

PERSPECTIVE ON
THE ENERGY TRANSITION
CAPITAL OF THE WORLD
HOUSTON'S OPPORTUNITY
TO WIN BY CATALYZING
CAPITAL FORMATION

OCTOBER 2022

GREATER HOUSTON **PARTNERSHIP**



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PREFACE

This report is the result of work by the Houston Energy Transition Initiative (HETI), a strategic initiative led by the Greater Houston Partnership, dedicated to strengthening Houston's leadership as the Energy Capital of the World.

The economic vitality and growth of the region's economy is inextricably tied to the energy industry, and the industry is changing rapidly to meet growing global energy demand while simultaneously lowering emissions. HETI builds on the best of traditional energy skills and systems to leverage Houston's industry leadership to accelerate global solutions for an energy-abundant, low-carbon future. HETI's objective is to create a vision and a blueprint for growing the region's economy, exporting low-carbon products and expertise, equitably creating new jobs, and helping the city of Houston achieve the goals of its Climate Action Plan.

This perspective complements the broader efforts of HETI, including reports such as "Houston Leading the Energy Transition" (June 2021), and "Houston as the epicenter of a global clean hydrogen hub" (June 2022). Capital Formation is just one of the working groups within HETI, which also includes efforts on decarbonization; hydrogen; carbon capture, utilization, and storage (CCUS); and circular value chains.

The energy transition will reshape Houston's economy and the role Houston will play in the global economy. The report examines the opportunity for Houston to serve as the capital for future energy transition efforts through the following lenses:

1. **Ambition.** How much capital funding is required to make Houston the energy transition capital of the world? Why and how can Houston achieve this?
2. **Capital flow starting point.** What are the current flows of capital into Houston for energy transition?
3. **Unlocking and enabling energy transition capital.** What types of financial, commercial, and policy unlocks would catalyze flow of more capital into Houston to fund energy transition?

Opportunity abounds for the Houston region and its established community of financial institutions, such as commercial and investment banks, venture capital (VC), private equity (PE) firms, corporates, and start-ups. This report showcases the various ways in which Houston can leverage its unique advantages in talent, industry expertise, presence of established financiers, and existing infrastructure to originate energy transition capital



and foster, attract, and develop energy transition projects across the entire value chain.

A synthesis of this effort, along with a call to action for various stakeholders in the Houston business community, conclude this report.

The intended audience for this report includes members of the financing ecosystem, business community, non-profits, academic institutions, policymakers, and other organizations with an interest in Houston's future in energy transition.

This paper includes statistics, forecasts, and other figures obtained from publicly available sources, companies in HETI's working groups at the Greater Houston Partnership, and interviews with subject matter experts. The main body of the report is meant to be a summary of the findings; a thorough and detailed set of analysis that underpins the report can be found in the appendix. Estimated

projections of energy transition capital are context specific and reflect a particular set of conditions (detailed in appendix). While much of the quantitative data included in the analysis looks backward through recent years, the policy section of this report looks ahead to identify the initial impact that the recently enacted Inflation Reduction Act (IRA) of 2022 will create for energy transition-related business ventures, projects, and assets.



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EXECUTIVE SUMMARY

Houston can become the world's energy transition capital and accelerate activities to enable project economics and financing through its distinct advantages and capabilities.

Houston's community, companies, and energy financiers can leverage the strengths of the region to create an energy transition financing ecosystem that could become a benchmark for other cities in the United States and around the world. To achieve this, the region can ensure both broad and deep participation from the financing community – VC, PE, capital advisors, etc. – to help mobilize capital along Houston's journey from current state to its ambition of being a leader in energy transition finance.

What qualities will enable Houston to become the energy transition capital of the world?

Houston has many strengths that could help it transition from being the energy capital of the world today to the energy transition capital of the world by 2040. For Houston to be as pivotal for energy transition as Silicon Valley has been for technology, it likely would benefit from strengthening the end-to-end ecosystem encompassing new technologies, entrepreneurs driving innovative projects, diverse talent, financing across the entire capital stack, and favorable policies and regulations.

Houston has numerous natural and competitive advantages:

- established industry expertise, including a large group of capital allocation decision makers in integrated energy companies
- a successful record of traditional energy financing
- established energy industry financiers and a strong base of PE talent
- access to low cost of power
- a diverse talent pool with a varied skillset including engineering and project

management

- academic institutions focused on developing and scaling energy transition technologies
- direct access to large ports and other critical infrastructure for certain energy transition technologies
- energy industry infrastructure such as refineries and pipelines
- integrated energy incumbents with net zero commitments to fund, develop, and scale projects
- general ease of doing business and access to permitting

These advantages can catalyze Houston's energy transition leadership, particularly in spaces such as clean hydrogen, carbon capture, utilization, and storage (CCUS), chemicals and plastics, and renewable fuels. With the passage of the IRA, even greater economic incentives exist for investors to allocate capital to many energy transition technologies.

The region is already attracting energy transition capital today: it is estimated that ~\$15B of energy transition-related investments flowed into Houston in 2021¹. Bringing investment decision makers to Houston, and further strengthening the city's capabilities, will be critical to increasing its global reach and impact on energy transition.

How can Houston become the energy transition capital of the world?

From the analysis, for Houston to realize its ambition to become the energy transition capital of the world, capital flows for energy transition will need to scale to ~\$150B p.a. in Houston by 2040 (by a factor of ten vs. 2021 estimated energy transition capital flows), which is equivalent to ~80% of capex outlaid by all US based oil and gas (O&G) companies in 2021². More than half of this (~\$85B of the ~\$150B) would come from energy transition technology spaces where Houston is well placed to have success, such as: industrial

¹ Source: PitchBook Data Inc. 2022, Prequin, expert interviews, team analysis

² Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, NGFS: ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, expert interviews, team analysis

CCUS, hydrogen, renewable fuels, chemicals and plastics, and power³.

For this to happen, Houston would likely need to exponentially increase engagement by the financing community, specifically debt capital and PE funding, to accelerate commissioning and scaling of clean energy projects in the region. Houston will also require the support of VCs to emerge as a leader in the start-up ecosystem with a focus on emerging cleantech.

How can Houston unlock and enable more energy transition capital in the region?

The Houston business community can continue to make the city an attractive business destination that is bustling with high quality talent, incumbent capabilities, infrastructure and geology, and a favorable business and regulatory environment. For Houston to become the energy transition capital, it also needs to become a talent and innovation, project, and financing hub for the energy transition. Some key actions across these dimensions are highlighted below:

Talent and innovation hub. Serve as a center for diverse, high-caliber skillsets that foster greater entrepreneurship in Houston:

- continue to attract incubator programs and accelerators to support entrepreneurs and budding ventures (e.g., Greentown Labs, Rice Alliance Clean Energy Accelerator, and Halliburton Labs); these entities support entrepreneurs through providing mentorship, a sense of community, and access to resources
- improve recruiting from local universities (e.g., Rice University, the University of Houston, and Texas A&M University) to retain top talent; encourage entrepreneurs to explore energy technologies and locate their start-up operations in Houston; and attract talent from other top universities such as Stanford and MIT (e.g., through programs such as the Texas Entrepreneurship Exchange for Energy, which brings together Texas universities, Greentown Labs, and the Martin Trust Center for MIT Entrepreneurship, to increase energy entrepreneurship)

- provide incentives for rapid execution of pilot projects (e.g., HIF's green hydrogen/e-fuel plant in Matagorda County) and encourage investment in joint ventures (e.g., Archaea Energy and Republic Services' joint venture to develop renewable natural gas projects) and other strategic partnerships to improve confidence in the viability of new and innovative energy transition technologies
- encourage Houston incumbents to further engage in energy transition and innovation by partnering with local universities to advance clean energy research and programs (e.g., University of Houston's Energy Transition Institute was founded with support from Shell's \$10M donation)
- provide incentives (e.g., tax holidays, fast-track approval/permitting) for energy transition projects that move to Houston, employ local Houston talent, and make significant investment in reskilling the workforce
- attract major energy companies that are headquartered outside of Houston (e.g., Exelon, Duke Energy, and NextEra Energy) to locate their energy transition headquarters in Houston and encourage developers to build their plants/infrastructure in Houston
- continue to seek out innovation-driven programs to increase talent, research, and funding dedicated to energy transition (e.g., submitting a proposal to the National Science Foundation's Regional Innovation Engines program to promote new ideas and technologies in Houston)

Project hub. Provide a supportive business and regulatory environment to enable project development, implementation, and scaling:

- enable interconnectedness between ecosystem participants (e.g., carbon producers and consumers, technology developers, suppliers, offtake counterparties, and project financiers) and foster an interconnected energy transition innovation ecosystem to attract more start-ups and VC flows. The importance of this driver is highlighted in Section 5

³ Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, expert interviews, team analysis



- leverage learnings from other regions (e.g., California, Singapore, New York) on incentives for clean energy development and provide recommendations to state/local government on policy actions (e.g., tax holidays, direct pay subsidies, property tax abatements, loan enhancements) that will be needed to incentivize energy transition projects to locate themselves in Houston. More importantly, ensure there is continuity and predictability of certain critical energy transition enabling state/local policies – the importance of this is highlighted in Sections 2, 3 and 5

Financing hub. Enable capital formation by creating a robust ecosystem of capital providers and advisors (including financial and industrial players), policymakers, and ventures to connect energy financiers to projects:

- encourage financiers (debt capital providers such as banks, and bond markets, funds focused on core Houston energy transition technologies such as CCUS and clean hydrogen – e.g., VCs such as Breakthrough Energy Ventures with its focus on net zero emissions, Energy Impact Partners with its focus on decarbonization of industry, and the MIT Engine; as well as PE firms such as General Atlantic with its BeyondNetZero venture, and Carbon Direct with its focus on CCUS) to establish and expand the energy transition presence in Houston
- evaluate the opportunity to develop a financing mechanism, such as a “low-carbon” bank, that could 1) help to support common energy transition infrastructure investment required by both public and private parties, such as CO₂ pipelines, hydrogen pipelines, and grid improvements, and/or 2) provide credit support and innovative financial products to assist new energy transition projects/ technologies that are experiencing issues in scaling through traditional energy financing. Some of these innovative products could include providing extended terms, loan guarantees, aggregation/warehousing, loan-loss reserves, and/or lower costs of capital
- market Houston and its potential to become an energy transition financing hub through efforts like roadshows to educate financiers outside of Houston (e.g., New York, San Francisco, Boston, the Middle East, London, and Singapore), as well as policymakers and industry executives; conduct energy transition financing conferences with participation from both financiers and energy transition project owners
- develop the critical skills necessary to effectively access government funding opportunities (federal, state, and local) to help shorten approval cycle times and increase the amount of capital allocated to projects in Houston
- encourage start-ups, corporates, and financiers leading the energy transition to choose Houston as their decision-making headquarters for piloting and scaling new energy transition projects
- assess the implications of the recently enacted IRA to identify new opportunities to attract capital and encourage the development of energy transition projects, as well as new bottlenecks businesses will need to mitigate (see Section 5)

Immediate next steps for Houston’s finance community to support the region’s capital formation efforts

- work closely with the Texas state government to explain the criticality of continuity and predictability of certain key energy transition enabling state policies, and provide recommendations on policy actions (e.g., tax holidays, direct pay subsidies, property tax abatements, loan enhancements) that will be needed to incentivize energy transition projects to take place in Houston
- further explore the concept of a financing mechanism, such as a “low-carbon” bank, that could focus on structural unlocks such as (a) bolstering low-carbon infrastructure such as CO₂ and H₂ pipelines, (b) helping early-stage low-carbon technology ventures/projects to achieve final investment decision (FID) and (c) strengthening the resilience and reliability of the Texas electricity grid
- promote Houston’s economic development and increase energy transition financing by marketing the city’s capabilities and comparative advantages to financiers and decision makers that are currently located outside Texas



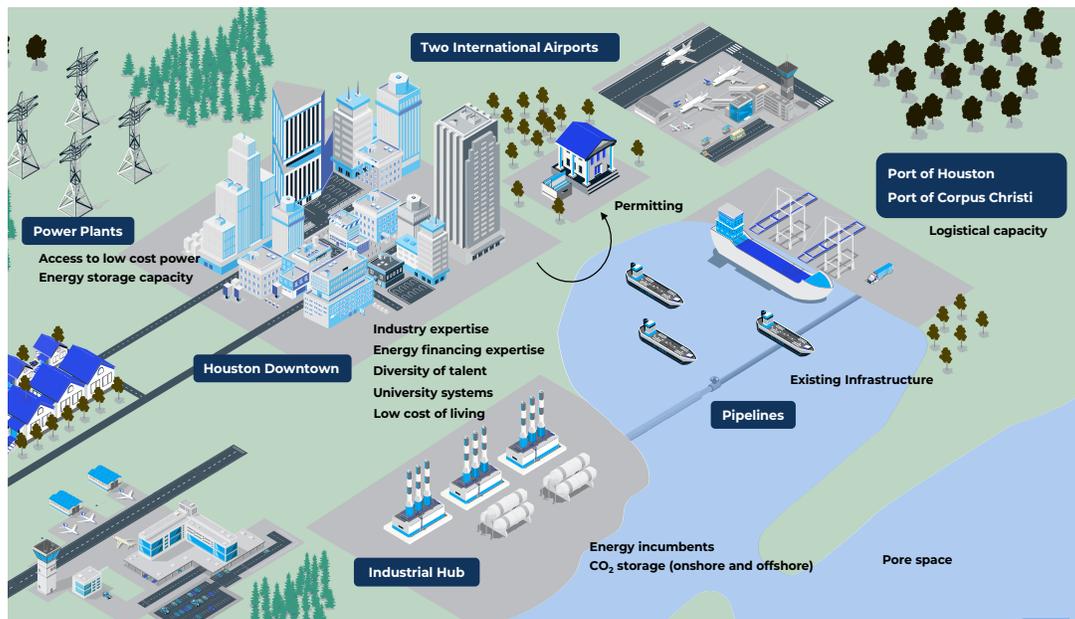
HOUSTON'S STRENGTHS

WHY IT IS WELL PLACED TO BECOME THE ENERGY TRANSITION CAPITAL OF THE WORLD

Houston is the current energy capital of the world. This leadership can be attributed to its energy financing expertise, existing assets, infrastructure and geological attributes, talent, and advantaged business environment.

Exhibit 1

Houston has many of the necessary capabilities to attract energy transition capital and businesses



Energy financing expertise

Decades of experience in energy production and distribution have led to the development of deep expertise in financing O&G mega projects and the scaling of new transformative technologies, as seen in the shale revolution of the last decade. The Houston energy finance ecosystem is comprehensive and has played a significant role in capital formation for small independent producers as well as complex multi-billion-dollar capex-intensive energy projects. Historically, many incumbents have actively contributed to close the public-private financing gap. Houston's energy industry financiers have the required competency to fund projects of varying sizes and risk profiles – from seed-stage technologies to large-scale energy transition projects.

Established physical infrastructure

Existing infrastructure such as pipelines, logistics capacity, and proximity to the ports of Houston and Corpus Christi, as well as other ports along the Texas Gulf Coast, can serve as catalysts for the development and scaling of emerging technologies. This established infrastructure can be rapidly repurposed for clean hydrogen and CO₂ transportation. Houston's logistics capacity and proximity to ports has made it one of the largest liquefied natural gas (LNG) and crude oil exporters in the world. The region has a distinct advantage in leveraging a range of capabilities to export renewable feedstock (e.g., renewable natural gas (RNG), clean H₂, biofuels, synfuels) to other international markets. Houston is also

home to two international airports.

Talent

Houston has a culturally diverse workforce with specialized skills across all aspects of the energy industry. The city boasts the fourth largest concentration of engineers in the US. This includes the highest number of employed petroleum (5,850) and chemical engineers (3,890) in the country, three to five times as many as in the next closest cities⁴. Engineers are just one part of the talented workforce in Houston. Experienced project managers, trained finance professionals, senior executives, and an emerging class of start-up entrepreneurs add to the exciting mix of talent in the region. These talented individuals are well placed to use their existing capabilities and develop new skills necessary to serve in current and emerging roles across the energy transition ecosystem. Houston is home to energy incumbents, premier academic institutions, and energy focused incubators (e.g., Greentown Labs) that drive research, development, and deployment of innovative technologies and industrial decarbonization ventures. Academic institutions in the region are scaling efforts to deploy emerging energy transition technologies – including the Rice Alliance, and the new University of Houston Energy Transition Institute.

Particularly of note, is the depth and breadth of Houston finance community talent, which will be instrumental in unlocking the city's energy transition potential. Houston already has a large financial talent pool across all levels of capital deployment (i.e., debt financing, VC, corporate VC and PE) that helps the business community conceptualize, develop, and scale energy transition projects. Decades of growth, innovation, and investment in the energy industry are testimony to the strength of this talent pool. As energy transition capital grows in the city of Houston, so will the need for attracting financing talent.

Advantaged business environment

Houston's economical cost of living, abundant land, cultural diversity, and low-cost power provide the region with a competitive advantage over cities that have a more traditional reputation for raising and deploying capital (e.g., New York, San Francisco, Boston, and London). Houston's modest taxes and pro-business regulatory environment are attractive for new ventures that are looking to expand or relocate.

Aside from O&G organizations, Houston is also home to a substantial number of energy companies who play in a variety of spaces. Power companies, focused solar/wind companies, original equipment manufacturers, and supporting technology/software companies all have a footprint in the city. In total, the region hosts 44 publicly traded O&G companies, 100+ solar companies, 30+ wind companies, 67 energy tech companies, 21 energy focused R&D centers, and 30+ incubators/accelerators⁵. This diversified energy environment provides Houston with a wide range of expertise that spans the entire energy industry and sets the city apart from peers competing for energy transition capital.

In summary, Houston's ease of doing business, as well as its accessibility to industry partners, and diverse talent pool, create an attractive destination for energy transition companies and investors looking to drive innovation and maximize their return on investment.

⁴ Source: US Bureau of Labor Statistics 2021 data

⁵ Source: The Greater Houston Partnership

HOUSTON'S AMBITION

WHAT WOULD IT TAKE TO BECOME THE ENERGY TRANSITION CAPITAL OF THE WORLD?

From the analysis, for Houston to become the energy transition capital of the world by 2040, the city will need to capture ~\$150B p.a. in energy transition investment. Houston will also need to continue attracting financial talent and leadership to lead capital deployment from the region.

According to analysis by the McKinsey Global Institute (MGI) and the Network for Greening the Financial System (NGFS), the US in a net zero pathway will likely grow from ~\$280B p.a. of energy transition investment in 2021 to ~\$1.5T p.a. by 2040 (CAGR of ~9% p.a.). The analysis estimates that Houston currently has ~6% market share of total US energy transition capital, at around \$15B in 2021. Three scenarios were modeled for Houston (see Exhibit 2), which show that the region can potentially capture between 6-15% of energy transition capital flows in the US by 2040⁶.

Exhibit 2

Three scenarios were developed for Houston energy transition capital flow projections by 2040⁷

Global scenario and temperature pathway	Houston case	Houston role	Share 2020 to 2040
 <p>Net Zero 1.5°C</p>	1	Maintain current share of energy transition capex	6% to 6%
	2	Base Case: tempered share of energy transition capex	6% to ~10%
	3	Significant growth in share of energy transition capex	6% to ~15%

⁶ Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, NGFS: ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, team analysis

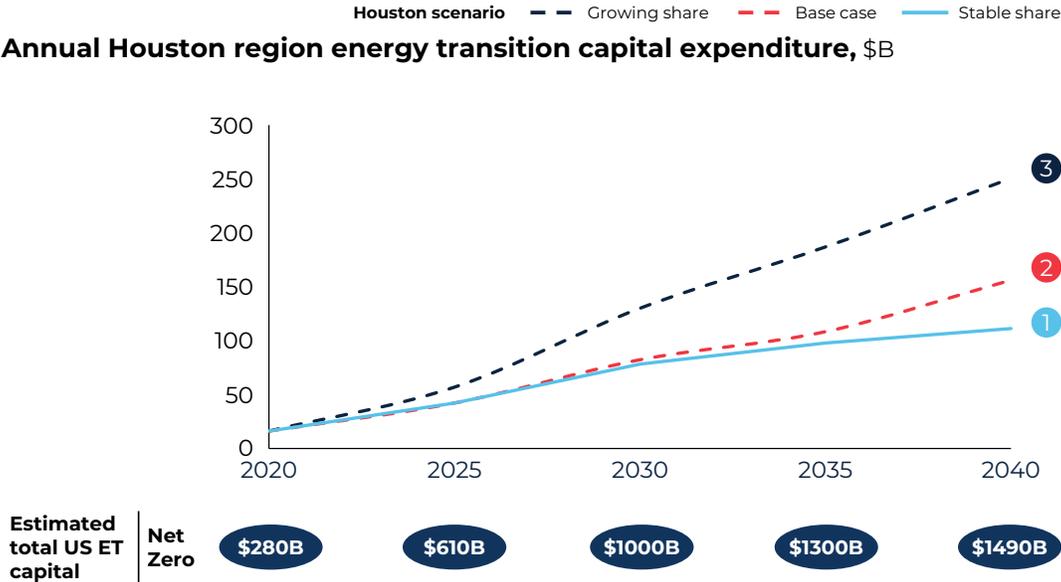
⁷ Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, NGFS: ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, team analysis



These scenarios indicate that Houston will likely require ~\$100-\$250B p.a. in energy transition capital by 2040. Specifically, the Base Case annual capital flows by 2040 are estimated to be ten times the current levels of energy transition capital flows.

Exhibit 3

This exhibit shows Houston’s energy transition potential capital growth over time across the three scenarios within the net zero temperature pathway⁸



In the Base Case of up to ~10% energy transition capital flow share, Houston has the potential to reach ~\$150B p.a. in energy transition capital by 2040. To put this into context, this is equivalent to up to ~80% of the existing total US O&G capex in 2021. It is anticipated that this would help the diversity of the city’s economy, workforce, and infrastructure.

To bring the aspiration to reality, Houston likely will need to capture a disproportionate share in key technologies that build upon the core competency of Houston. These include CCUS, clean hydrogen, chemicals/plastics, and renewable fuels (i.e., “molecule” based technologies). Houston also has a competitive advantage in bridge fuels such as LNG and in O&G decarbonization technologies such as methane emissions reduction and operational electrification.

The analysis shows that Houston may have significant opportunity in areas such as energy storage, mobility, and renewable power. These are all areas where both Houston’s incumbent industrial businesses and the investing community are substantially increasing investment.

The IRA is an advancement toward realizing Houston’s ambition: it allocates ~\$415B in total funding (over the next ten years) through grants, tax credits, and investments to support clean manufacturing, renewable energy production and consumption, transportation and industrial electrification, climate-smart agriculture, and carbon capture⁹. Houston can access a significant portion of this funding to develop emerging projects in categories with benefits under the IRA.

⁸ Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, NGFS: ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, team analysis

⁹ Based on analysis, provided by McKinsey & Company, on the impacts of IRA, September 2022



HOUSTON'S STARTING POINT WHERE IT IS TODAY

An analysis of capital flows and the current state of financiers in Houston breaks down how the city is currently financed, and where it can continue pushing forward.

Today, Houston's status as energy capital of the world has enabled a finance community that is experienced and accomplished, with great appetite for the next investment wave, based on decades of leadership in the energy market. With a desire to be the center of gravity for energy transition, the Houston business community has turned its attention toward attracting capital and financial talent (including decision makers) to the city. Houston has an established PE and traditional finance community that will need to be actively supported to continue to grow its involvement in energy transition-related endeavors. The region needs to attract substantially more investment geared toward early stage and start-up projects (i.e., via VC flows), where it lags cities such as San Francisco and Boston. Scaling growth from corporates and financial institutions will be another important avenue for Houston to continue to develop and capture more energy transition investment moving forward. Capital flows in energy transition will be driven by technological innovation leading to larger investments, and, importantly, by effective communication of Houston's value proposition to investors who may not fully appreciate the region's advantages for new energy transition ventures.

This section of the paper describes Houston's current status of energy transition capital flows. The analysis breaks down Houston's current energy transition-related capital inflows and outflows by funding source (VC, PE, debt financing, corporate investment, and government funding).

Bottom-up analysis of Houston's energy transition capital

Houston's energy transition capital flows were examined from two angles: capital inflows (capital coming into Houston for energy transition projects) as well as capital outflows (capital originating from Houston-based financiers/companies deployed outside of Houston). The bottom-up analysis constitutes six types of capital pools: a) VC, b) PE and growth capital, c) financial institutions (e.g., debt, credit), d) O&G companies, e) power, basic materials, chemicals, engineering, procurement, construction, and waste, as well as f) federal, state, and municipal government mechanisms (see Exhibit 4). Its estimated current energy transition capital inflows are ~\$15B p.a., while current energy transition capital outflows are ~\$25B p.a.



Exhibit 4
The bottom-up analysis reveals where Houston’s capital inflows and outflows originate

		Houston ET inflows in 2021 (\$B)	Houston ET outflows in 2021 (\$B)	
A Financial players	A1	Venture capital (e.g., start-ups, emerging tech)	\$0.7	\$0.6
	A2	Private equity and growth capital	\$1.7	\$2.2
		Pension/sovereign wealth funds	N/A	N/A
	A3	Financial institutions (debt and sustainability-linked credit)	\$4.5	N/A
B Industrial players	B1	O&G	\$0.4	\$20.7
	B2	Basic materials, chemicals, EPC, power, waste	\$0.4	\$1.9
C Government	C1	Federal, state, and municipal mechanisms	\$7.0	N/A
		Sum	~\$15B	~\$25B

Inflows

The bottom-up analysis shows that capital inflows into Houston were ~\$15B in 2021. This is supported by the findings from the top-down analysis (see appendix), which estimates 2021 inflows to be between ~\$7B and ~\$22B.

- **VC¹⁰:** It is estimated that energy transition start-ups in Houston raised ~\$0.7B of capital in 2021¹¹. Houston was fifth and sixth in global VC fund capital raise and start-up capital raise respectively (as of 2021)¹². The region has steadily grown its position in the energy transition VC capital deployment share from eighth to sixth place from 2017 to 2021 and looks to continue to attract

more VC capital in the coming years (e.g., via energy transition incubators). The top technologies funded by VCs were mobility/delivery, battery, renewable energy, and agtech

- **PE and growth capital¹³:** Houston-based companies backed by PE and growth capital¹⁴ raised ~\$1.7B in 2021¹⁵. Traditionally, PE has been very active in Houston and there is a strong history between PE funds and Houston’s energy players. The number of energy transition PE deals have increased over the years: from 2017 to 2021, Houston averaged ~23 such deals per year, a significant increase compared to the previous five years (2012-16), where Houston saw 11 energy transition PE deals p.a. on average

10 Source: PitchBook Data Inc. 2022, Prequin, expert interviews, team analysis

11 The analysis leveraged databases such as PitchBook by flagging energy transition deals for start-ups raising capital at the seed stage all the way to Series D+, including early-stage grants. In the private sector, the analysis defined the energy transition as involving emerging energy technologies, cleantech, climate tech, mobility tech, solar, renewable, geothermal, wind, and hydroelectric power, low-carbon, hydrogen, carbon capture, biofuel, electric vehicles, biogas, biomethane, decarbonization, circularity, green electricity, green building, and building efficiency; PitchBook data set (Energy Transition Deals), July 2022; Prequin; expert interviews.

12 Source: PitchBook Data Inc. 2022, Prequin, expert interviews, team analysis

13 Source: PitchBook Data, Inc. 2022, Prequin, Team Analysis, Expert Interviews

14 Inclusive of companies that went public via Initial Public Offering (IPO) or Special Purpose Acquisition Company (SPAC)

15 The analysis leveraged the same databases and flagged energy transition deals backed by private equity capital. Tags such as LBO (buyout), Debt – PPP, Debt – General, IPO, M&A, PIPE, PE Growth Capital, Reverse Merger used. Source: Pitchbook Dataset (Energy Transition Deals) – July 2022, Prequin, expert interviews

- **Financial institutions**¹⁶: It is estimated that Houston-based companies attracted ~\$2.5B of debt funding in 2021 and ~\$2B in credit line funding in 2022 for energy transition efforts. Financial institutions in Houston will be vital for continuing to fund later-stage projects. Most financial institutions have meaningful Houston-based teams focused on deploying capital into energy. This is a significant advantage for Houston over other areas that will also be home to energy transition companies in the future. As projects progress, Houston's financial institutions can enable the city to scale successful innovations and unlock new value opportunities for investors
- **O&G**¹⁷: Projects in Houston funded by O&G players raised ~\$0.4B in capital in 2021. O&G companies have the capacity to augment their investments in Houston energy transition projects. While the industry experienced ~\$0.4B in capital inflows in 2021, they spent ~\$21B on energy transition projects outside of Houston (see next section) in 2021. This is a promising signal of these organizations' growing commitment to proactively pursuing energy transition investment
- **Power, basic materials, chemicals, EPC, and waste**¹⁸: Estimated capital inflows for energy transition projects in this category are ~\$0.4B
- **Federal, state, and municipal government mechanism**¹⁹: Houston currently receives ~\$7B p.a. from municipal and state programs (primarily via tax rebates). However, federal funding to Houston is negligible in 2020/2021²⁰. Given the level of federal funding made available through the Infrastructure Investment and Jobs Act (IIJA) and IRA, this represents a significant opportunity for the region

Outflows

The bottom-up analysis estimates capital outflows from Houston to be ~\$25B p.a. and primarily driven by industrial O&G players.

- **VC**²¹: It is estimated that VCs headquartered in Houston currently invest ~\$0.6B p.a.²² in energy transition projects outside of Houston. As the region works to bring in more VC capital, Houston's energy transition VC community is increasing capacity to fund energy transition projects outside of the region
- **PE and growth capital**²³: PEs and growth capital players supplied ~\$2.2B of energy transition capital outflows in 2021. As Houston works to grow its PE and growth capital funding for energy transition projects, outflow projects could see a rise in funding from Houston-based PE funds

¹⁶ Source: Press Search, Expert Interviews, Team Analysis

¹⁷ Source: CapitalIQ, Investor Reports, Team Analysis

¹⁸ Source: Investor Reports, Press Search, Team Analysis

¹⁹ Source: Database of State Incentives for Renewables & Efficiency, Press Search, Team Analysis

²⁰ The federal funding in the analysis is non-inclusive of university research grants

²¹ Source: PitchBook Data Inc. 2022, Prequin, Team Analysis, Expert Interviews

²² The analysis leveraged databases and expert interviews to find recent VC fund raises. Corporate Ventures, as a nature of how they operate, would not show up on a search list dedicated toward external fund raises, so analysts leveraged expert interviews and general search to generate this list. Second, to find how much capital these active funds would allocate in one year, the analysis assumed an average fund life of 5 years and divided the collective sum of all funds raises by 5.

²³ Source: PitchBook Data, Inc. 2022, Prequin, Team Analysis, Expert Interviews



- **Financial institutions ²⁴:** Based on public information, no known debt or credit financing flowed out from Houston-based financiers for energy transition initiatives
- **O&G ²⁵:** It is estimated that O&G players ²⁶ with headquarters or a significant presence in Houston spent ~\$20.7B in energy transition outflows for 2021. O&G companies play a major role in deploying capital for trial new projects and investing in R&D, as well as enabling energy transition projects to scale once they are deemed successful. Increased energy transition capital commitment from energy incumbents raises investor confidence in Houston's potential for energy transition leadership
- **Power, basic materials, chemicals, EPC, and waste ²⁷:** Houston-based companies in power, basic materials, chemicals, and EPC spend an estimated ~\$1.9B p.a. on energy transition outflows
- **Federal, state, and municipal government mechanisms:** This category is not applicable to energy transition capital outflows

²⁴ Source: Press Search, Expert Interviews, Team Analysis

²⁵ Source: CapitalIQ, Investor Reports, Team Analysis

²⁶ This includes O&G companies, midstream, E&P, LNG, engineering service providers, and energy service providers with headquarters located in Houston

²⁷ Source: Investor Reports, Press Search, Team Analysis

HOUSTON'S JOURNEY

WHAT WOULD IT TAKE TO UNLOCK ENERGY TRANSITION CAPITAL INFLOWS?

Reduction of commercial risk through improved supply and offtake (i.e., credit protection), stability in regulatory incentives, and greater support from stakeholders and partners are some areas crucial to enabling capital formation for Houston.

Reduced commercial and project risks drive greater investor confidence, while durable regulatory frameworks facilitate planning for the capital needs of long-term projects. Combining these with support from public and private partners provides energy transition projects with the momentum to progress to FID and beyond.

To gain a comprehensive understanding of critical unlocks, Houston's journey was examined from two angles: case studies using a framework for assessing viability of energy transition investment (Section A), and assessment of IRA implications (Section B). Combining the findings from these two angles helped inform the overall perspective (Section C).

A. Case studies and framework for assessing viability of energy transition investments²⁸

Three case studies were evaluated (HIF Global, Archaea Energy, and Humble Midstream) as examples of industrial energy transition projects in Houston. These were reviewed to identify successful factors to this point, and potential unlocks to enable further investment and FID.

Across these projects, success factors and pain points for attracting energy transition capital, recommendations for unlocking capital, and the role that Houston financiers can play in facilitating these recommendations were identified.

Although many types of energy transition projects could take place in Houston, including new green developments and brown-to-green industrial decarbonization projects, priority was given to initial case studies in a few areas where Houston has the best opportunity to lead, i.e., synfuels production, RNG, and clean hydrogen production. These project types offer innovative commercial and policy unlocks, are actively looking for more capital, continually occur in Texas, and are Houston-based.

Background: HIF specializes in e-fuel production and plans to build a ~\$6B plant in

²⁸ Source: expert interviews, company websites, investor presentations



Matagorda County, Texas (commencing construction in 2023 and producing by 2026). This plant is expected to add 5 GW of renewable electricity to Texas's capacity, produce 300M kg/year green hydrogen, capture ~2M metric tons/year of carbon dioxide, and produce 200M gallons/year of e-fuels. This project has not yet reached FID, but an engineering partner has been selected. HIF has raised ~\$260M in equity investments financing for the project and is working with federal, state, and local governments on tax incentives (e.g., secured property tax exemptions for ten years in Matagorda County). The major investors include Porsche, EIG, AME, and Baker Hughes.

Lessons learned: HIF's partnership with Siemens and Exxon Mobil in developing the e-fuel production methodology helped to greatly reduce commercial risk and enable supply and offtake agreements. HIF de-risked cash flows via offtake agreements with its sister plant. Local tax incentives (i.e., property tax exemptions) represent how favorable policy can enable energy transition efforts.





Background: Headquartered in Houston, Archaea is an RNG producer with expertise in end-to-end development of RNG facilities at landfills and went public through a SPAC merger in 2021. The company focuses on long-term commercial partnerships alongside its long-term feedstock to de-risk cash flows and provide multi-decade solutions to decarbonization. Archaea entered into a joint venture with Republic, a large environmental services company, to develop RNG facilities at landfill sites owned or operated by Republic, which has added 40 projects to their approximately 90 project backlog. Construction for the projects is expected to begin in late 2022, with projects planned through 2027. Archaea produced approximately 6M MMBtu of RNG in 2021, and plans to produce 50M MMBtu/year in the longer-term, once all projects currently in its backlog are developed and operating. Their continued development of RNG projects is supported by significant offtake agreements with creditworthy counterparties including utilities, corporations, and universities; commercial partners of Archaea include Fortis BC, NW Natural, BP, Energir, and The University of California.

Lessons learned: Archaea's stated corporate strategy of de-risking cash flows by contracting 70% of RNG production volume with long-term fixed-price contracts helps reduce cash flow volatility, increasing its attractiveness to investors and other financial partners. Similarly, its existing portfolio of RNG facilities (13) and landfill-gas-to-energy facilities (33) instills greater investor confidence in its proven and scalable technology. Access to relatively low-cost and flexible bank debt facilities, alongside cash flow from operations, will enable the company to execute on its backlog of almost 90 projects without expected need for additional external capital.



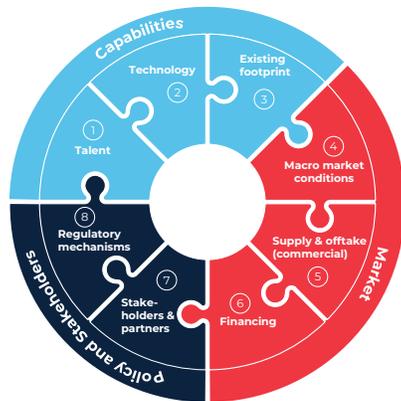
Background: Humble Midstream (formed in 2020 through a ~\$300M equity commitment from EnCap Flatrock) has partnered with Enbridge to develop a low-carbon hydrogen and ammonia production and export facility, located at Enbridge Ingleside Energy Center (EIEC). Humble will leverage existing EIEC assets and infrastructure, utilizing the Texas Eastern Transmission Pipeline to provide transportation for the feed gas used in production. At least 95% of the CO₂ generated during production will be captured and sequestered.

Learnings: Upfront capital has allowed Humble and Enbridge to advance the engineering design process, while engagement with potential offtakers for the last two years has provided credibility to progress discussions. As such, the level of interest in offtake has given the project encouragement to continue. Humble also has significant access to feedstock, sequestration, and markets (in part due to the location providing access to developing domestic hydrogen/ammonia markets, existing global ammonia market, and future global power markets). While the project was already economically viable, the passage of IRA improved project economics and has increased interest amongst potential customers. Risks/pain points include regulatory uncertainty surrounding the Class VI well permitting process in Texas that could potentially hinder project financing, as well as perceived potential volatility of Texas power markets.

Analyzing and drawing insights from the case studies for Houston

Each case study was reviewed against the Partnership’s newly developed framework qualitatively assessing viability of energy transition investment opportunities. The framework, developed through interviews with energy industry financiers and experts, highlighted some unlocks and limitations of energy transition initiatives based on patterns seen in these case studies.

Exhibit 5
Applying the framework below provides a consistent approach to identifying unlocks and pain points across selected case studies



Description of factor

- 1 People providing project, management, or subject matter expertise
- 2 Considers whether the project technology is first-in kind, proven, and/or scalable
- 3 Leverage assets, infra-structure, and connectivity resulting in advantaged project economics
- 4 Market dynamics including market liquidity and total size, cyclical, and resilience
- 5 NPV enablers, de-risked cash flows and credit-worthy counter-parties; includes supply and off-take arrangements, and pricing
- 6 Financing dynamics including equity pools (e.g., VC, PE), debt, project or JV financing
- 7 Accessibility to government entities or potential commercial partners (including JVs) to facilitate project progress
- 8 Government (federal, state, and municipal) policy / regulatory mechanisms, and incentives

Capabilities consist largely of factors that are intrinsic to a company or start-up. Market refers to the macro economy and financing climate that impacts an ecosystem’s ability to enact change. Policy encompasses the interconnectedness between the various ecosystem players and accounts for incentives impacting decision-making.



Major pain points across these case studies

Market:

- **Macro market conditions:** business is subject to high inflation and instability in demand and cash inflows for uncontracted volumes
- **Supply & offtake:** secure more long-term commercial contracts (e.g., to enable a 1.5-fold debt coverage ratio) with investment-grade counterparties, reduce risk by contracting feedstock (CO₂), set up additional agreements for long-term offtake, diversify suppliers to limit exposure and risk, and minimize inflationary risk by increasing the share of long-term contracts with inflation protection; permitting uncertainty creates a perception of significant risk for potential offtakers looking to pursue long term projects (e.g., Humble Midstream)
- **Financing:** improve credit protection, regulatory uncertainty surrounding the Class VI well permitting process can hinder project financing (e.g., Humble Midstream)

Policy and stakeholders:

- **Regulatory mechanisms:** Federal: offer direct pay generally (currently available under IRA for tax exempts, for CCUS and hydrogen for 5 years, and for advanced manufacturing) to encourage carbon capture utilization projects, further extend fuel tax credits; ease requirements for RINS program, and replicate LCFS across states to enable energy transition efforts. State and Local: extend property tax abatements in Texas law code, improve permitting, increase guarantees/loans/credits, replicate LCFS in-state, and consider carbon-neutral guidance

Unlocks highlighted by these case studies

Capabilities:

- **Talent:** high credibility within leadership team given established track record of traditional energy mega-project developments, and increased expertise via acquisition
- **Technology:** reduced execution risk and improved investor confidence through development of a small-scale pilot project before the large-scale development (e.g., HIF developing a small, working e-fuels plant in Chile prior to US development)
- **Existing footprint:** location provides access to developing domestic hydrogen/ammonia markets, existing global ammonia market, and future global power markets (e.g., Humble Midstream)

Market:

- **Macro market conditions:** stable end market (i.e., gasoline) with long term liquidity, interconnectedness of ERCOT power grid, proximity to port of Houston and industrial emissions sources
- **Supply & offtake:** de-risked cash flows via offtake agreements with sister plant (e.g., HIF Global), target to contract 70% of RNG volumes under long-term fixed price contracts to stabilize cash flows and have fixed-price offtake agreements with creditworthy counterparties (e.g., Archaea)
- **Financing:** partnered with a solid investor base and successfully raised \$250M+ in equity investments (e.g., HIF Global)

Policy and stakeholders:

- **Regulatory mechanisms:** access government funds through local tax incentives with Matagorda County, which offers \$60-100M p.a. property tax exemptions for ten years via the Texas Economic Development Act (e.g., HIF Global), stable and transparent business regulatory environment; passage of IRA improved project economics and interest among potential customers (e.g., Humble Midstream), clear regulatory framework (i.e., permitting, etc.)
- **Stakeholders & partners:** a mix of utilities, corporations, and universities provide strong backing to energy transition efforts (e.g., Archaea); leveraging the recently acquired Ingleside facility and Enbridge affiliate Texas Eastern Transmission Pipeline helps to de-risk project (e.g., Humble Midstream)

B. IRA: What it means for Houston

As a result of the IRA, changes in economic incentives for the energy space will provide Houston with an opportunity as a first mover to develop and execute the blueprint of the energy transition for CCS/CCUS, clean hydrogen, and renewable and fuels, as well as generally catalyze more investment in solar, wind, charging infrastructure and electric vehicles in Houston.

The IRA includes economic incentives for investments in clean hydrogen, CCUS (including direct air capture), battery storage, geothermal, manufacturing and mining and continued investment in wind, solar, and electric vehicles and charging infrastructure. It is expected to provide ~\$350B in funding for at least the next ten years for energy transition efforts. It is expected to reduce US GHG emissions by ~40% by 2030²⁹.

Historically, regulatory and market uncertainty have created significant challenges for accelerating investments in energy transition, particularly the short-term nature of prior incentive structure and extensions hindered long term investment horizons and the limitation to primarily wind and solar limited access to investment across other energy transition verticals. The recently signed IRA marks a strategic shift in US climate policy, signals long-term policy support to accelerate investment and development across multiple energy transition verticals. This shift has clear benefits regarding emerging energy transition technologies particularly where Houston has a comparative advantage.

The IRA creates a production tax credit (PTC) for clean hydrogen that can be as much as \$3/kg. The IRA also extends the renewable diesel and alternative fuels income and excise tax credits and creates a new clean fuel production tax credit that will be available beginning in 2025. The investment tax credit (ITC) for energy projects is also extended and expanded by the IRA to include standalone storage and certain biogas property.

The IRA continues the trend of growing support for CCUS in the US. Under the Energy Act of 2020 (within the FY2020 Budget Reconciliation Bill), more than \$20B was allocated for CCUS research, development, and demonstration (RD&D) over five years, and these funds are expected to significantly bolster investment in this area. Under the IRA, one of the most significant changes relates to the extension and expansion of the carbon capture tax credit (45Q Tax Credit). The maximum per metric ton credit available for carbon capture increased as a result of the IRA to \$85/metric ton for carbon capture and sequestration, \$60/metric ton for carbon capture used as a tertiary injectant in enhanced oil recovery (EOR), \$180/metric ton for direct air capture sequestered, and \$130/metric ton for direct air capture sequestered and used as a tertiary injectant in EOR. The IRA also significantly lowered capture requirements for qualifying facilities, expanding the universe of facilities that qualify, as well as provided new opportunities to monetize 45Q credits with the provision of direct pay (government pays credit generator cash regardless of tax position) for as much as five years after the facility is placed in service and the credit may be transferred or utilized by a tax equity investor following the direct pay period. The expansion of the 45Q Tax Credit results in an estimated ~\$100B of the IRA's historic ~\$369B for climate and energy attributed to CCUS. In addition, two new White House taskforces have been formed to provide recommendations on increasing the efficiency and equity of CCUS permitting and development, with one focused on federal lands and offshore waters while the other focuses on non-federal lands. As a result of all these programs, the carbon capture industry is anticipated to grow with a significant number of CCS/CCUS projects entering service by 2040.

²⁹ Princeton University REPEAT Project estimate as of August 4, 2022

The IRA will also provide billions of dollars in loans, grants, tax credits, and incentives for the manufacturing and mining of clean energy components, critical minerals, electric vehicles and charging infrastructure, and batteries.

To provide context on how this could affect energy transition capex over the next ten years, it is estimated that energy related infrastructure will increase over \$600B between 2024 and 2035 due to the IRA³⁰. In addition, capex in infrastructure for sectors where Houston has a significant competitive advantage (e.g., CCS/CCUS, hydrogen, renewable fuels) is expected to increase 13-fold between 2024 and 2035³¹.

The next step will be tackling the upcoming wave of local regulatory, permitting (may be addressed via legislation currently under development), and financing bottlenecks to get projects to FID and completion.

C. Perspectives on unlocks to support energy transition financing in Texas

To unlock greater energy transition capital flowing into and out of the region, Houston needs to become an oasis for new and early venture projects, serve as a decision-making hub that attracts thought leaders, further develop its talent and innovation hub to attract entrepreneurs and start-ups pursuing and scaling new technologies, and serve as a financing hub that brings together capital advisors, new ventures, and policymakers. Major actions to help support Houston's opportunity can be summarized with the following key actions.

Extension of state/local property tax abatement incentives and increase in level of government funding received

The Houston business community and other similar Texas business communities need to come together to support extension of state/local tax incentives. In addition, Texas could secure additional capital unlocks by introducing new tax incentives and innovative energy transition financing mechanisms. These policies can help maintain Texas's energy leadership and specifically increase innovation and investment into Houston. To take advantage of this, as well as of existing DOE loans/grants, energy incumbents and financiers may consider being open to seeking government funding. This may require a mindset shift and additional relationship building considering the limited flow of federal funding into the region to date, but can be helpful in getting new projects off the ground.

³⁰ Princeton University REPEAT Project as of August 4, 2022

³¹ Princeton University REPEAT Project as of August 4, 2022



Continue improving ease of doing business

While Houston is considered one of the best locations to situate physical assets in the US³², research and interviews highlighted practices of other economic development councils and chamber of commerce bodies (including those in Louisiana and South Carolina). For instance, the Louisiana Department of Economic Development (LDED) has been at the forefront of growth and relocation of energy projects into the state. A key driver of this has been LDED providing, through its initiatives, a central hub where entrepreneurs and businesses can access comprehensive information about tax incentives credits, mentorship/apprenticeship, business development programs, and other resources that give end-to-end scoping process and application assistance. LDED does this by actively and directly engaging with companies, serving as a facilitator between federal, state, local incentive programs, and potential investors through every aspect of a project, and even assisting with site selection.

Explore innovative energy transition financing mechanisms (e.g., “low-carbon” banks)

There are currently 22 low-carbon/energy transition banks in the US, that offer a different business model and help alleviate some of the pain points in energy transition financing³³, such as: inefficiencies of scale, marginal economics of early developments, and a lack of investment pipelines. These banks are primarily funded by public capital, with some public-private partnerships in existence, as well. However, there is currently no low-carbon energy focused bank in Texas. A “low-carbon” bank could 1) help alleviate common energy transition infrastructure issues shared by public and private parties, such as the need for CO₂ pipelines, hydrogen pipelines, and grid improvements and/or 2) provide innovative financial products to scale new energy transition projects/technologies that are experiencing issues in scaling through traditional energy financing. Some of these innovative products from the bank could include providing extended terms, loan guarantees, aggregation/warehousing, loan-loss reserves, and/or lower costs of capital.

Accelerate Texas's path to primacy

At the federal level, a challenge faced by carbon capture and sequestration projects is the permitting process for Class VI wells necessary to sequester carbon captured by projects. Interviews and analysis identified that Texas lags other states with similar business climates regarding Class VI underground injection control for carbon sequestration. For CCS projects, Texas does not have state primacy to issue permits without Environmental Protection Act (EPA) approval, whereas states such as North Dakota and Wyoming do. As a result, obtaining a Class VI permit takes much longer for Texas CCS projects, i.e., an estimated two years or longer under the federal EPA process, versus six to eight months in states such as North Dakota or Wyoming. In Louisiana, the path to primacy is at an advanced stage and the state is scheduled to receive primacy by late 2022 or early 2023. This has a significant impact for raising capital and financing as lenders are hesitant to engage in projects without assurances that the project has the permits necessary for completion. The Texas Railroad Commission finalized revisions to its CCS rules in August 2022 and a primacy application to the EPA is imminent; however, uncertainty still remains with respect to EPA's timeline for approval of Texas' pending primacy application. As an example, Louisiana submitted a primacy application in early 2021 that is still under review by EPA. Texas's path to primacy requires additional industry and commercial support to drive regulatory expediency. A collective push from industrials, financiers, chamber of commerce bodies, as well as regulators could help unlock this crucial mechanism.

³² Source: Expert interviews

³³ Coalition for Green Capital

HOUSTON'S CALL TO ACTION

Answering the call to maintain Houston's leadership in energy requires moving early in the transition to clean energy. This will help protect the region's strength and capabilities and allow all ecosystem participants to reap significant economic benefits. To achieve Houston's energy transition ambition, some suggested actions that might help achieve this ambition are:

Talent and innovation hub. Serve as a center for diverse, high-caliber skillsets that foster greater entrepreneurship in Houston:

- continue to attract incubator programs and accelerators to support entrepreneurs and budding ventures (e.g., Greentown Labs, Rice Alliance Clean Energy Accelerator, and Halliburton Labs); these entities support entrepreneurs through providing mentorship, a sense of community, and access to resources
- improve recruiting from local universities (e.g., Rice University, the University of Houston, and Texas A&M University) to retain top talent; encourage entrepreneurs to explore energy technologies and locate their start-up operations in Houston; and attract talent from other top universities such as Stanford and MIT (e.g., through programs such as the Texas Entrepreneurship Exchange for Energy, which brings together Texas universities, Greentown Labs, and the Martin Trust Center for MIT Entrepreneurship, to increase energy entrepreneurship)
- provide incentives for rapid execution of pilot projects (e.g., HIF's green hydrogen/e-fuel plant in Matagorda County) and encourage investment in joint ventures (e.g., Archaea Energy and Republic Services' joint venture to develop renewable natural gas projects) and other strategic partnerships to improve confidence in the viability of new and innovative energy transition technologies
- encourage Houston incumbents to further engage in energy transition and innovation by partnering with local universities to advance clean energy research and programs (e.g., University of Houston's Energy Transition Institute was founded with support from Shell's \$10M donation)
- provide incentives (e.g., tax holidays, fast-track approval/permitting) for energy transition projects that move to Houston, employ local Houston talent, and make significant investment in reskilling the workforce
- attract major energy companies that are headquartered outside of Houston (e.g., Exelon, Duke Energy, and NextEra Energy) to locate their energy transition headquarters in Houston and encourage developers to build their plants/infrastructure in Houston
- continue to seek out innovation-driven programs to increase talent, research, and funding dedicated to energy transition (e.g., submitting a proposal to the National Science Foundation's Regional Innovation Engines program to promote new ideas and technologies in Houston)

Project hub. Provide a supportive business and regulatory environment to enable project development, implementation, and scaling:

- enable interconnectedness between ecosystem participants (e.g., carbon producers and consumers, technology developers, suppliers, and offtake counterparties) and foster an interconnected energy transition innovation ecosystem to attract more start-ups and VC flows
- leverage learnings from other regions (e.g., California, Singapore, New York) and provide recommendations to state/local government on policy actions (e.g., tax holidays, direct pay subsidies, property tax abatements, loan enhancements) that will be needed to incentivize energy transition projects to locate themselves in Houston. More importantly, ensure there is continuity and predictability of certain critical energy transition enabling state/local policies



Financing hub. Enable capital formation by creating a robust ecosystem of capital providers and advisors (including financial and industrial players), policymakers, and ventures to connect energy financiers to projects:

- encourage financiers (debt capital providers such as banks, and bond markets, funds focused on core Houston energy transition technologies such as CCUS and clean hydrogen – e.g., VCs such as Breakthrough Energy Ventures with its focus on net zero emissions, Energy Impact Partners with its focus on decarbonization of industry, and the MIT Engine; as well as PE firms such as General Atlantic with its BeyondNetZero venture, and Carbon Direct with its focus on CCUS) to establish and expand the energy transition presence in Houston
- evaluate the opportunity to develop a financing mechanism, such as a “low-carbon” bank, that could 1) help to support common energy transition infrastructure investment required by both public and private parties, such as CO₂ pipelines, hydrogen pipelines, and grid improvements, and/or 2) provide credit support and innovative financial products to assist new energy transition projects/technologies that are experiencing issues in scaling through traditional energy financing. Some of these innovative products could include providing extended terms, loan guarantees, aggregation/warehousing, loan-loss reserves, and/or lower costs of capital
- market Houston and its potential to become an energy transition financing hub through efforts like roadshows to educate financiers outside of Houston (e.g., New York, San Francisco, Boston, the Middle East, London, and Singapore), as well as policymakers and industry executives; conduct energy transition financing conferences with participation from both financiers and energy transition project owners
- develop the critical skills necessary to effectively access government funding opportunities (federal, state, and local) to help shorten approval cycle times and increase the amount of capital allocated to projects in Houston
- encourage start-ups, corporates, and financiers leading the energy transition to choose Houston as their decision-making headquarters for piloting and scaling new energy transition projects
- assess the implications of the recently enacted IRA to identify new opportunities to attract capital and encourage the development of energy transition projects, as well as new bottlenecks businesses will need to mitigate

Immediate next steps for Houston’s finance community to support the region’s capital formation efforts

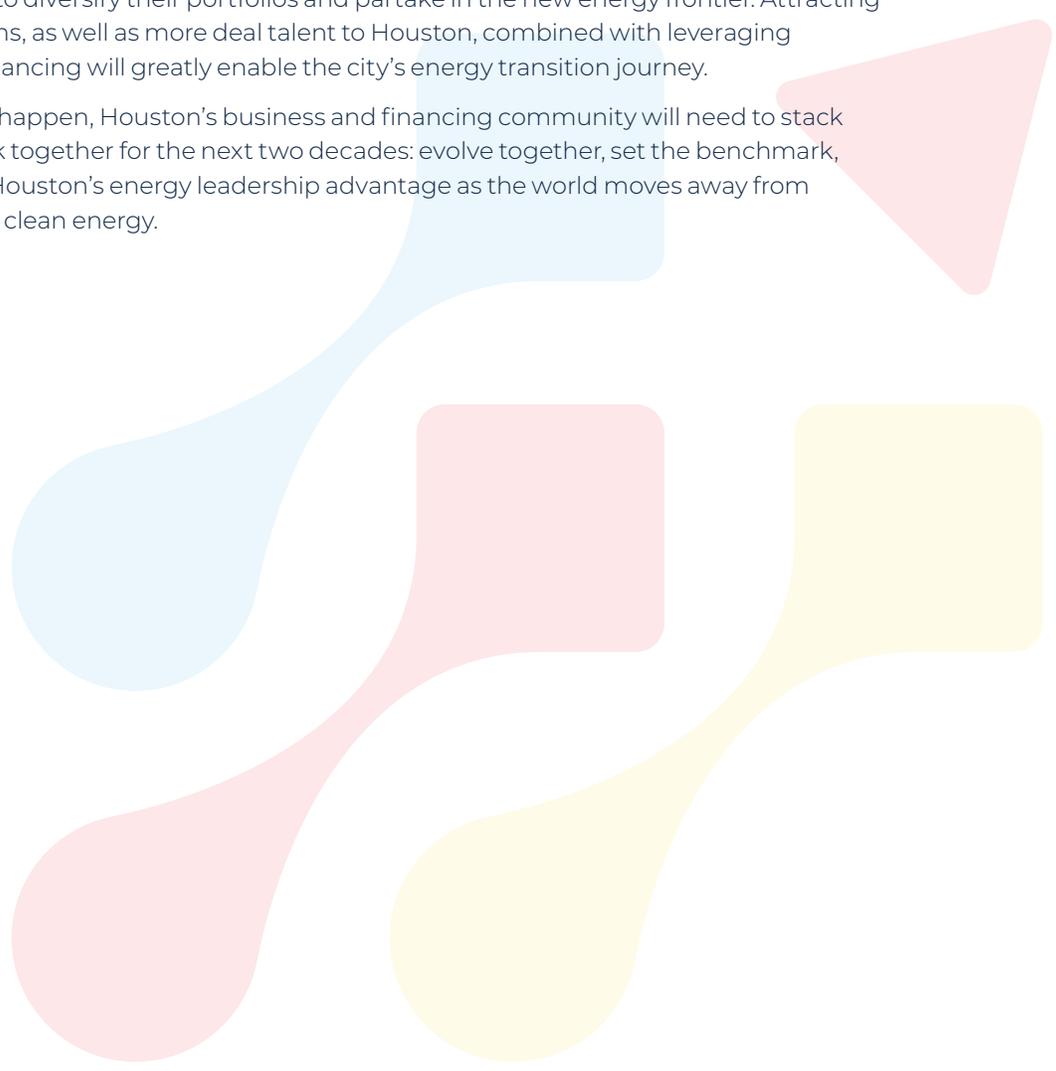
1. work closely with the Texas state government to explain the criticality of continuity and predictability of certain key energy transition enabling state policies, and provide recommendations on policy actions (e.g., tax holidays, direct pay subsidies, property tax abatements, loan enhancements) that will be needed to incentivize energy transition projects to take place in Houston
2. further explore the concept of a financing mechanism, such as a “low-carbon” bank, that could focus on structural unlocks such as (a) bolstering low-carbon infrastructure such as CO₂ and H₂ pipelines, (b) helping early-stage low-carbon technology ventures/projects to achieve FID and (c) strengthening the resilience and reliability of the Texas electricity grid
3. promote Houston’s economic development and increase energy transition financing by marketing the city’s capabilities and comparative advantages to financiers and decision makers that are currently located outside Texas

In summary, fully leveraging Houston's current capabilities as well as bolstering the region's strength by filling some of the gaps will be needed to reach the critical center of mass required to become the energy transition capital of the world.

Supporting and growing a comprehensive ecosystem, from the smallest start-ups to the largest scale projects, will help fuel energy transition efforts and attract capital for new and mature technologies.

Start-up incubators and deals conferences can go a long way in attracting the attention of VCs based out of hubs like San Francisco and Boston. Many such VC investors are gaining interest in Houston once they learn about the city's unique capabilities and growing eagerness to pursue energy transition. For VCs, Houston offers attractive technologies in the area and in the coming years, many more technologies for energy transition will continue to develop here and further strengthen Houston's ecosystem. Many PE firms already have a presence in Houston, and the transition to cleaner technologies provides a huge landscape for growth and investment opportunities. For industrials, the testing grounds for energy technologies already exist, and being an active participant will help them leverage existing infrastructure to encourage energy transition. Many established banks have a global footprint and allocating funding to energy transition technologies in the Houston area provides a way to diversify their portfolios and partake in the new energy frontier. Attracting these institutions, as well as more deal talent to Houston, combined with leveraging government financing will greatly enable the city's energy transition journey.

For all of this to happen, Houston's business and financing community will need to stack hands and work together for the next two decades: evolve together, set the benchmark, and hold onto Houston's energy leadership advantage as the world moves away from conventional to clean energy.



Appendix



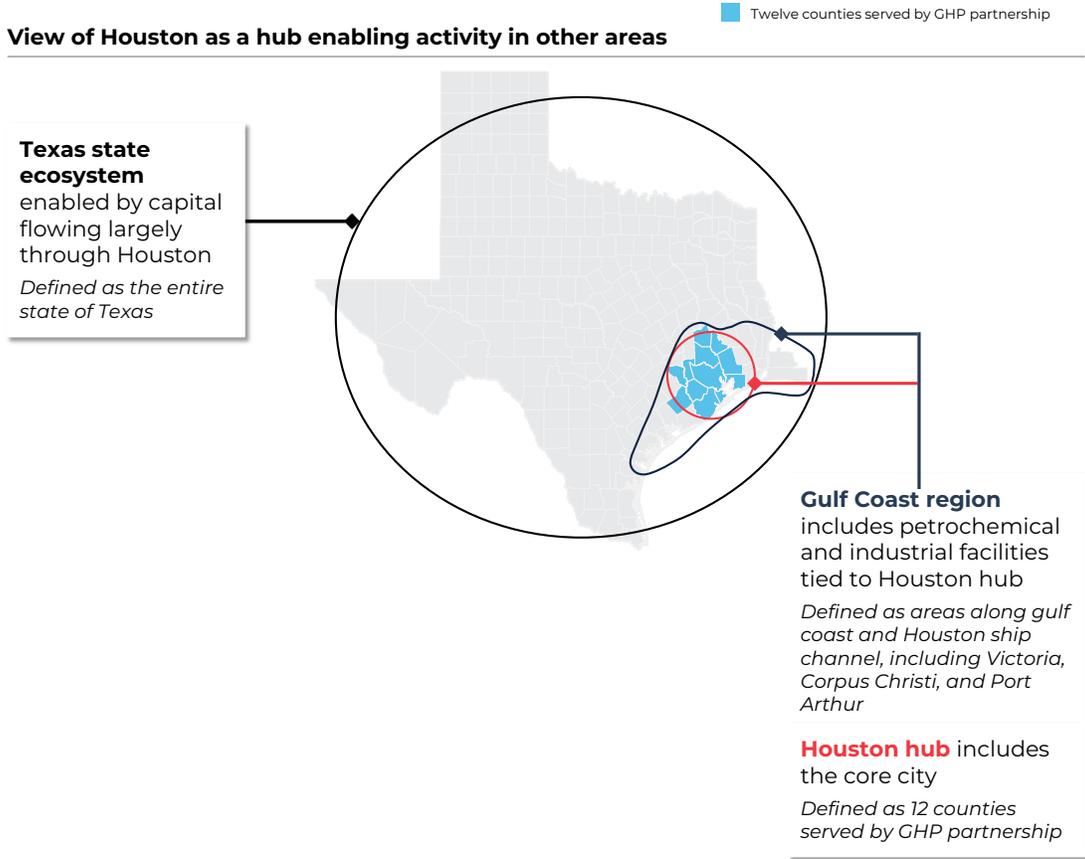
APPENDIX

Supporting analysis, methodology, and definitions

To be consistent in all approaches for mapping energy transition capital flows, boundaries were defined for a) Houston, b) energy transition areas of focus, and c) capital flow approaches

- a. Houston is viewed as an enabler for economic growth outside of the core city itself. For this analysis, the scope for “Houston” was defined in **three ways** (see Exhibit 6): 1) Houston (defined as the 12 counties served by the Partnership)³⁴, 2) US Gulf Coast region (the 30+ counties including two from Louisiana), and 3) the state of Texas

Exhibit 6 For analysis, three different geographic boundaries for the Houston area were considered



34 12 counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, Walker, Waller, Wharton



- b. For this analysis, energy transition was defined through nine verticals: mobility, hydrogen, power, industry, circularity, agriculture, heat supply, buildings, and renewable fuels (see Exhibit 7). Additionally, spend in the energy transition space was viewed from the lens of **new capital expenditures only**, not operational or maintenance expenses. The analysis does include enabling infrastructure, software etc. if capitalized

Exhibit 7
Energy transition was defined through nine verticals³⁵ for this study

 <p>Mobility EVs, storage, and infrastructure</p>	 <p>Hydrogen Blue and green sources</p>	 <p>Power Wind, solar, geothermal, hydro, transmission infrastructure</p>
 <p>Industry CCUS (steel, cement, etc), electrification of equipment, other decarb (e.g., low carbon chemicals)</p>	 <p>Circularity Waste tech, plastics circularity, sorting and processing tech</p>	 <p>Renewable Fuels Liquid biofuels, HEFA, synfuels, ethane, RNG</p>
 <p>Agriculture Crop, poultry, and livestock; new technologies</p>	 <p>Heat supply Power and heat plants burning biomass</p>	 <p>Buildings Low-carbon heating, heat pumps</p>

- c. For Houston to be recognized as the energy transition leader, capital will need to flow both into and out of the city. Capital inflows (capital coming in) refers to projects based in the city of Houston that receive capital: these include start-ups, large-scale energy transition projects, and more. Capital outflows (capital flowing out) refers to pools of capital providers like industrial O&G players and PE firms who supply capital toward energy transition efforts globally

To come to a consensus on the current energy transition financing landscape in Houston, various capital pools were evaluated utilizing several methods. First, the top-down analysis provided an estimate of how Houston energy transition capital relates to US level energy transition capital. This figure yielded a range of ~\$7 to ~\$22B p.a. A bottom-up analysis, detailed below, was also developed, which measured the various capital pools (e.g., PE, VC, industrials, government influence, etc). This methodology arrived at a figure of ~\$15B p.a. inflows, and ~\$25B p.a. outflows, providing color to the range developed in the top-down analysis.

³⁵ Source: Network for Greening the Financial System (NGFS): NGFS Climate Scenarios for central banks and supervisors, NGFS: ngfs.net/ngfs-scenarios-portal/, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, team analysis

Top-down analysis

In the top-down analysis, the energy transition capex spend into Houston (inflows) is estimated to be between ~\$7B and ~\$22B.

The top-down approach leveraged the MGI's study, which mapped energy transition capex investments globally. According to this study, the US spent ~\$280B in 2020. A way to scale this national number down to a number that was specific to Houston was created by weighing regional GDP, energy consumption, and emissions. These local perspectives were used to scale the analysis and determine the ranges shown below (see Exhibit 8).

Exhibit 8 Three scaling methods to size US energy transition capex spend to Houston³⁶

	1 GDP as scaling factor 	2 Energy ¹ consumption as scaling factor 	3 Emissions as scaling factor 
Approach	GDP used as proxy for economic activity and therefore applied as a directional indicator of investment levels	Energy consumption used as a measure for general power activity in the relevant areas can serve to size transition investment potential	Emissions used as a measure of regional industrial activity ³ can help size opportunities for investment (i.e., energy transition investments will likely target these sources)
Sources of insight	Bureau of Economic Affairs: 2020 GDP by county	US: EIA electricity consumption Texas and Houston: ERCOT hourly demand by region	GHG Industrial Point Source Emissions from EIA
Annual Energy Transition Investment 2020	Texas: \$24B Gulf coast region ² : \$8B Houston: \$7B	Texas: \$27B Gulf coast region: \$10B Houston: \$8B	Texas: \$40B Gulf coast region: \$22B Houston: \$12B
	<small>1. Electricity specifically, ERCOT full electricity demand including industrials 2. Includes 36 counties in the coastal/Houston region and 2 parishes in Louisiana 3. Industrial point source activity only - does not include residential-based activity</small>		

³⁶ Source: Bureau of Economic Analysis: GDP United States & the World, GDP by States & Territories, GDP by County, Metro and Other Areas, Energy Information Administration website, ERCOT website, McKinsey Global Institute (MGI): The net-zero transition: what it would take and what it would bring, MGI: Transition Risk Report Capex Dataset, team analysis



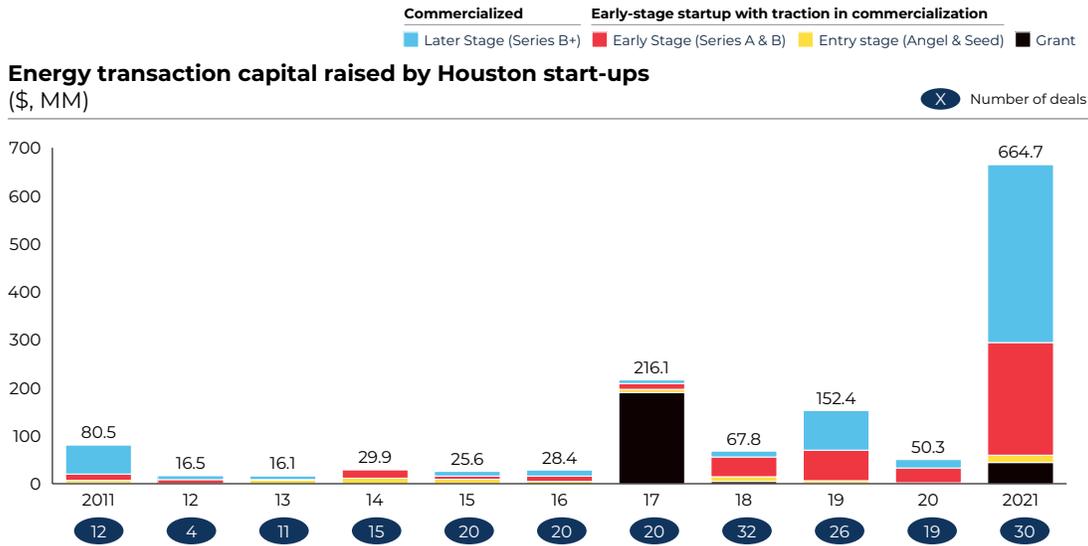
Bottom-up analysis

The bottom-up analysis was used to provide a detailed view on the top-down analysis from two angles: capital inflows as well as capital outflows in Houston. The bottom-up analysis was built by examining six different pools of capital by type: a) VC, b) PE, c) financial institutions, d) O&G, e) power, basic materials, chemicals, and EPC, and f) federal, state, and municipal government mechanisms.

1. **Bottom-up, inflows:** The calculations in the bottom-up analysis show that capital inflows into Houston were ~\$15B in 2021, which supports the findings from the top-down analysis
 - a. **VC³⁷: energy transition start-ups in Houston raised an estimated ~\$0.7B of capital in 2021³⁸**

Overall, the analysis showed that Houston start-ups are focused on three sectors: Chemical, Power, and Industrial. Although these are in line with the region’s strengths, Houston faces stark competition from other energy transition cities like San Francisco, Boston, Stockholm, and London on venture efforts. For example, in 2021 San Francisco start-ups raised ~\$13B³⁹ in capital for energy transition, ~19 times more than Houston. If Houston wants to be the leader in energy transition, it needs to **strengthen its early-stage branding efforts by hosting venture-related energy transition conferences as well as fostering and scaling more start-ups using accelerators/incubators like Greentown Labs.**

Exhibit 9 Houston start-ups raised ~\$0.7B of energy transition capital in 2021



37 Source: PitchBook Data Inc. 2022, Prequin, Team Analysis, Expert Interviews

38 The analysis leveraged databases like Pitchbook by flagging energy transition deals for start-ups raising capital at the seed stage all the way to Series D+ including early-stage grants. In the private sector, the analysis defined energy transition as Emerging Energy, CleanTech, ClimateTech, Solar, Renewable, Geothermal, Wind, Hydroelectric, Low-Carbon, Hydrogen, Energy Transition, Carbon Capture, BioFuel, Electric Vehicle, Biogas, Biomethane, Mobility Tech, Decarbonization, Circularity, Green Electricity, Green Building, Building Efficiency. Source: Pitchbook Dataset (Energy Transition Deals) – July 2022, Prequin, expert interviews

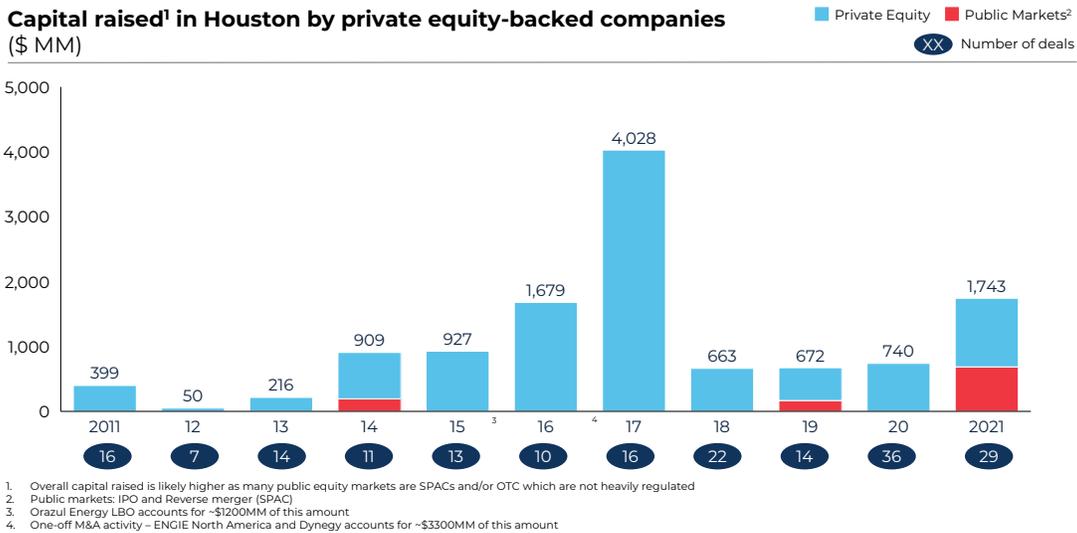
39 Source: Pitchbook Dataset (Energy Transition Deals) – July 2022



b. PE and growth capital ⁴⁰: Companies backed by PE capital ⁴¹ raised ~\$1.7B in 2021 in Houston⁴²

Companies backed PE capital raised ~\$5.7B out of ~\$7B ⁴³ (in the last five years) on power (82% of invested capital) largely due to the de-risked profiles and predictable returns of this vertical. However, power deals only represented 40% of total deal count. The second largest proportion of invested PE capital went toward industrials, ~\$0.6B (~9% of total invested capital). This ~9% of invested capital resulted in ~22% of the overall deal flow. **While innovation is occurring in all areas of energy transition, PE funds are placing their bets on the more established technologies (power).** If industrials were to be de-risked similarly to power, more capital could be expected to flow into the space.

Exhibit 10
Private equity-backed companies raised ~\$1.7B of energy transition capital in 2021



40 Source: PitchBook Data, Inc. 2022, Preqin, Team Analysis, Expert Interviews

41 These include companies that went public via IPO or SPAC

42 The analysis leveraged the same databases and flagged energy transition deals backed by private equity capital. Tags such as LBO (buyout), Debt – PPP, Debt – General, IPO, M&A, PIPE, PE Growth Capital, Reverse Merger used. Source: Pitchbook Dataset (Energy Transition Deals) – July 2022, Preqin, expert interviews

43 Source: Pitchbook Dataset (Energy Transition Deals) – July 2022



c. Financial Institutions ⁴⁴: Houston headquartered companies attracted an estimated ~\$2.5B of debt funding (2021) and ~\$2B in credit line funding (2022) for energy transition efforts

From a credit perspective, it is estimated that Houston headquartered companies (based on publicly available data) received ~\$2B in multi-year credit line funding in 2022 for sustainability efforts.

Credit line funding could be characterized as new or an extension/amendment. Each credit line was typically issued by several participating banks/credit partners and the fees and loan interest margins were often tied to performance targets. Some companies that received a new multi-year credit line in 2022 for sustainability efforts include Oceaneering, Milestone Environmental Services; DCP Midstream, Select Energy Services, and Blackbuck Resources received a credit line extension/ amendment in 2022.

Exhibit 11
Overview of credit line funding⁴⁵ for Houston headquartered companies for 2022 for sustainability efforts

Not exhaustive – publicly available data

Type of Credit line	Company	Credit line details	Participating Banks/credit partners	Credit Line Amount, \$B
 New	 OCEANEERING	Potential to increase credit line to \$300MM; possibility of reduced borrowing rates based on performance against future sustainability targets	Wells Fargo, JP Morgan Chase, DNB Markets, Credit Suisse AG, New York Branch, and Woodforest National Bank	0.2
	 MILESTONE	Loan interest margin based on performance against sustainability performance targets	Community Bank of Texas, Gulf Capital Bank	<0.1
 Extension/ amendment	 dcp Midstream	Includes sustainability-linked pricing metrics. Interest and fees paid linked to progress against targets on greenhouse gas emissions reduction, and exceeding peers in safety performance	Mizuho Bank, JPMorgan Chase	1.4
	 SELECT ENERGY SERVICES	Pricing linked to performance against targets for increased volumes of recycled water production, and safety performance	Wells Fargo, Bank of America, Amegy Bank, Royal Bank of Canada, Cadence Bank and BOK Financial	0.3
	 BLACKBUCK RESOURCES	Includes feature for additional liquidity; facility pricing based on Blackbuck's performance against sustainability performance targets	Riverstone Credit Partners LLC	0.1
Total				~2.0

44 Source: Press Search, Expert Interviews, Team Analysis

45 Source: Press release, BusinessWire, GlobeNewswire, PRNewswire

- d. O&G ⁴⁶: Projects in Houston funded by O&G players raised ~\$0.4B in energy transition capital in 2021

Through expert interviews and press releases, a list of twelve major projects was built (see Exhibit 12). Three of these projects broke ground this year and produced ~\$0.4B in inflows for 2021^{47 48}.

Exhibit 12 Twelve O&G-backed projects totaling ~\$110B in projected capex were found, between both current and future announced projects

Not exhaustive – publicly available data

Current Commitments Future Commitments

Key Investor	Project Name	Brief Description	Total Investment	Completion Year, Current Stage	Other Stakeholders
AIR PRODUCTS	Air Products La Porte	Liquid hydrogen production plant	\$0.2B	Unknown, Launched 2021	N/A
NETPOWER	Clean Energy ERCOT	Delivered zero-emission electricity onto the ERCOT grid	\$0.15B	Built	N/A
ARCHAEA ENERGY	Waste RNG	Convert landfill gas into pipeline-quality RNG	\$0.03B	Construction 2022, Launch 2027	Renewable Energy Group
Current Total: ~\$0.4 B					
Houston CCS	Houston Ship Channel	Conversion the ship channel to a CCUS Hub	\$100B	TBD	Government (Local, State, & Federal) with Port Houston
HIF	HIF Matagorda	Carbon-neutral gasoline plant	\$6B	2026, Start 2023	N/A
AIR PRODUCTS	Louisiana Blue Hydrogen	Blue Hydrogen Production (Louisiana to USGC)	\$4.5B	Expected onstream 2026	N/A
OXY	DAC Project	Direct air capture	~\$1B	Launch 2024	N/A
CHEVRON	Bayou Bend CCS	CCS project in the offshore region	\$0.1B	Execution of definitive documentation	Talos Energy, Carbonvert
ENBRIDGE	Ingleside Blue H2 Ammonia Plant	Low-carbon hydrogen and ammonia production and export facility	\$0.1B	N/A	Humble Midstream
bp	Gulf Coast CCUS	Carbon storage for hydrogen facilities	TBD	Launch 2026	Linde
FREEPORT LNG	Freeport LNG CCS	CCS in Gulf Coast	TBD	Launch 2024, Initial Ground Testing	Talos Energy
ExxonMobil	Baytown H2 Project	Blue H2 production facility to support industrial applications with low-carbon H2	TBA	TBA, 2030 (FID, 2025)	N/A
Future Commitments: ~\$110B					

The remaining nine projects that have not broken ground are projected to bring in ~\$110B over the next five to ten years. Although significantly larger in investment size, many of these projects are still pre-FID and at pre-investment levels. Only a handful of projects have launched or been verbally committed to, **yet the pipeline is filling up with technologies that are strengthened by the core competencies of O&G players, including CCUS and clean hydrogen.**

- e. Power, basic materials, chemicals, EPC, and waste ⁴⁹: Capital inflows for this category are estimated to be ~\$0.4B. This includes companies like CenterPoint Energy, a Houston-headquartered electric and natural gas utility.

46 Source: CapitalIQ, Investor Reports, Team Analysis

47 One of the three projects [Archaea Energy's Waste RNG] included nation-wide investments in multiple geographic locations, as a result the number of projects Archaea aimed to invest in was divided linearly to scale its total project capital (\$1.1B) to Houston (0.03B).

48 Source: Press release

49 Source: Investor Reports, Press Search, Team Analysis

f. Federal, state, and municipal government mechanism⁵⁰

Houston received ~\$7B p.a. from municipal and state programs, however, the most impactful of these programs is scheduled to sunset in 2022. If Houston wants to be a leader in energy transition, it would benefit from creating new local and state incentives to attract businesses.

While Houston has historically received a negligible amount of federal government funding for energy transition projects, there is up to ~\$415B across six key segments coming available that Houston could take a large share of (see Exhibit 13).

Exhibit 13
The IRA implements ~\$415B in climate spending across multiple energy transition focus areas⁵¹

Industry	Spending, \$B	Key programs
Total	Total: \$415B	
 Energy	263	Extend and modify production tax credit (PTC) Technology-neutral investments in generation and storage Nuclear lifespan extension of existing reactors
 Climate and env. justice	48	Green banks funding to accelerate zero emission technologies and support low-income and disadvantaged communities
 Manufacturing	48	Funding for a wind, solar, and battery manufacturing production tax credit to encourage domestic production/sourcing
 Land & agriculture	27	Environmental quality incentives programs Regional conservation partnership programs
 Transportation	24	Consumer tax credits for new and used EVs Tax credits for qualified commercial vehicles
 Water	5	Drought impact mitigation in Reclamation States

State and local incentive programs are designed to offset Texas's commercial property taxes, which are currently 70% higher than the national average. As a result, these programs have been a critical driver of capital-intensive projects. In recent years, Texas has broadened incentive programs to include energy transition technologies beyond wind and solar, such as biorefineries.

~\$15B of the ~\$16B p.a. of grants, bonds, and tax credits available to Texas companies is from the Ch. 313 tax abatement program, which is scheduled to end in December 2022.

⁵⁰ Source: Database of State Incentives for Renewables & Efficiency, Press Search, Team Analysis

⁵¹ Based on analysis, provided by McKinsey & Company, on the impacts of IRA, September 2022

Exhibit 14 94% of Texas state energy transition incentives are from the Ch. 313 program⁵²

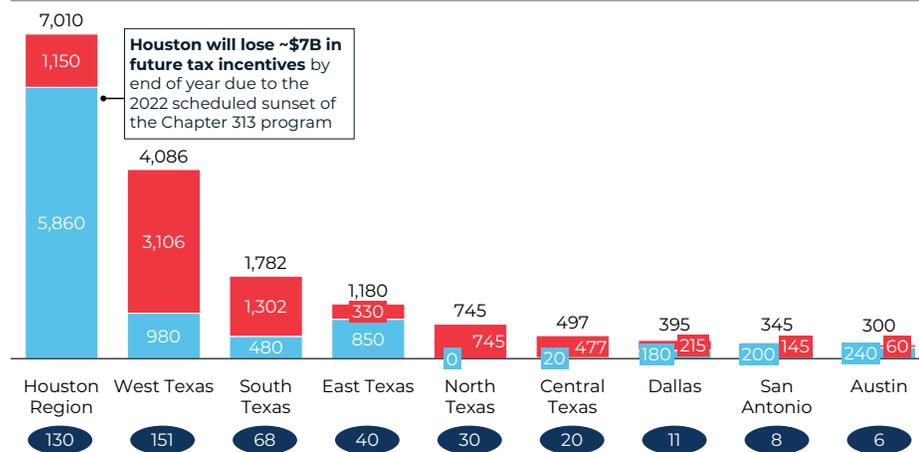
Incentive Type	Program Name	2022 FY Program Funding ² , \$B	What this program is, and who qualifies for the funding
Grants and Bonds 	Texas Enterprise Fund	0.2	Performance-based cash grant to companies that exceed 75 full-time jobs in urban areas or 25 full-time jobs in rural areas
	Industrial Development Bond	<0.1	Tax-exempt or taxable bond financing issued by economic development corporations on behalf of a local municipality for companies investing in industrial facilities or equipment
	Emission Reduction Incentive Grants Program	<0.1	Provides financial incentives for the early retirement of heavy-duty vehicles and equipment by the private and public sector
	New Technology Implementation Grant (NTIG)	<0.1	Provides grants to owners of a facility in Texas to assist with emission reduction of pollutants from facilities and stationary sources
Tax Credits 	Texas Economic Development Act (Chapter 313s) ¹	15.0	Temporary property tax abatements for capital intensive projects with a minimum required threshold of 25 qualifying jobs in non-rural and 10 qualifying jobs in rural school districts
	Manufacturing Machinery or Equipment Tax Exemption	1.0	State sales and use tax exemptions available to TX taxpayers who manufacture, fabricate, or process tangible property for sale
	Enterprise Zone Tax Credit	0.1	State sales and use tax refund program for private investment in economically distressed areas. Capital investment minimum threshold is 40k, minimum job creation is 10 and max is 500

1. Set to sunset December 2022
 2. Award amount/total amount available
 Source: Texas Comptroller Office, Texas Commission on Environmental Quality, Texas Bond Review Board

To further breakdown the impact of tax abatement policy, the award allocation across Texas and Houston was reviewed (see Exhibit 15).

Exhibit 15 Over \$7B of tax abatements were awarded to Houston in 2022 for capital intensive projects⁵³

2022 tax abatements for qualified Chapter 313 projects¹, \$MM



1. Projects that have qualified between 2008 through 2022 that are receiving tax abatements in 2022
 Source: Texas Comptroller Office

52 Source: Texas Comptroller's Office

53 Source: Texas Comptroller's Office

Historically, Houston’s projects are about two times more capital intensive than other Texas projects. Recent projects that were awarded in Houston include HIF USA, a ~\$6B green hydrogen and e-fuel project based in Matagorda County, and Air Products, a ~\$190M hydrogen and methane project in Harris County.

2. Bottom-up, outflows: The bottom-up analysis showed capital outflows from Houston to be ~\$25B p.a. and were primarily driven by the industrial O&G players

a. VC ⁵⁴: VCs headquartered in Houston currently invest an estimated ~\$0.6B p.a. ⁵⁵

VCs and CVCs that have a significant presence in Houston and invest in energy transition related projects, were found to have most of their recent investments directed at start-ups based outside of the region. This indicates that Houston VCs have the opportunity to invest more into local start-ups.

Exhibit 16 Non-exhaustive list of major VC players accompanied with recent fund raises and investments

Venture Capital Firms with HQ / significant presence in Houston			Corporate Venture Capital		
Venture Funds	Total AUM (\$MM)	Key Investments	Venture Funds	Total AUM (\$MM)	Key Investments
Mercury Fund	500	Benson Hill, Molecule	CSL Energy Ventures Fund	46	GoExpedi , Omne
GEC	398	Freedom Solar Power, Locus Bio-Energy	Tantalus	45	Tantalus
YELLOWSTONE CAPITAL	150	WellDog	SOFTCO Venture Fund	40	Home Outside
SCF PARTNERS	100	Revterra , Qube	MONTROSE LANE	32 ¹	Tachyus, Ambyint
Energy Innovation Capital	130 ²	Infinium Electric, Titan Advanced Energy Solutions	CARNDITE	15	Persefoni, Futureproof
ENERGY TRANSITION VENTURES	100 ³	Ohmium Resilient Power	CLIMATE SPACIAL CAPITAL	3	OpConnect
HX VENTURE FUND	90	Fund of Funds	VC FUEL	Not Available	Carbicrete
GOOSE	80	None			
	55+	Syzygy Plasmonics , Drylet			INOVUES
					bp ventures
					Chevron Technology Ventures
					equinor
					KINDER MORGAN OXY
					Schlumberger
					ExxonMobil
					ConocoPhillips
					HALLIBURTON
					Other s

1. Formally known as Cottonwood Venture Partners
 2. Projected close, still open
 3. This firm is based out of SF and Houston
 Source Pitchbook Dataset (Energy Transition Deals) – July 2022, Expert Interviews, Prequin, Company Press Releases

Recent fundraising efforts on a national level were examined. Last year, VCs in Houston raised ~\$405M toward energy transition efforts (more than 50% coming from CVCs), whereas SF’s VC community raised ~\$12B ⁵⁶ in one year, about 30 times more than Houston’s VC community. There are three implications for early-stage VC players in Houston: a) most VC investments from local players are outside of the city leading to missed start-up opportunities b) most VCs need a more active entrepreneurship community, which can be enabled through accelerator hubs, and c) much of the VC capital is controlled by CVCs.

54 Source: PitchBook Data Inc. 2022, Prequin, Team Analysis, Expert Interviews

55 The analysis leveraged databases and expert interviews to find recent VC fund raises. Corporate Ventures, as a nature of how they operate, would not show up on a search list dedicated toward external fund raises, so expert interviews and general searches were leveraged to generate this list. Second, to find how much capital these active funds would allocate in one year, the analysis assumed an average fund life of 5 years and divided the collective sum of all funds raises by 5.

56 Source: Pitchbook Dataset (Energy Transition Deals) – July 2022

- b. PE and growth capital⁵⁷: PE fund managers are supplying ~\$2.2B p.a. of capital on average

Exhibit 17
Non-exhaustive list of major PE players⁵⁸ accompanied with recent fund raises split by local or global investors (local = Houston-based)

Not exhaustive

	Fund manager	Fund Names (Funds with an ET Remit)	Combined Fund Size (\$,MM) ²	Last raise, Year
Mega PE Firms with strong ET focus in Houston		Sustainable Resources Credit Platform ³ , Blackstone Energy Partners III	\$4,300	\$4,300 2020
		Pattern energy II & III, Decarbonization Fund	~\$1,500	\$750M 2022
		Climate Infrastructure Fund	\$2,200	\$2,200 2021
		Brookfield Global Transition	\$15,000	\$15,000 2022
		PG Life, Direct Infrastructure III, Global Infrastructure, Global Real Estate	~\$10,000	\$8,500 2022
		KKR IV Infrastructure, Global Impact Fund	~\$20,000	\$17,000 2022
		Global Infrastructure Opportunity Fund, Renewable & Sustainable Energy Fund	~\$3,000	\$703 2022
Houston region-based PE funds with strong ET focus¹		Macquarie Green Investment Global Group	\$2,000	\$2,000 2021
		Fund Energy Tech Partners III & IV	\$950	\$750 2022
		Energy Partners VII, Energy Structured Capital Fund I	\$6,500	\$840 2019
		ET Fund I, Energy Capital Fund XI	\$8,000	\$1,200 2021
		SCF IX	\$800	\$800 2018
		Sustainable Infrastructure, International Power	\$2,300	\$2,000 2021
		Ara Fund I, Ara Fund II	\$2,000	\$1,100 2021
		Lime Rock New Energy	\$375	\$375 2019
		EIG Emerson Energy Partners	\$100	\$100 2017

1. Not fully comprehensive due to lack of public information
 2. Active funds from 2017 that have an ET component
 3. Blackstone sees \$100B of ET investments over the next 10 years. We have estimated they will invest ~\$10B and have allocated that to this platform. From 2019-2021, Blackstone invested ~\$7.5B annually
 Source Pitchbook Dataset (Energy Transition Deals) – July 2022, Prequin, expert interviews

A list of managed funds focused on energy transition was built. The list included funds based out of Houston as well as global funds with a strong operational presence in Houston (Exhibit 17). Their most recent fundraising efforts (in the past five years) were examined to get an overall feel for how much capital is available.

Based on two categorizations (local or global), and the various types of funds (energy transition, energy, general), overall capital was scaled down from a national level to Houston’s level.

- **local:** Houston-based funds were categorized as either energy transition or energy. For energy transition funds, 100% of available capital was captured, and for energy funds, publicly available information was used, taking the average proportion of capital allocated to energy transition from industrial O&G players (about 15% of overall capital spend)⁵⁹
- **global:** global or mega funds were categorized as either energy transition, energy, or generalist. Similarly, all the capital within a fund was captured if it was energy transition based, and 15% if it was a broader energy fund. If the fund was labeled as generalist, it was assumed to have an equal distribution of capital across the various sectors it targeted. The fund was then scaled down to the Houston-level by equally distributing capital among its offices

57 Source: PitchBook Data, Inc. 2022, Prequin, Team Analysis, Expert Interviews

58 Source: Expert interviews, Pitchbook Dataset (Energy Transition Deals) – July 2022, Prequin

59 Capital invested in US ET deals for the past five years divided by how much capital was invested in energy deals globally in that same time period.



Finally, each fund was divided by its fund lifespan (approximately five years) (see Exhibit 18).

Exhibit 18

Process of sizing overall capital available from global and local investors who have an energy transition remit to sole energy transition dollars flowing from Houston



Houston has a strong presence in PE due to its O&G ecosystem that has historically attracted local and global investors. Most of these energy transition players are former O&G investors who are beginning to diversify their portfolios. These core investors are also supported by rapidly growing energy transition-only funds.

- c. **Financial Institutions⁶⁰**: Based on public information, no known debt or credit financing outflowed from Houston HQ’s financiers
- d. **O&G⁶¹**: O&G players with headquarters or a significant presence in Houston were estimated to spend ~\$20.7B in energy transition for 2022⁶²

Seven companies were found to have published energy transition forecasts for 2022 and beyond: Shell, Chevron, ExxonMobil, bp, Kinder Morgan, ConocoPhillips, and Occidental Petroleum (see Exhibit 19).

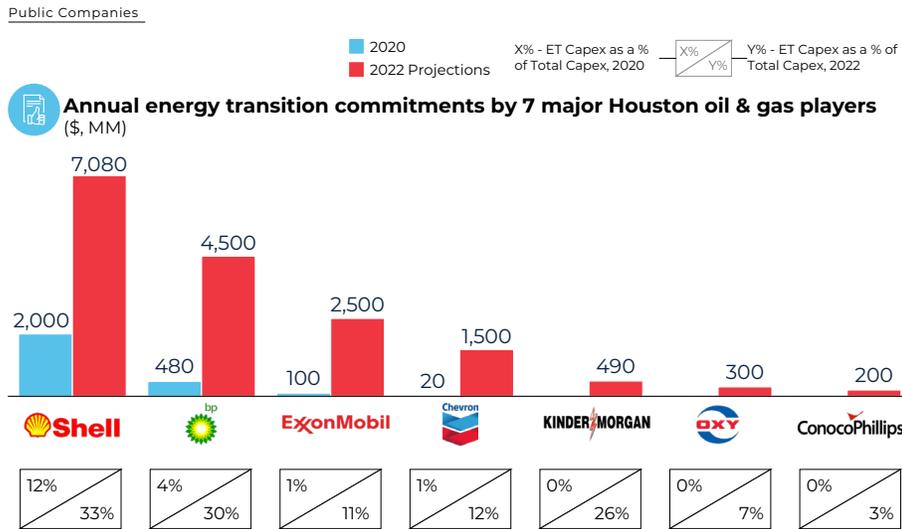
⁶⁰ Source: Press Search, Expert Interviews, Team Analysis

⁶¹ Source: CapitalIQ, Investor Reports, Team Analysis

⁶² This includes O&G companies, midstream, E&P, LNG, engineering service providers, and energy service providers with headquarters located in Houston



Exhibit 19 Historic and future energy transition commitments from seven Houston-based O&G players



On average, these firms were found to have spent ~15% (likely skewed by energy transition capital spend of larger companies) of their overall capital expenditure on energy transition. This ratio was applied to the rest of the O&G public companies in Houston providing an estimate that public O&G companies are investing ~\$20.7B in 2022 (see Exhibit 20).



Exhibit 20

The 15%⁶³ energy transition capital ratio was scaled and spread across the remaining public O&G players from Houston⁶⁴ to get total energy transition commitments for 2022

$$\sim\$16.5B \quad + \quad [\sim\$20B \times 15\%] \quad = \quad \sim\$20.7B$$

2022 projected ET CAPEX commitment from 7 public O&G companies¹ [(2021 historical CAPEX figures from the remaining 85 public O&G companies²) * (Average ET CAPEX Commitments as a % of Overall CAPEX)] Total Estimated Energy Transition Spend in 2022



1. Shell, Chevron, ExxonMobil, BP, Kinder Morgan, ConocoPhillips, and Occidental Petroleum
 2. 85 total companies were analyzed and the top 50 (organized by 2021 CapEx) are featured in the graphic; This includes E&P, midstream, refining, LNG, and service provider companies
- Source: Investor Presentation Reports

From the ~\$20.7B, ~\$16.5B (around 80%) comes from Shell, Chevron, ExxonMobil, bp, Kinder Morgan, ConocoPhillips, and Occidental Petroleum.

O&G players are the largest capital providers in Houston. As a result, the region will exponentially accelerate in the energy transition race as these players continue to diversify their capital spend toward more energy transition focused efforts. These current capital providers have created an ecosystem where certain technologies can come together faster (CCUS, clean hydrogen, and power) as they build off current capabilities (such as engineering talent and current energy infrastructure) within the region.

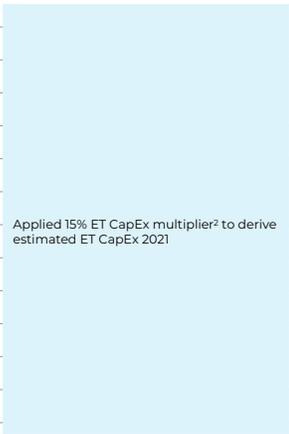
63 Source: Investor Presentation Reports

64 Source: Companiesmarketcap.com

e. **Power, basic materials, chemicals, EPC, and waste**⁶⁵: It is estimated that Houston-based companies in power, basic materials, chemicals, and EPC spend ~\$1.9B p.a. on energy transition. For this estimation, only public companies that had capital information available were considered. For most of the companies, the 2021 capital expenditures for the respective entities were reviewed and a Capital energy transition multiplier for 2021 was applied. This 15% multiplier was the average energy transition capital commitment, as a % of overall capital, of the seven O&G companies with publicized data in 2021 (Shell, Chevron, ExxonMobil, bp, Kinder Morgan, ConocoPhillips, and Occidental Petroleum). For Sunnova Energy and WM, separate assumptions were made and have been included in Exhibit 21, below.

Exhibit 21 Houston-based industrial players are allocating ~\$1.9B to energy transition capital ⁶⁶ annually

Not exhaustive

Industrial player	Entity name (publicly listed companies only) ¹	CapEx 2021, \$MM	Assumptions	Estimated ET CapEx 2021, \$MM	
 Basic Materials	Quanex Building Products Corporation	25		4	
	5E Advanced Materials Inc.	20		3	
 Chemicals	LyondellBasell Industries	2,100		300	
	Westlake	700		100	
	Orion Engineered Carbons	200		30	
	Kraton	100		15	
 EPC	Quanta Services, Inc.	400		Applied 15% ET CapEx multiplier ² to derive estimated ET CapEx 2021	60
	Orion Group Holdings, Inc.	20			3
	Comfort Systems USA, Inc.	20			3
	IES Holdings, Inc.	10			1.5
 Power	CenterPoint Energy, Inc.	3,200		100% CapEx allocated to ET	480
	NRG Energy, Inc.	300			50
	Orbital Energy Group, Inc.	10			1.5
	Via Renewables, Inc.	5			1
	Sunnova Energy International Inc.	600	600		
 Waste	WM	1900	2021 and 2022 ET CapEx are equivalent	300	
	Total	~9600		~1900	

1. Only considered public companies that had CapEx information available
 2. 15% is derived by averaging the % of CapEx that 7 O&G companies (Shell, Chevron, ExxonMobil, BP, Kinder Morgan, ConocoPhillips, and Occidental Petroleum) allocated to ET in 2021

Sources: CapitalIQ, Company documents, C&EN analysis

65 Source: Investor Reports, Press Search, Team Analysis

66 Source: CapitalIQ, Company documents, C&EN analysis





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