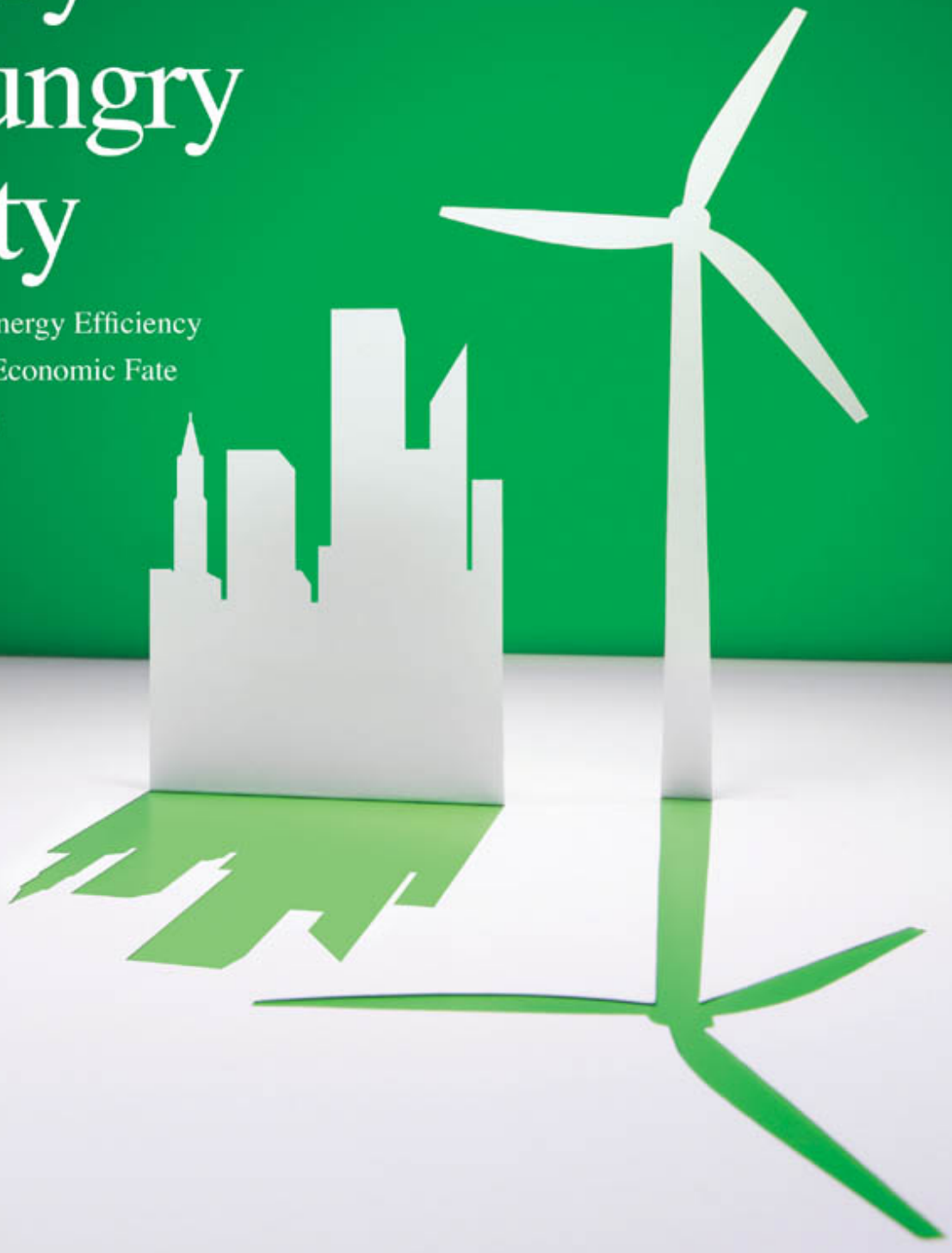
The Very Hungry City

Urban Energy Efficiency and the Economic Fate of Cities



Austin Troy

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AUSTIN TROY

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To the memory of Joseph F. Troy

Contents

Preface

It was the late spring of 1979, and third grade was coming to a close at Brentwood Elementary in Los Angeles. Summer vacation was about to begin. The days were getting longer. I had a new ten-speed Schwinn. Life was good.

Nonetheless, at recess each day I was beginning to notice that something odd was happening just across the street at the Union 76. Lines of cars waiting for gasoline mysteriously sprouted and steadily grew at this normally sleepy filling station, until at one point they wrapped around the block. As a nine-year-old, I didn't have the faintest understanding of what caused the pileup—how it related to political upheaval in Iran, price controls in America, or OPEC production quotas. And frankly, it didn't matter much to me, because it had little impact on my daily life; after all, I rode my new bike to school, and the other places I cared to go—the store where I bought baseball cards and my friends' houses—were all within easy walking distance.

But beyond my tiny world, the impacts were momentous. Even though predicted shortfalls in oil supply were modest, just the threat of not being able to fill up whenever needed sent Californians into an irrational frenzy that resulted in hoarding, multi-hour wait times, and physical attacks in the gas lines, including one against a pregnant woman. Why were all these adults acting so crazy?

It's not surprising to me that the 1979 panic began in Southern California, the motherland of urban automobile dependency, before spreading east. Residents of the Los Angeles area knew just how crippling the lack of fuel could be to their way of life. Even though the

actual shortages were modest, the fears were real. In Los Angeles, there simply was no substitute for internal combustion.

As I look back on that experience, it strikes me that energy is something we don't notice until there's a crisis. When these crises happen, they can fundamentally change our behaviors—even our whole outlook. When a crisis abates, so too does our attention to the issue. In the years following the 1979 oil crisis, price controls were lifted, oil production dramatically increased, and prices fell as supplies burgeoned. Cars and houses got bigger. People turned up their thermostats in winter. Commuters drove ever longer distances. Energy slowly drifted out of public consciousness.

Fast forward to 2008. After gradually rising for a few years, prices at the pump suddenly skyrocketed to more than four dollars a gallon. Only this time it wasn't due to revolutions, price controls, or embargoes. Rather, far more frighteningly, it was caused by a simple supply-and-demand imbalance. A red-hot global economy was demanding far more fossil fuel than producers could supply. Some would say this was due to insufficient investment in production capacity. Others would contend that we were beginning to reach the physical limits to global oil production. Whatever the cause, it was another awakening in energy consciousness. Just as they had done twenty years earlier, behaviors changed: cars slowly got smaller, investments in energy efficiency increased, and some people moved closer to their work. However, there wasn't a lot of time for these effects to take hold. Within a few months, recession struck, in turn reducing demand and sending energy prices plummeting. Worries about energy use were suddenly replaced by much more immediate concerns about unemployment, mortgage foreclosures, and debt. But eventually the economy limped out of recession and, with this recovery, oil prices rebounded. As I write this preface in mid-2011, those prices are again approaching their 2008 peak.

One thing these oil shocks illustrate is that people can adapt to rising energy prices and reduced energy availability when they have to.

In fact, many were able to reduce their energy consumption without compromising their quality of life.

But there are limits to this adaptability. And the most important determinant of these limitations is where people live. The rate at which people use energy varies across rural, exurban, suburban, and urban contexts, and from one city to another. These variations are due not just to differences in automobile dependency, traffic, and commuting lengths but also to factors like climate, building-stock quality, water delivery and filtration, and waste processing.

The Very Hungry City is about the intensity of energy use in cities, which I refer to as "urban energy metabolism." Typically this has been considered an environmental issue. My premise is that it's equally important as an economic issue. There's strong evidence that long-term energy prices will rise considerably as global demand for energy increases, while supplies face growing constraints—not just geophysical constraints but also regulatory ones related to climate-change mitigation and political ones related to instability in countries that produce fossil fuel. As prices climb and energy costs make up an increasingly large share of the cost of living, urban energy metabolism will go from being just an environmental virtue to a core determinant of urban economic competitiveness. Efficient metropolitan areas—those that are laid out and planned well, have a good mix of land use, have efficient and well-designed building stock, are geographically well located, and have low-energy solutions to providing and delivering essential resources like clean water—will have an ever-increasing competitive advantage over those with a poor metabolism in terms of attracting firms, employment, and investment. Some cities will be able to adapt quickly, but others will face significant hurdles, particularly if they are car-dependent, sprawling, dominated by inefficient buildings, and located in energy-intensive climate zones. This issue is relevant to economic competition not just between cities but also between nations.

This book focuses on why cities have the metabolisms they do, and what they can do to improve them. I believe that predicting the fu-

ture impacts of energy metabolism on regional economies would be interesting. Such an analysis would, however, be a speculative modeling exercise at best, since history offers no significant long-term energy price increases that we could use for data. But both common sense and economic theory tell us that if something as irreplaceable as energy becomes significantly more expensive, there will be winners and losers, and the losers will most likely be those unable to quickly adapt. Given this, I think it's a safe bet to assume that urban energy metabolism matters.

The book is in two parts. Part One (Chapters 1–5) deals with some of the major determinants of urban energy metabolism: water supply, climate control, and transportation. Chapters 4 and 5 discuss the history of highway and transit development and why certain cities have ended up dominated by one mode versus the other. Part Two (Chapters 6–10) addresses solutions to the energy metabolism problem. Chapters 6 and 7 examine programs and approaches that tackle building and transportation energy efficiency, respectively. Chapter 8 looks at central-city redevelopment as a strategy for reducing energy use. Chapter 9 is about regional solutions to energy metabolism. Chapter 10 is a summary of some of the major policy approaches that I feel could make a big difference with energy metabolism and, in the process, address a whole host of other related urban issues.

In between chapters I have inserted what I call "energy interludes"—brief sections that explore the constraints on energy supply. The first offers a quick synthesis of why I think energy will get more expensive. The next five deal with fossil fuels, while the last three examine alternative sources of energy. If there's a main point that comes out of these interludes, it's that with the depletion of the easily available fossil-fuel deposits, supplies just won't be as responsive in the future as they once were. And with growing demand, that means increasing prices. The other main point is that no alternative energy source offers the silver bullet needed to fill in these growing supply gaps.

The book focuses particularly on American cities and the steep challenges they face following decades of energy profligacy. As a basis

for comparison, I look at several cities in Europe that are at the other end of the energy-use spectrum for developed nations. Rather than being an exhaustive inventory of all cities in these areas, this book details just a few cities that are illustrative of particular challenges or opportunities related to energy metabolism. (Readers who are interested in comprehensive rankings of cities' energy metabolisms can turn to such excellent sources as Sustain Lane's *How Green Is Your City* or the Brookings Institution's *Shrinking the Carbon Footprint of Metropolitan America.)*

Finally, as someone who has lived in a wide range of housing and community types, I have tried my best not to be judgmental about people's lifestyle choices or where they live. While I do, for instance, point out the energy consequences of living in more distant and automobile-dependent suburbs or exurbs, I don't in the least bit condemn people who choose to live in such places. Rather, if I have a gripe, it's that Americans have far too few choices when it comes to the type of community or neighborhood in which they can live. While there is a decided preference in the United States for living in so-called "suburbs," Americans are, by and large, not getting the kinds of suburbs that they want. If they were, we'd be using a lot less energy.

I don't expect this book to directly contribute to expanding these choices. But if it can get a conversation started, I'll be happy.

Acknowledgments

Almost five years ago, I had a phone conversation with the literary agent Gillian MacKenzie about some ideas for nonfiction book projects. One of those related to the different ways that cities consume energy and what that could mean as energy gets more expensive. Around this time I'd been frequently reading *The Very Hungry Caterpillar,* by Eric Carle, to my oldest son, Theo, for bedtime. Somehow, synapses in my brain crossed and this nascent idea became *The Very Hungry City.*

This book is almost the same age as Theo, who is nearing the end of kindergarten as the final edits are being made; it feels like writing this has taken almost as much time, effort, and nurturing as raising him. Writing began in earnest in mid-2009, by which time my second child, Ben, was a toddler and my one-semester writing sabbatical from the University of Vermont was over. Needless to say, making this book a reality required some big sacrifices on the home front. So, above all else, my deepest thanks go to my family, particularly my wife, Sheryl Glubok. Not only did she pick up huge amounts of slack with managing kids and household, but she also served as an editor extraordinaire, reading almost every bit of prose I wrote and telling me what worked and what didn't from the perspective of an omnivorous reader. Without her, this book truly never would have happened. To say that I'm in her debt is an understatement.

Another person without whom this book would have been nearly impossible is my sister, Darcy Pollack. She introduced me to my literary agent, Gillian, and also arranged for me to interview Ed Begley Jr., an important character in this book, and to visit his house (a visit she accompanied me on). Additionally, she and her husband, Jeff, were

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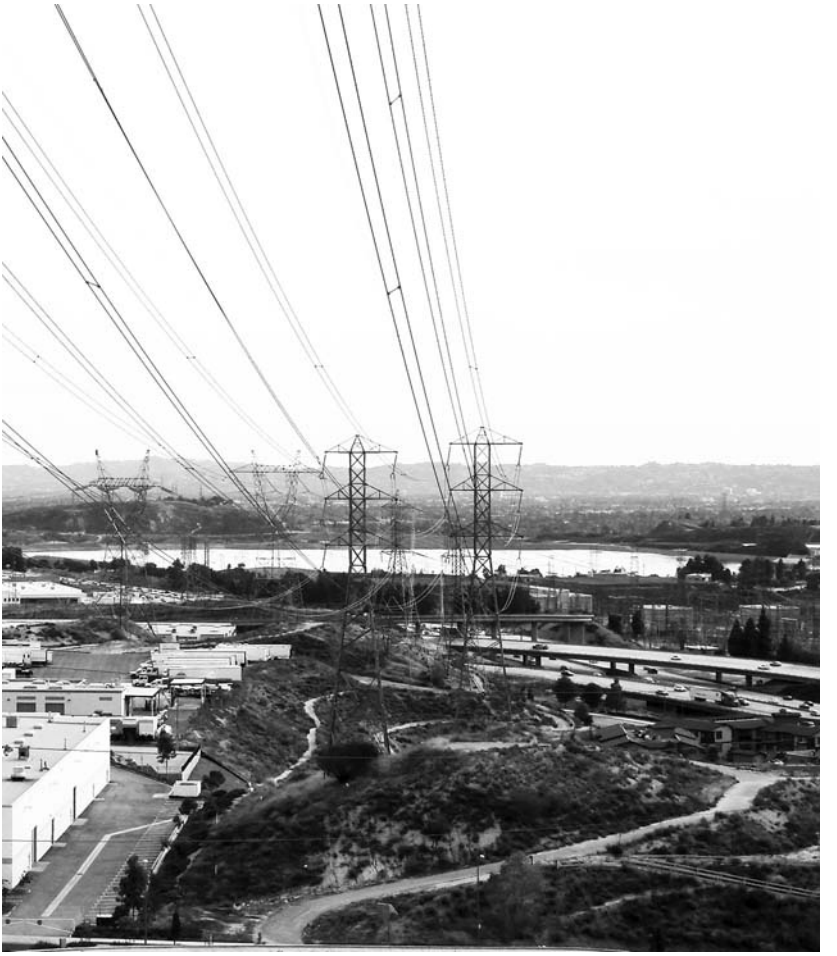
Also, I'm thankful to the many institutions and individuals that granted permission to reproduce the images used in this book, such as the Eisenhower Presidential Library, the William H. Hannon Library at Loyola Marymount University (Cynthia Becht), the Southern California Automobile Club Archives (Morgan Yates), the University of Vermont Libraries Special Collections (Chris Burns), the Airwell-Fedders Corporation, the Stockholm Traffic Administration, Treg Christopher, Anders Flodmark, and Duncan Crary.

Introduction: Why Urban Energy Metabolism Matters

I have yet to see a place where the icons of urban energy use come together on a grander and more poetic scale than around the interchange for Interstates 5 and 210 and Highway 14 in the city of Sylmar, just outside of Los Angeles. For those who love the sight of acres of reinforced concrete and steel, this is the place to be. Here, I-5 expands to up to fifteen lanes in width to accommodate the massive amounts of traffic these interchanges generate. Running every which way around these ribbons of concrete are dozens of high-tension transmission lines supported by a forest of massive steel pylons, which carry electricity to 3 million people. To one side of I-5 is the Sylmar Converter Station, a 35-acre knot of concrete and pulse-valve semiconductors. Adjacent is the energy-hungry Los Angeles Aqueduct Filtration Plant—the largest direct filtration plant in the United States—which daily makes 600 million gallons of water drinkable. Finishing off the scene is the 1,100-acre Sunshine Canyon landfill.[1]

Until one visits a place like this, it's hard to appreciate just how hungry cities are for energy. And it's far harder to appreciate what makes a city energy efficient.

Most people have an idea of what makes a building efficient or inefficient—leaky windows, insulation gaps, old furnaces. But, while a building manager may keep track of energy use, there is no one to monitor overall urban energy use. Further, while the boundaries of



Near the interchange of I-5 and I-210 in Sylmar, California.
(Photo by author)

a building are obvious, the same can't be said for an urban system—should urban energy efficiency be defined in terms of neighborhoods, individual municipalities, counties, or whole metropolitan areas?

In the 1960s, inventor and sanitary engineer Abel Wolman coined the term "urban metabolism" to describe the flows of matter and en-

ergy in an urban system.[2] A generation later, I argue that the time has come for us to talk about urban energy metabolism, which describes the differing rates at which cities consume energy. Any number of factors can cause this metabolism to vary, among them climate, access to water, the quality of the building stock, industrial use, and the linked issues of transportation and urban form.

Having a high-energy metabolism is like having a high metabolism for food. Take, as an example, the former speed-eating champion Sonya "Black Widow" Thomas, who although only ninety-eight pounds, can eat thirty-five bratwursts in ten minutes. She can consume pounds of food in a matter of minutes without gaining a single pound herself. But her insanely high metabolism is a good thing only in the context of cheap and abundant food. If food were suddenly scarce and expensive, that high metabolism would become a liability. That is, a slow metabolism would be a competitive advantage because it would mean being able to do more with less.

Many American cities have metabolisms like those of competitive eaters—they are structurally constrained to require a huge amount of energy per capita to meet their basic functions. From an economic perspective, none of this has mattered while energy has been cheap. But, as I discuss in this book, there are a lot of good reasons why it's unwise to assume that it will remain so.

Energy conservation has long been thought of as an environmental virtue. But as energy becomes more expensive in the long term, urban energy metabolism will become ever more critical to cities' economic well-being and success. This is particularly important for the United States, because it has some of the world's hungriest cities and because Americans are among the highest per capita consumers of energy, with the typical American using twice the energy of a Briton, six times that of a Chinese, and eleven times that of a Salvadoran.[3]

There is a whole branch of economics that addresses the reasons why industries and firms choose one location over another—reasons such as wages, access to natural resources, transportation routes, work-

force education, taxation, and preexisting clusters of firms and industries. As energy gets more expensive, urban energy metabolism will rank increasingly high on that list, and cities with a high energy metabolism will find themselves with a significant competitive disadvantage.

One reason for this disadvantage is that in the new world of high energy prices, residents of high-metabolism cities will require compensation for their increased energy-related expenses, such as transportation, heating and cooling, waste processing, and water supply. Phillip Schneider, a principal for Deloitte Consulting's Location Strategy and Site Selection Team, helps firms choose locations. He told me that he believes that firms in cities with long commutes will likely have to increase wages to compensate workers for increased transportation costs as energy gets more expensive: "It does stand to reason that cities that are more compact and that have mass transportation should do better." Higher wages may sound like a good thing, but in this context they're a liability. Employees in the high-metabolism city are no better off than employees earning less in a low-metabolism city, because the former must spend additional income on transportation, and meanwhile the costs for the employer have gone up (some of this compensation would also be accounted for by lowered housing values which, although good for those buying a home for the first time, is disastrous for existing homeowners and highly destabilizing for a regional economy). Practices like locating corporate headquarters in suburban or exurban areas may become unsustainable. According to Schneider, such facilities may eventually have to be relocated or "there will have to be a transportation solution to get people out there once gas prices are high." Consequently, "cities in America that have good mass transit systems . . . stand to be winners when it comes to condensed activities, like headquarters." European cities, by contrast, are better prepared "because they never got rid of their mass transportation and they stopped urban sprawl."[4]

Schneider believes, however, that there is plenty of opportunity for cities to adapt. Those that are currently inefficient "won't give up and go away. The price of fuel will stimulate workarounds." I agree that they

will try. But the question is, can they afford to wait until prices rise? Recent experience shows that waiting can be costly.

In Rio Vista, California, at the intersection of Park Place and Hearth Lane, not far from the banks of the lazy Sacramento River, is the ironically named Hearth and Home at Liberty, a subdivision intended for 855 upscale homes that were never built. Today, long after ground was first broken, only 13 lonely model homes sit vacant within an otherwise empty 40-block street grid, complete with pavement, underground utilities, street lights, fire hydrants, sidewalks, bike lanes, crosswalks, a parking lot—and now tumbleweeds.

Hearth and Home was just about the farthest frontier reached by the Bay Area's red-hot housing market. Located about an hour and forty minutes from downtown San Francisco, in typical rush hour traffic, this bedroom community offers an example of energy metabolism gone to its extreme. Once a small rural town, Rio Vista's population exploded as developers built subdivisions such as the 250-unit Homecoming and the 2,000-unit Trilogy. However, by the time Hearth and Home broke ground in 2005, that frontier had become an inhospitable place for new developments. Between 2005 and 2009, median home prices there dropped by almost 45 percent, and by the end of that period, nearly every home for sale in town was a short sale or a foreclosure. With population dropping and property taxes plummeting, the town came close to declaring bankruptcy in 2009.

Rio Vista's situation is by no means unusual for the "exurbs"—that is, commuter communities located beyond the traditional suburban fringe. It and other satellite towns epitomized a phenomenon known as "drive 'til you qualify," which means that if you couldn't afford a home of a certain size and quality in a particular area, you moved to an area where land values were lower. The United States is today littered with the remnants of this trend in the form of so-called zombie subdivisions—distant exurban housing developments where empty lots grow weeds and unfinished houses deteriorate as they await fore-

closure sales. Some of these developments are half built; some have just been platted. Many were planned for thousands of residents and today are occupied by only a few dozen homeowners.

Zombie subdivisions can now be found just about anywhere there are exurbs. For instance, in tiny but fast-growing Teton County, Idaho, there are 33 partially built developments nearing the expiration of their permits, involving over 1,800 lots (upon which only 83 have been built) on 5,300 acres, all of which has had such a significant negative impact that the county is considering replanting almost all the land.[5]

But by far the most numerous examples of this phenomenon can be found in the formerly upbeat Sun Belt states. Among these, few have a greater zombie problem than Florida, where a white-hot real estate market fueled by speculation and loose credit led to massive overbuilding of distant exurban housing. Here, in developments like Antillean Isles, over 30 miles south of Miami, lots that were supposed to contain large up-market homes today contain only subtropical weeds. In the nearby Enclave at Black Point Marina, which was recently foreclosed upon by the lenders, there are 40 partially built homes, 180 empty lots, and no residents. Down the road, in Old Biscayne Villas, vagrants live in unfinished cinderblock structures, while in the Mirage subdivision cars are regularly coated with dust and dirt from the vacant home sites comprising 75 percent of the lots. Throughout Miami's far-flung southern suburbs, homes lost on average half their value in just a year, a decline so extreme that brand-new four-bedroom homes are frequently available for around $100,000. And even at that bargain-basement pricing, people aren't buying. In fact, in a recent bulk sale, a large number of new and unoccupied three-bedroom homes in Antillean Isles were sold for just $70,000, even though many neighbors had paid in the mid-$300,000s for the same homes a few years earlier.[6]

Most people would probably blame this on the collapse of the mortgage market and subsequent global recession that started in 2008. But they'd be only half right. If we examine the geographic distribu-

tion of abandonments and mass foreclosures, it becomes evident that they're disproportionately found in the outer suburbs and exurbs—the most recently built parts of the American housing frontier.

Several studies have looked at the geographic distribution of price declines in housing. A 2010 report from the Federal Reserve Board found that the stock of distressed "real-estate owned" properties, known as REOs (generally foreclosed properties owned by banks or mortgage companies) is now far greater for so-called boomburbs, or recently established suburbs, than for core cities, and that the concentration of REOs increased greatly in the past few years. By early 2010, the percentage of REOs in boomburbs was almost three times that of core cities, and the percentage of delinquencies was double. Furthermore, the report stated that prices in boomburbs fell on average three times more than those in established cores.[7]

A 2008 study by the economist Joe Cortright, who examined the geographic variation in housing price declines, found that although prices were declining almost everywhere as of 2008, the magnitude of decline was considerably greater for neighborhoods that were distant from the urban core. He attributed these geographic differences in price declines to the steep rise in fuel prices from 2004 to 2008, during which time gas went from an all-time inflation-adjusted low in 1999 to an all-time high in 2008. In other words, cheap gas fueled the expansion of the housing frontier into distant satellite communities like Rio Vista by making multi-hour commutes economically feasible. These areas of the housing market were therefore the most vulnerable to rising gasoline prices.[8]

Another 2010 study from the Federal Reserve Board found that gas prices had a significant effect on suburban housing construction; a 10 percent increase in gas prices resulted in a 10 percent decrease in construction in distant suburbs relative to central cities, meaning that the run-up in prices just between February and June 2008 would have been enough to reduce construction by one-third in these far-flung areas. At least some in the mortgage finance world anticipated this kind

of effect well before rising gasoline prices took their toll. A 2006 article from a mortgage-industry trade publication predicted that "there is a possibility that homebuyers will find the price/cost trade-off is no longer feasible. This could drive down the price of housing in far-flung suburbs and put an additional premium on homes that are close in or with access to public transit systems. . . . If energy prices continue their upward climb homeowners are going to be unable to afford the big homes they have been demanding for the last two decades."[9]

One of Cortright's most interesting findings was that the distance of the suburb from the central city mattered less than what sort of metropolitan area it was part of. When looking at the overall health of the regional housing market, metropolitan areas with more "vital" urban cores were found to have fared better in the housing downturn than those without ("vitality" was defined as a high spatial concentration of people with advanced educational levels within the core relative to the periphery). In other words, metropolitan areas where differences between the core and periphery are modest (like Phoenix and Las Vegas) experienced steeper declines in housing prices and greater foreclosure rates overall than those areas with defined centers and clear density gradients (like New York and Portland, Oregon).

None of this proves exactly how rising energy prices will affect the economies of high- versus low-metabolism cities. But it does suggest that the layout of metropolitan areas will begin to matter more as energy becomes more expensive. As John Norquist, president of the Congress on New Urbanism and former mayor of Milwaukee, told me, "If you look at the difference between Europe and the US in terms of energy consumption, it's almost all accounted for with human settlement pattern and the availability of transit. . . . We're completely in favor of energy efficient lightbulbs. Building materials, green building, using insulation appropriately, thermal windows—these things are all spreading and being used like crazy. But human settlement is the one big thing that could be done that would really change things—the one big thing that hasn't been popularly embraced."[10]

Places like Hearth and Home at Rio Vista pushed the outer limits on a certain type of settlement pattern. Maybe this settlement pattern is inherently unsustainable, or maybe we just built too much of it. Whatever the reason, there are lessons to be learned in those lonely, weed-choked streets.