Rebuilding After the Gulf Coast Hurricane: Sustainable Communities Using Energy Efficiency

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Abstract

On August 29, 2005, a Category 4 hurricane made landfall near Buras, Louisiana, bringing 145 mph winds, inundating New Orleans, and leaving a path of destruction the size of the United Kingdom. Within four hours, a city dubbed "the Big Easy" was awash in tragedy. As a result, more than 300,000 new single family homes will need to be built in Alabama, Louisiana, and Mississippi in the coming months. Six of those homes are being piloted in Pass Christian, Mississippi.

This paper proposes energy efficiency as the recommended path for all new residential housing in the Gulf Coast region, makes the financial case for doing so, and presents a snapshot of reconstruction using smart energy choices featured in one current pilot program.

Recent changes in building policies (2005 Energy Policy Act, upgraded IECC 2006 codes, 2006 ENERGY STAR for New Homes Guidelines) were modeled for funding leverage and potential for residential energy efficiency mass deployment. Supported by DOE-2 modeling analyses, this research compares the consequences of rebuilding baseline (inefficient) homes to energy-efficient scenarios in both theoretical and actual situations. The paper concludes with recommendations for energy-efficient rebuilding along the Gulf Coast.

Hurricane Katrina Devastates a Region

On August 29, 2005, at 6:10 a.m., a Category 4 hurricane made landfall near Buras, Louisiana, with 145 mph winds. By 9:00 a.m., the city called "the Big Easy" was awash in tragedy. New Orleans Lower Ninth District was under 8 feet of water and a path of destruction the size of the United Kingdom remained, leaving 1.5 million people without power. Thirty-one parishes in Louisiana and 47 counties in Mississippi were affected, while 8 counties in Alabama saw damage to 2.1 million single family housing units.

In Pass Christian, Mississippi, the storm surge was prevented from returning to the sea by a barrier island that held the flood waters longer than other coastal regions experienced. This storm surge and subsequent high water destroyed 138 of the 150 pre-Civil War mansions that graced this coastal town and annually brought tourism revenue to the seaside village. Of the 3,000 single family homes in Pass Christian, none remained habitable after the storm subsided.

Of the total population of 6 million in the affected areas, many were among the country's poorest citizens, with an average per capita income of approximately $17,000. An estimated 1.5 million were evacuated from Louisiana alone and hundreds of thousands set out on the largest migration across America since the Dust Bowl of the 1930s. In the weeks that followed the storm, the death toll attributed to Hurricane Katrina approached 1,300. By October 2005, an estimated 2.2 million people had registered for aid from the Federal Emergency Management Agency and more than 400,000 people were still without power in Texas and Louisiana.

The scope and scale of the healing and rebuilding are monumental. An estimated 160,000 new single family homes need to be built in the coming months in New Orleans alone, with 310,353 single family homes needed to be built in the three states.

Mobilizing to Rebuild

Since the Civil War, an estimated 2 million single family homes had been built in the Gulf Coast region affected by Hurricane Katrina. In 2000, the average cost of those homes was $71,685, nearly $48,000 less than the average single family home in America.

Nineteen percent of the population in the parishes and counties struck by Hurricane Katrina were living at or below the poverty line but in Pass Christian, the percentage was much higher. The average age of the destroyed homes was three decades and their relative energy efficiency was lower than the national average. In Pass Christian, the average home was 80 years old and less efficient than the norm. In addition, the region hit by Hurricane Katrina had a history of lagging behind the rest of the country in infrastructure, housing quality, and economic robustness. In short, the region was ripe for the kind of disaster the hurricane wrought.

Since the hurricane, some organizations have stepped forward to take an active role in the reconstruction of the Gulf Coast region. For example, The Home Depot and its suppliers have partnered to donate nearly $1.2 million in products to areas in need, along with $4 million in donations from the Home Depot Foundation. Meanwhile, Congress is seeking to pass bills to shield contractors from litigation that could be brought by workers exposed to hazards in polluted, dangerous areas. In January 2006, the Bring New Orleans Back Commission proposed greater flood protection, storm water protection, increased use of canals, introduction of a light rail system, and improved neighborhood infrastructure, schools, and health facilities. Hospitals along the Gulf Coast, such as the University of Texas M.D. Anderson Cancer Center in Houston, have begun relocating their mechanical rooms to higher floors and installing flood gates that automatically drop into place. By February, the Bush Administration had released a review of the Federal response to Hurricane Katrina, citing 17 lessons learned, 125 special recommendations to the President, and 11 critical actions to be taken before June 1, when the hurricane season returned.

With an eye toward harmonizing reconstruction programs and projects, ICF International modeled rebuilding the 310,353 single family homes along the Gulf Coast to establish recommendations for reconstruction and to inform policymakers. The initial modeling generated several theoretical rebuilding scenarios, and was followed by a real world pilot project, Home Again, in Pass Christian, one of the hardest hit areas.

In the Pass Christian pilot, a local housing development organization selected six sites for modern housing at a reasonable cost for low and very low income residents of this devastated community. Home Again is sponsored by the Enterprise Foundation, The Home Depot Foundation, Oak Hill Fund, and John and Renee Grisham Foundation, with a team that includes Southface (Atlanta), Hope Credit Union, and local architects. Mercy Housing Human Development Inc. is leading the rebuilding effort using modular homes on the six sites where housing known as “shotgun” style previously stood.

Like other towns along the Gulf Coast, rebuilding in Pass Christian is complicated, in many cases, by a lack of clear title to the land. Of 150 family home sites proposed for the Pass Christian pilot, only six could prove clear title and a survey of their land. Many families were tenanted on land passed through several generations, sometimes over 200 years. Some had been gifted the land, others who had not paid property taxes, since the homes were paid for long ago, lost the land rights but had never been told they were tenants on someone else’s land, while some lost access to their land titles in a 1920s courthouse fire. Although virtually all citizens of this small town agreed to land demarcations such as fences and trees, these were swept away by the storm surge.

Reconstruction Modeling

ICF International modeled several reconstruction scenarios using data from a major manufacturer of energy efficient modular homes. For the theoretical modeling, housing characteristics such as construction type, architectural features, and quantity were obtained from 2000 U.S. Census Bureau data from the 86 counties and parishes in the three hardest hit states, Louisiana, Mississippi, and Alabama. Modelers established a baseline of housing prior to Hurricane Katrina, using DOE-2 modeling software to compare the economic and environmental benefits of rebuilding in an energy efficient manner. To model a representative sample, only single family homes units were considered since 67 percent of the homes destroyed were this type. Means Cost Data aided in modeling the per-unit cost to rebuild each home for each scenario. National Association of Home Builders data presented housing starts projections for 2005–2010, while Census 2000 data provided additional economic details about the region.

Gulf Coast state codes suggested what to expect during the theoretical rebuild. As of August 2005, local codes for energy efficiency in the three states were based on standards as recent as the year 2000 and as old as 1975. However, recent code revisions made energy efficient rebuilding possible. For example, the newly revised IECC 2006 of the International Codes Council was considered in one theoretical rebuild scenario. In addition, since the U.S. Environmental Protection Agency's ENERGY STAR program's amended New Homes Guidelines went into effect January 1, 2006, those guidelines were considered as another scenario in both the theoretical and actual rebuilding scenarios.

Prior to modeling the pilot project, a design symposium was held for Pass Christian residents and project representatives to discuss their preferences for the style, character, and function of the houses to be built. The original homes were single or double shotgun structures, and these styles were still preferred by the community for the rebuild. Shotgun style homes became popular in many southern states because of the long, narrow plots given to many new landowners after the Civil War. Typically, these plots were 35 feet wide and very long, and the shotgun style was born to accommodate the unusual site configurations. For ease of modeling a representative sample, only single and double shotgun style homes units were modeled for the pilot project.

Figures 1 and 2 illustrate the plans of single and double shotgun homes. As Figure 1 shows, the double shotgun style home has no central corridor, but all rooms have three doors, 12-foot ceilings, tall windows with transoms above all internal doors, and the capacity for natural ventilation, which residents wanted to have six months of the year. Single shotgun homes were similar, but had only two doors per room and did not have a double bank of rooms. Although found throughout the Gulf Coast region, the single shotgun was the hallmark of Pass Christian. Photos A and B reveal the charm of these homes with their gingerbread woodwork accents. .

Figure 1. Double Shotgun House

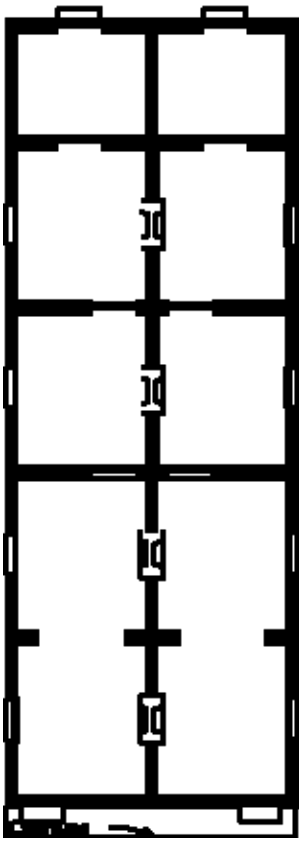
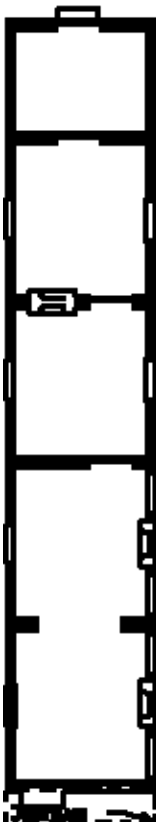


Figure 2. Single Shotgun House



Source: Bywater Neighborhood Association

Photo A. Single Shotgun House

Source: Bywater Neighborhood Association

Photo B Double Shotgun House

Source: Bywater Neighborhood Association

Theoretical Rebuild Scenarios

Four scenarios were selected for the theoretical modeling, against a baseline set at the Model Energy Code 1993 (MEC 93), which was used because a review of the actual build dates of the 310,353 homes destroyed found that most had not been built to any code. MEC 93 assumes that all houses destroyed were constructed according to a standard that was only a decade old.

The baseline was established as if the home had a window solar heat gain coefficient (SHGC) of 0.58, a wall R-value of 13, an attic R-value of 23, an air conditioner Seasonal Energy Efficiency Rating (SEER) of 10, and an estimated size of 2,000 square feet. The four theoretical scenarios are shown in Table 1.

Table 1. Comparison of the Baseline and Four Theoretical Scenarios

	Baseline MEC 93	Scenario 1 Quick Payback	Scenario 2 IECC 2006	Scenario 3 ENERGY STAR 2006	Scenario 4 Best Practices
Window SHGC	0.58	0.58	0.40	0.40	0.30
Appliances and Lighting	Standard	ENERGY STAR Labeled	Standard	ENERGY STAR Labeled	ENERGY STAR Labeled
Duct Leakage	~13%	~6%	~13%	~6%	~6%
Wall R-Value	13	13	13	13	19+
Attic R-Value	23	~23	30	30	44
AC SEER	10	Upgrade from 13 to 14	13	14	17
Square Footage	2,000 s.f.	2,000 s.f.	2,000 s.f.	2,000 s.f.	2,000 s.f.

Using datasets of several thousand factors and applying them to the four basic upgrades in energy efficiency shown in Table 1, researchers modeled 72,000 DOE-2 runs to characterize the impact in two climate zones and eight affected cities in the Gulf Coast region. The baseline single family housing unit in the three states on August 29, 2005, was compared with the four scenarios.

Rebuild Scenarios for Pass Christian

In the pilot project modeling, the housing characteristics of Pass Christian were obtained from Census 2000 data and town resident accounts. ICF International modelers established a baseline of pre-hurricane housing and used DOE-2 modeling software to compare the economic and environmental benefits of rebuilding Pass Christian in an energy efficient manner, with modular construction, and with the size and footprint of shotgun homes.

Six scenarios were selected for modeling, with the baseline set at MEC 93. As in the theoretical modeling, it was assumed that the six houses destroyed had been built to a code standard that was approximately a decade old. However, it is likely that the Pass Christian homes had not been built to any code.

Nonetheless, the baseline was established as if the home had an SHGC of 0.58, a wall R-value of 13, an attic R-value of 23, a SEER of 10, and an estimated size of 980 square feet for the single shotgun style and 1,960 square feet for the double shotgun style home. The six scenarios are shown in Table 2.

Table 2. Comparison of Six Scenarios for Pass Christian

	Scenario A Single Shotgun MEC 93	Scenario B Double Shotgun MEC 93	Scenario C Modular Medium Size ENERGY STAR	Scenario D Modular Large Size ENERGY STAR	Scenario E Single Shotgun ENERGY STAR	Scenario F Double Shotgun ENERGY STAR
Window SHGC	0.58	0.58	0.40	0.40	0.30	0.30
Appliances and Lighting	Standard	Standard	ENERGY STAR Labeled	ENERGY STAR Labeled	ENERGY STAR Labeled	ENERGY STAR Labeled
Duct Leakage	~13%	~13%	~3%	~3%	~6%	~6%
Wall R-Value	13	13	18	18	13	13
Attic R-Value	23	23	33	33	30	30
AC SEER	10	10	13	13	14	14
Size and Ceiling Ht.	980 s.f. 12'-0" (clg. ht.)	1,960 s.f. 12'-0" (clg. ht.)	1,291 s.f. 9'-0" (clg. ht.)	1,916 s.f. 9'-0" (clg. ht.)	980 s.f. 12'-0" (clg. ht.)	1,960 s.f. 12'-0" (clg. ht.)

Using datasets of several thousand factors and applying those factors to the basic upgrades in energy efficiency as shown in Table 2, researchers performed 192 DOE-2 runs to characterize the impact in the climate zone of Pass Christian. The modeling revealed significant data on the potential for making smart energy choices, particularly in economically tenuous communities.

Modeling Results

The theoretical modeling studied only those homes that were obliterated, and costs associated with constructing new homes with the scenario upgrades should be considered estimates only. The cost of materials, regional labor cost differences, the value of money, the cost of electricity or gas, and other factors might affect these building costs and simple payback period estimates.

Recognizing those variables, the cost to upgrade presented in Scenario 4 proved to be the most expensive initial investment at $6,003 per home, with a simple payback period of 12.5 years. Yet when this payback period is considered within the context of a 30-year mortgage, the return on investment appears more favorable. The next most costly upgrade was Scenario 3 (ENERGY STAR) at $2,754 per home. Yet the ENERGY STAR scenario had a much quicker payback than Scenario 4 (Best Practices) or the less expensive option, Scenario 2 (IECC 2006). The simple payback period for Scenario 3 was just 7.5 years.

The initial investment per home is shown in Table 3 while annual utility bills savings per home are outlined in Table 4.

Table 3. Incremental Cost to Upgrade*

Scenario			
1	2	3	4
Quick Payback	IECC 2006	ENERGY STAR 2006	Best Practices
$527	$1,511	$2,754	$6,003
*Upgrade costs consider cost of materials and labor at present day prices for purposes of establishing simple payback.			

Table 4. Incremental Annual Utility Bill Savings**

	Scenario			
	1	2	3	4
Yr	Quick Payback	IECC 2006	ENERGY STAR 2006	Best Practices
1	$254	$179	$365	$485
5	$1,268	$894	$1,777	$2,427
10	$2,536	$1,788	$3,555	$4,853
15	$3,804	$2,683	$5,332	$7,280
20	$5,072	$3,577	$7,110	$9,706
25	$6,340	$4,471	$8,887	$12,133
30	$7,609	$5,365	$10,665	$14,559
**Utility costs at present day prices without adding cost increases that may occur.				

In Pass Christian, approximately 3,000 homes will need to be rebuilt. As in the theoretical modeling, the cost estimates for constructing these new homes must be considered estimates only. The cost of modular homes completed, labor, electricity or gas, and other factors can affect building costs and, therefore, simple payback period estimates. Since the modular home size that most closely fit the shotgun style was the larger modular unit, only three scenarios were compared. For the cost to upgrade, Scenario B (Double Shotgun at 1,960 square feet) was the baseline. Scenario D (Modular Large ENERGY STAR) proved more costly to build than the baseline by $1.75 per square foot, while Scenario F (Double Shotgun ENERGY STAR) cost $0.81 per square foot more. Table 5 shows the initial investment per home while Table 6 details annual utility bill savings.

"We want to avoid having folks drive down the road 10 years from now and be able to point and say, 'That's a Katrina house' and 'There's another Katrina house.' Instead, we want people to have nice looking homes, in the style they had before the storm, so the character of Pass Christian remains constant even if everything else has changed."
–Mercy Housing Human Development Inc.

Table 5. Incremental Cost to Upgrade*

Scenario		
B	D	F
Double Shotgun MEC 93 12′-0″ (clg. ht.)	Modular Home Large Size ENERGY STAR 9′-0″ (clg. ht.)	Double Shotgun Site-Built ENERGY STAR 12′-0″ (clg. ht.)
----	$1.75 s.f.	$0.81 s.f.
*Upgrade costs consider cost of materials, labor, and foundations at present day prices to establish simple payback.		

Table 6. Cumulative Annual Utility Costs**

Yr	Scenario		
	B	D	F
	Double Shotgun MEC 93 12′-0″ (clg. ht)	Modular Home Large Size ENERGY STAR 9′-0″ (clg. ht)	Double Shotgun Site-Built ENERGY STAR 12′-0″ (clg. ht)
1	$710	$591	$552
5	$3,550	$2,955	$2,760
10	$7,100	$5,910	$5,520
15	$10,650	$8,865	$8,280
20	$14,200	$11,820	$11,040
25	$17,750	$14,775	$13,800
30	$21,300	$17,730	$16,560
**Utility costs at present day prices without adding cost increases that may occur.			

The Benefits of Smart Energy Choices

> "The typical Mississippi family spends $1,300 annually on their homes' utility bills. Home energy costs are often the second-highest expense, after the mortgage payment."
> –Mississippi Development Authority

The simple payback period for both the theoretical and actual rebuild scenarios was calculated without considering rising costs of electricity (3.3 percent in this region in the past year) or rises in crude oil prices (64 percent in the past year). In the recommended ENERGY STAR scenario, an estimated 713 MW annually would be avoided, roughly equal to the output of one nuclear power plant. The increased benefits in savings for local power plants, and environmental benefits in an already challenged region would be reduced greenhouse gas (CO_2) equivalent to removing 51,221 cars from the roads. For every 1 MW avoided, an estimated $1 million is saved, and similar savings are achievable in reduced distribution costs.

In Pass Christian, the numbers are much smaller, but still noteworthy. The larger modular homes initially appear to be more expensive to build but would return $119 to each homeowner every year. (Yet site-built homes with non-standard 12-foot ceilings as modeled may prove more costly than the modular). In 30 years, modular home energy savings for the six pilot homes would amount to $21,420, and potentially more if natural ventilation was used an additional two months annually. The Pass Christian savings would amount to 234 kW in 30 years and a CO_2 reduction equal to removing 30 cars from the road.

Building energy efficient homes following 2006 ENERGY STAR for New Homes Guidelines, along with Indoor Air Quality guidelines being piloted, will ensure occupants of the new homes will spend less on medical-related problems and mold remediation costs associated with poor construction techniques in hot, humid climates. Recognizing that indoor air pollution is responsible for one death every 20 seconds, and that the economic impact of indoor pollution is estimated at billions of dollars a year, spending slightly more on each home is prudent. However, because the modular homes being produced for Pass Christian are ENERGY STAR qualified, similar savings may not be achievable in less efficient modular homes.

In addition, with the rebuilding, the citizens of Pass Christian are eager to recapture the sense of community and front porch interaction that shotgun style homes have historically fostered. Citizens also cited walkability, the need for human-scale elements, and replacement of lost trees as other essential reconstruction features, and they proposed using the dry bayous that criss-cross the town as bike and walking paths as the rebuilding continues. Because mature shade trees allowed residents to rely on natural ventilation half the year, they also requested transplantation continue with energy efficient micro-climates around each home.

For homeowners along the Gulf Coast, building single family homes that have tight envelopes, good insulation, suitable windows, and energy efficient equipment will reduce their monthly energy bills and increase their comfort and physical well-being. Currently in Mississippi, 34 percent of household income goes toward paying the mortgage and the second highest cost is for energy and some regions are harder pressed than others. For example, a study in North Carolina found that of every 100 trailers sold, 20 were repossessed. The problem was not mortgage costs that were too high, but monthly energy costs that were more than the mortgage. With utility bills as high as $230 a month, the 30-year mortgage on a $25,000 mobile home was less costly.

Household incomes and $1,200 average annual energy bills in the Gulf Coast region should be considered when proceeding with rebuilding there. Therefore, Scenario 3 (ENERGY STAR), which returns a higher amount than the quick payback scenario, is the recommended minimum for the theoretical rebuild in Alabama, Louisiana, and Mississippi.

For Pass Christian, the pilot project using modular homes has many benefits. Manufacturers can control the quality of the homes and test them for air tightness and insulation levels at the factory. The same quality control is unlikely at site-built homes in this region (unless they are ENERGY STAR) given rapid crew turnover, speedy construction, and an unusually high competition for skilled labor along the Gulf Coast. Additionally, the cost of materials has skyrocketed. Rebuilding with ENERGY STAR qualified modular homes (Scenarios D and F, depending on size) is the recommended minimum for the pilot project in Pass Christian (and similar areas with special needs in Mississippi, Louisiana, and Alabama.)

Recommended Next Steps

A large modular homes manufacturer has agreed to create style differentiators that will make each Pass Christian modular home distinctive, which residents desire. Similarly, residents' request to be able to use natural ventilation two more months of the year has prompted re-tooling to create higher ceilings and taller windows. At least one major manufacturer of modular homes has raised its standard ceiling height from 8 feet to 9 feet and discussions are underway to increase that to 10 feet. This manufacturer also has agreed to use 72-inch tall windows for the Pass Christian pilot, an increase of 14 inches over the previous standard. While the modular homes modeling data presented in Table 6 reflects natural ventilation four months of the year, if the larger modular homes had taller than standard windows, ceiling heights of 10 feet, and long open spaces, they might realize additional energy savings through natural ventilation and additional two months.

Based on the results of the theoretical and actual modeling:

- The 2006 ENERGY STAR for New Homes Guidelines are recommended for all new single family site-built home construction during the rebuilding of Alabama, Louisiana, and Mississippi.
- Energy efficient ENERGY STAR qualified modular homes with the design characteristics and training of local builders are the recommended solution for communities such as Pass Christian.
- State and local incentives, federal tax credits, and federal funding should be leveraged for all new home construction during the rebuild to enhance the impact.
- Energy Efficient Mortgage programs and similar initiatives should be extended to include new home construction and should be available for purchasing energy efficient modular homes.
- The financial benefits derived from smart energy choices made during the rebuild should be tracked to structure a case for energy efficient development and subsequent mass deployment of energy efficient practices.
- For Pass Christian and similar communities, smart energy choices should consider homeowner requests, and modular home manufacturers should be included in the design process so they can revise their standards to suit those requests.
- Communities along the Gulf Coast may need to look closely at opportunities to build energy efficiency alternatives into their housing programs.
- Scarcity of skilled labor for site-built homes, the enormous demand for supplies such as roofing materials and drywall, and the amount of debris to be removed before rebuilding can progress must be considered when working in storm-ravaged areas.
- Manufacturers who train local crews and re-tool to accommodate special design needs should be allowed to access state or federal funding to make modular homes more cost-competitive with site-built ones.
- In Pass Christian and other disadvantaged communities, new homes should be built to operate frugally and minimize energy costs.
- In planning for rebuilding and formulating timelines, expect obstacles such as lack of clear title to land and obliterated boundary demarcations.
- All rebuilding efforts should be integrated into a comprehensive reconstruction program.

Conclusion

Decisions made in the months ahead will have an impact on the economies and resources of households, utilities, and the Gulf Coast region for decades. Rebuilding such a large area will be challenging but as the modeling demonstrates, rebuilding to higher energy efficiency standards makes sound economic sense and presents the most viable strategy for launching sustainable reconstruction.

Homeowners will benefit from reduced energy bills while area builders will have the opportunity to distinguish themselves as ENERGY STAR builders. Similarly, manufacturers of energy efficient modular homes can find new markets in providing truly customized homes at reasonable costs. The recommendation for energy efficient customized homes (suggested in the Louisiana Speaks Pattern Book produced by the Louisiana Recovery Authority) reflects the consensus toward a holistic approach to rebuilding.

Incentives under the new tax credits bill, energy efficient mortgages, and state-centered incentives and financing, supplemented with federal funds, will add to the financial benefits of smart energy choices. Rebuilding the 310,353 homes to ENERGY STAR standards promises to be an investment that pays for itself quickly and returns $3.2 billion dollars into the local economy in just 30 years.

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ICF International (http://www.icfi.com) partners with government and commercial clients to deliver consulting services and technology solutions in defense, energy, environment, homeland security, social programs, and transportation. Combining passion for our work with industry expertise and innovative analytics, we deliver compelling results throughout the entire program life cycle, from analysis and design through implementation and improvement. Since 1969, ICF International has been serving government at all levels, major corporations, and multilateral institutions. More than 1,600 employees serve these clients worldwide.

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