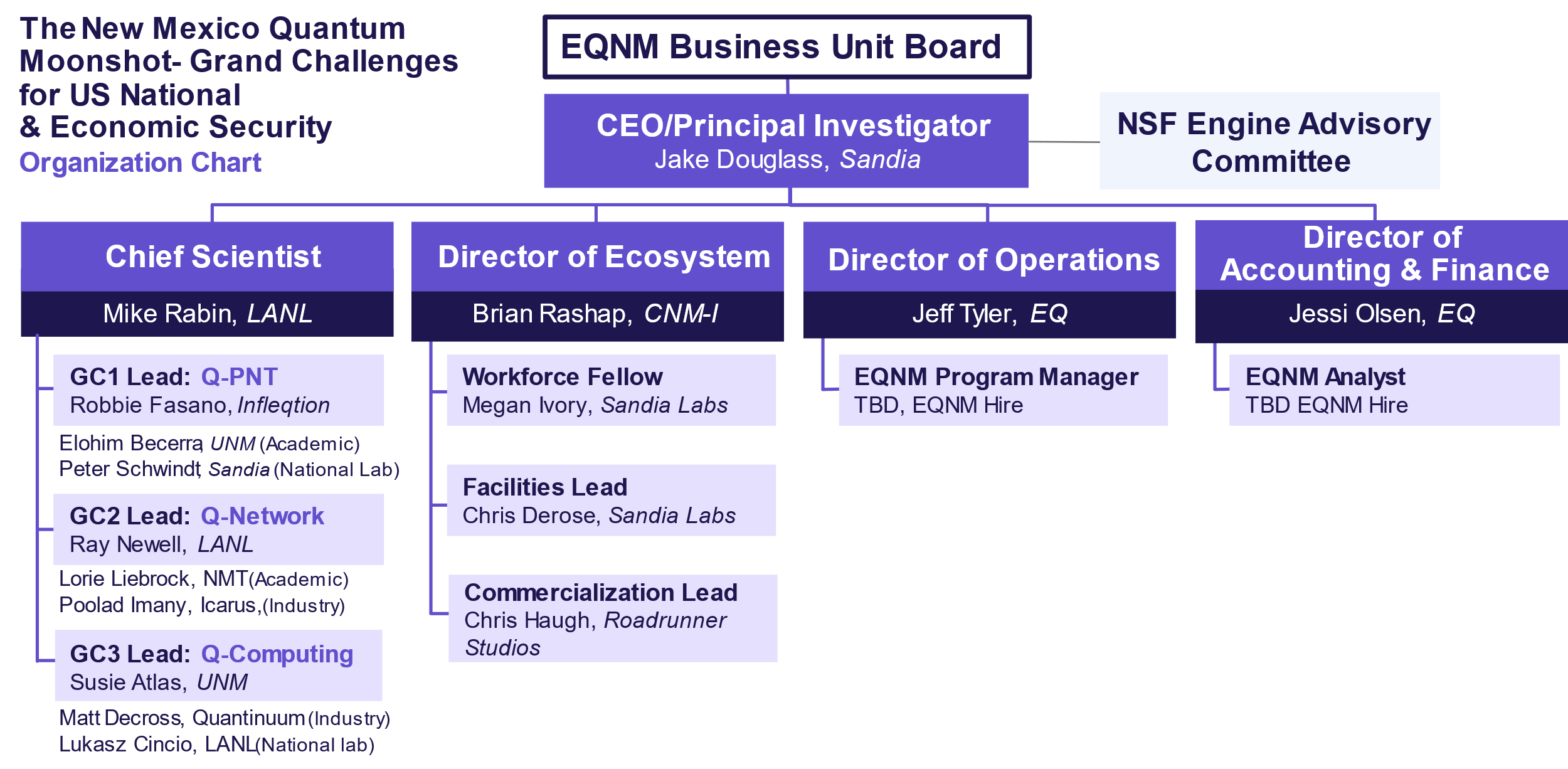
This Engine will leverage the more mature advanced technology and economic development infrastructure from CO and extend it to NM. Senior government stakeholders in CO are industry and nationally recognized leaders in advanced tech development, with individuals like Wendy Lea, National Advisory Council on Innovation and Entrepreneurship board member, and Scott Davis and Corban Tillemann-Dick, both board members of the QED-C. EQ will provide the Engine with invaluable talent and capital to leverage for better deployment of NM-focused programming. EQ’s overarching economic development, monitoring and evaluation, accounting, legal, and HR programs are already funded by the Tech Hub program and state resources, along with major aspects of a workforce development agenda. All of this infrastructure and know-how will support the Engine with dramatically less capital and effort than starting an organization from scratch.

Exhibit 8: Elevate Quantum New Mexico Organizational Chart

***Project Leadership:*** The NM EQ team will oversee the Engine (Exhibit 8). The Engine CEO will oversee all Engine activities and serve on the EQ senior leadership team, reporting to **Zachary Yerushalmi (PI)**, CEO of EQ. Engine activities will operate as a business unit with a dedicated team and director in the region of service. **Jake Douglass (Senior/Key)** will serve as the CEO and lead efforts in close partnership with Engine co-PIs based in Albuquerque. Jake Douglass is the Quantum Business Development Leader at Sandia. Born in Roswell, educated at NMT, and a BD leader at Sandia, Jake has the experience, capacity, and cross-sector trust throughout New Mexico that is needed in an Engine CEO. A chief scientist responsible for coordinating across all three GC efforts will ensure cohesiveness and maximize impact. **Dr.** **Michael Rabin (co-PI) from LANL** will serve as interim chief scientist. EQ employees, working with Jake Douglass will oversee other Engine roles including the director of operations (DO), responsible for organization-wide operations and program management (including accounting of subcontractors) and run day-to-day operations, alongside a director of accounting and finance (DAF) responsible for financial reporting for the organization and oversee reporting, grant management, and all activities of the analyst. Finally, the director of ecosystem (DE) will be responsible for leading crosscutting initiatives and PBCB activities. **Brian Rashap (senior/key)** will serve as interim DE. A workforce fellow, commercialization lead, and facilities lead will support the DE to coordinate across all Engine stakeholders. EQ will work closely with interim Engine leadership to execute Engine goals until full-time employees are hired, planned in the first 3 months of Engine operations.

***Engine oversight****:* The EQ Executive Board retains ultimate fiduciary responsibility for activities across the organization, with specific oversight of The Engine under the purview of the EQ NM Business Unit Board. Chaired by Corban Tillemann-Dick, CEO of Maybell Quantum and a former partner at the BCG, the EQ Executive Board represents senior leaders from a broad variety of entity types, featuring members with extensive experience leading R1 universities, quantum companies, ecosystem development organizations, and $10bn+ companies. Zachary Yerushalmi, CEO, is a founding member of the world’s largest university-focused venture studio and accelerator at the University of Oxford. The EQ Executive Board will oversee all EQ operations, including reporting. Two advisory boards (Science and Industry) and the Elevate Quantum Workforce Collaborative (EQWC) support the EQ Board and connect with EQ’s 120+ member organizations, engaging the regional community to build a thriving and equitable workforce. These bodies will serve key ecosystem stakeholders, ensuring that quantum in the Mountain West flourishes and represents everyone in this region. ***EQNM Business Unit Board (BUB):*** The Engine CEO and leadership team will report to the EQNM BUB, a formal legal entity running EQ’s NM operations and positioned to run the Engine effectively, ethically, and within the bounds of the award. The EQNM BUB is a legal subsidiary and subcommittee of the EQ Executive Board and represents institutions best suited to drive Engine goals for advancing science in lockstep with commercialization. UNM, SNL, and LANL play key ecosystem and national roles driving quantum science. Zachary Yerushalmi, Chair of the Business Unit Board and CEO of EQ, will help infuse the voice of industry members. **Alex Greenberg** **(co-PI)**, economic development advisor to the Governor of NM, will ensure a strong partnership with state priorities and investment. Finally, Wendy Lea will bring decades of economic development leadership. The EQNM BUB will report and serve on the EQ Board to ensure organizational continuity.

*Table 2: Core leadership and EQNM Business Unit Board (BUB)*

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Role | Affiliation |  |
| Zachary Yerushalmi | Elevate Quantum CEO | EQ | EQNM BUB |
| Alex Greenberg | Economic Development Advisor | NM Gov Office | EQNM BUB |
| Ellen Fisher | VP of Research | UNM | EQNM BUB |
| Reno Sanchez | Director of MESA | SNL | EQNM BUB |
| Wendy Lea | Board Director | EQ | EQNM BUB |
| Jake Douglass | CEO | SNL | Core Leadership |
| Michael Rabin | Chief Scientist | LANL | Core Leadership |
| Brian Rashap | Director of Ecosystem | CNM-I | Core Leadership |
| Jessi Olsen | Director of Accounting and Finance | EQ | Core Leadership |
| Jeff Tyler | Director of Operations | EQ | Core Leadership |

***Engine Advisory Committee***: In addition to Engine leadership and EQ, an Engine Advisory Committee (EAC) will be established, made up of Engine co-PIs, key leadership from core partners and EQ advisory boards. The Advisory committee will comprise stakeholders across national security organizations, industry partners, economic development experts, and workforce development professionals. Led by UNM’s **Ivan Deutsch (co-PI)**, the committee will meet no less than quarterly with the Engine leadership team to discuss Engine status, provide strategic guidance on maximizing regional impact, and to ensure core organizations are appropriately engaged in Engine programming. See Table 3 for EQC composition.

*Table 3: Advisory Committee \*\*indicates NM Subcommittee participation*

|  |  |
| --- | --- |
| Committee | Committee Members |
| Science Advisory Board | Co-chairs: Margaret Martonosi (**Princeton**) and Jun Ye (**CU**) | Members: Michael Rabin (**LANL**)\*\*, Ivan Deutsch (**UNM**)\*\*, Lincoln Carr (**Mines**)\*\*, Michael Chen (**Harvard**), Scott Diddams (**CU**) ,Cindy Regal (**CU**), Ben Bloom (**Atom Computing**) |
| Industry Advisory Board | Chair: Kaniah Konkoly-Thege (**Quantinuum**) | Members: Matt Kinsella (**Infleqtion**), Scott Davis (**Vescent**)\*\*, Sristy Agrawal (**Mesa Quantum**), Michael Brett (**AWS**), Bob Wold (**Quantum Rings**), Michael Hayduk (**AFRL**), Josh West (**FormFactor**) |
| EQ Workforce Collaborative | Co-chairs: Lucy Sanders (**CU Boulder**) and Jake Douglas (**SNL**)\*\* | Chairman: Manuel Heart (**Ute Mountain Ute Tribe**) | Members: Helen Hayes (**ActivateWork**), Danielle Couger (**Lockheed**), Joelle Martinez (**Latino Leadership Institute**), Joe McBreen (**St. Vrain Valley School**), Chris Gustavson (**CU Boulder**), Yolanda Lozano (**CS Alliance**)\*\*, Lindsay Box (**Southern Ute**), Susan Schwamberger (**Quantinuum**), Emily Edwards (**National K-12 Education Partnership**), Bryant Preston (**AFL-CIO**), Bradley Holt (**IBM**), Renise Walker (**CWDC**), Susan Atlas (**UNM**)\*\* |

***Technical Leadership:*** To provide impactful quantum dual-use technologies, the Engine will leverage the experience and expertise in developing quantum technologies for national security applications of our chief scientist. Additionally, close coordination with technical experts from industry, academia, and national labs will drive efforts to innovate and commercialize quantum technology. The chief scientist will work closely with leadership from each GC, which will be co-led bytechnical experts on each topic. **Quantum Sensing for Next-Generation Navigation**: Led by *Infleqtion,* a world-leader in cold-atom technology that will provide technology leadership and deep industry experience, with *SNL* supplying critical engineering and applied R&D expertise, and *UNM* providing both use-inspired research excellence and leading workforce development programming. **Quantum Networking for Critical Infrastructure Security**: Led by *LANL*, a pioneer in quantum networking R&D, with leadership support from *Icarus Quantum* for expert industry insight and *NMT* for R&D and workforce development expertise. **Quantum Computing & Algorithms for** **The Next Revolution for Materials Science and Chemistry**: Led by *UNM,* with support from *LANL* and Quantinuum, for deep expertise in materials science, computational chemistry, quantum computing, and quantum machine learning, and QIS with significant strengths in quantum and computational chemistry, driving advancements in commercially relevant quantum computing use cases. **Place-Based Capacity Building:** *EQ team in NM* to provide comprehensive governance, *SNL and Colorado School of Mines* to provide leadership on fabrication, testing, and tech support coordination, *EQ Workforce Collaborative and CNM-I* to provide workforce development leadership, and *Roadrunner Venture Studio (RVS) and NM state partners* providing entrepreneurial support in NM.

***Key Stakeholders and Partners:*** A wide coalition of partners will support the Engine. We aim to deliberately grow and strengthen our region through PBCB activities made accessible to the entire ecosystem. Current stakeholder and partner institutions can be seen in Table 4.

*Table 4: Committed NSF Engine Organizations.*

|  |  |
| --- | --- |
| Academia | UNM, CNM, NMSU, NMT, CU Boulder, Colorado School of Mines |
| National Labs | LANL, SNL, AFRL, NIST, and National Renewable Energy Laboratory (NREL) |
| Industry | Quantinuum, Infleqtion, QuEra, IonQ, IBM, Atom Computing, Xairos, MESA, Octave, Vescent, Microsoft, Icarus Quantum, Lockheed, QCWare, Qrypt, ODMR, Honeywell |
| State & Regional Government | NM Governor’s office,NM Economic Development Department (EDD), NM Department of Workforce Solutions (NMDWS), NM Higher Education Department (NMHED), NM State Investment Council, City of Albuquerque Office of Economic Development, City of Santa Fe Office of Economic Development |
| Other partners | Explora Science Center and Children’s Museum of Albuquerque, Computer Science Alliance (CSA), Unitary Fund, NM EPSCOR, RVS, New Mexico Partnerships, Innosphere, NM Tech Council, Santa Fe Business Incubator, Albuquerque Regional Economic Alliance |

We have secured commitments for new resources valued at $327m. The State of New Mexico is committing to a legislative package with NSF Engine dedicated items that will provide $75m in tax incentives to industry partners doing business in NM. The tax incentive, if fully utilized, will require industry partners to spend $250m on capital expenditures in NM to receive the fully benefit. This, plus the additional in-kind contributions of $2.3m of other new resources to be committed by Engine partners, will support the creation of our innovation ecosystem, including technology translational infrastructure, workforce development, and entrepreneurial support. This represents invaluable backing, but nearly all funding for critical use-driven innovation is contingent on the grant of this NSF Engines award. In addition, the Engine has secured $1.32b in existing resources, including $368.5m from the State of NM, $697.5m in existing facility access, and $252.5m in other in-kind resources and investments from Engine partners.

This Engine will not include foreign organizations. It will include foreign (non-US-citizen) personnel as employees of partner organizations, as is typical for NSF-sponsored projects and partner organizations. The Engine supports noncitizen participation in strict adherence to applicable laws, regulations, and guidance, and only in cases where noncitizen employees provide capabilities essential to overall success.

***Governance and Management***

*Table 5: Engine Activities to Address Gaps—Key Driver: Governance & Management*

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| --- | --- |
| Key Goals | Establish effective NM leadership team and governance practices reflective of all stakeholders |
| State of Practice & Gaps | Emergent: EQ and QNM have laid the groundwork for governance, management, and coordination within the region; need to right size NM participation  Gap: Need convening mechanisms and management to drive progress and cut across silos |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90:** All full-time Engine personnel hired  **Y2:** Establish NM leadership team; define policies and practices to scale ecosystem (emergent)  **Y5:** Refine policies and practices as needed (grow)  **Y10:** Refine policies and practices as needed (mature) |
| Expected 10Y Outcomes | * 5 of top 10 commercial quantum players have permanent presence in NM |

*NOTE: The 6 other Key Drivers of Ecosystem Change are covered in Section C.*

***Goal*:** To drive the success of NM’s quantum initiatives, this Engine will establish an effective leadership team and robust governance practices. This team will bring together experts from industry, academia, national labs, and local communities, ensuring diverse representation and collaboration.

***State of practice, baseline data, and gaps:*** EQ and QNM-I have built a solid foundation for governance, management, and coordination within the region. Today, EQ’s structure is centered in CO, with QNM and NM government collaboration. As we operationalize the Engine, expanding EQ NM Business Unit operations is essential to meet our goals.

***Activities:*** Along with cross-sector partnerships, governance and management structure is a crosscutting initiative impacting both the GCs and PBCB programs. ***Engine Coordination and Business Rhythms:*** Our unified governance structure across NM and CO, alongside a national advisory board, will blend globally unique expertise with a robust local NM presence to undertake Engine activities. ***Strategic Alignment and Goal Setting*:** The Engine will employ a tiered governance structure to ensure alignment across stakeholders while maintaining efficient decision-making. The EQNM Business Unit Board, comprising senior leaders from industry, national labs, academia, and government, will ensure operational excellence and assist Engine leadership with overseeing the Engine’s major initiatives. The Engine Advisory Committee will provide independent expertise and perspective, while dedicated working groups for each GC and PBCB initiative enable focused execution. This structure will be supported by formal quarterly review processes where stakeholders evaluate progress against established metrics and adjust strategies as needed. Annual strategic planning sessions bring together the full consortium to refresh priorities and ensure continued alignment with both regional needs and national objectives. ***Partnership and Innovation Framework:*** To facilitate effective collaboration across our diverse stakeholder base, we will establish frameworks for partnership development and innovation management: (1) A standardized partnership agreement template, developed in consultation with national lab and industry partners, streamlines collaboration while protecting intellectual property and ensuring appropriate data sharing. (2) Standardized IP Tech Transfer policies for institutions of higher education and efficient tech transfer processes at participating national labs and federally funded research and development centers. (3) Regular innovation roundtables bring together researchers, entrepreneurs, and end-users to identify emerging opportunities and align R&D efforts with market needs. (4) Structured processes for technology assessment and commercialization support help partners navigate the transition from research to market impact. ***Community Engagement and Inclusive Leadership*:** Our leadership team brings connections across key stakeholder communities. Regular town halls and community feedback sessions were used to ensure our initiatives are responsive to local needs, while our Workforce Collaborative provides dedicated input channels. Both will remain key to our strategy. The Engine’s management team will participate in NSF-organized training and collaboration events to enhance our effectiveness and align with national priorities. We will structure our leadership roles to ensure adequate capacity for this significant time investment while maintaining operational excellence. ***Operational Excellence:*** Day-to-day operations will be managed through clear reporting structures and regular coordination meetings: (1) Weekly leadership team meetings align priorities across functional areas. (2) Monthly program reviews track progress on GCs and PBCB initiatives. (3) Quarterly Board Meetings and stakeholder updates ensure transparent outcome communication. (4) Annual independent assessments and reports to the States of NM and CO to provide objective impact evaluation. This framework ensures efficient execution while maintaining flexibility to respond to emerging opportunities and challenges.

***10-Year Outcomes:***Over the next decade, a dedicated local leadership team will deliver strategies and initiatives tailored to NM, driving quantum sector growth and solidifying the state’s position as a national innovation and commercialization leader in quantum technology. This team will also develop and implement policies and practices to guide cross-sector collaboration, technology advancement, and workforce development. These efforts ensure effective governance and long-term Engine success and sustainability.

# C. Strategic and Implementation Plans

Our Engine’s mission—to secure American leadership in quantum technology while building broad-based prosperity in NM—requires coordinated action across multiple dimensions. Our comprehensive strategy for achieving this mission is organized around NSF’s seven key drivers of ecosystem change. For each driver, we outline specific goals, the current state of practice, planned activities, and metrics across four time-horizons—the first 90 days, years 2, 5, and 10—creating a roadmap from initial capacity building through sustained ecosystem impact. This phased approach reflects both the urgency of the mission and the methodical work required to build lasting change. Specific actions are included for all drivers in the first 90 days. By year 2, we will have built a foundation for delivering tangible outcomes in our GCs and established the foundational capabilities in all PBCB initiatives. Year 5 marks our transition from building the technology foundation to driving impact beyond research, with multiple quantum technologies advancing toward commercialization and robust support enabling broad participation in the quantum economy. By year 10, we envision NM as a globally recognized leader in both quantum R&D and commercialization, with thriving industrial and research ecosystems generating opportunities across all communities.

Momentum is the fuel of major economic development initiatives. As an independent and nimble non-profit, EQ’s programing can deliver near-immediate impact. EQ has already developed all necessary governance, administration, accounting, and legal operating protocols across the region. Engine leadership is identified alongside high-impact initiatives that can be launched in the first 90 days across research, entrepreneurship, capital formation, and workforce development.

### C1: Cross-Sector Partnerships and Stakeholder Alignment.

*Table 6: Engine Activities to Address the Gaps—Key Driver: Cross-Sector Partnerships*

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| --- | --- |
| Key Goals | Locally based, globally leading industry cluster infused with NM research and state stakeholders |
| State of Practice & Gaps | Nascent: While the region is #1 for QED-C members, the bulk of our industry presence is concentrated in CO. Significant opportunity to improve partnership between academia, industry, national labs, and local gov.  Gap: Need for additional industry presence in NM and coordination across statewide efforts |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90:** Cross-sector initiatives kickoff, including GC teams programming and a meeting of the Elevate Quantum Workforce Collaborative  **Y2**: Two major commercial quantum organizations establish permanent presence in NM (nascent)  **Y5:** Expand collaboration among stakeholders to address systemic barriers and align quantum information science and technology (QIST) efforts with regional needs (emergent)  **Y10:** Five major commercial quantum organizations establish presence in NM (grow/mature) |
| Expected 10Y Outcomes | * 5 of top 10 commercial quantum players by market cap have permanent presence in NM |

***Goal:*** Our Engine will establish NM as a global leader in quantum technology partnerships by 2033 through increased commercial activity, documented economic benefits across urban and rural communities, and sustainable mechanisms for expanding partnership engagement. This partnership development approach creates a foundation for all Engine activities. Through coordination with our governance structures, these partnerships will accelerate GCs while creating sustained capacity for long-term ecosystem development.

***State of practice, baseline data, and gaps:*** The Mountain West’s quantum ecosystem benefits from decades of collaboration between industry, academia, and national security institutions. These partnerships, initially forged through dual-use technology development during the Manhattan Project, evolved into an innovation network that spans research excellence, commercial leadership, and national security expertise. Each member of the 120-organization EQ consortium has meaningful historical partnerships with multiple other members, creating a foundation of trust and shared mission that uniquely positions our region to accelerate quantum innovation. While our ecosystem demonstrates strong research partnerships, two critical gaps must be addressed to realize a vibrant quantum economy. First, despite world-leading research capabilities, NM has historically struggled to bridge the gap between laboratory innovation and commercial implementation. Second, we must expand our partnership network, deepening relationships with rural community groups, workforce development organizations, and arts and cultural institutions that can help communicate quantum’s potential to all communities.

***Activities*:** Cross-sector partnerships form the bedrock for this Engine, infusing the organization, its initiatives, and the ecosystem with the necessary relationships to deliver on quantum technology’s promise.

As a large public-private partnership, EQ can distill the needs of a diverse set of stakeholders and continuously solve for any challenges by leveraging existing consortium resources and partnering to identify and deliver new resources. To ensure that commercial organizations have the skilled workforce to be successful and all Americans can participate in the quantum economy, EQ created the EQWC—a collaborative to build a broad and deep quantum workforce development pipeline (Section C4).

The second major area for cross-sector partnerships is GCs collaboration (Use-Inspired R&D section). The GCs are designed to foster collaboration between varied partners, including academic labs, MSIs, and industry stakeholders to catalyze use-inspired R&D with transformative commercial potential. The outcome of these collaborations is not just technology, but lasting bonds that foster commercial organizations with novel ideas and research organizations with commercial channels to bring those ideas to market.

***10-Year Outcomes*:** Expanding partnerships across sectors will catalyze NM’s quantum ecosystem. As such, by the end of the 10 years, we expect 5 of the 10 largest quantum commercial players by market cap to have a permanent presence in NM. This progress will better position NM as a leader in QIS.

**C2: Use-Inspired Research and Development (R&D).**

*Table 7: Engine Activities to Address the Gaps—Key Driver: Use-Inspired R&D*

|  |  |
| --- | --- |
| Key Goals | Successful development of multiple critical, dual-use technologies through partnerships between industry, academia, and national labs |
| State of Practice & Gaps | Emergent: National lab community has significant use-inspired R&D programming; however, R&D needs partner with industry to expand beyond national labs to seed a local industry cluster  Gap: Need mechanism to break down silos between the "customers" of critical dual-use technology and the suppliers |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90**: All GC teams launch programs  **Y2:** Identify and prioritize 1-2 GC technologies based on likelihood of success  **Y5:** Accelerate development through network partnerships and pilot key technologies with TRL/MRL 7+ (emergent)  **Y10:** Major orders of $500m+ for GC technology (grow/mature) |
| Expected 10Y Outcomes | 1–2 GC technologies driven to TRL/MRL of 7+ with commercial orders of $500m+1 |

***Goal*:** At the end of 10 years, the Engine will drive the commercialization of multiple dual-use quantum technologies. As the nation’s largest dual-use quantum research ecosystem, NM is a natural home for this initiative. The GCs focus resources to drive the most promising quantum technologies to have commercial impact and use the lessons and infrastructure from initial focus technologies to forge permanent channels to commercialize transformational use-inspired R&D from the NM research ecosystem.

***State of practice, baseline data, and gaps:*** NM has too often been home to path-defining scientific breakthroughs, only to see its economic benefits materialize elsewhere. The semiconductor clean room was invented at SNL,[[51]](#endnote-52) Fairchild built its first cost-efficient semiconductor fab in the state,[[52]](#endnote-53) and Microsoft was founded in Albuquerque.[[53]](#endnote-54) In quantum, SNL fabricated ion traps delivered to partners across the world, including IonQ and Honeywell (now Quantinuum), and built the world’s smallest cold-atom chamber.[[54]](#endnote-55) The first deployed commercial optical clock[[55]](#endnote-56) was the basis for a product commercialized by Infleqtion. Even the idea of a neutral atom quantum computer, the technical basis for leading companies like QuEra, Infleqtion, and Atom Computing, was developed at UNM.[[56]](#endnote-57) However, in each case, the lasting economic impact—jobs, companies, and prosperity—took root in other regions. This pattern reveals a crucial gap: while NM excels at pioneering breakthrough technologies, it has historically lacked the integrated ecosystem needed to transform these innovations into lasting economic prosperity for its citizens.

Today’s quantum technology landscape presents both similar risks and unprecedented opportunities. NM possesses extraordinary quantum research capabilities through its national labs and universities, but these assets alone cannot guarantee economic success. Current federal initiatives, such as the Defense Advanced Research Projects Agency’s (DARPA’s) QBI, provide crucial support for use-inspired R&D, but focus on technical accomplishments rather than ecosystem development. Capacity-building programs like Tech Hubs are designed for regions that already have mature commercial translation capabilities like CO.

This Engine proposes a fundamentally new approach combining ambitious technical goals with systematic ecosystem development. Our GCs framework is specifically designed to address this gap. By structuring major technical initiatives around dual-use applications with clear commercial potential and simultaneously building the infrastructure, workforce, and support systems needed for long-term success, we create a framework where innovations born in NM can thrive here.

As the nation’s leader in use-inspired R&D for national security, NM has a uniquely strong foundation. LANL and SNL have a longstanding history of excellence in quantum use-inspired R&D. SNL’s Quantum Scientific Computing Open User Testbed gives researchers access to a trapped-ion quantum computing platform, enabling exploration of quantum algorithms and hardware. SNL also co-leads the Quantum Systems Accelerator, a flagship DOE National Quantum Information Science Research Center focused on building next-generation quantum systems. LANL’s central role in another DOE Center, the Quantum Science Center, complements this with a focus on discovering new quantum materials for quantum hardware, algorithm development, and new quantum sensors. These programs leverage the capabilities of DOE fabrication facilities and nanoscience user facilities, CINT and MESA, to advance quantum technologies.

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| --- |
| **The MESA Fab complex** comprises two co-joined semiconductor fabs, a 200 mm silicon fab and 100 mm-capable compound semiconductor fab with a combined 66,000 ft2 of cleanroom space. The MESA Fab complex includes broad heterogeneous integration capability, an additional packaging facility, a design center, and over 100 laboratories supporting extensive R&D, product development, and product testing. Research programs run side-by-side with production on shared, duplicate, and independent toolsets, providing a uniquely flexible, adaptable, responsive, and credible foundry environment that enables capabilities like MEMS, surface traps, and photonic integrated circuits for quantum applications.  **CINT**, a DOE nanoscience user facility with two locations in NM, provides the international community with expertise and facilities for nanoscience research. CINT’s 96,000 ft2 microelectronics facility in Albuquerque and 36,500 ft2 facility in Los Alamos include semiconductor-style cleanrooms with standard film deposition and lithography capability, e-beam lithography, and advanced nanoscale processing and characterization capabilities. Access is free for open science. Through the Engine, the team can streamline partnership opportunities with industry partners and accelerate knowledge and technology transfer efforts to support the emerging quantum economy in NM. |

***Activities:*** Each GC was chosen for transformative potential and commercialization. GC activities are structured into two distinct periods to maximize impact and ensure sustained progress and competition. In Phase 1, covering years 1–2 of the Engine, we plan to award select teams head-start investments of $1–3m, with specific, measurable deliverables. These initial funds are designed to kickstart promising projects and attract additional public and private resources while enabling healthy competition for the GCs’ major grant phase. Teams who did not receive Phase 1 funding still have a chance to win in Phase 2.

The primary GC incentive comes in Phase 2, where selected teams and other NM quantum community members compete for upwards of $100m each in state, EQ, and NSF funding. Phase 2 seeks to facilitate trajectory-shifting economic impact in years 3–10 of the Engine and guide the implementation of GC solutions. The Phase 2 selection process must be rigorous, independent, and completed in close coordination with NSF and national security stakeholders. An independent review panel of scientists, industry, users, workforce, and NM representatives will undertake a thorough review of GC proposals and make recommendations to the EQNM Business Unit for selection. This process balances outcome ownership with independent assessment. Findings will be published for consortium review.

The award size and open eligibility, combined with extensive investments in PBCB, will help spur investments in startups with relevant technology across the region and country. Phase 2 investments are calibrated as globally competitive Series B/C equivalent funding rounds, sized to bridge quantum technology companies to commercial scale. At $50–100m per project, these investments are large enough that any ambitious quantum company in America must seriously consider expanding operations to the region to compete, helping overcome traditional barriers to establishing operations in regions with nascent startup ecosystems. Critically, the potential for these substantial investments creates powerful incentives for venture capital firms to back earlier-stage companies pursuing GC-aligned innovations, as the awards could provide non-dilutive capital bridging to major commercial or national security contracts. The goal is to kick-start a cycle where venture funding flows to promising technologies, which then scale through GC awards to become anchors of sustainable regional economic development.

EQ instituted a rigorous process to determine the GCs and their teams. After an open call for applications to over 120 EQ members, an independent selection board of leading quantum scientists, industry experts, and entrepreneurs reviewed competitive bids from nearly 40 organizations. The board received applications from community colleges, startups, MSIs, national labs, large companies, and individual researchers, showcasing the strength of the region’s quantum ecosystem. Evaluating proposals based on intellectual merit, societal impact, team strength, and potential market size and risks, the selection board chose three GCs capable of driving trajectory-shifting national security and economic impact within 5-10 years.

To account for technology risk, this Engine chose only GCs relevant for large, proven markets like GPS navigation, network security, and computational materials/chemistry design. GC technology readiness level (TRL) is deliberately varied given the uncertain timeline for quantum technology development. Quantum technologies, particularly computing, could exhibit similar speed up to AI. We chose a portfolio of technologies to assess, from higher TRL quantum sensing for navigation to lower TRL algorithms for quantum computing. Initial NSF Engine funding is *insufficient* for teams to fully deliver on 2-year goals, requiring teams to invest internal resources or secure additional funds, thus fostering n committed and resourceful environment. The promise of substantial awards in later years will spur significant internal and private investment. This approach is already bearing fruit, with QuEra, Atom, IBM, and the government of New Mexico committing internal resources to amplify the impact of federal dollars among others.

***10-Year Outcomes*:** Using the GCs framework, the Engine will drive transformative research, commercial development, and sustained economic growth in NM. Over the next decade, GC technologies will be driven to TRL/MRL of 7+ with commercial orders of $500m+. We anticipate that the three GC target markets will be worth $125–295bn annually, from immediate-impact quantum sensing to computing capabilities.[[57]](#endnote-58), [[58]](#endnote-59)

*Table 8: Summary of Grand Challenges*

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| --- | --- | --- | --- |
| **Characteristic** | **GC1: Sensing -Next Generation Navigation** | **GC2: Comms - Critical Infrastructure Security** | **GC3: Compute & Algos - The Next Revolution in Materials Science and Chemistry** |
| Commercial problem | Safe, efficient navigation not reliant on GPS | Infrastructure resilient to quantum and classical attacks | Unlocking intractable problems in materials science and chemistry |
| Solutions | Quantum PNT tech for resilient GPS-free navigation | Quantum enhanced networks that can safely and efficiently manage critical infrastructure | Quantum compute outperforming classical materials/chemistry design approaches |
| Time to Market Adoption | 5 years | 7–10 years | 10 years |
| Technical Maturity | Medium TRL (4–6) | Medium TRL (3-5) | Low TRL (2–3) |
| Primary Markets | Defense/navigation | Infrastructure | Materials/chemistry |
| Market Size (2035) | $10–20bn | $20-30bn | $100-250bn |
| Key Technical Hurdle | Miniaturization | System integration | Error correction; system scale |
| Primary Partners | Natl Labs/Industry | Utilities/Tech Companies | Computing Companies/Natl Labs |
| Risk Profile | Medium | Medium-high | High |

***C2.1. Grand Challenge 1: Quantum Sensing for Next-Generation Navigation.***

***National and economic security context:***From automated factory operations to critical infrastructure, GPS availability is the backbone of our modern economy, generating over $1 trillion in value.[[59]](#endnote-60) The vulnerability of GPS-based PNT systems—reliant on easily disrupted satellite links—represents a critical national security risk, as demonstrated by Russia’s successful defeat of advanced US weapons systems in Ukraine [[60]](#endnote-61) and Iran’s seizure and reverse-engineering of a US RQ-170 drone,[[61]](#endnote-62) both achieved through GPS spoofing. PNT also underpins modern civilian infrastructure, from financial transactions to manufacturing, and GPS disruption is estimated to pose a $1bn/day threat to the US economy.[[62]](#endnote-63) Consequently, PNT security is recognized as essential for economic stability, leading to mandates for public-private cooperation towards developing alternative non-GPS PNT technologies.[[63]](#endnote-64) Recent incidents of GPS interference grounding commercial aircraft from Estonia to Newark highlight the growing impact of these vulnerabilities. Accordingly, the DOD defines quantum PNT—requiring the combination of multiple quantum sensing technologies—as "existentially important," recognizing its crucial role in maintaining military advantage and protecting civilian infrastructure.[[64]](#endnote-65) The criticality of next-generation PNT solutions will create a large dual-use market opportunity of at least $10bn annually.[[65]](#endnote-66)

***Goal:*** Accelerated development and deployment of quantum sensing technologies to solve critical, real-world PNT challenges. In 5 years, demonstrate and commercialize sub-liter, field-deployable atomic clocks. In 10 years, demonstrate small package, vacuum compatible,[[66]](#endnote-67), [[67]](#endnote-68) and fieldable inertial/gravity sensors based on cold-atom interferometers,[[68]](#endnote-69), [[69]](#endnote-70) and compact, robust magnetic sensors for enhanced positioning and navigation,[[70]](#endnote-71) providing robust, accurate, and un-spoofable PNT capabilities for defense and civilian applications. This effort will transform the PNT landscape by developing miniaturized, high accuracy, and robust timing, inertial sensing and navigation systems that maintain PNT accuracy and precision in GPS-denied environments. This initiative combines three quantum technologies—atomic clocks, magnetometers, and inertial sensors—to create a complete quantum PNT solution that addresses critical national security vulnerabilities while opening new commercial markets (aviation, autonomy, networking, and more). The Mountain West’s concentration of quantum expertise and national security users positions it to become the dominant global ecosystem for scaled commercialization of next-generation PNT solutions.

***Current State & Technical Challenges*:** The development of field-deployable quantum PNT systems faces several fundamental challenges. Optical atomic clocks offer unprecedented timing precision and accuracy, but require complex configurations including atomic lattices, ion arrays, frequency combs, and high-power, narrow-linewidth lasers, which challenge efforts towards size, weight, and power (SWaP) reduction and reliability. Simpler clocks based on thermal atomic ensembles or microwave transitions in trapped ions offer a path to advanced commercial systems but require advancement in supporting technologies (see below). Similarly, atom interferometers face significant hurdles in maintaining long coherence times, reducing angular random walk errors, and achieving miniaturization. Current state-of-the-art packages occupy 30 liters and weigh >30 kg, far from field-deployment requirements. Spin-precession magnetometers based on NV centers and atomic vapors can enable compact, robust magnetic field sensing for magnetic navigation with the current highest accuracy. However, mass production, miniaturization, and commercialization require a coordinated effort across academia, national labs, and industry, which is lacking in the region and across the country.

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| **Technical Highlight: Atomic Clocks**  Atomic clock development focuses on (1) microwave Rb chip-scale atomic clocks using coherent population trapping, (2) two-photon optical Rb clocks employing 778 nm direct excitation, and (3) trapped Yb+ ion microwave clocks leveraging long coherence times. Critical technical innovations include: 1.) Developing ASIC-integrated laser control electronics achieving sub-100μW power consumption. 2.) Implementing microfabricated vapor cells with integrated getters maintaining 10-9 Torr vacuum. 3.) Creating monolithic optical frequency combs with <100 Hz linewidth for optical-to-microwave conversion. 4.) Integrating ion traps with 10–11 fractional frequency stability over 104 seconds  Primary technical barriers center on maintaining quantum coherence while dramatically reducing SWaP. Novel approaches include using thermal atomic ensembles rather than cold atoms, developing miniaturized vacuum systems with passive pumping, quantum optimal readout of spin and atomic inertial sensors, quantum control techniques to enhance robustness to noise and sensitivities,[[71]](#endnote-72) and deploying integrated photonic circuits and ASICs for laser delivery and control. |

***Team Profile*:** The Quantum Sensing for Navigation Grand Challenge team includes NM scientists in national laboratories (SNL, LANL, AFRL) and academia (UNM, NMSU) with regional industry partners (Infleqtion, Vescent, MesaQuantum, ODMR Technologies, Honeywell). This team is led by Robbie Fasano (Infleqtion) in collaboration with Prof. Elohim Becerra (UNM) and Dr. Peter Schwindt (SNL). The team is uniquely positioned to leverage its significant scientific resources, national laboratories, world-class fabrication facilities, and diverse academic institutions to drive technological innovation in Q-PNT.

***Activities & Milestones*: Years 0–2:** The initial phase focuses on rigorous assessment of quantum sensing approaches for PNT solutions alongside detailed commercialization planning. Key activities include developing a comprehensive commercialization report detailing TRLs; identifying new areas for developing next-generation Q-PNT sensors; establishing support mechanisms and technology transfer and licensing agreements for NM-based startups; developing new protocols for the preparation, characterization, and control of quantum sensors;[[72]](#endnote-73) and identifying supporting technologies ready for ASIC transfer. This phase will establish clear pathways for developing the innovation ecosystem in NM while forming strategic industry partnerships and identifying end users. It will also assess the potential of this GC to continue beyond year 2. **Years 2–5:** Teams selected for Phase 2 funding will develop fieldable versions of technologies, including vapor cell atomic and Yb+ microwave clocks, scalar[[73]](#endnote-74) and vector[[74]](#endnote-75) atomic magnetometers, and inertial sensing platforms. Success will be measured through successful collaboration with industry partners, increased external investment, capability demonstration in relevant or simulated environments, and establishment of clear production and commercialization pathways. **Years 6–10:** The final phase will focus on full commercialization of atomic clocks, magnetometers, and inertial sensors. Selected teams will demonstrate complete magnetic anomaly-aided navigation solutions and integration of quantum inertial sensors with inertial measurement units and atomic clocks for both defense and civilian applications. This phase aims to establish a mature commercialization mechanism for Q-PNT technologies in NM, supported by strong partnerships among industry, academia, and national laboratories.

***Expected Outcomes*:** The successful development of quantum PNT technologies will address critical national security vulnerabilities while creating substantial economic opportunities. Current estimates suggest the near-term economic impact could exceed $10-20bn annually. More importantly, these technologies will provide resilient navigation and timing capabilities essential for maintaining military advantage and ensuring the security of critical civilian infrastructure. The program will establish NM as an industry leader in quantum sensing, create hundreds of high-paying technical jobs, and foster a self-sustaining quantum technology ecosystem in the region. The GC1 thrust will serve as a vanguard effort to mature enabling technologies and establish lab-to-market pipelines, accelerating GC2 and GC3.

***C2.2. Grand Challenge 2: Quantum Networking for Critical Infrastructure Security***

***National and Economic Security Context:*** Cyber threats to information technology (IT) systems receive widespread attention, but operational technology (OT) systems are equally essential. These systems—the hardware and software that control and monitor physical devices, processes, and infrastructure—must be protected from malicious actors. The Stuxnet attack on Iranian nuclear facilities and recent actions targeting water systems in the US, Ukraine, and Israel demonstrate how compromised OT systems can harm or destroy critical infrastructure.[[75]](#endnote-76) Quantum technologies are progressing at a pace that moves us from “if” they pose a threat to "when." While many programs focus on the impact of quantum on IT systems, without preparation, quantum computing will similarly represent an unprecedented threat to our nation’s critical OT infrastructure. Like PNT, network threats underpin a major market opportunity of at least $20bn annually.[[76]](#endnote-77)

***Goal:*** A fielded hardware/software deployment of a Quantum OT-Secure Water and Electrical Grid within 7–10 years, providing quantum-enhanced security and resilience for critical infrastructure systems. This initiative will define and demonstrate a reference architecture for quantum-secured OT systems and show how real-world complex interconnected systems benefit from quantum technology at a cost that justifies broad deployment. Water and electric power transmission security are strategically chosen as the first foci because these networks have fewer end-nodes relative to data and financial networks. Success will set a foundation for expanded capabilities in additional large markets like financial and data security and establish the Mountain West and NM as the standard for quantum and post-quantum resilient OT ecosystems.[[77]](#endnote-78)

***Current State & Technical Challenges:*** Electric power generation, transmission, and distribution systems will undergo revolutionary modernization in the coming decade. Broader adoption of electric vehicles, increasing contribution from renewables, and utility-scale battery storage all motivate advances in monitoring and control throughout the network. These capabilities require built-in long-term security.[[78]](#endnote-79), [[79]](#endnote-80), [[80]](#endnote-81) Current OT networks are ill-prepared for the quantum computing threat to cryptographic standards; their resource constraints hinder adoption of quantum-safe cryptography. Complex interconnected systems can suffer from cascading failures, while gaps and overlaps in regulatory structures complicate unified security approaches. Quantum security technologies (including post-quantum cryptographic protocols) offer theoretical solutions but face significant hurdles in integration with existing infrastructure, maintaining low latency requirements, and achieving required reliability standards.

***Team Profile:*** The OT Security GC is spearheaded by LANL’s quantum networking team in partnership with NREL, Microsoft, Icarus Quantum, New Mexico Tech (NMT), SNL, and NMSU. LANL brings extensive experience in quantum networks for grid security and has demonstrated pioneering work in quantum random number generation and key management.[[81]](#endnote-82), [[82]](#endnote-83), [[83]](#endnote-84), [[84]](#endnote-85), [[85]](#endnote-86) NREL contributes expertise in energy grid resilience and integration of advanced technologies with existing infrastructure via its ARIES testbed.[[86]](#endnote-87) Microsoft provides classical computing infrastructure and post-quantum cryptography capabilities, bridging quantum and classical security domains. NMSU brings over 20 years of expertise in systems security and cryptography contributing to post-quantum cryptographic integration. NMT houses the NM Cybersecurity Center of Excellence, an industry-leading cybersecurity education and training program poised to grow into quantum security.[[87]](#endnote-88) Icarus will bring to market quantum-dot sources of non-classical light for high-security quantum networking hardware. The SNL team has experience in industry standards for critical infrastructure protection, having helped write the NERC-CIP standards currently in force.[[88]](#endnote-89)

***Activities & Milestones:* Years 0-2:** Initial focus will be on applied R&D to transition lab-tested quantum secured OT systems from participants’ laboratories into end products. In addition, scoping studies for integration into OT networks will be conducted. Primary activities include testing LANL’s quantum secure OT technologies in NM water and electric grid networks, integrating Icarus’s deterministic entangled photon sources, and developing a reference architecture for quantum-enhanced OT cybersecurity through collaboration with utility partners and cybersecurity experts. Selection for Phase 2 will depend on the technical and commercial feasibility of this integrated vision into a complete OT network on the Engine timeline of <10 years. To achieve this, each component will demonstrate robustness, scalability, and integrability into a complete, demo-scale OT network. **Years 2–5:** Phase 2 teams will focus on proof-of-concept demonstrations followed by real-world OT deployment in electric and water grid networks. Selected teams will work directly with utility and private-sector partners, leading to intellectual property development, technology transfer, creation of new startups, and expansion of existing companies. Resource concentration on the most promising approaches will ensure sufficient scale to achieve meaningful deployment. **Years 6–10:** Final phase focuses on widening the deployment ecosystem beyond initial water/electric grid demonstrations to more scaled scenarios.

***Expected Outcomes:***This initiative creates a new paradigm for critical infrastructure security, addressing both immediate cybersecurity concerns and future quantum threats. Quantum-secured OT networks will also enable more efficient resource management and enhanced grid resilience. The program will establish NM as a leader in quantum security architecture, creating high-value jobs in quantum technology and infrastructure while developing exportable solutions for global markets.

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| **Technical Highlight:** **Quantum Networking**  A comprehensive hardware/software integrated architecture needs to be designed for quantum systems that can be used as a bump-in-the-wire retrofit on existing industrial control systems and OT networks: (1) low-latency hybrid classical-quantum networking over shared optical transmission systems through optical/aerial fibers, (2) simultaneous quantum encryption and authentication done with long-lasting hardware module compatible with supervisory control and data acquisition (SCADA) systems, (3) software developed to use and manage quantum secure random keys for authenticated communications in both trusted/public distribution relay systems. Critical technical innovations include: Adapt tested and verified quantum random number generators to the OT network; Develop rack-compatible quantum encryption hardware module and verify NIST FIPS and NERC-CIP standards required for infrastructure suppliers and vendors; Migrate and upgrade the software in the application layer to post quantum cryptography; Develop deterministic integrated photonic modules such as entangled photon sources and waveguide-integrated single photon detectors for entanglement distribution, secure time transfer, and distributed sensing.  Primary technical barriers include environmental factors such as temperature, humidity and EM emissions from specialized power equipment which could impact hardware including optics/electronics and optical fiber polarizations. Advancements in additive manufacturing and rad-hard material coatings and boxes will help in passing environmental and prototyping/packaging tests. For multiple quantum-entangled inter-connected networks connecting different grid stations, efficient repeaters and transducers need to be developed. |

***C2.3 Grand Challenge 3: Quantum Computing & Algorithms for The Next Revolution in Material Science and Chemistry.***

***National and Economic Security Context:*** Quantum computing hardware—superconducting qubits, neutral atoms, trapped ions, and photonic qubits—has advanced at a breakneck pace since Google’s 2019 announcement of quantum advantage on an idealized sampling task.[[89]](#endnote-90) Useful quantum advantage, where a quantum computer outperforms classical supercomputers on a task of genuine scientific or commercial value, has yet to be demonstrated. Transformative advances in error correction and the demonstration of logical qubits with better performance than their physical components[[90]](#endnote-91), [[91]](#endnote-92) are moving quantum computing into the post-NISQ,[[92]](#endnote-93) fault-tolerant era, making useful quantum advantage likely to achieve in the next few years. This will be a pivotal moment for computing, and NM is positioned prepare for quantum computers to become capable of useful computations no prior device or method could achieve. The NM quantum ecosystem and team has quantum expertise, domain expertise, and a history of collaboration to potentially achieve practical quantum advantage in national and economic security applications sooner. Best estimates of the market size of quantum materials science and chemistry problems exceeds $100bn annually.[[93]](#endnote-94), [[94]](#endnote-95)

***Goal:*** Using a co-design strategy and leveraging the deep, collaborative expertise of domain and quantum computing scientists from academia, industry, and the two NM national laboratories, we will demonstrate *a quantum computing algorithmic framework, including software as well as hardware, capable of outperforming classical supercomputers* for commercially viable applications in chemistry and materials science over the next 10 years (Exhibit 9). A central hypothesis for GC3 is that our near-term advances in quantum computing algorithms will achieve crossover with hardware improvements. Fault-tolerant quantum computing promises decisive advantages for critical national and economic security applications such as novel catalyst design,[[95]](#endnote-96) new materials for extreme environments,[[96]](#endnote-97), [[97]](#endnote-98) and mission-critical energy technologies such as fuel cells.[[98]](#endnote-99) Many of these questions cannot be answered through any prior method. A large research program commissioned by DARPA[[99]](#endnote-100), [[100]](#endnote-101) identified chemistry and materials science as the most promising applications for achieving viable quantum advantage in the near-term. The heart of the challenge is the electron correlation problem: the challenge of computing the complex quantum mechanics of electrons interacting at the atomic scale with an accuracy that enables the rational, predictive design of real molecules and materials with targeted properties. In a special edition of *Science*, the correlation problem was named a key scientific challenge of the 21st century.[[101]](#endnote-102) In 2025, it remains the core technical puzzle at the center of quantum chemistry and materials calculations. This GC will tackle the correlation problem by bringing together scientists and quantum engineers to discover new approaches to map this problem onto emerging quantum computing hardware, enabling the solution of practical molecular and materials design challenges. Co-design is crucial and enables the coupled optimization of both hardware and application development. Understanding the needs of specific applications informs the design of future quantum computing technologies and error correction codes. Quantinuum has demonstrated co-design of hardware, low-level control, and circuits to accelerate near-term applications, including examples in materials science, physics, chemistry, biology, optimization, and machine learning.[[102]](#endnote-103), [[103]](#endnote-104), [[104]](#endnote-105), [[105]](#endnote-106)

Diagram

Description automatically generated***Current State of the Art and Technical Challenges:*** The promise of quantum computing for molecular and materials science is extraordinary: problems that would require impossibly large classical supercomputers could be solved by a quantum computing application on a moderately sized quantum computer. However, a new generation of algorithms is necessary to realize these in the near-term (Exhibit 9). The possibility of dramatic performance acceleration through algorithmic advances is well known from classical computing,[[106]](#endnote-107) and the more efficient simulation algorithms become, the sooner they are viable on early fault-tolerant (but not error-free) hardware. The path to practical quantum advantage requires innovation in algorithms, error correction or suppression schemes, and physical hardware. This necessitates collaboration between experts on low-level architectural details and scientists with domain knowledge and backgrounds in classical and quantum algorithms for simulating quantum systems.

Exhibit 9: Advances in algorithms can reduce the quantum computing resources needed.

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| **Technical Highlight: Quantum Computing/Algorithms**  In principle, quantum computers can address the Hilbert space dimension challenge by directly representing quantum states using superposition and entanglement. However, practical implementations require sophisticated algorithms to manipulate these states while managing resource constraints and noise. Current algorithms like quantum phase estimation (QPE)[[107]](#endnote-108) and variational quantum eigensolver (VQE)[[108]](#endnote-109), [[109]](#endnote-110) have promise but struggle with various limitations. Recent work on quantum imaginary time evolution (QITE)[[110]](#endnote-111) and quantum filter diagonalization (QFD)[[111]](#endnote-112) suggests new paths forward.  The key bottleneck in all approaches is the “ansatz”—the inspired guess for an initial trial state implemented as a parameterized quantum circuit and optimized. Current hardware-efficient ansätze lack the structure to efficiently represent many-body wavefunctions, while chemically motivated approaches like unitary coupled cluster (UCC)[[112]](#endnote-113) could require a prohibitive number of optimization parameters. Approaches using Givens rotation networks[[113]](#endnote-114) and tensor network-inspired circuits[[114]](#endnote-115) show promise but remain to be demonstrated for practical quantum simulation of a molecular system.[[115]](#endnote-116)  Progress requires developing algorithms that balance competing constraints while including error mitigation, which introduces additional overhead as systems scale. We expect to focus on structured ansätze that exploit physical symmetries; formal, theory-based constraints;[[116]](#endnote-117) and conservation laws[[117]](#endnote-118) while remaining implementable on imperfect hardware (e.g., Cartan decomposition-based circuits[[118]](#endnote-119)). These and new approaches will be actively developed by our team in search of best-suited techniques for quantum computers available to us. |

***Team Profile:*** The initiative is led by UNM and LANL, bringing together LANL’s deep expertise in materials science, computational chemistry, quantum computing and quantum machine learning[[119]](#endnote-120), [[120]](#endnote-121), [[121]](#endnote-122), [[122]](#endnote-123), [[123]](#endnote-124), [[124]](#endnote-125), [[125]](#endnote-126), [[126]](#endnote-127), [[127]](#endnote-128), [[128]](#endnote-129), [[129]](#endnote-130), [[130]](#endnote-131) with UNM’s strengths in quantum and computational chemistry, quantum information science, and quantum computing.[[131]](#endnote-132), [[132]](#endnote-133), [[133]](#endnote-134), [[134]](#endnote-135), [[135]](#endnote-136), [[136]](#endnote-137), [[137]](#endnote-138), [[138]](#endnote-139), [[139]](#endnote-140), [[140]](#endnote-141), [[141]](#endnote-142), [[142]](#endnote-143), [[143]](#endnote-144), [[144]](#endnote-145) Industry partners Atom Computing, Quantinuum, Quera, IBM, and IonQ provide essential quantum computing platforms and expertise. Partners from NMSU, NMT, and SNL form a comprehensive team spanning theory to application.

***Activities & Milestones:* Years 0–2:** The initial phase will develop a detailed analysis of classically intractable problems relevant to national security with strong industrial potential. Teams will work to demonstrate proof of concept for a co-design framework by publishing best-in-class computational chemistry results, establishing the foundation for practical quantum advantage. Selection for Phase 2 will depend on teams’ ability to show feasible algorithmic speed up of several orders of magnitude beyond current standards and a demonstrated commercial ecosystem to support associated startups. The GC3 bar is high to ensure the promise of quantum computing is matched with realistic and timely translational potential of this technology to the region in the Engine’s time horizon. **Years 2–5:** Phase 2 selected teams will focus on demonstrating quantum advantage, even if limited in scope, on commercially relevant problem sets. This will require integration between quantum algorithm development and experimental validation, concentrated on approaches with the clearest path to practical implementation. We expect the first hardware capable of practical quantum advantage to be available at the end of Phase 1 or early in Phase 2, based on published roadmaps from leading companies.[[145]](#endnote-146), [[146]](#endnote-147), [[147]](#endnote-148) **Years 6–10:** The final phase focuses on delivering fault-tolerant systems showing significant advantages over classical approaches for a broad array of commercially valuable applications. Selected teams will develop and deploy quantum software solutions that address real-world materials science and chemistry challenges.

***Expected Outcomes:*** Success in this initiative would mark one of the most significant advances ever in computational science. According to recent analysis,[[148]](#endnote-149), [[149]](#endnote-150) quantum computers addressing problems in materials science and computational chemistry could generate between $100-250bn annually in economic value. Specific applications like catalyst design for its $39bn industry[[150]](#endnote-151) could revolutionize energy storage, fuel cells, and artificial photosynthesis. These capabilities would accelerate critical materials development for national security and energy independence.

### C3: Translation of Innovation to Practice.

*Table 9: Engine Activities to Address the Gaps—Key Driver: Translation of Innovation to Practice*

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| Key Goals | Permanent pathways for tech transfer from NM research institutions to world-leading companies |
| State of Practice & Gaps | Nascent: Lack of integration between industry and academia inhibits bringing innovation from lab to market; commercial entities lack access to key NM resources and entrepreneurial support  Gap: Increase Q tech commercialization via new policies, facilities, entrepreneurial support |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90**: Short list of potential ventures for first ecosystem quantum startup  **Y2:** 2x tech transfer agreements at research institutions; Venture Studio (VS) creates 2+ quantum startups; NM state plan for entrepreneurial strategy developed and underway (nascent)  **Y5:** Recruit companies to fill 50% facilities; VS creates 5+ quantum startups per year (emergent)  **Y10:** 10x tech transfer agreements; VS creates 10+ quantum startups with 2 major funding rounds per year (grow/mature) |
| Expected 10Y Outcomes | * 10x+ tech transfer agreements from national labs, local univ. (CRADAs, license agreements) * 10 new quantum startups established per year with 2 major series A/growth rounds per year |

***Goal:*** This Engine aims to establish permanent channels to take use-inspired R&D to market. Over the next 10 years, translational activities will build off the GCs’ R&D to develop a sustainable translational ecosystem, cementing the leadership role of NM and the Mountain West in the quantum industry.

***State of practice, baseline data, and gaps:*** The disparity between research excellence and commercial implementation in NM’s quantum ecosystem demands a comprehensive and structured approach to market translation. While CO’s commercial quantum industry has achieved significant scale with over 3,000 professionals and more than $1bn in capital,[[151]](#endnote-152) NM’s commercial quantum sector remains nascent with fewer than 100 total employees and less than $10m raised.[[152]](#endnote-153)

A diagram of a company's development

AI-generated content may be incorrect.World-leading translational industry clusters continuously solve for innovation bottlenecks at every phase of technology and market readiness. Boston boasts not only a robust research ecosystem but features talent, infrastructure, and capital at every stage of a technology and market life cycle. In semiconductors, Belgium and Netherlands built a robust ecosystem with public-private partnerships between research institutions and companies to enhance the transistor technologies that power modern economies.

Exhibit 10: NM Incentive and Translation Programs

NM is already home to organizations with explicit translation remits for US government customers like AFRL, the center of the Air Force’s Quantum Sensing efforts, providing technical expertise and facilities to help companies mature and transition technologies for defense and commercial applications. This supported the emergence of a nascent space cluster in NM whose capabilities complement the quantum industry. The state also offers stackable incentive programs that encourage business formation (Exhibit 10), with the NM Economic Development Department launching the Quantum Technologies Award Pilot Program. Combined with programs that pay salaries for new employees (JTIP), assist infrastructure development (LEDAs), and offer technical assistance to companies (NM Small Business Assistance, TRGR Technology Readiness Initiative), local programs could drive significant value for industry partners. Yet, this capability is still nascent in NM because of a lack of integration between industry and academia. With historic investment from the State of New Mexico (section C6), this Engine identifies and solves these gaps in infrastructure access for industry and new startup formation to create permanent translation channels for quantum R&D to evolve to practice. Pairing these translational activities with GC outcomes gives a practical anchor and urgency to take critical ideas with commercial potential and drive them to market readiness and scale.

***Activities: Use-Inspired Research and Industry-Led Engagement:*** Use-inspired R&D is best positioned for translational success when industry is a close partner from the beginning of the innovation process. Our Engine proposes to leverage the GCs to create a strong monetary incentive to drive collaboration between partners in the state and beyond. GCs are structured to ensure NM and leading industry form tight, collaborative teams to undertake use-inspired research (Use-Inspired R&D section) that is valuable both for driving innovations and fostering connectivity. A prize-competition framework of $50–100m incentivizes even large companies to participate. Prize competitions are shown to help drive a range of scientific advancements.[[153]](#endnote-154) The GC prize competition creates a market signal to foster competition, but existing companies need additional place-based incentives to locate operations in new states. Combined with capital incentives (section C6l), access to critical infrastructure like fabs and facilities provides the missing ingredients for company expansion to NM.

***Technology Transfer in National Labs:*** While NM boasts some of the nation’s best infrastructure for quantum research and development, use-policies for these facilities are not tailored to industry needs. Coupled with the state’s historic disconnect with industry, the mismatch reinforces distance from commercially experienced organizations and translational impact. The demand for these facilities will be reinforced with the technology development requirements of the GCs.

To meet this swelling industry demand and the promise of commercialization in the state, SNL and LANL have undertaken major commitments to adapt technology transfer practices with an aim to streamline R&D and translational collaboration across research labs and user facilities. Changes will impact the transfer of both intellectual property and time with lab experts, i.e., capability transfer. Labs will reinforce marketing and communication to increase industry awareness and dedicate personnel to evaluate high-potential technologies for license development, addressing any systemic blockers that emerge. Specifically, work includes cooperative research development agreements (CRADAs), licensing processes, capability transfer agreements, and more. Commitments are detailed in the letters from SNL and LANL and will enable the commercialization of research into existing and new companies alongside providing a strong incentive for industry to develop operations in the state. As part of the Engines process, industry leaders like Vescent, Quantinuum, and Infleqtion identified three primary capabilities to prioritize for translational use: quantum device manufacturing, system integration & validation, and environmental testing & certification. Streamlining industry access to this infrastructure will drive not just industry collaboration but dramatically speed the translation of IP to the market.

**Quantum Companies Moving to NM** Quantinuum, the world's largest independent quantum computing company, announced its expansion into NM in Jan. 2025, demonstrating how the state’s quantum technology infrastructure and policy initiatives can attract industry players.

*Quantum Device Manufacturing:* The region possesses globally unique fabrication capabilities through CINT and MESA at the national laboratories. This instrumentation and knowhow are particularly salient for the quantum sensing and many of the computing capabilities supported by this proposal. However, current access policies and manufacturing protocols restrict work for commercial purposes, even when the development is years away from market-ready products. Of the 1,000+ programs undertaken last year at CINT, less than 8% included industry partners.[[154]](#endnote-155) The Quantum Foundry Consortium, led by SNL in partnership with commercial fabrication experts, will transform this landscape. Specifically, technology transfer and commercial collaboration policies will be adapted to enable collaboration through (1) process design kit (PDK) design enabling standardized device manufacturing at advanced fabrication facilities, (2) multi-project wafer (MPW) runs supporting cost-effective prototyping, and (3) assembly design kit (ADK) development for hybrid quantum systems and advanced packaging. *System Integration and Validation* (additional detail in C6: Strategic Regional Investment)*:* The Quantum Demonstration Facility, proposed in parallel to this Engine and supporting national lab work with defense partners, addresses the critical need for systems integration and validation capabilities. Led by SNL with support from quantum industry partners named above, this facility will provide (1) state-of-the-art testing and characterization equipment, (2) Co-location space for industry and laboratory personnel, and (3) standardized benchmarking protocols for systems. *Environmental Testing and Certification:* The National Security Mission and Environmental Testing program, coordinated between SNL, LANL, and industry partners, will ensure quantum systems meet rigorous operational requirements, enabling (1) engagement between industry and national security stakeholders, (2) environmental testing of prototype systems, and (3) field demonstration capabilities.

***Local Startup Ecosystem Development:*** Infusing industry with GCs use-inspired R&D alongside facilitated access to critical lab capabilities will drive innovation in quantum at world-leading speed. Nevertheless, the presence of mature companies does not guarantee the emergence of a startup ecosystem. While North Carolina has been successful in building a large ecosystem of major companies in its biotech cluster, the region attracts just one tenth as much venture capital as Massachusetts. To foster major startup clusters, this Engine will establish a quantum-focused venture studio programming in partnership with RVS, which will expand its expertise in deep technology company creation to the quantum sector. Launched in December 2023 in Albuquerque, RVS has emerged as a key player in advancing frontier technologies. Backed by America’s Frontier Fund (AFF) and an initial commitment of $50m from the New Mexico State Investment Council [[155]](#endnote-156) to start and scale over 20 companies in NM, the studio focuses on turning groundbreaking innovations in semiconductors and microelectronics, energy, and advanced manufacturing and materials into commercial ventures. With the support of this Engine, it will extend its focus to quantum technology. The organization’s deep ties to NM’s national labs and innovation ecosystem have attracted leading technologists and industry veterans from In-Q-Tel, the venture arm of the US intelligence community, Schmidt Futures, headed by former Google CEO Eric Schmidt, and more. It supports students, scientists, and researchers in transforming their work into viable businesses, ensuring US leadership in critical technology fields. The studio’s hands-on approach provides more comprehensive support than traditional accelerators, with dedicated teams working alongside founders from concept through early growth stages. This model is particularly crucial for quantum technologies, where complex technology and extended development cycles create additional barriers to startup formation. The Engine’s chief scientist will be responsible for working with RVS to identify promising opportunities emerging from the GCs for company creation. Coupled with the technology and capability transfer work expanded on earlier in this section, RVS and EQ will be able to rapidly evaluate and license promising innovations. The expanded quantum program will start at least two companies. As the ecosystem matures and demonstrates success, this will scale to 2-4 companies per year, creating a sustained pipeline of quantum technology startups in NM. Importantly, startups will also receive streamlined access to ecosystem resources including fabrication capabilities, GC advisors, and additional infrastructure not available anywhere else in the world. Through these coordinated interventions from research translation to startup support, NM will be home not just to innovations that shape the modern world, but startups that call the state their lasting home.

***10-Year Outcomes:*** Over the next decade, we will expand the number of technology transfer agreements from national labs and local universities by 10 times. This integration between academia, national labs, and industry will help accelerate the growth of 10 new quantum startups across the ecosystem per year, with at least two reaching a significant Series A or growth funding round.

### C4: Workforce Development.

*Table 10: Engine Activities to Address Gaps—Key Driver: Workforce Development*

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| Key Goals | Develop a range of skilled talent for quantum technologies in NM |
| State of Practice & Gaps | Nascent: Sgnificant workforce gaps in NM; drive need engagement with graduate, undergraduate, non-degree holders, and K-12 partners  Gap: Need additional programming to support K-12 and post-secondary degrees; establish training program to support QIS entrepreneurs |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90**: EQWC convening held in NM to align all stakeholders  **Y2:** Implement new programming; first cohort of 10 senior entrepreneurs trained; 150 industry jobs created (nascent)  **Y5:** Expand programming; 500 direct and 3,000 indirect industry jobs created (emergent)  **Y10:** Scale successful quantum programming across NM; 8,000 direct, indirect, and induced jobs (grow/mature) |
| Expected 10Y Outcomes | * 8,000 direct, indirect, and induced jobs * Entrepreneurship training for 50 potential founders per year by Y10 * 4 new degree programs |

***Goal:*** Over the course of this Engine, EQ aims to build a comprehensive workforce that spans K-12 to career that will build the necessary skills of our workforce to fuel a leading advanced technology ecosystem. This workforce will serve communities across NM, expanding opportunities to reach rural populations while advancing the quantum revolution for the benefit of all residents.

***State of practice, baseline data, and gaps:*** NM faces a critical workforce paradox in quantum technology. While the state leads the nation in PhDs per capita and hosts world-class quantum research programs, it struggles to retain talent. A recent study highlights that Albuquerque reports one of the lowest net gains of college-educated residents in the Mountain West, emphasizing the challenge of attracting talent to the region.[[156]](#endnote-157) “Brain drain” is a significant challenge and can occur from limited commercial opportunities rather than lack of talent or training capabilities.[[157]](#endnote-158) Despite this, NM already has exceptional quantum education programs including QCaMP’s K-12 initiatives, QuLL’s industry-recognized certificates and community college pathways, coordinated higher education pathways across UNM-NMSU-NMT, and prestigious internship and postdoc programs at the national laboratories.[[158]](#endnote-159) Nationally, the quantum industry faces severe workforce shortages, with a report by McKinsey identifying a 3:1 ratio of open positions to qualified candidates.[[159]](#endnote-160) This gap is particularly acute in the Mountain West, where rapid growth and unmatched commercial scale of quantum technology has led to a rapidly accelerating need for trained teams from technicians to PhDs.[[160]](#endnote-161) While programs are underway to address technician-level training needs, a comprehensive strategy must span the full education spectrum to create sustainable career pathways.

NM includes differentiated and world leading capabilities that can be leveraged to help train the next generation QIS workforce, including MESA and CINT.[[161]](#endnote-162) Meanwhile, UNM’s Physics and Astronomy Interdisciplinary Science building, NMT’s Cybersecurity Center of Excellence (NMCCoE), CNM’s Quantum Learning Lab,[[162]](#endnote-163) and partnerships like the QNM-I, and more all position the state as a hub for quantum innovation if properly aligned and coordinated.[[163]](#endnote-164) To help bring about the impact for the region, the Engine will focus on THREE coordinated interventions to drive impact:***1.) Continuous assessment and alignment of workforce programs with industry needs, leveraging both GC requirements and broader quantum sector demands.*** Specifically, the EQWC will coordinate across existing programs and identify and fill critical gaps from technician programs through graduate education. ***2.) Entrepreneurial development to build the commercial leadership needed for a thriving ecosystem.*** Working with RVS, UNM’s Anderson School of Business, CO’s Innosphere, and leveraging CO’s quantum startup expertise, we will create structured pathways for technical talent to become business leaders. *3.)* ***Expanded educational programming spanning K-12 to higher education, building on successful models like QCaMP and QuLL****.* This includes creating new degree programs, as well as hands-on training opportunities for students and professionals. Coordinated public outreach efforts will also be modeled on NM’s successful hydrogen hub engagement strategy. Moreover, aligning these efforts with Tech Hubs workforce initiatives will create complementary programming that addresses the full spectrum of career pathways.

The quantum industry offers diverse career opportunities spanning all education levels, from entry-level technician roles to advanced research positions. According to industry reports from sources such as The Quantum Insider, PhD level jobs, such as quantum research scientist and theoretical quantum physicist, command salaries up to $192,226, while roles requiring bachelor’s or master’s degrees, like quantum hardware engineer or quantum machine learning engineer, offer competitive salaries exceeding $145,000. Accessible pathways also exist for candidates with associate degrees or certifications, with positions like quantum computing technician earning between $45,000 and $60,000 annually and certification-based roles like quantum systems technician providing entry points with salaries starting at $30,000. To meet the demands of this evolving labor market, the Engine must expand education and certifications with industry-aligned programs, partner with all levels of higher education (particularly community colleges and universities to create new courses and degree pathways), and launch industry mentorship & internship programs*.* By addressing gaps across all education levels, the Engine will create comprehensive career pathways, ensuring accessibility, economic mobility, and the development of a robust quantum workforce.

***Activities:* *Coordination and Funding of Workforce Development Initiatives:*** To sustain a skilled ecosystem with all critical industry and non-profit stakeholders, EQ created the EQWC in September of 2023. The EQWC will provide the organizational and convening power needed to build on the strong workforce development programs already in place in NM and implement programs that help democratize access to quantum across the region. EQWC is composed of the key stakeholders in the quantum economy to ensure both workers and employers succeed. The board includes industry giants like Lockheed and startups like Quantinuum alongside labor and workforce-focused groups like Explora Science Center and Children’s Museum in Albuquerque, K-12 school districts, R1 universities, regional government workforce organizations, the College Board, and more. As part of this Engine, we will be able to expand partnerships and drive higher impact by engaging with new partners such as the NM Public Education Department and the Department of Workforce Solutions, as well as other workforce providers.

The collaboration expands QCaMP, our high school summer camps for students and teachers, and complements existing efforts like the Quantum Learning lab, a hands-on quantum hardware training program that offers pathways to high-paying jobs through 10-week bootcamps, and the Quantum Computing Summer School at LANL, a premier intensive research internship, providing participants with hands-on experience in cutting-edge quantum computing research. With a highly competitive 2% acceptance rate, the LANL program has established itself as one of the best quantum summer programs worldwide.[[164]](#endnote-165) By building on the strong existing workforce development efforts and leveraging the significant organizing power and strategic engagement opportunities with the EQWC, we will integrate industry-informed workforce requirements and align these efforts to strategically support the needs of the Engine.

Additionally, through the Engine and EQWC we will partner with academic institutions to provide early-stage qubit experimentation and workforce training for students pursuing certificates, associate degrees, and undergraduate degrees. This includes tailored curriculum creation across all education levels to prepare students for a career in quantum, as well as training entrepreneurs through CNM’s (Q-EID) program and UNM Anderson School of Management coursework, which will mentor rising talent and support them in launching successful quantum ventures. By fully connecting our workforce ecosystem, expanding out our partnerships to new organizations, and taking advantage of the critical expertise of our core partners, we will be able to train, mentor, and engage students from across NM and the region. Through coordinated investment in new degree programs, hands-on training opportunities, and targeted support for resource-limited areas, we will create comprehensive career pathways. This strategy leverages existing funding while directing new resources to areas of greatest need.

***Skills Support for Aspiring Entrepreneurs:*** Entrepreneurs are the lifeblood of any advanced technology industry ecosystem. Without these skilled individuals, industry clusters cannot succeed. This group most typically germinates from an existing entrepreneurial cluster; however, with NM’s historic paucity of entrepreneurs in advanced technology, the ecosystem faces a chicken-or-egg challenge that has been hard to overcome. The creation of RVS and its dedicated funding for entrepreneur development and the businesses they start has begun to address this experience gap. The NSF Engine team plans to build on this programming with a dedicated quantum focus and by leveraging the largest US industry cluster of quantum in CO to infuse the NM ecosystem with the practical know-how of starting and scaling quantum technology companies. To continue to foster the regional ecosystem – where many companies like Quantinuum and Mesa have started in CO and expanded into NM -- activities will include establishing structured entrepreneurial pathways to integrate technical expertise with business leadership training and providing access to mentorship and resources from established quantum entrepreneurs in CO with Innosphere Ventures. Importantly, the CO industry ecosystem is led not by big tech companies—who bring invaluable resources and scale-up potential but lack the practical know-how around starting companies—but instead is led by independent startups that live and breathe what it takes to build world-changing companies from scratch. The combination of local infrastructure with startup quantum knowledge presents a historic opportunity to seed entrepreneurship in an ecosystem with unparalleled potential.

***K-12 and Public Outreach:*** Global-scale advanced technology ecosystems are not born overnight; they require the support and engagement of entire regions to be long-term successful. NM recognizes that fostering interest in quantum and building the necessary skills in the next generation are essential to make the state a global destination for quantum. Equally important is the role of high-quality education programs in attracting and retaining talented professionals and their families. While the long-term nature of this challenge is a fit for the 10-year goals for the NSF Engines, this Engine will initially focus on developing a K-12 program engagement strategy and a public outreach pilot over the first two years. This programming will be expanded with further support from the NSF in years three to ten. These programs will be modeled after successful initiatives, such as the CO K-12 strategy and community engagement series modeled on the NM hydrogen hub—both successfully featured public outreach town-halls and K-12 engagement.

Workforce development typically has one of the longest time horizons for economic development return. This Engine has chosen to focus on the most immediate gaps that set the foundation and enable the ecosystem to continuously address challenges as they emerge over the 10-year horizon.

***10-Year Outcomes:*** This Engine will lead workforce development by establishing comprehensive pathways for education, training, and employment in the quantum industry. This includes new student programs tailored to meet evolving industry demands and entrepreneurial training for up to 50 potential founders per year by the end of the project. By the end of the decade, our initiatives will directly support the creation of 8,000 direct, indirect, and induced quantum jobs in NM, establishing a full spectrum, highly skilled workforce and solidifying NM’s position as a national leader in quantum talent development.

### C5: Inclusive Engagement.

*Table 11: Engine Activities to Address Gaps – Key Driver: Inclusive Engagement*

|  |  |
| --- | --- |
| Key Goals | Make NM the home of quantum industry, research, and jobs for all New Mexicans |
| State of Practice & Gaps | Nascent: Limited industry presence restricts economic opportunities for all  Gap: A EPSCoR, rural, and majority-minority state, NM needs vibrant economic engines tied to workforce development pipelines to give career opportunities for all residents |
| Activities & Milestones by Day 90, Years 2, 5, 10 | D90: First Quantum Opportunity Roadshow  Y2: Establish Community Engagement Council and define inclusive engagement strategy; engage key stakeholders in leadership positions (nascent)  Y5: Implement quantum education in MSA schools (emergent)  Y10: Scale outreach strategy across NM (grow/mature) |
| Expected  10Y Outcomes | * Quantum jobs are supplied by all NM citizens including rural, veteran, tribal, and Hispanic communities * Learning pathways for quantum education formed for all core MSA schools   a |

***Goal:*** This Engine is committed to building a NM-based quantum workforce reflective of all populations in the state. To do that, we must prioritize the expansion of economic opportunities fostered by GC and PBCB activities and the state’s nascent quantum industry. We will align these emerging industry jobs with leading workforce development programs and targeted outreach alongside the state of NM to ensure everyone has a chance to participate in the quantum economy.

***State of practice, baseline data, and gaps:*** NM is the embodiment of federal policies that have left behind so many in the US—the rural, poor, and working class located in places far from the coasts and rich financial centers. The state is one of only seven majority-minority states in the country, with the highest proportion of Hispanic residents (50.1%) and a significant Native American population (11.2%).[[165]](#endnote-166) The federal government chose to locate important assets like national labs in NM precisely because of its remoteness, but this has stymied synergistic economic development. The remoteness of NM was a historic disadvantage except for the remit to develop critical yet high-risk technologies that well-resourced ecosystems could ignore while competing for more popular technology trends, whether in biotechnology, semiconductors, or finance. Quantum research’s own ‘remoteness’ from classical physics and criticality for national security meant disconnected places like NM had special leeway to drive advancement in these technologies. The result is historic leadership for quantum innovation going back eight decades.

Now, with quantum as a nascent industry on the cusp of dramatic commercial expansion, NM’s remoteness offers a once-in-a-generation opportunity to capitalize on its global leadership in this domain to become an economic powerhouse in the 21st century, providing opportunity for all its citizens.

***Activities: Organizational Design:*** *Engine*programming across GC’s, industry and entrepreneurship support, and workforce development will foster a thriving innovation ecosystem offering thousands of jobs. Ensuring effective and coordinated teams and infusing programming to deliver for all citizens is a key goal for the Engine, EQ, and the EQWC (detailed in C3 Workforce Development section). To ensure NM voices are appropriately represented, the organization will further adapt EQ’s governance structure. The NSF Engines Advisory Board will play a focused role in NM to ensure that programming is well-delivered and adheres to the principles of leadership representation, cultural competency, transparent decision-making, and accountability. ***Coordination with State Government:*** This NSF Engine’s success rests on close coordination and collaboration with the State of NM, including significant investments outlined in section C6. The State will serve on the Business Unit and EQ Executive board and foster deep connectivity across Engine programming. Specifically, the Engine will work with the state to establish Community Engagement Councils and launch Quantum Opportunity Roadshows. Working closely with the NM Tech Council (NMTC) and partners in the Department of Workforce Solutions among others, we will build on efforts launched through the Quantum Technology Peer Group, established in 2023, to continue educating the community about the promise of quantum and lowering barriers of entry to the field. Multilingual education and outreach materials will be created, regular community feedback sessions established, and culturally relevant programming developed through partnerships with trusted community organizations and leaders. This Engine will work with the state to ensure these opportunities are afforded to all core MSA schools.

*Table 12: 50th Percentile Income Comparison*[[166]](#endnote-167)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Location | US Average | California | Massachusetts | Illinois | New Mexico |
| Median Income | $80,020 | $89,300 | $105,700 | $87,620 | $60,100 |
| % Difference from NM | +33.1% | +48.6% | +75.9% | +45.8% | — |

Federal and NSF support has produced economic impact in coastal and wealthy regions across the US, driving incomes materially above the national median. To date, NM has largely missed out on the rising economic tide, resulting in median incomes 33% below the national average leaving the state the second poorest state in the country.[[167]](#endnote-168) The NSF Engines is a historic moment that—matched with the right opportunity in quantum—can give the citizens of the state of New Mexico the same opportunity as those in California, New York, Illinois, and other states to realize the American dream.

***10-Year Outcomes:*** Over the next ten years, the Engine will facilitate inclusive engagement by fostering a thriving research and industry ecosystem featuring workforce pathways available to all New Mexicans. In partnership with the state, we can help ensure all core MSA schools and more jobs for all New Mexicans, including rural, veterans, tribal, and Hispanic populations.

### C6: Strategic Regional Investment/Capital Investments.

|  |  |
| --- | --- |
| Key Goals | Secure sustainable capital through public-private partnerships & dedicated funding mechanisms |
| State of Practice & Gaps | Nascent: Minimal capital investments preventing critical resources like labs and fabs from starting and scaling a deep technology business  Gap: Lack of capital formation capacity |
| Activities & Milestones by Day 90, Years 2, 5, 10 | **D90:** Investor convening in Albuquerque and Engine integrated in Roadrunner Technology Forum annual investment conference  **Y2:** Identify $100m in committed funds (nascent)  **Y5:** Identify $500m in committed funds; complete 75% QDF (emergent)  **Y10:** Raise >$1bn in commitments across public/private sectors; 80%+ use of QDF (mature) |
| Expected 10Y Outcomes | * $1bn+ in committed quantum funds * $500m+ raised by NM-based companies |

*Table 13: Engine Activities to Address Gaps—Key Driver: Strategic Investment & Sustainable Capital*

***Goals:*** This Engine will identify $1bn+ of investment capital ready to deploy in quantum companies based in NM with $500m raised from startups operating in the state within 10 years. By collaborating with state and federal agencies, national labs, industry leaders, and venture capital firms, the Engine will attract and align resources to fuel NM innovation and growth.

***State of practice, baseline data, and gaps:*** Public and private sector commitments have historically been critical to enabling advanced technology clusters to thrive. More recently, this pattern has been demonstrated in CO’s quantum industry, where state policies and investments in advanced technologies over the past two decades have helped form a thriving industry cluster of over 3,000 quantum jobs. Currently, startups in NM lack the connectivity to major venture capital providers. We aim to infuse the lessons learned from CO’s success to create similar scale outcomes in NM.

***Activities: State Commitments:*** Recognizing the transformative opportunity that quantum presents and the special role the state can play in its development, NM is stepping forward with historic commitments to this Engine—unprecedented legislation amounting to over $800m in Resources outlined in the state letter of commitment, split between explicit NSF Engine commitments and support for wider advanced technology development, with a special focus on quantum-industry growth.

Bolstered by momentum from the Tech Hub’s win and LANL and SNL’s key role in DARPA’s quantum benchmarking initiative, the state is committing itself to developing an advanced technology sector as the future of its economic growth, with quantum playing a central role. DARPA is working closely with institutions in NM on their quantum benchmarking initiative, a $1bn+ USG program to assess and develop quantum computing capabilities for US national and economic security. As part of this initiative, the state will commit $60m in matching funds, totaling $120m with DARPA’s investment, to support NM partners, gaining access to NM based infrastructure and expertise to assess quantum computing capabilities. This will expand the globally unique infrastructure already found in the state and importantly reinforce the special role that institutions in NM play as trusted partners for test and evaluation in the quantum industry. This creates a powerful incentive for quantum companies worldwide to engage with national labs and other state institutions to meet the high standards set by the benchmarking initiative.

Additionally, Representative Meredith Dixon, the Vice Chair of the NM House Appropriation and Finance Committee, has introduced a major legislative initiative aiming to enhance economic development and workforce infrastructure across advanced industries. The bill will have a major quantum focus including shared-use facilities for scaled cryogenics, quantum computer acquisition to enable innovation across the quantum stack, and additional support for venture formation and entrepreneurial development

Specific to NSF Engine support, NM is stepping forward with a $150m tax credit program to create economic incentives for world-leading quantum-relevant companies to locate in the state. This program will offset 30% of capital costs up to $150m for qualifying companies. Similar schemes in other states, though at much smaller scales, have demonstrated success in driving job growth and robust industry presence. These capital commitments have been outlined in letters of support from the Governor, with legislation expected to be introduced and passed in the state legislature by summer 2025.

***Quasi-State Commitments:*** The State Investment Council (SIC), NM’s state-controlled $59bn sovereign wealth fund, supports the NSF Engine and quantum industry development. The second largest fund of its kind in the US, the SIC is also one of the largest limited partner investors—a fund that invests in other VC funds like DCVC, Playground Global, and Lux Capital. In the SIC’s letter of commitment, they signal both the scale of their existing investments and their intention to double down on the quantum industry through their fund-of-fund strategy, explicitly tying the goals of their investments to the development of the quantum industry in NM. This brings not just capital, but also the networks of globally leading venture capital firms, deeply tying them to the formation and scaling of quantum businesses in the state.

***Private Sector Commitments:*** Venture capital (VC) is critical for sustaining entrepreneurial ecosystems (C3 addresses business creation) and startups rely on close ties with VC providers to maintain their momentum. This Engine will extend the network for VCs from the globally leading CO ecosystem to NM. The role of the SIC as a fund-of-funds to top VC firms will accelerate NM-based startups access. Using these relationships and specific investment summits like the annual Roadrunner Technology Forum (RTF), we will identify $100m+ in investment funds available for NM quantum startups by year 2, $500m+ by year 5, and $1bn+ by year 10. RTF is a major event for institutional investors in the state, with over 400 attendees with 100+ investors including major deep tech players with significant quantum investments like Anzu, Crosslink, Playground, Khosla, Airbus Ventures, AFF, and Overmatch, representing funds with $10bn+ in assets under management, not counting SIC’s $59bn. We will use these activities to help companies that start and locate in the state to raise a combined $500m over the next decade of the Engine.

***10-Year Outcomes:*** Over the next 10 years we will identify $1B+ in committed quantum funds for the state with $500m+ raised by NM-based companies.

Additional details requested by the NSF: ***Sustainability:*** Long-term financial sustainability for key programming is core to the mission of this Engine from its inception. EQ will ensure financial sustainability of these activities through the following mechanisms: **Time-Bound Catalytic Activities:** The GCs are deliberately structured with a finite timeline and do not need to extend past the 10-year horizon, as they are designed to be explicitly seeding activities. The resulting collaborative teams and technologies will seed a self-sustaining model that can be leveraged for future technology development opportunities. This approach ensures that initial federal investment creates lasting partnerships without requiring ongoing external support. **Partnership Sustainability:** The entrepreneurial support provided through venture building with RVS operates on a sustainable model for studio management. While requiring public support initially, this program is designed to attract leading venture capital dollars into the region, building on the $50m already committed through the New Mexico State Investment Council. **EQ Direct Governance and Infrastructure:** All EQ governance and management is sustained by the administration of facilities that are open access but require payment from users. This model benefits from efficiencies already established through Tech Hubs, with much of the administrative foundation and oversight being already undertaken by those activities. Based on current projections, these facilities will generate over $150m in revenue over their first decade of operations, providing sufficient operating reserves to sustain and grow core Engine activities.

# D. Evaluation Plan

***Purpose and Goals of the Evaluation Plan:*** This Engines will develop and implement a comprehensive evaluation framework to assess progress toward establishing a thriving quantum innovation ecosystem. The evaluation process will be overseen by the Director of Operations contracting with a fully external vendor to undertake rigorous and independent assessment of all Engine operations.

***Alignment with Engine Goals***: Evaluation criteria and metrics map to the Engine’s overarching goals, ensuring alignment with its mission to catalyze innovation, economic growth, and inclusive workforce development. Each phase incorporates specific benchmarks to track and meaningfully report progress.

*Table 14: Sample Evaluation Metrics Across Key Drivers*

|  |  |
| --- | --- |
| Key Drivers/ Goals | Activities & Evaluation Plan |
| **1. Partnerships: Locally based, globally leading industry cluster infused with NM research and state stakeholders** | **D90:** Cross-sector initiatives kickoff, including GC teams programming and EQWC meeting  **Y2**: Two major commercial quantum organizations establish permanent presence in NM  **Y5:** Expand stakeholder collaboration to address barriers and align QIST with regional needs  **Y10:** Five major commercial quantum organizations establish presence in NM |
| **2. R&D: Development of tech through partnerships with industry, academia, & nat. labs** | **D90:** All GC teams launch programs  **Y2**: Identify and prioritize 1–2 GC technologies based on likelihood of success  **Y5:** Accelerate development through network partnerships and pilot key tech with TRL/MRL 7+  **Y10:** Major orders of $500m+ for GC tech |
| **3. Translation: Permanent pathways for tech translation from NM institutions to world leading companies** | **D90:** Short list of potential ventures for first ecosystem quantum startup  **Y2**: 2x tech transfer agreements at research institutions; Venture Studio (VS) creates 2+ Quantum (Q) startups; NM state plan for top entrepreneurial strategy developed and underway  **Y5:** Recruit companies to fill 50% of facilities; VS creates 5+ Q startups  **Y10:** 10x tech transfer agreements; VS creates 10+ Q startups with 2 major funding rounds |
| **4. Workforce: Develop** **diverse, skilled talent for quantum technologies in NM** | **D90:** EQWC convening held in NM  **Y2:** Implement new programming; first senior cohort trained; 150 jobs created  **Y5**: Expand programming; 500 direct and 3,000 indirect jobs created  **Y10:** Scale successful quantum programming across NM; 8,000 direct, indirect, and induced jobs |
| **5. Engagement: Make NM the home of quantum industry, research, and jobs for all New Mexicans** | **D90:** First Quantum Opportunity Roadshow  **Y2:** Establish Community Engagement Council and engagement strategy; engage stakeholders in leadership positions  **Y5**: Implement quantum education in MSA schools across the region of service and State  **Y10:** Scale inclusive engagement strategy across NM; jobs supplied by underrepresented groups |
| **6. Investment: Secure capital through public-private partnerships & funding mechanisms** | **D90:** Investor convening in NM and Engine integrated in RTF annual investment conference  **Y2:** Identify $100m in NM quantum fund commitments and finalize plans for Q Demo facility  **Y5:** Identify $500m in NM quantum fund commitments; Complete 75% Q Demo Facility  **Y10:** Raise over $1bn in commitments across public/private sectors; 80%+ use of Q Demo facility |
| **7. Governance: Establish leadership team & governance practices reflective of all stakeholders** | **D90:** All full-time Engine personnel hired  **Y2:** Establish NM leadership team and define policies and practices for scaling ecosystem  **Y5:** Refine policies and practices, as needed  **Y10:** Refine policies and practices, as needed |

***Workplan: Baseline Data Collection:*** To establish a robust foundation for evaluation, we will partner with an independent professional services firm. This collaboration will ensure accurate baseline data collection across all metrics outlined in the key evaluation components. These metrics will align with the Engine’s proposed goals and milestones, calibrated to its various phases, from nascent to mature. This data will provide a critical benchmark against which progress can be measured throughout the Engine’s lifecycle.

***Continuous Evaluation:***Evaluation criteria will be updated and delivered at quarterly board meetings and semi-annually in line with NSF requirements. EQ will hire an outside and impartial partner to undertake this work with the support of the Engine staff, particularly the Directors of Accounting and Operations.

***Risk Assessment and Mitigation:*** This Engine employs a risk assessment framework to address challenges in technology, market adoption, and governance. Risks are evaluated for likelihood and impact, with mitigation strategies emphasizing collaboration with scientific advisory boards, industry partners, and national labs. Success metrics, such as TRL advancements and private capital raised, ensure accountability and alignment with NSF goals, driving sustainable innovation and commercialization.

|  |  |  |  |
| --- | --- | --- | --- |
| Risk Category | Risks (Likelihood, Impact) | Mitigation Strategies | Key Success Metrics |
| Technology Risk | **Low, High** - Given current maturity, major commercial opportunities will exist even with limited advancements.  **Examples:** Quantum hardware development delays, technical bottlenecks in scaling, and integration challenges with existing systems. | - Portfolio approach across TRL levels (sensing to computing)  - Use natl labs expertise and facilities  - Stage-gated funding with tech milestones  - Scientific Advisory Board and industry/end-user input | - TRL advancement metrics  - Market readiness advancement metrics |
| Market & Capital Formation | **Medium, Medium** - Defense applications ensure material baseline funding and support for quantum sensing, security, and chemistry over the Engine’s time horizon.  **Examples:** Market adoption slower than projected, insufficient private capital, and competition from other regions or countries. | - Focus on dual-use applications with national security customers  - NM sovereign wealth fund backing  - Strategic industry partnerships  - Staged investment approach with clear KPIs | - Commercial contracts secured  - Private capital raised  - Company acquisitions |
| Human Capital & Governance | **Medium, Medium** - Building on the robust foundation of EQ’s governance and national lab infrastructure for resiliency.  **Examples:** Talent retention challenges, leadership gaps, partnership misalignment, and decision-making delays. | - Robust govt framework from Tech Hubs  - Regular leadership dev programs  - Clear decision rights and processes  - Active advisory board engagement and redundant human capital networks | - Deliver on NSF scope of work  - Talent retention rates  - Leadership performance metrics |

***Reporting Structure, Methods, and Tools***: The evaluation process will include a structured reporting cadence for monitoring and adjustments: **1.) Reporting Cadence and Involvement**: Regular progress updates will occur quarterly, complemented by annual reports and mid-phase reviews to ensure alignment with the Engine’s objectives and any new challenges. Stakeholders from all sectors, including community representatives, industry partners, and academic contributors, will participate in the evaluation process for transparency and inclusivity. **2.) Methods and Tools**: The evaluation will use advanced analytics and qualitative assessments to monitor and track outcomes. Tools such as real-time data dashboards, econometric models, and scenario-based forecasting will provide actionable insights. Surveys, interviews, and focus groups will capture stakeholder feedback, while third-party evaluations will ensure impartiality and rigor. **3.) Integrated Monitoring Systems**: A centralized data platform will integrate all metrics, providing stakeholders with access to performance indicators and insights. This system will support dynamic decision-making, enabling the Engine to proactively adapt strategies.

This reporting structure and robust methods and tools will ensure the Engine’s activities are effectively measured, continuously improved, and transparently communicated to NSF and regional stakeholders.

**Conclusion:** For decades, NM has been a quiet pioneer for many of America’s most transformative technologies. Yet historically, the economic benefits of these innovations have largely accrued elsewhere, leaving the state’s extraordinary technical capabilities underleveraged. With the $3.5 trillion dollar race for quantum leadership reaching an inflection point, both in dollars and in the pace of progress, lasting US economic and national security will require the right mix of technical and commercial prowess, bold state and federal investments, and right strategies to win. The dual-pronged approach of Grand Challenges and Place-Based Capacity Building, NM’s >$1.65bn in resources powered by its $59bn sovereign wealth fund, the federal support of NSF Engines, and the work of generations of New Mexicans make NM uniquely suited to meet the moment and secure US leadership. The future of quantum technology will be written somewhere. With this Engine, the future of quantum technology will be written in NM. **References Cited**

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