



Impact of IRA, IIJA, CHIPS, and Energy Act of 2020 on Clean Technologies

Deep Dive | Geothermal

APRIL 2023



Background | Objectives and context of this work

Objective

- Explore impacts of recent legislation¹ on U.S. opportunity and remaining challenges for emerging clean technology deployment

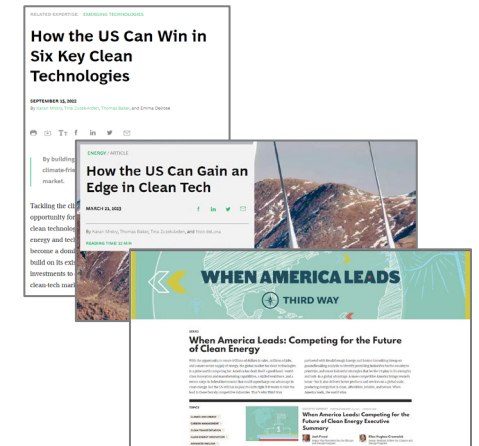
Stakeholders involved

- Analysis was commissioned by Breakthrough Energy and Third Way, with input from stakeholders across the public and private sectors



Related publications

- BCG report | How the US Can Win in Six Key Clean Technologies
- BCG report | How the US Can Gain an Edge in Clean Tech
- Third Way publication | When America Leads: Competing for the Future of Clean Energy



1. Legislation assessed here includes Inflation Reduction Act (IRA), Infrastructure Investment and Jobs Act, CHIPS and Science Act, and the Energy Act of 2020
Source: BCG analysis

200-500 Mtpa

Annual U.S. abatement potential in 2050

\$230-270B

Cumulative domestic market for US '20-'50

\$100-200B

Cumulative US exports '20-'50

~100k

New U.S. jobs created

Geothermal | Executive Summary

- IRA-IIJA marks a shift in policy treatment of geothermal, moving it into the same category as other clean power and decarbonization solutions, but significant barriers continue to block deployment despite attractive economics and strategic benefits
- Geothermal is well-positioned to play a critical role in U.S. decarbonization by providing zero-carbon firm dispatchable power to enable solar and wind penetration, zero-carbon residential and industrial heat applications, and an opportunity to unlock significant domestic lithium supply sources
- While geothermal is currently cheaper than solar + storage the extended tax credits will reduce the LCOE by a further ~40% making it more cost competitive with natural gas CCGTs and other sources of firm generation
- Despite the economic and qualitative attributes, geothermal growth remains limited due to burdensome permitting that drive project timelines (7-10 years) significantly longer than those for O&G and a lack of support for commercializing novel technologies such as Enhanced Geothermal Systems (EGS) and lithium extraction
- Fixing permitting and other blockers could increase geothermal capacity by as much as 15-20x by 2050 as new technologies like Enhanced Geothermal Systems (EGS) and supercritical drilling unlock vast untapped U.S. reservoirs, similar to what fracking innovations did for the shale revolution
- The U.S. can capture substantial upside geothermal potential but risks losing out to other players if it doesn't capitalize on the window of opportunity provided by its current position as the global industry leader, significant legacy O&G experience in drilling and exploration, and early leadership in emerging breakthrough technologies such as fracking for EGS

Note: All numbers on lefthand side are based on projections from IEA's Announced Pledges (APS) 2021 scenario and are sums across all value chain segments for the 2020-2050 timeline, which include . Source: BCG analysis, IEA, DOE



Context | Geothermal provides many important benefits to support decarbonization



Lithium Extraction to address potential battery input bottlenecks

- Geothermal brine contains substantial concentrations of lithium that can be extracted using sorbents
- The pilot project at the Salton Sea in California is **estimated to contain roughly the same amount of lithium as Chile and Bolivia, the two largest markets today, combined**



Direct heating to offset fossil fuel usage

- Heat from geothermal reservoirs can be used for residential and commercial district heating, as well as some industrial processes
- District heating and direct heat use **could provide most of residential heating and up to 50% industrial heat demand**



Clean firm, dispatchable generation to balance high renewable penetration

- Geothermal can provide continuous baseload and is dispatchable, offering ancillary grid services like spinning and non-spinning reserves, load following, and regulation
- It can **unlock additional deployments of variable generation resources like solar and wind** by providing balancing services and baseload generation



Co-location to support Direct Air Capture (DAC)

- Geothermal can be paired with DAC deployments to provide onsite clean energy to power carbon removal and heating to recycle sorbent
- **Consistent, clean energy and heat are needed to enable DAC**, a key solution for meeting our climate goals by 2050

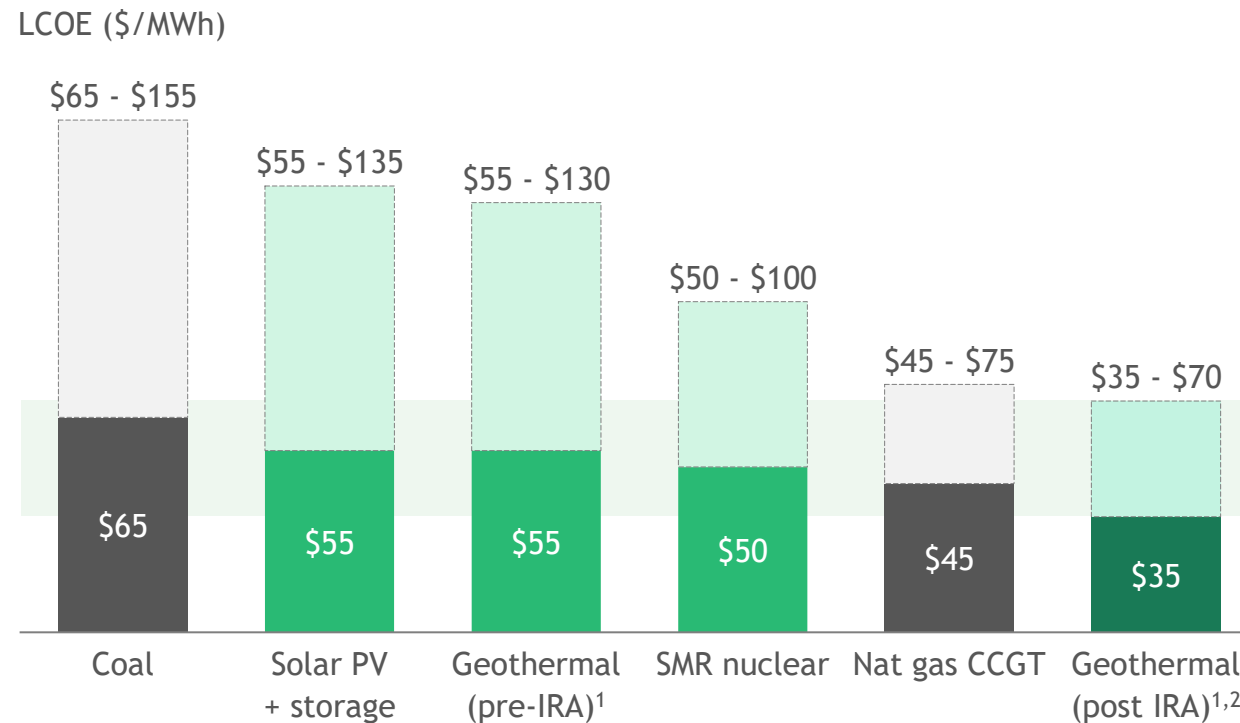
Legislation impacts | IRA tax credits significantly reduce geothermal cost and make it competitive with the cheaper dispatchable resources

Demand-side incentives from the IRA include:

- 1 ITC: **6% base** with 5x multiplier for wage and apprenticeship requirements
- 2 PTC: **1.5 ¢/kWh** if wage and apprenticeship requirements are met
- 3 ITC & PTC: **10% bonus** for domestic content + **10% bonus** for plants in energy communities
- 4 ITC: **Additional 20%** for facilities in qualifying low-income communities



Comparison of firm dispatchable resource LCOE



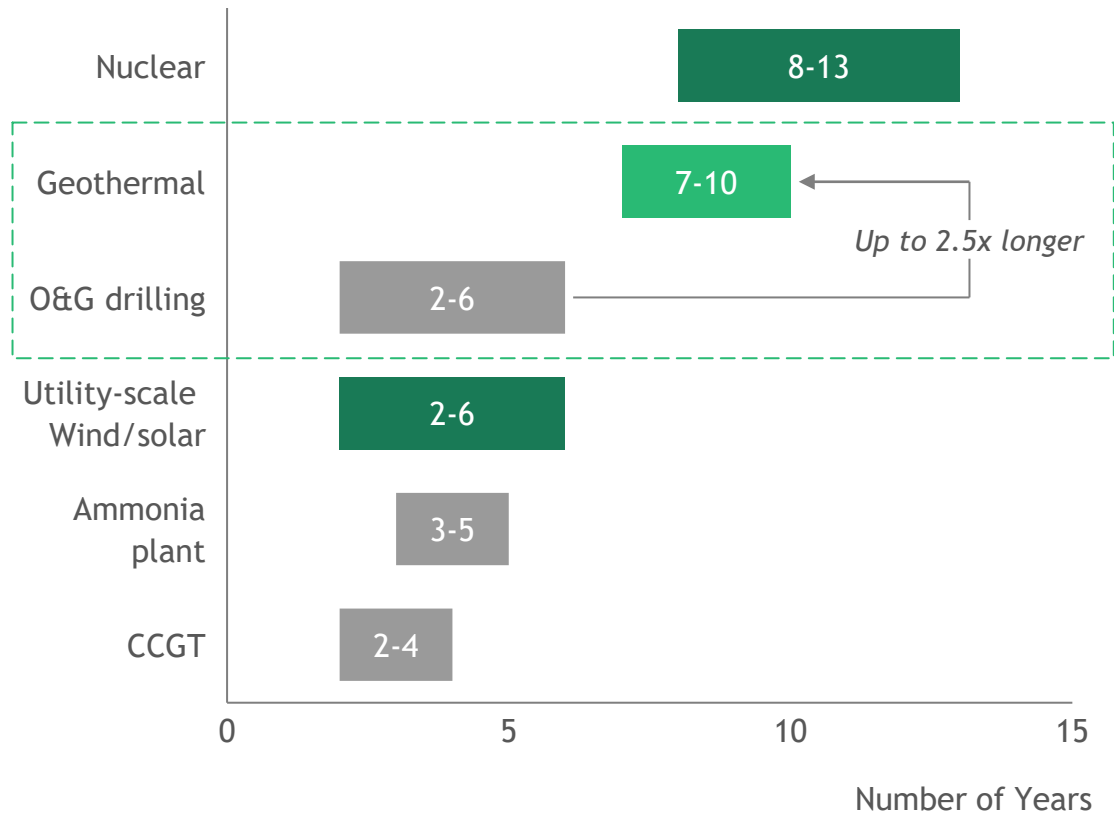
Post-IRA/IIJA geothermal can be cost competitive with cheaper fossil fuel generators

1. Range based on NREL Annual Technology Baseline LCOE for hydro/flash assets (lower end) and NF EGS/flash (upper end) 2. Assumes full 50% ITC is taken Source: IEA World Energy Outlook; IEA Projected Cost of Generating Electricity; Lazard LCOE Analysis v15; NREL Annual Technology Baseline; BCG Analysis

Barriers to growth | Unnecessarily long permitting timelines for geothermal prevent investment by introducing additional risk and cost



Comparison of project deployment timelines across different project types



Impact of longer timelines



Extended timeline drives higher financing costs, which make up ~30% of geothermal capital costs compared to 2-7% for wind and solar



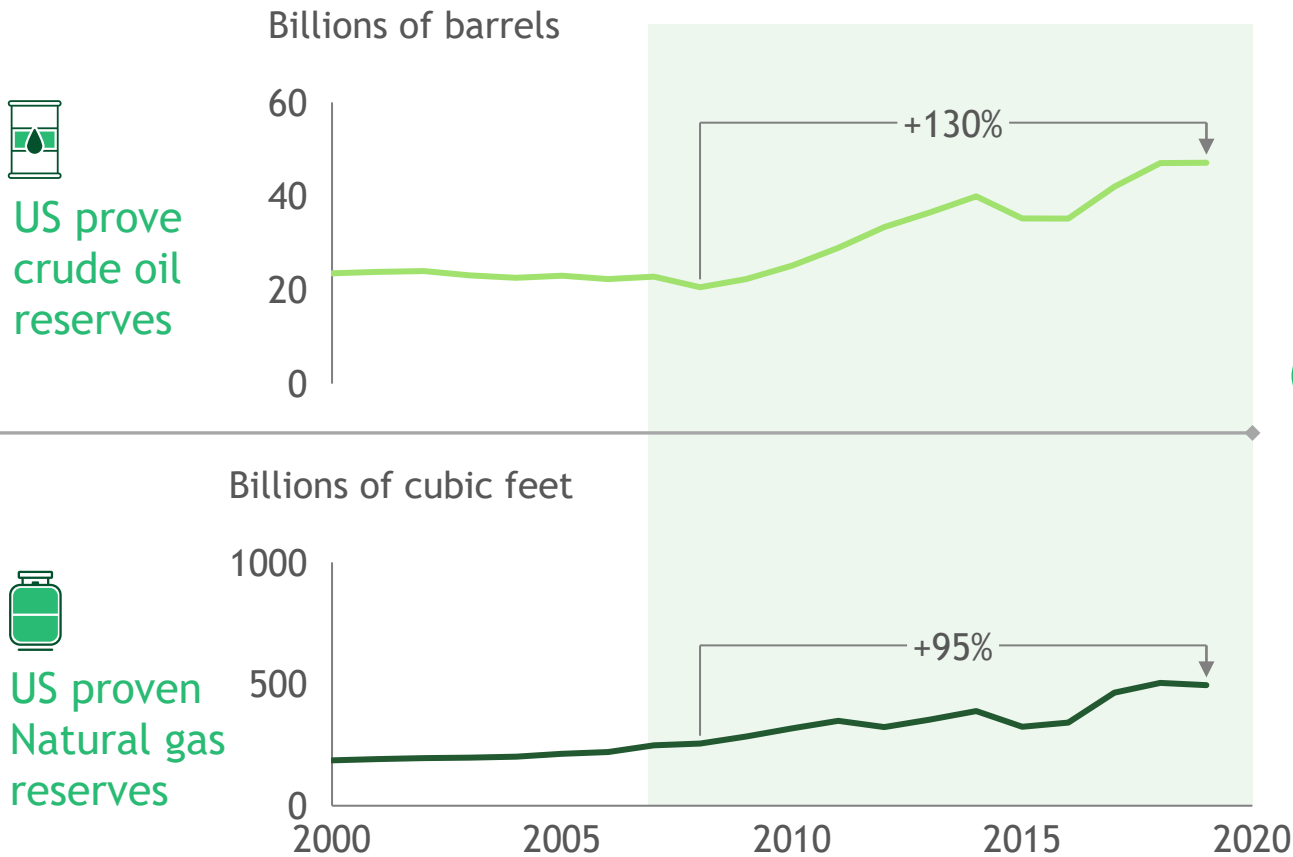
Additional risk introduced for investors as geothermal projects take 5+ more years than O&G projects to get permitted



Potential de-risk projects and reduce financing costs by granting same regulatory treatment as O&G, reducing timelines by 25-50%

Innovation potential | New technologies such as EGS and deep drilling expand significantly potential geothermal potential, similar to the shale revolution

Comparison of US oil & gas growth pre & post fracking innovations



Key takeaways



Enhanced geothermal technologies leverage similar technologies and show similar revolutionary impact as fracking in O&G



EGS and supercritical wells make geothermal possible almost anywhere, making it no longer a niche resource but a scalable solution

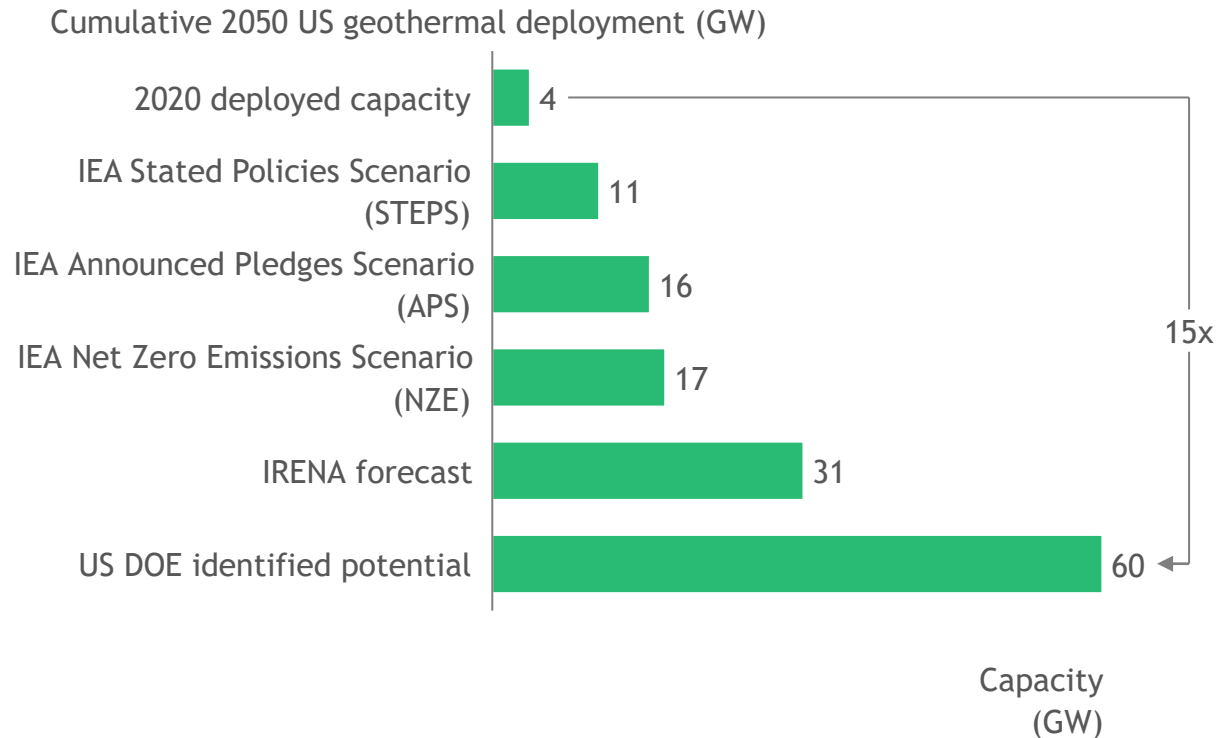


US is the current leader but risks being displaced by countries making significant investments in geothermal - e.g., New Zealand, Indonesia, Japan, and Kenya

Potential upside | US has huge upside potential for geothermal deployments as new technologies give access to untapped reservoirs and reduce cost



Forecasts of U.S. geothermal deployment by 2050



Levers to unlock upside potential



New technologies like EGS and super critical drilling **open new geographies and drive down costs**



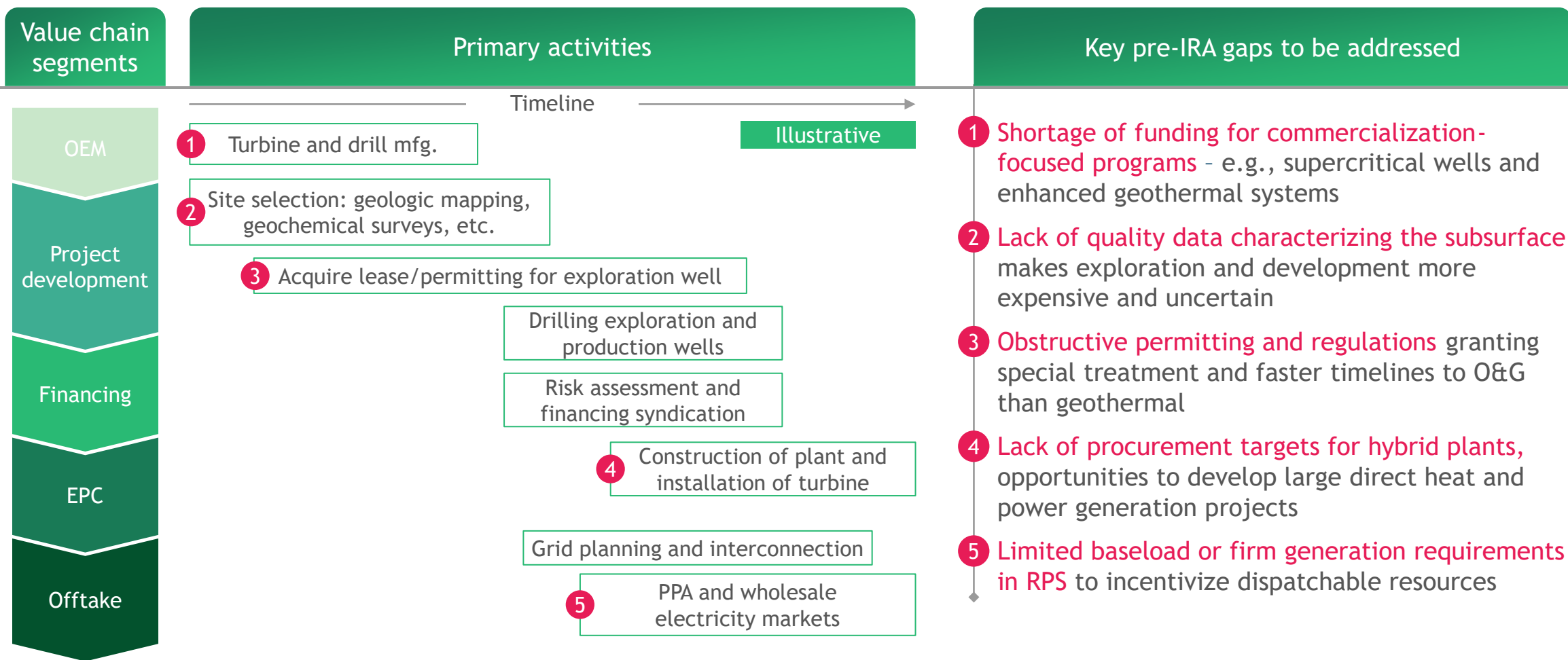
Permitting reform **speeds up deployment and reduces cost of financing**



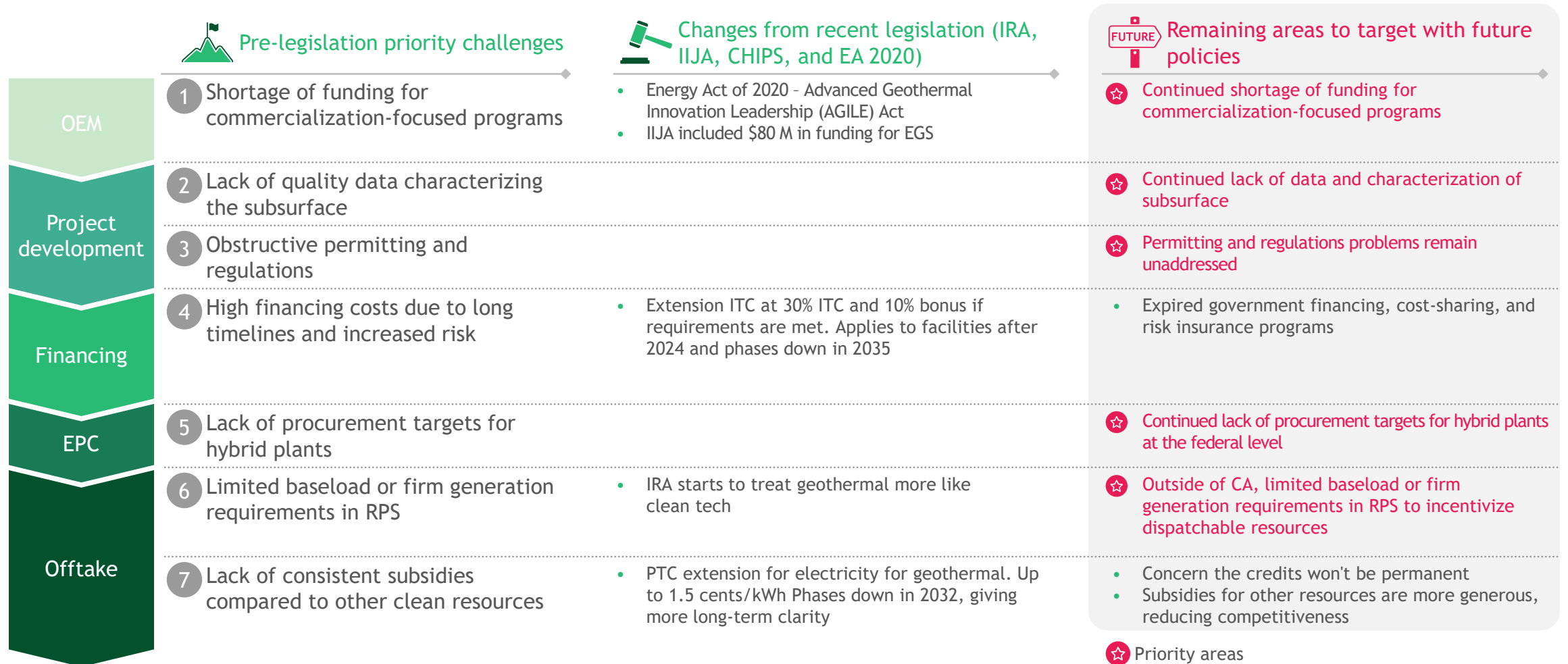
Demand-side signals and supply-side manufacturing and research **subsidies de-risk investment**

Note: All forecasts are through 2050; STEPS, APS, NZE are the three scenarios used by IEA in their WEO, IRENA represents the optimistic forecast put together by the agency, and DOE refers to the DOE's GeoVision report
Source: IEA WEO 2022, IRENA, DOE GeoVision Report - 2022; BCG analysis

Pre-legislation challenges | Across the value chain, there are key policy gaps that drive exceptionally long timelines and increase risk



Remaining challenges | Significant tax credits reduce cost of geothermal but did not address several important policy gaps



Summary | Actions to further boost U.S. competitiveness

Key levers that will enable the U.S. to win the geothermal market



Reform permitting

- Grant categorical exceptions for new federal leases
- Cap BLM review time at 30 days - the same as O&G wells
- Create template for new wells to speed approvals



Support private investment

- Add geothermal to the list of technologies that qualify for clean energy manufacturing tax credits
- Reinstate the project insurance and de-risking policies from the 1980's



Commercialize novel technologies





- Increase funding for research and commercialization of new technologies such as EGS, supercritical wells, and lithium extraction
- Increase funding for pilot projects in lithium extraction and co-location



Send demand signals





- Add RPS commitments to geothermal similar to California
- Develop geothermal heating and power generation for public buildings and assets

Backup | New legislation provides incentives for facilities and production of geothermal (I/II)

 Provision	 Summary	 Type	 Total investment
1 IRA Section 13101: Renewable Energy Production Tax Credit ¹	Extension and modification of PTC for electricity for geothermal. Base credit of 0.3 cents/kWh and 1.5 cents/kWh if Wage/Apprenticeship requirements are met. Applies to facilities after 2024 and phases down in 2032	Production Tax Credit (PTC)	\$51B
2 IRA Section 13102: Energy Investment Tax Credit ¹	Extension and modification of the Investment Tax Credit to expand clean energy manufacturing. 30% ITC and 10% bonus if domestic manufacturing requirements are met. Applies to facilities after 2024 and phases down in 2035	Investment Tax Credit (ITC)	\$13.96B
3 IRA Section 13501: Advanced Manufacturing Tax Credit (48C) ¹	Tax credit of up to 30% on investments into clean energy manufacturing facilities	Manufacturing Tax Credit	\$10B
4 CHIPS Section 10771: Advanced Research Projects Agency - Energy ³	Allocates funding to Department of Energy research, development, and demonstration activities (ARPA-E) for energy projects	Grant	\$1.2B
5 CHIPS Section 10771: Office of Electricity ³	Allocates funding to Department of Energy research, development, and demonstration activities related to electricity	Grant	\$1B

1. [CTVC IRA Tracker](#). 2. [BakerHostetler](#) 3. RMI
Source: BCG Analysis

Backup | New legislation provides incentives for facilities and production of geothermal (II/II)

 Provision	 Summary	 Type	 Total investment
6 CHIPS Section 10771: Office of Energy Efficiency and Renewable Energy - Renewable Power ³	Allocates funding to Department of Energy research, development, and demonstration activities for renewable power research	Grant	\$800M
7 CHIPS Section 10622: Regional Clean Energy Innovation Program ³	Authorizes a Regional Clean Energy Innovation Program at DOE to establish partnerships that promote the economic development of diverse geographic areas of the US by supporting clean energy innovation	Grant	\$250M
8 Energy Act of 2020 Section 3002: Advanced Geothermal Innovation Leadership (AGILE) Act	Reauthorizes DOE’s geothermal energy RDD&CA program, including enhanced geothermal research, research for heat pumps and direct use, and expansion of the DOE’s Frontier Observations for Research in Geothermal Energy (FORGE) program. Also, establishes a program to utilize DOE’s computing and modeling capabilities to understand geothermal resources, expands the definition of renewable energy to include thermal energy.	Combination	\$7.5B (not specific to geothermal)
9 IRA Section 13702: Clean Electricity Investment Credit ²	Intended to replace 13102. Tax credit for domestically produced, zero emissions electricity. Facility must be placed into service after December 31st, 2024. Technology agnostic	Investment Tax Credit (ITC)	\$50.9B

1. [CTVC IRA Tracker](#). 2. [BakerHostetler](#) 3. RMI 4. [Energy Act of 2020](#)
Source: BCG Analysis

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