The Meeting of Edison and Ford

Excerpt from *The End of Energy Obesity* by Peter Tertzakian with Keith Hollihan

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Chapter 1
After the Banquet

It seems fitting that the two men most responsible for growing our energy appetite over the 20th century met at a banquet. The occasion was the concluding ceremonies of the 17th 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 1000 residents and 8000 street lights in the Detroit area. Edison was Ford's lifelong idol. Ford was one of the young boys whose lives Edison had inspired when he gained worldwide fame for building an electric power plant in 1882 and illuminating the buildings of lower Manhattan. With his industrial research laboratory and his bold predictions and his many patents, Edison made great feats of science and engineering seem possible. As a young man toiling in his spare time on a horseless carriage, it had meant a lot to Ford when he read in a newspaper in 1895 that Edison 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 to be sitting at the far end of Edison's head table.

[1] Wheels of the World

Edison was nearing fifty, hard of hearing, and temperamentally disinclined to large gatherings, but he was always interested in learning about the latest ideas in technology. At some point, as the meal was being eaten and the knives and forks clattered, the dinner table 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 – but in the late 19th century, there were a variety 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 in those early days – and it was certainly the standard that was in the best interest of the men at the convention who were all in the electricity business. But Edison held serious doubts about its prospects. As the master of mass adoption, he knew that the popularity of the electric car would be forever limited by the range of distance the vehicle could travel without recharging.

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 that was being made. Of course, batteries were the answer. Edison dismissed some of the notions and ignored others, his own interest flagging. 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 as a proponent of the gasoline-powered car. 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 like anyone else to see it, annoyed by the idea that his own best engineer was wasting his time on such a diversion, scaring horses and pedestrians.

But instead of joining the other men in their tone of good-humored dismissiveness, Edison began asking Ford pointed questions about his hobby, showing sustained interest for the first time in any topic. The conversation at the table splintered. The other men mused about the meal and the conventions events to come, while the great Edison and the young Ford were soon sitting side-by-side like co-conspirators having a detailed private conversation.

Ford sketched out his engineering ideas on napkins and Edison pressed him on the nuances of cylinders and pistons. The questions and answers and debate went on at length. Then Edison sat back in appreciation and banged his fist on the table. “Young man, that’s the thing!” he said loudly and 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]

The deserts arrived but I wonder if Ford was able to eat. To get that kind of confirmation from the man who had done more than any other to change the modern world was a thrilling moment in Ford’s life. It inspired him to shore up his own entrepreneurial courage. Three years later he left the security and prestige of his position as general superintendent at the Detroit Edison Illuminating Company for his first venture, the Detroit Automobile Company. There he would begin development on a series of cars, with each new version solving more problems and getting closer to his vaunted Model T.

Edison was right. Motorized vehicles were the coming wonder, and the internal combustion engine – that self-contained mobile power station – was the thing. The two men, Edison and Ford, would become good friends in later years, heading out in one of

[2] Wheels of the World

Ford's cars on camping trips together with whatever president happened to be in the White House at the time. That banquet at Coney Island was a turning point in other ways as well. Within twenty years, automobiles were everywhere, as were lightbulbs and power sockets, a spiral of change and economic development we're still experiencing the impact from today. The way we work, live and consume has never been the same since. And as we shall see, that meal shared by Edison and Ford was the beginning of another great banquet of the 20th century – one marked by our voracious consumption of energy.

You've probably never heard of Gaius Sergius Orata. A Roman with bright ideas, entrepreneurial inclinations and a gift for getting things done, Orata invented something called the *hypocaust* about 2,100 years ago. Doing so, he fortified a historical supertrend: The ever-tightening bond between the way we live, and the energy we consume.

Breaking that bond is what this book is about. Can we, the world community, figure out how to keep improving our standard of living through the growth of our economy while actually cutting back on the amount of energy we consume? I am an optimist and I think it's possible, but not without recognizing the complexities behind the question and understanding how and why our dependence on energy has evolved.

Living through cold, damp European winters was not easy in Roman times. Houses were drafty and lacked fireplaces so people wore wraps or heavy clothes and shifted to whichever rooms were being warmed by the sun. The only artificial heat came from 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 today.

Orata's hypocaust – from the Latin word meaning heat from below – was a kind of centralized home heating system involving an architectural redesign of the typical Roman villa. The foundation was raised with small pillars to create a basement crawl space. Outside the house, a slave tended twigs and logs in a controlled-fire chamber, and the resulting hot air was channeled beneath the chilly stone floor providing the family inside with comfort from the cold. Offering a significant upgrade over the traditional lifestyle, the hypocaust would prove to be a popular addition to homes especially in the northern regions. Indeed, Orata increased his own wealth by buying estates, refurbishing them and selling them to those eager for the quality of life improvements afforded by his invention. Innovation took root and Roman builders soon began engineering systems that funneled hot air through hollow channels between stone walls. Later, Orata's system was adapted to heating water in communal bathing facilities and the Roman bath became a popular and culturally entrenched luxury.

Interestingly, radiant heating is making a serious comeback in houses today, because of the efficiency and comfort of the system. It's easy to imagine wanting a hypocaust if we were wealthy Romans. Central heating in a cold climate is just as essential to quality of life as air conditioning in a hot one. But we rarely consider the fuel that makes such an improved standard of living possible. In the main, charcoal was the primary fuel the Ancient Romans used for heating and cooking. As a fuel, charcoal had

many advantages – it was nearly smokeless and odorless; it was also very portable, easy to light and burned for a long duration. Orata's hypocaust offered a compelling alternative to the charcoal brazier, however, and increased the amount of wood consumed in the Roman energy diet as a result. This put greater strain on a resource already in heavy demand for the building of ships and houses. Deforestation was a serious issue in the Mediterranean world. Indeed, the degradation of the environment through our energy use is not a new problem limited to our own era.

But more than anything, the hypocaust illustrates how advanced societies begin achieving a higher standard of living through controlled consumption of energy. Once a society experiences the compelling advantages of energy-consuming technologies, it does not voluntarily choose to give them up. With those standard of living improvements, our appetite for energy grows and grows. We're seeing the logical extremes of that appetite today.

Even as we grapple with the great problems of our own energy intensive age – the depleting resources, the environmental impact, the insatiable demand for more and more – we somehow overlook the reasons why we consume so much energy in the first place. We have an appetite for energy because it improves our standard of living by growing our economy, making us healthier and wealthier, keeping us comfortable and connected, and enabling us to build, shop, travel and play. But the success of our current energy diet has led to obesity – an overconsumption of cheap energy calories beyond what is healthy or sustainable – and we are feeling that anxiety now.

Our symptoms of energy obesity consist of a trio of pressing problems: rising costs, increasing vulnerability in our energy security and a growing concern for the environment and climate. Since 2002, you've likely noticed these symptoms becoming rapidly more acute.

For a generation, oil seemed cheap and plentiful, then suddenly it wasn't, and now we've become accustomed to the idea of $100 a barrel. Of course, it's not only the high price of oil that is threatening our perceived birthright to affordable energy. All primary fuels – coal, natural gas, oil and uranium – have at least tripled in price since we welcomed in the new millennium. In terms of security, the usual lingering tension in the Middle East is being compounded by muscle flexing from emboldened, oil-and-gas-rich nations like Venezuela and Russia, and by the sense that we are beginning to jostle uncomfortably with emerging economic powerhouses like China in the scramble for new reserves in ever-more extreme and dangerous parts of the world. Then there is global warming. After many years as a fringe issue, concerns about our climate are now mainstream and urgent. Companies and communities are going green, people are learning they have a footprint, and carbon emissions, caps, and trades have become the new vocabulary of conservation. Yet there is a naiveté to the debate. The reality is that over 80% of the devices that power our world and provide us with the creature comforts of modern life are supplied by burning fossil fuels that emit greenhouse gases. What are you willing to give up?

Lacking magic bullets and miracles we find ourselves in an era of difficult choice. The conundrum is that efforts to resolve any one of these three symptoms independently exacerbates the other two, often unintentionally. Here are a few brief, simplistic examples to explain what I mean. It's difficult to reduce the cost of energy without degrading our energy security through heavier reliance on foreign oil – after all, oil is still cheaper than most other energy sources, and foreign oil from places like Saudi Arabia is cheapest of all. Home-grown alternative energy sources such as biofuels are considered greener and more secure than foreign oil. But biofuels cost more in dollars, energy input, carbon emissions, and lost agricultural output than we realize; and there are new reports

that turning natural arable land into cropland for such purposes is depriving the planet of a natural carbon sponge and hastening global warming.

Simple, straightforward and benign solutions to supply a lot more energy no longer exist without tough compromises. Even our efforts at improving the efficiency of our energy use through better technologies are usually for naught because we tend to "eat our efficiency gains" by adopting lifestyles that negate the benefits. For example, we switch out our incandescent light bulbs to those slinky-shaped high efficiency compact fluorescents (CFLs), but cannibalize the savings by plugging in more and more consumer electronic gadgets. Or we buy a more fuel-efficient car but then drive it farther than ever because it has better mileage. Meanwhile, offsetting carbon emissions can strike a skeptical observer as this millennium's version of the sale of papal indulgences. (As the jingle went in Martin Luther's day, "As soon as coin in coffer rings, the soul from purgatory springs!") Companies and countries with laudable green intentions often inadvertently produce more overall global greenhouse gases by outsourcing their production to less clean, less efficient nations of the world while shipping manufacturing materials and products over greater distances.

So what then can we do? The good news is that we can solve all three of our contradictory energy-related problems by focusing on the one fundamental challenge that is often overlooked: The quantity of energy we actually consume. If we can drastically reduce our energy appetite – the pressure on our dwindling fossil fuel resources will be lessened, prices will moderate, our environmental crisis will relax, and our energy security situation will improve. What's more, if we focus primarily on energy consumption – measured accurately as appetite – rather than putting so much emphasis on searching for oil in extreme parts of the world, relying on energy effciency improvements as a temporary bandage, making dubious tradeoffs between food and

fuel, or curbing, trading, or burying carbon emissions, we won't fool ourselves by hiding our cake and still managing to eat it, too.

It all sounds good, but how do we go about ending energy obesity? Any successful dieter knows that losing significant weight permanently is not just about vowing to eat less and exercise more, but also understanding the habits, lifestyle, personal history, and mindset that create a relationship with food in the first place. In the same way, to successfully change our energy intake, we need to understand the habits, lifestyle, history, and mindset that have led to our obesity. Only then can we learn to improve our relationship with the energy we are so dependent upon.

Right now, energy obesity is not the focus of the conversation. Instead, 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. But although these are necessary 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 appetite. The reality of our energy needs – the hard numbers, the objective analysis, the global perspective – requires that we broaden the paradigm in which we are looking for solutions, and start considering answers elsewhere. We need to shift our thinking from the way we consume energy, to the reasons why we consume so much.

In other words, our efforts to find alternative forms of energy, alternative sources for the energy we already consume, and alternative means of reducing waste and carbon emissions are all vital, but they are insufficient for handling the magnitude of the difficult situation we are facing. Instead, in this book, I want to talk about habits,

lifestyles, mindsets and technologies that might seem alternative now, but may soon be part of the way we live.

Nobody wants to hear that their lifestyle is going to change, particularly when that change is being forced on them. And really, what politician will risk their political future on an authoritarian platform that mandates, regulates or inhibits behavior? Few 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 have had the courage to try. It's far easier for our leaders to promise us strong economic growth without acknowledging the corresponding need for more and more energy. That's what we want to hear, and no matter how clearly we understand the issues, most of us are highly resistant to changing the way we live, work and play.

But take a moment to consider how much change you have actually experienced in the last 15 years. Many things about your life – the way you shop, communicate, meet people, listen to music, find yourself on a map, entertain yourself, and do business – have been dramatically transformed. When was the last time you made a call from a pay phone? Do you even think twice about shopping on-line anymore? Most of us have embraced those changes or at least tally them on the plus side of the ledger. To have a successful impact on reducing our energy appetite, any potential changes we make to our lifestyle, habits and mindset will need to be just as eagerly and widely adopted.

The Empty Skyline

In practical terms, there's nothing simple or easy about curbing energy appetite, even if everyone were to share the conviction that it is the critical answer to all of our problems. To understand why, it's necessary to fully appreciate what energy brings to our lives. Just consider what happens when the lights go out.

At 4:11 PM on August 14, 2003, a blackout spread across much of northeast North America. 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 9-11, but for a time the disruption and confusion was reminiscent of that day. On Wall Street, the markets had just closed, but the terminals and television screens went dark without warning, as they did all over the city. Subways, powered by electricity, came to a sudden halt, and 400,000 passengers found themselves stuck beneath the ground. In the office towers, elevators stopped working, air conditioning units and fans gave up, and many thousands of workers began the trek down long stairwells promptly without returning to their desks for personal belongings, conditioned by the lessons of the terrorist attack almost two years before. The streets filled up as department stores and shops and train stations emptied. It was a brutally hot afternoon, and there was no place you could go to get cool. Vendors immediately began selling their bottled water and ice cream products with extra vigor, sensing the market opportunity.

Using our Blackberries and cell phones, we're accustomed to being in contact with any one, 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. Long lines formed at the few payphones still in operation with those trying to reach their loved ones and coworkers. 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 large crowds. 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 upended. 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, carrying 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. In the boroughs, travel by car was an adventure in chaos and a lesson in social adaptability. Some 11,600 signal lights 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, plucking bottles of water or baseball caps from grateful drivers passing by, enjoying the cheers and thanks.

The grocery stores, corner delis, and restaurants needed to sell their perishable goods or throw them out. Home refrigerators – those convenient but energy intensive replications of the grocery story aisle – 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 who lacked 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 ATM's were sealed as tightly as Egyptian tombs. You couldn't even fill your car with gas, since the pumps, run by electricity, were out of order, too.

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 barbeque

feasts 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 black.

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 dark. The way we work, the way we get from place to place, the way we communicate, the way we shop – everything about the way we live was disrupted on that day.

The Untold Story

The bright lights of New York City may provide the iconic image of a modern city skyline, but on the other side of the world, cities across Asia have seen an unprecedented burst in growth and wealth over the past decade. Shanghai – the New York or London of the industrializing world – is a modern marvel, its architecture striking, its economic growth and pace of life exhilarating. Air conditioners, billboards, computers, television sets, and skyscrapers have become dominant features of its new environment. As a result, everyone living in Shanghai has seen their energy appetite increase dramatically over the past few years. To feed that hunger, giant dams have been built along the Yangtze River, valleys and villages flooded, and thick power cables strung across the country on immense steel towers.

Nor are Shanghai or New York unique just because they are mega cities. Across the world, whether in Bangalore, Des Moines or Copenhagen, energy appetite is surging as the twenty-five year trend of strong economic growth and increased trade and development deepens and spreads. In the West, we are feeling the pressures of this global energy demand more acutely now than in past decades because the collective economies of China, India and the other aggressively industrializing countries are close to outstripping our own 'western world'. Suddenly, their voracious appetite for fuels like crude oil, natural gas and coal is competing with ours. In the intensified scramble for limited resources, energy supplies are tightening, prices are being driven up, and the possibilities of geopolitical conflict are growing, even as we are doing further damage to the world's sensitive ecosystem. But how do we tell the developing world that it is okay for us to have grown obese on energy consumption, but it would be better if they remained malnourished and underfed? In our comfortable lives of plenty, we may have forgotten the basic importance of energy to the way we live, but nations like China and India understand that an appetite for energy *is the fundamental basis of the 'American Dream*.' They want what we have in the twenty-first century equivalent of Rome; and they know that they need reliable, plentiful energy to get it.

Without energy and energy consuming devices modern life is unthinkable. Today, whenever we debate the many (and often conflicting and contradictory) energy problems we face, it's easy to lose sight of the great positives that have come about during the last two hundred and twenty five years because of our growing dependence on fossil fuels. As a society, we are increasingly addicted to energy because we thoroughly enjoy the standard of living that energy-consuming devices and services make possible. The challenge in reducing our energy appetite or obtaining the calories we need from some other energy source stem from this conundrum. How do we reduce

our demand for the energy sources we rely on now when that is the foundation of our ever-improving quality of life?

In fact, throughout history, the untold story of the rise of civilization is the story of the growth of energy consumption. I call this the “Supertrend” because it runs like a common narrative through every successful society. Six thousand years ago, for instance, the early agrarian age experienced an increase in energy appetite when human beings yoked an ox and used the power of the animal to till fields or draw water from a well. The ox was an energy-consuming device, like 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 horse or ox. All the farmer needed to do in order to benefit from this extra power was to supply the ox with hay – one of the dominant biofuels of that era.

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, or more work out of more oxen, the farmer needed to grow more hay. (We need only think of our own increasing consumption of crude oil to understand this feedback loop.) 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 work required to grow and harvest the hay, produced a surplus of energy that could be devoted toward improving quality of life.

In other words, the farmer, with his labor-saving oxen, had more 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, supply an army to defend his interests, tell stories, sing songs, make crafts, and produce art, or be entertained by those who did.

When archaeologists and historians tell the stories of past civilizations, they typically focus on the cultural outputs of society. Occasionally, they describe key technological innovations, like the yoke and oxen, the hypocaust, or the automobile, and how such devices have impacted the way we live. But rarely does anyone focus on the energy that is needed to make technological devices work, or consider how a secure and ample supply is a critical factor in whether a civilization grows and thrives or weakens and fails.

If energy, as I have said, is the untold story of every civilization, then let's deconstruct that epic tale – repeated again and again throughout history and around the world – into its key plot elements. The story begins when widespread adoption of a pioneering technology leads to an improved standard of living, and an increased demand for the energy that device requires. When pioneering technologies are successful they spur innovation that lead to an array of other devices relying on the same energy source. (For example, the oxen was not only used to till fields and draw water but later to turn a millstone and grind grain; the hypocaust heated floors and later walls and baths.) This explosion of new energy-consuming devices deepens our dependence on energy, and encourages our society to organize itself around obtaining more.

Eventually, if we are very successful and lucky enough to have access to cheap, reliable energy for a long time, our demand for that energy leads to a luxurious lifestyle that in turn leads to potentially unsustainable levels of consumption – what I call obesity. The conflict or crisis arrives when our supply of energy becomes strained, typically through some blended combination of problems including overconsumption, political tension, heightened competition, environmental degradation, or reduction in the quantity or quality of the resource available to us. At that point, we face a fatal choice: do we shrink our appetite – which typically means a decline in standard of living – or do we

manage to find new technologies and new energy sources to recharge our economic growth and continue the long-term trend of growing wealth and improving quality of life?

This is the challenge we face in dealing with a 6,000 year old Supertrend. Before the industrial revolution, our appetite for energy was 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 their slaves. The industrial revolution – and several other key events over the last two and a half centuries – expanded our energy appetite dramatically while bringing a higher standard of living to more people than ever before in human history. Energy-consuming devices like the steam engine, the furnace, and the tractor provide the work of many slaves, and make kings of us all. But what do we do now that our appetite has grown so large that it challenges our supply, and our planet's climate and political stability may be adversely affected by the fuels we need to support the way we live?

Admiral Hyman Rickover, the father of the nuclear navy, and an advisor to President Carter during the energy crisis of the 1970s, has stated 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..." Most energy analysts and economists would agree. If we were to sufficiently ration, conserve or cut our energy appetite today in order to bring a measure of healthy balance to our consumption levels, the impact on our economy and way of life would be immediately painful and harmful to our long-term 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 UK in the 1970s to recall societies that were under stress, economically depressed, and jarred out of a comfortable lifestyle because the supply of important sources of energy were threatened. In comparison, those events

were only short-term periods of discomfort compared to the challenges we may be facing now.

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 because of a major reduction in energy diet. And yet, 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 people realize.

For 6,000 years – from the first farmers, to the Roman Empire, to the industrialized societies – the world's great nations and civilizations have developed according to a simple and direct formula: Standard of living rises in tandem with, and as a consequence of, greater energy use. I call this the *First Principle of Energy Consumption*, a rule that seems as historically inviolable as any law of thermodynamics.

Our greatest challenge today is to learn how to break this increasingly unsustainable Principle. In other words, we must accomplish what no other civilization has successfully managed before: We need to continue improving our standard of living while reducing collective energy demand.

By the end of the first third of this book, I believe you'll agree that breaking the First Principle is essential for our continued success on this planet. By the end of the book, I hope you'll agree that it will be possible to do so.