Next-Generation Geothermal: Deployment in California

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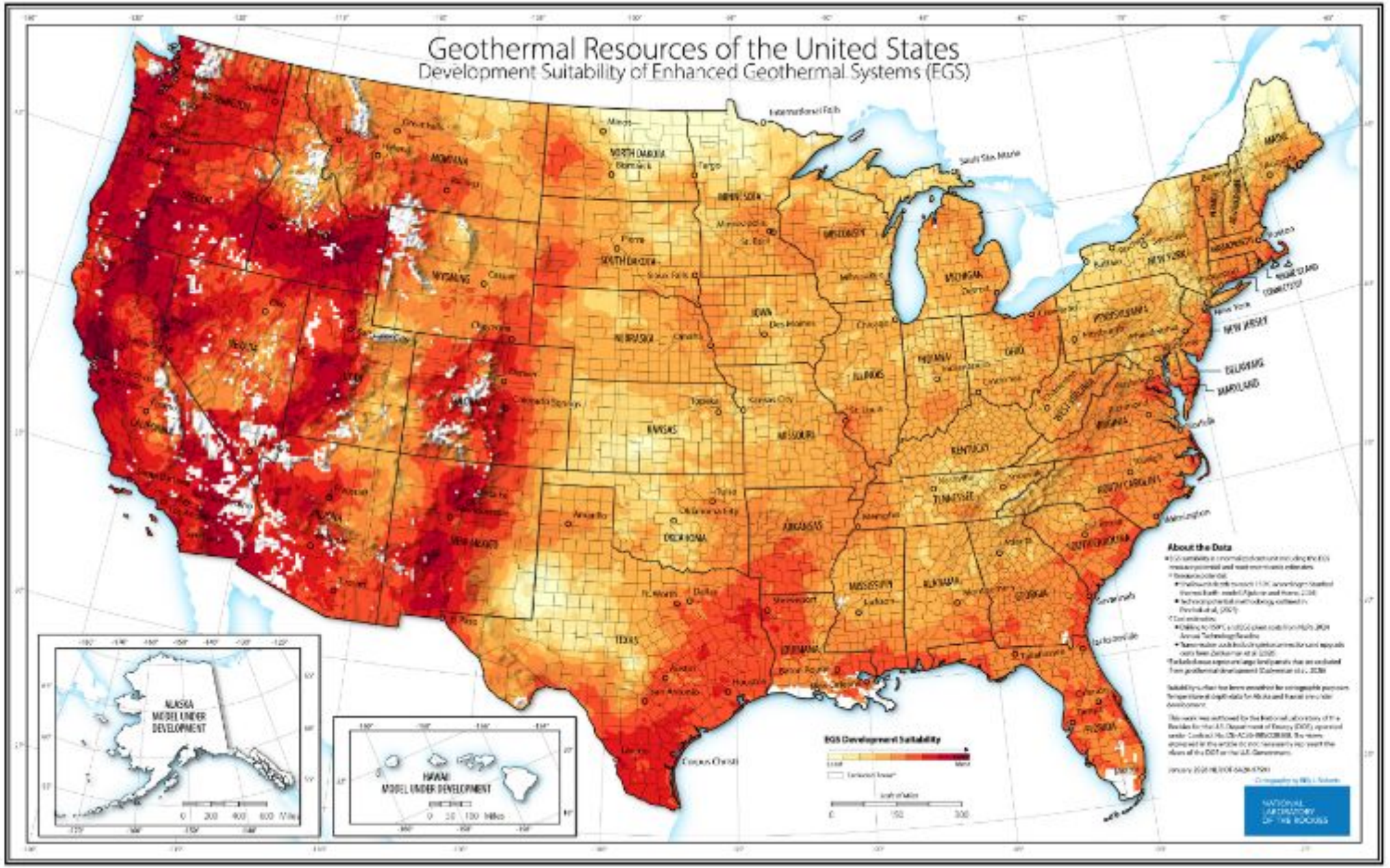
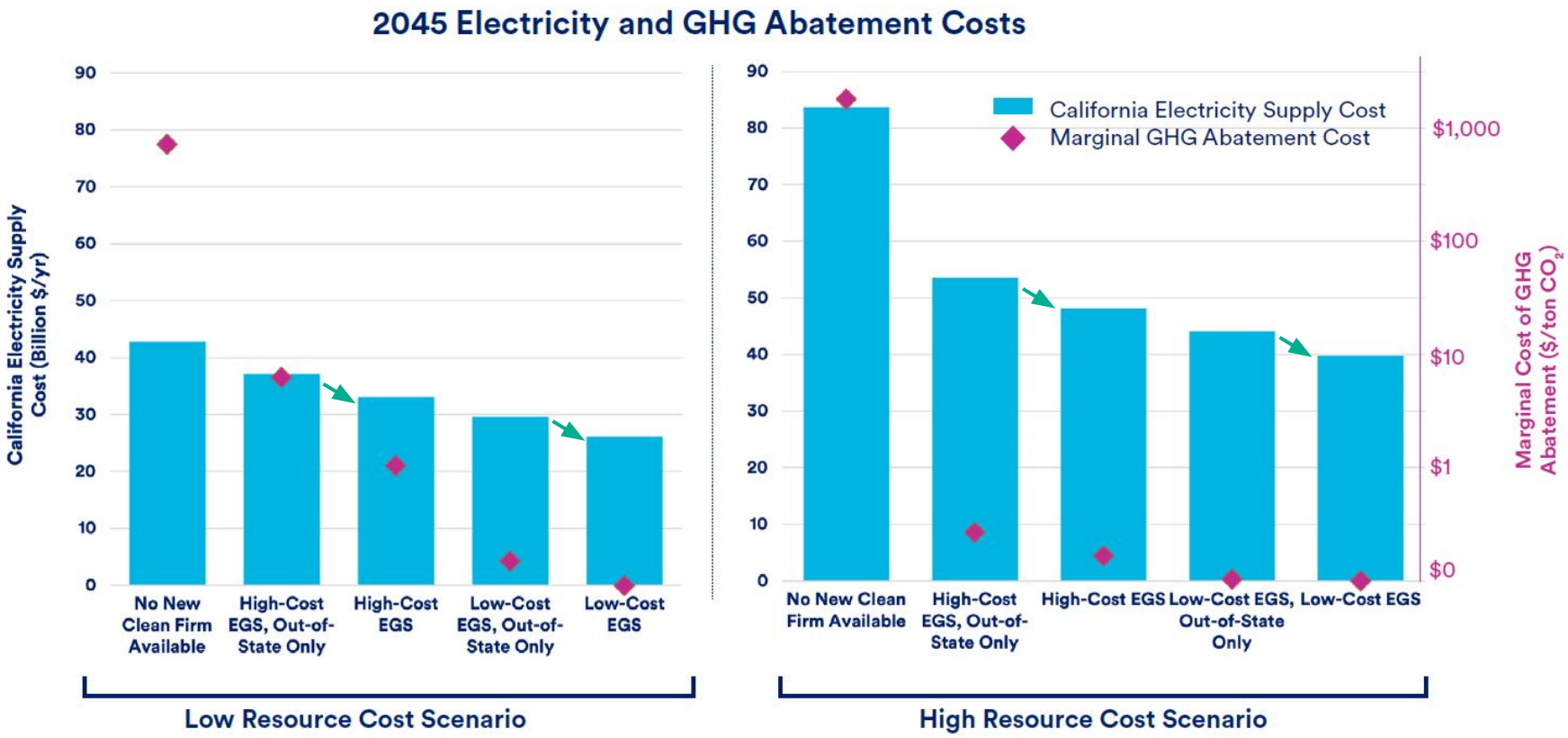
CLEAN AIR TASK FORCE


Geothermal Resources of the United States
Development Suitability of Enhanced Geothermal Systems (EGS)
ALASKA
MODEL UNDER
DEVELOPMENT
HAWAII
MODEL UNDER DEVELOPMENT
About the Data

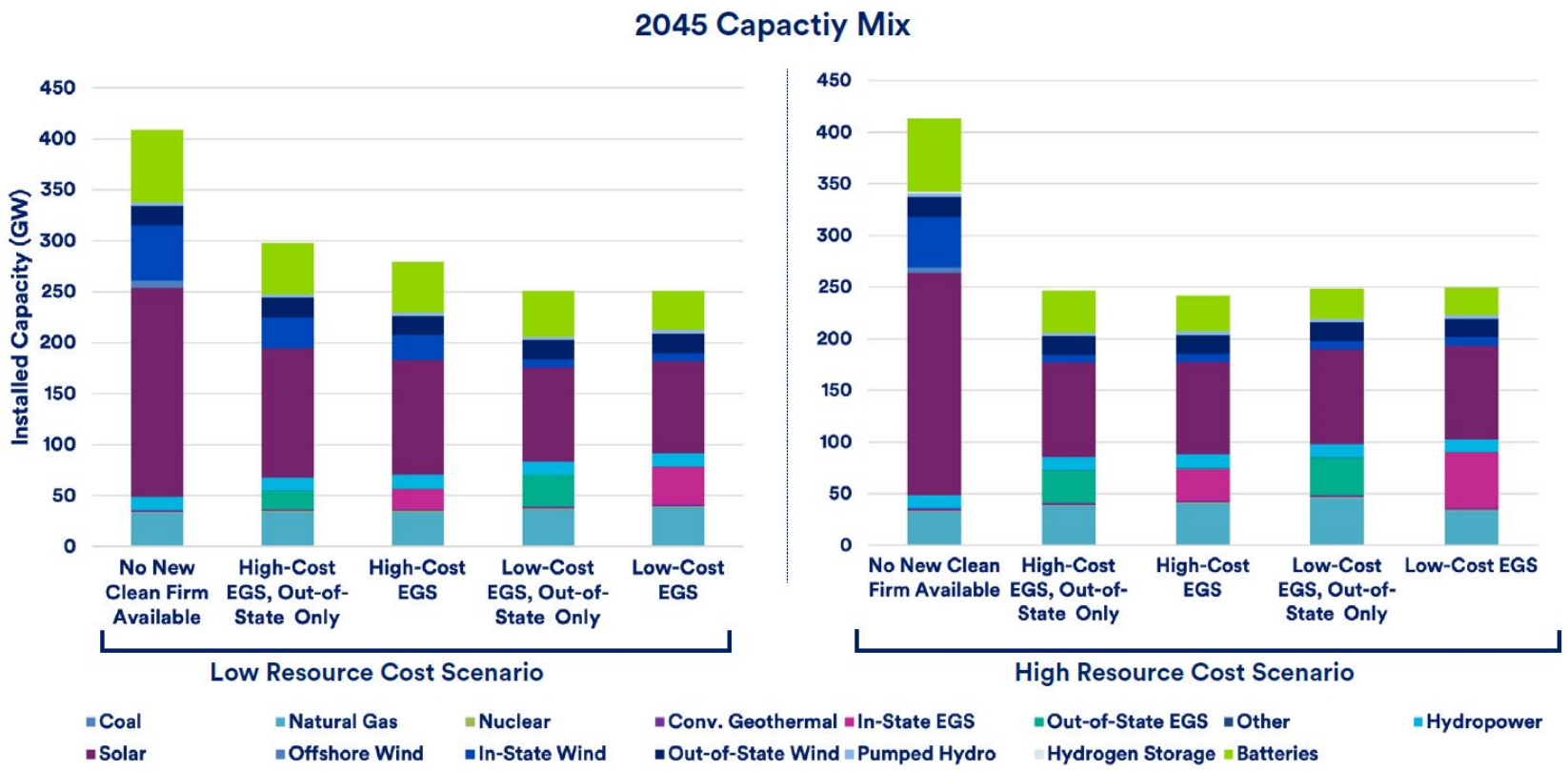
Clean firm availability reduces costs

- **Availability of clean firm resources (like geothermal) reduces annual electricity supply costs by $10-44 billion, or 23-52%**
- Costs are moderately lower ($3.5-5.5 billion per year) when clean firm resources are deployed in-state



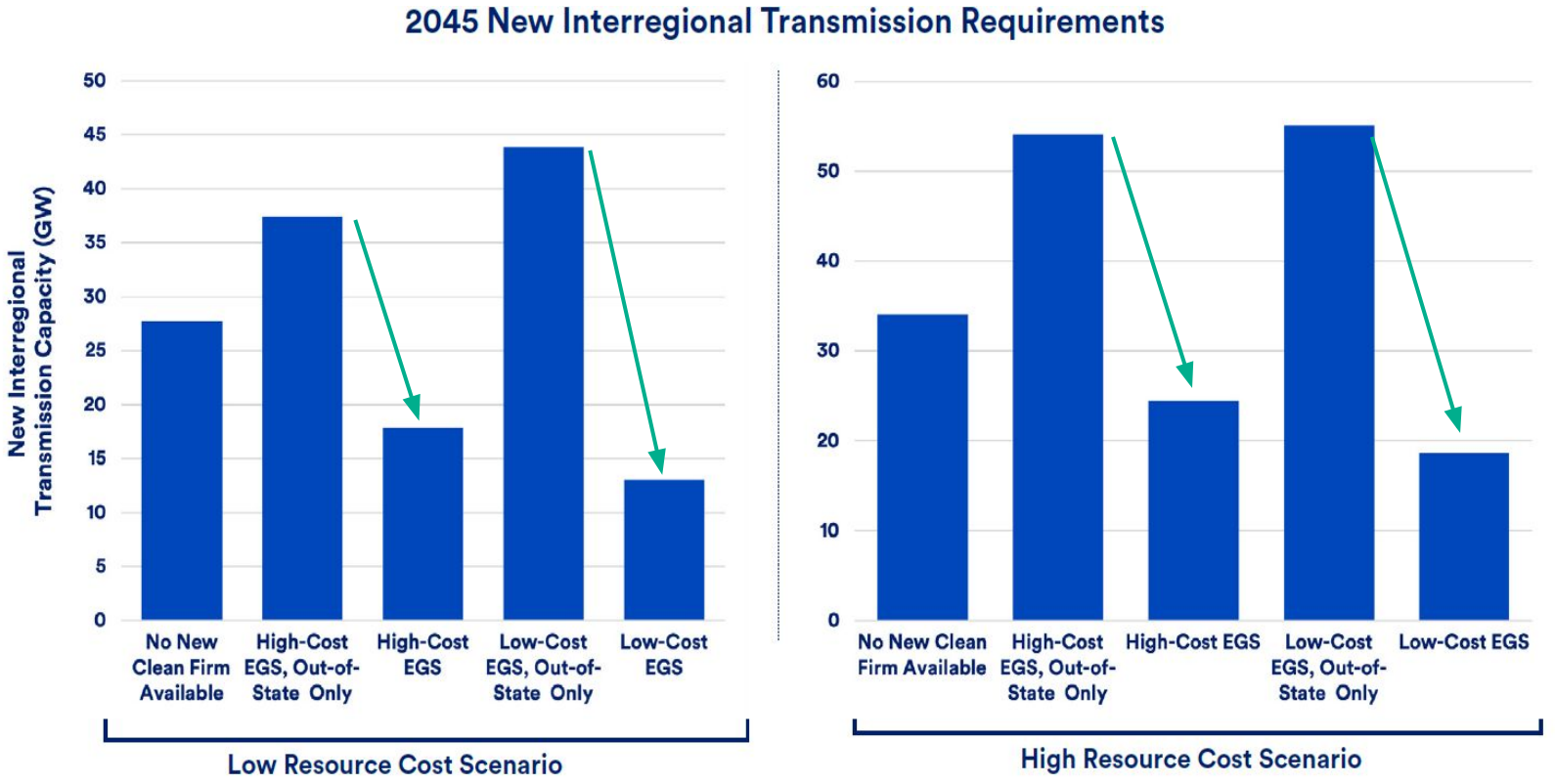
Required buildout rates are substantially lower

- Without clean firm options, hitting the 2045 target requires **large amounts of low-quality in-state wind**, and **solar buildout at a rate of 10 GW/yr**
- Clean firm availability reduces the required solar buildout to 3 GW/yr – roughly the present pace



In-state availability reduces transmission needs

- Relying only on out-of-state clean firm increases necessary interregional transmission by more than **10 GW**
- **Deploying in-state drastically reduces interregional transmission buildout requirements**
- Long-distance, cross-jurisdictional transmission deployment is one of our most difficult infrastructure challenges: **SunZia took almost two decades**



The problem: a structural finance mismatch

- Fundamental need is for private investment
- 1. High upfront capex ($7M-5.5M per GW)
- 2. Slow and steady returns over decades
- 3. Next-generation geothermal is (and is seen as) risky
- Result: limited investment, high cost of capital for the investment that does exist

Five Levers for Geothermal Deployment

🗺️ **Characterize**
Map geothermal's subsurface resource potential

⚖️ **Govern**
Establish a regulatory system that works for industry and communities

🛡️ **Finance**
Incentivize exploration and demonstration

⚡ **Connect**
Develop supportive infrastructure

🔬 **Innovate**
Sustain R&D

What California can do

🗺️ Characterize

- Fund subsurface mapping
- Digitize existing subsurface data

⚖️ Govern

- Update geothermal regulations

🛡️ Finance

- Implement the $20M program for geothermal exploration and development

⚡ Connect

- Include geothermal in transmission planning processes

Appendix

Community support is essential to project success

- CATF conducted research into public perceptions of geothermal – benefits, risks, and reassurances
- Strong public support for geothermal
- Main concerns focus on health and environmental impacts
- Ultimately, community members want to know that projects can be developed safely
- Key message to build trust: **We have safeguards in place to minimize risk, informed by scientific and technical knowledge**

🗺️ **Characterize**: Map geothermal's subsurface resource potential

- Understanding the subsurface is crucial for project success
- Private investment is uniquely unwilling to pay
- Policy Recommendations:
  - Expand geologic mapping
  - Digitize historical well logs to provide geothermal-relevant data

⚖️ **Govern:** Establish a regulatory system that works for industry and communities

- Clarity and predictability derisk projects
- Regulations and legal frameworks do not account for geothermal (especially next-generation)
- Agencies unfamiliar with geothermal (especially next-gen)
- Challenges with communication among/between agencies and external stakeholders
- Policy Recommendations:
    - Streamline processes, increase agency capacity, improve coordination
    - Update regulations and establish clear ownership principles

Finance: Incentivize exploration and demonstration

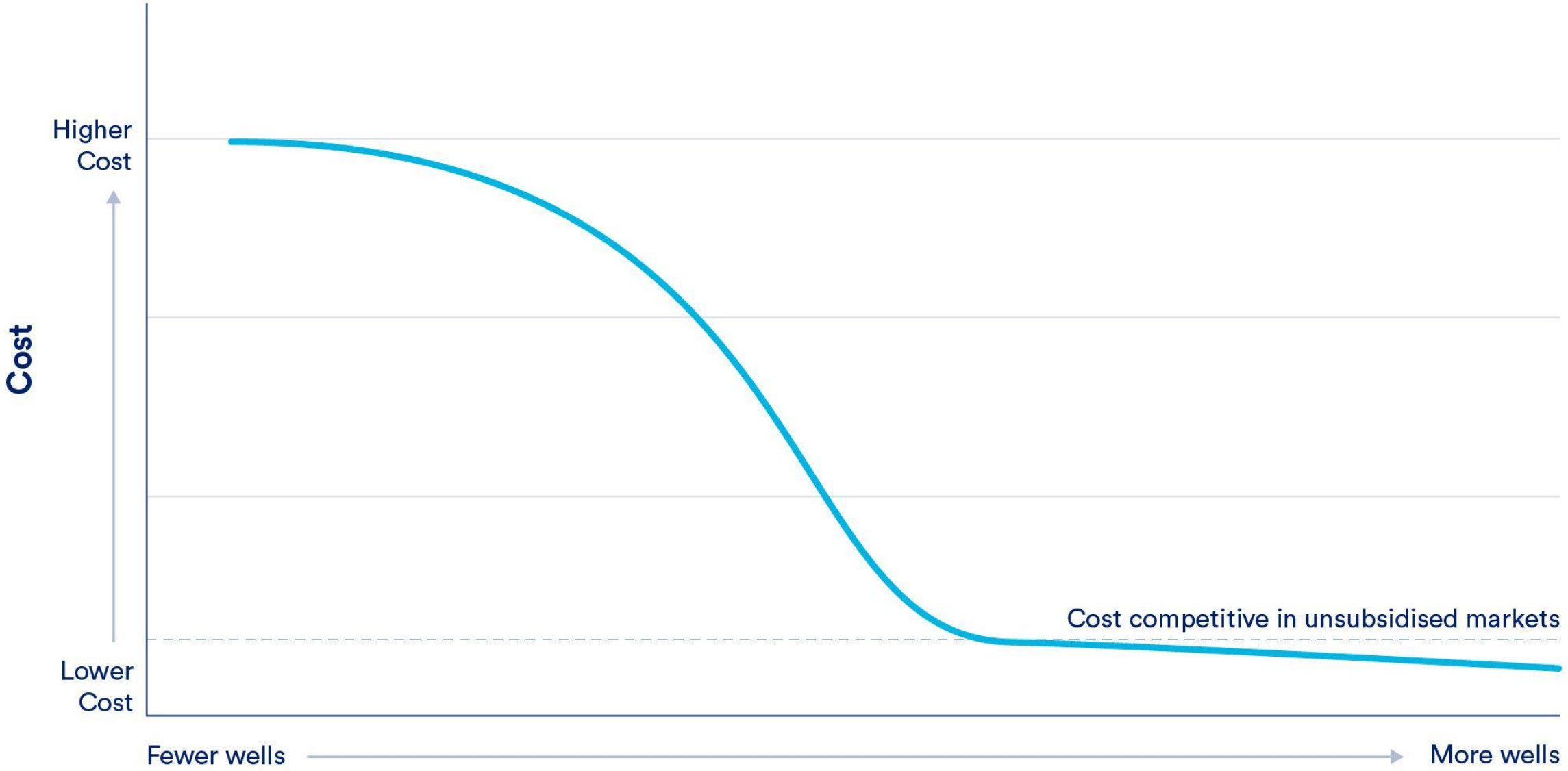
- “First-of-a-region” projects are risky
- Early deployment crowds in private investment and can kickstart a virtuous cycle
- Existing programs don’t move the needle (too small; not targeted)
- States can make a difference even with limited resources
- Policy Recommendations:
  - Establish procurement targets or standards for geothermal energy
  - Launch financing programs such as milestone-based convertible loans; target first projects in new regions

⚡ **Connect:** Develop supportive infrastructure

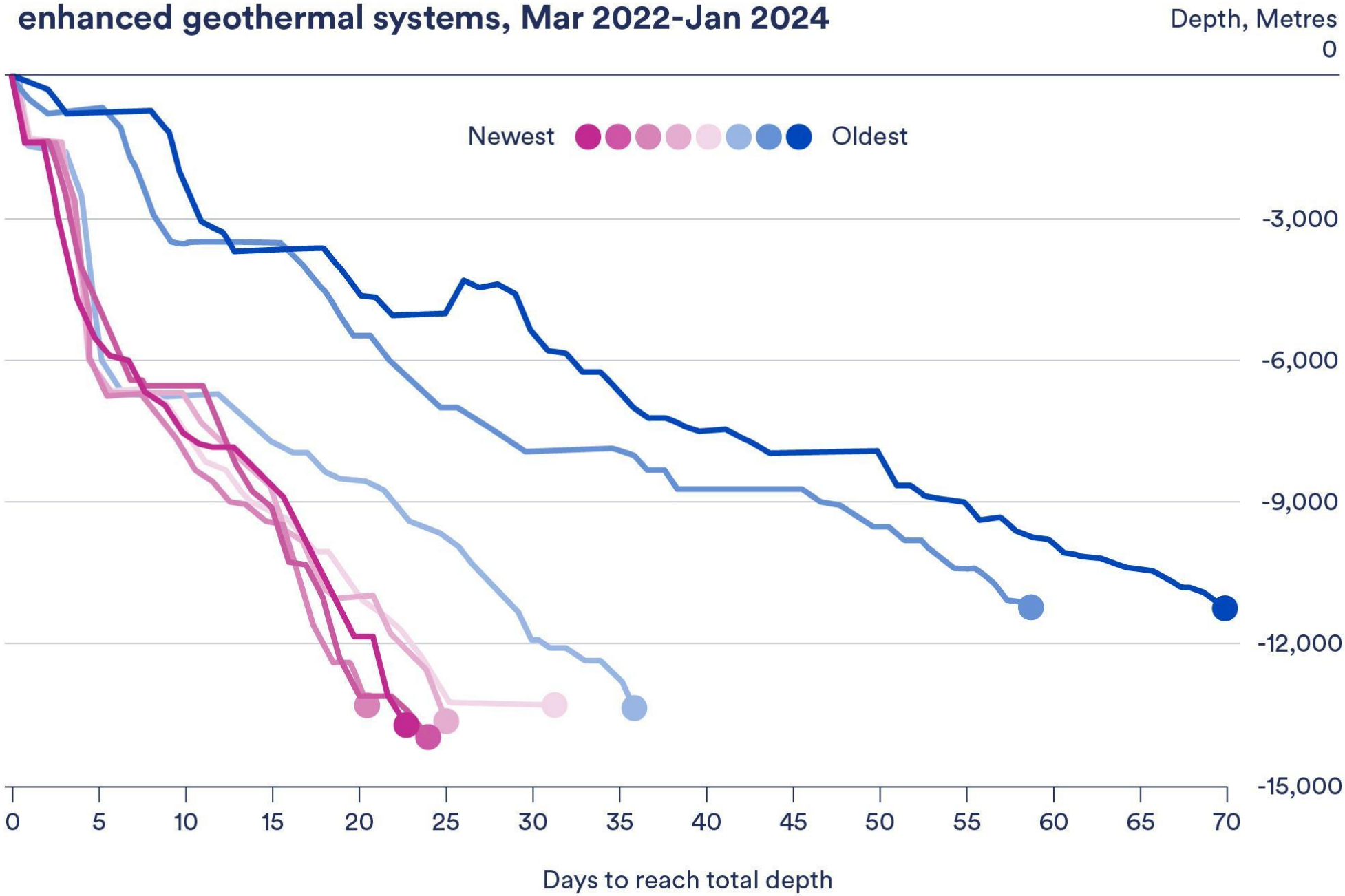
- Transmission access is one of the biggest barriers to near-term deployment
- Policy recommendations:
  - Build more transmission
  - Integrate geothermal potential into transmission planning processes so that transmission is built to areas with high geothermal potential

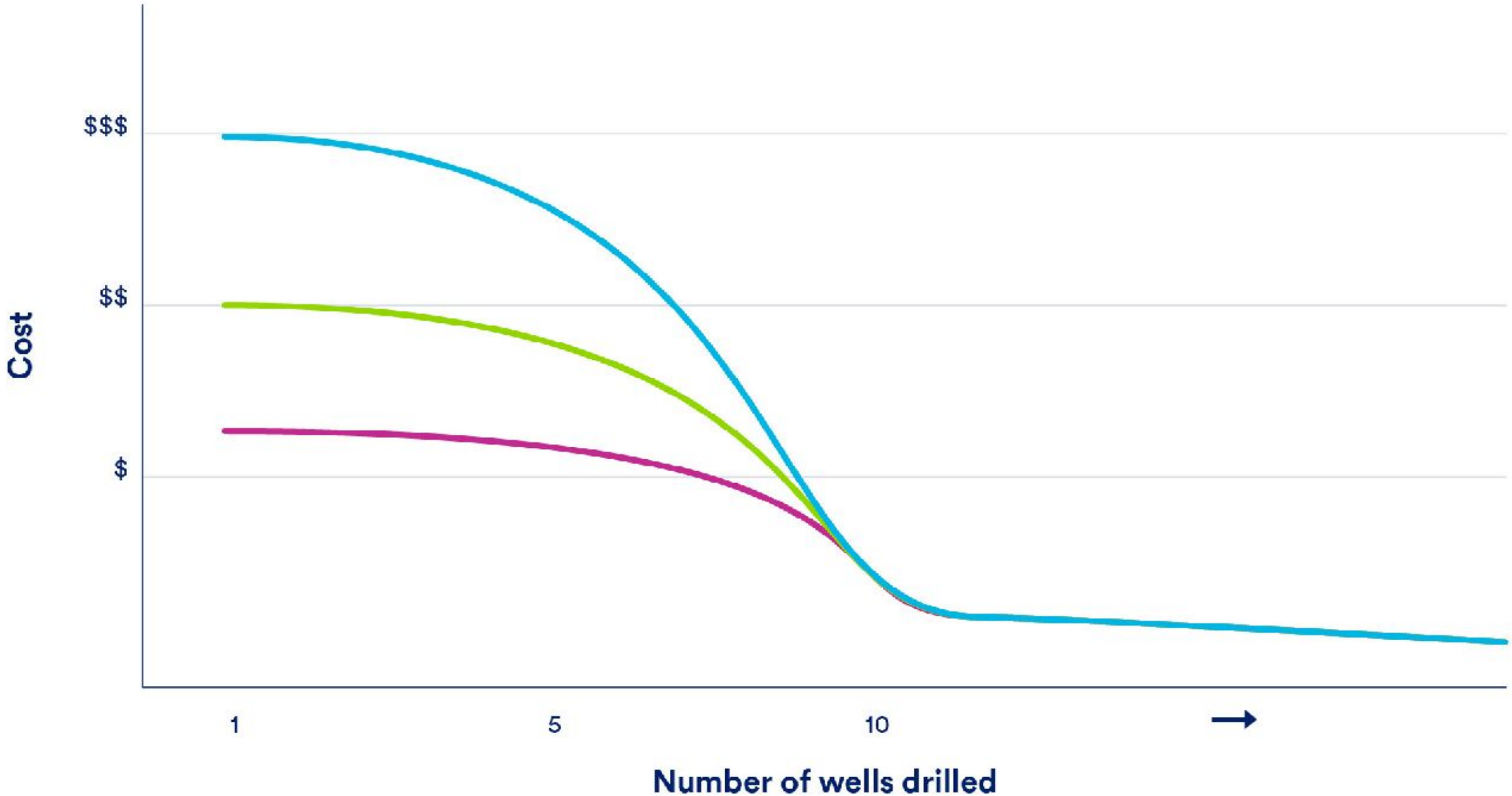
🔬 **Innovate:** Sustain R&D

- Higher temperatures = greater energy density = cheaper power
- Additional innovation needed to expand geothermal across the whole US and reach hotter temperatures
- Policy Recommendations:
  - Fund geothermal R&D
  - Support field test sites and full-scale testing facilities in real-world conditions


Higher Cost
Cost
Lower Cost
Cost competitive in unsubsidised markets
Fewer wells
More wells

Fervo Energy, drilling performance using enhanced geothermal systems, Mar 2022-Jan 2024




Cost
$$$
$$
$
1
5
10
Number of wells drilled