

SUMMARY REPORT

Intellectual Property Frameworks for Geothermal Test Centers

A summary of **Designing an Intellectual Property and Data-Sharing Framework for a Superhot Rock Geothermal Testbed**

By Laura Katharina Mueller

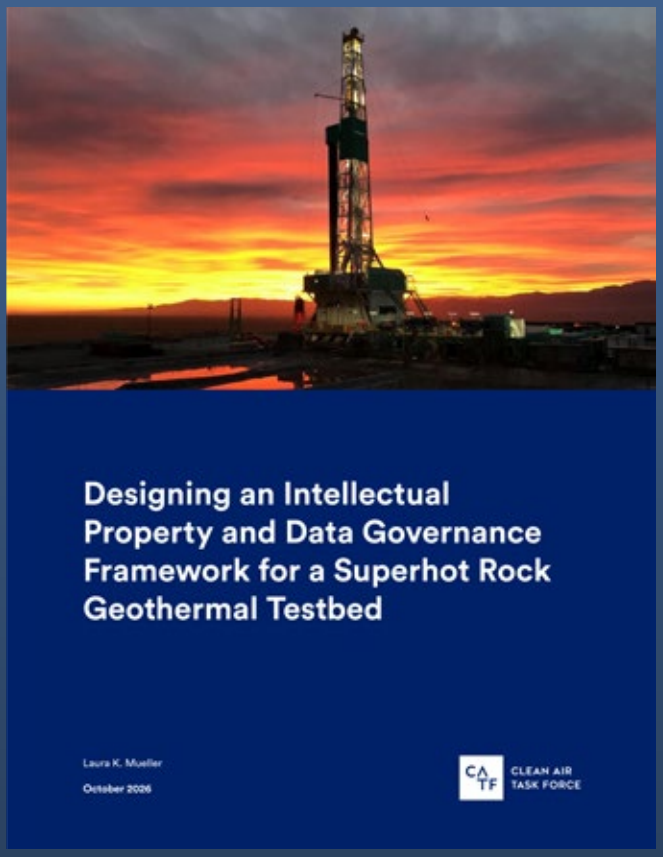
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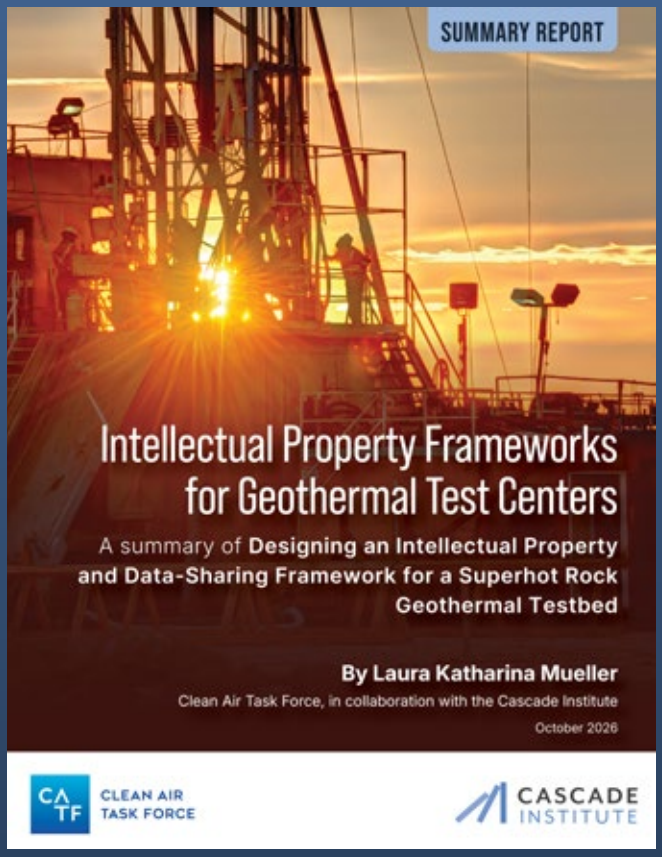
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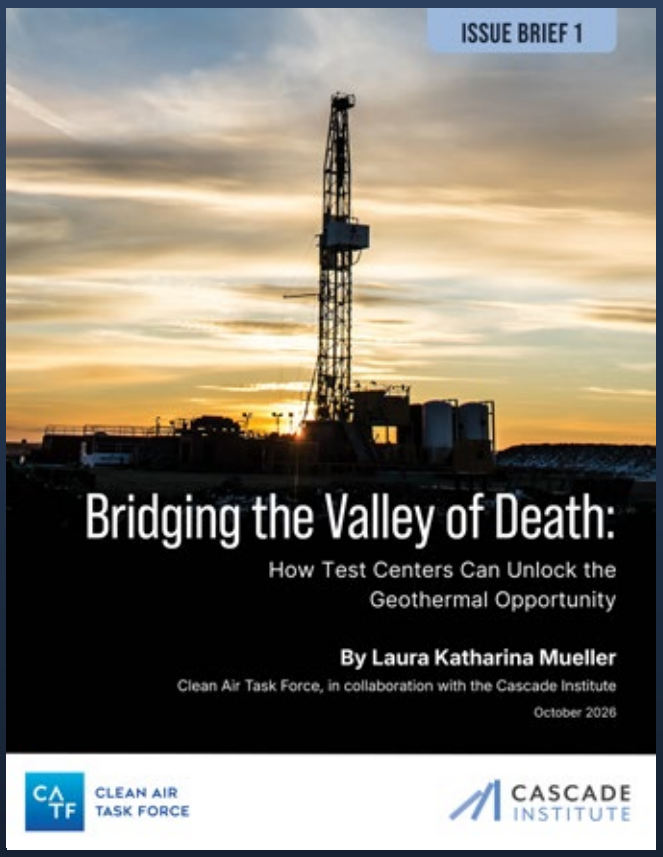
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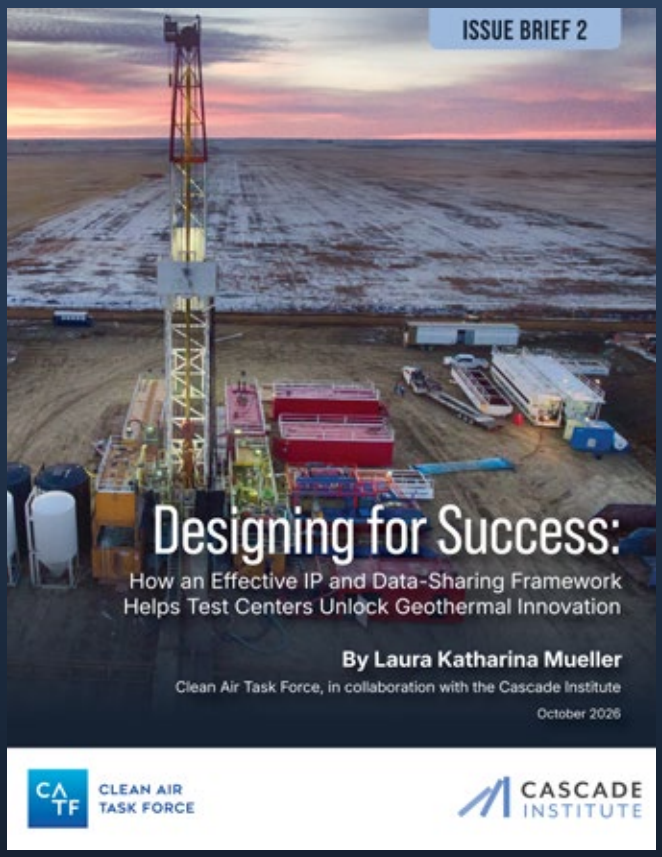
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Institutional partners

Author

Laura K. Mueller is a Legal Fellow at Clean Air Task Force (CATF), where her work focuses on legal and institutional frameworks for geothermal development, including intellectual property, data sharing, and corporate governance. A Swiss-qualified attorney with nearly four years of transactional legal experience at a leading Swiss law firm, she holds an LL.M. (Master of Laws) from Columbia Law School and has passed the New York Bar Examination.

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Next-generation geothermal is a promising yet largely untapped energy source, with significant potential to provide clean, always-on power and support the long-term transition away from fossil fuels. Achieving this potential requires field-scale testing to validate drilling performance, reservoir creation, and high-temperature technologies under conditions that individual companies cannot economically replicate on their own. Test centers, also known as testbeds within geothermal testing environments, have successfully catalyzed technology development across energy sectors by reducing technical risk, enabling collaborative research, and generating shared knowledge. These facilities can accelerate innovation across next-generation geothermal technologies, providing the shared infrastructure needed to unlock next-generation geothermal energy.

To function effectively, however, a geothermal testbed must offer participants clear and predictable rules governing intellectual property (IP) and data-sharing governance. These frameworks must protect proprietary technologies while enabling the knowledge-sharing needed to accelerate innovation and justify public and philanthropic investment. As part of an ongoing research collaboration, Clean Air Task Force (CATF) examined how existing research test centers and collaborative R&D programs have addressed these issues and how those lessons can inform the design of future geothermal testbeds.

This summary presents the principal findings of that research, while two companion issue briefs examine the role of test centers in accelerating energy innovation (Issue Brief 1), and present key considerations for designing an IP and data-sharing framework for test centers (Issue Brief 2). The full report presents the underlying benchmarking analysis and recommended framework in detail.

Why IP matters in geothermal

Public investment in geothermal development is increasing rapidly across the globe. In February 2026, the U.S. Department of Energy announced up to $171.5 million for next-generation geothermal field tests and confirmation drilling. Canada has committed C$468,000 to develop a national deep geothermal roadmap, Germany has launched a €600 million drilling guarantee framework, and Iceland has awarded 600 million króna to geothermal innovation and drilling projects. Together with growing private investment, exponential patent activity, and heightened interest by policy makers, these developments underscore the accelerating momentum behind next-generation geothermal.[1]

Public investment has catalyzed a surge in private capital. Fervo Energy's May 2026 Nasdaq offering raised US$2.2 billion at a valuation of approximately US$10 billion. This is the largest in a wave of investment dollars that includes Quaise Energy (closed an initial US$134 million Series B in July 2026), Hephae Energy Technology (closed a US$17.8 million Series A in July 2026), and others such as Rodatherm.

As investment accelerates, attention is shifting from whether geothermal testbeds should be developed to how they should be designed. Geothermal testbeds involve high up-front costs, sequential and multi-stage exploration, cross-border collaboration, and commercially sensitive technologies. Technology developers, host operators, national laboratories, and public funders have all identified uncertainty regarding IP, data sharing, confidentiality, and publication as major barriers to participation in test centers. This challenge is acute in the geothermal sector, where many technology developers compete through proprietary drilling, reservoir engineering, and high-temperature technologies, making participation decisions especially sensitive to the protection of IP and commercially valuable data.

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To date, there is no established framework for allocating IP, structuring data-sharing governance, or balancing commercial interests with the broader objective of generating shared learning—but there are strong examples to learn from. Because the value of many geothermal

1 U.S. Department of Energy, Office of Geothermal, Notice of Funding Opportunity DE-FOA-0003472 (Feb. 25, 2026), https://simpler.grants.gov/opportunity/3c361922-30e8-4d25-a270-bf2fa7b92c66 (last accessed July 8, 2026); Natural Resources Canada, Canada Invests in Its First National Geothermal Energy Roadmap (June 11, 2026) ; KfW, KfW-Förderkredit Geothermie (Dec. 18, 2025), https://www.kfw.de/About-KfW/Newsroom/Latest-News/Pressemitteilungen-Details_875520.html; https://www.thinkgeoenergy.com/germany-launches-kfw-geothermal-loan-and-drilling-risk-cover/ (each last accessed July 8 2026); Government of Iceland, Climate and Energy Fund (2026), https://www.thinkgeoenergy.com/iceland-announces-recipient-geothermal-projects-for-isk-600-million-in-grants/ (last accessed July 8, 2026).

companies lies primarily in proprietary tools, processes, and know-how, participants require confidence that these assets will remain protected before committing them to a shared testing environment. Establishing a clear and commercially credible IP and data-sharing framework is therefore a prerequisite for attracting participation and ensuring that growing public and private investment translates into successful testbeds and falling geothermal energy costs.

Key findings from our comparative analysis

This research examined a broad set of geothermal and subsurface test centers, analogous U.S. energy programs, and other large-scale research collaborations that have successfully accelerated technology development in their respective sectors, while operating under a wide range of governance, ownership, funding, and IP arrangements. The objective was to identify how these programs addressed and structured intellectual property (IP), data sharing, governance, and ownership arrangements, and to draw lessons for the design of future geothermal test centers.

The benchmarking included geothermal and subsurface initiatives such as Utah FORGE (Frontier Observatory for Research in Geothermal Energy), the Hydraulic Fracturing Test Sites, the Iceland Deep Drilling Project and Krafla Magma Testbed, the New Zealand Supercritical Geothermal Project, and Alberta's AOSTRA (Alberta Oilsands Technology and Research Authority), as well as analogous U.S. energy programs including the National Carbon Capture Center, the Gateway for Accelerated Innovation in Nuclear, RAPID, and the National Offshore Wind Research and Development Consortium.

Across the benchmarked examples, no single approach to governance, IP, or data sharing emerged. Each program developed an approach that reflected its objectives, participants, funding arrangements, and the characteristics of the technologies being tested. Despite this diversity, the benchmarking identified two overarching findings:

1. **Successful test centers are designed around stakeholder incentives rather than a single institutional model.** Across the benchmarked programs, governance, ownership, funding, and IP arrangements were structured to align the interests of operators, technology developers, host institutions, researchers, investors, and public funders. The benchmarked programs successfully catalyzed technology development under a range of governance, ownership, funding, and IP arrangements, including host-led models, public-private partnerships, industry consortia, nonprofit organizations, and special-purpose entities. Rather than adopting a single institutional model, testbed designers should select a framework that reflects their objectives, participants, funding arrangements, and the characteristics of the technologies being tested.
2. **Successful test centers establish a clear balance between protecting proprietary technology and enabling shared learning.** Across the benchmarked programs, participants retained confidence that proprietary technologies would remain protected, while non-proprietary operational and subsurface knowledge was shared in a manner consistent with the testbed's objectives. Where this balance was reflected in clear and predictable IP and data-sharing governance rules, testbeds attracted industry participation and generated durable sector-wide value.

Across the benchmarked programs, **three recurring design principles** emerged and informed the recommended framework presented in the full report:

3. **Strict protection of proprietary technology is non-negotiable.** Across all benchmarked models—whether publicly funded or not—participants retained ownership of pre-existing IP and other proprietary assets, with confidential and proprietary information protected through appropriate confidentiality and use restrictions. Only limited operational rights were granted where necessary for the safe and effective operation of the testbed.
4. **Data sharing should be structured through tiered access and time-bounded confidentiality.** Rather than requiring immediate disclosure, many benchmarked frameworks provided participants with an initial period of privileged access to high-value operational and subsurface data before broader release. This approach helped preserve commercial incentives while enabling the longer-term dissemination of non-proprietary knowledge.
5. **Public funding shapes IP and data obligations, but those obligations generally attach only to the funded scope rather than the entire testbed.** Where public funding was involved, obligations relating to IP, data sharing, and publication depended on the applicable funding arrangements. Successful frameworks aligned these requirements with commercial participation through clear contractual allocation of rights and responsibilities.

Taken together, these findings demonstrate that the success of a geothermal test center depends not only on technical capability, but also on the design of its governance, IP, and data-sharing framework. A well-designed framework provides participants with confidence that proprietary technologies will remain protected while enabling the knowledge-sharing necessary to accelerate innovation and maximize the value of public and private investment.

Central design considerations

An effective IP and data-sharing framework must balance two objectives: protecting participants' proprietary technologies while enabling shared learning. A framework that provides insufficient protection for commercially sensitive technologies is unlikely to attract industry participation. Conversely, a framework that is overly restrictive limits the exchange of operational knowledge and reduces the broader commercial and scientific value generated by the testbed.

This balance is particularly important in the geothermal context. Much of the sector is venture-backed, and participants derive much of their competitive advantage and commercial value from proprietary drilling technologies, high-temperature tools, stimulation methods, software, and technical know-how rather than from commodity assets. As a result, geothermal participants are generally more sensitive to the protection of intellectual property than participants in many past subsurface test sites, including oil and gas research collaborations. Confidence that these technologies will remain protected is therefore essential to attracting participation in a shared testing environment.

Our comparative analysis demonstrates that these objectives can be achieved simultaneously. Across the examined programs, established contractual mechanisms (including clear background and foreground IP provisions, tiered data sharing, time-bounded confidentiality, and publication review processes) were used to protect proprietary technologies while enabling the dissemination of non-proprietary knowledge. These approaches provide a practical foundation for the framework proposed in this report.

Choosing a structure: Governance and ownership models

Existing test centers have accelerated technology development under a range of ownership and governance arrangements. Across our comparative analysis of subsurface test centers, *host-led* structures (in which a single host institution owns or operationally controls the core test infrastructure and has primary responsibility for its operation) emerged as the predominant ownership model (including Utah FORGE, the Hydraulic Fracturing Test Sites, and the National Carbon Capture Center), reflecting the operational demands of early-stage, capital-intensive infrastructure. At the same time, programs have adopted different governance mechanisms, including industry technical committees (the Hydraulic Fracturing Test Sites), consortium-based decision-making (e.g., the National Offshore Wind Research and Development Consortium), independent advisory boards representing participants (National Carbon Capture Center), and independent expert boards (AOSTRA), to reflect their objectives, participants, funding structures, and operational needs.

The appropriate governance and ownership model ultimately depends on the objectives of the testbed, the participants involved, the funding structure, and the characteristics of the technologies being tested. Drawing on these observations, the report outlines four governance and ownership models applicable to energy test centers generally, with particular relevance for future geothermal testbeds:

Model	Governance	Financing	Best suited for	Key IP / data consideration
Host-led Closest example: Utah FORGE, the Hydraulic Fracturing Test Sites, National Carbon Capture Center	**Host** owns infrastructure Centralized decision making by host (participant advisory committee optional)	Host debt, participation fees, grants	**Early-stage** testbeds where one operator controls the site, drilling risk dominates, and speed matters. The host is typically the most creditworthy entity and is therefore best positioned to carry debt.	**Prevent perceived host capture** Clear IP and data rules are needed to reassure participants that the host will not gain unfair access to proprietary technology.
Consortium Closest example: National Offshore Wind Research and Development Consortium, RAPID (for governance)	**Shared** ownership, steering committee of member participants	Member contributions Shared across members; may require creditworthy members. Consortium-funding dramatically lowers individual exposure	**Later-stage or research-intensive** testbeds where multiple aligned participants contribute complementary technologies. Shared funding lowers individual exposure.	**Avoid joint-IP and governance gridlock** Requires clear allocation of ownership, decision-making authority, and foreground IP, plus escalation pathways and quorum rules, to avoid governance gridlock and joint-ownership disputes.
Mission-oriented non-profit (capped return, neutral operator) Closest example: AOSTRA	**Nonprofit** owns assets, board of directors with mission obligations	Philanthropy, grants, participation fees	Public-interest or internationally coordinated sites where **neutrality, credibility, and long-term data stewardship** are central to participation. Compatible with philanthropic and catalytic capital.	**Maintain commercial incentives** Neutral governance should not weaken incentives for industry participation.
Independent special-purpose entity	**Special-purpose** vehicle owns assets, board / managing members	Equity, debt, blended finance	**Complex, large, multi-party sites requiring flexible ownership** and blended finance. Ownership is allocated through equity or membership interests.	**Strong contractual discipline** Provides maximum flexibility in ownership and financing but requires robust contractual allocation of rights and responsibilities

The benchmarked programs illustrate a range of combinations between ownership models and governance structures, rather than falling into rigid categories. While many align broadly with one of the four models presented above, most also incorporate design elements drawn from other approaches to reflect their particular objectives, participants, funding arrangements, and operating context. The four models should therefore be understood as generalized *design archetypes derived from recurring patterns* observed across the comparative analysis, rather than as fixed classifications. Their purpose is to provide a practical framework that helps organizers calibrate the ownership, governance, financing, and design-making arrangements best suited to the specific technical, commercial, institutional, and funding circumstances of a particular testbed. Although each model presents different governance considerations, the recommended IP and data-sharing framework is designed to operate across all four.

Recommended IP and data-sharing framework

Drawing on the benchmarking analysis, the report recommends a modular IP and data-sharing framework that can be adapted to different governance structures and funding models. Six core design principles underpin the proposed framework:

1. **Support modular, multi-stage, multi-actor participation.** The IP and data-sharing framework must allow different companies to enter at different phases (drilling, reservoir creation, tool deployment) through modular participation agreements with clear sequential and access provisions that protect proprietary technology.
2. **Protect background IP and proprietary information.** Participants retain ownership of background IP, while participation agreements provide robust protection for proprietary information. No disclosure is required except to the operator when necessary for test site safety and effective operation of the testbed.
3. **Allocate foreground IP based on creation.** Ownership of new intellectual property should follow creation, pursuant to the default ownership rules of the governing jurisdiction. Joint ownership should be minimized wherever possible to facilitate commercialization and reduce administrative complexity.
4. **Separate data sharing from IP creation, ownership, and protection, and adopt tiered data access.** Test centers will generate large volumes of operational and subsurface data, much of which is commercially sensitive. While IP rights are governed by established legal principles, parties retain considerable flexibility in structuring ownership, licensing, and commercialization arrangements by contract. The commercial value of many technologies, however, depends not only on IP rights but also on preserving the confidentiality of proprietary know-how and commercially sensitive information. Data sharing therefore plays a critical role in determining what information participants must disclose, who may access it, and when it may be shared. Resulting arrangements should also address potential asymmetries between participants, recognizing that organizations may enter the testbed with different technical capabilities, commercial positions, and existing IP portfolios. Data sharing should therefore be designed as a distinct but complementary component of the IP framework, using a multi-tier classification. The report recommends distinguishing protected background data (what a participant brings in), restricted test data (operational and performance-related results from testing), and public data (sanitized, aggregated

results released after any embargo), allowing operational and subsurface learning to be shared without disclosing proprietary technologies.

5. **Use time-bounded confidentiality to encourage participation.** Structured confidentiality periods and staged data release provide participants with an initial period of privileged access to high-value operational and subsurface data before broader dissemination of non-proprietary information. By giving contributing companies a meaningful head start on the data they generate, time-bounded confidentiality turns a transparency obligation into a commercial incentive for participation.
6. **Design for both private and publicly supported test centers.** Public funding can introduce mandatory IP and data-sharing obligations, but these generally attach only to the funded scope of work rather than the entire test center. Clear contractual ring-fencing allows public and private activities to coexist while preserving commercial participation.

A toolkit, not a template

The report does not recommend a single governance or IP model for all geothermal testbeds. Instead, it provides a modular framework that can be adapted to different governance structures, ownership models, funding arrangements, and national legal systems. Its objective is to help testbed developers, hosts, funders, policymakers, and prospective participants identify the key design decisions early in the planning process and understand how those decisions influence participant incentives, protection of proprietary technologies, and the generation of shared learning.

The recommended framework is deliberately configurable, enabling operators, funders, and participants to select and tailor governance, IP, and data-sharing arrangements to their policy, commercial, or research objectives, as well as their governance structure, funding source, and stage of development, rather than prescribing a single framework. The framework identifies a set of structural levers and design principles, including scope-based compliance, ring-fencing, tiered data, and time-bounded confidentiality. Because these considerations recur wherever public funding, shared infrastructure, and commercially sensitive innovation intersect, the framework is intended to be adaptable across jurisdictions while remaining responsive to local legal requirements.

The framework presented here focuses on IP and data-sharing arrangements that can help enable and structure participation in a collaborative geothermal test center by addressing concerns identified through the comparative analysis of IP and data-sharing arrangements applied in previous R&D programs and raised in ongoing stakeholder discussions. It does not purport to provide a comprehensive IP strategy or address every legal and strategic IP consideration that may arise. Broader and more detailed IP considerations will depend on the applicable legal framework, technologies involved, participants, and commercial objectives, and should be addressed with appropriate IP expertise.

For policymakers, funders, and testbed organizers, governance, IP, and data sharing should be addressed early, during feasibility studies, requests for proposals, and other planning stages, rather than as a downstream legal exercise. These discussions should take place before major capital commitments are made, when stakeholder expectations can still be aligned and key project parameters remain flexible. Early discussions with prospective project partners and early decisions about governance and IP design shape participation incentives, determine how proprietary technologies are protected, and help ensure the framework reflects the practical needs of host institutions, industry participants, technology developers, investors, and public funders.

Although this report focuses on intellectual property and data sharing, successful testbeds also depend on complementary legal and commercial considerations, including land access and the value of leaseholds in well-characterized locations, water rights, reservoir ownership, liability allocation, insurance, and permitting. These issues fall outside the scope of this report but must be considered alongside IP and data sharing during testbed design.

This summary provides an overview of the report's principal findings and recommendations. Readers seeking the detailed benchmarking analysis, recommended IP and data-sharing framework, and discussion of the implications of different public funding arrangements should consult the full report. Issue Brief 1 examines the role of test centers in accelerating energy innovation, while Issue Brief 2 provides a practical guide to designing an effective IP and data-sharing framework for energy test centers. Together, these publications are intended to support governments, host institutions, funders, and industry to establish successful geothermal test centers that drive innovation to unlock clean, affordable, secure, and widely available geothermal energy.