Negawatt Media

Inside the Outlet

by Joe Symons

America's Electricity Challenge: Urgent, Big, Invisible

Inside the Outlet, pdf

Notes on the PDF Version

Inside the Outlet was designed around many interactive features available only for the Apple iPad. For this pdf version, where possible, the iPad-designed interactive graphics have been replaced with identical content.

Not all graphic images in this book are interactive. Some are simply colorful drawings. Those that are interactive on an iPad say “Tap to enlarge” in the bottom of the graphic window.

In this pdf version, to discover if a graphic is more than just a colorful image, click on it. Most will open a pdf file showing the images that would be available if you were using an iPad. If clicking on a graphic does not open a page, no graphic information is available.

Note that when a clicked image opens a related pdf file, that file may have multiple pages. *Be sure and scroll* to see all the information!

The iPad version has review questions at the end of most chapters. These are deleted in the pdf version.

You can get the iPad version via the Store on the iPad app iBooks; using your iPad, tap the image shown here. The book is free.

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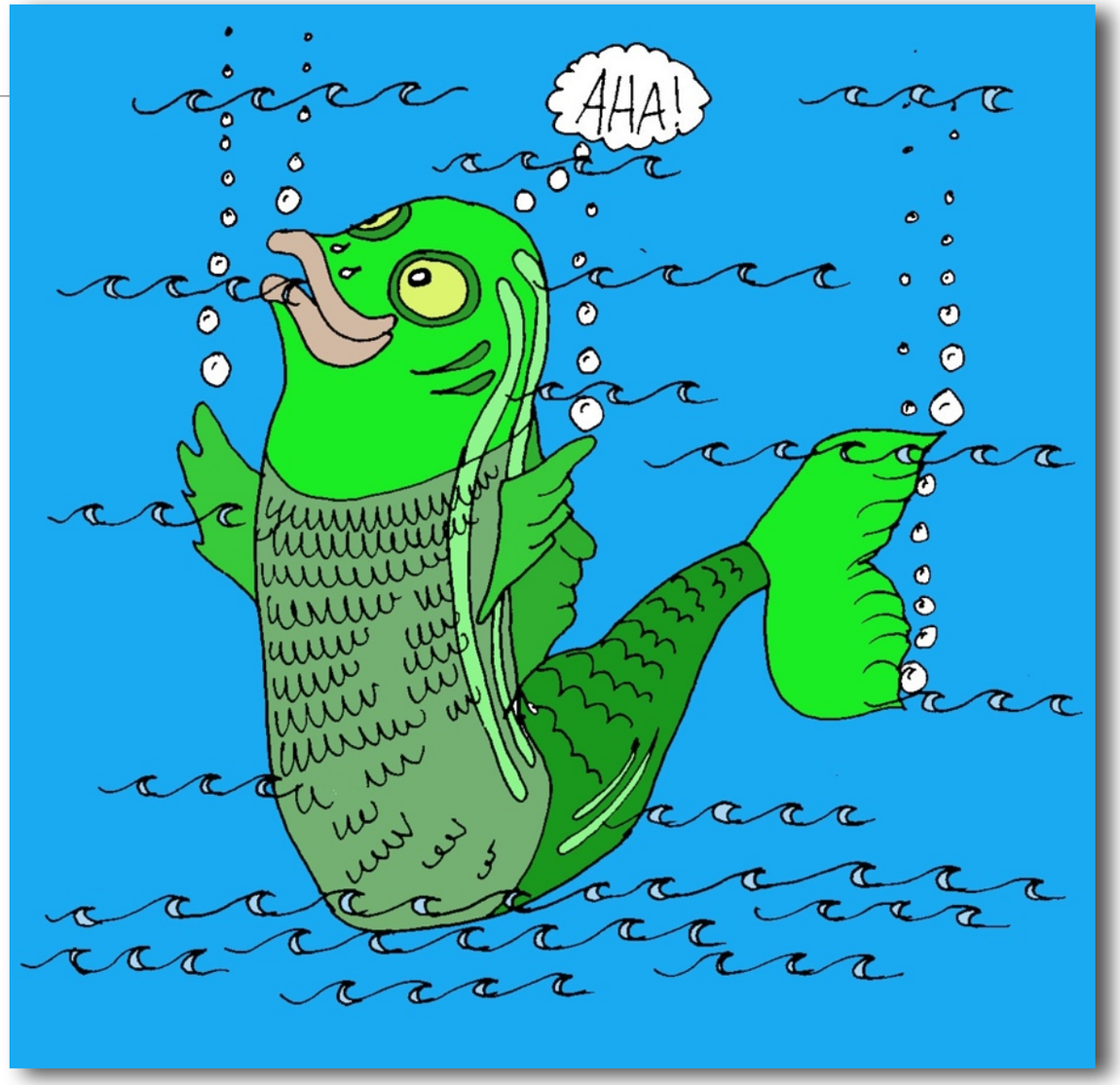
Preface



How is it that we can be surrounded by something and yet know so little about it? Think fish and water.

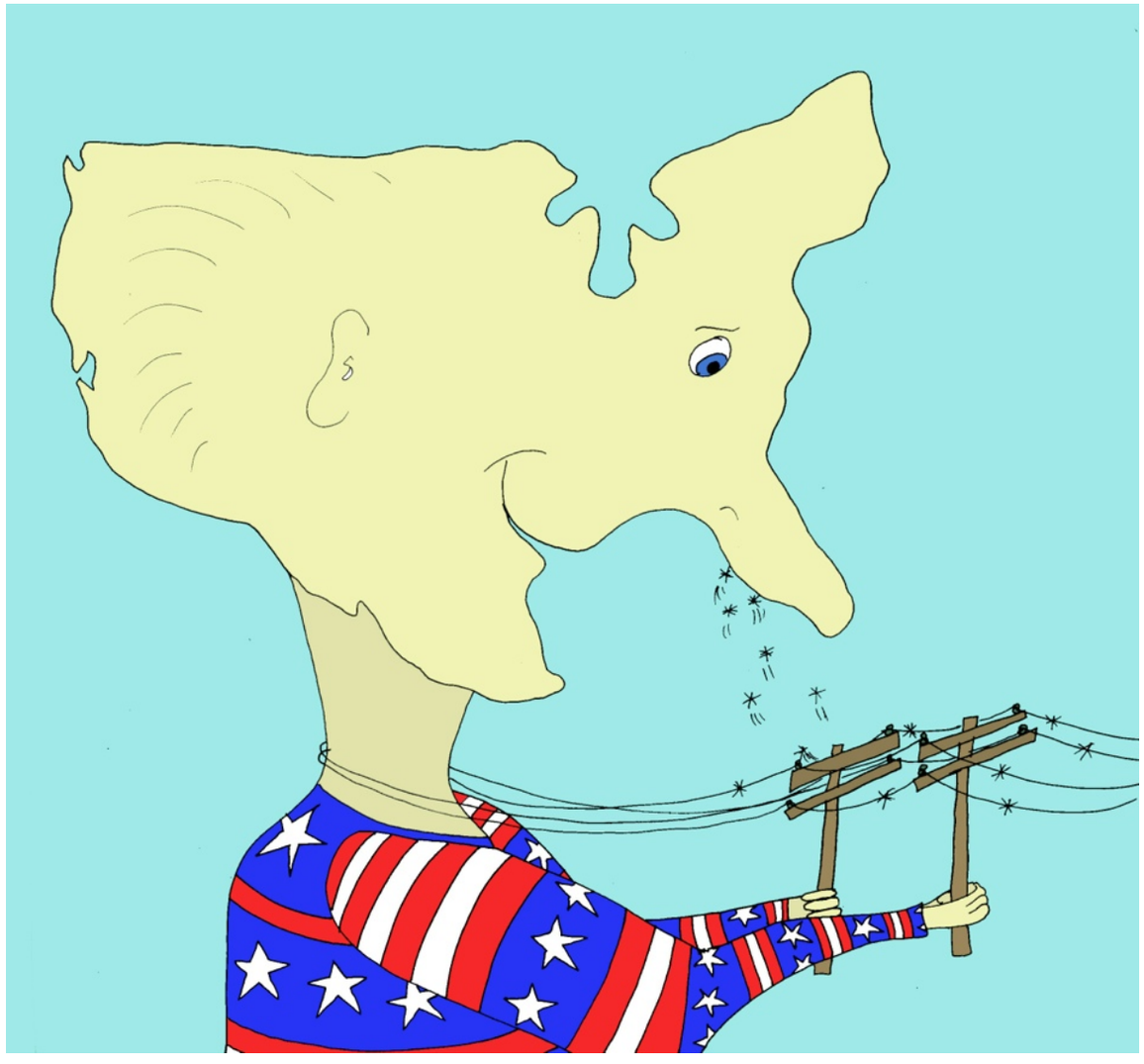
The something referred to here is electricity. Many people don't know the basics (how it is made, what it really *is*, how it is embedded in just about everything, even how to measure it). It's just there. It's pretty handy. It's more than handy. It's essential. It's also got some skeletons in its closet, which is to say, *we* have some big unresolved issues about the creation, distribution and consumption of electricity.

This primer reviews these issues. The information upon which it is based is freely available to anyone with an internet connection, curiosity, and a fully operational BS detector. The intention is to trigger your own investigation into something that most likely you just take for granted.

Imagine yourself a fish. *Discover* the water.

CHAPTER 1

Where We Are Now



America inhales energy. Almost all of it is carbon based (diesel oil, gasoline, jet fuel, coal, natural gas, heating oil) used to move us, heat/cool buildings, power our lives. We hear about energy issues every day, yet for all we are exposed to, we know next to nothing about the Big Energy Picture. This book takes a quick view at how and why this picture is changing.

The Biggest Part of the Story has to do with electricity. Why? Because electricity is the only fuel that can be created without burning fossil fuels.

So What?

Because the *Really Big Story* of the 21st Century is Global Climate Change. As a global culture, humans are poised at the edge of creating a mass extinction event. The personal part of this event is that we—humans—will go down with the ship along with all the other species that we have, are or will take down.

Global Climate Change is occurring because we are consuming fossil fuels at a rate that nature can't absorb. When burned, fossil fuels create heat (what we want) and carbon dioxide (something we've paid no attention to until the last decade or so.) We are now paying attention to carbon dioxide in the same way we might should we hear a screeching tire and turn our head. "Oh my!" we might say, "there is going to be a crash!"

We are watching, but we are not doing much (like, perhaps, running from the scene so we don't become a casualty).

Let's get back to electricity.

In order to solve the climate problem, we have to dramatically reduce the consumption (the use, the burning) of fossil fuel. At the same time, no one used to the benefits of the systems that run on fossil fuel wants to lose those benefits. Those benefits are metastasized into the function of our economy and our lifestyle aspirations. Once you have air conditioning, you are not going to give it up without a great deal of whining. Now, replace the words "air conditioning" with just about everything you touch: your cell phone, your computer, your refrigerator, your car, your airline ticket to Paris, your kid's clothes, your dog's food.

Most of which, actually, would not exist if there were no electricity. But most of it wouldn't exist if there were no trucks to move it, or buildings to house it, etc.

The good news is that those benefits of fossil fuels (gasoline, heating oil, even electricity) don't have to disappear if we transition away from fossil fuels. We can still have the benefits without the carbon dioxide.

How?

From electricity. From electricity made without burning fossil fuels like coal and natural gas. The term

for this kind of electricity is “clean spark”. The term for electricity made with fossil fuels is “dark spark.” See the interactive chart.

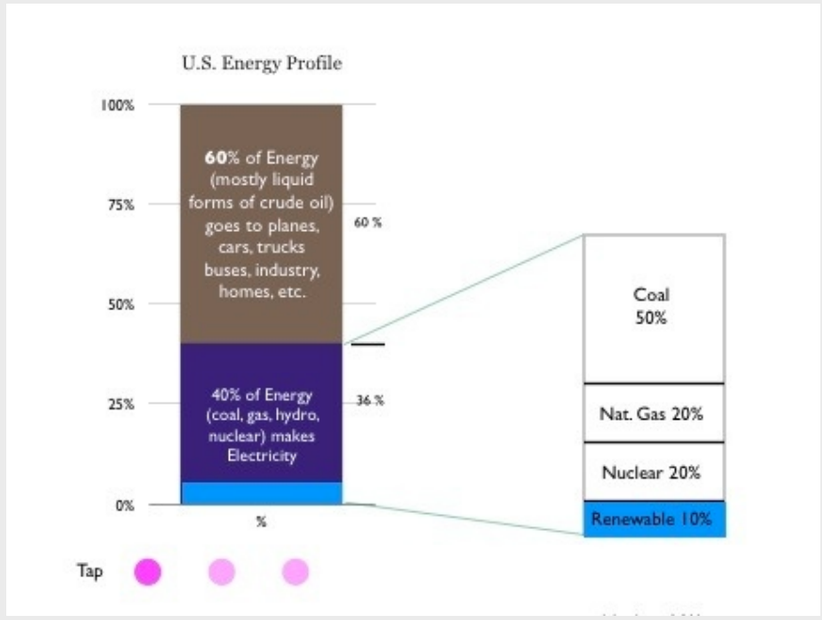
70% of electricity in America is today—2012—dark spark. Nuclear energy, which comprises another 20%, also can be called dark spark because of its economic and environmental reality.

That means 90% of the electricity in America is dark spark. Let’s call that Version 1.0 electricity. Various forms of dark spark electricity have been around for about 100 years. Dark spark electricity has created untold benefits for hundreds of millions of Americans.

The idea here is to transition to Version 2.0 electricity. Clean spark electricity. It can be done. It will be done. It must be done.

No one really disagrees with this.

INTERACTIVE 1.1 U.S. Energy Profile



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The biggest issue is: when will we get there?

Unfortunately, there is a rather large elephant in the living room.

We not only have to transition the bottom part of the graph, the dark spark electricity to clean spark electricity.

We also have to transition the top part of the graph, *the bigger part (1.5 times bigger than the bottom part)*, to clean spark electricity. If we don’t deal with the top part, we are not going to solve the climate problem, which is to say, we are going to accelerate faster into that mass extinction event, which is to say, life as we all know it is going to get a lot worse.

We do have a choice. We can party on, saying it doesn’t matter, which, really, is a way of saying it doesn’t matter *to us*. It will matter to our kids and our grandchildren and to people around the world less fortunate than we are. James Hansen, the NASA scientist who sounded the carbon dioxide=global temperature rise alarm over 20 years ago, calls this

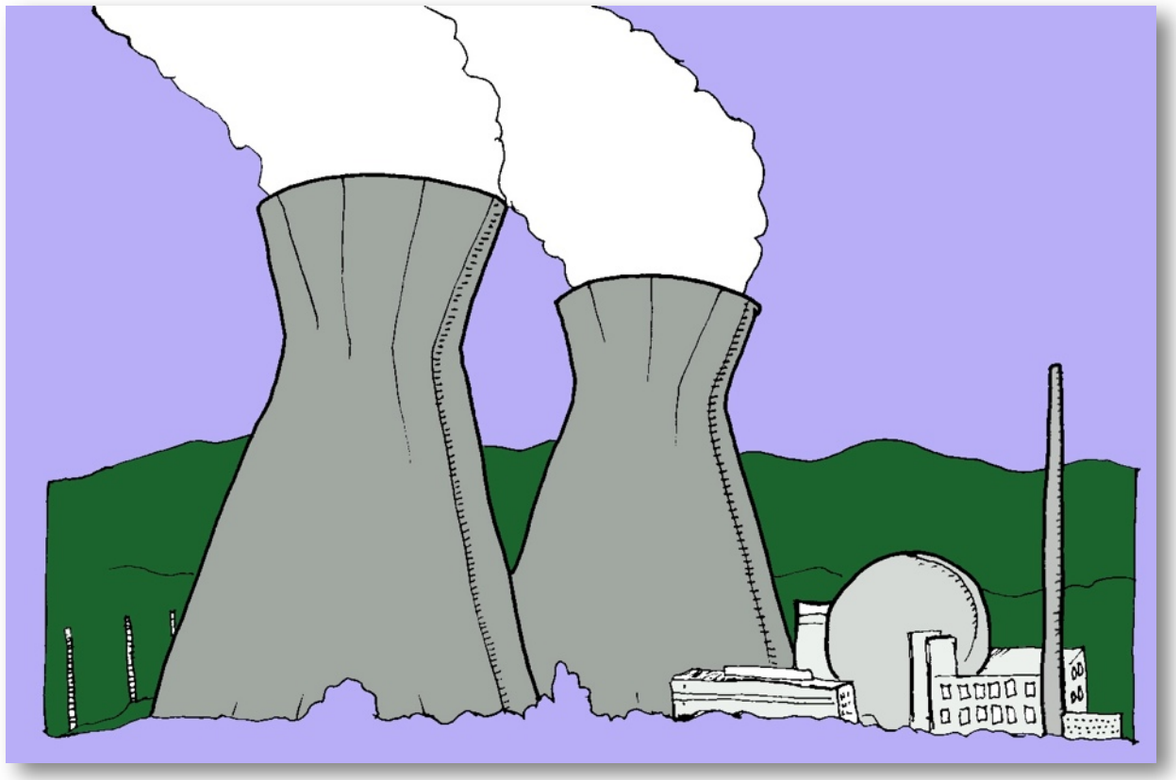
situation “intergenerational injustice”. It’s not *our* problem. It’s our *kid’s* problem. Party on!

Or, we can say, well, gosh, this is another rather dramatic example of the law of unintended consequences, so let’s roll up our sleeves and do the right thing.

This book takes this second point of view.

CHAPTER 2

Overview of Version 1



Before we can even begin to solve the transition to clean spark problem, we need to know more about where we are. What follows is a quick overview of the Version 1.0 electricity system (the legacy system) that we have pretty much maxed out today.

Reality check. How many nuclear power plants have been built in America in the last 20-30 years? Ask Google. Answer: zip.

Reality check. How much has the capacity of coal fired power plants increased in the last 20 years? Ask Google. Answer: basically zip.

Reality check. How much renewable electrical energy (wind, solar, hydro, geothermal) exists in America today (in terms of its total contribution to the system)? Answer: less than 10%.

Today we're bumping into the maximum output of the system. The cost of building new coal or nuclear plants is in the handfuls of billions of dollars. The time frame is decades. Natural gas peaking plants are expensive to build and operate. How many Americans want to have a coal or nuclear plant nearby? How many are concerned about the global warming impacts of dark spark energy? More and more.

One of the generally unknown side effects of burning coal and natural gas is that about two thirds (yes, 2/3) of the heat value in the fuel goes up the stack. Only about 1/3 of the heat value of the fuel turns in to electricity. If you were heating your home with firewood, and you understood that 2/3 of the wood you cut up, stacked, schlepped, and cleaned up after was going up the flue and not heating your house, would that work for you?

But here are a few facts also generally unconsidered. Electricity is *invisible*. Carbon Dioxide is *invisible*. The *waste* of fuel everywhere up and down the supply/consumption chain is *invisible*. Do you see the wasted electricity in your home or office? Do you get information from your electricity provider about how much of your bill goes to electricity that is wasted where you use it? If your monthly statement showed that 20% or 30% of the power you were paying for was disappearing through the walls, through the windows, through those Version 1.0 light bulbs and furnaces and refrigerators and hot water tanks, through the blueray player and router and printer and game station and flat screen and (fill in your own blanks here) that are always on even if you're not using them, would you be happy?

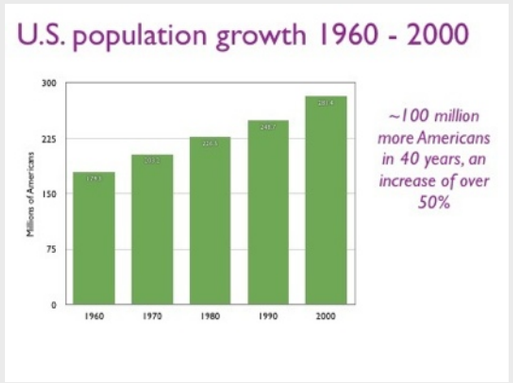
Here's the short version of how we got here.

Coal is plentiful which makes it really cheap. (Setting aside environmental issues like mountain top strip mining or black lung disease.)

Coal boils water to make steam; steam power turns turbines; turning turbines make electricity. We are making electricity by boiling water (this is how nuclear power plants work as well) just like they did 150 years ago. Technological progress? Zip.

But it works. It's cheap. It's relatively simple. We have the coal. We have the trains. Done deal. After WWII, there was a bad feeling about nuclear power. At that time, it meant bombs. The Atomic Energy Commission decided to re-frame nuclear power as good, thus nuclear power plants were born. At the time, the imagination, and the marketing, was that the electrical power provided by these plants was going to be so huge and so cheap that it would be "too cheap to meter," which meant, free.

US Population Growth
1960 - 2000



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No one really could imagine the future, which consisted of two rather large, mutually reinforcing, trends.

First, more people. Way more people.

Second, more electrical devices, systems, services, opportunities. Much much more.

Growth in Power per Person

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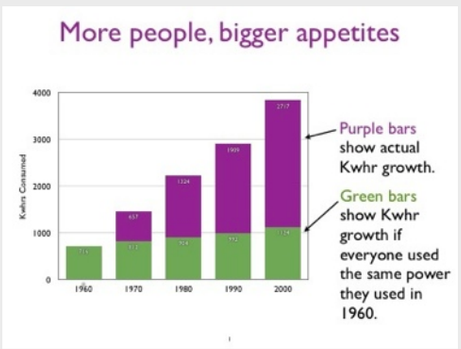
The combination meant a huge increase in the demand for electricity.

This is where we are today.

Growth in Demand



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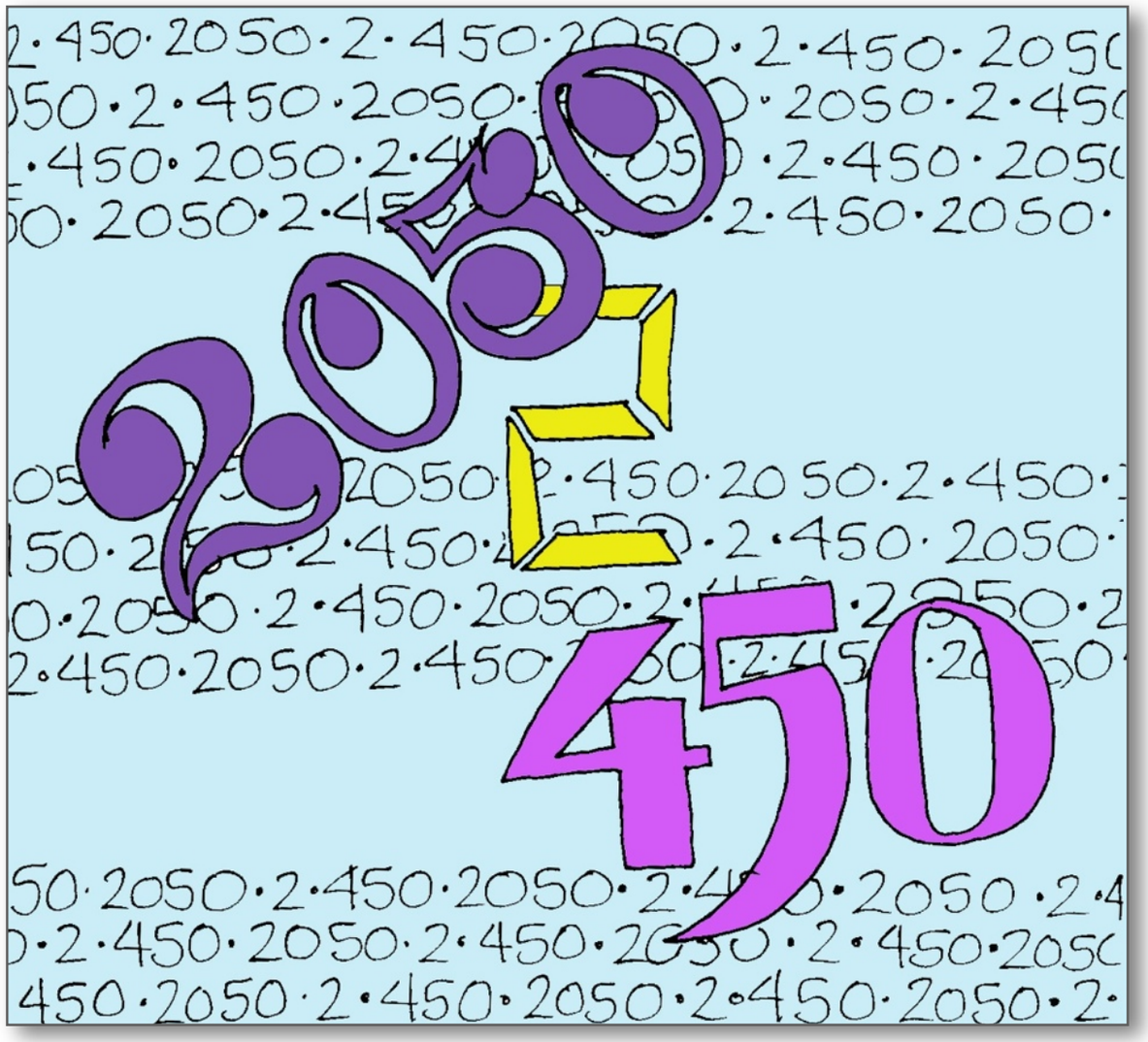
Chapter 3

The Climate Conundrum



The future of the planet is known. For the next 10 million years it'll be pretty much as it is.

The future of the planet's habitability for advanced life forms (mammals, etc.) is unknown. We know the oceans have been higher; we know the land mass of America has been covered with ice.

The issue, then, is not to "save the planet." The planet doesn't need saving. We couldn't "save" the planet if we tried.

The issue revolves around three numbers: 2050, 2, 450. You need to know what these numbers stand for. You then need to make your own assessment of who, or what, is right, or wrong, as to what these numbers *mean* for a sustainable, livable habitat. Right now, *no one knows for sure*. However, the stakes are high. If we get it right, we (as humans) live on more or less like we have for recorded history. If we get it wrong, well, not so much.

2050 refers to the year, which is less than 4 decades from now.

2 refers to degrees Celsius (generally written as 2°C), the expected average rise in global temperature from pre-industrial (i.e., before the massive use of fossil fuels) levels, approximately 250 years ago.

450 refers to parts per million of CO2(e), which is the amount of Carbon Dioxide or it's greenhouse gas equivalent (that's the "e"), that a group of scientists believe, if it is not larger, will keep the temperature from exceeding 2°C.

It goes like this. We are dumping CO2(e) into the atmosphere. Pre-industrial levels were about 285 ppm CO2. Once we started burning coal, oil and natural gas, the CO2 level, in ppm, started rising. So did global temperatures. As of 2012, the CO2 level is about 392 ppm. The increase in temperature is about one-something °C. It's pretty clear that as CO2 goes up, temperature goes up. The details are arguable and complicated and give a wide latitude for anyone to weigh in, which, if you've been following this story in virtually any media, they're doing. This is not the place to repeat the arguments.

The bottom line is that the temperature is going up, which affects climate, which affects weather. To most of the scientists, these effects are *not good* and are getting worse.

The unknown part is whether those two related numbers (450ppm means no more than 2°C) are right. Humans control the ppm part. Nature controls the temperature part. We're running an experiment that we've never run before. It's really simple. We *think* that if we don't exceed 450ppm we won't raise the global temperature more than 2°C. We *think* that 2°C is the line in the sand. If we're below it, we're cool. (so to speak…) If we're above 2°C, then all hell breaks loose.

Let's look at this a bit closer. Who are the "we" in the above sentences that begin "We *think*.."? A group of scientists, virtually all of whom are experts in the fields of oceanography, atmospheric science, glaciology, etc. At the same time, they are basically being ignored, as if they were all Chicken Little wannabees.

What about that 450 part? No one knows for sure. There are some scientists who believe we got that number wrong. It should be 350. Since we are at 390-something now, we've overshot the mark.

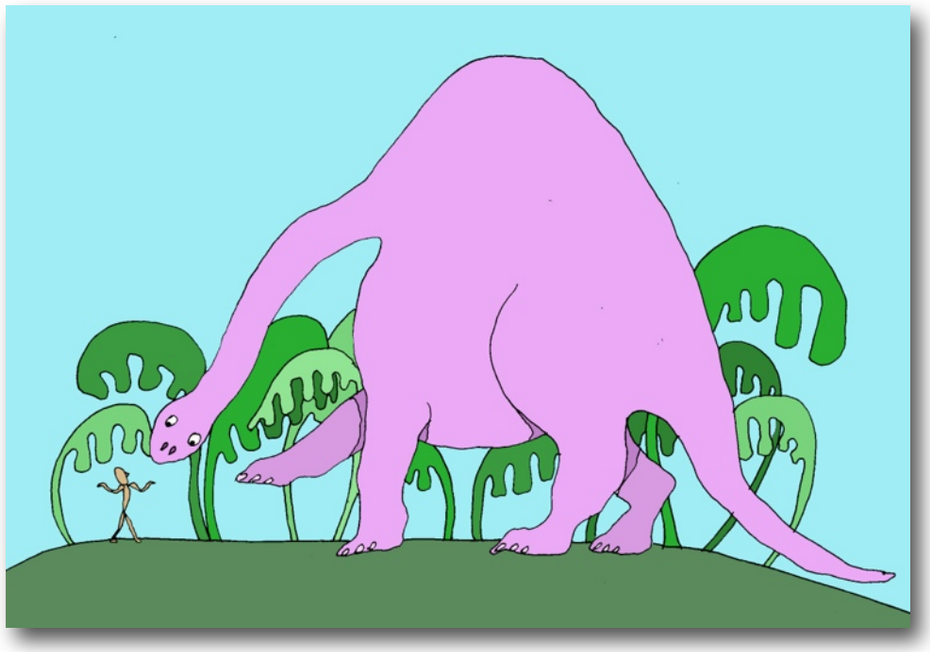
(It should be clear that we can't simply remove CO2 out of the sky as if it were some dust that a rag soaked in Mop n Glo will dispose of in a quick wipe. Current thinking is that once it is there, it takes a thousand years for it to disperse.)

What about that 2°C part? Why is it ok to increase temps by 1.995°C but not ok to increase temps to 2.003°C? What's the logic here?

Bottom line: *no one knows*. That however doesn't remove the "are you feeling lucky?" question. It just means that we will have to make a judgment even when we don't know. The easy thing to do when you don't know what to do is to do nothing. This is the default case. Wait until you know more.

The problem with this is that by the time you may know more, it is way too late. Think cancer. By the time you feel sick enough to wonder if there is something wrong and, further, overcome your resistance to seeing a doctor, it is probably way too late. You gotta catch it early or your happiness level may be... *really* not so much.

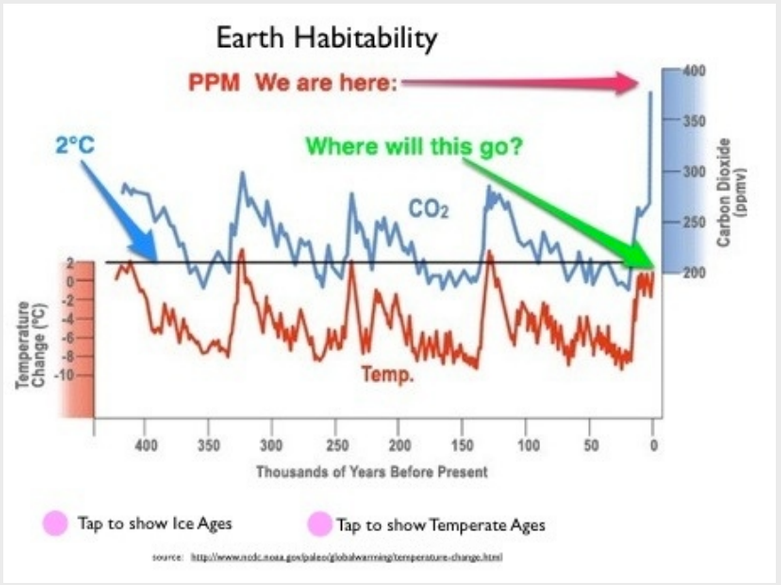
This is the same issue writ at a global habitat scale. Remember, it's not the planet's problem. It's the "life



as we know it" problem. Mother Nature, aka *Mom*, has been through the mass extinction cycle a bunch of times. Been there, done that. The difference is we haven't.

Here's a graph that is the best evidence we've got to date about the probability of exceeding 2°C:

CO2 v temperature over the last 450,000 years



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Look carefully at this graph. Take a moment. You can do this. You *need* to do this.

Why?

Because this is the biggest story of the 21st Century. This is not just another adrenal rush on the 24 hour news cycle. This is not the latest skirmish in (pick a country) or the latest incarnation of the choke points in the rush hour commute.

The graph shows the relationship between global temperature (the squiggly red line) and global CO2 levels (the squiggly blue line) for the last 450 thousand years. The relationship between the two is extremely predictable and consistent. If one goes up, so does the other. If one goes down, so does the other. No brainer. It works.

The horizontal black line illustrates where 2°C (above pre-industrial levels) is on the graph (it's labeled with a blue arrow). The "red PPM We are here" arrow shows the current ppm level. Note that it is way higher than it has ever been for the last approximately half million years. (Note also that it's rising at about 2ppm per year and that we *think* that we're going to be ok if it doesn't exceed 450 ppm, which is way off the top of the chart).

Here's your assignment:

Predict where the temperature is going to go (see the green arrow).

Predict what the planet's habitability will be like at the temperature you predict.

Predict **when** your predicted temperature rise is going to occur.

Extra credit: predict the global human population when the highest temperature you have predicted has been in effect for a decade.

The big boys are arguing over the deck chairs on the Titanic. No one wants to look at where the ship is going.

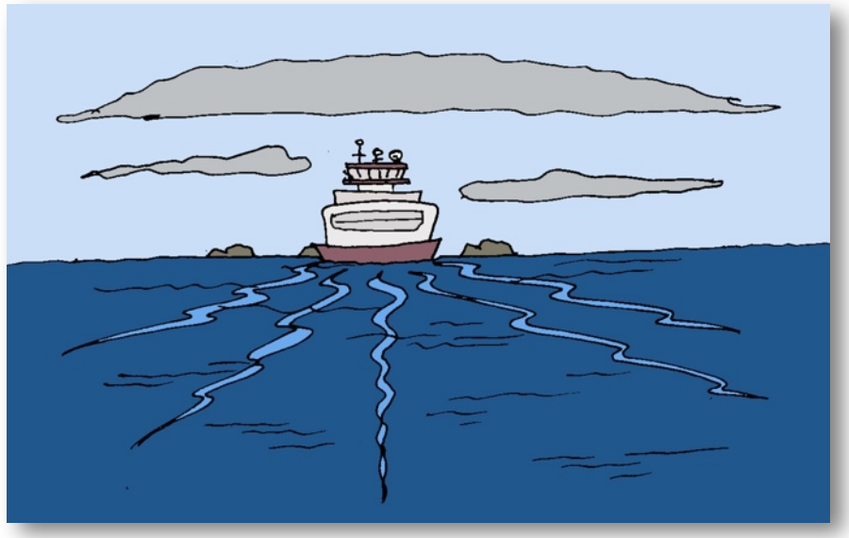
However busy one is fighting over the deck chairs, the ship IS going somewhere. The chart demos the planet's history, which is to say, the laws of physics. If you don't like those laws, a special extra credit will be given if you figure out a way to change them (without triggering the law of unintended consequences, unless you additionally figure out a way to eliminate that).

Whether you elect to accept this last challenge, you still have the main assignment. The planet's climate *is* changing—it is changing in the direction of getting *hotter*.

It will likely change significantly in your lifetime. Once it starts moving, it's like a supertanker. To stop a supertanker, put it in full reverse—it'll take a mile. If the fog lifts and you discover that the rocks are a half mile ahead, whoops!

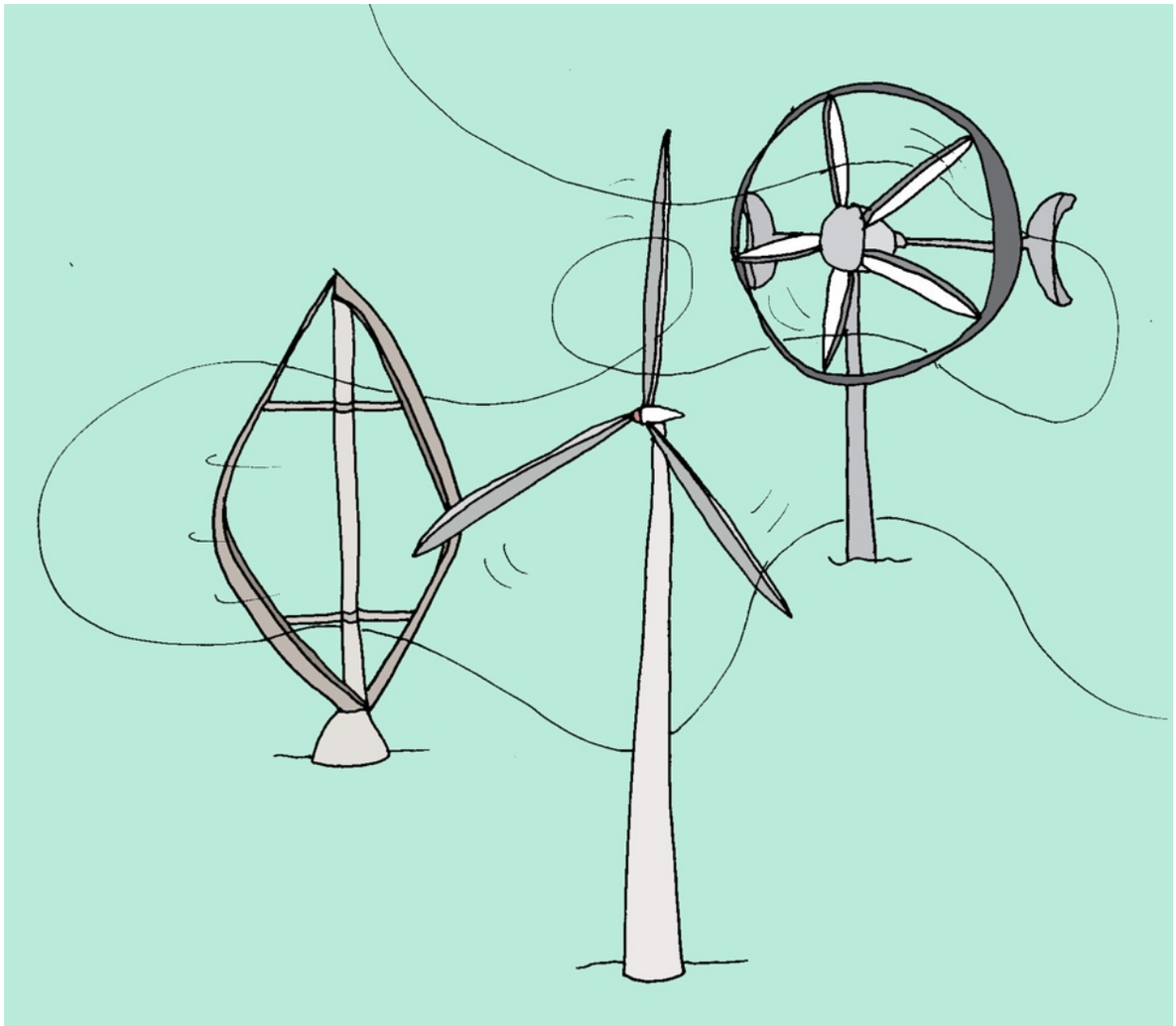
Even more extra credit:

What is the equivalent of full reverse in order to stop the destructive effects of climate change? Using years instead of miles, how long will it take to stop?



CHAPTER 4

Where We Need to Go



Before you think you're done with your assignment at the end of the last chapter, you might want to factor in the fact that, basically, the human population of the world has pretty much, to date, taken the "wait and see" option. The few, brave scientists who are willing to call it like they see it are saying that we are going to go way over 450ppm by 2050, and thus we are going to go way over 2°C.

Take a ruler to the temperature line on the graph at the end of the last chapter. If it goes up like it has for the last 4 up/down CO2-temperature cycles, and the world goes to 450ppm, what temperature do you pencil in?

The International Energy Agency has run some numbers under the "we're ok if we don't exceed 450ppm" assumption. Basically, in order to *not* exceed 450ppm, we as a global community will have to replace fossil fuels as a power source with other, non-carbon producing energy sources. In 2008 they condensed their findings into a graph.

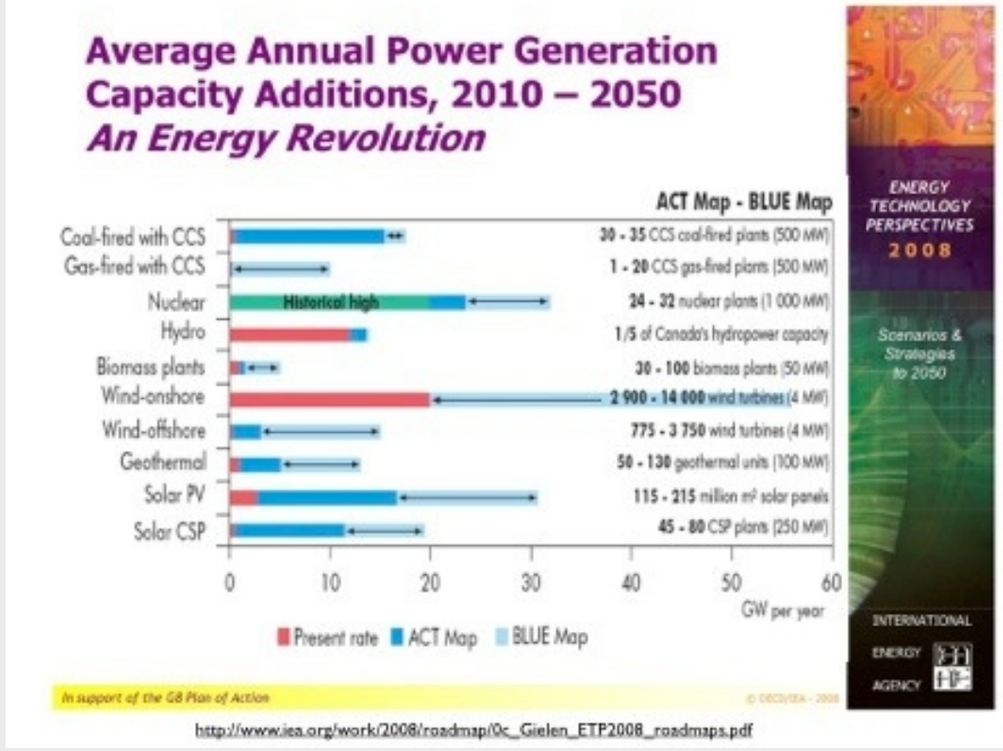
Here it is.

I know. Too much information. But since you are reading this on an iPad, you can take the time.

This is the global energy challenge (which is to say, the global habitat reality check) in one simple graph.

Let's deconstruct it.

ILLUSTRATION 4.1 Staying below 2°C means...



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Narration of Illustration 4.1

Start this sound file before viewing illustration 4.1 in order to follow the text while viewing the image in full screen.

The following is a transcript of the narration:

First, the title: Average Annual Power Generation Capacity Additions 2010-2050

Huh?

Simple. For the 40 years 2010 to 2050, *everything* below the title has to be constructed and brought on line *every year*. These are *annual additions*.

That's why the subtitle is in italics: *An Energy Revolution*

Second, the legend at the bottom: Present rate, ACT Map, BLUE Map.

Huh?

Every row in the graph

(e.g., the top row is “Coal-fired with CCS”) has a red mark (that’s the Present rate of annual implementation), a dark blue line (that’s the ACT part) and then a light blue line (the BLUE part).

Every row represents a component of the electricity generation system that needs to be constructed every year in order to meet either ACT or BLUE goals.

What are the ACT and BLUE goals anyway?

The ACT goal is a scenario designed to ensure that by 2050 CO2e emissions do not exceed those generated in 2005. Global CO2e PPM unknown but understood to be ***way*** over 450 and climbing. Global temperature rise? Does its accuracy matter? It’ll be **way** over 2°C.

The BLUE goal is a scenario designed to ensure that by 2050 CO2e emissions are 50% *less than* those generated in 2005. The presumption is that global PPM will level off at 450 PPM.

Kiss off the ACT goals; they all but guarantee we will create a mass extinction event.

The BLUE goal is designed so the human-induced CO2e emissions do not create a greenhouse gas concentration exceeding 450 PPM by 2050. The idea is that from now, where the CO2e concentration is about 392 PPM, to the year 2050, the world will have dialed down the rate of growth of CO2e from today’s about 2 PPM per year to zero PPM per year and we’ll slide into home plate just before the 2°C ball gets to the catcher. Home Free! Unstated here is the presumption that if we meet this goal, we won’t exceed 2°C and we won’t fry.

Note that the red shows what the present rate of annual construction/implementation of that electricity resource. Note that the light blue (BLUE) is generally way way out there on the right, far far larger than the current rate of addition of that resource. (Pick a row, any row. They all show the same thing. Red is what we have been doing. Light blue is what we need to do.)

You don’t even have to know what each of those rows actually stand for. Many are self explanatory (say, Hydro or Nuclear). Others require new, undeveloped, untested, controversial technologies (CCS).

For example, take Wind-offshore. The current rate of annual additions is so small you can hardly see the red mark. The light blue line goes out to about 18 gigawatts per year. The text on the right says to achieve this goal, 3750 wind turbines of 4 megawatt capacity have to be up and running every year somewhere on the planet.

The big kahuna is Wind-onshore, where 14,000 4 megawatt turbines have to be up and running every year for the 40 year time frame.

Nuclear shows 32 1 gigawatt plants to be up and running every year, 2010 to 2050.

How many nuclear plants do you think were constructed, globally, in 2010? 2011? 2012? Hint. Fukishima.

Not mentioned here is what this would cost. Not mentioned here is whether we have the collective global willingness to do it. This simply shows the engineering reality. You want 450 by 2050 to not exceed 2? Here's how you must do it.

Assuming, of course, that we all party on the way we've been doing it, in the developed nations, anyway, for the past century. Not mentioned here is who will join, or not, the developed nation party, when, and what they'll get for joining (bigger flat screen tv's, say). Stated here is a massive shift from fossil fuels to electricity. Unstated here is how this will play out in, say, transportation. It means virtually all vehicles will be electrically powered.

You don't want this to happen by 2050? When then? 2060? 2100? Never?

It's going to happen. How and when are the variables. You can join the parade early. What's in it for you? Being on the side of history. Being on the side of *physics*. Being on the side of *Mom*.

Like other infrastructures that enable our lives (like potable water delivered to your lips 24/7 virtually everywhere in America), electricity has some really cool properties, and one to-date major Achilles Heel.

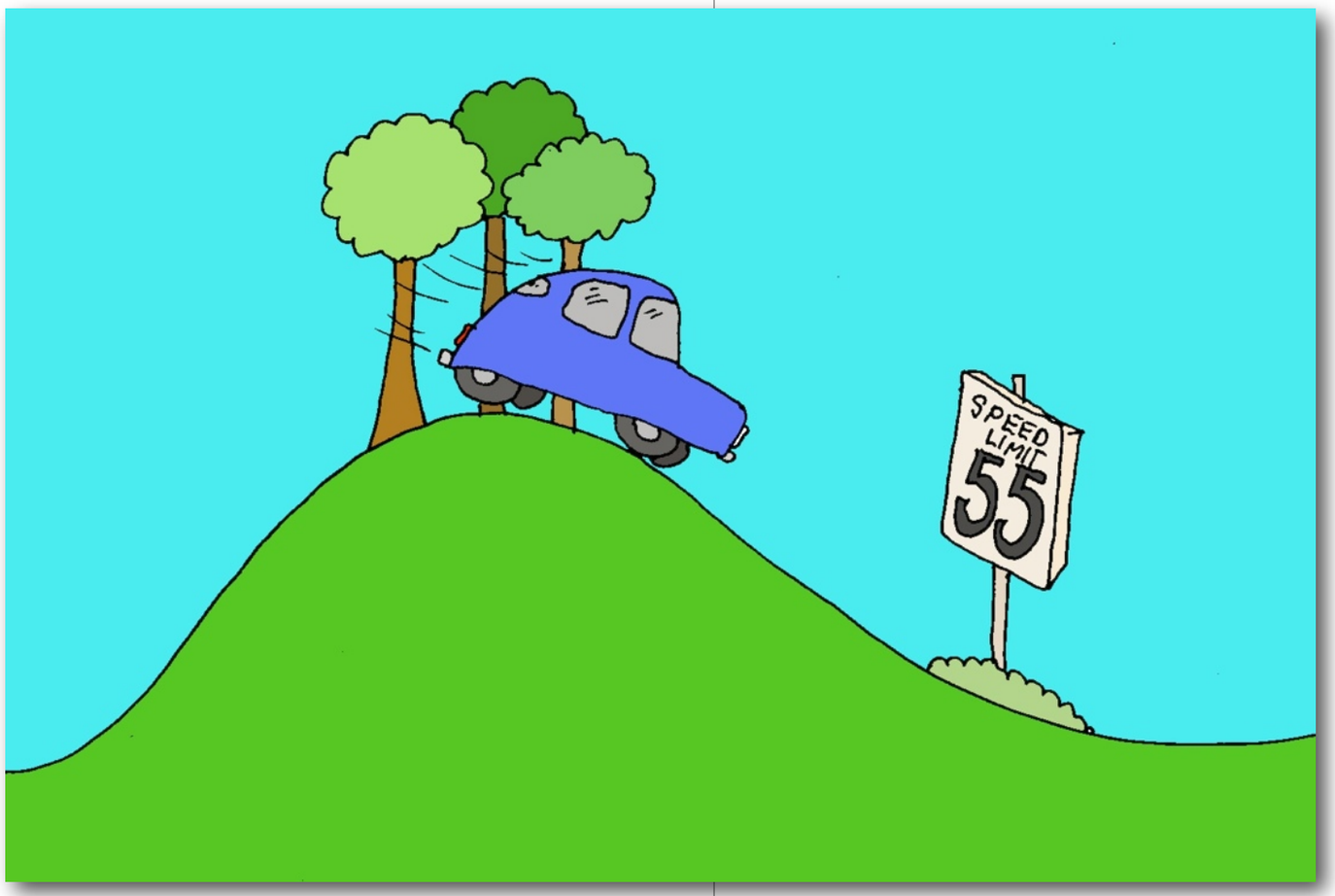
The cool properties can be summed up as follows: you can do anything with electricity. With fossil fuels you can do only one thing: make heat.

The Achilles Heel property of electricity (and here we're talking the national grid, i.e., the electricity that we all use every day, not the electricity in the batteries in your flashlight): demand and supply must be equalized every half second.

Huh?

You flip on a light. You have created demand. (Not much). Your city flips on lights and your city has created demand. Much more. The electricity system is demand-driven. Those coal and nuclear plants don't

just crank out inventory and stack them in the company parking lot like so many tractors. They are listening to you and your 300 million compadres. Every fraction of every second. When demand changes, either up (you turn on your A/C) or down (you turn off your oven), the system responds. When you turn on something (and when I say "you" I could mean just you or you and maybe 100,000 strangers none of which know what any of the others are doing) the voltage starts to go down, which is not good for children, other living things, and especially electrical equipment (your refrigerator, your computer). The "system" has to respond by cranking up. It's as if demand were a freeway and supply the car you're driving. When you start to go up a steep hill, demand goes up. But if you have to go 55 mph, in order to get to Memphis in time, you will step on the gas to compensate for the effect of gravity; you've just increased supply (in this case, more gasoline to your engine). When you get to the top of the hill, and start going down the other side, demand (for gasoline) goes down. If you don't compensate by lowering the pressure of your foot on the gas pedal, you'll be going way over 55 on the way down. The system has a mandatory requirement that vehicles *must go precisely 55 all the time*, regardless of the road's twists and turns and hills and valleys. It's just not a straight flat freeway through Kansas. And it's not just one car and one freeway. It's 300 million cars and 300 million freeways, all operating at the same time, 24/7/365 and *everyone has to go exactly 55*.



And, it's not you stepping on the gasoline. You are the freeway, which means you are the hills and valleys and

curves. You are the *demand* (all 300+ million of you). Some other folks, whom you have never met, sitting in bunkers all over America, looking at computer screens, are the *supply* guys stepping on the gasoline or taking their foot off the pedal to keep the car at precisely 55. Doing their best.

But the "you" in "you are the demand" isn't just you alone. It's all the electrical systems you are responsible for. Some of those have a mind of their own, like your refrigerator. It doesn't create demand on a manual basis, waiting for you to turn it on like you flip on a light. It creates demand on an automatic basis, like when it senses that the internal temperature is getting a bit warmer. The same applies to your hot water tank, or your furnace, or your air conditioner or your water, or sewage, or pool pump. Those systems don't ask your permission to create demand. You've given them permission by hooking them up. *They* are part of your freeway, and the supply guys are dealing with them as well. If they can.

But sometimes…

There's a blackout. 50 is too slow. "Supply" drops to 53 and the car may shudder. "Supply" drops to 50 and the engine stops.

But what if the hill is too steep? "Supply" just can't go 55. Too bad. There are no exceptions.

When the system has plenty of reserve power, big hills don't slow it down. The engine might be maxed but thankfully the hill doesn't get steeper and eventually you'll reach the top.

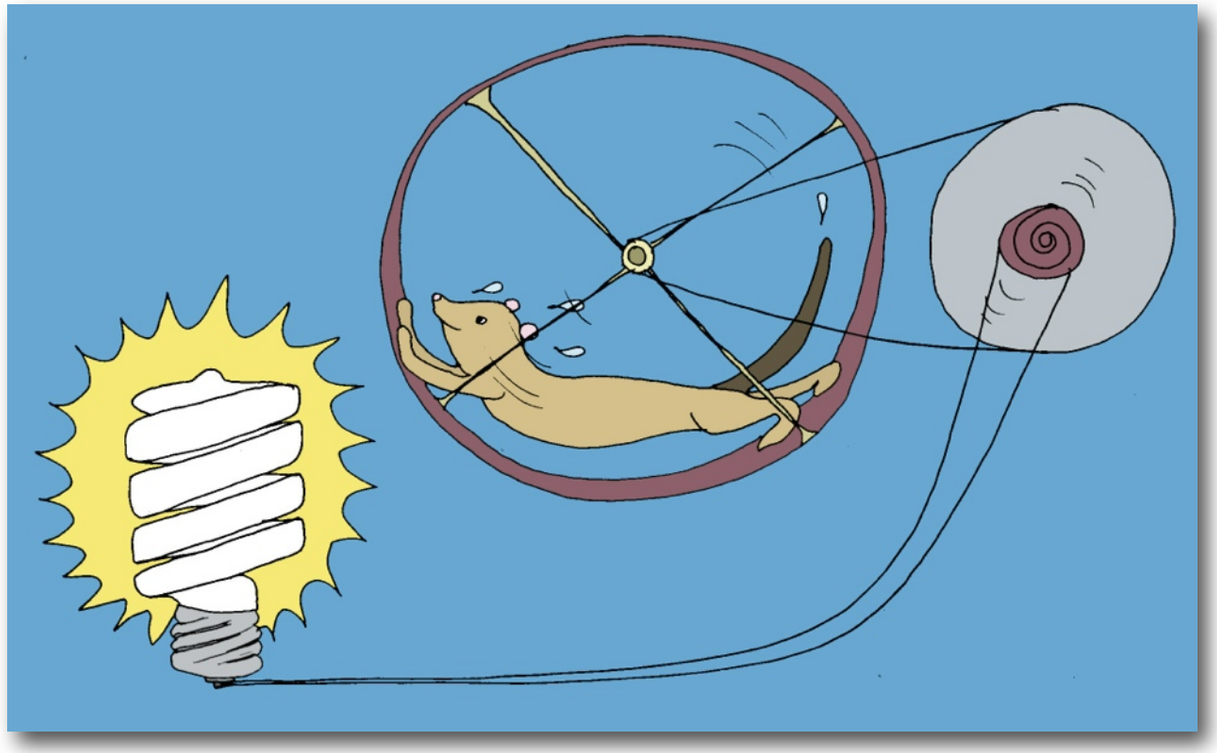
America has two big electrical problems. First, the system is pretty much maxed out. The supply guys are dancing on slippery rocks trying to get you through hot Texas summers without going below 55. Doesn't always work.

Second, there's that climate problem. We're pumping CO2(e) into the sky 24/7.

What to do?

Chapter 5

Nega *What*?



We have two big ticket items to deal with. They are: 1) shift (fast) from fossil fuels to electricity to reduce greenhouse gases, and 2) add more capacity to the electrical system because the system is bumping into its upper limit during peak periods of demand. The short version: make a lot more carbon-free power to meet demand. How much more?

If 90% of the existing electrical system is unsustainable, then only 10% is clean spark, renewable, sustainable. Recall that 40% of all energy goes to making electricity, while the remaining 60% is used to heat building, move planes, make concrete. None of that 60% is sustainable—it all is fossil fuel, which means it is *from fossils* and it makes CO2. That means that *only 4%* (10% of 40%) of America's energy, today, is *sustainable*. That means *96% isn't*. (Recall the interactive graphic on page 4.) We have to build many many times the renewable energy infrastructure currently in place, swapping out both the dark spark *and* non-electrical fossil fuel, mostly transportation and heating systems, with clean spark electricity.

In short, replace just about everything that uses energy. Soon. Even if we do, we additionally have to include more clean spark power to allow for growth in demand.

We know that supply is created to precisely match demand. Most of the conversation about electricity is about supply. Making more—hopefully all of that—clean spark power.

What about demand? Is there any wiggle room on that side of the equation?

Yes. There is a lot. Electricity delivered to your home or business falls into two bins: useful services and waste.

What is waste? It is a service for which there are no benefits. It's like the blister pack wrapping on almost anything you buy. Assuming you don't cut yourself trying to extract the item you bought from a package designed to survive a nuclear attack, you have before you two things: the item you bought and a useless pile of plastic and paper that you will have to dispose of. The item has benefits. The wrapping doesn't.

What is electrical waste? It takes many forms, but they fall into 3 bins: efficiency, conservation and disregard. Like auto mileage, efficiency measures the effectiveness of the power your appliance consumes. With a car, the higher the mpg the more miles you can travel on a gallon of gas. With an appliance, the lower the kilowatt hours, the greater the efficiency. Lighting offers a classic example. An 100 watt incandescent bulb uses 100 watts to produce a certain amount of light. A CFL bulb uses 23 watts to produce the same amount of light. A LED bulb might use 14 watts to produce the same amount of light. It's not just the amount of light that makes for efficiency. The incandescent bulb will burn out in about 1500 hours. The CFL will burn out in about 10,000 hours. The LED may burn out in 25,000

hours. Cost to buy? incandescent: cheap. CFL: mostly cheap. LED: not so much. Cost to own? incandescent: expensive. CFL: relatively cheap. LED: really cheap.

Cost to buy means what you pay for it at the store. *Cost to own* means what you pay for it at the store plus the cost of operating/maintaining it over its lifetime. The cost to buy doesn't reflect what you will pay to use this item.

What motivates your purchase decision? Cost to buy? or Cost to own?

There are many opportunities for improving the efficiency of electrical items. Those opportunities have not been aggressively pursued because, so far, electricity for most Americans has been really inexpensive. The old mousetrap still works. Why should I design (if you're an inventor), build (if you're a manufacturer), or buy (if you're a consumer) something that, when used, will save me pennies a year? For the residential consumer, the big kahunas in efficiency improvements today are refrigerators, lighting, heat pumps. The higher the efficiency, the lower the waste. In terms of that blister-packed item, you'd ideally buy it with no packaging whatsoever—there would be zero waste. *Cost to buy* a more efficient whatever: greater than the cost of a less efficient one. *Cost to own* a more efficient whatever: way less, maybe way way less, than a less efficient one.

What about conservation? Different from efficiency, conservation refers to preserving the benefit of the electrical service for as long as possible. Classic example: insulation in a building. Adding insulation conserves the heat that is being created by the heating system. The system could be fairly inefficient (for example, using baseboard electric heaters instead of a heat pump) but the insulation conserves what heat there is, thus lowering the demand for more power.

Other forms of conservation are behavioral, not structural. Turning off lights when leaving a room, turning down the heat at night are examples. If a service (e.g., heat) is provided when no one needs or uses it, it is a form of waste. Another flavor of conservation wanders into lifestyle choices. You may be used to a certain temperature of a home or office, but would you really notice or care if it were a degree warmer (in summer) or a degree cooler (in winter)? You may be used to the lighting that came standard in your bathroom or study, but do you really need 800 watts of lights to brush your teeth? What about 700? 600? 300? Most people just accept what they encounter (it's the way Dad did it; it's the way the office

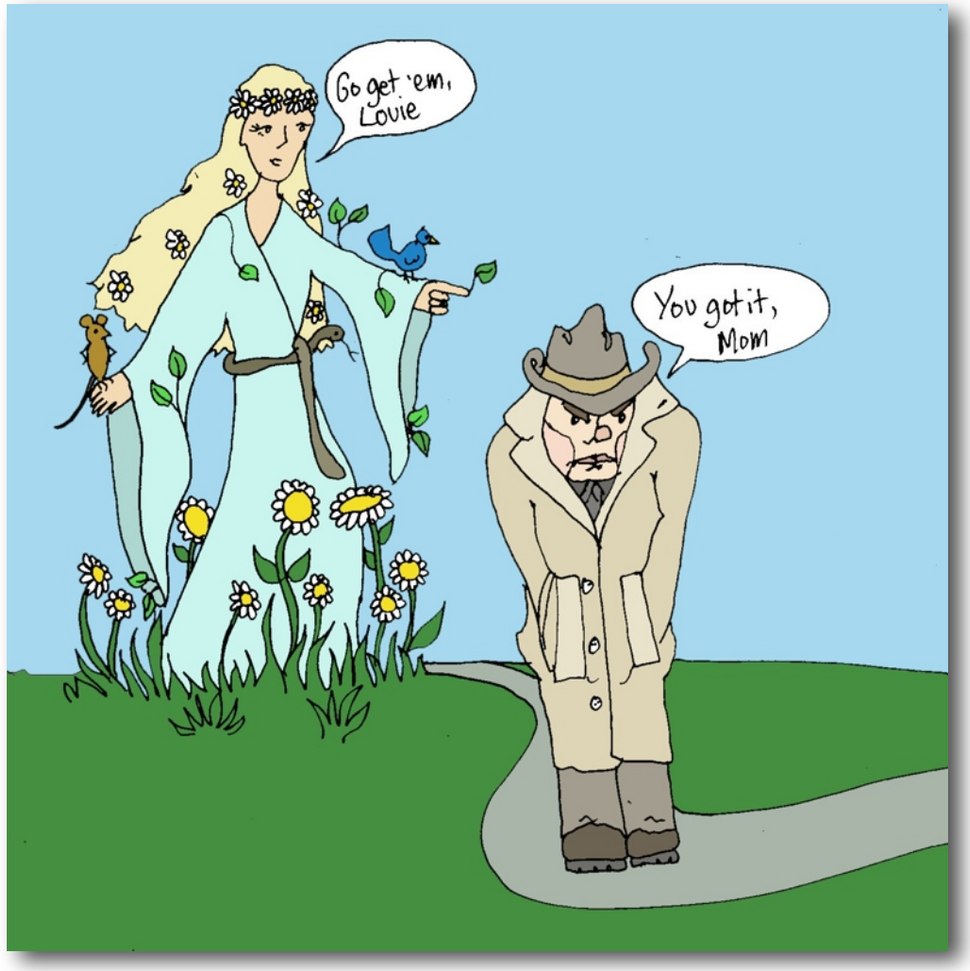
is set up) rather than start from zero: Gee, how much (of whatever) do I really need here? Again, if power has been really inexpensive, why bother to shave pennies?

Disregard carries the waste of inattention to personal or collective consequences. Lights on all over the house when only one room is occupied. Electronic equipment designs that consume the same electrical power whether they are on or off, in use streaming *Casablanca* from Netflix or just twiddling electron thumbs, charging that cordless phone, or not. Vampire power supplies that draw the same power regardless of what the device they are powering needs. Electrical appliances that are clueless as to whether the whole system is about to tank. This type of waste is unthinkable to any other species, because we are the only species that consumes way more energy than what we can gather and eat. Think about it: did you ever see a fat microbe? eagle? earthworm? flower? blade of grass? Every species on earth, except humans, has to function with only the energy it absorbs from its environment. If it were overweight, it would have to eat more to move its larger mass. It couldn't catch its prey or run away from its enemies as well as a more efficient member of its class. It wouldn't survive.

We operate outside that limitation. Waste has been the cost of doing business. Collateral damage. But mostly, *invisible*.

Step one in the recovery and rehabilitation process is to stop the bleeding. In energy terms, this means reducing waste to zero. There is no benefit to waste, unless you adhere to the philosophy behind the Gross National Product, where an automobile accident that creates jobs for emergency responders, hospital employees, rehabilitation specialists and undertakers pencils out higher than the cost of a seat belt. That philosophy does not fly in any court of law based on the way *Mom* works. Just as it is always easier to spend other people's money, it is always

easier to use other people's (or non-people's) energy. Especially when it is so monetarily cheap! That we

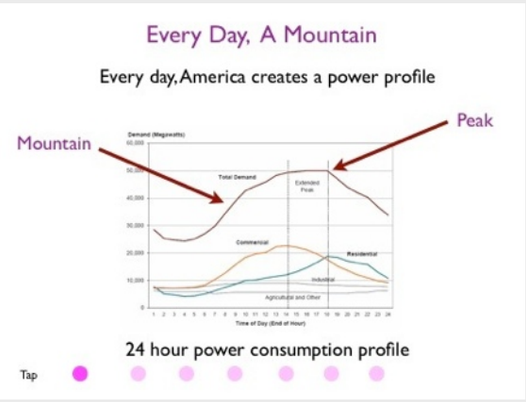


haven't been paying the true cost of energy doesn't mean there isn't one. For the remainder of the 21st century, the bill is due. Don't pay it? *Mom* will send Louie.

No one escapes Louie.

A negawatt is a measure of energy *not used* compared to the energy that was being used. In the light bulb example, for the same light from an LED compared to an incandescent, one could save 86% (14 watts versus 100 watts). Those 86 watts saved are negawatts. If you turn down the heat at night and save 2 kilowatthours of power, that's another way to generate negawatts. If you raise your air conditioner from 74° to 78°, you'll use less power and generate more negawatts.

Every Day, the Mountain



Tap to enlarge

If you adhered to the same general efficiency and conservation principles that are inherent in every living organism (except humans), you'd be constantly working the system to generate negawatts everywhere, since the more negawatts you generated, the more options you would have (run faster, swim deeper, catch prey, etc.)

California has translated the essence of the negawatt mindset into a goal that by 2020 all new residential construction must be net zero, i.e., that a residence

must, on average, use no more energy than it generates.

In a sense, this is what Americans did 200 years ago, before there was heating oil or natural gas or electricity. Your house was smaller; you burned wood to stay warm; you didn't waste any of it, because you chopped, hauled, stored, and fed it to the fire, grateful that it was there for you to harvest, at a time long before there were chain saws. When you are doing it by hand, attention to conservation and efficiency is a no brainer.

Don't Know

You can't stop the bleeding if you don't feel pain or see blood. The first barrier to be overcome is the "Don't Know" barrier.

There are two parts to the Don't Know barrier. One is: not knowing what your own kilowatt profile is. The other is not knowing what the collective profile is. The interactive chart on the previous page gives a sense of both.

Noted earlier was the invisibility issue. If you can't see, touch, hear, smell, taste the waste, it falls into the "out of sight, out of mind" bin, especially when the price of electricity is artificially low (no carbon tax, no nuclear waste disposal fee, no cap and trade, no fracking groundwater treatment charge, no Erin Brockovich).

Cancer is invisible too. That didn't stop the invention of tools to detect it. Tools exist to detect all flavors of electrical waste. The key is to make them as much a part of one's attitude as having breakfast. Overcoming the Don't Know barrier is technically trivial.

Don't Care

Assuming you know (and now you do!), what about caring?

What is it that we should care about?

At the deepest level, it is our relationship with the mother. The Big Mother (*Mom*, aka Earth). The Mother that really supports the whole grand experiment of life. No oxygen, no food, no water (think the moon) and life would be rather short.

Here we are, citizens of the 21st century, who are waking up to the relatively unexpected reality check that life is moving, or *possibly* moving, to a moon scape. Not tomorrow, and not really the moon, but *less habitable*. How much less? That was your assignment two chapters ago.

Don't flip forward to the end of this book to see "the answer". There isn't one. There is no silver bullet, at least not **one** of them. There is a silver lining, though, but it involves 300 million of you, not one Lone Ranger who's gonna ride into Dodge and clean up the mess. There *won't* be a local saying "Who *was* that masked man?" after order has been restored.

Think more like a barn raising, which is a more positive image than filling sand bags to stave off a rising river. Both involve collective behavior, which is to say, individual behavior coordinated around a task.

Tom Sawyer got a bunch of boys to paint a fence, not normally a recreational activity for boys. What matters here is that they *wanted to!*

That's the challenge. To *want* to *lean up* toward a deeper resonance with *Mom*.

The Interactive shows the sociologist picture of this transition.

The short version is: some people embrace a new idea or thing right from the get-go.

They are the Innovators.

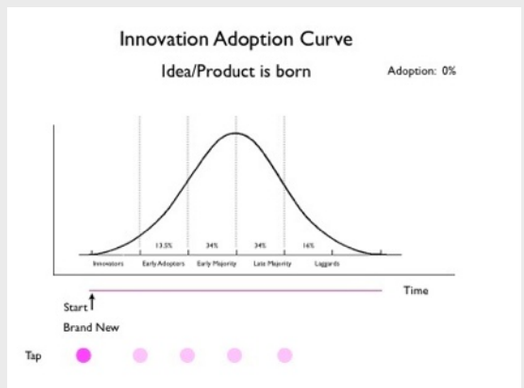
Some time later, because what they are embracing is either cool or *right*, another group sidles up to the bar. These are the Early Adopters.

Then, more time passes and yet Another Group signs up. These are the Early Majority.

Think about yourself. Depending on your age, it could be adapting to using seat belts (first lap belts, then shoulder belts) or adopting to the latest iteration of a cell phone (first, a brick that only allows calls, now, a featherweight smartphone that sends text messages, talks to you and surfs the web.)

Were you at the front of the innovation curve? Somewhere in the middle? At the end?

INTERACTIVE 5.1 Moving the Needle



Tap to Enlarge

Everyone is somewhere on the curve for everything new: at the front, in the middle, at the end. The time frame for many many transformations (from gay rights to smoke detectors to insulation requirements in the building codes to <pick your example>) is roughly two generations, or,

roughly, 40 years.

The issue is not whether we will transition to an updated Version 2 electrical system. We will. The issue is three fold.

First, do you know where *you* are on the adoption curve? You are on it. Your assignment is to *become conscious* of where you are on it. There is no wrong answer. There is, however, *an answer. Yours.*

The answer is complex and granular. Every single negawatt opportunity is somewhere on your personal innovation adoption curve. Example: you *know* about higher efficiency light bulbs (say, CFL's). That's the Know part of the "Don't Know" issue. You *know* they save electricity, money and carbon dioxide.

But! Have you replaced any of your incandescents with CFLs? Have you replaced all of them? That's the *care* part of the "Don't Care" issue.

The exquisitely personal part of this "Care" question is that for the most part, not caring causes you no obvious grief. Your pals are not likely to be the Negawatt Police when they come over to your home and inspect your lighting fixtures, much less the efficiency rating of your refrigerator or furnace. They are *very unlikely* to notice whether you have low-e triple glazed xenon gas filled windows or take a tour of your attic to see that you have R-50 fiberglass batts up there. Unless you are not only an Innovator but an *Innovator with Attitude*, they're not going to know either.

Conversely, next time you are in your favorite mall or grocery store doing retail therapy, you are *very unlikely* to notice, much less comment, on whether the lighting (or air conditioning, or flat screens on display, or…) is efficient or, even more subtle, excessive. Same at your office.

Which segues into the second fold of the transition to Version 2. Where is "the system" on the adoption curve? Do you know? Not likely since there is no national plan and very little national leadership. In fact, there is a lot of sound and fury as the system approaches the fire of change (think Phoenix). The "system" oscillates between the Innovators and Laggards. Watching the needle move between these two positions will quickly make any normal person nauseous.

No Man is an Island. We are social beings. If the big boys are dithering, it's easy to step back from the front

of the *care* barrier having already jumped the *know* hurdle.

But that's not the right thing to do. It's just a socially acceptable (read: default) behavior.

The third fold is really where the rubber meets the road.

It's assignment time again!

What is the time frame from Start to Essential (where 50% of the people have adopted the idea or product)? In this case, the idea is adopting a National Negawatt Mindset, which is to say, crossing both the don't know and the don't care bridges to Know and Care (and Act) Land.

Given that you've hung in this far, maybe you are looking for just that little extra bit of inspiration to step up to Tom's fence and begin painting. Swipe the page.

CHAPTER 6

Lean Up

There's a really good chance you are on the left side of the innovation adoption curve if you have read this far. You may be an Innovator and, if you are, you already know this stuff and are deep into care mode. You may be an Early Adopter or perhaps adventuring into your future from the safety of your Early Majority rocking chair.

Generally, you are open to marching to the sound of a different cultural drum.

It's actually a very old drum, the drum of resonance with sustainable life rhythms.

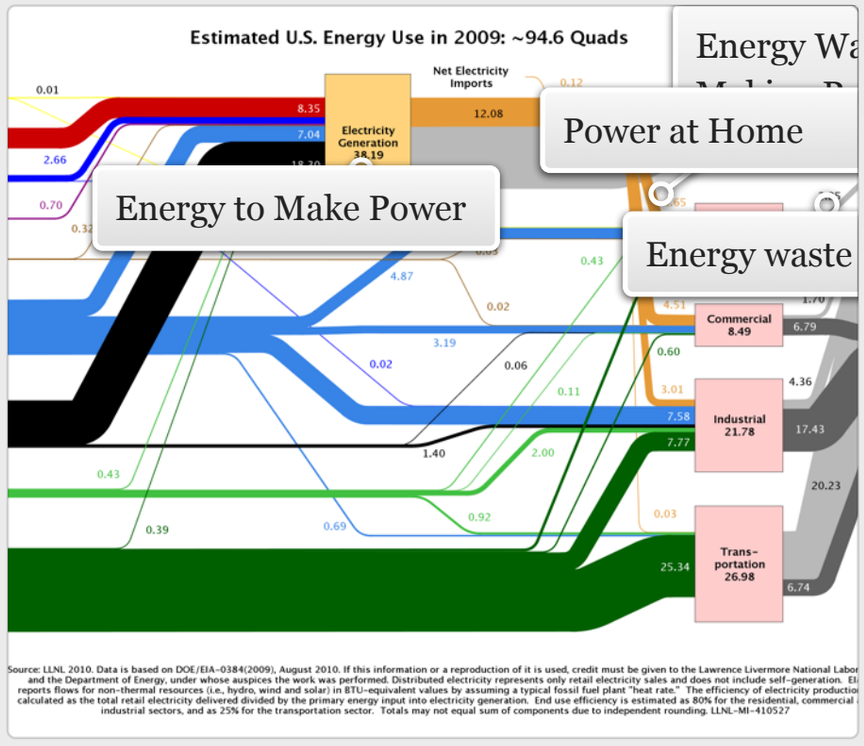
It's really a no brainer. We are either on a sustainable life course or we're not. Sure, lots of noise and uncertainty as technology and behavior do an increasingly accelerated dance. But to *Mom*, who is much more patient than we are, we're either doing the right thing or we won't survive.

Recall the invocation in the last chapter on how to begin. Stop the Bleeding.

How much bleeding is there?

Hint. We're not talking a bandaid. We're not talking a tourniquet either. This is the energy equivalent of a mass casualty event.

INTERACTIVE 6.1 How much bleeding (waste) exists in the electricity sector?



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energy.llnl.gov/ click on "energy informatics"

As you can tell from the graphic, two thirds of the energy used to *make* electricity is wasted. Like Pentagon-speak, it is not called something obvious like "wasted energy". It is called "rejected energy" as if it were little more than a couple of rotten apples in a bushel.

According to the engineers at the Lawrence Livermore National Lab (see slides 3 and 4 of the interactive graphic), about 20% of the energy *used* in the home is wasted too.

What the graphic is really saying is that, as a nation, we are so wealthy that we intentionally design one of the most critical infrastructures underlying our economic, cultural and personal life in such a manner as to deplete our natural resources at the bleed rate of a train wreck.

Daily.

For a hundred years.

There's a lot of talk about the national debt, that grandmother wouldn't approve. She wouldn't approve

of this energy waste either. But unlike the national debt, which she can't help but know about since it is in the news every day, the energy bleed rate is not in the news.

There's lots of arm waving about whether renewable energy sources should get subsidies, or whether the fossil fuel subsidies that energy corporations have enjoyed for decades should be dialed down or removed. There's virtually no conversation about the inefficiency by which fossil fuels are turned into electricity. It's just the cost of doing business.

What about this?

If we want to waste less fuel, we burn less coal.

To burn less coal, we use less power.

We can use less power by *reducing or eliminating wasted power*.

How? Hint: Nega ..ahh. ahh.. ahhhhhhh....

It's the *fastest, cheapest, easiest form of new power* out there.

It's a total no brainer.

You'll find this discussed at the policy level in obscure documents created by Public Utility Commissions and Large Power Generators (like Bonneville). You are unlikely to have this message repeated frequently by your favorite news source.

Why is that?

The 24 hour news cycle is built around keeping you on a caffeine drip, then selling you something to calm the nerves that are continuously rattled. Tracking the rising Parts Per Million of an invisible gas is worse than watching the grass grow. It's too hard to create drama in the slowly rising temperature tide. A stronger storm here, another centimeter of ocean rise there, a bit less ice in the arctic. No one in power is willing to take a strong position that challenges the status quo. Even if they did, who is going to repeat that daily for the next 40 years? (Unlike most events that have a time-critical element to the story, the idea of waiting to see if we "make it" to 450 PPM, and hence 2°C, *by 2050* has surprisingly little mojo.)

What's this mean to you?

It means that until the planetary ship hits the metaphorical iceberg, assuming there could be an event that was unambiguously tied to the increase in

CO_2e and the event was *ugly*, there will likely be little leadership.

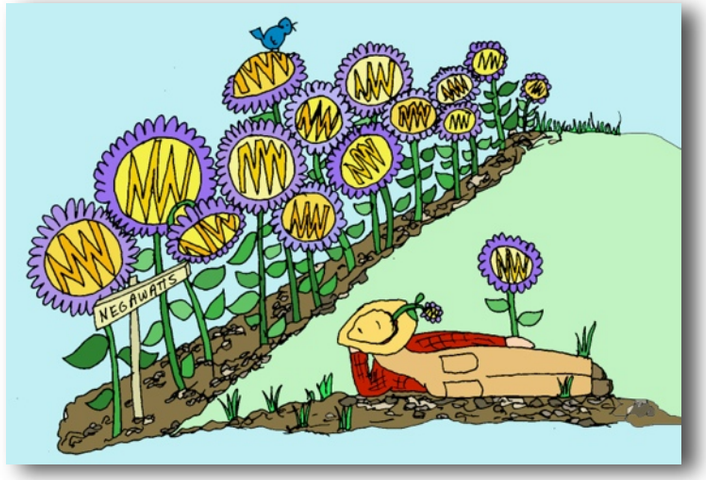
You want change? Don't expect it from them. If you need inspiration, think Ghandi: Become the change you want to see in the world.

Start by adding a negawatt garden to your (watt consuming) backyard. Adopt as your moral guide the Little Red Hen.

Abandon the expectation that you might experience a big wow factor. You are engaging at the front end of perhaps the biggest, most important, and most time-sensitive transformation of consciousness in the history of humanity. You are dealing with waste that is *invisible*. Most of the changes you will make will be *hidden*. Until technology catches up, making some of the waste-reduction activities automatic, to be effective you will have to go *manual*. In the early days of the automobile, you had to hand crank the engine in order to start it.

While that may seem crude today, few complained because the obvious benefit of an automobile over a horse or walking was huge. The challenge today is that negawatt benefits are *not obvious*. They are, however, cool.

You can create an organic negawatt garden. Like a farmer, you will attend to your growing negawatts every day, making sure that they are safe from pests (aka weeds, bugs, etc. which metaphorically are forms of waste). Your growing field of negawatts will nurture the next generation of clean, fresh, locally sourced waste-free *watts* that will help not only you, but particularly the ecosystem that extends out physically to include your family, friends, community and *Mom's* Biosystem Support Staff while also extending out temporally to include your (*and Mom's*) many descendants who *need your negawatts*.



The culture is starting to march to the sound of a sustainable drum.

Starting.

Kind of like the first hour of a brand new marching band's organizational meeting.

It knows it has a game coming up. It knows it has 10 positions that it has to get into sequentially. It knows it doesn't have a lot of time to get from one position to the other. When the leader calls out the first position there is a lot of banging and crashing into each other as they scramble to get where they are going. (Actually it's pretty pathetic—or humorous—depending on whether you are just watching or you are the guy in charge of half time).

You are in this band. Along with 300+ million of your fellow band members (some are better at playing their instruments than others).

Your instrument is *your* cluster of watt-consuming entities, from your clothes to your hot water tank to your dryer, your cell phone, your night light and everything in between (including your house and the influence you can have at work and while shopping).

Maybe you can't be an Innovator with every part of your instrument the first time the leader (who is actually a voice in your head) calls out the first position. But you don't just stand there. You attempt to get into position, even if you bang into a few people (or they bang into you.) You try again. You practice. *They* practice. You *all practice*. It comes together.

Your kids (real or surrogates) are watching you. *Mom* is watching you. They are proud.

No one said it was supposed to be a piece of cake. It's not. There is a learning curve. So what else is new?

Here's the takeaway: It's nuts to build more power plants so we can continue to dump carbon in the sky to power waste. The challenge is big enough without unknowingly leaving the equivalent of at least a couple of windows *always open* during a Minnesota winter or a Texas summer. Zero means smart. Zero means wise.

Zero means *cool*.

How to do this?

Journey of a couple miles.

Since you've read this far, you have already put on your shoes and tossed your backpack on your shoulder. You are *really really close* to taking that first step of your journey of a thousand miles.

Only it's not really a thousand miles. It's a short walk around the block.

This is not a difficult physical journey. It's a far more difficult mental, actually spiritual, journey. The road is clear. The question is whether you get on it voluntarily and cheerfully, now, or whether you will be dragged on to it (think Laggard) sometime later.

There will be time-of-use rates. There will be higher prices for electricity. There will be struggles to avoid rolling blackouts, which the Pentagon-Speaking suits call "load shedding" as if it were no more consequential than removing some clothes from an overstuffed (and thus too heavy) suitcase that you are planning to schlep on a plane.

In this scenario, you become the clothes that are metaphorically removed from the bag, where "you" is a placeholder for the electricity you consume. If the system has to shed load in order for it not to entirely crash (think of it as throwing someone out of an overloaded life boat so at least some survive), that someone might be you.

You might think you have no choice, but if you are growing negawatts and this innovation has been adopted about half way through the bell curve (Innovators, Early Adopters, Early Majority), there won't be load shedding. The light at the end of the tunnel won't be the headlamp of an oncoming train.

There are folks in the conservation and efficiency sections of every utility in America who are standins for the Maytag repairman, growing spiderwebs on their phones because no one calls. These folks have two things in common. First, they *really want you to save money* on your power bill. They have rebates. They have trusted contractors. They have low income loan options. They have ideas.

Second, they are *really not good* at marketing. Why should they be? They've never really had to do this before.

What is it they've never done before?

Sell you *less power*. Get you to believe in the **negawatt mindset**. This is brand new stuff. This is culture change writ at a planetary scale. This is contrary to the whole concept (more power sold means more revenue generated) that has made Version 1 work for decades.

They need *your help!!*

And.

You need their help!

Think peanut butter and jelly. Horse and carriage. Yin and Yang.

As noted, saving a sizable chunk of that 20% energy wasted in every home in America is NOT rocket science. It involves *no new technology*. Anyone can *do it today*. It's a matter of taking that mental step, that it actually *matters*.

You don't need this book to hold your hand while you swap out inefficient light bulbs. You don't need this book to hold the ladder whilst you check the insulation level in your attic. You don't need this book to give you the links to a bazillion web sites that give you products and ideas to shave a little, or more than a little, power off your monthly habit. Want simple and fast here?

Surprise yourself! Call your electric utility.

Here's your next assignment.

Visualize the environment you want for your descendants, real or surrogate. Maybe that's too vague. Visualize the *electrical energy* environment you want. Is it abundant? sustainable? gentle? environmentally supportive? Whatever it is, call that Version 2. Dream big. Then picture where we are today. Reality.

Your job is to imagine, then design, the bridge that gets us from where we are today to your Version 2. What's that bridge look like? Who will build it? When will it be finished? Can anyone start walking across the bridge before it is finished? What does crossing that bridge look like? Who should, who will, cross the bridge? What will be left behind? What can't cross?

Got a headache? The whole thing is just too much? Break it down. Go *simple*!

Find a model. Why not Goldilocks? Bottom line: she knew what was Just Right. Too much was just as useless as too little.

Just Right works. Easy to remember. Not Big Brother. *Mom* will notice. So will your kids.

Want another model? How about the kid in *The Emperor's New Clothes*? The one who wasn't afraid to speak the truth.

Lean up.

Hard.

CHAPTER 7

Taking that First Step

Pick up the phone. Call your utility. Schedule a home energy audit. Learn about your own bleed rate.
Validate if what you have read here has any basis in reality. Dig around the internet. Make sure your BS detector is *on and working*. You will find plenty of words. What you are looking for is *credible information*.

Turn over all the electrical stones in your house. This will require you to find them. Many are invisible, tucked away in basements, closets, garages, even the ground (water and sewer pumps, irrigation systems, security systems).

Take one room at a time. You are a fish. This is unexamined water. You are looking not through it, but *at it*, for the first time. Any negawatt potential here? Any?

Multiply your negawatts by ~130 million. That's the number of households in America. The number you come up with can be translated into some number of coal fired power plants and their ecosystem components: mountain top removal, trains, sulphur dioxide, as well as CO2e and its implications about which you got a flyby here.

This is the "stop the bleeding" phase. No one is going to do this for you. It's your energy (and monetary) blood. If you saw a puddle of gasoline under your car, indicating that your gas tank was dripping away your $4/gallon gas, you'd be a rare person who wouldn't care.

Don't stop there. Get into this new outlook. The water is big. There is a lot of it. What about work? your kid's school? Where you shop? Even a simple "Did you know..?" to a teacher or a retail clerk or an office manager might be all that's needed. What's that cost?

The sky's the limit. There are negawatts ready to fall off trees everywhere! The big boys call it the lowest hanging fruit.

What's this look like in the real world?

McKinsey created a chart showing what the cost of reducing (abating) CO2e is based on applying a specific measure (say, increasing supply by building a coal fire power plant, or decreasing demand by swapping out light bulbs.)

As you might expect, increasing supply the Version 1 way (burn more coal) increases CO2e, so new technologies (such as CCS, or Carbon Capture and Sequestration) have to be introduced to lower CO2e. The power plants *plus* these new abatement technologies cost something.

(A Lot.)

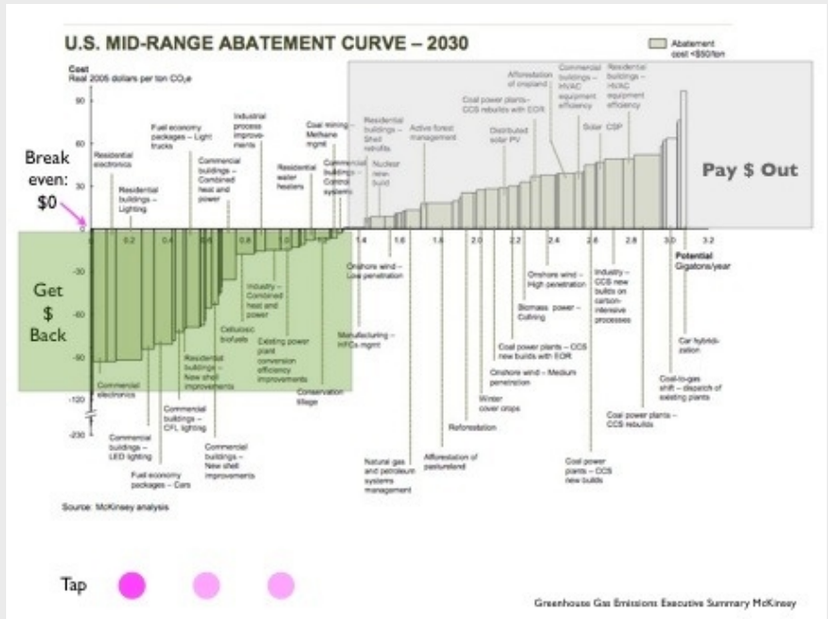
In fact, they cost a Whole Lot More than the no brainer negawatt (lower demand) activities. The chart is rich with information, so take your time. Basically, the activities on the left side of the chart are below the $0

(cost) line, so they are activities that it pays to do, since they save money *and* CO2e. The activities on the right side of the chart are above the $0 line, so they cost money in order to lower CO2e. Not surprisingly, the negative cost activities reduce demand, while the activities that cost the most increase supply.

Let's recap so the significance of this graph is not lost.

The world is spitting out CO2e at about 2 PPM per year. We're at ~392 PPM in 2012. We have taken almost no steps to lower the rate we're spitting out CO2e, which means the total global PPM is growing. Assume that 450 PPM is the max we can grow to in order to keep the global average temperature increase below 2°C. That means we are going to have to lower the rate we're spewing CO2e, so we can arrive at 2050 (and go on to 2060 and 2100, etc.) with *zero growth in global PPM* which means *generating **zero** additional CO2e* starting in 2050.

INTERACTIVE 7.1 Lowest Hanging Fruit come from Negawatt Trees!



Tap to Enlarge

That means that everything we're doing now that produces CO2e is going to have to be reduced, or abated (dialed down to zero) over the next 4 decades.

The chart shows the cost of each different type of abatement activity. Negawatt actions *save money* while supply actions *cost money*.

Mom doesn't care *how* we lower our PPM. In fact, *Mom* doesn't care *whether* we lower our PPM. *She* operates under the laws of physics.

We have been pretending we can ignore them.

Species? Easy come, easy go. There's no special exemption for humans. If you think there is, look up the definition of delusional.

So much for the preliminaries. It's time to get down to the short hairs.

There are three ways of managing your watt flow: structural, equipment and behavioral.

Structural methods involve up-front funding and activities. Structural means a one-off intervention that will pay back forever. You know the drill: insulation, weatherstripping, window and furnace/air conditioning upgrades.

Ever heard of the Passiv Haus? Those homes in Germany that use *90% less energy* than a typical American house? What's the secret sauce? Proprietary German technology?

No.

Ceiling insulation at least double U.S. standards. Wall insulation and window heat loss reduction at least double U.S. Standards.

Is Germany located near the equator?

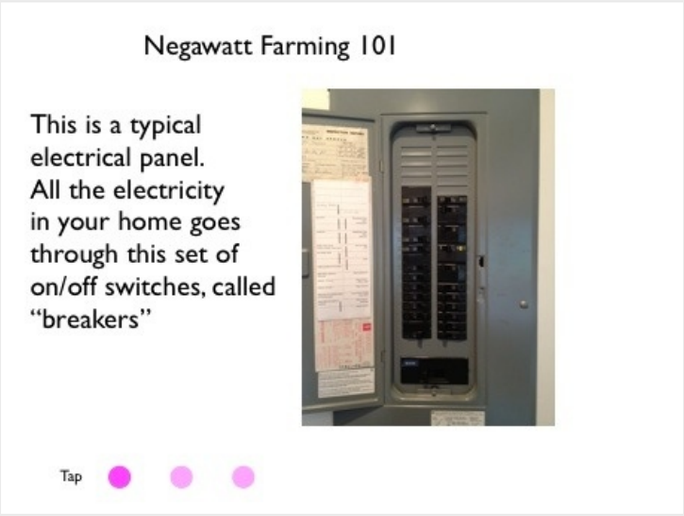
Is doing this in America a *technology* problem?

Equipment methods also involve up front funding and activities that are mostly one-off interventions and pay for themselves over time. They involve all that watt equipment that needs replacing, upgrading or managing. You've got a lot of equipment: refrigerators, hot water tanks, maybe a pool pump or hot tub, oven, light bulbs, computer, router, video game station, flat screen, on and on. Some of that equipment drinks watts 24/7 even when it is apparently "off."

You've heard of Energy Star. You've crossed the Don't Know barrier. Now there's only that pesky Don't Care barrier.

Here's where the low cost/low tech rubber might meet your "This is too much to deal with" road. You *can* go manual. You *can* exercise the **power of the hand**. You *can* pull the plug or flip the breaker.

INTERACTIVE 7.2 Negawatt Farming 101



Tap to enlarge

Breaker?

See the interactive chart to get up close and personal with the intersection of your hand and your watt control center.

Want to save power the simple easy zero-tech no-cost way? Flip a breaker.

You may not really do this (tho you could and can). But something will. It could be a smart grid appliance. It could be a simple timer. Negawatt gardening means using less power. There are options to choose from. Each has tradeoffs.

The manual option has the virtue of simplicity, zero cost, absolute effectiveness, and total confidence that you are creating negawatts. There is "vanilla" manual, where you train yourself and your kids to just unplug the flat screen when you are no longer watching. Another example: turn down the thermostat (in winter) when you leave the house or go to bed. (In summer turn up the thermostat when you leave home or go to bed.) Even a few degrees makes a difference. There are all kinds of variations on manual. You are in charge. This is the "I'm taking ownership" option.

We are not used to this.

The automatic option can go from a programmable thermostat to having your utility talk to your refrigerator or dryer and dial down the power being used. This is the "Look Ma, No Hands" smart-grid-that-doesn't-exist-yet option.

Here's an example of negawatt gardening practices applied to the lighting in any room.

First, make sure the bulbs creating the lighting are efficient (CFL or LED). If the bulbs being replaced were incandescent, right there you grew some negawatts. Second, don't have more lighting than you need. Whatever the space, it's not likely to be an Operating Room. These two actions are a mixture of structural and equipment negawatt gardening. Do them once. Done deal. Permanent negawatts.

Third, turn them off when you leave the room. This action is manual. Call these daily negawatts, as if you were picking strawberries every time you left the room. Simple. Cost free. No heroics.

Basically, this sequence is the drill for every Overweight-Watt to Negawatt conversion. Doing this manually is effective, cheap, and keeps you attentive. Setting things up to do this automatically is effective, relatively cheap, and requires less attention to all the electrical animals running helter-skelter around your Waste-Not Watt-Not homestead.

The intention of the fully operational Version 2 system is to create a lot of automatic options via technology, so you don't have to feel like an Australian Shepard to all those little FatWatt-to-Negawatt Opportunities invisibly spending your money and degrading the options for your descendants.

However.

We are not there yet.

We are not even close to being there yet.

You can wait until Version 1 morphs into Version 2. Figure 30 years. It'll be a lot hotter then.

Or.

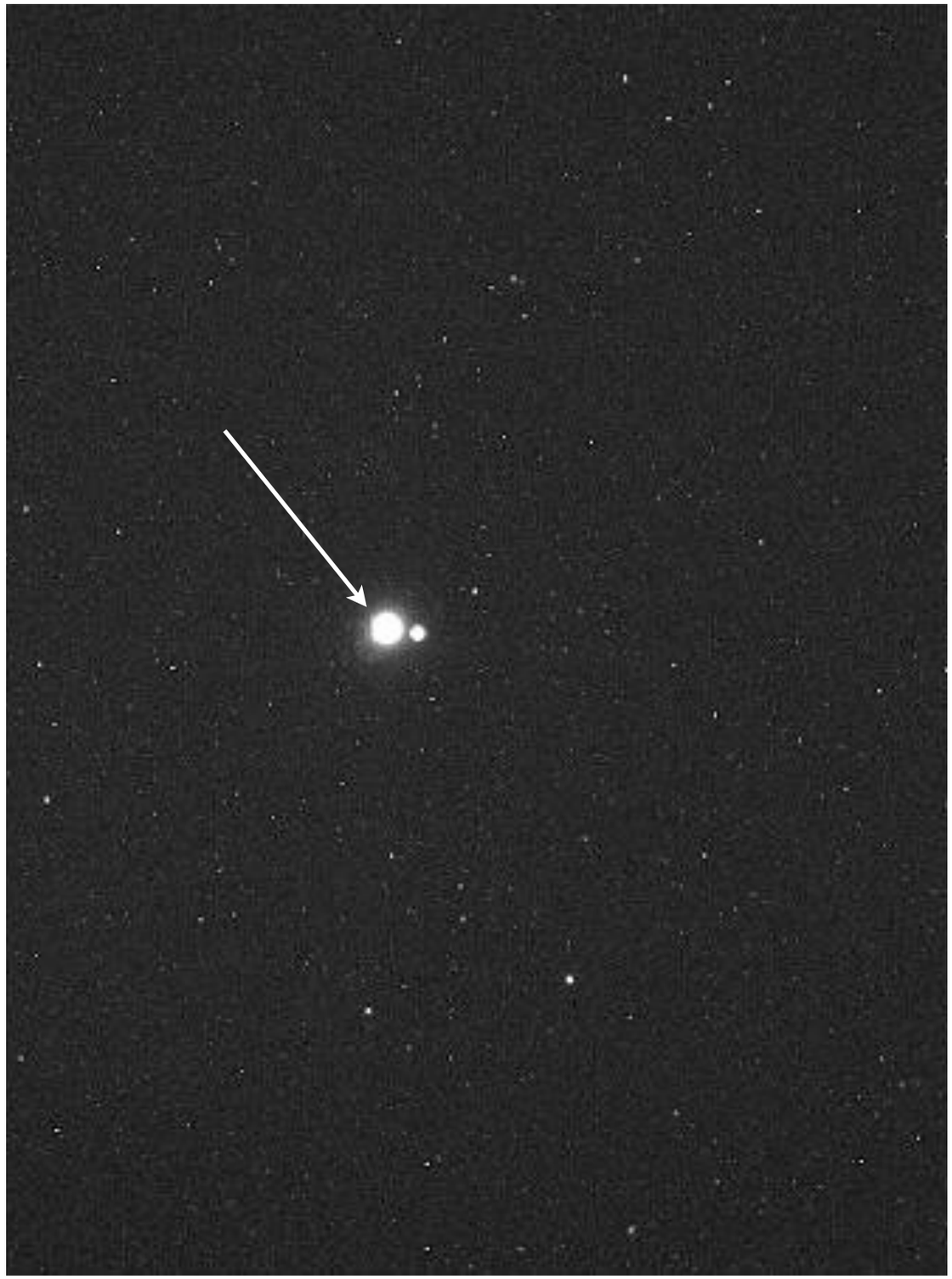
You can start today. You won't have all the automatic bells and whistles of Version 2 but you *can* grow a lot of permanent clean-spark negawatts. Now.

This is where many hands make light work. You want 450 by 2050 so we don't get past 2?

Make that call.

CHAPTER 8

You Are Here



You've made the call. You've agreed to invest in your future in order to save money and lend your shoulder to the wheel of sanity's effort to burn through the thick fog of cultural misunderstanding regarding the impact of human's on their own habitat.

The short version is that Mother Nature, affectionately called *Mom* here, really doesn't care how hot the planet gets, and therefore how well her biological systems operate under serious duress.

You've started down the road to watt sanity. Every negawatt counts, especially if it can be multiplied by 130 million.

This book has focused on the first step of the journey. Stop your own invisible watt bleeding.

There are many more steps.

United we stand. Start a negawatt parade. Even a small one. Get your best friend, your parents, your kids, your kid's teacher, the grocer, your boss, your employee—*someone*—a *bunch* of *someones*—to take their first step. Since you took it, you are no longer in the inactive or reactive camps. You are in the proactive camp. You are on the left side of the innovation adoption curve. *You are an ambassador for maturity*. Your compadres want to do the right thing. Their feet are stuck in inactive/reactive land. They imagine that others will see that there is a real problem and those others will do the right thing and since that's the way it has always been why get bothered?

The problem is: those others are stuck even deeper. They need numbers to get unstuck.

Numbers of people. People asking questions. People wanting change. People wanting to get the country off the carbon binge so there is something meaningful left to pass on to the next generation.

Setting a goal of zero waste is a no brainer.

The real brainer is getting to net zero energy.

Ultimately this will mean Americans burn zero petroleum, zero coal and zero natural gas to produce zero carbon dioxide. We transition to getting all our energy the way everything else in *Mom's* world gets it: from the sun, which makes rain and wind, which means wind power and hydro power. There's plenty to go around. We've been seduced long enough now that what was a miracle to your grandparents is now an entitlement.

The biggest issue is not technology. It's in your mind.

No one really cares how electricity is made. People just care that there is plenty of it.

This cuts both ways. If you don't really care how it is made, what's wrong with making it clean spark?

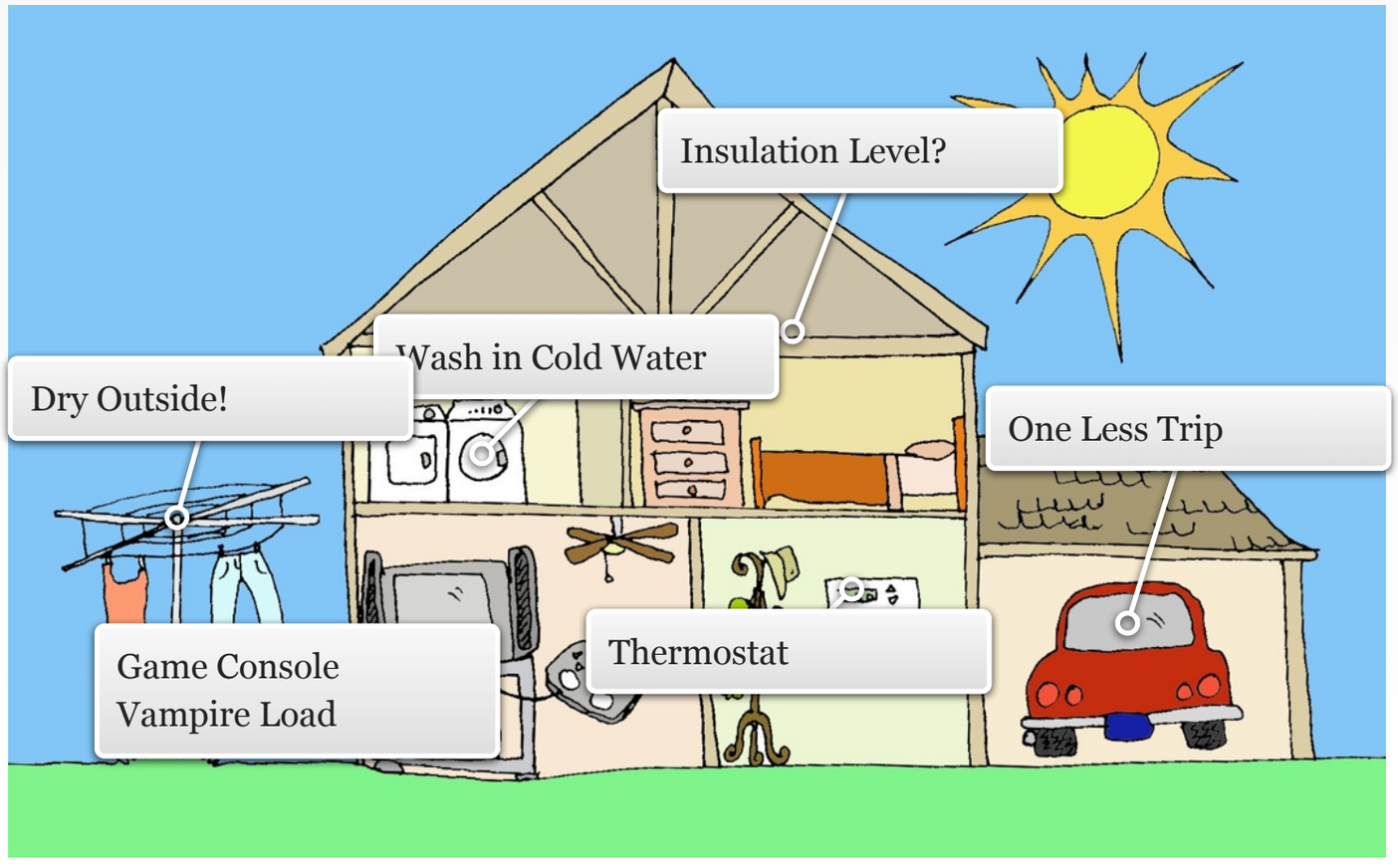
On the other hand, if you don't really care how it is made, you'll let others decide. Most of the big boys, today, are still leaning on the overloaded wobbly legs of tweaked Version 1 dark spark power ("clean coal", "advanced nuclear power", "natural gas peaking plants" from gas fracked in the good ol' U.S. of A.)

Why?

Partly because it is known. Because it works (well, not the tweaks). Because there isn't enough pushback. Because the users (that's *you*) demand huge quantities whenever where-ever. If you didn't need as much, or were willing to negotiate even a little bit, the supply guys would have a lot more wiggle room to advance the renewable power agenda.

Especially if you said you would offer some wiggle room yourself in trade.

INTERACTIVE 8.1 Negawatt Gardening at Home



1 2 3 4 5 6

Your next assignment is to have a real conversation with yourself (and your household). Got any flexibility with that thermostat? *Any?* Got any flexibility about the daily commute or the clothes washing temperature or when (or how) you dry those clothes? *Any?* Hot tub? Pool? Hair dryer? Game Console?

The issue is willingness. The issue is how soon your change begins. The issue is 450 and 2, which today looks like a joke, 2050 or not.

450 and 2 represent laws of the universe, from quarks to black holes, whereas hopes, dreams, and fears are not. For those who counter that there's always geo-engineering, one could respond that they are auditioning for the role of Mickey Mouse in the Sorcerer's Apprentice, *knowing in advance there is no Sorcerer* who is going to come in at the last minute, wave a wand and bail us out.

It's a cool problem. You can play, or you can watch. You can't, however, leave the stadium.

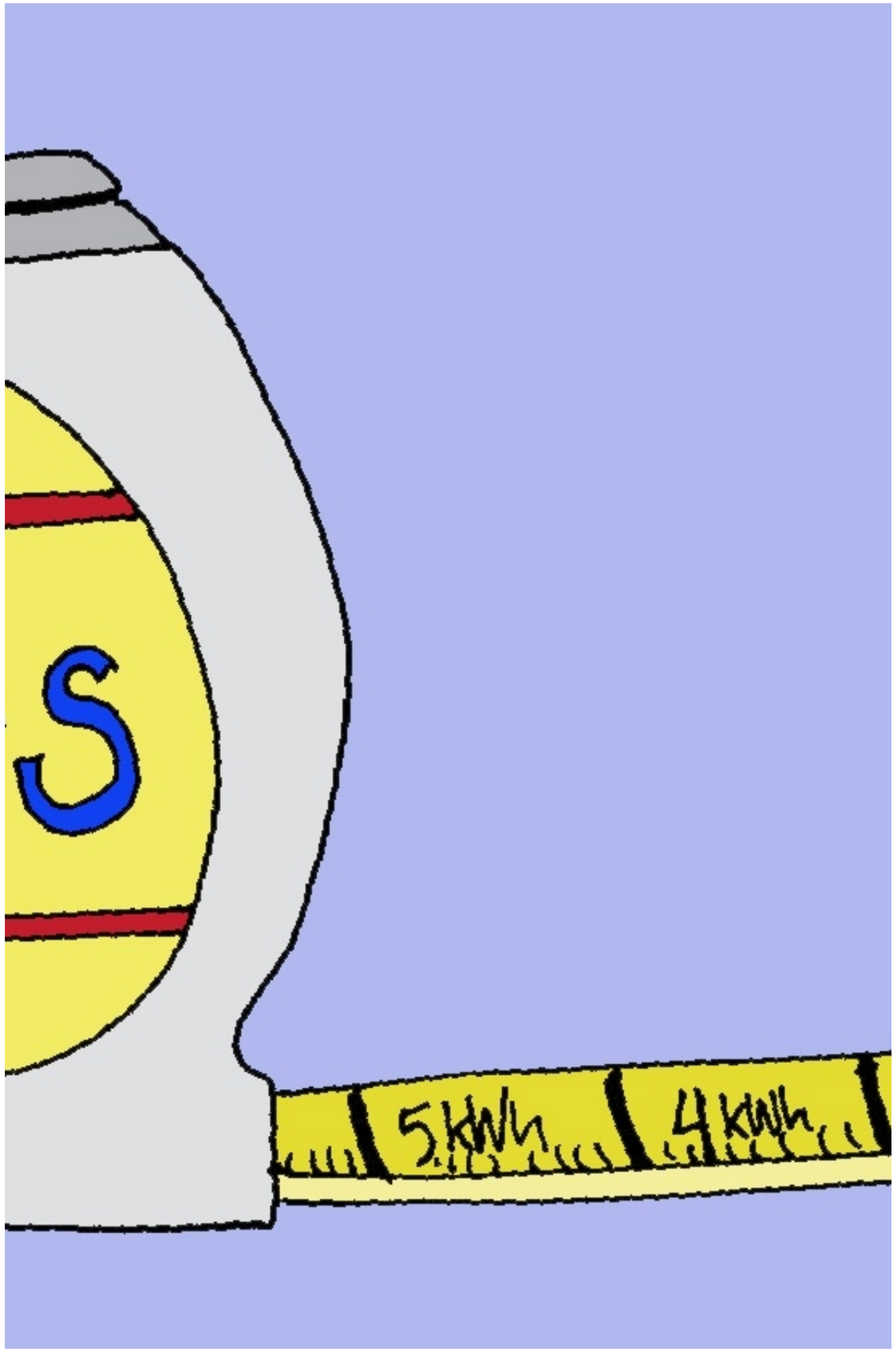
Whose team are you rooting for?

Since you're reading this on an iPad, you're wired. So *wire away*.

Chapter 9

Plan B

One of the buzzwords for the 21st century is metrics. If you can't measure it, you can't really mess with it. Measuring has become more refined (more *granular*), allowing greater precision in response to better data.



In the world of electricity, reading a meter once a month used to be sufficient. We are moving to a world where reading the meter once an hour is going to be standard. We might get to reading a meter once a minute.

We might read more than the meter. We might go more granular and read what each electrical device is consuming every time it turns on. Given this data, we could know much more about how our little watt farm was doing, in real time. Knowing is the prerequisite to caring. Caring is the prerequisite to action. Many people acting much more quickly than what used to be called normal would be described as *going viral*.

This could be measured. The term for collective action that has gone viral is "moving the needle."

Moving the needle means *accelerating* the transition to the adoption of a new idea, product or system. The meter that the needle is on measures the *rate of change*, not the change itself. Think of a glass of iced tea on your dashboard. You're buzzing along at 45. The glass just sits there. All of a sudden, some clown cuts in front of you and you have to floor it to avoid a crash.

The glass tips over dumping the tea in your lap. The glass tips because the rate of change went from zero (steady 45) to "Yowza" in just a few seconds. That's "moving the needle." If the needle doesn't move, it means that the transition to the new thing will proceed pretty much along a standard human scale, which generally means about two generations, or roughly 40 years.

Perhaps that is why the choice was made to pick 2050 as the moment of truth. It's about 40 years out. It takes time to decommission dirty coal plants. Many plants whose lives have been extended well beyond their intended lifespan are still up and running because there has been no replacement. Power is more important than some invisible gas that might cause heartburn long after the decision makers are retired or dead. It's a collective thing: if as a nation we *wanted* to accelerate the transition to a clean spark world, we could and we would.

The big picture is simple. We build clean spark systems to replace dark spark systems. It will cost very big bucks. It will take decades and it will take unrelenting commitment. It's not rocket science.

So far the needle has not twitched. It seems as a nation we are playing chicken. Only it's not with *Mom*. It's

with ourselves. Given the weather events of 2011 and 2012, *Mom* isn't losing. She's not playing either. She's simply keeping score.

Absent a mass conversion experience, whereby the needle starts moving seriously into the kick-butt section of the meter, what is likely?

It is likely that until weather events and their related consequences (drought, bugs, drop in agricultural yields, destroyed towns, flooded cities, unmitigated sweltering temps, etc.) get bad enough, the needle won't move.

What no one knows is what the size of the climate change avalanche will look like by the time the needle starts moving. As a species we do not do well with discontinuity. Anyone who has ever run out of gas knows the sinking feeling of helplessness. For whatever reason, the driver has dropped the proactive pay-attention-to-the-gas-gauge ball. The car starts to sputter, at which point awareness hits like a freight train. If the driver happens to be within a half block of an open gas station, *Whew*!

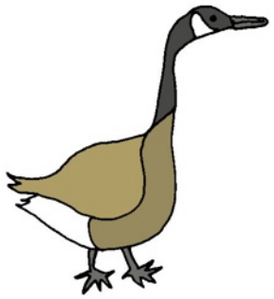
Generally that is not the case.

The climate change problem is a bit like that, only with a longer time scale (*Mom* works in minimum increments of 100,000 years). We're puttering along, things seem to be going well enough, then sputter sputter cough (which in climate terms means breaking weather records at an accelerating and undesirable pace). All of a sudden, we're running out of standard-habitat gas. Sudden to us. Not to *Mom*.

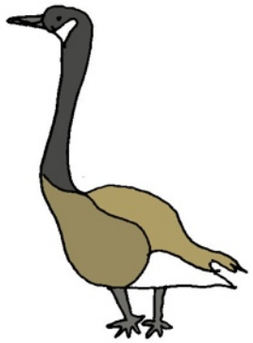
How will this translate to daily life in America?

It would not be difficult to imagine a scenario where a form of power rationing emerges. It might most easily take the form of progressive rate structures for electricity. Everyone gets, say, 500 kwhrs a month at a fairly low and familiar rate. (The average household in America today consumes roughly 900-1000 kwhrs/month). The next 500 kwhrs are twice as expensive. The next 500 are double again. Added to this will be the time of use layer. Use power at 4am and it will be relatively cheap. Use power at 4pm and it will be like buying tickets to the Super Bowl in front of the stadium on the day of the game.

Not once a year. Every day.



This structure will of course apply to commercial and industrial users as well. Good for the goose, good for the gander, jah?



Why?

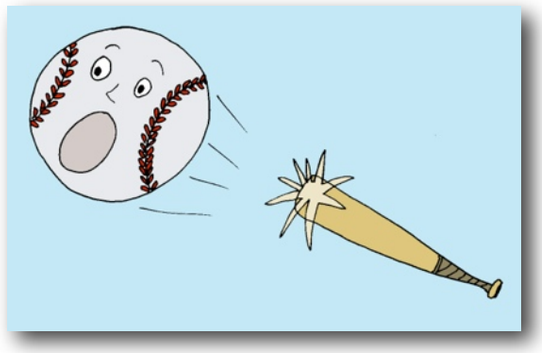
To avoid load shedding, i.e., rolling blackouts.

Why?

Because the weather has become so bad that power plants don't have the water to cool them. Why? Because the cities and the farmers are claiming first rights. Or because the power plants can't keep up even if they have the water because it has become so hot that air conditioning loads are tanking the system. Or (and here is yet another assignment) *because*. You create the scenario and you provide the answer. Maybe it is that the promise of some new biofuel or technological silver bullet is discovered to have been a hack or, worse, the law of unintended consequences has laid down a royal flush.

What will you be doing?

You will be triaging your power use. You will be going from easy negawatt gardening to Houston We've got a Problem. You don't have the money and you don't have Mickey's Sorcerer.



Suddenly the full impact of converting that 60% of petroleum energy (mentioned in Chapter One) to electricity will hit like a Babe Ruth homer. Only you are the ball. That's *in addition* to replacing the existing dark spark electrical system that is old, inefficient, and unsustainable.

Fast.

Fast enough to move that needle.

On the other hand, everything you've read here could be wrong. Entirely wrong. You cannot avoid making an assessment of the information you've read here unless you are Da Queen of Da Nile.

Have a cup of coffee. Acknowledge that the cultural sound bites whereby technology will save us are diversionary pablum. Roll up your sleeves. Ask real questions. Don't accept answers without the attentive scrutiny you'd invoke if you were on a jury or you found out your kid has cancer.

This is a numbers game in which the numbers are people. You and your neighbors and your boss and your friends and six degrees of separation to everyone.

Why? Because *demand* rules.

No one has ever built a power plant just for practice; when is the last time you bought a car then let it forever sit idle in the driveway?

There are precious few leaders. Corporations and governments are run by people who follow. They follow you. They want your money. They want your vote.

Make a deal.

Trade your money and your vote for the truth. *Mom* is telling you her truth. It's simple: *Physics Rules*. Full transparency. No back-room deals. You can trust her. She has been consistent for a very long time.

There are two contradictory narratives in America. One celebrates the power of the Individual. Pick your favorite: Steve Jobs? Abraham Lincoln? Susan B Anthony? Someone who rises from obscurity and does something really valuable. The other narrative spins the opposite tale. "I don't count. My vote doesn't count. My impact is insignificant" (therefore I can do what I want and it doesn't matter.)

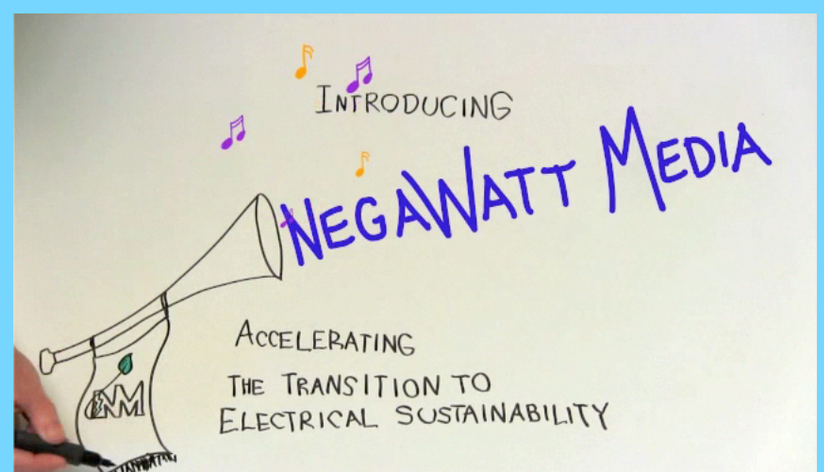
The reality is that *everything adds up*. Add up the first narrative and you have a March on Washington or an Occupy Wall Street. Add up the second narrative and you have national sleepwalking.

Often the driving force for that first narrative is love. Love of an idea, of justice, of a clever new way of doing something, of a person or a group. Love of children is right up there with love of breathing. It translates as protection, empowerment, nurturing, and preparation for independence.

Who do you love enough to bite the carbon bullet?

Written and adapted for iBooks by: Joe Symons
Illustrated by: Anita Orne
Reviewer: Sophie Padelford

Who We Are!



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