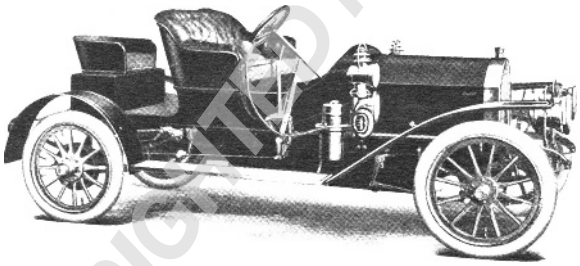
Part I

THE MAKING OF OUR ENERGY APPETITE



Chapter 1

After the Banquet

It seems fitting that Henry Ford and Thomas Edison—the two men most associated with growing our energy appetite—met at a banquet. The occasion was the concluding ceremony of the Seventeenth Annual Association of Edison Illuminating Companies, held in August 1896 at Manhattan Beach on Coney Island.

Henry Ford was 33 years old and had been working at Detroit Edison for five years, but he was already chief engineer for a company that supplied electricity to 1,000 residents and 8,000 streetlights in the Detroit area. Thomas Edison, 16 years Ford's elder, was the ambitious younger man's lifelong idol. Ford was part of the generation Edison inspired when he gained worldwide fame in 1882 for building an electric power plant and illuminating the buildings of lower Manhattan. With his industrial research laboratory at Menlo Park, his bold predictions about the future, and his many imaginative inventions, Edison made great feats of science and engineering seem both exciting and attainable. For Ford, as a young man experimenting in his spare time with gasoline-powered engines in the barn behind his house, it meant a lot when he read in

P1: OTA/XYZ P2: ABC
c01 JWBT094-Tertzakian May 6, 2009 7:35 Printer Name: Yet to Come

a newspaper the year before that Edison had proclaimed the horseless carriage "the coming wonder"[1] and predicted that cities would one day be filled with them. That's how Ford saw the future, too, and he was awestruck as he sat at the far end of Edison's head table at their company's yearly send-off dinner.

Edison was hard of hearing, and temperamentally disinclined to large gatherings, but he was always interested in keeping tabs on the work of his most promising engineers. As knives and forks clinked against plates, the conversation turned to the problem of batteries for electric cars. Edison leaned forward to listen. Today, most of us think of the electric car as a possible future alternative to the traditional gasoline-powered automobile. In Edison's day, there were a number of options—including steam, the internal combustion engine, and electricity—all battling to become the accepted standard for propelling motorized vehicles. In fact, battery power was the more popular consumer choice at the time—and it was certainly the standard that was in the best interest of the men at Edison's table, who were all in the electricity business. But Edison held serious doubts about its prospects, understanding clearly that the electric car would be forever limited by the short distance the vehicle could travel before needing to recharge.

Down the length of the table, the men discussed the latest developments in battery technology with enthusiasm and confidence, as though trying to impress Edison with the progress being made. Of course, batteries were the answer—electricity, after all, was the wonder source. But Edison dismissed some of the notions and ignored others, his own interest in the conversation waning. To spark things up again, Henry Ford's boss, a man named Alexander Dow, mentioned offhandedly that his young chief engineer was on the other side of the fence, technologically speaking. Ford was a proponent of the gasoline-powered car. It was a ridiculous idea, and Dow described an amusing scene to accompany it. Ford was fond of driving his wife and son in a four-wheeled quadricycle of his own invention up to the walls of the Detroit Edison Company. Dow had been drawn to the window to see it, annoyed by the idea that his best engineer was wasting his time on such a diversion, accomplishing little more, he believed, than scaring horses with a loud engine and forcing pedestrians off the road.

Instead of joining the other men in their tone of good-humored dismissiveness, Edison began asking Ford pointed questions about his

hobby. While the senior engineers and businessmen lost interest and mused about the meal and the convention, Edison and Ford were soon sitting side-by-side, deep in conversation.

Ford sketched out his engineering ideas on scrap paper and Edison pressed him on the nuances of cylinders and pistons. The questions and answers went on at length until even a curious listener might have turned attention elsewhere. Then Edison sat back in appreciation and banged his fist on the table. "Young man, that's the thing!" he said enthusiastically. "You have it. Keep at it. Electric cars must keep near to power stations. The storage battery is too heavy. Steam cars won't do either, for they have a boiler and fire. Your car is self-contained, carries its own power plant, no fire, no boiler, no smoke, and no steam. You have the thing. Keep at it!"[2]

Ford was ecstatic. To get that kind of affirmation from the man who had done more than any other to invent the modern world was a thrilling moment in his young life. Edison's words inspired Ford three years later to shore up his own entrepreneurial courage and leave the security and prestige of his position at Detroit Edison and found the Detroit Automobile Company. There he would begin development on a series of cars, tirelessly tinkering with a vision in mind, each new vehicle solving more problems and getting closer to the achievement of the first ever mass-produced car, the Model T.

Edison's prophecy came to pass. Ford's motorized vehicles were the coming wonder. Twenty or so years after their first meeting, Ford's success, wealth, and fame would outstrip Edison's (who Ford admitted, with regret, was the world's worst businessman). But Ford never stopped revering Edison and wondering at the impact of his ideas. The two men eventually renewed their acquaintance and became good friends. Ford funded some of Edison's later work and built a shrine for him in his museum in Dearborn, Michigan. Every year, the two men took a car camping trip with whichever president was leading the nation at the time. They called themselves the Vagabonds and took pride in how dirty they got while exploring the great outdoors.

By then, automobiles were everywhere, as were light bulbs and power lines, those innovations spreading outward in a spiral of change and economic growth, the ramifications of which we're still experiencing today. The way we work, live, and consume goods has never been the same since. As I aim to show you, our energy appetite also expanded as

P1: OTA/XYZ P2: ABC
c01 JWBT094-Tertzakian May 6, 2009 7:35 Printer Name: Yet to Come

a result of those two men in ways that even the great Edison couldn't imagine. The meal shared by Edison and Ford at that banquet in Coney Island was just the beginning of America's, and indeed the world's, never-ending energy feast. To power the modern societies Edison and Ford made possible, immense quantities of oil, coal, natural gas, and uranium have been consumed over the century that followed.

The problem we face today is what to do now that the great banquet is over.

The First Principle of Energy Consumption

Innovations like electricity and the automobile change our lives. Because they bring us many advantages, we want them and readily accept the changes they bring to our lifestyles and behaviors in comfort, efficiency, and productivity. Our economy grows and our standard of living improves as a direct result of these life-altering inventions. We consume more energy, too. In fact, the relationship between economic growth, an improved standard of living, and an expanded energy appetite is so strong and so consistent throughout history that I call it the *First Principle of Energy Consumption*.

Simply put, this principle means that the better off you are, the more energy you use. History bears this principle out. During the early agrarian age 6,000 years ago, human beings increased their energy appetite when they first yoked the ox and used its power to till fields and draw water from wells. The ox was just as much an energy-consuming device as an automobile or a vacuum cleaner. For the early farmer, the increase in productivity that resulted made oxen a compelling alternative to doing the same work by hand. After all, human muscle provides about 35 watts of power, a mere one-twentieth the power of a large animal. All the farmer needed to do to generate this extra power was to supply the ox with hay—the biofuel of the day.

At the same time, however, as the benefits of this power source were realized and reliance on oxen increased, so did the farmer's dependence on energy. In order to get more work out of the ox, the farmer needed to grow more hay. Of course, if the farmer didn't see a net benefit from his efforts, there wouldn't be any reason to increase his appetite

for energy. But the work supplied by the ox, even taking into account the extra work required to grow and harvest the hay, produced a surplus of energy that could be devoted toward improving quality of life. The farmer won time to till more fields and produce more food, raise a larger family, build a better house, see to religious concerns, manage the affairs of government, contribute to communal defense, tell stories, sing songs, make crafts and produce art, or have surplus to pay to be entertained by those who did.

Consider something closer to our times. You may not have heard of Gaius Sergius Orata before, but he was the Edison or Ford of his time. A Roman merchant and engineer with bright ideas, entrepreneurial inclinations, and a gift for getting things done, Orata invented the *hypocaust* about 2,100 years ago.

Orata's hypocaust—from the Latin word meaning "heat from below"—was a kind of centralized home heating system for the typical Roman villa. In order to build it, the foundation of the villa was constructed with small pillars to create a crawl space beneath the stone floors. Outside the house, a slave was needed to tend twigs and logs in an attached, subsurface fire place, and the resulting hot air was then channeled through the crawl space, heating the cold stone floors and providing the family inside with climate controlled comfort all winter long.

Orata's innovation was received with open arms by the Roman world. Prior to this, living through cold, damp European winters was not easy, especially in the north. Houses were drafty and lacked fireplaces, so people wore wraps or heavy clothes and shifted their activities to whichever rooms were being warmed by the sun. The only artificial heat came from small charcoal braziers— metal containers with legs and handles that could be moved from room to room. Though primitive, such devices were a cheap and relatively effective system, and are still in use in parts of Italy today.

When the hypocaust came along, it offered a significant upgrade over the smoky charcoal brazier. Soon, it became a popular addition to homes and Orata became wealthy buying estates, retrofitting them for his hypocaust, and selling them to those eager for the quality of life improvements afforded by his innovation. Indeed, Orata's idea caught on in unanticipated ways. Roman builders soon began engineering systems that funneled hot air through hollow channels between stone walls as

P1: OTA/XYZ P2: ABC
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well as below the floors. Later, Orata's system was adapted to heating water in communal bathing facilities. The famous Roman bath was the result, a tangible symbol of the luxury and quality of life the people of that ancient empire enjoyed.

It's easy to appreciate why the Romans would readily adopt Orata's new technology. Imagine your own life without central heating in the winter—indeed, without stoves, electric lighting or a car—and picture how eagerly you might snap those advantages up as soon as they became available. When we think about such devices, however, we rarely consider the fuel or energy required to make them work and we don't calculate or project how much our energy appetite will grow as a result. Instead, we long for the luxury or the convenience, and only worry about the fuel when it becomes too costly or inconvenient to obtain.

Charcoal was the primary fuel used for heating and cooking in ancient Rome, as it was in Europe until well after the Industrial Revolution. Charcoal is the result of wood burned in the absence of oxygen. As a fuel, it has many advantages—it is relatively smokeless and odorless; it is very portable, easy to ignite, and burns for a long time. The wood required to heat hypocausts is less efficient than charcoal and, on its own merits, would seem to be a step backward. But the charcoal brazier had its limitations and the hypocaust had plenty of compelling advantages. The hypocaust was fueled by great quantities of wood, replenished and fed, of course, by the attendant slaves. As wealthy Romans began to appreciate their improved quality of life, the innovation spread. More hypocausts, more luxury, and more wood were needed. The logical conclusion? The use of the hypocaust in more and more houses and community baths was directly responsible for the deforestation of land wherever the innovation took hold. In order to feed the growing Roman energy appetite, the great forests of Europe literally went up in smoke.

The hypocaust is just one example of how advanced societies achieve a higher standard of living through increased consumption of energy. Once we have become accustomed to the advantages of a new energy-consuming technology like the hypocaust, or in our case the light bulb or the automobile, we do not voluntarily choose to give them up. In fact, from the time humans first learned to use fire in a controlled

manner, with each standard of living improvement throughout history, our appetite for energy has grown ever larger.

Breaking that 6,000-year super trend—the empirical law that I call the First Principle of Energy Consumption—is what this book is about. Can we, the world community, figure out for the first time in our history how to keep improving our standard of living while actually cutting back on the amount of energy we consume? I believe we can, but first we must understand the complexities behind the evolution of our dependence on energy.

The Way We Live

There's nothing simple or easy about curbing energy appetite. Without energy and energy-consuming devices, our modern life is unthinkable. Every i-Phone and laptop, every gas station and subway, every cup of coffee and bowl of cereal—every commodity we use, consume, or enjoy embodies the energy needed to produce it, deliver it to our hands, and turn it on. Think of a time in your life when the power went out or you ran out of gas—how helpless and disconnected that made you feel. The car engine, the refrigerator, the battery on the telephone were immediately revealed to be essentials that you took for granted until their power source was removed. Just imagine the chaos it would bring if these essentials were unavailable for any length of time.

One such time was the massive blackout that started at 4:11 P.M. on August 14, 2003 when a power plant in Cleveland, Ohio, went offline. The blackout spread in a chain reaction across much of northeast North America, as the regional electricity grid effectively short-circuited itself. Suddenly, fifty million people were given a hands-on lesson in how wired our world is, even in a supposedly wireless age, and how pervasively energy is integrated into the way we live.

In New York City, the birthplace of the electric grid, the abrupt power failure was particularly jarring. This wasn't another 9-11, but the disruption and confusion that ensued had people thinking it was. On Wall Street, computer terminals and television screens went dark without warning, as they did all over the city. Subways came to a sudden halt, and 400,000 passengers found themselves stuck beneath the ground. In office towers, elevators stopped working, trapping employees inside, air

P1: OTA/XYZ P2: ABC
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conditioning units and fans went dead, and many thousands of workers began the trek down long, dark stairwells, lighting their way with the low glow of their cell phone screens. The streets filled up as department stores and shops and train stations emptied. It was a brutally hot afternoon, and there was no place to get cool. Vendors, sensing the opportunity, immediately began selling their bottled water and ice cream with extra zeal.

Using our Blackberries and cell phones, we've grown accustomed to being in contact with anyone, anywhere, at any time. When the power went out, that infrastructure of instant communication collapsed as circuits got overloaded and area cell towers ceased to function. Those trying to reach their loved ones and coworkers formed long lines at the pay phones still in operation. The electronic billboards that bathe Times Square in a constant neon light were dark, the endless flow of information and advertising cut like a ribbon. Anyone with a portable radio drew listeners around them as people were eager to get news about what had happened, even as they were puzzled by what to do next and how to get home.

Without subways and commuter trains, the mass transportation system was nonexistent. Taxis and buses could not begin to handle the overflow. The tunnels were closed for safety and security so the only way out of Manhattan, suddenly an island again, was to walk across the bridges. Tens of thousands began the trek in the heat, slinging jackets over shoulders, opening shirt collars, kicking off uncomfortable shoes. The exodus was another reminder of 9-11, but this time the mood was calm and peaceful, even jovial, as everyone marveled at the city emptying out one step at a time. In the boroughs, travel by car was an adventure in chaos and a lesson in social adaptability. Some 11,600 traffic signals were out of order. Inevitably, at least one civilian took charge at every major intersection, standing tall in the middle of the traffic, directing the cars to go forward or wait, accepting bottles of water or baseball caps from grateful drivers passing by, enjoying the cheers and thanks.

Grocery stores, corner delis, and restaurants needed to sell their perishable goods or throw them out. Home refrigerators needed to be emptied, too. Prices on food plummeted even as the cost of batteries, flashlights, candles, bottled water, and portable radios went up. But anyone without cash in their wallet before the power went out couldn't buy what the stores and street vendors were selling. Cash registers didn't

work, credit cards couldn't be used, and ATMs were sealed as tightly as Egyptian tombs. You couldn't even fill your car with gas, since the pumps, run by electricity, were also out of order.

And yet for one night the city got by. The mood was upbeat, the troubles few. Bars and public squares became gathering spots as spontaneous parties and barbeques broke out. Most people relaxed on their stoops, gathered with neighbors on the sidewalk, or leaned out their windows to get air. For once, you could see the stars twinkling brightly in the sky, but the darkness at street level was stunningly thick and disorienting. Here and there generators hummed—and certainly in the hospitals, babies were still being born, operations taking place, patients being cared for—but even the most iconic landmarks, like the Chrysler Building and the Empire State Building, were utterly dark.

For many, it was that image of the New York City skyline at night that seemed most strange. The strings of lights across the bridges, the sparkling buildings, the amassed collection of all that commerce, finance, culture, and humanity: everything had gone black. It would be several days before power was fully restored to the city, as block by block the lights and air conditioners and refrigerators came back to life. It was a short-lived energy fast that changed not a bit the long-term appetite for energy in the United States. Within a week, New York and the rest of the country were back to business as usual.

Breaking the First Principle

The bright lights of New York may provide the iconic image of a modern metropolitan skyline, but on the other side of the world in Asia, new types of cities saw an unprecedented burst in growth and wealth over the past decade. Shanghai—the New York or London of the rapidly industrializing third world—is a modern marvel, with striking architecture, rapid economic growth, and an exhilarating pace of life. Billboards, traffic jams, and skyscrapers are ubiquitous. Air conditioners, high tech lighting, refrigerators, large screen TVs, computers, and cell phones are the norm. As a result, residents of Shanghai have experienced a dramatic increase in energy appetite over the past few years. To feed that hunger, giant hydroelectric dams have been built, valleys and villages flooded,

and thick power cables strung across the countryside on immense steel towers. Throughout China, with government policies and economic growth steering the change, urban lifestyles are expanding and wealth is growing as a once dormant fifth of the world's population has begun buying the cars, modern living spaces, and refrigerators we all take for granted. The scale of that shift and the impact on our global energy appetite cannot be overlooked.

Elsewhere in the world, whether in Bangalore, Toronto, or Mexico City, energy appetite has surged as twenty-five years of strong economic growth and increased trade and development have deepened and spread. Up until the financial crisis of 2008, in the West, we were feeling the pressures of this global energy demand more acutely than in past decades because the collective economies of China, India, and the other aggressively industrializing countries were suddenly competing on the same field for fuels like crude oil, natural gas, and coal. In the intensified scramble for limited resources, energy supplies were tightening, prices were being driven up, and the possibilities of geopolitical conflict were growing, even as we further stressed the world's ecosystem by exploiting and burning fossil fuels. But how do we tell the developing world that it is okay for us to have grown obese on consuming all of the world's cheap energy, but it would be better if they remained malnourished and underfed? In our comfortable society of plenty in the west, we may overlook the underlying importance of energy to the way we live, but nations like China and India understand that an appetite for energy *is the fundamental means of achieving the "American Dream*," a dream they now wish to share in themselves. Regardless of the financial crisis, they want what we have, and they know that they need reliable, plentiful energy to get and maintain it.

Today, whenever we debate the many energy problems we face, it's easy to lose sight of the great benefits that have come about because of our growing dependence on fossil fuels. As a society, we have become increasingly addicted to energy because we thoroughly enjoy the standard of living that energy-consuming devices and services make possible. In previous eras, our appetite for energy was relatively low, but so was our quality of life. In the medieval age, most people survived at a subsistence level through the labor of their own hands, while kings and lords lived off the labor of others—much like early farmers lived off the work of oxen

and Romans lived off slave labor. The industrial revolution increased our energy appetite dramatically as a higher standard of living reached more and more people. Even those we think of as moving from the idyllic countryside to overcrowded cities and awful factory conditions did so not because they were forced into slavery, but because the industrializing cities, however grim, still represented a step up from where they came from. Energy-consuming devices like the air conditioner, the light bulb, and the car serve us like slaves and make kings of us all. But what do we do now that our energy appetite has grown so large that it threatens our energy supply, our environment, and our political stability?

The answer is that we must reduce our overall energy consumption while still improving our quality of life, not only in the comfort of the richest nations on earth, but around the world, where standards of living are just beginning to rise. Admiral Hyman Rickover, the father of the American nuclear navy and an adviser to President Carter during the energy crisis of the 1970s, observed that, "A reduction of per capita energy consumption has always in the past led to a decline in civilization and a reversion to a more primitive way of life."[3] And he's right. If we were to sufficiently ration, conserve, or cut our energy appetite today in order to bring a measure of balance to our consumption levels, the impact on our economy would be immediately painful and harmful to our standard of living. You need only think of long lines for gasoline in the United States or the impact of the coal miners' strike in the United Kingdom in the 1970s to recall societies that were under stress, economically challenged, and jarred out of a comfortable lifestyle because their supplies of important sources of energy were curtailed. In comparison, those events were only short-term periods of discomfort compared to the potential challenges we are likely to be facing in the not-too-distant future.

Few of us today, no matter what our political or economic values, would eagerly embrace a decline in our standard of living and an adoption of a more primitive way of life through a major reduction in energy appetite. And what politician would risk their political future on a platform that mandated, regulated, or inhibited lifestyles we have come to think of as part of our birthright? Since President Nixon imposed a 55 mph speed limit and President Carter wore a sweater on national television to argue for the imperative of conservation, few have had the courage to try. It's far easier for our leaders to win elections on the

promise of economic growth without acknowledging the corollary of their promise: that it requires an ever-increasing amount of energy to sustain that growth.

Edison and Ford did not create our energy appetite when they met at the banquet in Coney Island; they just catalyzed a new and particularly steep phase of its growth. Our problem is not energy. We need energy, and always have and always will. Our problem is that our current lifestyle is predicated on an overconsumption of cheap energy calories beyond what is healthy or sustainable for the rest of the world. Additionally, our options for getting more out of the energy sources we currently depend on, or obtaining new, secure sources as reliable substitutes to sustain the way we live, are more limited than most of us realize.

Meaningful changes in the world of energy take decades, if not centuries, to realize. Even so, most of the discussion among experts, policy makers, and concerned citizens is about changing the nature of our energy diet—by substituting traditional energy sources with new or improved alternatives such as solar power, biofuels, or wind—or on converting more energy into useful work through improvements in efficiency. Although these are efforts worthy of scientific and entrepreneurial endeavor and undeniably part of the overall solution, even revolutionary success in such areas will not be enough to give everyone on this planet sufficient cheap, clean, and secure energy to satisfy our growing global appetite, especially over the next few decades. The reality of our energy needs—the hard numbers, the objective analysis, the global perspective—requires that we break out of the paradigm in which we are currently looking for answers and start seeking solutions elsewhere.

At the same time, nobody wants to think about taking a step back in quality of life, particularly when that change is being forced on them. For 6,000 years, energy consumption and growth in energy demand have gone hand-in-hand as part of *the First Principle*. So how do we break *the First Principle* and reduce our appetite for energy while still growing our economy and improving our standard of living?

I believe that new generations of Fords, Edisons, and Oratas will save the day. Indeed, their inventions, innovations, and progress in developing new technology are already shifting our lives in ways few of us have yet to grasp. Before this book ends, I will tell you what those converging technologies and social changes are and explain how they are shaping a world in which energy appetite can actually be reduced. Luckily, it's

not a grim or depressing picture of a diminished standard of living and a stagnant economy. Instead, it's a brand-new reality that we will embrace because the new lifestyles, comforts, and entertainments, as well as more efficient and productive ways of working, will improve our lives.

To glimpse that future, imagine a lifestyle, not twenty years from now but less than ten, which doesn't center on working in a tall office building far away from your home. No more long commutes or traffic jams. No more cultural isolation in a distant suburb. Instead, you go to work on foot or in a light natural gas or electricity-powered car to the corporate headquarters in your neighborhood. Actually, it's not just *your* corporate headquarters; it serves many of your neighbors, most of whom work for a different company or in a different occupation. You like going there because it's a hub of activity. There are coffee shops, restaurants, stores, fitness centers, medical clinics, a post office, and bank outlets on that block. Inside the building, you greet familiar faces and enter a room. You enter alone but once inside people surround you. Some of those people notice you coming in and look up from their work to greet you. It's taken you some time to get used to the fact that none of these colleagues are actually present in the room. Instead, what you're seeing is their vivid and clear images projected on the telepresence wallpaper. Similarly, the communication between you and them is instantaneous, so you can not only see them but speak to them in real time as well. Occasionally, you get a visit from one of your customers or partners, and the scenery changes to allow for private consultation. You might also replace the colleagues on your display with a calm nature scene or family photos when you take a break.

Your work awaits, and you get down to it. The morning's schedule is packed with meetings, and you marvel at the fact that a few years ago every one of those events would have required a separate airplane trip. You still remember how arduous and frustrating such trips can be. These days, you only travel by plane when you want to go on vacation or make essential in-person contact; the congestion, frustration, and long waits at airports have been reduced a great deal. At lunch, you have time to see your family or friends because everyone is nearby. After work, there's a special occasion and you hurry home. It's your oldest daughter's birthday. She's away at college and has no time to come home for the weekend, but she nevertheless joins the family at the dining room table for the birthday celebration. Everyone sings and the dog, always confused by who's really

P1: OTA/XYZ P2: ABC
c01 JWBT094-Tertzakian May 6, 2009 7:35 Printer Name: Yet to Come

there and who's not, wags his tail excitedly. The dinner table conversation is about school, work, the upcoming Superbowl, and a vacation you're planning for Mexico. Your youngest daughter tells everyone about her recent exams. She goes to the neighborhood school and sits in a classroom with her friends, but a few of her more exciting electives are with teachers from other parts of the world. That still amazes you, but she finds telepresence kind of boring, actually. She much prefers the online gatherings in which she meets friends in their avatar forms. Sometimes they go shopping or watch a movie that way. You don't approve of the risqué way she dresses her avatar, but that's what being a teenager is all about.

On Saturday morning, you and your wife go for a hike in the countryside with the dog. When you get back, your water heater has left a message on the household message board that it's using too much electricity. You'd noticed the increase in home energy consumption a few days ago because the orb on your kitchen counter was glowing a pale yellow rather than green. Now you've confirmed the reason. You've found a copy of an automatic e-mail your home energy computer sent to an electrician identifying the problem. A simple confirmation will have him come to your house on Monday and have the appliance repaired. It's getting late in the afternoon, so your wife squeezes in a workout in the basement fitness room. The avatar instructor chides her jokingly for missing a few days. That evening, you join two other neighborhood couples at a restaurant and then go to the neighborhood concert hall where Yo Yo Ma is playing. He's not actually at your neighborhood performance center, he's playing at Lincoln Center in New York, but the three-dimensional image on the stage and pristine quality of the acoustics make the experience essentially the same as an in-person appearance, at a much lower ticket cost. The standing ovation surprises you because suddenly the view is blocked by people who are actually attending the event in New York.

Over coffee you talk about the music. The concert was great, but you're more excited about the big game tomorrow. You've got three cameras reserved at the Superbowl in Miami. It will be like following the action from the 50 yard line. You'd been skeptical about paying extra for the service when it first came out two years before, but once you'd experienced sports filling up the entire wall of your family room with a picture so clear you can see sweat on skin, it was impossible to go back

to simple TV. Besides, the prices and energy consumption rates have come down so much, it only made sense to switch.

Does all of that sound unlikely—a fantasy of science fiction? I'm not claiming I know the exact look and feel of our world five or ten years from now, but I do know the coming changes are that dramatic, or more. It's possible, looking back at other major shifts in energy consumption over the past 250 years, to predict the way today's technologies and social and market forces might align. Consider the shift in lifestyle that someone living before Edison and Ford would have experienced when things like the light bulb, car, and airplane arrived. Would they have believed it if you'd told them what was going to happen? In a few short decades, American cities were converted from whale lamps and horse drawn carriages to telephones and family cars. More to the point, think of the changes you've experienced in your own life in the last 10 years. The way you shop, communicate, meet people, listen to music, find your way when you're lost, entertain yourself, and do business have all been utterly transformed. When was the last time you made a call from a pay phone? Do you even think twice about shopping online anymore? Have you used your computer to call or Skype someone for free, even though they're halfway around the world? People born in the last twenty years barely know what it's like to communicate without e-mail, hold a physical plane ticket in their hand, or "dial" a phone. The changes in our own lifetimes have been radical, and there will be a lot more where that came from.

Technology is not the sole answer to our energy problems. Social and policy changes will need to contribute to the overall solution, as will improvements in our current energy infrastructure. I'll address all those challenges and possibilities in the chapters to come. But technology combined with enthusiastic consumer demand for new lifestyles will be the real difference maker. Right now, we're blindly focused on searching for answers within the old paradigm of energy, and it's a vision that really needs to shift. Our efforts to find new forms of energy, alternative sources for the energy we already consume, and different ways of reducing waste and carbon emissions are all vital, but they are insufficient for handling the magnitude of the problems we face. Instead, we need to embrace habits, lifestyles, mind-sets, and technologies that might seem on the fringe now, but will soon become part of the new way we live.