

HOUSTON LEADING THE ENERGY TRANSITION

Strategy Report

JUNE 2021

GREATER HOUSTON **PARTNERSHIP**



INTRODUCTION

Houston has a long history of solving many of the world's greatest challenges – developing medical breakthroughs, leading human spaceflight, and powering the world – we are a city of problem solvers and innovators who tackle big, complicated, and consequential problems.

Houston is being called again to solve a global challenge of extreme magnitude: how to meet growing global demand for energy while simultaneously dramatically lowering climate-changing greenhouse gas emissions.

The challenge of our time is the Energy Transition. Solving it – developing and scaling the right technologies, creating and servicing markets for the right mix of energy sources, investing in the right energy priorities – is a challenge and an opportunity that Houston is determined to embrace and lead.

The Greater Houston Partnership's effort to develop a regional energy transition strategy was informed by a deep dive into industry and economic trends as well as insights from interviews with more than 60 key leaders from business, government and academia on how the region can capture that opportunity. The effort complements a range of existing initiatives, such as the City of Houston's [Climate Action Plan](#), The Center for Houston's Future and University of Houston's report on "[The Houston Region as a Global Hydrogen Hub](#)," Rice University's Baker Institute report "[The Future of Houston as Energy Transitions](#)," and ExxonMobil's proposal for a \$100 billion carbon capture zone centered along the Houston Ship Channel, among others.

The outcome of that work is a comprehensive plan for achieving a critical and bold vision:

Leverage Houston's energy leadership to accelerate global solutions for a low-carbon future.

Houston's Energy Transition Strategy is rooted in the city's eagerness for innovation; its appetite for high-risk and high-reward business investments; and its capacity for executing on massive, complex projects around the world. It also leverages Houston's deep experience and infrastructure in producing, moving, financing and marketing energy in all its forms.

Finally, it is a strategy backed by plans and commitments, not just talk and ideas.



JUST WHAT IS THE “ENERGY TRANSITION”?

Our modern world and the advancement of billions out of extreme poverty depends on energy. Lots of it.

We use it to power our cities, cars, airplanes, homes, electronic devices – virtually everything that makes modern life possible. It’s also used to produce our food, run our factories, protect and heal our bodies, and build our infrastructure.

By 2050, the world’s population will consume 20 percent more energy than we do today. That’s partly because there will be more of us on the planet – 10 billion versus today’s population of seven billion – and therefore more of those cities, cars, factories.

It’s also because as emerging nations advance, their citizens seek the access and opportunity to live a higher quality life, which is more energy intensive. The growth in energy demand in those nations will outstrip growth elsewhere, as they develop.

That’s because for over 200 years oil, gas and coal – or “fossil fuels” – have been the lifeblood of industrial economies. Fossil fuels are dense with energy, easy to transport, widely available and largely affordable. They have transformed human societies, making possible mobility, climate-controlled homes and workplaces, production of vast amounts of food, life-saving medicines and medical devices, and almost every man-made object we can touch, from massive structures like the Hoover Dam to the tiniest microchips.

But we face a much bigger challenge than simply meeting growing demand for energy: We will need to meet that demand in a way that addresses climate change caused by today’s energy system.

But the way fossil fuels are used today also imposes an enormous cost. That cost comes in the form of greenhouse gases (or GHGs) – especially carbon dioxide and methane – that are emitted when fossil fuels are burned to create energy or escape into the atmosphere.

Put another way, in the same way that we turned to oil, gas and coal to lift much of humanity out of poverty, we now need to turn to more and new sources of energy – along with zero-emission ways of using fossil fuels – to protect humanity from the dangers of a changing climate.

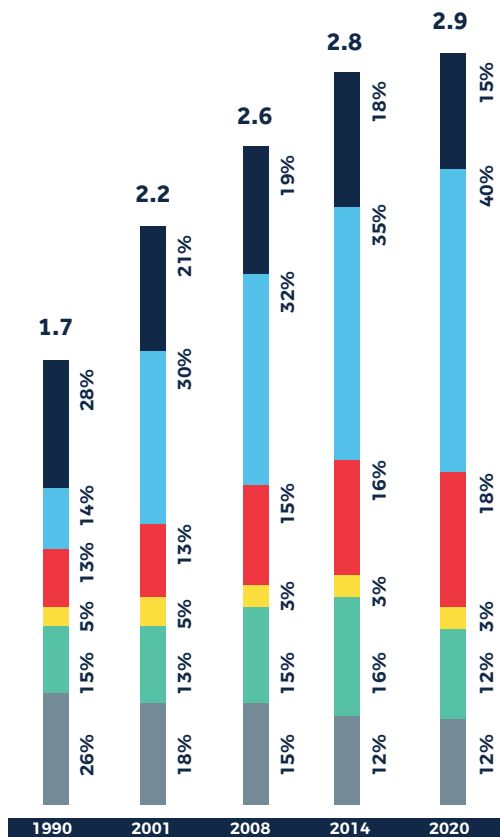
This, in short, is what the “energy transition” is about. It’s urgent but will take a long time. It will be hard and complex. It will require investing trillions of dollars in new energy technologies and infrastructure around the world. It is the kind of challenge that Houston is uniquely equipped to lead.



WHAT DOES THIS MEAN FOR HOUSTON?

For over 100 years, Houston has been at the epicenter of the U.S. energy system. It has played a critical role in the world's energy economy as well. The city is home to 44 of the 113 publicly-traded oil and gas exploration and production firms. Fourteen percent of America's total oil refining capacity and 44 percent of its petrochemical capacity are located in Houston. And 160 million tons of oil, gas and other fuel products pass through the ports of Houston, Freeport, Texas City and Galveston each year. An estimated 24 percent of Houston's jobs are in upstream, midstream, refining and petrochemicals. When considering indirect and induced jobs related to the energy sector, this figure reaches roughly 40 percent of Houston's total jobs (Figure 1).

FIGURE 1
HOUSTON MSA¹ NON-FARM EMPLOYMENT BY SECTOR
Number of Jobs, Millions



● Portion of other sector employment that is induced from Hydrocarbon sectors (i.e., jobs that are created through household spending)

● **OTHER SECTORS**
All other non-farm Houston employment sectors (e.g., education, retail, accommodation & food services, entertainment, real estate, construction, logistics).

● **HEALTH CARE & LIFE SCIENCES**
Hospitals, ambulatory services, medical equipment manufacturing, pharmaceutical manufacturing, research and development in the Physical, Engineering, and Life Sciences, and employment from sector-related purchases of goods and services in the community³

● **POWER & UTILITIES**
Electric power generation, transmission & distribution, natural gas distribution, and employment from sector-related purchase of goods and services in the community³

● **REFINING & PETROCHEMICALS**
Petroleum products manufacturing, chemical manufacturing, and employment from sector-related purchases of goods and services in the community³ (e.g., Refining & Petrochemicals-related financial, legal, engineering, and construction services)

● **UPSTREAM & MIDSTREAM**
Oil & Gas extraction, pipeline transportation, machinery manufacturing, and employment from sector-related purchases of goods and services in the community³ (e.g., Upstream & Midstream-related financial, legal, engineering, and construction services)

¹ Metropolitan Statistical Area (Houston-The Woodlands-Sugarland, TX)

² Data as of Q2 2020

³ Estimated using indirect job multipliers from IMPLAN and Economic Policy Institute

Source: IMPLAN; Economic Policy Institute; U.S. Bureau of Labor Statistics (BLS); Current Employment Statistics (CES), Quarterly Census of Employment and Wages (QCEW); Center for Houston's Future

At first glance, Houston's title as "the energy capital of the world" might seem secure.

But a closer look shows how changes in the way the world produces and uses energy have begun to impact Houston (Figure 2). From 1990 to 2020, approximately 125,000 jobs in the upstream and midstream oil and gas industries have been lost in the greater Houston area (Figure 3). That's a 26 percent reduction, and the figure does not include the loss of what economists call "induced" jobs - that is, jobs that existed because those 125,000 former oil and gas employees were spending their salaries at establishments such as restaurants, retail or home improvement stores.

While the energy industry is known for its cyclicality, it is likely these jobs will not be fully recouped, given ongoing efficiency gains in production. In short, it takes fewer people today and will take even fewer people in the future to produce a barrel of oil or a MMBtu of natural gas than it did before.

FIGURE 2
GLOBAL PRIMARY DEMAND PER FUEL
Million TeraJoules(TJ)

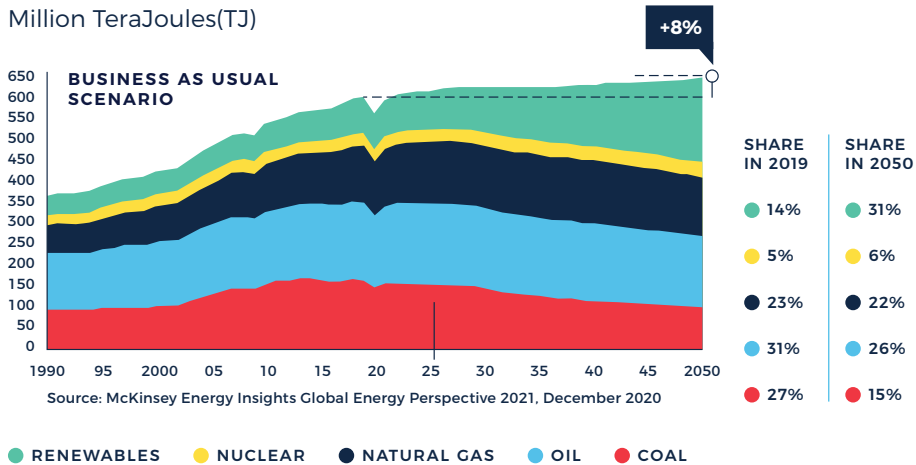
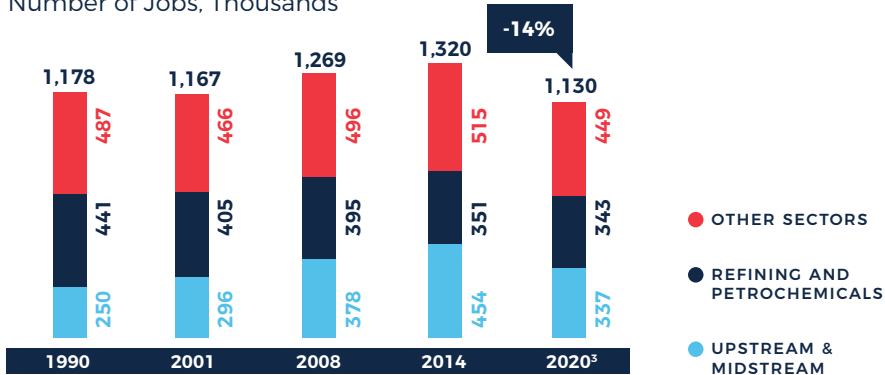


FIGURE 3
HOUSTON MSA¹ EMPLOYMENT IN THE ENERGY SECTOR²
Number of Jobs, Thousands



¹ Metropolitan Statistical Area (Houston - The Woodlands - Sugarland, TX)
² Includes direct and indirect employment ³ Data as of Q2 2020

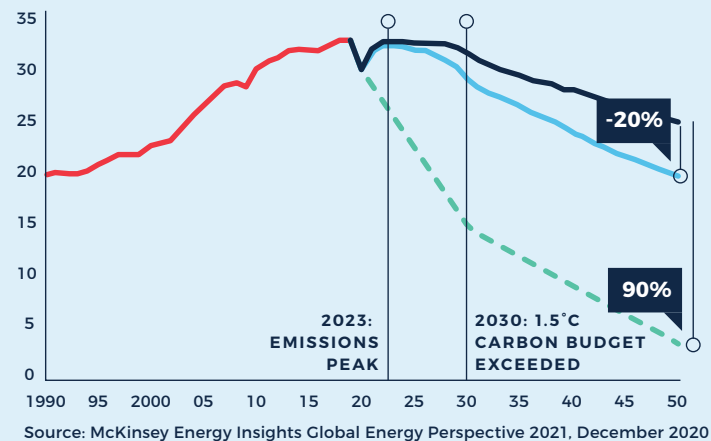
Source: IMPLAN; Economic Policy Institute; U.S. Bureau of Labor Statistics (BLS); Current Employment Statistics (CES), Quarterly Census of Employment and Wages (QCEW)

THREE ENERGY TRANSITION SCENARIOS

- BUSINESS AS USUAL**
 represents the continuation of existing trends and captures expectations of how global consumption and future technologies will evolve. It also incorporates current public policy and extrapolates key policy trends.
- ACCELERATED TRANSITION**
 illustrates a scenario where there is a more accelerated uptake and development of lower-carbon technologies and more aggressive government policies to develop and scale these technologies.
- 1.5C PATHWAY**
 would require CO2 emissions by 2050 to drop by 90 percent compared to the Business as Usual projection and 70 percent from the Accelerated Transition projection to meet the 1.5C Pathway.

ENERGY SECTOR FUTURE COULD PLAY OUT ALONG DIFFERENT SCENARIOS

Global Gross Energy-Related CO₂ Emissions



If the city chooses to continue doing business as usual, its energy-based economy will continue to contract, which will have ripple effects throughout the rest of Houston's economy. A McKinsey & Co. analysis estimates that Houston could lose another 270,000 jobs over the next 30 years under the Business as Usual Scenario if current trends in energy demand and gains in production efficiencies continue. That number could rise to 370,000 jobs if the world follows – as seems likely – an Accelerated Transition Scenario to low-carbon energy or up to 650,000 jobs in a 1.5C Pathway that calls for CO2 emissions to drop by 90 percent by 2050 (Figure 4).

But Houston is not a city content with “business as usual.” Changes in the world’s energy market – and changes in the

climate itself – pose real challenges. But they offer enormous opportunities as well.

If Houston were to take decisive action to lead in the energy transition, the region could gain up to an additional 400,000 jobs under the Accelerated Transition Scenario or 560,000 jobs in the 1.5C Pathway (Figure 5).

There are multiple lenses that can be used to compel action or evaluate success beyond job creation. These include parallel priorities like environmental benefits, such as reductions in greenhouse gas emissions, or equity considerations in how talent at all levels receive the education and training needed to secure opportunities in new energy industries. Many dimensions must be factored into shaping a successful path forward for all Houstonians.

FIGURE 4

HOUSTON COULD LOSE UP TO 650,000 JOBS IF NO ACTION IS TAKEN TO RESPOND TO THE CHANGING ENERGY LANDSCAPE

Houston Energy Employment Across Scenarios (Thousand Jobs)

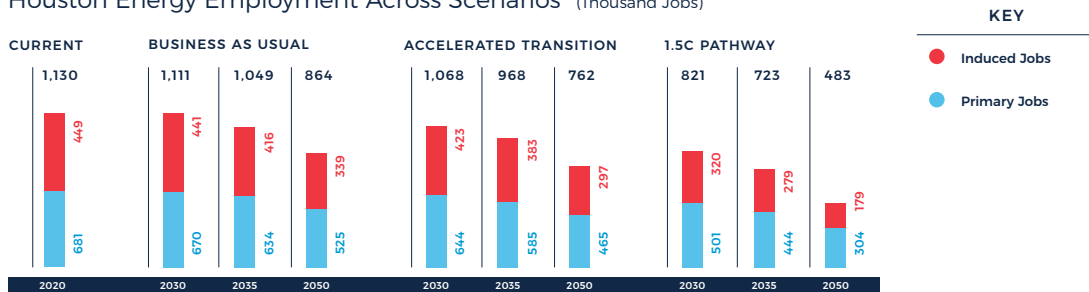
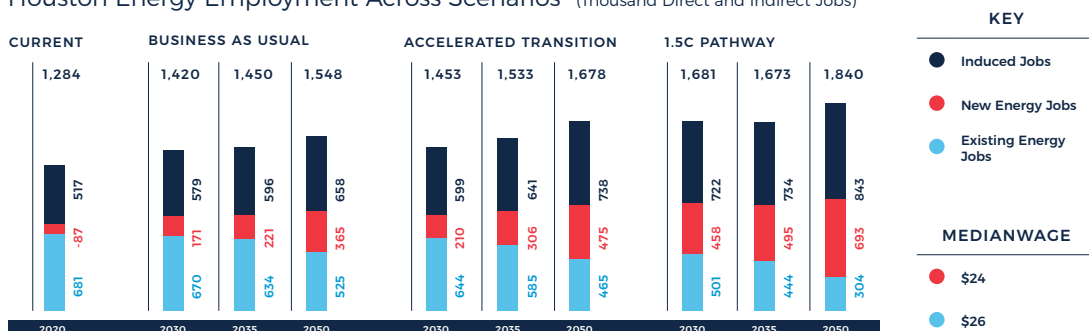


FIGURE 5

WITH DECISIVE ACTION TO LEAD IN THE ENERGY TRANSITION, HOUSTON COULD GAIN UP TO 560,000 ADDITIONAL JOBS

Houston Energy Employment Across Scenarios (Thousand Direct and Indirect Jobs)



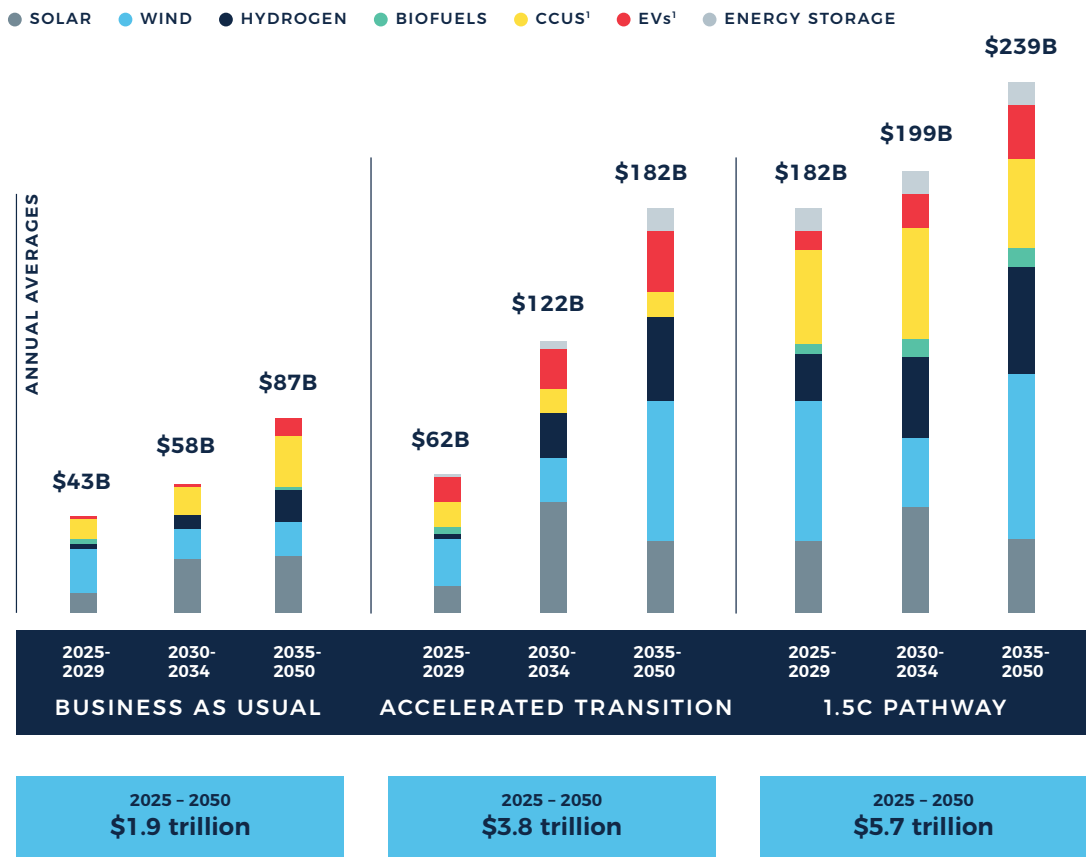
Source: McKinsey analysis; E2 “Clean Jobs, Better Jobs” report (October 2020)



The transition to low-carbon and net-zero forms of energy will require trillions of dollars of investment globally. In North America alone, an estimated \$1.9 trillion could be invested in emerging energy sectors by 2050 under the Business as Usual Scenario. If there was a concerted push to deploy low-carbon strategies, that figure could increase to \$3.8 trillion by 2050 under the Accelerated Transition Scenario or \$5.7 trillion under the 1.5C Pathway (Figure 6).

Houston is well-positioned to take advantage of this opportunity, potentially capturing \$35 billion annually on the low side and as much as \$210 billion annually in the aggressive case.

**FIGURE 6
CAPITAL INVESTMENT IN EMERGING ENERGY SECTORS IN NORTH AMERICA**



CALCULATED TOTAL Annual averages multiplied with years in range

¹ Does not include power transmission and distribution, energy efficiency, circular economy
² Carbon Capture Use and Storage
³ Electric vehicles, including BEV (Battery electric vehicles) and FCEV (Fuel Cell electric vehicles)
⁴ Oil upstream, gas upstream, oil refining, and petrochemicals production; ICE vehicles are out of scope

THE REGION HAS **FIVE KEY ATTRIBUTES** THAT MAKE IT UNIQUELY POSITIONED TO DRIVE AND TO CAPTURE ECONOMIC VALUE FROM THE ENERGY TRANSITION.

1 Houston is home to a large, diverse and technically-oriented workforce.

It is a city with deep experience in all aspects of the energy industry. The region's expertise ranges from engineering and digital tech to complex industrial project management, to commercial acumen, to research and development, to deep understanding of global trading markets and policy drivers. The emerging low-carbon energy market may call for additional skills, but those new skills will complement and build on the capabilities that developed in Houston over several generations.

2 There is no place in America – and few in the world – that begin to match Houston for its concentration of energy infrastructure.

The miles of pipelines, refineries, storage facilities, and logistics capacity all lend themselves to rapidly scaling new energy technologies like CCUS, hydrogen and advanced recycling of plastics.

3 Houston benefits from significant, already-existing and further expanding renewable generation capacity as well as project expertise.

As part of ERCOT, the city taps directly into the Texas power grid, which generates more wind power than any other state and more solar power than any but California. Nearly all of the power consumed by the City of Houston municipal government is renewable.

Another advantage is this allows Houston to be the center of renewable-based solutions, such as green hydrogen.

4 The city's policies and culture are strongly supportive of business innovation and growth.

The region maintains a stable and consistently moderate tax and regulatory burden on both established and start-up enterprises. Such a business-friendly environment is critical to the kind of growth and scale required for a comprehensive transition to new low-carbon technologies and infrastructure. Additionally, Houston offers start-ups a proximity to and connections with an industry hungry for new solutions and technologies that they can scale and rapidly commercialize.

5 Houston's enormous port, rail and air infrastructure represents a significant platform for implementing large-scale decarbonization initiatives.

For example, the Houston Ship Channel's concentration of point source emissions, pipeline and logistics infrastructure, and energy-consuming manufacturing facilities presents an ideal ecosystem for capturing and transporting CO₂ as well as producing and distributing hydrogen, and reprocessing plastics. Waterborne transport of hydrogen, ammonia, biofuels, clean LNG and other products would be facilitated by operating in the largest port in the United States in terms of tonnage.



HOUSTON'S ENERGY TRANSITION VISION

During the Greater Houston Partnership's **2020 Annual Meeting**, then board chair Bobby Tudor spelled out the challenge – and the opportunity – arising for Houston from the energy transition.

Houston's reality was framed around four key observations. First, energy has been very good to Houston, powering economic growth for over a century. Second, oil and gas production and consumption will not disappear anytime soon. Even in a net-zero emissions world, hydrocarbons will be needed to supply high-density energy for critical applications like steel production and aircraft travel and to meet growing energy needs in less-developed parts of the world. Third, the traditional oil and gas business is not likely to be the same engine for Houston's growth in the next 25 years as it has been for the past 25 years. And finally, Houston has an opportunity and a responsibility to lead the global transition to a low-carbon energy system.

Tudor's speech – and the launch not long after of the City of Houston's **Climate Action Plan** – encouraged and normalized business and policy conversation in the region around the urgency of the climate challenge and the importance to Houston of leading the energy transition.

As part of that conversation, the Greater Houston Partnership led an intensive study starting at the beginning of 2021 to understand how the region should best tackle the challenge. The Partnership's objective was to create a vision and a blueprint for growing the region's economy, equitably creating new jobs, exporting low-carbon products and expertise, and of course, helping Houston to achieve its net-zero emissions target that is core to the City's Climate Action Plan.

Drawing on strategic analysis and recommendations from McKinsey & Co., the work of the Center for Houston's Future, University of Houston, Rice University and more than 60 leaders from across the business, academic and public sectors, the Partnership crafted an ambitious vision:

Leverage Houston's energy leadership to accelerate global solutions for a low-carbon future.

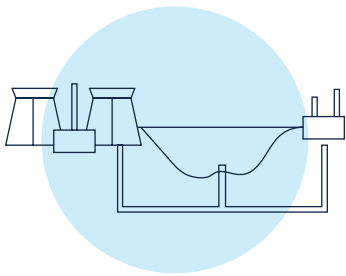


BLUEPRINT—HOW HOUSTON WILL LEAD

The Greater Houston Partnership has translated the vision into a strategy and plan that rest on **three broad objectives**.

01

JUMPSTART emerging sectors where Houston has a distinct advantage



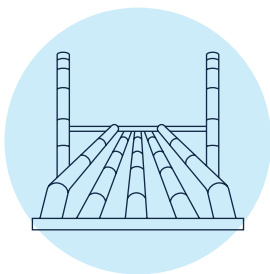
CARBON CAPTURE

Carbon Capture, Use and Storage—or CCUS

is a good example. CCUS refers to the process of stripping (or capturing) the CO₂ that is emitted from point sources like power plant smoke stacks, refineries, steel mills and cement factories. The captured CO₂ is either put to use – as raw material for carbon-based materials, for example, or to improve the efficiency of existing oil and gas wells – or it is pumped deep underground for permanent storage. Experts worldwide cite CCUS as critical to any realistic strategy for achieving a net-zero emissions energy system and meeting the climate goals set by the 2015 Paris climate accords.

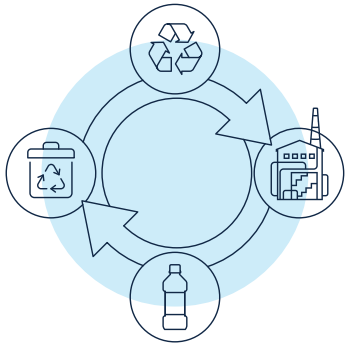
Houston is an obvious place to develop CCUS technologies and to implement them at scale. That's because of its concentration of manufacturing facilities with point source emissions, its extensive infrastructure of pipelines for moving CO₂, and its ready access to underground reservoirs for storing CO₂ once it is captured.

Houston is also home to leading policy and scientific research on CCUS through the Center for Houston's Future, University of Houston and Rice University. The Greater Houston Partnership has already kicked off implementation of this strategic workstream with the formation of a working group to support the decarbonization of the Houston Ship Channel.



HYDROGEN HUB

Other examples of technologies and markets in this leg of the energy transition strategy include a **hub for low-carbon hydrogen production and application**. The Houston Gulf Coast region is home to the world's leading hydrogen system, producing approximately a third of the nation's hydrogen gas annually. The region also encompasses a network of 48 hydrogen production plants supported by over 900 miles of hydrogen pipelines, which is more than half of the U.S.'s hydrogen pipelines and one-third of the world's hydrogen pipelines. Studies sponsored by the [Center for Houston's Future](#) and others have highlighted the potential for Houston to become a leader in driving a hydrogen-based economy – including “green hydrogen,” produced from zero-emissions power sources and raw materials.



CIRCULAR ECONOMY

Advanced strategies and technologies for recycling plastics – often referred to as part of the “circular economy” – represent another advantaged opportunity for Houston. The region’s petrochemical leaders have been sponsoring work to develop recycling technologies that break plastics down at the molecular level for reuse. This effort, supported by the Partnership, is creating a complete end-to-end circular economy value chain to be deployed in Houston.



BATTERY MANUFACTURING & ENERGY STORAGE

Battery manufacturing and energy storage solutions – an essential part of any path to net-zero energy emissions– represent yet another priority in this leg of the Houston energy transition strategy. Utility-scale energy storage enables an increasing share for renewable energy in the power sector. Houston possesses the required underlying backbone for this sector – a result of its leading chemical and advanced materials expertise, large scale manufacturing capabilities, as well as the industrial port area that supports the development and export of battery and energy storage systems. The Partnership is working to attract battery manufacturing companies and startups as part of a growing energy storage eco-system, paving the way for emerging new energy storage technologies, incorporating mechanical and chemical advances to increase the efficiency, reliability and duration of energy storage, as well as recycling at end of life.

ATTRACT and support companies in established “new energy” industries

02

The emphasis here is on wind energy, solar power, renewable natural gas, low-carbon LNG and biofuels, key enablers for decarbonizing the energy industry as well as for advancing the hydrogen and energy storage value chains.

Texas produces more wind power than any other U.S. state and more solar power than any state other than California. It is well-positioned to have the first zero-carbon grid, and Houston can play a key role in this development by expanding the city’s renewable capacity and leveraging its access to talent and energy financing.

The Houston Energy Transition Strategy aims to take steps to support solar and wind development in conjunction with the City of Houston’s **Climate Action Plan** by actively attracting and retaining project developers, asset owners, and financial traders to Houston.



The future composition of energy value chains that will dominate a low-carbon future is uncertain and will depend on a combination of factors including technological breakthroughs and government policies. Houston will need to create the environment that encourages investment in the development and deployment of a wide-range of value chains. This includes everything from nature-based solutions and the cleaner production of natural gas, oil and petrochemicals to developing breakthroughs in energy efficiency, geothermal energy, and advanced materials.

The Partnership will drive seven cross-cutting initiatives to create an ecosystem that enables activities across this wide range. They include many activities that are already part of the Partnership's strategic priorities – for example the longstanding efforts to attract leading energy companies and startups, the UpSkill Houston initiative aimed at reskilling and upskilling regional talent, and advocacy for smart and supportive public policy.

The initiatives involve new efforts as well. They include the facilitation of large-scale innovative pilots in the critical energy transition sectors, like CCUS, hydrogen and the circular economy.

Another example is working with other regional institutions to promote collaboration among diverse thought leaders, industry players and government representatives.

Working with the City of Houston and other partners, the Partnership will also publicly promote Houston's commitment to energy transition leadership on a global stage – welcoming new generations of talented, innovative individuals, start-ups and established enterprises from around the world.

Finally, these cross-cutting initiatives will include a workstream on ensuring a flow of capital into the region – tapping sources and financing models ranging from federal government appropriations to venture capital to green bonds.

CROSS-CUTTING INITIATIVES TO BUILD ENERGY TRANSITION ECOSYSTEM



BOLD INNOVATION AND CROSS-INDUSTRY PILOTS

Jumpstart emerging sectors and industries with bold pilots to test and scale new technology



CROSS-SECTOR THOUGHT LEADERSHIP

Convening the right stakeholders to collectively push the thinking on energy transition



FUNDING

Rapidly secure sufficient funding for the Energy Transition platform and all initiative needs



ATTRACTING LEADING ENERGY COMPANIES AND STARTUPS

Concerted effort to attract companies across all energy value-chains; provide optimal ecosystem for smaller companies to succeed



TALENT RESKILLING

Ensure Houstonians are trained for in-demand skills needed in new energy industries



BRANDING AND URBAN INFRASTRUCTURE

Raise the profile of Houston as an attractive and sustainable urban destination and deliver on that perception



POLICY SOLUTIONS

Houston actively participates in policy debate and shapes policy that will boost new industries

CONCLUSION: IT TAKES A CITY

Houstonians have come together around this energy transition strategy in ways that highlight both the can-do spirit of the region and the shared sense of urgency of the climate challenge. Business leaders, elected officials, academic researchers, policy makers, environmental and social justice advocates, entrepreneurs, bankers and investors have all contributed insights and ideas to the energy transition blueprint.

More importantly, they have committed their time and resources to collaborating on its execution.

The effort represents Houston's collective ambition. But it also reflects Houstonians' sense of responsibility for putting their capabilities and resources to work on global solutions to the climate and energy challenges. The strategy builds on the best of traditional 20th century energy skills and systems to pave the way for a new, 21st century net-zero emissions world.

None of this will be easy. None of it will happen without huge investments with significant risk. But high risk investments have long been the recipe for Houston's economic success. And the risk of doing nothing – for the world's as well as well as for Houston's well-being – are far greater.

Houston's sleeves are rolled up. We look forward to you joining us.



ACKNOWLEDGMENTS

The Greater Houston Partnership would like to thank Bobby Tudor, Chairman of Tudor, Pickering, Holt & Co., for his tremendous leadership and commitment to the creation of the energy transition strategy and for chairing the Houston Energy Transition Initiative. The Partnership would also like to thank Thomas Seitz, Filipe Barbosa, Nikhil Ati and Clint Wood from McKinsey & Co. for their significant contributions in developing the strategy and initiative along with Niel Golightly, Jenny Philip, Jose Beceiro and the Center for Houston's Future.





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