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Peter Thiel’s CS183: Startup - Class 14 Notes Essay

36-45 minutes

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Here is an essay version of my class notes from Class 14 of CS183: Startup. Errors and omissions are mine. Credit for good stuff is Peter’s.

Class 14 Notes Essay—Seeing Green

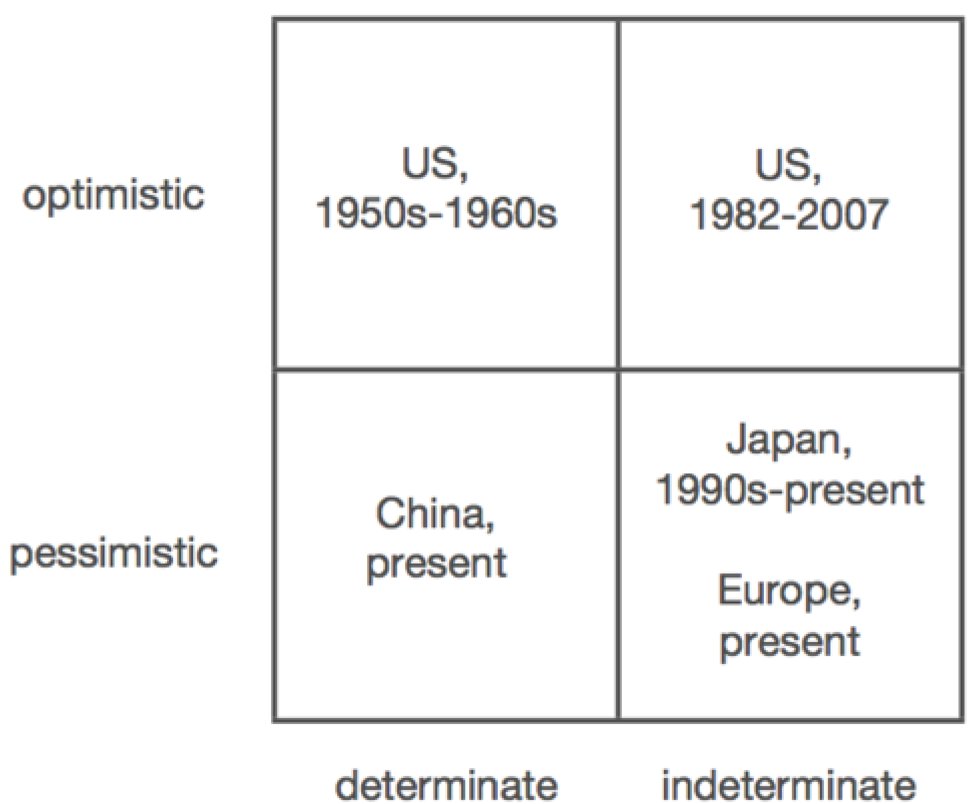
I. Thinking About Energy

Alternative energy and cleantech have attracted an enormous amount of investment capital and attention over the last decade. Almost nothing has worked as well as people expected. The cleantech experience can thus be quite instructive. Asking important questions about what went wrong and what can be done better is a very good way to review and apply many of the things we’ve talked about in class.

A. The Right Framework

How should one think about energy as a sector? What’s an appropriate theoretical framework?

Revisiting the 2x2 matrix of determinate/indeterminate and optimistic/pessimistic futures may be useful. To recap, here are examples of those respective quadrants:



It is important to note—especially in the cleantech context, we we’ll see—that planned indeterminacy doesn’t really work. You can’t just plan to go and get a new job every 2 years and call it a plan. That’s the absence of a plan. It’s equivalent to having a plan to get rich. “I intend to get rich and famous” is a vague aspiration, not a plan. Plans can’t just be a portfolio you throw together. For a portfolio approach to work, it must have a specific granularity to it. "If I do *x*, it will lead to 5 specific options at a certain time in the future, at which point I'll choose the best of them" *might* be specific enough to work.

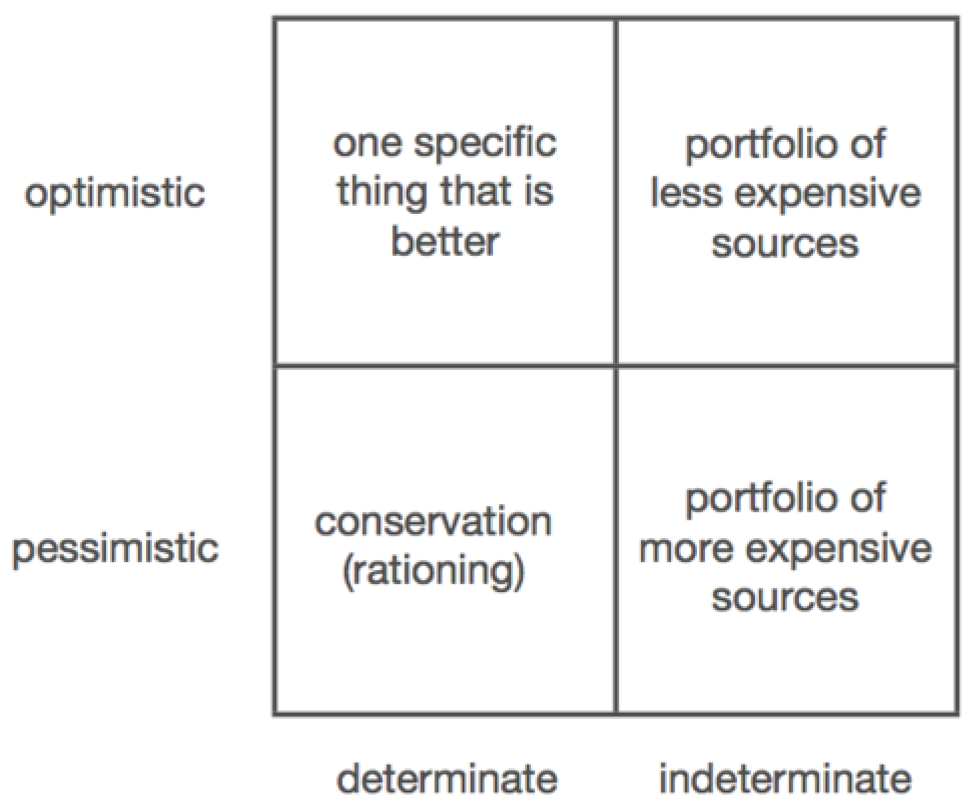
But in practice, people don't usually target specific options that will unfold. They just figure that they will have plenty of options, and that they'll figure everything out later. So while in theory there can be a more determinate, substantive version of indeterminate optimism, in practice statistical thinking breeds radical indeterminacy and process-based thinking. Aspirations replace plans.

And yet people are skeptical of startups with plans. The conventional wisdom is that detailed plans are worthless because everything is just going to change anyway. But having a detailed plan is key. To be sure, there are some cases where things work despite the lack of a plan. But there is an awful lot of failure there too. Winning without a plan is hitting the jackpot, and most people do not hit the jackpot. Since you want to have as much mastery over things as possible, you need to plan.

B. Applied to Energy

To think about the future of energy, we can use the same matrix. The quadrants shake out like this:

- **Determinate, optimistic:** one specific type of energy is best, and needs to be developed
- **Determinate, pessimistic:** no technology or energy source is considerably better. You have what you have. So ration and conserve it.
- **Indeterminate, optimistic:** there are better and cheaper energy sources. We just don't know what they are. So do a whole portfolio of things.
- **Indeterminate, pessimistic:** we don't know what the right energy sources are, but they're likely going to be worse and expensive. Take a portfolio approach.



The determinate optimistic quadrant arguably makes the most sense. But it's also the least talked about today.

The energy market is huge. It's probably good to think about it as two separate markets. One part of the division is power generation: things like wood, coal, natural gas, nuclear, biomass, hydro, and solar—basically things that feed into the power grid. The other part is transportation, which is essentially oil and then electricity for buses, trains, etc. On the transportation side, you cannot easily tap into the power grid; you have to take the power with you as you're using it.

One preliminary question to think about in all energy contexts, then, is what the actual market is. Is it energy as a whole? Power generation? Transportation? Or are there submarkets that are worth identifying within those divisions?

C. Power Generation

In the 1950s and '60s, people were very bullish on nuclear power. It was the one thing that mostly everybody thought would be better. President Eisenhower declared in his 1953 Atoms for Peace speech that nuclear power was going to produce energy too cheap to meter. Today, by contrast, there is no specific thing that people agree will be better and cheaper. Determinate optimism in energy is dead.

That's not to say that people still aren't optimistic. Some are. They are just indeterminately so. The focus is thus on constructing a portfolio of cheap fossil fuels. One might also want to subsidize cleantech, since in some versions of indeterminate optimism, cleantech may actually be cheaper than fossil fuels when you consider fossil fuels' hidden environmental costs. But in any case the future is basically a pie chart that consists of many different things.

	determinate	indeterminate
optimistic	1950s: nuclear Today: nothing	Portfolio of cheap fossil fuels Cleantech (with subsidies)
pessimistic	Conservation More expensive fossil fuels	Cleantech (without subsidies)

The pessimistic perspectives on power generation are straightforward. The determinate view stresses conservation; things are definitely not going to improve, and fossil fuels will just become more expensive. The indeterminate version would also focus on a bunch of cleantech endeavors, since that may prove marginally better than fossil fuels.

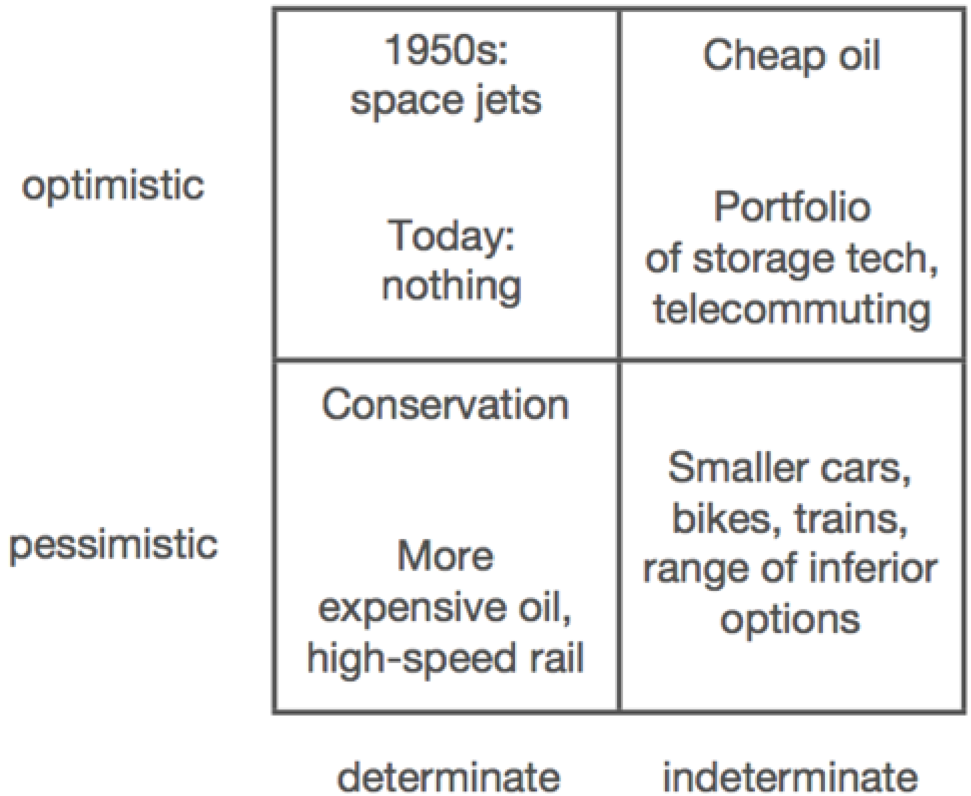
D. Transportation Power

In the 1950s, people seriously envisioned a future filled with space jets and ever-faster and cheaper supersonic planes. Things were thoroughly optimistic and determinate. Today there is almost no activity in this quadrant. There is no broad agreement that any particular transportation technology will get better and dominate.

There is some activity in the indeterminate optimistic quadrant. This is the modern portfolio approach. People here tend to focus on portfolios of different storage technologies. Battery improvements, electric cars, telecommuting, and cheap oil all seem like viable solutions, but none seems best or particularly promising.

In the indeterminate pessimism of Japan and Europe, you get a whole range of inferior options. People ride bikes. If they drive they drive tiny cars. Or maybe they take the train and have a long commute. The sense is that none of that is going to improve.

High-speed rail is the best example of determinate pessimism. The only way you can get high-speed rail to work is to rearrange where everyone lives and make them live in much smaller places. The urban planning and redesign effort is enormous and takes a long time. Gone are the days where Robert Moses could unilaterally re-architect the state of New York. We don't do things on that scale anymore. Instead we think about the future indeterminately. All we know is that oil will probably get more expensive and the one thing we can do—high-speed rail—is almost impossible to pull off.



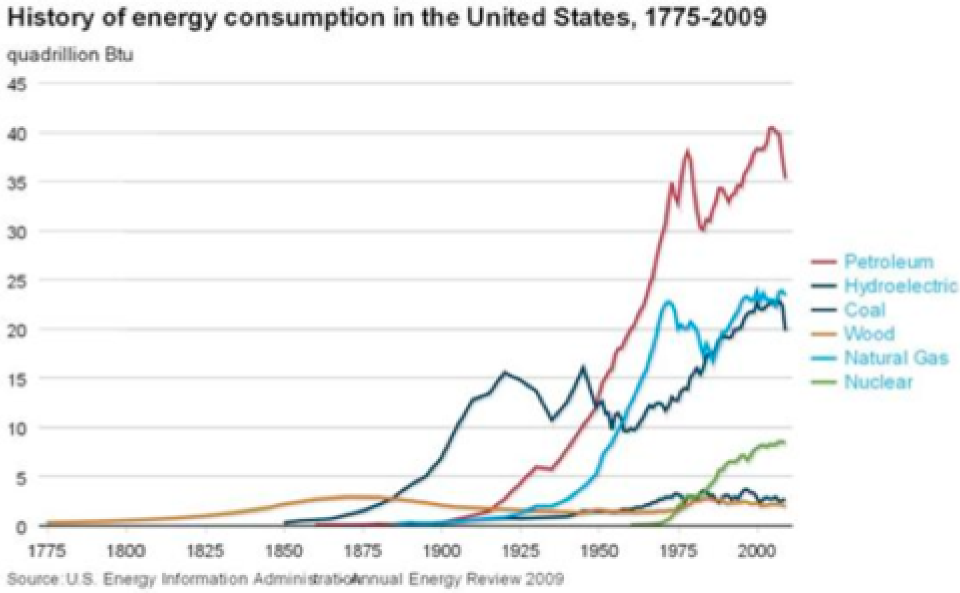
Today, the U.S. is in the upper right quadrant of optimistic indeterminism. Republicans advocate a range of hopefully better things, and we need to get rid of all regulation in order to get them. Democrats advocate a range of hopefully better things, and we need to subsidize cleantech in order to get them.

China falls in the bottom left quadrant of pessimistic determinism. The future is coal and oil. The plan is to buy up oil fields in Africa and domestically mine as much coal as possible. Something like 3,000 to 5,000 people die in coal mining accidents every year in China. They're essentially fighting small war each year to get enough coal.

II. A Brief History of Energy

A. Power Law Redux

One argument against the indeterminate view is that the history of energy consumption in the U.S. has been very determinate. A single energy source has always tended to dominate. Up until the mid-19th century, that source was wood. One reason that America had such a higher standard of living than Britain is that we had more wood. People more or less ran out of trees to cut down in Britain and so they would get cold at night. Coal started to take off around the mid-19th century and dominated up through the early 20th century. Petroleum took over as the leading energy source in the 1930s and '40s. Natural gas has now emerged and overtaken coal as number two. Nuclear comes in at a very distant third.

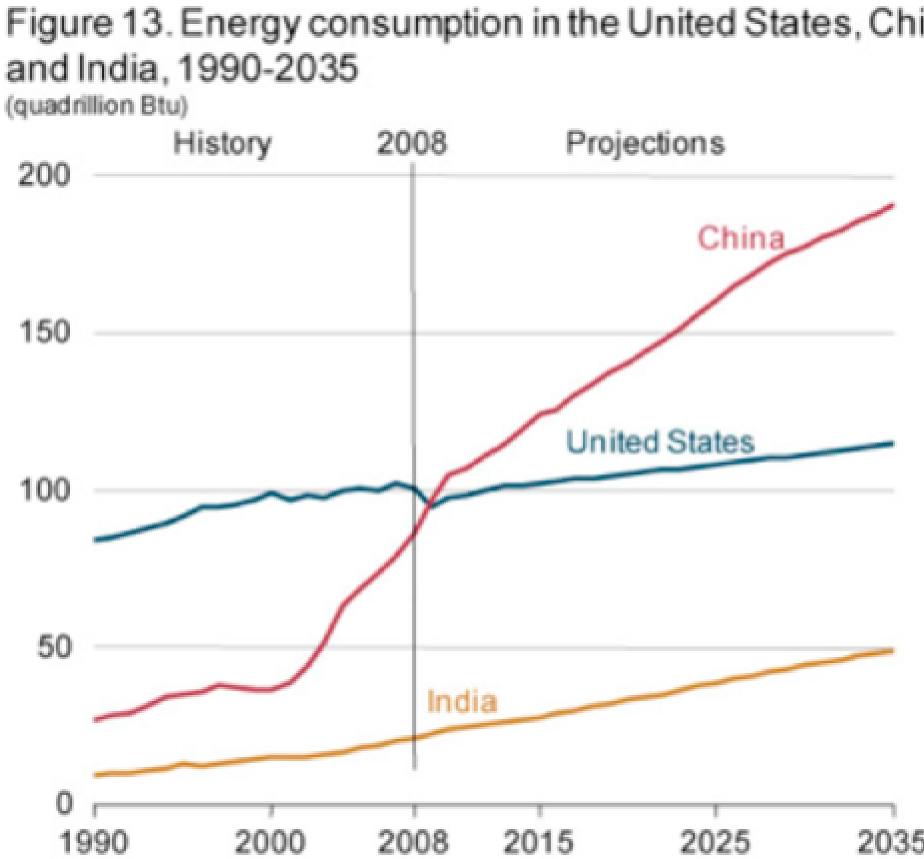


Petroleum has dominated transportation. Coal has dominated in power generation, though it's looking like natural gas might displace it. But typically a single source dominates at any given time. There is a logical reason for this. It doesn't make sense that the universe would be ordered such that many different kinds of energy sources are almost exactly equal. Solar is very different from wind, which is very different from nuclear. It would be extremely odd if pricing and effectiveness across all these varied sources turned out to be virtually identical. So there's a decent ex ante reason why we should expect to see one dominant source.

This can be framed as a power law function. Energy sources are probably not normally distributed in cost or effectiveness. There is probably one that is dramatically better than all others. Perhaps the second and third best, while nowhere near as good as the first, fill an important niche. The rest are probably much less useful. But just as the power law is overlooked in other contexts, people tend to ignore it in energy as well. We still tend to think about energy through a statistical/portfolio lens. You can't predict the future. Everything is indeterminate. It doesn't make sense to believe anything is or can be unique.

B. Challenges to Come

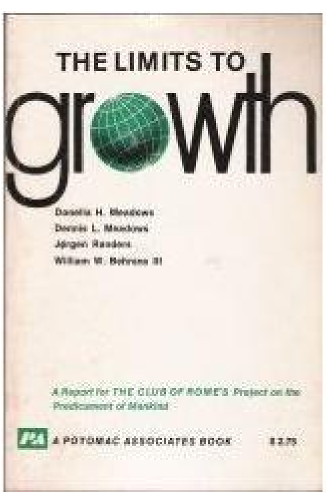
Another problem with indeterminacy becomes apparent when you look at worldwide energy demand trends. Energy consumption in the U.S. is rising at a modest rate. China has overtaken the U.S. in total consumption. India is still far behind but is rising relentlessly. China's GDP growth and increasing energy consumption make a 1:1 function. Each grew by about 8% annually over the last decade. This is quite startling. It means that, at least with respect to energy, there have been no improvements. It's a story of marginal efficiency gains at most. You get more only if you expend more.



Transportation trends are also odd. More cars are now sold in China than are sold in America. Worldwide oil consumption is 85 million barrels a day. The U.S. consumes about 18 million—just under 25% of total global consumption. China consumes 9 million barrels daily. But China has 4x the people that the U.S. does. If, on a per capita basis, China were to consume as much oil as Americans do, it would have to consume 72 million barrels every day. But that is roughly the entire worldwide production. There is a sense that something is going to have to give at some point. Even downsizing to so-called smart cars would only get that figure down to about 45 million barrels.

It’s also worth noting that the inelasticity of oil prices is something on the order of 10:1. If oil demand increases by 10%, prices increase by 100%. Together with globalization generally, the combination of inelastic pricing and the difficulty of finding direct substitutes suggests that we’re in for some serious challenges over the next few decades.

C. Resource Constraints

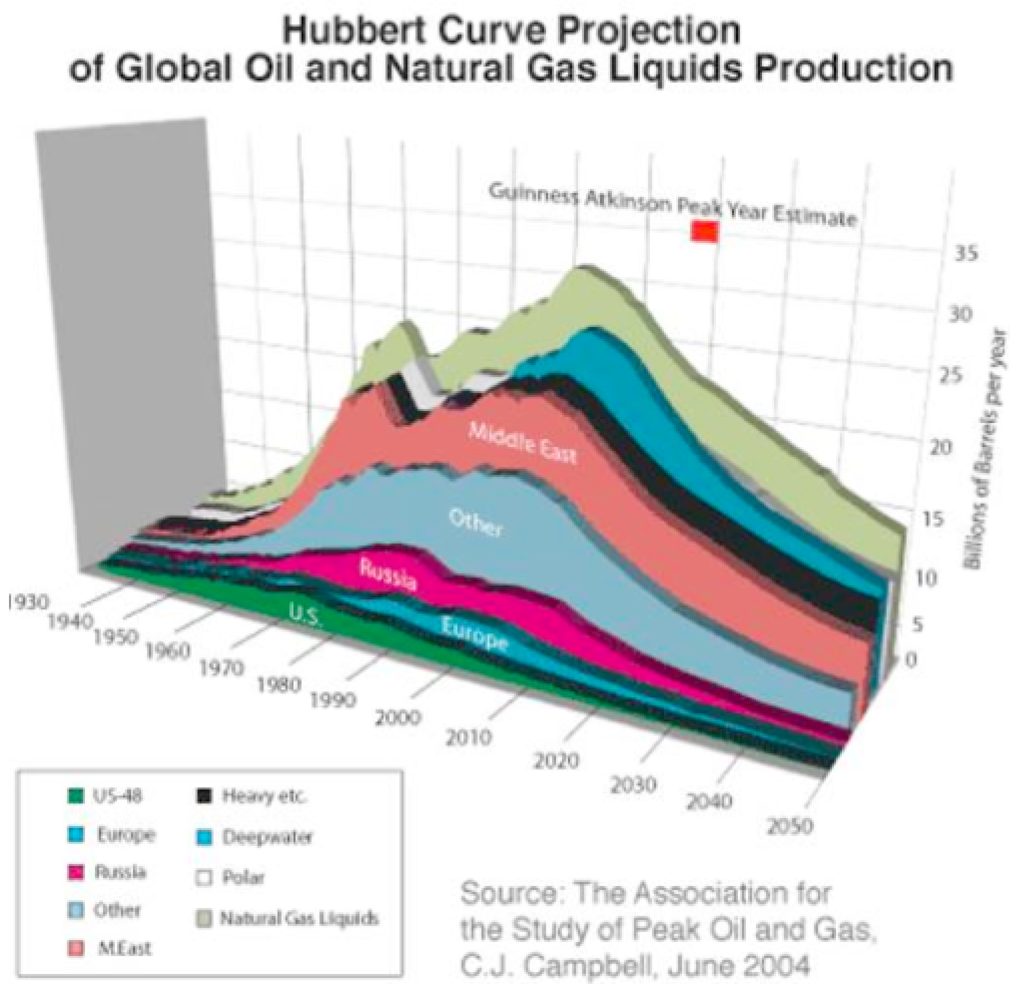


There have always been worries about running out of resources. There’s the familiar Malthus stuff. In the early ‘70s, a big global think tank called the Club of Rome commissioned a book called Limits to

Growth, which became the biggest environmental bestseller ever. The thesis was that there are all sorts of ways to run out of capacity either on a resource basis or on a population basis.

Paul R. Ehrlich wrote a book called The Population Bomb in 1968. In it he claimed that the world was far beyond its carrying capacity with 3.5 billion people. That turned out to be quite wrong. There are now twice that many people living today. Resource constraints thus seem more real than population constraints. Of the 7 billion people on earth, only one billion live in the developed world. It would take enormous energy increases to bring the other 6 billion up to standards.

One interesting take on resource constraints is peak oil theory. In 1956 a Shell oil geologist named M. King Hubbart noticed a drop in the rate at which new oil wells were being discovered. He identified a lag of 20-30 years between well discovery and tapped production. Hubbart predicted that U.S. oil production would peak in the mid 1970s and would then start to decline. No one believed him at the time because oil didn't seem to be problematic. The U.S. then was like Saudi Arabia today—a very big exporter. The Texas Railroad Commission effectively set the world oil price. Things were good. But Hubbart's prediction came true, more or less exactly. In 1970 the Railroad Commission didn't impose any quotas; supply and demand were in equilibrium. But by 1973 there were oil shocks. U.S. production was declining. The Commission was replaced by the OPEC cartel.



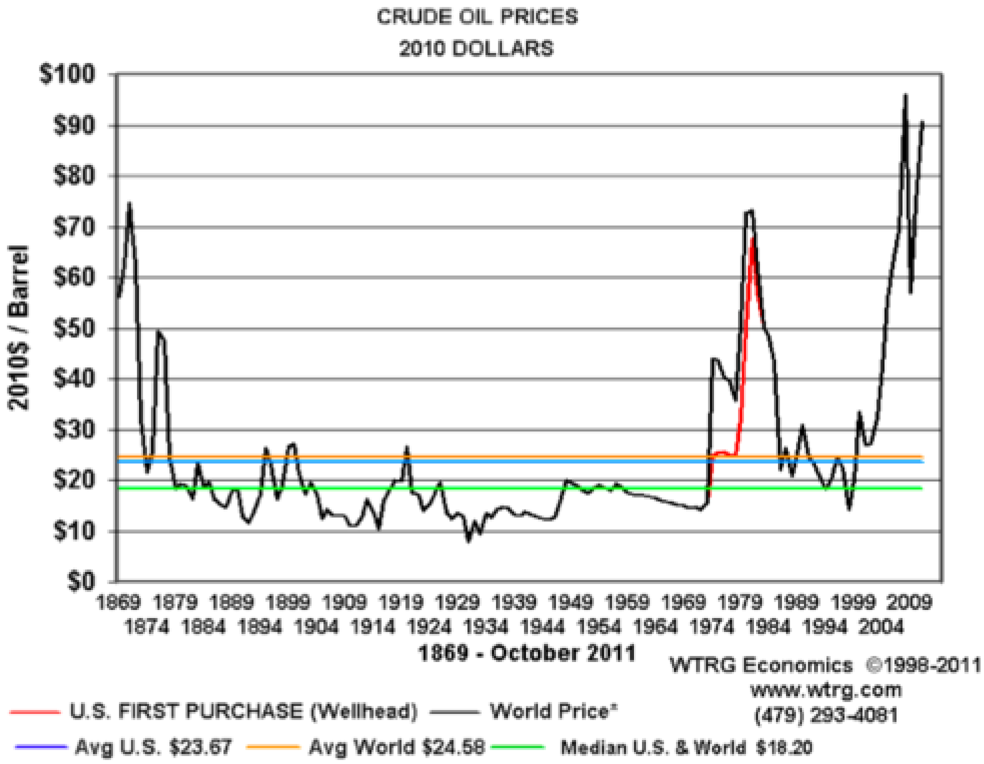
Then OPEC overreached. It quadrupled prices, from $3 to $12 per barrel. It quadruped them again in 1989, sending oil to $40 per barrel. Then Alaska came online. But we've started to run into problems again over the course of the last decade. On a worldwide basis, the Hubbart projection is that the world is now where the U.S. was in 1970; production has already peaked or is peaking soon.

The many crises of the last decade can be interpreted as crises about energy. People might be focusing too much on the financial aspect of the so-called financial crisis of 2007. What if we just hit Hubbart's peak? Oil goes to $140 per barrel. The only thing to do to contain it is to destroy a lot of economic activity. That happened. Oil came down to $32. But now, a few years later, oil is back up to $100 per barrel. This cynical view is that it's all a game of musical chairs game. In a determinate pessimistic world, who gets shot next? Southern Europe or China are the likely candidates. In a world of scarcity, there is simply not enough to go around. Crises about money and central banks may not just be about money and central banks.

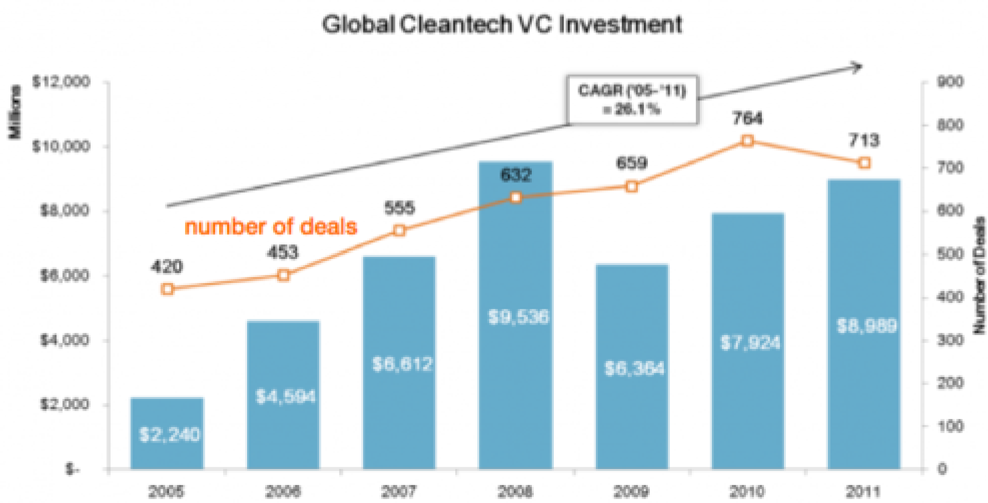
Even if you don't believe in peak oil, oil has always been linked to problems. There was the Exxon Valdez spill in 1989 and the Deepwater Horizon spill in 2010. There are the iconic images of burning oil fields in Kuwait in 1991. There's much talk about 9/11 somehow being linked to U.S. oil entanglement overseas.

One working thesis is that most major conflicts in the last 2000 years have involved energy in some important way. Oil trade and embargos contributed to the tensions that sparked World War II's pacific theater hostilities. As Secretary of the Navy, Winston Churchill nationalized the Anglo-Persian oil fields in what is now Iraq some two months before World War I broke out. Going back even further, one of the most important events in the Civil War was the secession of West Virginia from Virginia. This was a big move because it effectively gave the North 20x the coal that the South had, which played no small part in the war's outcome.

Consider oil prices over the course of the last century. Prices were very high in the late 19th century when oil was first discovered. But then oil became quite cheap up until the 1970's, when OPEC eclipsed the Railroad Commission as the primary oil policy/pricemaker. The Indian summer in subsequent years overlaps perfectly with the U.S.'s indefinite optimism from 1982 to 2007. And now, as oil hovers around $100 per barrel, the problem has reasserted itself.



Investment in cleantech accelerated massively through 2010. It has come down a bit since then. But there was significantly more investment in cleantech than there was in the Internet during the last decade. No doubt a big driver of this was the environmental component. Al Gore won a Nobel Prize for drawing people's attention to climate change.



In 2007 venture capitalist John Doerr gave a TED talk about climate change and alternative energy investment:

(16 minutes later…)

The main idea was that we must make investing in cleantech make economic sense, so that the right outcomes are the profitable and thus the likely ones. Doerr obviously became very emotional. Certainly we can understand why he wants to look forward to the conversation he'll have with his daughter 20 years from now. If you're cynical you can dismiss this as a sob story. But this feeling that something must be done has certainly pushed people very hard to try to make cleantech work. Many of the investment dollars poured into cleantech weren't simply seeking good returns, but were also driven by various environmental and social factors.

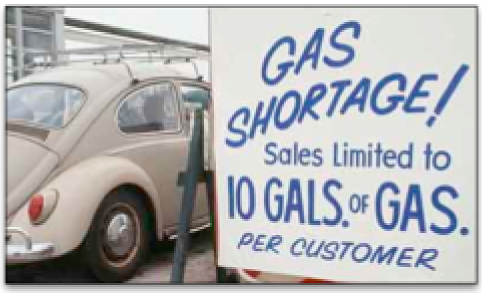
III. The Failure of Cleantech

Even if one grants that all these concerns are very legitimate and very real, something still went wrong. Good wishes and noble goals didn't make cleantech investment profitable. So what happened? And is cleantech still questionable today?

A. The Nature of the Problem

One problem was that people were ambiguous on what was scarce or problematic. Was there resource scarcity? Or were the main problems environmental? Granted, the environment can be framed a resource in some sense. But people tend to conflate the two without really thinking through it. There is an argument that both resources and the environment might have been scarce or problematic. But people tend to focus on the environmental stuff over resource scarcity. That is probably a mistake.

resource



environmental

Think about how it plays out. If you believe that there is an environmental problem but no resource problem, you'll be inclined to favor subsidies for cleantech. Conventional energy sources like oil will always be abundant and cheaper than alternatives, so you need to prop up the alternatives. If, by contrast, you believe the problem is resource scarcity but not the environment, you might just want to ration conventional things.

Often the solution will be the same whether you're facing a resource problem or an environmental one. But sometimes they point in very different directions. Joseph Stiglitz has observed that peak oil theory might have been invented and pushed by environmentalists who were against climate change; the carbon emissions problem, after all, is solved just as soon as (you convince people that) oil runs out.

B. List of Mistakes

Enumerating all the mistakes that were made in cleantech would be quite a project. But the most important were mistakes about the following:

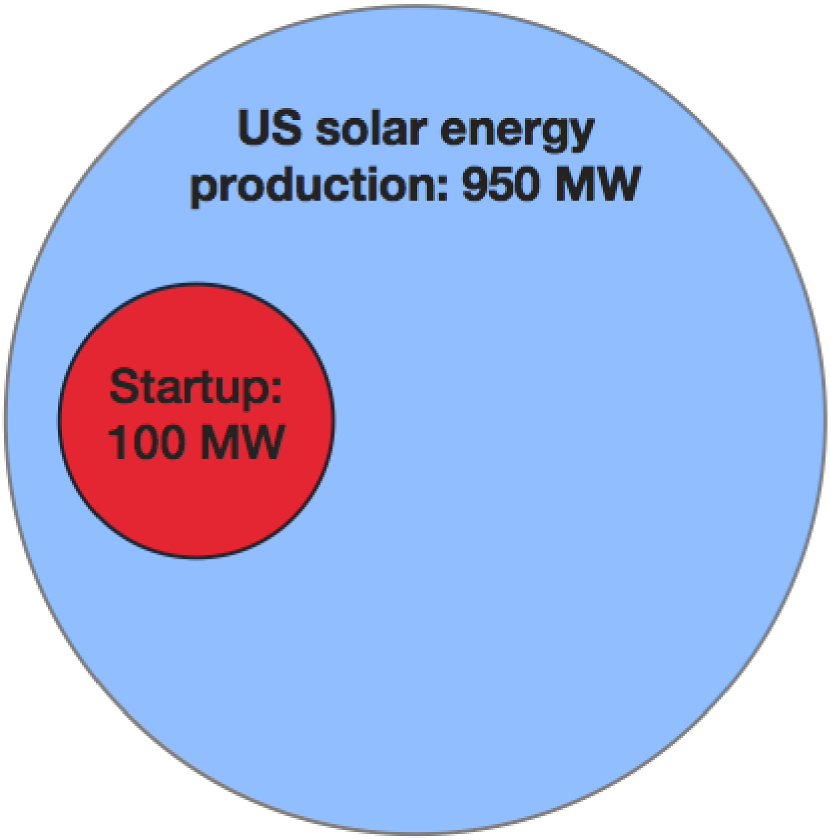
1. markets
2. mimesis and competition
3. secrets
4. incrementalism
5. durability
6. teams
7. distribution
8. timing
9. financing
10. luck

To have a successful startup, you must have good answers—or at least a good plan for getting those answers—to all 10 of these points. But with cleantech, very often people were starting companies or investing at 0 or 1 out of 10. And, to reiterate, you really do need all 10; 8 out of 10 is sort of a B-, and 5 of 10 earns you an F.

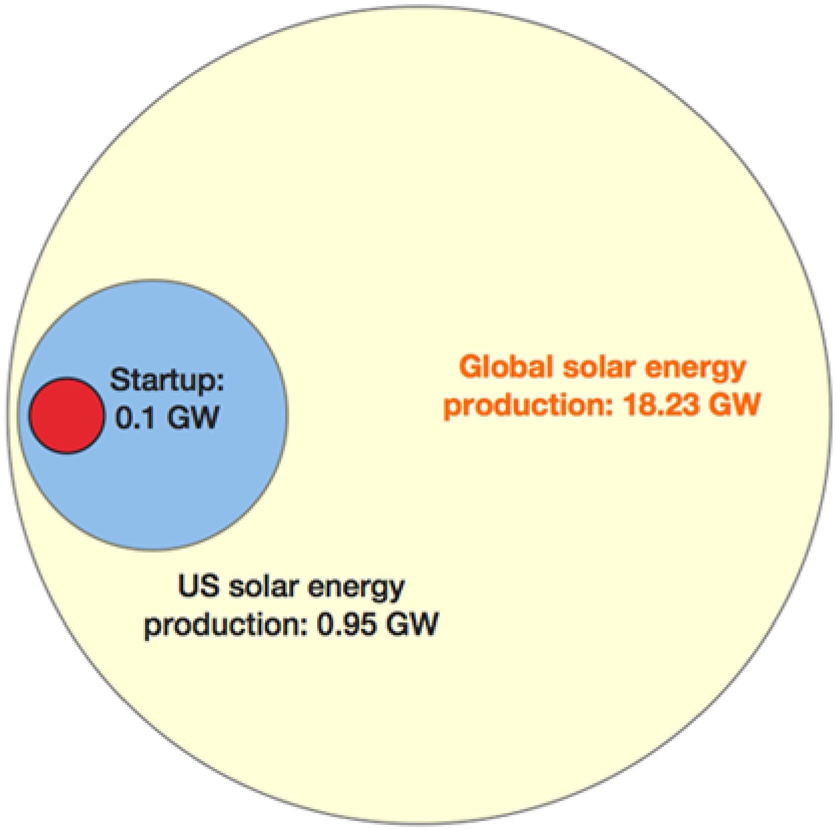
C. Market Mistakes and Competition

We've discussed how people dupe themselves into telling lies about their market, or knowingly lie about their market to dupe other people. The fear with energy is that it's a commodity. The market is huge. The problem with huge markets is that you can't protect yourself from whatever monsters are out there, ready to eat you up.

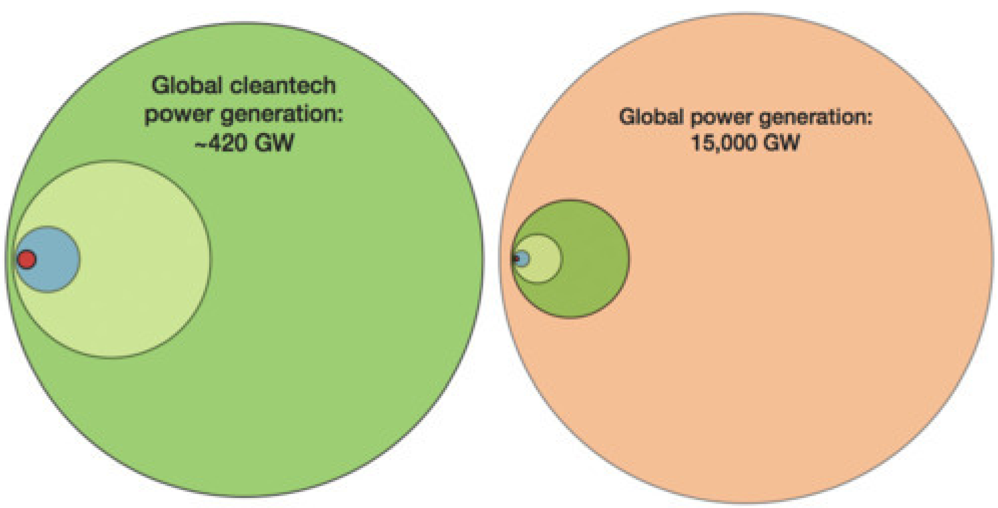
Some people understand this, perhaps too well. So they try and tell stories about being big players in a very small market. Suppose your company is the new Solyndra. You have over 1000 systems installed and represent over 100 megawatts (MW) of power generation. U.S. solar energy production is 950 MW. By that measure, at 10.5% of the market, you're a decent-sized player.



But is the U.S. solar energy market the right market? Or is the relevant market the *global* solar market? Global solar energy production is 18 gigawatts. If you claim to be "the global solar energy provider," all of a sudden you're a small fish indeed—less than 1% of the market.



We can take this even further. What if what we should be thinking about is cleantech in general, not just global solar? Global cleantech production is 420 GW. You just got a lot smaller. And then at 15,000 GW of global power generation generally, you're just a dot in the ocean.



So some cleantech companies rhetorically shrank their market to give the impression that they could easily dominate it. Many others made the opposite mistake and just talked about trillion dollar markets in their pitches. That is probably even more dangerous since it starts to look like the world of perfect competition. You're probably much better off just opening a pizza restaurant in Palo Alto.

There is both an economic aspect and a psychological aspect to perfect competition. The economic insight is that the battles are so fierce because the stakes so small. Since profits are competed away, people are fighting over scraps. The psychological insight is that the economic insight is really weird. Why in the world would people want to fight for scraps?

But there's a psychological counterpoint to the psychological insight, and that is that people fight because they think it's the cool thing to do. This explains the phenomenon of social entrepreneurship, which can be defined as doing well while doing good. The problem is that social entrepreneurs usually end up doing neither. This is not to say that companies should always maximize profits to the exclusion of everything else. But companies *should* have a specific mission. They should be solving some discrete, important problem. Social entrepreneurship fails that test. It has an incredible ambiguity to it. Is it actually good for society? Or is it simply *approved of* by society? Those are very different questions. If they are not—if what is good is simply what the masses approve of—progress is very doubtful, since everyone will end up doing more or less the same thing. Everyone will have a solar startup. Each will have some story about how theirs is slightly different. But query whether those are meaningful differences or just eccentric ones. In vast, competitive markets you often end up with mimetic competition.

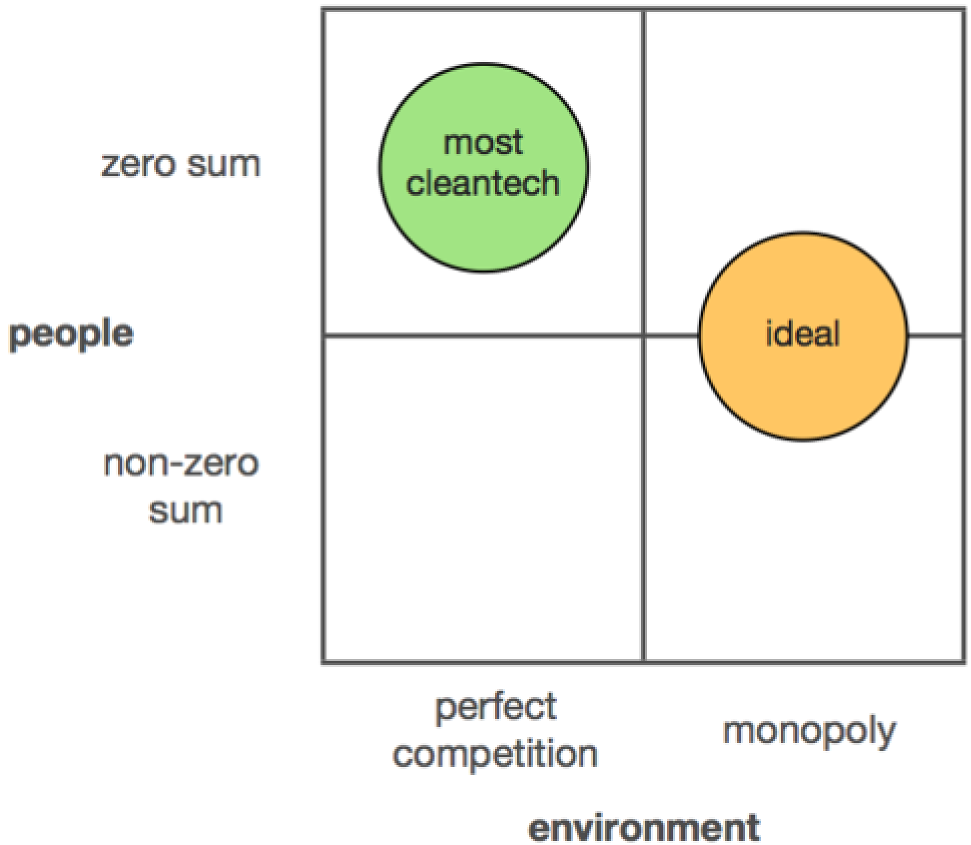
D. Secrets and Incrementalism

If you want to start a company, you should have some important secret. The secret doesn't need to be that big if you're doing a classic Internet company, since those generally take less time to build and you can scale them pretty quickly. But if you have something that takes 10-15 years to do, having a small or esoteric secret is not enough to build a decisive lead. Secrets can allow you to escape mimesis and competition in a world of long time horizons, but those secrets need to be pretty big. But in practice, most wind, solar, and cleantech ventures relied on incremental improvements. Solar costs fell slowly over a number of years. Wind power came down a bit quicker, but there was still no real step function to it. Improvements in battery technology have been fairly incremental as well.

E. Durability Mistakes

The counterpoint to the incrementalism problem is the durability question. There are many different solar cell technologies. There's thin-film tech. There is multi-junction concentrator tech. There are crystalline Si cells. And there's emerging photovoltaic tech. And then there are several distinct approaches within each of these categories. To build a great solar startup, you have to be better than all the executions of all these competing technologies. And then you have to fight at the level of next pie chart up; you have to be better than wind, hydropower, etc. Your goal in a startup should be to dominate and own your market for 20-30 years. What are the odds that your incremental solar cell technology is going to be durable over that kind of timespan? When there's an identifiable pattern of incremental progress, it is very unlikely that you'll have the last mover advantage when you make a marginal addition. But the question of durability has been obfuscated in cleantech. Like manufacturing in 1980s, things have steadily improved. But no single great companies have emerged or are likely to remain.

F. Team and Culture Mistakes



Most cleantech companies in the last decade have had shockingly non-technical teams and cultures. Culture defaulted toward zero-sum competition. Savvy observers would have seen the trouble coming when cleantech people started wearing suits and ties. Tech people and computer people wear t-shirts and jeans. Cleantech people, by contrast, looked like salesmen. And indeed they were. This is not a trivial point. If you're dealing in something that's incremental and of questionable durability, you actually have to be a really good salesman to convince people that it's dramatically better. Salespeople and athletes are important, but they shouldn't run things. They are trained to compete and tend to think that all that matters is how to defeat other people just like you.

G. Distribution Mistakes

Many startups run into problems because they discount the importance of distribution. But cleantech's problems in this sphere were even sharper; companies literally couldn't distribute the power they would generate. Even if you build a huge, efficient solar farm in Southern California, how do you build power lines to get the energy to L.A.? In practice, people tended to ignore the difficulty of connecting with the grid. It was assumed not to be a very interesting or major problem. But in many cases it proved decisive.

Distribution issues certainly weren't impossible to spot. Peter Orszag, President Obama's former budget director, explained that relatively little of the Stimulus was spent on infrastructure because it would take too long to get all the zoning permits necessary to build the power lines. The administration concluded that it would just be too hard. So to their credit, they foresaw the serious distribution problem and didn't build the useless, unconnectable wind farm. Plenty of companies didn't see that and failed.

H. Timing Mistakes

Bad timing can ruin you, even if you have all the other pieces figured out. Where you are on the timing curve is incredibly important. The usual timing argument in cleantech goes like this: cleantech is inevitable because it's really important. The big wave will come 4 or 5 years from now. So we should start now and we'll catch that wave when it comes. The general insight is right; if you don't start paddling sometime before the wave arrives, you're too late and you'll miss it. But if the wave is really several years away, it's not at all clear when you should start paddling. It's very hard to get the timing right, especially in cleantech when cost curves can change rapidly.

I. Financing Mistakes

When thinking about cleantech investments, it's useful to remember how the power law applies to venture capital. Since company outcomes are not normally distributed, VCs have to look for 10x returns. But Solyndra, for instance, took $1.65 billion in late stage venture-type financing. When investors put in that kind of money into a company, it has to grow phenomenally large for things to work out. A good, broad rule of thumb is to never invest in companies who are looking for less than $1 million or more than $1 billion. If companies can do everything they want for less than a million dollars, things may be a little too easy. There may be nothing that is very hard to build, and it's just a timing game. On the other extreme, if a company needs more than a billion dollars to be successful, it has to become so big that the story starts to become implausible. This is especially true in cleantech, where there are many others who are doing uncannily similar things.

J. What Is Required

One perspective on tech and energy innovation makes a distinction between brilliant inspiration and incremental improvement. Another thing to keep in mind is complex coordination; even if you can execute on a brilliant idea that you can then incrementally improve over time, you have to coordinate how it fits into rest of society. Complex coordination is easier on the Internet. Web businesses can take the Asperger's approach where they can succeed without having to talk to anyone. Cleantech is different. With cleantech, you do have to talk to people, and you have to get a great many of them to do things.

Here is how cleantech has stacked up on these three variables, generally:

- **Incremental technologies:** the record has been pretty good on this. There have been some improvements and costs are going down. But there aren't really any secrets. Everything is mostly convention. One gets the sense that the questions almost answered themselves.
- **Coordination:** people were mainly counting on luck here. Distribution and integrating technology with society was an afterthought. The attitude seems to have been, "I'm scientist. I'll build better solar tech. How to deliver it to L.A. is not my job. Others will do it." But when everyone thinks that, it doesn't get done. When it is assumed that the nature or the market is beneficent and will provide, it's all just magic, mystery, and luck.
- **Breakthrough technology:** for the most part, people haven't even tried to operate under this paradigm. No one has been asking the biggest questions. People have assumed that only incremental approaches would work.

K. The Solyndra Failure

What is striking about the Solyndra fiasco isn't what happened, but rather how people talked about it afterwards. No one asked whether Solyndra's technology worked. But that is precisely the kind of substantive engineering question that you would ask in a determinate world. In an indeterminate world, though, people ask legal and financial questions. They focus on whether the proper processes were followed. And this is exactly what happened.

The Republican criticism was that government officials were too involved with the company and that raised all sorts of ethics questions. The Democrats countered by insisting that the process was legitimate and transparent. From the definite optimistic perspective, the Republican critique is way off base. If the technology actually worked, some very minor wrongdoing about how some funds were spent becomes almost a footnote. The Democrats’ defense was equally weak and process-focused. Much better would have been the President to declare, “Here are 2 or 3 technologies that we think are going to work” and then try to get serious about them. The best defense was not made. Indeed, it was probably impossible to make given how modern politics works. The entire Solyndra aftermath was one big fight about processes. It was the government version of the HP board fiasco.

IV. Energy Futures

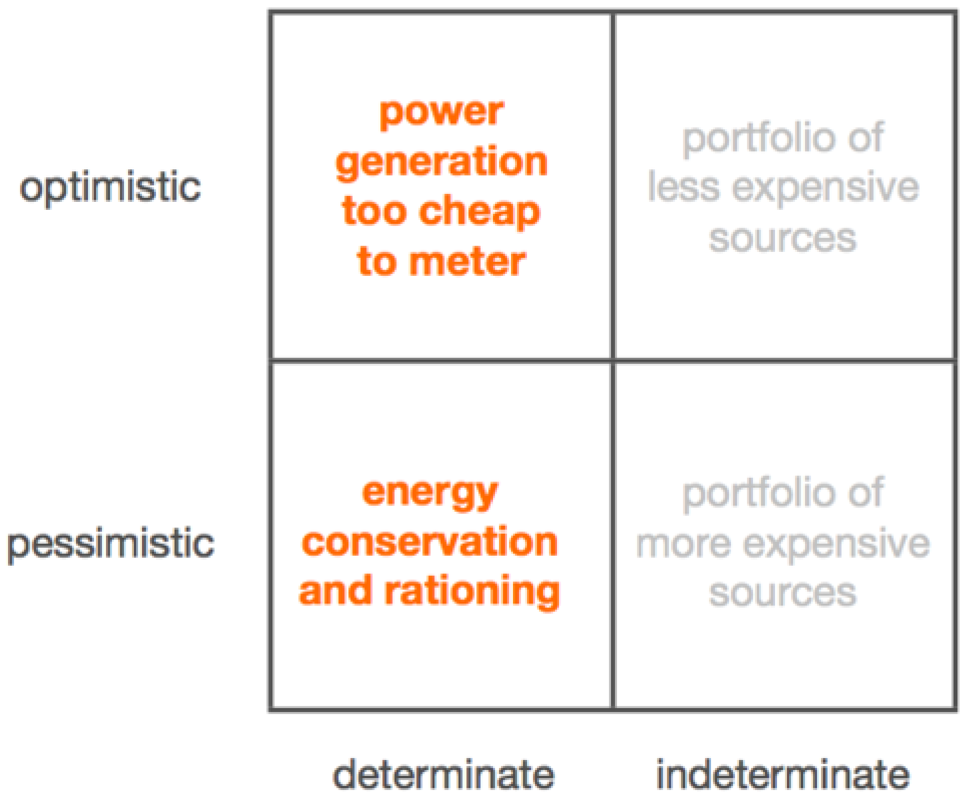
It’s easy to be critical of cleantech. Hindsight is always clear. It is thus important to go beyond criticism and offer up some thoughts—however vague—on what might be done better the future.

A. The Optimistic Determinism of Software

It might be fair to say that the Internet has been cleantech’s closest cousin over the last decade. eBay is basically a recycling company. Amazon is getting rid of suburban sprawl. And Airbnb is curbing excess and unnecessary hotel construction costs.

Determinate pessimism simply won't work in energy. Conservation and rationing may help, but they aren't quite enough. Even if Americans actually started conserving energy in a serious way—even if, say, everyone got much smaller refrigerators—the developing world is relentlessly consuming more. When everybody in Uttar Pradesh gets a fridge, it will just cancel out our conservation here at home.

The question is thus whether there is some way of actually realizing the idea of generating power that is too cheap to meter.

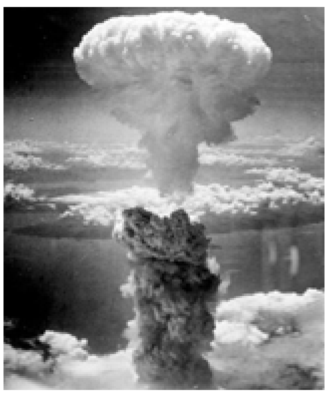


Software may play a large role in answering this question. We might be able to figure out ways to use IT to optimize conservation. One really big problem is that energy pricing fluctuates wildly during the day because that's when most of the power is consumed. Things like smart appliances and smart thermostats may be able to downshift daytime consumption.

There are very interesting applications of computer technology on the transport side too. Things like the self-driving car or finding ways to outsmart and defeat traffic could have a very big effect.

B. God of Thunder

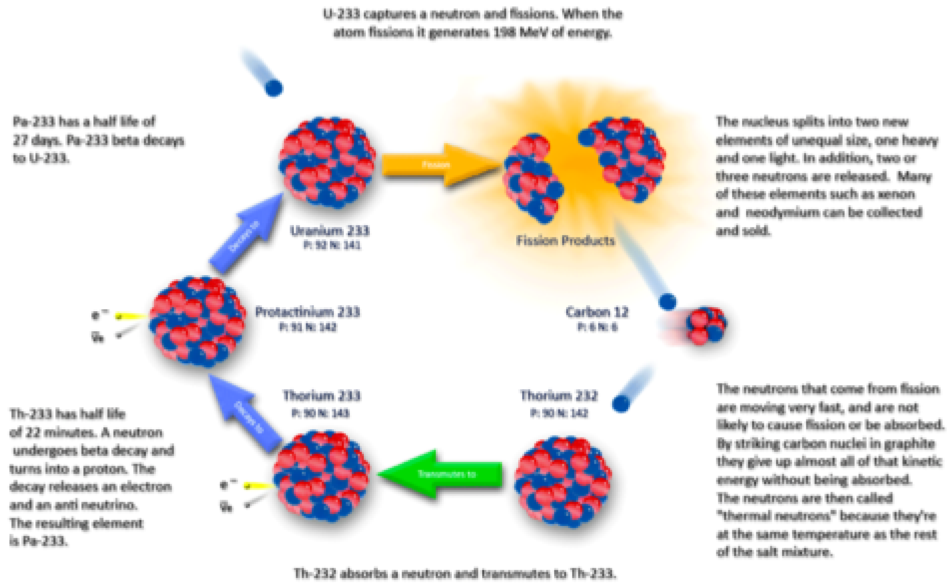
But suppose we wanted to shift all the way to optimistic, determinate solutions. How would we do that? One suggestion is that we should explore thorium power in a very serious way. Thorium is a big secret.



When the government became very interested in nuclear technology in the 1940s, it found that you could get nuclear power from three chemical elements: plutonium, uranium, and thorium. The problem with Thorium was that it contains no fissile isotopes, which means you can't weaponize it. And the government was interested in building bombs, not generating power. Eisenhower's '53 Atoms for Peace speech was originally intended to warn of the perils of a thermonuclear age where everyone could be obliterated instantly. When that seemed too dark, it was retooled to talk about the promise of non-weaponized nuclear energy as well. Power generation was decidedly *not* the government's focus during the intensive R&D of the 1940s. But there is a sense today that we really don't need any more nuclear weapons. On that basis alone, thorium power seems worth revisiting.

Thorium seems promising for a couple of reasons:

- Thorium is much more abundant than uranium. There is enough to power the world for a million years at current energy consumption levels.
- Thorium is relatively clean. With uranium, you only end up using about 0.7% and there's a lot of waste from the enrichment process. With thorium, by contrast, there's much less waste because it's a self-contained cycle.
- You can build thorium reactors that don't require hundreds of atmospheres of pressure like uranium reactors do.
- You can't get a runaway thorium reaction for the same reasons you can't weaponize it.
- Thorium is something like 1/10 as expensive as other forms of nuclear power. Thorium plants would cost about $250 million to build, whereas uranium plants cost $1.1 billion.



If you sum all these benefits, thorium power would be something in the zone of an order of magnitude better than what's currently possible.

Of course, some very tricky questions remain. How would one actually build it out? There's a considerable coordination and distribution problem. There's also a regulatory problem. But let's return to that list of 10 essential things to get right. Unlike most cleantech ventures, where the score was 0 for 10, with thorium power you basically get 6 of 10 right off the bat:

markets
✓ mimesis and competition
✓ secrets
✓ incrementalism
✓ durability
teams
distribution
✓ timing
✓ financing
luck

1. You solve the mimesis/competition problem by avoiding fashionable competition. Solar companies are hot. Thorium companies aren't.
2. The big secret is that thorium has been underexplored for political reasons.
3. Thorium power is certainly not incremental.
4. Durability comes from thorium's being an order of magnitude cheaper. Pull off a move to thorium and you'll own the energy market.
5. The timing seems right.
6. The venture would be expensive, but not prohibitively so. Given all the investment in cleantech, raising $250m over the course of several years of hitting targeted milestones seems reasonable.

The market, team, distribution, and luck pieces are harder to figure out. It would be wise to do that before moving forward. Are there specific countries or markets that should be targeted? Are there even any nuclear engineers left that can work for you? Solve these pieces, though, and you'll have done all you can to maximize your mastery over luck.

Admittedly, this isn't a rock-solid case for thorium. It isn't intended to be; we're not starting a thorium power company. Rather, this is simply an idea of how one might think about doing things in alternative energy. We've had 10 years of failure in cleantech. All the intentions have been good. 20 years from now John Doerr *should* be able to tell his daughter that progress has been made. But well wishes won't usher in that progress. People have to think seriously about coving the 10 bases we've identified.

V. The Government Question

For better or worse, you cannot talk intelligently about cleantech without talking about the government. There has been a great deal of government entanglement with energy and cleantech in recent years, so it is important to reflect on that experience and try to get a sense of what works and what does not.

A. Sell/Take/Replace

You can think of technology's relationship with government as fitting one of three molds: being sold to the government, being subsidized by the government, or replacing the government.

It turns out that all of these molds are pretty tough. VCs don't typically like investing in companies that depend on government sales because selling into government is quite difficult. Getting government subsidies—at least in large amounts—is even harder. And replacing government is tricky because government people tend to object to it. If your secret plan for your technology is to replace the government, it's best to keep it secret.

An important macro fact keep in mind is that the U.S. budget deficit is currently running about 10% of GDP. Optimistic projections have it going down to about 2%. Less optimistic forecasts have it going to 6-7% and then rising again in 2020 and beyond. This can be seen as a big secret that's hidden in plain sight. Since no one knows what to do about it, we're not really allowed to talk about it.

But thinking through it offers up a strong argument against relying on government subsidy. The budget math means that there probably won't be any money left when you need it. Money will be even tighter in the future. Contrast SpaceX with Solyndra. At least SpaceX's orientation is selling technology to the government (and possibly replacing it, now that the government has decommissioned its rocket-building programs). The risk with SpaceX is that the government runs out of money, and even a cheaper and more efficient space program isn't going to work. But that risk is minimal compared to the risk of relying on heavy subsidization in a future where government funds are likely to be very tight.

B. Future of Cleantech?

Probably the best place to anchor in thinking about the future of energy is in the optimistic determinate quadrant. The key questions are the same as those for Internet businesses: What can be done that's better and cheaper? Can you do more for less? That, of course, is the classic definition of technology.

So can we do more with less in cleantech? Quite possibly we can. But we need to think about things in the same way we do in the computer industry. Is the breakthrough thorium? Is it something else? We certainly need a big breakthrough. Only then does it makes sense to work on incrementally improving it. The first step, as usual, is to think big and think boldly about the future.

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