Policy and research priorities to advance the next-generation geothermal supply chain in the United States

Category	Priority	Detail
Policy	*Strengthen and clarify demand signals*	With varying projections for next-generation geothermal deployment, some manufacturers are still sitting on the sidelines. One opportunity to provide manufacturers with the certainty they need to invest in domestic capacity is to clarify the sourcing requirements in the Section 48E investment tax credit (ITC) and the Section 45Y production tax credit (PTC). DOE could also consider other forms of near-term demand-side support. *Clarify domestic content provisions:* Treasury can publish domestic content safe harbor tables for the geothermal supply chain, as it has for solar and storage, to reduce the compliance burden on geothermal developers and fully incentivize the use of domestic suppliers. Without clear guidance, the domestic content bonus and foreign entity of concern provisions in the electricity tax credits cannot achieve their intended effect of directing procurement toward American-made components. *Targeted demand-side support:* The U.S. Department of Energy (DOE) could help coordinate offtake agreements between equipment manufacturers and project developers or consider using its Other Transactions Authorities (OTAs) to serve as a buyer-of-last-resort for critical components like organic Rankine cycle (ORC) turbines. DOE could also use its convening powers to promote equipment standardization across the geothermal supply chain, building from recent efforts on distribution transformers. Uniform designs would lower costs, reduce spare-part requirements, and broaden the supplier base.
Policy	*Scale domestic manufacturing capacity*	Key components needed for next-generation geothermal are insufficiently supplied in the United States. For surface plant equipment like ORC turbines, domestic capacity is negligible and faces cost-of-production gaps with imports. For the subsurface, geothermal developers rely on equipment designed and principally supplied for the oil and gas industry, which can have long lead times and require modifications for deeper, hotter geothermal applications. Federal policy interventions, such as tax credits, loans, or grant programs, could meaningfully improve manufacturing project economics and help spur investment in subsurface and surface supply chains. *Extend manufacturing tax credits to geothermal:* Congress can add geothermal components to the list of technologies eligible for the Section 45X advanced manufacturing production tax credit (PTC) to drive investment in new domestic manufacturing capacity and close cost-of-production gaps with imports. Policymakers could also consider an investment tax credit to reduce the upfront cost of new or modified production facilities. States can also establish their own manufacturing tax credits. *Ensure access to low-cost scaling capital:* Existing federal loan programs, such as DOE's Energy Dominance Financing Program or the Small Business Administration (SBA) loan programs, can provide access to low-cost capital for geothermal equipment manufacturers seeking to build commercial-scale production facilities. *Consider competitive grant programs for startup costs and retooling:* Similar to DOE's Domestic Manufacturing Conversion Grants Program for the automotive sector, Congress and DOE could consider creating a competitive grant program for geothermal component manufacturers to cover start-up costs or fund retooling efforts needed to transform production lines.
Policy	*Accelerate lab and field research, development, and demonstration*	While geothermal developers draw heavily from mature oil and gas technologies, some aspects of the geothermal supply chain are still nascent, such as the materials, tools, and drilling systems needed for higher-temperature projects. DOE can leverage its R&D capabilities and the network of national laboratories and manufacturing institutes to accelerate innovation and commercialization of next-generation geothermal equipment. *Early-stage R&D:* DOE, in partnership with the national laboratory system, can support the private sector in developing and testing next-generation geothermal components through existing programs including the Frontier Observatory for Research in Geothermal Energy (FORGE), Small Business Innovation Research (SBIR), Small Business Technology Transfer (STTR), collaborative research efforts, and prizes and competitions. DOE's labs are also well-suited to conduct the national geothermal supply chain research outlined below. *Pilot-scale manufacturing:* DOE could expand access to pilot production lines and demonstration-scale manufacturing to support early-stage geothermal component manufacturers through programs such as ARPA-E SCALEUP and shared facilities and equipment at the Manufacturing USA Institutes.
Research	*Inventory of equipment, components, and upstream materials*	While available evidence suggests that the United States is well-positioned to compete along several parts of the geothermal supply chain, additional research can help policymakers and industry leaders identify potential opportunities and vulnerabilities. *Catalog geothermal equipment, components, and production capacity:* Develop an open-source and regularly updated inventory of all equipment, components, and materials used and proposed across enhanced geothermal systems (EGS), closed-loop geothermal systems (CLGS), and superhot rock (SHR) as well as global and country-by-country production capacity for each item. This catalogue should also identify overlaps with other technology supply chains to enable policymakers to identify cross-cutting vulnerabilities, be they in specialty alloys or permanent magnets or other strategic technologies and materials. *Benchmark production capacity against projected demand:* Benchmark current manufacturing capacity and procurement lead times for each major component against up-to-date deployment projections. Existing modeling by Lawrence Livermore National Laboratory (LLNL) illustrates the type of analysis needed but relies on turbine manufacturing capacity and production-cost data published in 2018; since then, turbine sizes for planned EGS projects have increased substantially.
Research	*Modeling of manufacturing costs and capacity expansion*	*Update manufacturing cost models for critical components:* Develop up-to-date, bottom-up cost models comparing domestic and overseas production for priority components at the scales now entering deployment. Updated models can account not just for the increase in turbine size but also the different types of turbines under consideration, including SHR-compatible steam turbines, supercritical carbon dioxide (sCO_2) turbines, and thermoelectric generators (TEGs). These models can also account for improvements in manufacturing efficiency. *Model capacity expansion under federal and state policy scenarios:* Model how existing and proposed policies at the federal and state level can translate into new investment, alleviate equipment procurement delays, and drive job growth in the manufacturing and deployment of geothermal power systems.
Research	*Regional economic development analysis*	*Identify relevant industry clusters:* Identify which states and metros have existing concentrations of employment in manufacturing activities relevant to the geothermal supply chain. Data from RMI's Clean Growth Tool can illustrate these regional employment strengths. For more on this, see above and the appendix. *Assess component-specific site readiness:* Identify specific areas with the site-level characteristics needed to support geothermal equipment production — including electricity infrastructure and capacity, available and appropriately zoned industrial sites, transportation and logistics access (rail, highway, and port access for heavy and oversized equipment), upstream supply chain proximity, and workforce training infrastructure (community colleges, technical programs, and apprenticeship pipelines that can be oriented toward geothermal-relevant skills). This can and should include existing manufacturing facilities, such as gas turbine campuses with the machinery and expertise needed for geothermal turbine production. *Develop greenfield investment attraction strategies:* Even though near-term capacity growth is likeliest to come from expanded activity at existing facilities — such as co-locating ORC production lines within gas turbine campuses or adding geothermal product lines at oil and gas equipment manufacturers — state and regional leaders can start assessing their readiness for greenfield manufacturing investment. Here, state and regional leaders can leverage technoeconomic analysis described above to identify, specific areas with the site-level characteristics needed to support geothermal equipment production. Such factors might include electricity infrastructure, transportation and logistics access, and proximity to upstream materials supply chains. This work can take place as part of broader efforts to develop subnational industrial strategy.

For more on federal and state-level support for next-generation geothermal deployment, see work by Clean Air Task Force, World Resources Institute, the National Laboratory of the Rockies (formerly National Renewable Energy Laboratory), and the National Association of State Energy Officials.

Source: Authors' analysis