

Interview with Thomas Casten

by David Roberts, for Grist.org

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All across the nation, factories and power plants are wasting energy -- lots and lots of it. If that energy could be captured and put to good use, greenhouse gas emissions could be substantially reduced, at a profit.

[Thomas Casten](#) has been proclaiming this good news for almost 30 years now. Not only that, he's been trying to make it happen, starting and managing a series of profitable companies, founding and consulting for nonprofits, writings [reports, articles, and a book](#), and testifying before Congress. Despite becoming a nationally known energy expert and a successful businessman, he has often played the role of Sisyphus, pushing uphill against the gravity of antiquated regulations, perverse financial incentives, and above all the poisonous conventional thinking that reducing pollution increases costs.

I spoke with Casten back in Dec. 2006. Since then, energy bills have passed both the House and Senate, including provisions that would begin to remove the barriers to distributed electricity generation and waste energy capture. Greek mythology notwithstanding, Sisyphus may be making progress.

David Roberts: What's wrong with the electricity generation system in the U.S.?



Thomas Casten: Thirty-eight percent of U.S. CO₂ comes from the generation of electricity -- a bigger percentage than transportation or anything else -- and that number is growing. Electric power is not that big a chunk of total energy use, but because so much of it comes from coal, the carbon number is higher.

The U.S. electric system on average converts 33 out of every 100 units of potential energy into delivered electricity. The energy that's arriving at the light fixture over your desk represents 33 percent of the energy that went into the power plant.

But that doesn't mean you're getting 33 percent of it in light. After it gets to the light fixture, if you've got CFLs, about 14 percent of that 33 ends up lighting the room. If you've got an incandescent bulb, it's 6 percent of the 33.

So we start with 100 units of fuel, and we produce two units of light. Not very efficient.

DR: What is cogeneration? Is it different from "recycled power"? And are they different from "combined heat and power"?

TC: Whenever you produce electricity with any kind of fossil or nuclear fuel -- I don't care whether it's a piston engine or a gas turbine or a boiler in a steam turbine -- you will have a significant amount of potential energy left over as low-grade but usable heat.

The three terms are the same. The Carter administration coined the first one, cogeneration. They defined it as the "sequential generation of electricity and thermal energy." The Europeans didn't like that term, because people didn't quite know it. They used the term "combined heat and power." But what is combined heat and power? It is the sequential generation of electricity and heat.

The term I have introduced is "recycled power" -- I think it's the first term the man on the street can understand. You have produced electricity, and there's something left over. You can throw it away, or you can recycle it into something useful. Industrial processes also use energy once -- they turn some kind of raw material into more finished goods. These processes often have a stream of energy coming out of them, which still has some value but is typically thrown away.

DR: How do you capture the waste power?

TC: While electricity travels relatively economically through the wires -- you lose 9 percent of it on average -- heat takes about seven times as much energy to travel. So if you've got a power plant located 50 miles from Seattle, there is no economic way to move the waste heat from that power plant to downtown Seattle.

So what happened is my friend Jim Young, who ran the Seattle District Energy System for a time, developed a project: they built a gas turbine right downtown. He gets 40 percent plus of the energy as electricity. He's got this 1,000-degree turbine exhaust left over, and uses it to boil water to make high-pressure steam. He drives the steam through a steam turbine, and gets more power out of it to make more electricity. The rest of it is used to provide steam for Seattle's downtown.

By moving the power local, he's maybe 85 percent efficient. The electricity has become more than twice as efficient as the national average. Instead of using three units of fuel to make one unit of electricity, he's using 1 1/4 to 1 1/2 units of fuel to make a unit of electricity.

If all you do is look at the fuel and the electricity that comes out of the generator, the big plant is more efficient. Jim wins in downtown Seattle in two ways. The big way is that instead of throwing away all the remaining heat, he's doing something useful with it, and that doubles his efficiency. The second way, which is smaller but still significant, is that because his power generation is located close to users, the losses on power he generates, by the time it gets to your office, is 2 percent rather than 9.

There is a set of coke ovens in Vansant, Va., that has been throwing heat out into the atmosphere for the last 40 years. Primary Energy spent \$165 million, put 16 waste-heat recovery boilers on top of them. **In total last year, that plant produced 1.6 billion kilowatt hours of clean energy, burning not one single BTU of additional fossil fuel, not putting out a single incremental pound of carbon dioxide. In 2004, the solar collectors connected to the grid worldwide are estimated to have produced 1.6 billion kilowatt hours of clean energy.**

DR: From the one set of coke plants?

TC: Yes. It gets better. The solar collectors represent a collective investment of about

\$5 billion. This plant cost \$165 million.

We have calculated that **recycling industrial energy in large plants produces 72 times as much carbon reduction per dollar as a solar collector.** Dollars will always be scarce. At the end of the day, what we need to do is get the maximum bang for the buck. So a dollar spent on recycling energy produces about 70 times as much CO2 reduction as a dollar on solar, and about 15 times as much reduction as a dollar spent on a wind turbine.

Our president has said that America cannot afford Kyoto, implying that the cost of making these changes to reduce carbon will destroy the economy. He's almost right. He's left out one word -- America can't afford *not* to reduce the carbon. It's costing us so much money to buy this carbon and burn it! Every bit of carbon we put out that's wasteful, *we paid for*. Our trick is to find ways to deliver the energy to you. All you want is the light over your desk and the power to run your computer.

People have always argued, "well Mr. Casten, you can be more efficient, but there's economies of scale. These big plants are so much cheaper to build that it offsets the efficiency of small plants." That's the wrong argument, and the wrong question.

It is true that it is cheaper per kilowatt capacity to build a generating plant 100 miles out of Seattle than in downtown Seattle. Expensive real estate, tight spaces, difficult to be small scale. But that's absolutely the wrong question. *You don't care*. What you care about is how much capital it will cost to deliver a new kilowatt *to you*.

Let's say you're building a new apartment building, and it's going to be new electric load on the system; it's going to need 10 megawatts. The question is: how much capital are we going to spend to generate and deliver 10 megawatts to that apartment house? Well, it turns out that the wires, the distribution, the transmission, the substations, and the auxiliary equipment you need cost more than the central plant.

Last year the International Energy Administration said that the average cost of building new central generation in the world was \$890 per kilowatt. A big study for the Department of Energy about four years ago -- and several other studies corroborate -- said that the total cost of transmission and distribution of that kilowatt averages \$1,400. You've got \$900 for the plant, and another \$1400, that's \$2100 bucks a kilowatt.

Jim spent less capital for the new kilowatts, around \$1500. He didn't need to build any transmission, because he's sitting right where the power goes.

So local power costs less capital. It also uses half the fuel. It also puts out half or less of the pollution. It's also far less vulnerable to extreme weather and terrorists than central stations. Also, because of the way probabilities work, if you have a system made up of a lot of smaller units, you can get reliability with less redundancy. If you have a system made up of 10 or 15 very large units, you have to cover for one or two of them simultaneously failing. National average, we need 18 percent redundancy with our central system. A PhD thesis recently done at Carnegie Mellon says **we could get by with 5 percent redundancy if we had multiple smaller generators.**

DR: If every industrial facility in the world has been throwing money on the ground, why has it taken so long for somebody to come along and pick it up? What's the catch?

TC: EPA did a study and it appears that **we can generate 20 percent of our electricity with industrial energy that's now being thrown away**. So we can't do everything. There is not silver bullet.

DR: That's not small potatoes.

TC: No. It would require an investment of somewhere north of \$100 billion, but it has been identified fairly well.

To calibrate you, that is about 64,000 megawatts of capacity that could be built. There is about 10,000 MW of that capacity existing. This is not a brand new idea that nobody's ever tried. 10,000 MW is the equivalent of ten large nuclear plants. There's quite a lot out there. It's in the steel business, pulp and paper ... but there's 54,000 MW not done.

Why hasn't it been done? There are three answers. First, there are barriers to putting in local generation that have been imposed by the monopoly utilities and their regulators. In order to rapidly electrify a state or country, governments enter into a Faustian bargain. They give utilities a monopoly in perpetuity. In return, they get to regulate rates.

DR: Those regulators aren't exactly scrupulously independent.

TC: That's absolutely true, but the difficult part is more structural than bad regulators. The structural issue is that it rewards capital and not efficiency. The utilities, whether municipal or federal, have a bias in favor of throughput, and they put all kind of rules to block local generation. People have worked on them; those barriers are falling. That's why this subject is more and more in the news. But there are barriers out there.

The second issue is that these projects are more expensive to build than the great big projects in the middle of nowhere. They create benefits -- they avoid the building of that \$1400 of transmission; they avoid the pollution of burning more fuel; they avoid a whole bunch of problems -- but they are not allowed to capture most of those benefits.

Let's say the wholesale market is 4 cents an hour. You get 4 cents an hour for a kilowatt hour of power 100 miles east of Seattle; the wholesale market for Jim's power downtown is also 4 cents. Jim's power didn't require transmission lines, but he didn't get any credit. His power has line losses of 2 percent. The other line has losses of 9 percent. Just doing that math, you would think he ought to get paid a bit more. He doesn't.

The third is a market blocker. Every polity in the world, with two exceptions, has a law that absolutely forbids private wires to cross public streets. Let's get back to Jim Young's plan in downtown Seattle. Lets say his electric plant is 10 megawatts, much

more than he needs. It is illegal for him to move that power to the bank across the street. The utility will pay him 4 cents for it wholesale. The power will automatically go across the street -- the utility company buys it for 4 and sells it for 12 (again, I'm making up numbers here), even though they didn't have any line losses.

So there's three reasons it doesn't happen. **You've got barriers to it, you can't capture the benefits, and you're not allowed to sell the power for what it's worth to somebody next to you.**

That leaves us with trying to understand, well, why wouldn't the industrial plant have done it where they can use all the power within their own plants? Typically, the amount of power they'd make is less than they are consuming in their own operations. Primary Energy is making 64 megawatts at the coke plant, but the mill is using 400 megawatts. So why don't more industrial plants do it?

A couple reasons. First of all, it is capital intensive, and well-managed companies don't put their capital in non-core areas. The sort of naive notion is that they look at all their opportunities and invest in the top one first, then the next one. Not true -- they look at all their *core* opportunities.

DR: Because of habit, or is this good management?

TC: It is good management. They don't have the intellectual resources to do recycled power. The worst mistake you can make in business is to say, gee, I'm making good profits, so I'm smarter than everyone else, so I can go do this, that, and a third thing. You stumble and fail in all of them. It's not a simple slam dunk to do this. There are a lot of skills involved. They're masterable, but you have to be focused.

A typical industrial corporation that's well-managed doesn't do their own payroll. They don't do their own phone service. They don't do their own security. They don't do their own janitorial. They hire somebody that's good at all that stuff.

DR: Seems like there's a market there.

TC: I've been in that market for 30 years. My colleagues have deployed over \$2 billion. When people ask me, "who are your competitors?", I say, "I wish I could tell you." I would not have lasted thirty years except for the passion I have. If you're going to be in this business, you have to overcome the barriers: you don't get paid what it's worth, you can't run your power across the street, the utility can delay you and delay you and delay you with the interconnect.

But the more important thing is, there is an unusual risk of building this \$165 million facility for the coke guy. You depend on him to produce the waste. If he stops making coke, you stop making power. Everybody knows that people fail, they go in and out of business. The banks lending the money get extremely nervous about that, because they know they've got no control over it.

DR: They're not just risking the failure of your business, they're risking the failure of the business you're attached to. It's parasitic.

TC: If there's one single silver bullet that would put us in compliance with Kyoto: have the government provide a limited guarantee of the capital costs of industrial waste energy recycling facilities. *Limited* in the sense that it doesn't trigger if the host ceases to provide the waste energy flow over some defined period of time.

DR: Why is that the silver bullet rather than changing some of these perverse regulations about interconnecting and power transmission?

TC: I love your question. The reason it's a silver bullet is, it is by far the best for the carbon. I'm making electricity with no fuel. In fact, I may be offsetting some boiler fuel. But there's two other reasons. All of the [regulatory] barriers I described are at the state level. It's your state commission that decides on standby fees, on interconnect policies, etc. Even if we had a president with a brain and a sympathetic Congress, they would get into enormous states' rights issues.

Frankly, the right thing to do is to declare electricity interstate commerce -- which it is -- and overrule all of these state regs, but that's very hard to do politically.

Bottom line, why I'm so excited is that I live in this business and have identified -- and proven, with some \$2 billion worth of capital -- that there are a bunch of ways to lower carbon and lower costs. Not lower carbon in a way that doesn't cost too much, which is about as far as I've ever been able to get Al Gore to go. No: *make money lowering the carbon*.

DR: The conservative argument on global warming is that CO2 emissions are a good indicator of economic activity. They rise and fall together. Thus, fighting global warming is a secret UN plot to hobble the American economy relative to China and India. That's Inhofe's theory, anyway.

TC: He's the only elected official in Washington that might possibly be stupider than the man in the White House.

Even people that very much want to do something about global warming make the mistake of thinking that carbon is like any other pollutant. With the Clean Air Act, the criteria pollutants have no value, so taking those things out adds costs. You're running a process that puts out a lot of sulphur dioxide, it adds cost to put scrubbers on the back of that. If an American manufacturer has to comply with all of these standards, and a Chinese manufacturer doesn't, then the American manufacturer is disadvantaged -- there is some truth to that.

Carbon is totally different. *Carbon costs you money to make*. There is no way to filter the carbon out, or to chemically change it, or to do anything on the back end that doesn't take more energy than you're saving. **The way you take carbon out is to not burn as much fuel. It's efficiency.**

Recycled energy is simply the most glaring inefficiency. The low-hanging fruit is to take the energy that's thrown away in the electric industry and to use it to displace boiler fuel, and to take the energy that's thrown away in the industrial world and make electricity.

DR: The political powers that be, and the corporate powers that be, seem obsessed with finding alternative forms of massive, centralized power generation. Why?

TC: When we initially started learning how to make electric power, the plants were ugly. You had carts of coal coming in, guys shoveling coal with no dust collection, dirty black plumes. Kids got rickets because there wasn't enough sun getting through the air. So we said, get this stuff out of sight! After that went on for two or three generations, the fuels changed, the technologies changed, the science changed. I have built power plants under the lobby of a major office building in New York -- 11 West 42nd Street. We've learned how to control the noise, there's no smoke, there's no dust, there's nothing.

The second part is, the public absolutely demands reliable electricity. The government is scared to death of monkeying with it. They feel like they're taking an enormous bet if they do anything, so their tendency is to go to the big stuff -- and of course the providers of the big stuff are quick to tell them that that other stuff is toys.

DR: People have trouble getting their heads around the idea of multiple, simultaneous small bites out of the problem, rather than a big silver bullet.

TC: One of the big mistakes environmentalists have made is that they insist that the only clean power is renewable -- we're going to force renewable standards on everybody. It is an awful position to have put themselves in, because nobody can make a believable argument that renewable energy is cheaper. I'm all for renewables, but they've put themselves in the position of saying we've got to pay extra. It plays right into the hands of these conservative folks, the Inhofes of the world. In spite of my lack of respect for him, the guy has a lot of power, and there's a lot of people like him.

By embracing *all* clean technologies, and by saying we'd like to do the low-hanging fruit first, the environmental community can gain some credibility with the financial community.

Let me give you an example. There are natural gas pipelines lacing the country, and they run all the time. Every hundred miles, there is a compressor station, purposely located in remote places. This gas is coming from the Gulf of Mexico. It's coming from Alberta. It's coming from Colorado. It's moving lots of miles. Almost all of the compressors are gas turbines, which take some of the gas in the pipe and run a big gas turbine. Every one of these gas turbines has 1,000-degree exhaust, and a lot of it. They are typically about 33 percent efficient. So they are basically throwing away about 65 percent of the energy in the gas, in heat that goes right up the stack. You can cost-effectively go to the substack, put a heat-recovery steam generator on the exhaust, make steam, run a combined cycle steam turbine, and make 8 to 13 megawatts of fuel-free energy -- at every one of them! 24/7!

In the United States, 3 of the 3,800 compressor stations have implemented this. Three out of 3,800.

DR: Has anyone ever tried to calculate how much waste energy is produced in the U.S., in total?

TC: Oh, absolutely. Lawrence Livermore Labs said we could make 95,000 MW -- they included some fired CHP plants, which I took out, which leaves 64,000 megawatts. U.S. electric load take is about 750,000 megawatts. So we could make about 9 percent of our peak, but because it runs all the time, 20 percent of our power with just heat from the electric.

On the other side, I've done a study of what would happen if the United States went all the way with power recycling. **We could cut our electric fuel in half. We could drop CO2 by between 20 and 30 percent. And we could make money on the first 25 percent drop with today's technology.** In the process, the technology would improve and we would be able to go farther.

DR: One would have thought that industrial processes and power generation would have improved their efficiency over the years, and not be shooting off so much energy into the air. If they *do* increase their efficiency, won't it reduce the capacity for cogeneration?

TC: I think you have just gotten to the most telling point.

In 1900, about 3.5 percent of the potential energy put into electric generation actually became delivered electricity, and about 1.5 percent of it ended up as useful work. The curve rises for the next 60 years, as these things get more efficient. By 1960, about 32.5 percent of the potential was arriving as electricity. In 2005, we're at 33 percent. **The electrical generation industry stopped improving its efficiency.** Can anybody name me another industry that hasn't advanced its efficiency by a single percentage point in 45 years and is still in business?

DR: This is a disadvantage of having a monopoly in perpetuity, right?

TC: People often ask me, is the problem with energy because of the Democrats or the Republicans? And I can give you an unequivocal answer: yes. In that 45 years, most states have changed parties back and forth, and nothing we've tried has improved the efficiency. How many more decades do you want to keep beating that horse before you say, we need to start thinking about a different species? Maybe we got all we can get out of this horse.

The thing is, that's about as good as you can get with central generation. It is a mistake to think that all we've got to do is pour money into R&D, go to clean coal and so forth. Public Service of Colorado has just gotten approval for a plant that will gasify coal and then run a combined turbine gas cycle; they're scrubbing everything and so forth. \$2500 a kilowatt to build that plant, and it will have a delivered efficiency of about 42 or 43 percent. \$1500 a kilowatt Jim Young put in downtown Seattle, with a delivered efficiency of 85 percent.

The answer is sitting in front of us. **The enemy is conventional thinking.**

DR: There hasn't been any public pressure either. Most people don't even know how electricity is made. It comes out of the wall like magic.

TC: You are so right. In Ontario, they did a massive peer-reviewed study to identify

the health and environmental effects of making power with coal, and what they thought would be saved if they replaced the coal with gas or nuclear. **They talked about being able to save \$3 billion a year in health and environmental costs.** When you divide that number by the kilowatt hours made from coal plants, it turns out that the health and environmental costs of coal-fired power is 12.3 cents per kilowatt hour. They are selling electricity to consumers at between 6 and 8 cents per kilowatt hour.

How much public pressure would there be to get rid of coal plants if every kilowatt hour coming from a coal plant cost 18 or 19 cents? The EU did a study in Serbia and they came up with 23 cents a kilowatt hour. This was mostly the costs of emphysema, emergency room, premature death. This is not hypothetical global warming costs.

Energy is the most subsidized commodity on the planet. One of the longer term things we could do is put the full costs onto energy, and do it in some kind of revenue-neutral way.

DR: You mean a carbon tax?

TC: Without getting into the specifics, in some way identify the health costs. I'm not a great fan of a carbon tax, relative to a cap and trade, because the number gets set politically and it's hard to change. Then the government has all the money and has to figure out what to do with it.

The lower the price is, the more we will overuse a commodity and underinvest in saving it. So somehow or other the number needs to get to the number you pay for electricity. At the end of the day I would rather depend on your economic instincts -- you being 300 million people -- than on your goodwill.

DR: The roadblocks seem more political than technological.

TC: I agree with you that it's political. A lot of it is a perception that if we change, it's going to hurt the economy.

I don't spend much time thinking about the venality of politicians. You've got vested interests and the vested interests are going to give money to certain people, and certain people are going to take the party line, no matter what. It's better to dig deeper, and get into the underlying perceptual issues causing people to think that way.

The way we're going to get out of this is that California is going to reduce its greenhouse gases more than Kyoto requires. More importantly, the Terminator signed another bill that said if you're going to supply power to California from outside the state, you have to meet the standards. He killed 15 coal plants when he signed that bill.

The naysayers will say California's going to go bankrupt, and California's economy is going to boom. Your job, if I could be so bold, is to be on top of those things and highlight the successes.

DR: There's a tectonic shift going on underneath the federal level that a lot of people miss.

TC: On Sunday, I flew to North Carolina to testify before the North Carolina Legislative Commission on Global Warming.

DR: Who woulda thunk it?

TC: Not only that, but on the panel was a guy considered the most powerful politician in the North Carolina Senate, and he was sitting there with rapt attention.

I was a speaker, an invited speaker at the Clinton Global Initiative six weeks ago. I got introduced to Carl Pope, executive director of the Sierra Club. I said, "Carl, my commitment is to form a not-for-profit effort to promote the deployment of clean technology, called the Alliance for Clean Technology. I would ask you to do your due diligence and see if this isn't something the Sierra Club might like to get behind." He said, "I don't need to do any due diligence. My members have been asking me for some response to global warming." So Sierra Club has decided that they're going to get behind this. We've got a set of proposals that would eliminate some of the barriers for clean technology.

I think the original thing with the enviros was the assumption that all business is evil, and it's an absolute fight to the death. I've always had the impression that whether you were a businessman or an environmentalist, you probably had children, and the fact of the matter is, we're the first generation in history that's leaving the world worse for our children than we found it.

DR: There's some meeting in the middle. There's a new generation of businesspeople who have this at heart.

TC: You know what else they're finding out? They're making money doing it.

About six years ago, in *Foreign Affairs*, there was a long article by Lord Brown, the chairman of British Petroleum. It was all about climate change. Well-articulated -- he's a pretty special guy. He mentions the fact that BP decided it would have its own internal carbon system, and use that system to find the least expensive ways to get rid of carbon. They would set a goal of getting back to their 1990 levels.

He then -- and it was so damn subtle you wonder if he's trying not to give it all away -- he said, "In fact, we've given ourselves 10 years and it took 3 years, and it cost less than we thought. In fact, we created \$600 million of shareholder value." I've got the paragraph almost memorized. **BP, who cut their carbon to 1990 levels, made over half a billion dollars doing it.**

What we don't have is examples of people that decided to cut their carbon and found out it *cost* them half a billion dollars. For some reason we believe it will, but we don't have an example.