



America's Emerging Clean Energy Capital

How Houston Can Lead the Nation
to a New Energy Future



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Executive Summary

In recent years, Houston has emerged as a nationwide leader in expanding its production and use of clean energy. The City of Houston has adopted strong, energy-saving building codes, ramped up purchases of clean, renewable energy, and begun laying the groundwork for widespread adoption of electric cars – all steps that have jump-started the area’s transition toward a clean energy economy.

However, Houston and the surrounding eight-county area (hereafter “Greater Houston”) still have a great deal of untapped potential to save energy and avoid pollution. Local governments should build on the Houston area’s current momentum through a number of clean energy technologies, including net-zero

energy home construction, rooftop solar installations and electric vehicles (EVs).

By 2030, improvements in energy efficiency and expanded solar power could reduce demand for electricity from fossil fuel sources by enough to power 627,000 Houston homes, while expanded deployment of electric vehicles would avoid consumption of more than 104 million gallons of gasoline annually.

To continue reaping the benefits of clean energy into the future, Houston should build on its track record as an emerging environmental leader, and other local governments in Greater Houston and elsewhere should follow suit.

Houston is using clean energy to reduce dependence on fossil fuels.

- In 2008, Houston set standards for building energy efficiency that exceeded the international model standard by 15 percent, becoming among the first cities in Texas to do so. Two years later, the state government raised minimum standards statewide to match those in Houston.
- The City of Houston is the largest municipal purchaser of renewable electricity in the country. It purchases enough renewable energy credits to cover 32 percent of electricity consumption by city facilities each year.
- In recognition of Houston's commitment to clean energy, the Department of Energy named it an American Solar City in 2008 and contributed resources to help the city develop solar initiatives.
- The City of Houston has the third-largest hybrid-electric municipal vehicle fleet in the country.
- As part of a city-wide effort to foster widespread adoption of electric vehicles, the City of Houston has installed dozens of electric vehicle charging stations for its municipal fleet and helped several private firms develop plans to build at least 150 more publicly available electric vehicle charging stations, some of which have already opened.

Houston has the potential to deploy much more clean energy technology. Key areas for progress include:

- *Building net-zero energy homes.* Local governments in Greater Houston could ensure that all new

single-family homes are built more efficiently and with the capability to generate their own power by the end of the decade. Steadily strengthening building energy codes could help achieve this vision, as shrinking demand for electricity allows more homes to draw their power entirely from small-scale solar or wind installations.

- *Installing solar panels.* Existing rooftop space in Greater Houston represents a huge untapped energy resource. Houston receives more sunlight than several of the world's leading solar producers, including Germany, where policymakers have launched the world's largest solar market.
- *Deploying electric cars.* Greater Houston can avoid consuming millions of gallons of gasoline by replacing more of its gasoline-powered vehicles with electric vehicles.

Building net-zero energy homes can prevent pollution, protecting our health and our environment.

- By 2030, new net-zero energy homes could avoid the need for more than 6 billion kilowatt-hours (kWh) of electricity from fossil fuel sources per year through energy efficiency savings and electricity generated by solar panels. That's about 7.8 percent of Greater Houston's annual electricity use (at current rates of consumption).
- By 2030, net-zero energy homes could annually prevent more than 2.3 million metric tons of global warming pollution, 1,150 tons of smog-forming nitrogen oxide emissions, and nearly 60 pounds of highly toxic mercury pollution.

Taking advantage of rooftop space for solar panels would generate vast amounts of electricity.

- If Greater Houston achieved just 15 percent of its total rooftop solar potential (including installations on net-zero energy homes), it could generate 5.4 billion kWh of solar electricity. Combined with the energy saved through efficiency in net-zero energy homes, that number would increase to 9.2 billion kWh, which would allow Greater Houston to avoid 5.2 million metric tons of carbon dioxide emissions per year – the equivalent of taking approximately one million cars off the road.

Increasing the percentage of electric vehicles on the roads could cut Houston’s dependence on fossil fuels for transportation.

- Ramping up electric vehicle sales so that 22 percent of all new light-duty cars and trucks sold annually by 2030 are electric would put more than 378,000 electric cars on the road, resulting in oil savings of more than 104 million gallons of gasoline annually.

The City of Houston and neighboring local governments should build on Greater Houston’s emerging status as an environmental leader by implementing policies and programs that move the region toward a clean energy economy. Specifically, they should:

1. Maintain a strong commitment to increasing building efficiency and renewable energy in new homes. By 2020,

local governments should ensure that all new homes achieve net-zero energy performance, meaning that they are at least two-thirds more energy efficient than conventional Texas homes and they generate as much energy as they consume through small-scale renewable energy systems.

2. Reward builders for going beyond minimum energy efficiency requirements using financial incentives, either through a state program or a ratepayer-funded program through CenterPoint Energy.
3. Facilitate widespread installation of solar panels on existing homes and businesses. In order to achieve the benefits outlined in this report, Greater Houston should set a minimum goal of installing the equivalent of 1,000,000 residential solar power systems by 2030.
4. Continue to make electric vehicle charging infrastructure widely available to the public by facilitating further development and expansion of the charging network.
5. Create incentives to encourage widespread adoption of electric vehicles by individuals and businesses. The City of Houston should offer property tax breaks for businesses that install electric vehicle charging infrastructure or purchase electric vehicles for their fleets. The city should also offer “preferred parking” or other privileges for EV owners at city-owned facilities.

Introduction

Houston has firmly established a reputation as the “Energy Capital of the World,” based on its status as the hub of America’s oil and gas industry.

In recent years, however, Houston has begun to stake a claim as a clean energy capital as well.

Houston’s leaders and residents of the Greater Houston region are keenly aware of the challenges we face in meeting the energy needs of a growing population while reducing our dependence on polluting fossil fuels. Houston is on track to gain 3.5 million people by 2030, increasing the number of houses on the electric grid and the number of cars on the road. Houston already faces severe air pollution problems from its heavy reliance on fossil fuels for electricity, transportation and industry. Burning fossil fuels contributes to health-threatening air pollution, such

“Houston has the opportunity to become a leader in the clean energy economy, and create thousands of good jobs in the process.”

– Mayor Annise Parker, commenting on the launch of the Houston Drives Electric initiative, September 9, 2011.⁴²

as soot and smog, and contributes to global warming.

Houston’s leaders understand that investing in clean energy is the best way to meet future energy challenges. In recent years, Houston has committed to deploying policies and programs to ramp up clean energy production and

use, earning top spots in national rankings for building efficiency standards and purchases of renewable electricity. It is also currently building one of the most extensive networks of electric vehicle charging infrastructure in the country. These measures have not only delivered significant energy savings and avoided millions of pounds of pollution, but they have also laid the groundwork that could make Houston the nation's clean energy capital.

In order to achieve this vision, Houston's leaders must capitalize on the city's current momentum by deploying more clean energy strategies using untapped or underutilized technologies, such as net-zero energy homes, rooftop solar panels, and electric vehicles. Houston is in an ideal position to accelerate progress in its clean energy programs – positioning the Houston region as the energy capital of a cleaner, less fossil fuel-dependent world.

Houston Is an Emerging Clean Energy Leader

Houston's track record of seizing opportunities to ramp up its production and use of clean energy has made it a nationwide environmental leader. Houston has adopted strong, energy-saving building codes, accelerated purchases of clean, renewable energy, and begun laying the groundwork for widespread adoption of electric cars. These measures have generated the momentum that Houston and the surrounding area needs to transition to a clean energy economy.

Houston's Strong Building Energy Codes Provide a Model for Other Cities

Making buildings more energy efficient through better building codes is one of the most cost-effective means of

reducing energy use, lowering electricity bills and reducing demand for fossil fuels. Much of the electricity we produce is wasted through inefficiencies such as leaky enclosures, poor insulation and outdated or improperly installed equipment. These inefficiencies result in an unnecessarily high demand for energy. Building energy codes that require new buildings to achieve a high level of energy efficiency can save electricity and avert millions of pounds of pollution every year.

In 2008, Houston officials passed an ordinance to make new buildings in Houston 15 percent more energy efficient than required by the 2006 International Energy Conservation Code (IECC), which was, at the time, the international model for building energy codes. Two years later, the state followed Houston's lead and raised minimum standards



Texas is the nation's leader in wind energy production, and the City of Houston purchases more renewable wind energy than any other city in the country. Shown is the King Mountain Wind Ranch near Odessa.

for building energy efficiency, so that new buildings statewide must achieve energy performance roughly equivalent to new buildings in Houston. Houston City Council is once again considering strengthening the city's residential building energy codes beyond state minimums – this time only by five percent.¹

In addition to strong building energy codes, Houston has hundreds of buildings certified under the Leadership in Energy and Environmental Design (LEED) and Energy Star standards that far surpass minimum requirements for energy performance. Houston now ranks eighth and seventh, respectively, in the number of LEED-certified and Energy Star-certified buildings nationally.² According to the U.S. Environmental Protection Agency (EPA), Energy Star-certified homes in Houston saved the city \$62.9 million in 2010 and avoided emissions equivalent to 47,000 homes' electricity

use.³ Other programs promoting energy efficiency in the city include the Green Office Challenge, the City of Houston municipal building retrofit program, and the Energy Efficiency Incentive Program for commercial office buildings.

Powering Houston with Renewable Energy

The City of Houston is the largest municipal purchaser of renewable electricity in the country. Through a contract with its chief retail electric provider, Reliant Energy, the city purchases about 438 million kWh of renewable wind electricity annually, equivalent to about 32 percent of what city facilities use annually.⁴ These purchases currently help the city avoid 250,000 metric tons of carbon dioxide pollution every year.⁵ The current contract allows Houston to purchase up to

80 megawatts, or 700 million kWh, at a fixed rate of 7.5 cents per kWh, which is 2.4 cents lower than the average price of electricity in 2009.⁶ These purchases are part of an ongoing strategy to increase wind power purchases for the city by 10-megawatt increments for five-year terms.⁷

The city's efforts to promote clean energy prompted the U.S. Department of Energy (DOE) to name Houston a Solar America City in 2008. The DOE launched this program to provide funding and expertise to cities to help them develop "comprehensive approaches to urban solar energy use that can serve as a model for cities around the nation," according to the DOE website.⁸ As part of this initiative, Houston has completed several solar demonstration projects, including one at the George R. Brown Convention Center. It has also completed comprehensive studies identifying market barriers to solar expansion within the city, as well as new opportunities for solar development, such as affordable housing, public facilities, schools, major campuses and emergency response facilities.⁹

The scale of Houston's planned purchases of renewable electricity is unprecedented, even among federal agencies.¹⁰ By committing to purchase large amounts of renewable electricity for the city, and by developing ways to increase solar capacity, officials are creating a lasting foothold for renewable energy in Houston that will eventually expand into the Greater Houston area and deliver great benefits directly to the public.

Houston is Clearing the Way for Electric Vehicles

As with its commitment to purchase renewable electricity, the City of Houston is leading by example to encourage the widespread adoption of electric cars – it already has the third-largest municipal hybrid-electric fleet in the country. The city has also announced plans to purchase 23 additional all-electric passenger cars to bring the total of plug-in hybrid and all-electric vehicles up to 40.¹¹ To power its municipal fleet, the city has built dozens of electric vehicle charging stations, some of which are also designated for public use. The city has also developed plans with public and private stakeholders for an additional 150 privately developed charging stations for public and private users. Some of these stations provide high enough voltage to charge vehicles in 1-4 hours, and one station has the first-ever publicly available rapid DC charger, which gives vehicles a 50-mile boost in range after just 15 minutes.¹² In the coming years, Houston intends to install up to 250 charging stations citywide.¹³

The City of Houston's early commitment to invest in electric vehicles and in charging infrastructure will make it one of the first places in the country where electric vehicles penetrate the market in a meaningful way. As more individuals and businesses buy electric cars or electrify their fleet vehicles, Houston will be ready to accommodate them and to realize immediate gasoline savings.

Clean Energy Has Room to Grow in Houston

Because of the work Houston has already done, it has a bright future in clean energy. However, in order to maintain its current trajectory and continue to deliver benefits to all Greater Houston residents, policymakers must accelerate efforts to save energy through energy efficiency measures and produce more renewable electricity, steps that will enable the Houston area to further reduce its dependence on fossil fuels.

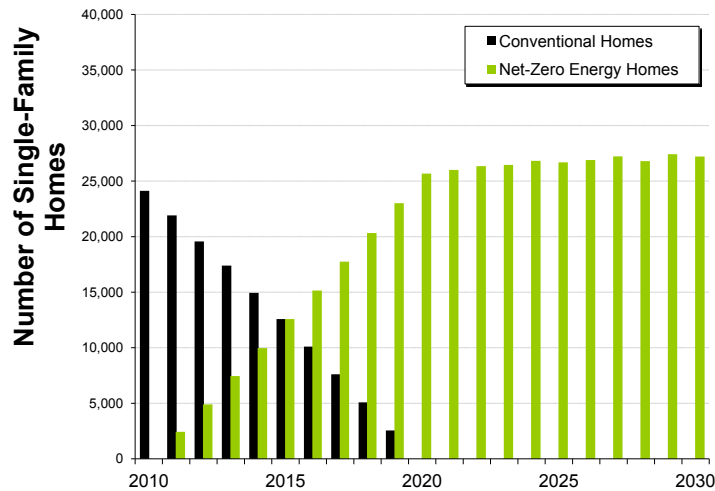
Net-Zero Energy Homes Save Energy and Cut Pollution

New homes in Texas built to traditional energy performance standards

require a lot of energy to power appliances and maintain a comfortable indoor climate, particularly in hot and humid parts of the state, such as Houston. This energy consumption results in pollution that threatens public health and disrupts Texas' climate.

Energy efficiency is by far the most effective tool homeowners have to reduce energy consumption. By incorporating energy-efficient design, quality construction and efficient appliances, builders can create high-performance homes that deliver equal or better comfort while using at least two-thirds less electricity and natural gas. By including a rooftop solar energy system, or a small-scale wind energy system, new homes can actually produce as much energy as they

Figure 1: Estimated Number of Homes Built per Year in Greater Houston under the Net-Zero Energy Homes Scenario¹⁶



consume, achieving “net-zero energy” performance.

Such high performance homes can help reduce Texas’ dependence on fossil fuels and reduce the pollution associated with energy consumption.

All New Homes Can Achieve Net-Zero Energy Performance by 2020

The U.S. Census Bureau projects that Houston will need to build 542,947 new single-family homes by 2030 to accommodate its growing population.¹⁴ If these homes are built to typical standards, they will consume 7,997,000 MWh of electricity by 2030.¹⁵

However, if Texas builders rapidly adopt a suite of strong energy efficiency measures and the state increases the use of solar energy systems on new homes, such that all new homes built in 2020 or later reach net-zero energy performance, Houston residents will save energy and achieve greater independence from fossil fuels.

Under this scenario for net-zero energy home construction, builders will construct a declining number of homes that achieve standard energy performance and an increasing number of net-zero energy homes. In order to achieve this vision, building energy codes must be steadily strengthened over the next decade so that with the help of solar panels, homes produce as much energy as they consume by 2020. Under this scenario, 84 percent of the new single-family homes built in the Houston area by 2030 will achieve net-zero energy performance. (See Figure 1.)

Building Net-Zero Energy Homes Would Yield Substantial Energy Savings

On average, net-zero energy homes use two-thirds less electricity than conventional Texas homes, with small-scale renewable energy installations meeting the remainder of their energy needs. By 2030, new net-zero energy homes could avoid the need for more than 6 billion

kilowatt-hours (kWh) of electricity from fossil fuel sources per year through efficiency savings (3.8 billion kWh) and electricity generated by solar panels or small-scale wind installations (2.4 billion kWh).¹⁷ That's equivalent to roughly 7.8 percent of Greater Houston's annual electricity use (at current rates of consumption).¹⁸

Net-Zero Energy Homes Protect Public Health and Houston's Environment

Net-zero energy homes use significantly less electricity than typical Texas homes. Reducing demand for electricity reduces the amount of energy power plants must produce, which results in lower amounts of global warming and health-threatening air pollution.

If Houston ensures that 457,000 of the 543,000 homes projected for 2030 are built to net-zero energy performance, the city could avoid more than 2.3 million metric tons of global warming pollution, 1,150 tons of smog-forming nitrogen oxide emissions, and nearly 60 pounds of highly toxic mercury pollution every year.¹⁹

Houston's Solar Energy Potential Remains Untapped

Through energy efficiency and large-scale purchases of renewable electricity, Houston has already achieved significant energy savings and avoided millions of pounds of pollution. Almost all of the renewable energy purchased by the City of Houston comes from wind farms, as Texas is the nation's leading producer of wind energy.²⁰

Houston also has tremendous untapped potential for solar power. Houston is sunnier than Germany, where policy-

makers have launched the world's largest solar power market.²¹

Improving Greater Houston's capacity to harness solar power could produce enough energy to cut back even further on the use of fossil fuels and significantly advance Greater Houston's progress toward a clean energy economy.

Rooftop Solar Energy Systems Can Start Delivering Benefits Today

Solar energy can be harnessed in two ways: through rooftop solar systems and utility-scale solar farms. Large solar farms supply electricity to a city's power grid. Rooftop solar systems supply electricity directly to the homes and businesses on which they are built, with any excess generation flowing to the power grid. Rooftop solar systems require a relatively small capital investment and can be installed easily on most existing appropriate roof space. Because electricity generated by solar panels directly displaces electricity produced with fossil fuels, these systems start delivering immediate energy savings the moment they come online.

Greater Houston has a great deal of roof space that could accommodate solar installations. Most residents live in single-family homes rather than apartments.²² Of course, not all residential and commercial roof space is appropriate for solar panels. Some rooftops are shaded by trees or lack proper pitch or orientation toward the sun; others have areas blocked out by objects such as chimneys or fan systems. Still, on average, around 22 percent of residential roof space and 65 percent of commercial roof space can be used for solar panels, according to a 2008 report by Navigant Consulting for the National Renewable Energy Laboratory.²³

In Greater Houston, installing solar systems on all available residential and

Photo: Courtesy of GRIDbot



To charge its hybrid-electric municipal vehicle fleet, the City of Houston contracted GRIDbot, an Austin-based company, to install 28 electric vehicle charging stations at Tranquility Park Garage. The site can charge up to 56 vehicles at a time.

commercial roof space could generate more than 29,000 megawatts of electricity in 2030.²⁴ If Greater Houston were to install solar panels on existing buildings to complement those on new buildings under the net-zero energy homes scenario, it could achieve 15 percent or more of this potential by 2030. Achieving this level of solar capacity would be equivalent to installing 4.4 kW solar systems on 1,000,000 rooftops.²⁵ Such solar capacity would generate nearly 5.4 billion kWh of solar electricity per year.²⁶ Combined with the annual energy efficiency savings of net-zero homes by 2030, the Houston area could avoid the need to generate 9.2 billion kWh of electricity at fossil fuel-fired power plants – enough to power 627,000 Houston homes (at current rates of consumption) and avoid 5.2 million metric tons of carbon dioxide emissions – the equivalent of taking one million cars off the road.²⁷

Houston Is Ready to Reap the Benefits of Electric Vehicles

Houston promises to be one of the first places in the United States to see the wide-scale adoption of electric vehicles. It has already begun to lay the groundwork for an extensive electric vehicle charging network throughout the city that will allow more people in Houston to reduce their dependence on gasoline by switching to electric or plug-in hybrid vehicles. In other cities, a lack of charging infrastructure may hinder the growth of a robust electric vehicle market, as residents have no charging options beyond plugging in at home (if they have a garage with electric outlets) to charge their vehicles overnight. Houston, however, is giving more charging options to would-be electric vehicle owners, including high-voltage AC and DC charging, and

more locations, such as at libraries and parks, which will increase the number of electric vehicles sold in Greater Houston and extend gasoline savings benefits to more people.

Houston's efforts to promote electric vehicles have made electricity the most serious challenger to gasoline as the passenger vehicle fuel of the future.

Increased Deployment of Electric Vehicles Will Benefit Houston's Environment

When obtained from renewable sources, electricity is non-polluting and limitless in supply. Even when obtained from dirty energy sources such as coal, electricity is still cleaner and more efficient than gasoline, as it has no tailpipe emissions and doesn't waste energy in the form of heat, as occurs in internal combustion engines. Switching to electricity as a transportation fuel can greatly reduce global warming and health-threatening air pollution – a key benefit for Houston, which currently ranks eighth among the smoggiest metropolitan areas in the United States, according to the American Lung Association.²⁸

Other than building electric vehicle charging infrastructure, policymakers can use a variety of tools to encourage the deployment of electric vehicles, including fuel economy and global warming emission standards, financial incentives,

and minimum sales requirements for automakers. These policies all have an impact on the level of market penetration electric vehicles achieve over the next decade or so – and therefore how much gasoline residents can save.

In Greater Houston, implementing a policy scenario in which strong fuel economy standards and steadily increasing minimum sales requirements for automakers over the next two decades would result in significant savings. For instance, if electric vehicles made up an increasingly large portion of annual light-duty vehicle sales, such that 22 percent of new vehicles sales were electric vehicles by 2030, Greater Houston would have more than 378,000 electric vehicles on the roads and save more than 104 million gallons of gasoline annually.²⁹ Our scenario is conservative. Other studies have projected even higher rates of market penetration for electric vehicles in the Houston area on a shorter timeline.³⁰

With the continued expansion of its electric vehicle charging infrastructure, Houston will ensure that it can accommodate thousands of new electric vehicles on the roads every year. To achieve this kind of penetration and gasoline savings, Houston must maintain its commitment to building EV infrastructure, and along with other local governments in the Greater Houston area, it must facilitate purchases of electric vehicles for individuals and businesses.

Policy Recommendations

Houston's existing clean energy policies and programs have put it on a path to becoming a clean energy capital. However, in order to tap into its full potential, Greater Houston must seize every clean energy opportunity, including improving building efficiency, producing more renewable electricity, and switching to electric vehicles. **The City of Houston should build upon its current track record as an environmental leader, and other city and county governments in Greater Houston should implement more clean energy policies and programs. Specifically, they should:**

1. Maintain a strong commitment to increasing building efficiency and renewable energy in new homes. By 2020,

local governments should ensure that all new homes achieve net-zero energy performance, meaning that they are at least two-thirds more energy efficient than conventional Texas homes and they generate as much energy as they consume through small-scale renewable energy systems. In order to achieve this vision, governments in Greater Houston should adopt the 2012 International Energy Conservation Code (IECC) for new buildings, which is roughly 30 percent stronger for new, single family homes than the 2006 IECC performance standard.³¹ By 2015, new homes should be 50 percent more efficient than the 2006 IECC standards; by 2018, 60 percent; and by 2020, they should achieve net-

zero energy performance with the help of rooftop solar installations or other small-scale renewable energy systems.

2. Reward builders for going beyond minimum energy efficiency requirements using financial incentives, either through a state program or a ratepayer-funded program through CenterPoint Energy.
3. Facilitate widespread installation of solar panels on existing homes and businesses. In order to achieve the benefits outlined in this report, Greater Houston should set a minimum goal of installing the equivalent of 1,000,000 residential solar power systems by 2030.³² CenterPoint Energy should offer incentives for solar installations to homes and businesses as part of its regular suite of energy efficiency program offerings. For the long term, the Legislature should create a comprehensive program to develop solar capacity throughout the state and protect net metering laws that allow ratepayers to sell renewable electricity back to the grid.
4. Continue to make electric vehicle charging infrastructure widely available to the public. The City of Houston has forged highly beneficial relationships with various stakeholder groups such as ECOTality, the Houston Advanced Research Center, and the Clinton Climate Initiative to create and implement a long-range plan for the city's electric vehicle charging infrastructure. The city should continue to work with community stakeholders and private firms to further develop and expand the infrastructure network.
5. Create incentives to encourage widespread adoption of electric vehicles by individuals and businesses. The City of Houston should offer property tax breaks for any building that installs a charging station or free parking in busy downtown areas for electric vehicles. The city

should also create “preferred parking” for EVs at airports and other city-owned facilities. Houston METRO should allow electric vehicles use of highway HOV lanes for a proscribed, limited period of time to reward early adopters and incentivize additional purchases. Additionally, the Harris County Toll Road Authority should allow electric vehicles to use toll roads at a discounted rate.

Houston's efforts to promote electric vehicles will be far more successful if they are supported by policies at the state and federal levels. Therefore, the state should:

6. Expand programs designed to reduce air pollution to include helping individuals and businesses buy electric vehicles and expanding electric vehicle infrastructure. Potential programs to expand could include the Texas Emissions Reduction Program and the Low-Income Vehicle Repair and Replacement Program (LIRAP). The budgets of these programs should be increased to accommodate new goals for electric vehicle expansion without diverting funds from the original goals of each program.

At the federal level, policymakers should:

7. Adopt and enforce strong corporate average fuel economy (CAFE) standards for automakers. The Obama Administration should set a nationwide goal to achieve the equivalent of a 62 mpg standard for vehicles through federal fuel economy/global warming emission standards 2025. These standards will result in an increase in electric vehicles entering the market as automakers use electric vehicles to lower average fleet emissions and comply with these standards.

Methodology

Net-Zero Energy Homes Scenario

To determine the amount of electricity saved and solar energy produced by net-zero energy homes in Houston annually by 2030, we used the methodology described in Travis Madsen et al. in *Building for a Clean Energy Future: How Texas Can Reduce Pollution, Save Energy and Cut Costs with Efficient Solar Homes* for Environment Texas Research & Policy Center. That report models the annual energy consumption characteristics of a “standard” single family home and a “net-zero energy” version of the same home, and then outlines a scenario for single-family home construction in Texas from 2010 through 2030, analyzing the impact

of phasing in net-zero energy homes such that all new single-family homes built in 2020 and later achieve this high level of performance.³³

To narrow down the results of the Environment Texas Research & Policy Center report to Greater Houston, we used the raw data from that report for the eight-county area that makes up the Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area: Harris, Montgomery, Waller, Liberty, Chambers, Brazoria, Fort Bend and Galveston counties.³⁴

The home construction scenario is based on population forecasts by county, assuming, per the U.S. Census Bureau, that 75.8 percent of all housing units were single-family homes (with the rest

in multi-unit structures, which were not considered in this report), and assuming 2.71 residents per single-family home.³⁵

Rooftop Solar Potential

For the total amount of solar photovoltaic power that could be installed on residential and commercial rooftops in Greater Houston, we used an estimate that Navigant Consulting computed for the National Renewable Energy Laboratory. Navigant calculated that installing solar panels on all suitable residential and commercial rooftop space in Texas would result in 42,773 MW of solar power in 2007, increasing along a linear progression to 70,449 MW in 2015.³⁶ In calculating these numbers, Navigant took into account factors such as tree and other shading on residential and larger buildings, roof tilt and orientation, and the room needed on roofs between solar panels and taken up by other objects such as chimneys and fan systems. Navigant estimated that 22 percent of residential roof space and 65 percent of commercial roof space could be used for solar panels.³⁷ We extrapolated Navigant's linear progression between 2007 and 2015 through 2030, with a resulting projection of 122,485 MW of technical potential for solar energy by 2030.

We apportioned this projection to the eight counties in the Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area by calculating the percentage of Texas' residential units and employees in each county in 2010, per the 2010 U.S. Census, and then averaged the two percentages. For example, the eight-county area that makes up Greater Houston has 23 percent of the state's housing units and 25 percent of its employees, so we assume it holds 24 percent of the state's total technical potential for solar capac-

ity identified by Navigant. Twenty-four percent of the 2030 Navigant projection is 29,396 MW.

Finally, in order to estimate how much solar electricity would be generated by installing 15 percent of Houston's total technical potential (approximately 4,409 MW), we used the National Renewable Energy Laboratory's PVWatts Grid Data Calculator Version 2 to calculate how many kilowatt-hours could be produced by one kW of solar capacity in Houston. We did this to account for variances in solar radiation levels in different parts of the state.

Electric Vehicle Deployment Potential and Gasoline Avoided

We based our calculations for the number of electric vehicles on the road and gasoline saved annually by 2030 on a policy scenario and methodology described in Tony Dutzik, et al., *Getting Off Oil: A 50-State Roadmap for Curbing Our Dependence on Petroleum* for Environment America Research & Policy Center.³⁸ The Environment America Research & Policy Center report assumes that due to improved light-duty vehicle fuel economy standards, seven percent of all new light-duty vehicles sold by 2025 will be electric vehicles. Between 2025 and 2030, the scenario assumes a rapid, linear increase of an additional 15 percent, so that by 2030, roughly 22 percent of new light-duty vehicles sold each year would be electric vehicles.

We applied this scenario to the anticipated number of new light-duty vehicles sold annually in the Central South West census division through 2030, listed in Energy Information Administration's *2010 Annual Energy Outlook*.³⁹ We then multiplied these estimates by the percent-

age of the Central South West region's population living in Texas, and then by the percentage of that population living in the eight-county Houston metro area, according to the 2010 U.S. Census.

In order to estimate the number of new electric vehicles on the road by 2030, we multiplied anticipated annual sales of new electric vehicles in Hous-

ton (per the scenario) by the car survival rate, or the rate at which vehicles are retired.⁴⁰

Reduced motor gasoline from the electric cars in 2030 was calculated by multiplying the number of electric vehicles on the road by 2030 by gasoline consumed per gasoline-powered vehicle in 2030.⁴¹

Notes

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4. DSIRE Database for State Incentives for Renewables and Efficiency, “City of Houston—Green Power Purchasing” *Texas Incentives/Policies for Renewables and Efficiency*, 2 March 2011, available at www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=TX22R&re=1&ee=1.
5. Assuming 1,252.57 pounds of carbon dioxide emissions per MWh of electricity, per Environmental Protection Agency, *eGRID 2010 Version 1.1—ERCT subregion year 2007 data*, May 2011.
6. 7.5 cents per kWh: See note 7; average retail price of electricity in Texas is 9.86 cents/kWh, per Energy Information Administration, *Texas Electricity Profile*, April 2011.
7. City of Houston, *Green Houston: Comprehensive Renewable Energy Plan*, downloaded from www.greenhoustontx.gov/epr-energysources.html#wind on 26 September 2011.
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9. Ibid.
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11. City of Houston, *Green Houston: Mayor Annise Parker and Partners Announce Launch of Houston Drives Electric*, downloaded from www.greenhoustontx.gov/ev/20110908.html on 10 October 2011.
12. City of Houston, *Green Houston: Houston Expands Electric Vehicle Fleet; Adds Public Charging Stations*, downloaded from www.greenhoustontx.gov/ev/20110909transnation.html on 26 September 2011.
13. City of Houston, *Green Houston: Houston Drives Electric*, downloaded from www.greenhoustontx.gov/ev/houstondriveselectric.html on 26 September 2011.
14. Population Estimates and Projections Program, Texas State Data Center, Office of the State Demographer, Institute for Demographic and Socioeconomic Research, The University of Texas at San Antonio, *2008 Population Projections*, February 2009.
15. Travis Madsen et al., *Building for a Clean Energy Future: How Texas Can Reduce Pollution, Save Energy and Cut Costs with Efficient Solar Homes*, Environment Texas Research & Policy Center, September 2009.
16. Scenario assumes that each year, the percentage of new homes in Houston that are net-zero energy increases, while the percentage of conventional homes decreases (see Methodology). To the extent that construction of new net-zero energy homes in 2011 differs from the schedule in this scenario, the city will have to make up the difference in later years in order to achieve the benefits outlined in this report.
17. See Methodology.
18. 7.8 percent of Houston’s annual electricity use calculated assuming Houston’s share of total electricity use for the state (per Energy Information Administration, *Texas Electricity Profile—2009 Edition*, April 2011) reflects the percentage of the state population living in Greater Houston, or 23 percent (per U.S. Census Bureau, *2010 Census*, May 2011).
19. Calculated using statewide average electric sector emissions rates for the Texas region in U.S. Department of Energy, Energy Information Administration, *Annual Energy*

Outlook 2009 (Updated Reference Case), March 2009.

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21. Erik Kirschbaum, “Germany moves toward trimming solar power incentives,” *Reuters*, 13 January 2010.

22. U.S. Census Bureau, *State and County Quick Facts*, downloaded from quickfacts.census.gov/qfd/states/48000.html on 22 September 2011.

23. J. Paidipati et al., Navigant Consulting, Inc. for National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*, February 2008.

24. See Methodology.

25. Calculation assumes Houston’s technical potential in 2030 to be 4,409 MW. See Methodology.

26. See Methodology.

27. Average Texas home in hot and humid region uses 14,700 kWh of electricity every year, per Travis Madsen et al. *Building Solutions: The Potential for Zero Energy Homes to Save Energy, Reduce Pollution and Cut Energy Bills*, Environment Texas Research & Policy Center, September 2009; pollution prevention: calculation assumes 1,252.57 pounds of carbon dioxide emissions per MWh of electricity, per Environmental Protection Agency, *eGRID 2010 Version 1.1—ERCT subregion year 2007 data*, May 2011; 1 million cars: U.S. Environmental Protection Agency, *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle*, February 2005, available at www.epa.gov/otaq/climate/420f05004.htm.

28. American Lung Association, *State of the Air 2011*, downloaded from www.stateoftheair.org/2011/city-rankings/most-polluted-cities.html on 10 October 2011.

29. Energy Information Administration, “Light-Duty Vehicle Sales by Technology Type and Census Division—Table 54: West South Central” (spreadsheet), *Annual Energy Outlook 2010*, available at www.eia.gov/forecasts/aeo/tables_ref.cfm.

30. The City of Houston, *Electric Vehicle Charging Long Range Plan for the Greater Houston Area*, downloaded from www.greenhoustontx.gov/ev/pdf/longrangeevplan.pdf on 19 October 2011.

31. Alliance to Save Energy, *Potential Nationwide Savings from Adoption of the 2012 IEC*, November 2010.

32. If Greater Houston achieves 15 percent of its technical potential for solar capacity, it could install 4,409 MW of solar capacity (see Methodology). Calculation of 1,000,000 residential solar installations assumes the average residential solar panel installation to be 4.4 kW.

33. Florida Solar Energy Center, *Energy Gauge USA, Version 2.80.2*, available at www.energygauge.com.

34. The City of Houston, *Houston Facts and Figures*, downloaded from www.houstontx.gov/about/houston/houstonfacts.html on 27 September 2011.

35. 75.8 percent: U.S. Census Bureau, *Texas Quickfacts: Housing Units in Multi-Unit Structures, Percent, 2000*, downloaded from quickfacts.census.gov on 2 June 2009; 2.71 people per single-family, free-standing house: U.S. Census Bureau, *American Housing Survey 2005, Table 2-25. Units in Structure by Selected Characteristics – Occupied Units, 2005*

36. See note 23.

37. Ibid.

38. Tony Dutzik et al., *Getting Off Oil: A 50-State Roadmap for Curbing Our Dependence on Petroleum*, Environment America Research & Policy Center.

39. See note 29.

40. U.S. Environmental Protection Agency, National Highway Traffic Safety Administration and California Air Resources Board, *Interim Joint Technical Assessment Report: Light-Duty Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025*, September 2010.

41. We calculated that gasoline-powered vehicles will consume an average of 277.159 gallons of gasoline per year in 2030. The U.S. Energy Information Administration provides

data in its *2011 Annual Energy Outlook* on the number of new light-duty vehicle sales and the total number of vehicles in the light-duty vehicle fleet in 2030. We calculated the average motor gasoline consumption for all vehicles in the light-duty fleet by dividing the projected light-duty vehicle share of motor

gasoline consumption in 2030 (per the *2011 Annual Energy Outlook*) by the number of light-duty vehicles in the fleet.

42. Mayor Annise Parker, "Jump-Starting the Clean Energy Economy," *AnniseParker.com*, 9 September 2011.

