

# The Future of Geothermal

***Research, intelligence, and insights on geothermal technology, costs, applications, and implementation***

Multi-Client Study Prospectus  
Summer 2023



440 COBIA DR • STE 1704  
HOUSTON • TEXAS 77494  
+1 (281) 506-8234  
[INFO@ADI-ANALYTICS.COM](mailto:INFO@ADI-ANALYTICS.COM)  
[WWW.ADI-ANALYTICS.COM](http://WWW.ADI-ANALYTICS.COM)

**CONFIDENTIAL**

# Outline

- ▶ **Study Prospectus**

- ▶ About ADI

# ADI's new study will analyze geothermal energy technologies, projects, costs and economics, and its outlook

## Multi-client study drivers

- Decarbonization and energy security are two major themes of the energy transition.
- Geothermal energy offers a renewable power source without the intermittency issues of wind and solar.
- It is estimated that 0.1% of earth's heat could conceptually supply all of humanity's energy needs for 2 million years.
- Geothermal is seeing increased investments from the private and public sectors with new companies and technologies emerging to advance the industry.
- The geothermal industry is looking at incorporating tools and technology from the shale revolution to propagate and advance geothermal.

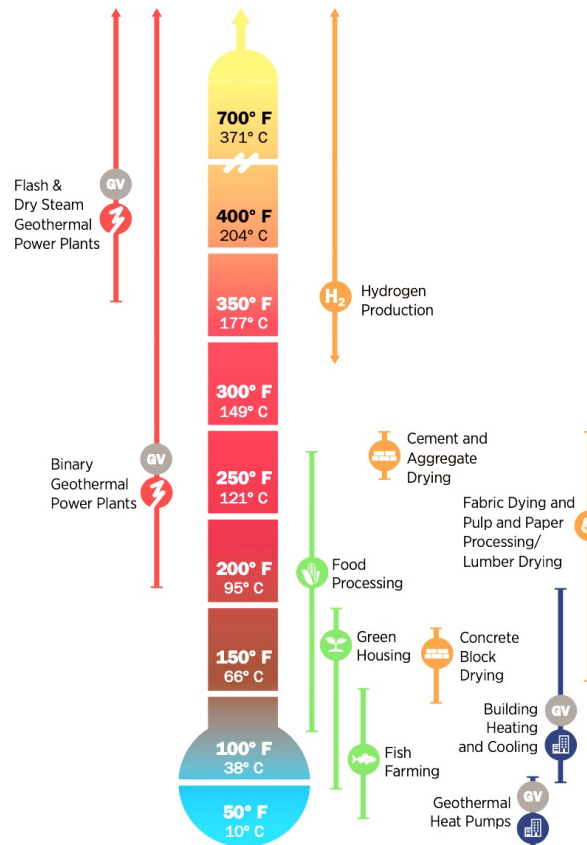
## Strategic questions for the ADI study

- What is the state of the geothermal industry?
- What advances are being made in technology, and how are they improving costs?
- What longer-term technology challenges remain?
- Who is playing in this space, both developing technology and implementing projects?
- What geothermal projects are being developed, and what challenges are they facing?
- What environmental and regulatory challenges are affecting the industry?
- Where is geothermal headed over the next decade?
- What are the strategic implications and associated risks and uncertainties for current and new participants?

# This report focuses on geothermal for power generation with some coverage at a high level of other applications

## Power generation

- Power generation requires higher temperatures – typically above ~100 °C
- Older generations of geothermal power plants used steam directly from the ground and require heat of at least 200 °C
- Newer “binary” plants pass fluids through a heat exchanger and then use heat to flash steam



## Direct use

- Geothermal heat can be used directly in residential, commercial, and industrial applications
- Applications include heating homes and buildings to drying cement and concrete
- Higher temperature geothermal can also be used for hydrogen production

## Other applications

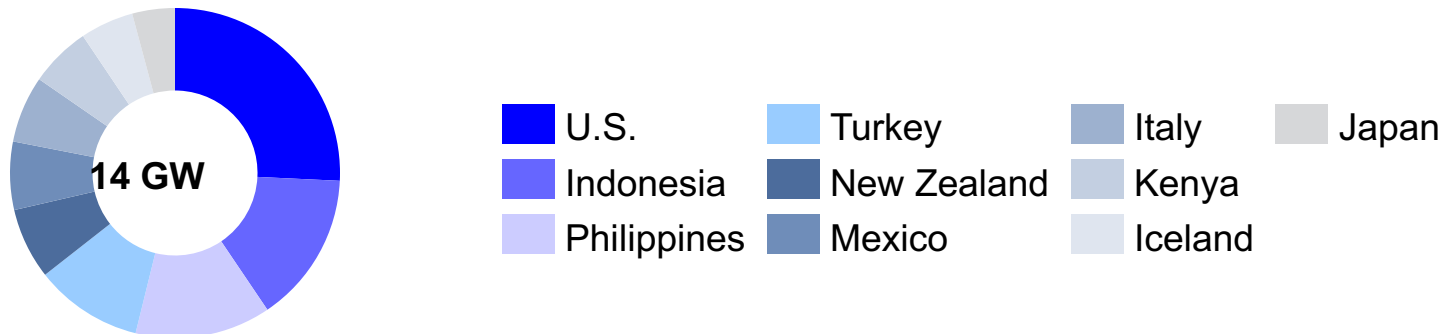
- Geothermal resources are increasingly being looked at for lithium extraction
- Process includes extracting lithium from geothermal brine before recirculating into the subsurface

# Geothermal is a minor part of the renewable energy mix today, largely due to limitations with conventional technology ...

Location of geothermal power plants



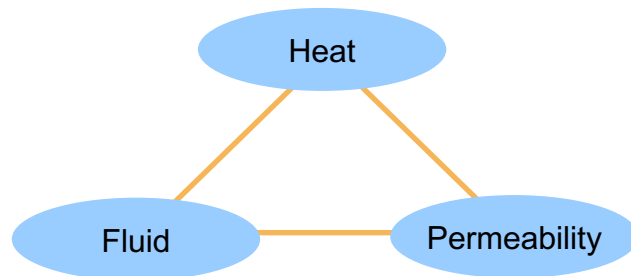
Top 10 geothermal producing countries



# ... Although conventional geothermal is cost-competitive when compared to other renewable power technologies

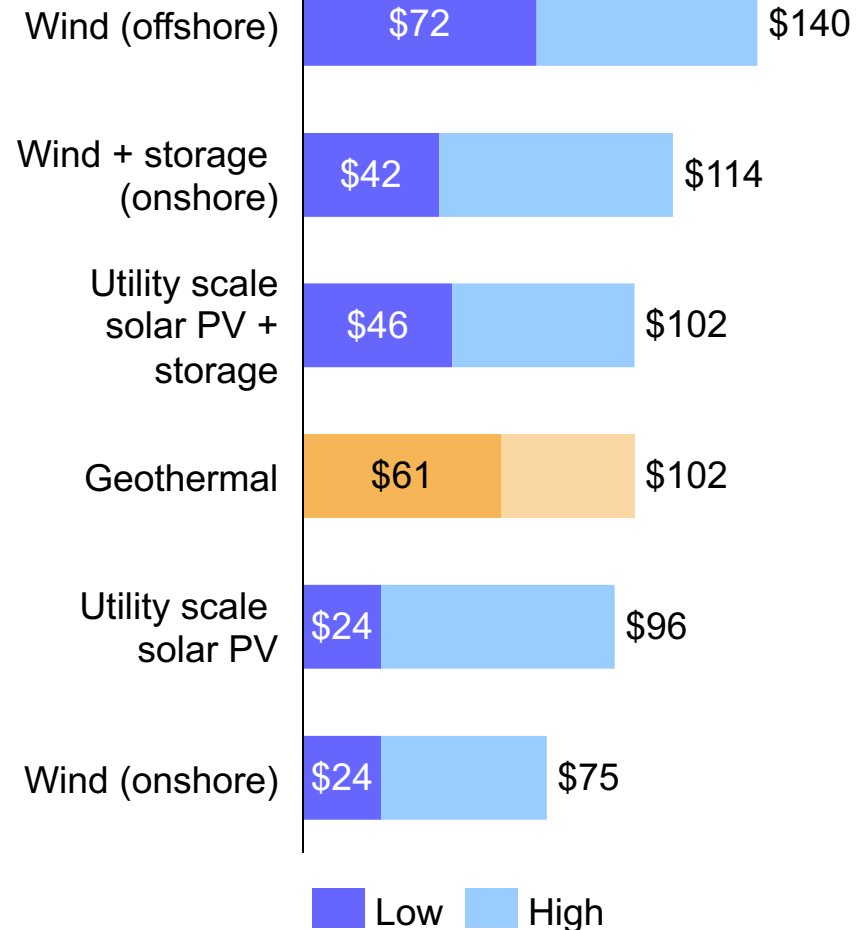
## Technology overview

- Conventional geothermal is cost-competitive with renewable technologies ...
- ...However, conventional geothermal is limited in where it can be developed
- Geothermal systems require three ingredients:



- New geothermal technologies are being developed to expand geothermal to areas where one or more of these ingredients are missing
- Dozens of new start-ups are entering this space to advance these technologies

## Levelized cost of energy for renewable energy (\$/MWh)



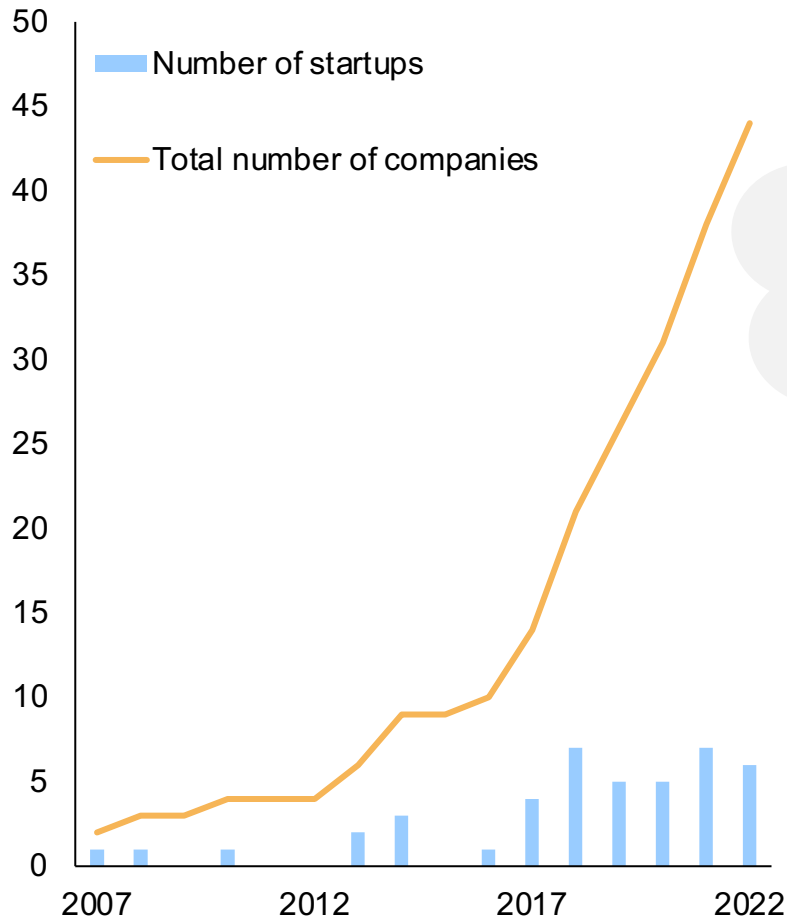
# There are four key types of geothermal energy technology

## Key types of geothermal energy technologies

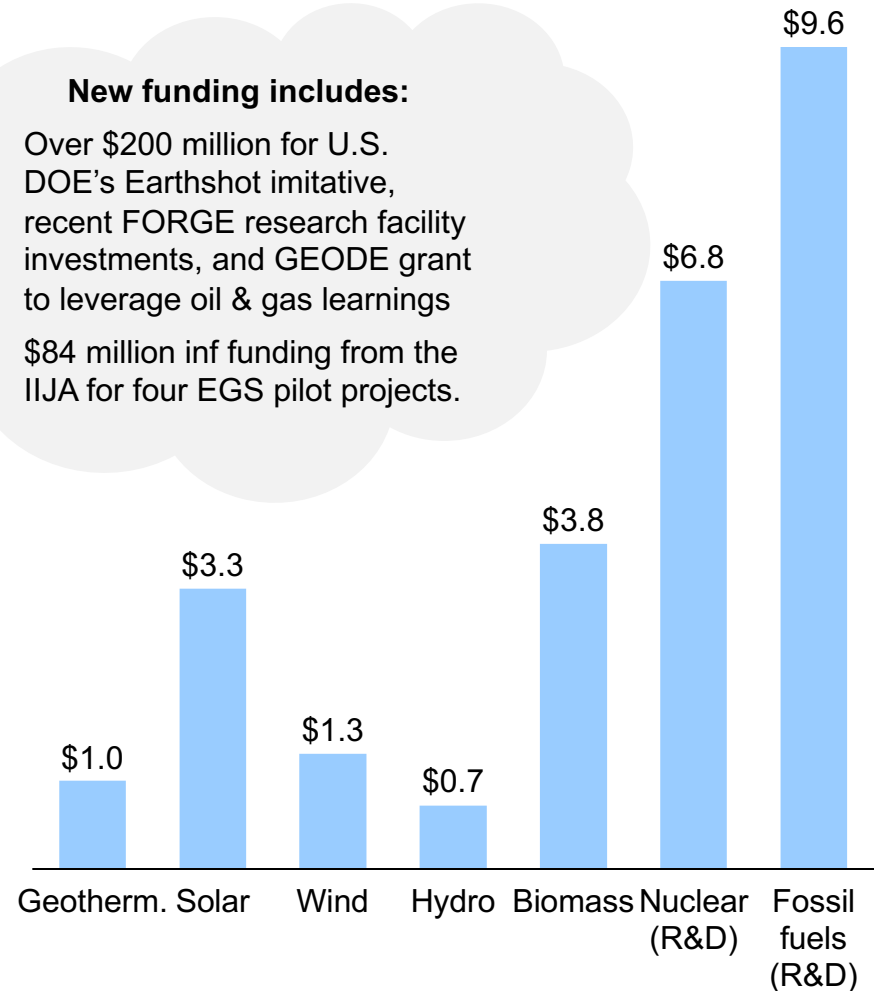
1 Conventional geothermal	2 Enhanced geothermal systems (EGS)
<ul style="list-style-type: none"><li>▪ Mature technology behind all commercial geothermal capacity in place today</li><li>▪ Requires all three geothermal ingredients: heat, fluid, and permeability</li><li>▪ Limited in deployment due to siting challenges</li></ul>	<ul style="list-style-type: none"><li>▪ Next-generation geothermal technology that can be deployed in without permeability or fluid</li><li>▪ Currently estimated to cost ~\$450 per MWh</li><li>▪ Recent U.S. Department of Energy “Earthshot” program has goal of cutting cost by 90%</li></ul>
3 Advanced geothermal systems (AGS)	4 Supercritical geothermal
<ul style="list-style-type: none"><li>▪ Systems have been around for years</li><li>▪ Next-generation systems are revamping with oil and gas technologies</li><li>▪ No fluids are introduced or extracted; rather fluid is circulated in sealed pipe and boreholes to pick up heat by conduction</li></ul>	<ul style="list-style-type: none"><li>▪ “Holy grail” of geothermal with significant engineering challenges</li><li>▪ Requires water above 373 °C and 220 bar pressure, where it becomes supercritical</li><li>▪ At this supercritical state, more energy is produced from a well and more electricity from that energy</li></ul>

# Several new start-ups have emerged along with new public funding and ...

**Development of geothermal companies**  
(Number of companies)







**U.S. DOE funding 2004-2019**  
(USD, billion)

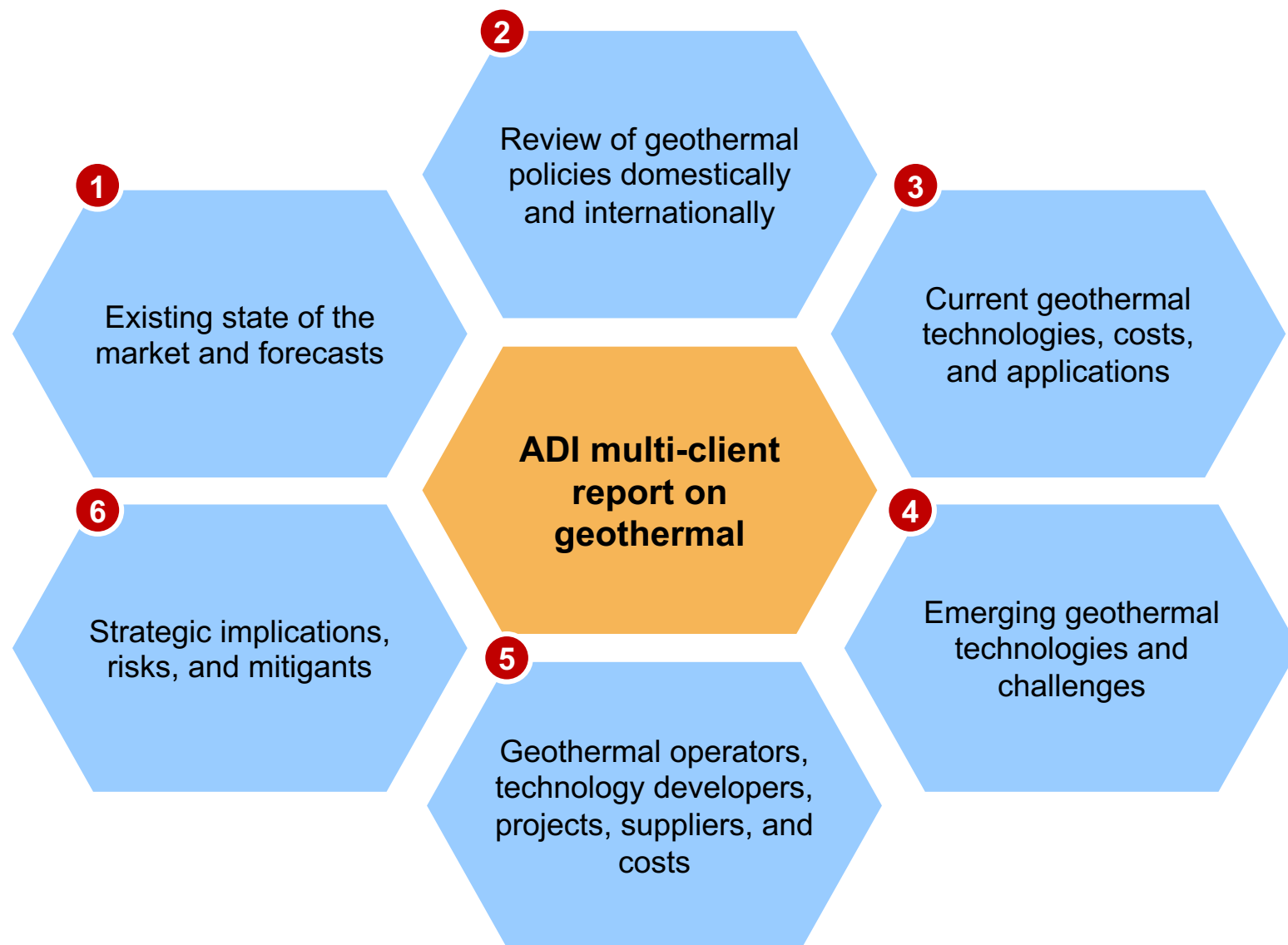




# ... The industry is seeing investments from the private sector, largely by oil and gas companies

Geothermal company	Private investor	Discussion
		Devon has invested \$10 million in venture funding
		Established a joint venture to develop geothermal projects in the U.S.
		Chevron and BP have invested \$40 million venture funding
		Partnering for a geothermal study in Canada
		GM has made a 'multimillion-dollar investment' to develop CTR's Hell's Kitchen geothermal lithium project
		Ford signed lithium supply contract with ESM for geothermal lithium from their Project ATLiS

# The ADI study will be an in-depth review of geothermal drivers, technologies, costs, incentives, innovation, projects, and players



# ADI's expertise and experience in geothermal includes serving U.S. DOE on EGS costs, economics, and analytics since 2010

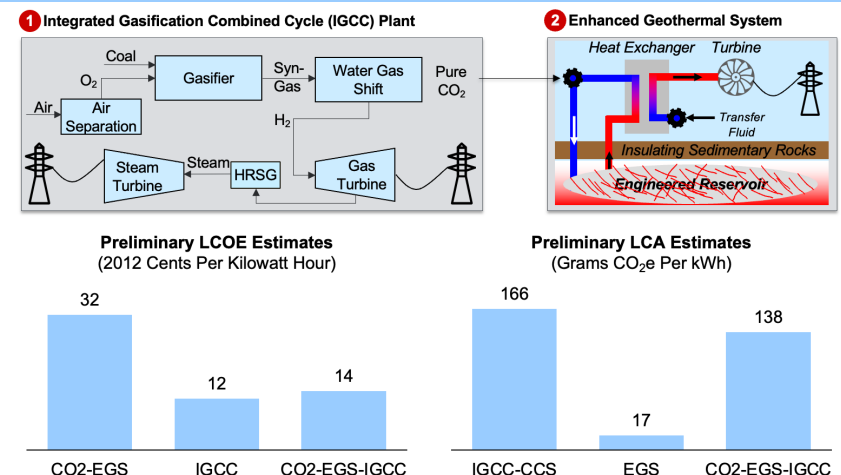
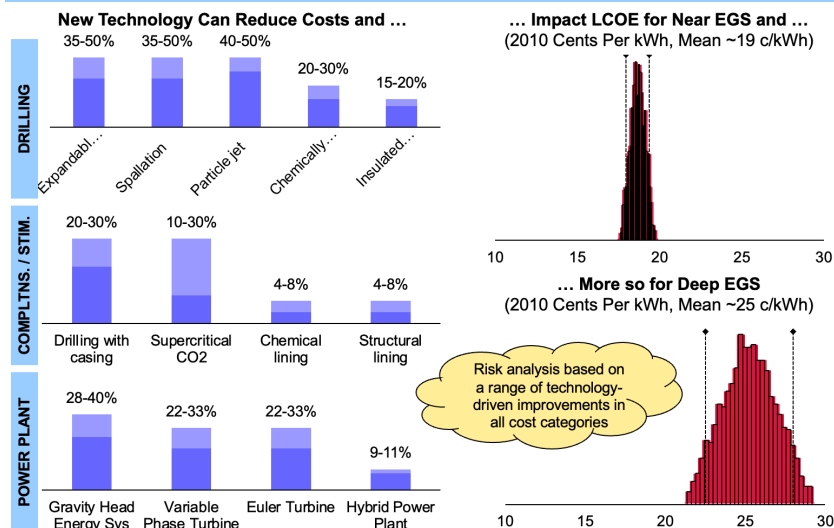
## ADI's geothermal experience

- ADI led a 3-year, U.S. DOE-funded study on costs and economics of geothermal energy ...
- ... Exploring how oil & gas technologies and practices can cut costs of EGS in particular
- Advised many start-ups, oil & gas majors, oilfield service players, renewable power developers, and investors on geothermal

## ADI publications on geothermal

- Four proprietary reports on costs, learning rates, patent analytics, and new configurations
- Spoke at leading geothermal events, e.g., GRC, GSPAWG, DOE Peer Review, ICCS&T
- Published ~10 peer-reviewed articles and conference presentations on various aspects of geothermal energy costs and technology

## Examples of ADI's geothermal research for U.S. Department of Energy



Assumes 200 °C resource; 30 kg/s flow rate; 5,000 m depth; and 0.3% thermal drawdown.

# The proposed study's table of contents is detailed and comprehensive and can be shaped and refined by subscribers

<b>1</b>	<b>Executive summary</b> <i>Key conclusions, findings, and strategic implications with a review workshop and data pack</i>	<b>7</b>	<b>Challenges for geothermal</b> <i>Analysis of challenges including in technical advances and implementation</i>
<b>2</b>	<b>Introduction to geothermal</b> <i>Background and introductory information on existing geothermal technology and projects</i>	<b>8</b>	<b>Geothermal projects in progress</b> <i>Details on geothermal projects and review of companies operating in this space</i>
<b>3</b>	<b>Geothermal market and forecasts</b> <i>Review of geothermal projects, investors, and forecasts and drivers for growth</i>	<b>9</b>	<b>Geothermal costs and economics</b> <i>Breakdown of costs and economics for geothermal technology and facilities</i>
<b>4</b>	<b>U.S. policies and incentives</b> <i>Review of local and federal policies and regulations promoting and financing geothermal</i>	<b>10</b>	<b>Risks and mitigants</b> <i>Review of risks for geothermal implementation and mitigants available</i>
<b>5</b>	<b>Global policies and incentives</b> <i>Review of international policies and regulations promoting and financing geothermal</i>	<b>11</b>	<b>Market and strategic implications</b> <i>Analysis of implications for various technical, structural, and regulatory changes for geothermal</i>
<b>6</b>	<b>Innovations in geothermal</b> <i>Analysis of emerging technologies, innovations and players in this space</i>	<b>12</b>	<b>Conclusions and recommendations</b> <i>Key findings and major conclusions</i>

# ADI's "The Future of Geothermal" study offers subscribers a number of benefits

Outcomes	Deliverables
1 In-depth coverage of geothermal space	~100-page report in Q3 2023
2 Extensive review of existing and emerging global policy and initiatives	~20-page executive summary deck
3 Review of projects, technology, players, and stakeholders	Spreadsheet data package
4 Geothermal costs and breakdown by technology type and cost improvement opportunities	Review workshop
5 Key commercial insights and strategic implications	Analyst access

Contact Uday Turaga, +1.281.506.8234 or [info@adi-analytics.com](mailto:info@adi-analytics.com) to purchase this study.

# Outline

- ▶ Study Prospectus

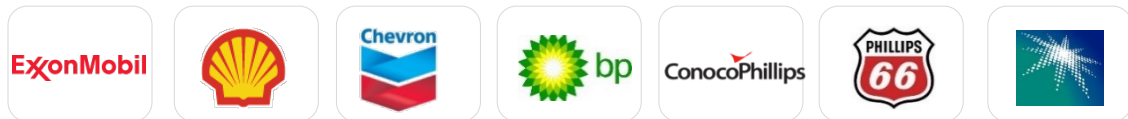
- ▶ **About ADI**

# ADI is a consulting firm serving oil & gas, energy, chemicals, and industrial clients with expertise, rigor, and passion



# Over 300 clients - Fortune 500 brands, mid-sized firms, start-ups, and investors have engaged ADI to shape decisions

## Oil & Gas



## Chemicals



## Industrials & Digital



## Oilfield Services



## EPC



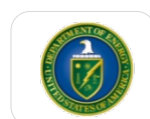
## Investors



## Early-stage



## Public





# Our value proposition – expertise, experience, analytics, and thought leadership – is designed to help clients succeed

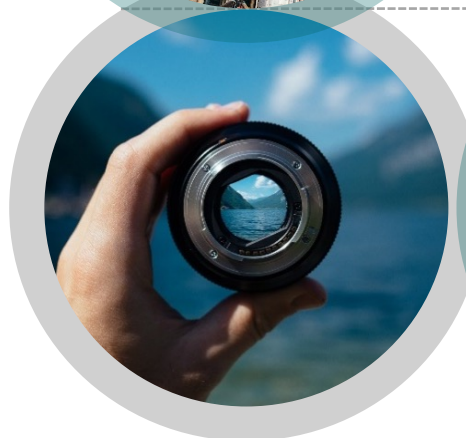
Deep, frontline  
**industry expertise**



Over **600 projects** for  
**300+ clients** since 2009



Differentiated  
**thought leadership**



**Proprietary analytics-**  
and **data-driven**

# Clients accelerate priorities with ADI's consulting services, subscription research, data analytics, and conferences

## Consulting

Discover and capture opportunities, solve problems, and help businesses thrive amid uncertainty with ADI's market research and management consulting services

## Research

Track markets with ADI's subscription research

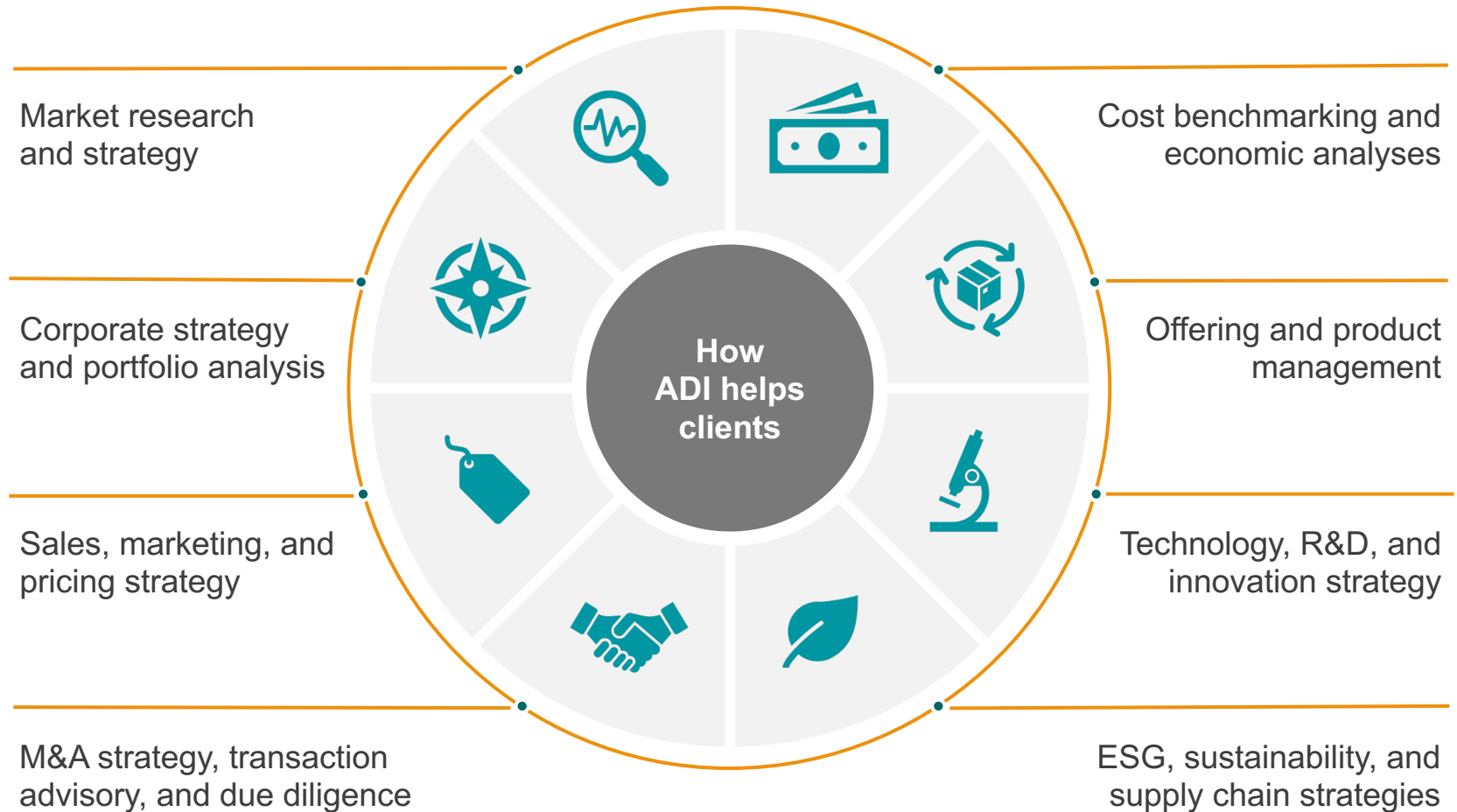
## Analytics

Inform workflows with ADI data, models, and analytics

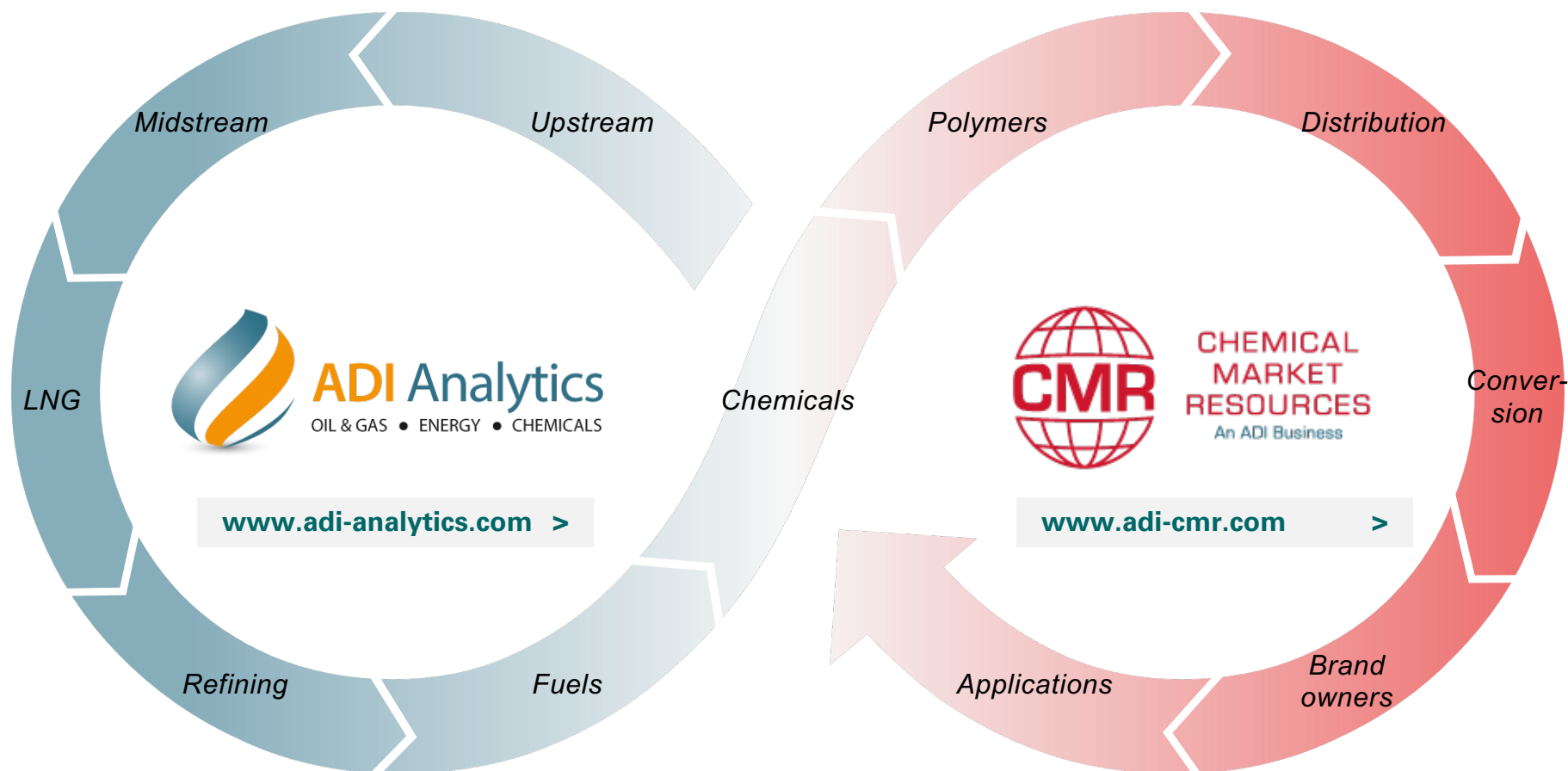
## Forums

Build a strategic view and network at our conferences

# Clients shape strategy, grow sales, refine costs, drive deals, and build competencies with ADI's consulting services



# After acquiring Chemical Market Resources, ADI's expertise has grown and now spans the entire hydrocarbon value chain



# Stay ahead of the curve with market intelligence, forecasts, and analysis from ADI's subscription research services

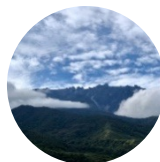
## ADI subscription research >>



SAF tracker



Downstream market advisory



The future of direct air capture



Natural climate solutions



Sustainable aviation fuel (SAF)



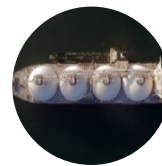
Global CapEx / OpEx outlook



Energy transition advisory



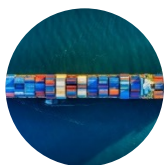
Alternative marine fuels market study



Global / NA small-scale LNG



U.S. gasoline and octane outlook



Refueling North America with LNG



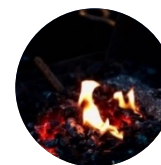
Latin America refined product exports



Assessing opportunities in bio-based chemicals



Benchmarking shale gas monetization options



Critical minerals and energy transition

## ADI multi-client reports >>

[Access research and reports >>](#)



# ADI enjoys a stellar reputation for exceptional project delivery and client service and satisfaction



"Work directly with firm partners ... high-quality work products."

– Alex Rozenfeld, *VP, Ventures, Shell*



"Lots of oil & gas expertise. Very analytically driven. Better customer service."

– Vikki Dunn, *CMO, GE Oil & Gas*



"The best about ADI is their ability to drill into a specialized area."

– Johanna Schmidtke, *Director, Saudi Aramco*



"Very diligent, very detailed ... went the extra mile."

– Elliott Smith, *VP, Strategy, Voith*



"They've been outstanding. ADI is very thorough, very professional. They deliver a lot of good insights right out of the gate."

– Randy Benson, *VP, Sales, Harsco*



"The thoroughness of ADI's research is phenomenal."

– Steve Woodward, *SVP, Antero Resources*



"ADI did a great job to help us think and advance in making our investments."

– Meghan Leggett, *Principal, White Deer*



"ADI has very deep market knowledge and access to the right experts and delivered very successful projects."

– Brian Orkin, *Partner, Arsenal Capital Partners*

# Build a strategic view of energy and chemical value chains informed with executive perspectives at ADI's conferences



**ADI Forum**, our flagship conference held annually since 2017 in Houston, focuses on the oil & gas value chain [!\[\]\(3dfb8d66e81160ad61421a3452093d1b\_img.jpg\)](#)

**FlexPO+**, hosted by ADI Chemical Market Resources since 1996, covers polymers, plastics, chemicals, and petrochemicals [!\[\]\(99f58673407353e96a019fbca558fd72\_img.jpg\)](#)



# ADI Analytics

OIL & GAS • ENERGY • CHEMICALS

440 COBIA DR • STE 1704 • HOUSTON • TEXAS 77494

+1 (281) 506-8234 • [INFO@ADI-ANALYTICS.COM](mailto:INFO@ADI-ANALYTICS.COM)

[WWW.ADI-ANALYTICS.COM](http://WWW.ADI-ANALYTICS.COM)



CREATING  
VALUE SINCE  
**2009**

**300+**  
CLIENTS

**600+**  
PROJECTS

**15+**  
SERVICES

**90+**  
DATABASES

**2**  
CONFERENCES