Capitalism to the Rescue

By JON GERTNER
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How Green Was the Valley

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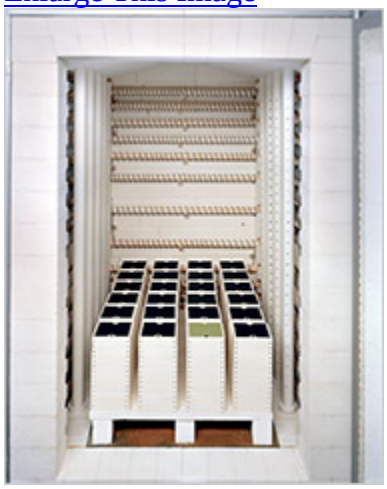

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Off the Grid: Bloom Energy's fuel cells, a low-emission, ''fuel flexible'' power source — and one of Kleiner Perkins's biggest green-tech bets.

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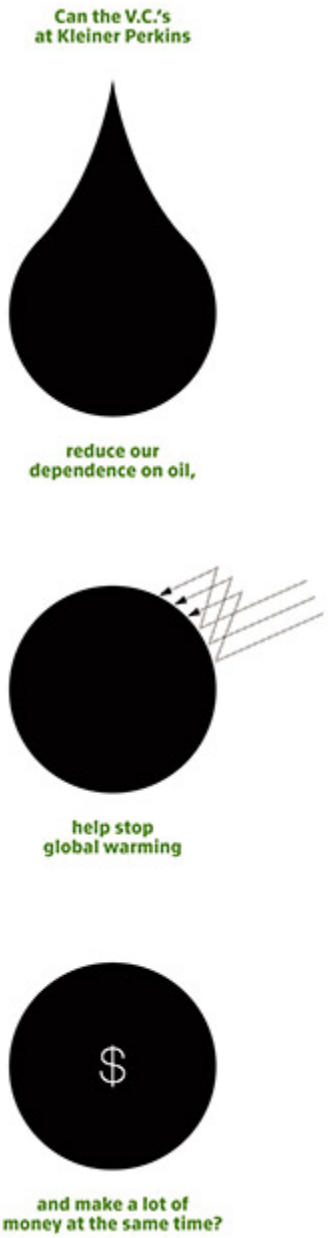
Ausra, a start-up in Palo Alto, Calif., uses mirrors to concentrate solar energy on water pipes to produce steam and, ultimately, electricity. The first installation, in 2011, should power more than 100,000 homes.



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A fermenter in a lab at Amyris, a California company that plans to use synthetic yeast to convert sugar into diesel and jet fuel. The potential market is huge, but its success is hardly guaranteed.

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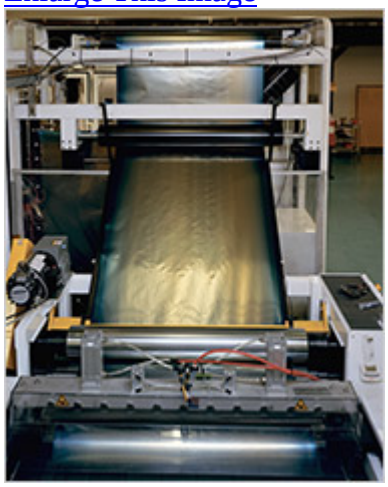

Mitch Epstein for The New York Times

Miasolé, one of five solar photovoltaic companies in Kleiner's green-tech portfolio, creates "thin film" solar cells at its factory in Santa Clara, Calif.

One afternoon last May in Menlo Park, Calif., a venture capitalist named Ray Lane led me from his office to the parking lot, where an automobile had been delivered a few hours earlier by flatbed truck. The car, built in Norway, was powered by batteries and had a plug-in outlet hidden under a flip-top cover near the driver-side door. To my eye, the car resembled a generic European compact, but with some differences; the body, for instance, was made from a textured, plasticized material. In a lot full of gleaming new vehicles, some of them owned by the wealthiest venture capitalists in the United States, this car — branded the Think — seemed distinctive mainly for its lack of sparkle.

“You want to drive?” Lane asked, tossing me the key. Inside, the dashboard was seemingly made of densely woven fabric, and the seat was covered in a material that felt decidedly un-Corinthian. “The Think is 95 percent recyclable,” Lane said matter-of-factly, giving me the sense that we were about to drive a milk carton rather than a car. A turn of the key started up a barely perceptible hum somewhere under the hood. “There we go,” Lane said, sitting back with a pleased expression. I shifted into drive and hit the gas pedal — actually, the electricity pedal — a little too hard, and the Think lurched forward.

It was one of those hot, dry, cloudless days on Sand Hill Road, the wide avenue in Silicon Valley lined with some of the country’s most powerful venture-capital firms. It would have been a fine adventure to see if the Think could hit its top speed of 65 m.p.h. on U.S. 101, which snakes through Menlo Park and down into Mountain View, Sunnyvale and San Jose, high-tech towns where Lane and his colleagues at Kleiner Perkins Caufield & Byers have been financing companies (Google and Netscape, among others) for the past 36 years. But this Think, one of only three in the United States, had no license plates or registration. So Lane and I explored the private streets around the two Kleiner Perkins buildings instead. As we drove, Lane told me that if things went well — if the Think’s manufacturing process could be made more efficient, for instance — the car would go on sale in the United States in 2009. He said he hoped to sell several thousand in the first year and eventually reach annual sales in the tens of thousands, with a sticker price below $30,000. But then outcomes were hard to predict with precision, he admitted, even for venture capitalists who spend their working hours imagining the future.

It was late last winter when I began speaking with Lane and his partners at Kleiner Perkins. My conversations lasted to mid-September, just as the financial turmoil on Wall Street was leading to bank failures and jagged movements in the stock indexes. The firm wasn’t unconcerned about the crisis — problems with the markets could potentially slow down the development of some of the companies it backed. Still, most of its ventures were long-term investments. And entrepreneurs were still bringing new ideas through the door at a steady pace. “I don’t expect the credit crunch will change that,” John Denniston, a Kleiner partner, said. Indeed, throughout the summer the partnership was raising hundreds of millions of dollars to pour into clean or green technologies — in V.C.-speak, “clean tech” or “green tech” investments. By the beginning of autumn, Kleiner had financed 40 different green-tech companies and raised a total of about $1 billion to that end. Some of the firm’s fledging green ventures were evolutionary improvements on current technologies that would soon hit the market, like the electric Think car. Others I heard about promised to revolutionize various aspects of the energy economy — in, say, solar power or biofuels — much as Netscape or Google remade the Web or Genentech (another Kleiner Perkins venture) ushered in the biotechnology era several decades earlier. In many parts of Silicon Valley, it seemed misguided to regard the U.S. economy as reliant solely on Wall Street. The future still depended on entrepreneurs and innovations and green-tech businesses getting “traction,” as the V.C.’s at Kleiner liked to say.

Kleiner was not the only venture firm that had suddenly seen the future and decided it was green. But Kleiner’s past success tended to legitimize the prospects of business ideas

that in many cases had spent decades on the economic fringe. California this past summer seemed like a fantasia of alternative-energy start-ups, where legions of garage tinkerers were taking a break from writing software code so they could help solve the climate problem. At Kleiner, which might have fielded perhaps a dozen business plans a year for new green-tech companies earlier this decade, at least 100 ideas were filtering in every month. The smooth-talking serial entrepreneurs, the university physicists toiling in obscurity, the great throngs of unshaven engineering grad students — every day they were pitching low-carbon devices that utilized cow dung or nanofilm or supersecret ceramic compounds that had so much transformative potential they could be discussed only in the strictest confidence. John Doerr, one of Kleiner's managing partners and arguably the world's most influential venture capitalist, made the case to me in his office one morning in July that these were signs that the multitrillion-dollar energy market would inevitably, and imminently, undergo a wholesale eco-transformation. In the view of Doerr and his partners, Kleiner's efforts to seed this prospective renewable economy with its investments and the help of its new partner, Al Gore, would help address some of the most vexing problems of the modern era — namely, climate change, fuel costs and energy independence. Amid economic hardship and the turmoil within the financial-services industry, such efforts could also contribute to a profusion of green jobs in technology as well as in manufacturing. On a different morning, another Kleiner partner, Randy Komisar, told me that the firm's green-tech investments didn't seem terribly risky to him because the energy market was so large and outdated. "I'm so dead certain that we're solving the next huge problem for the planet," he said. "I'm not very good at hitting the bull's-eye. I need a big target. And this is the biggest target I've ever seen in my life."

Was this true? One heated topic of debate in the valley last summer was whether Kleiner had found a way to create yet another pile of riches or whether the firm was making a grievous miscalculation. What intrigued me most about Kleiner's plans, though, wasn't whether its green-tech investments would (or would not) reap huge financial returns, but whether this country's private sector, spurred primarily by venture capital, could start to change the way the U.S. and the world use energy. In many respects, the solutions to global warming and fuel prices have been defined over the past year almost exclusively in terms of government action — the policies of a Barack Obama or a John McCain administration, in other words, that could effect a new energy infrastructure or help forge international treaties to reduce global carbon emissions. One shortcoming of this view is that while government has a longstanding role in underwriting scientific research and regulating or (with less positive results) deregulating industries, government doesn't really innovate, at least not in the sense of readying technologies for the marketplace and integrating those technologies into mainstream companies. That's left to firms like Kleiner, which happened to be financing precisely those kinds of businesses, but largely out of the public eye. If they were succeeding in green tech — an uncertain prospect — then conceivably big profits would follow, not to mention a social and environmental dividend for the rest of us.

'The Map of Grand Challenges' as Investment Plan

While venture capitalists are sometimes mistaken for their cousins who work in private equity, they tend to have a very different role within the U.S. economy. Private equity funds invest large sums — hundreds of millions or even billions of dollars — on existing businesses. V.C. funds, by contrast, typically back entrepreneurs clutching a coffee-stained business plan. The V.C.'s swap money (often anywhere from $1 million to $15 million) for an ownership stake (usually from 20 to 40 percent) in the start-up. And the sums that a firm like Kleiner invests each year are modest compared with what a company like General Electric might spend on research and development. Yet venture dollars can be extremely potent. Many of the most innovative American companies — FedEx, Amazon, Apple and Google, for instance — have received venture money; a recent study by Global Insight noted that such businesses now account for nearly 18 percent of America's gross domestic product and 9 percent of our private-sector employment. According to Josh Lerner of the Harvard Business School, "When you try to quantify it, a dollar of venture capital is somewhat equal to three or four dollars of corporate R&D." But one of the larger misunderstandings is that all V.C.'s have a Midas touch and a private jet. "I think it's fair to say that by and large the median venture fund is a quite disappointing performer," Lerner says. "Most of them are losers." Still, he adds, the data suggest that a few V.C. firms — like Kleiner Perkins, or its neighbor the Sequoia Fund — seem to do well year after year.

Kleiner's offices in Menlo Park have been described as a temple of capitalism, but inside they feel more like a ski chalet of capitalism. Set far back from the bustle of Sand Hill Road, the firm occupies two cedar-shingled, Arts and Crafts-style buildings shaded by redwood trees. Most of the firm's 29 partners occupy glassed-in offices around a common area with exposed wood beams that support a soaring, peaked ceiling. A breakfast is laid out on a table in the common area each morning; at about noon, chafing dishes arrive with lunch. Kleiner is among the most rarefied of guilds. Every few years, the firm raises a pool of money that ranges from $500 million to $700 million; the pool gets a name that includes Roman numerals — the most recent is KPCBXIII — and serves as a kind of bank account that the partners use to invest in 30 to 40 business ideas. Many venture firms struggle to raise this kind of money. At Kleiner, it pours in without much apparent effort. It comes from the Kleiner partners themselves, from foundations and university endowments (Stanford, Harvard, Yale, among others) and from wealthy individuals (the Google founders Sergey Brin and Larry Page, for instance) who are allowed — "by invitation only," as one partner put it — to add a few million to the Kleiner pot. Most of these elite investors, known as limited partners, are also Kleiner's helpers; they often direct ideas or new entrepreneurs to the firm. Kleiner is, in essence, a mutual-interest society of wealth, knowledge and connections, and even if you wanted to, even if you begged, you couldn't invest with them.

Traditionally, the firm has split its investments between digital-technology companies and health-related companies. Occasionally there are forays into businesses that fit neither category, however. One of these was Kleiner's humiliating investment in Segway, the maker of the battery-powered scooter, which, back in 2001, John Doerr predicted would be the fastest company in history to hit $1 billion in sales. Seven years later, Segway is not even close. Nonetheless, Segway yielded a different kind of return. The

vehicle's creator, the inventor Dean Kamen, spent time at Kleiner talking with Doerr and his partners about the challenges in providing a growing and increasingly urban global population with clean water and energy. And, as it happened, around the time of the Segway's debut, Kleiner received a proposal from a professor at the University of Arizona named K. R. Sridhar, a former NASA scientist, who was working on a solid-oxide fuel cell in his garage in Tucson. Fuel cells are an old technology, dating back more than 150 years; they convert a fuel, like natural gas, into electricity through chemical reaction rather than combustion. Sridhar's pitch had some novel technological aspects, and his business plan called for making energy generators — essentially, large box-shaped units for a home basement, or an office building — for buyers who either had no access to an electrical grid or wanted to disconnect themselves from one. "You could put natural gas into it and get electricity out," Aileen Lee, the partner at Kleiner who researched Sridhar's proposal, told me. "Or it could be fuel-flexible" — meaning the boxes could run on, say, ethanol. At least in theory, the units, which Sridhar called Bloom boxes, would be reliable, quiet and very low in carbon emissions.

I heard a number of explanations about why the firm paused after investing in Bloom Energy in 2002. The consensus seems to be that it took time for the partnership to be persuaded that the economy would move in a greener direction and that green tech would have far larger potential payoffs than, say, the ideas for Web sites that were being financed at the time. Then, in late 2006, at one of Kleiner's corporate retreats, Bill Joy, a founder of Sun Microsystems and a new partner at the firm, displayed what later became known within Kleiner as "the map of grand challenges." This was a matrix of colored squares that itemized the firm's progress in locating potential investments in about 40 different categories: water, transportation, energy efficiency, electricity generation, energy storage and the like. In the blank spots there were lists of "things that ought to be possible," in Doerr's words — ideas, in short, that might produce huge changes and, if Kleiner bought a stake, huge profits. Thus the grand map was a rough, imaginary outline of a clean-energy economy that didn't really exist and perhaps wouldn't in any meaningful way for decades. But it helped Kleiner understand what to look for. That same year, Kleiner officially informed its investors that it would begin putting $100 million of its newest fund in green technology. Doerr, Joy, Ray Lane and John Denniston all joined the green-tech group.

There was little doubt that partners like Lane and Doerr, who have countless connections within America's high-tech worlds, would get good green-tech pitches as word got around. In the meantime, Joy and his more technically minded colleagues "went outbound," in Joy's words, which meant they started scouring laboratories throughout the United States, as well as academic departments around the world, for energy ideas that could satisfy challenges on the grand map. It has become a kind of received wisdom that American and European laboratories have yet to come up with enough innovations to ease our dependence on fossil fuels, or that effective (and affordable) technological solutions to climate change are still many decades away. In truth, there have been scores of recent scientific developments in wind, solar, biofuels and energy efficiency that have not yet entered the market, in part because the private sector has deemed them risky investments in a world where gas, coal and electricity are cheap. As Andy Karsner, who

recently stepped down as the Department of Energy assistant secretary in charge of renewables, told me, “Venture capital’s interest in the sector didn’t arise until price signals and climate change came into play a few years ago.” Before that, he says, green technology “was in a state of suspended animation.” Dan Arvizu, the head of the National Renewable Energy Laboratory in Golden, Colo., echoes this sentiment. Whenever Arvizu testifies in front of Congress on the state of renewables, he told me: “They always ask the same questions — ‘When is this going to be real?’ And I say: ‘It’s real now.’ ”

Kleiner’s partners largely shared this view. “Our overarching thesis,” Bill Joy says, “was that a lot of stuff had already been developed, but there were things that were not yet commercialized because they had been frozen by the low price of oil. The innovation had occurred, but they hadn’t been deployed.” In addition to a number of California ventures, Joy and his colleagues ultimately tracked down worthy ideas in Massachusetts, Florida, Texas, Pennsylvania, New York, New Jersey and Georgia, as well as in Israel, Germany and China. One morning early in the summer, I had breakfast with Joy in Manhattan, and he took a folded sheet of paper from his pocket to show me what remained of the map of grand challenges, under the condition that I would keep confidential the technologies that were not public knowledge. Some slots remained open, but the firm had identified a number of projects that could be deployed quickly as well as longer-term proposals that might be called breakthroughs. Whether any would turn into flourishing companies — let alone another Google — was a far more unpredictable matter. For the time being, at least, Kleiner’s partners had assembled the ideas for what they intuited to be the future. At one point during his globe-trotting pursuits, Joy recalled, John Doerr turned to him and said, “I don’t think anyone has ever really done venture capital this way.”

From Idea to I.P.O.

If you look over Kleiner’s clean-energy portfolio, it’s apparent that the firm has made a number of large and risky bets. In part this is because of the evolving economics of venture capital: to get the returns its investors have come to expect — the firm says it has returned an average of $1 billion in profits per year to its investors over the past decade — Kleiner has to produce one or two magical success stories every few years. Some of the risk taking, however, is a product of the firm’s culture. Brook Byers, the firm’s longest-serving partner, told me the place depends on a complementary mix of talents. This has been the case since the beginning, in 1972, when Eugene Kleiner, an engineer who had worked at the valley’s earliest semiconductor companies, went into business with Tom Perkins, a former executive at Hewlett-Packard. Kleiner, who died a few years ago, was an Austrian-born intellectual of modest tastes — “a very soft-spoken, very wise, very gentle man,” according to Doerr. Perkins was a brash gambler who would later build one of the world’s most expensive yachts. You could argue that Perkins, now retired, left the larger imprint on the firm. As Doerr told me, “Tom would say, ‘When you have a great opportunity, push all the chips, all the resources that you can, to the center of the table.’ ” Perkins, Doerr added, was more his mentor than Kleiner was.

Bloom Energy is a good example of a venture where the chips are now piled high. Though you wouldn’t know it from appearances. Located in a modest, unmarked one-

story building with large plate-glass windows off the highway in Sunnyvale, Calif., Bloom is one of the companies in the Kleiner portfolio closest to unveiling a commercial product. Over the past two and a half years, engineers at the University of Tennessee in Chattanooga have been testing a five-kilowatt Bloom box, which looks like a squat refrigerator and produces about as much electricity as a typical home requires. And at this point there seems little doubt that the idea K. R. Sridhar pitched to Kleiner in 2001 has become a high-functioning machine. “We installed one of his first units here to assess its durability and performance, to see if it matched the claims,” Henry McDonald, a professor at Tennessee who is overseeing the Bloom box, says. McDonald ran the box nonstop on natural gas for 6,000 hours, and its performance beat expectations. In everyday terms, the box was twice as efficient as a boiler burning natural gas, and its carbon emissions were 60 percent lower.

Kleiner didn’t invest in Bloom for precisely these reasons. Rather, the firm’s partners say that Bloom could eventually sell hundreds of thousands of boxes, either at the 5-kilowatt size or as larger, 100-kilowatt machines that power buildings or neighborhoods. The company’s ambitions are indeed breathtaking in scope. As Sridhar told me, referring to the world’s population: “Two billion people have no access to electricity. And of the other four billion people with access, probably two billion are actually getting below their demands.” That makes for a lot of potential users of his product. Sridhar also contended that even here, in the developed world, where the grid is reliable and electricity comparatively cheap, Bloom could find willing customers under the right circumstances. He showed me his first Bloom fuel cell, the one he made eight years ago in his garage in Arizona with some colleagues; it resembled a flat, rectangular metal plate, about the size of a pack of Chiclets. Etched across its face was a geometric pattern of tiny equilateral triangles. The prototype produced a couple of watts of electricity, he said, not even enough to power a light bulb. “This is what I showed Kleiner as the proof of concept,” Sridhar recalled. “I said, ‘This is what we can use to power the world and change the world.’ ”

Entrepreneurs sometimes refer to the period between a project’s origins and its commercial deployment as “the valley of death.” The meaning of the term may be self-evident: it is the bog where most ideas stall and expire. Kleiner’s partners will tell you that ventures usually die because they fail to overcome one of four risk factors. To begin with, there is technology risk. As Ted Schlein, a Kleiner partner, put it one morning: “Can it be built? How hard is it to build it? And if you can build it, can other people build it just as well?” Next, Schlein said, is what he and his partners call “people risk.” How good is the team pitching the idea, and can its members execute their idea well? The third risk involves selling a product in the market, which most Kleiner partners believe is the hardest to gauge before making an investment. In Schlein’s words: “O.K., let’s say we can build it and get great people. Will anyone buy it?”

The final risk is financial. Venture capitalists who back a company in its earliest stages, as Kleiner did with Bloom, typically invest only a fraction of what it takes to bring a business to market; as the company grows, the rest of the financing necessary comes at later stages — known as “B rounds,” “C rounds” and so forth — from other V.C. firms

and outside investment funds. Companies that have problems with their technology, management teams or marketing have difficulty attracting more financing. With green tech, this may prove especially dire. Software or Web-site development can be fast and relatively cheap — a couple of years, say, and a total of $50 million before a company can go public. A medical venture can cost double that amount and take up to a decade to mature. Green tech may well require more time and money than either. For companies requiring industrial production — those making fuel cells or solar installations, for example — Doerr estimated it would take anywhere from $200 million to $500 million to get them ready for public offerings. “It took $25 million of venture capital to get Google into business,” he said. “It’s taken $250 million of private capital to get Bloom into business. Google was five years from when we invested to an I.P.O. Bloom is six years since we invested to today.” If Bloom has an initial public offering, it probably won’t be for at least another few years.

A number of young companies, like SunPower and First Solar, have proved that green businesses can go from start-up stage to I.P.O. and be quite profitable. But the technology developed by those companies took well more than a decade to prove itself, and many other companies have died in the meantime. In recent months, Kleiner has tried to exploit investment opportunities in these long and complex start-up periods. The firm just raised $500 million for its Green Growth Fund, which is separate from typical Kleiner funds like KPCBXIII, to invest in up-and-running “later-stage” green-tech companies that need money to continue growing. (As an example, Green Growth has recently been considering an investment in an energy-efficiency company that sells wireless communications devices that utilities can install in the electrical grid — and within homes — to save power and money.) Meanwhile, almost all of the other companies in Kleiner’s green-tech portfolio, including Bloom, continue the treacherous slog to commercialization. In talking about this process with Kleiner partners, there can be a robotic quality to their conversation; they all tend say that they are “company builders,” or that “the least important thing we bring to the table is money.” By some measures, Kleiner is not necessarily the most popular firm in the valley; a new Web site, for instance, thefunded.com, which lets entrepreneurs rate their interactions with V.C.’s, gives the firm mediocre marks. Still, there’s truth to the assertion that Kleiner’s value isn’t so much its money as its worldliness: it can hire talented executives, offer expert advice on marketing and tap additional cash for growth. Moreover, a team that includes Al Gore and Colin Powell (who is also affiliated with Kleiner), as well as an extended network of well-heeled investors, provides something of a head start.

Ray Lane often divides the firm’s partners into technologists and networkers. In the first category are people like Bill Joy, whom the firm depends on to analyze the technical feasibility of green-tech ideas. Then there are those like Lane himself, a former president of the Oracle Corporation, and Doerr, a Kleiner veteran of 28 years, who use their vast numbers of contacts — in business, academia and politics — to help start-ups. “I probably have 6,000 people in my Rolodex,” Lane told me, adding that he and Doerr have a friendly competition over who has more. When Trae Vassallo, a partner in the firm, was flying around the world researching geothermal energy, Lane helped her arrange a tour of Iceland’s geothermal plants with Olafur Ragnar Grimsson. Grimsson is

the president of Iceland, and Lane apparently knows him well. When Lane and I first met, he had just returned from Qatar, where he saw the country's emir and took the opportunity to tell him about Ausra, one of Kleiner's more promising investments, which uses mirrors to concentrate solar energy on water pipes to produce steam and, in turn, electricity.

Renewable energy may ultimately be about the environment, but it is perhaps about economics first and foremost. To take an example, Kleiner could have backed a number of other solar-thermal companies besides Ausra. The company's appeal, according to Vassallo, was not so much technical wizardry as "a simplicity and elegance of design" that persuaded the partners its installations would be durable, easy to manufacture and easy to operate. Moreover, because the technology uses available commodities — steel, glass and ordinary turbines — it could be deployed quickly. Before investing, Kleiner commissioned two consulting firms to assess how much Ausra's power would cost, and the resulting studies concluded its electricity could be 15 to 20 percent cheaper than that produced by its solar-thermal competition. Soon thereafter, Kleiner backed the company. When I visited the Ausra offices, just off U.S. Route 101 in Palo Alto, Calif., the company's C.E.O., Bob Fishman, told me Ausra's low costs would allow it to compete in the mainstream energy market, not just in the renewable-energy market. (In California, state mandates make it possible for solar companies to gain a modest foothold.) A new factory in Las Vegas was producing mirrors and parts, and the firm's West Coast solar installations should bring power to about 125,000 homes by 2011. Soon "we want to go after gas and coal and displace them," Fishman said.

Unlike Ausra, most of the Kleiner's green-tech investments are not publicly discussed. By my count, the firm has acknowledged 15 of its 40 investments. The rest are in what V.C.'s call "stealth" mode, hidden from the press (and copycat V.C.'s) until they are on sounder footing. Last summer, the growing number of stealth companies involved with clean energy formed a kind of dark matter in the Silicon Valley universe, businesses that could not be seen yet nevertheless exerted a discernible gravitational pull. Executives would suddenly leave jobs at established companies to join ventures with no official name. Manufacturing facilities would set up shop in cheap, anonymous buildings in towns like Santa Clara, Calif., then begin round-the-clock operations. When Kleiner decided to invest in a company called FloDesign, a business in Massachusetts, sensitive pages on its Web site were quickly dismantled; when Kleiner decided to invest in a company known as Sundrop Fuels, online links that described the technology, which was developed at Los Alamos National Laboratory, were removed. In some respects, the more promising the technology, the more secretive the venture becomes. And both FloDesign and Sundrop were indeed promising. FloDesign intends to replace the common propeller wind turbine with something that resembles a jet engine. Doerr told me that the company's product, which is perhaps 18 months away from a prototype, would cost 25 percent less than any other kind of wind generation — that could make it one of the cheapest renewable-energy sources in the world. Sundrop, meanwhile, is what Joe Lacob, a Kleiner partner, calls "solar assisted" fuel generation — a process that combines the ingredients of carbon, hydrogen and sunlight to create a petrol-like product. "We can

actually take CO2," Lacob told me, "which is what we're trying to get rid of, and make that our source of carbon, and use the sun's energy to create liquid fuels."

Bloom Energy is not in stealth mode, but the company has been loath to offer progress reports, leading some in the venture community to wonder what $250 million in financing has actually achieved. The company's Web site, like those of many green-tech start-ups, is a prop, a confection of environmental images devoid of links or information. At the offices of Bloom, which now has over 200 employees, I questioned Sridhar about the willful obscurity, when Bloom will almost certainly have a commercial product ready within a year or two. He answered that there have been too many promises in the past, from both fuel-cell makers and other green-technology companies, that have never delivered on the hopes they stirred up. "We want our product to speak before we speak," he said.

The V.C.s Make the Case for Government Regulation

As the summer wore on, Bloom and Ausra hit various benchmarks on the path to commercialization. Bloom made a highly technical breakthrough to improve its fuel cell's efficiency; Ausra, at a remote test installation outside Bakersfield, Calif., in late August, began producing steam at about 600 degrees Fahrenheit — proof that its technical risk had been mostly overcome. To Kleiner's partners, watching such innovation happen in real time was largely satisfying. To an outsider, it seemed wearying. Rather than a swift series of eureka moments, progress took shape in setting goals, testing, tweaking and then setting more goals. Still, in September, Ray Lane told me he had concluded there were about 15 "Google-type opportunities" among the firm's green-tech investments. Unfortunately, he added, Kleiner's history suggests that the firm hits only one Google-type jackpot every few years. So either Ausra or Bloom might be a big winner. Or neither might. Kleiner's partners knew perfectly well that they needed to cover their bets. Hence the company had two other automotive-company investments besides the Think car. In addition to Bloom, there were two other fuel-cell ventures. There were five different investments in solar photovoltaic companies, several battery and electrical-storage investments and about a half-dozen bets on biofuels.

The venture capitalists at Kleiner nevertheless maintained their optimism. "If you have anxiety," Brook Byers told me, "this isn't a good business to be in." Or as Lane remarked: "If I had to guess, five years from now this is going to be a topic at the dinner table — the price of electricity, electric cars. Maybe not at the technical level we're talking now. But it's going to be routine." What makes Kleiner's green-tech ventures so risky, though, is that an assumption by the partners — a profitable market for biofuels, for example — could be correct and the investments could still falter. "If you look out far enough, I have no doubt that many of the bets will pay off," says Paul Kedrosky, a former investment banker, blogger and longtime observer of the venture-capital industry. "But in the venture business, being early is indistinguishable from being wrong. That's why everyone is terrified of being too early." In other words, imagine if electric cars become dinner-table conversation 10 years from now, rather than 5. As Harvard's Josh Lerner notes, it would be difficult for any venture firm to keep financing its start-ups for so long.

And Kleiner has not yet had what V.C.'s call an "exit" in green tech — meaning an I.P.O. or sale of a start-up to a private firm. It may be early still. At some point, though, the V.C.'s have to find a way to profitably disengage from their projects. "Exiting," Lerner says, "is ultimately the crucial thing."

If technology cannot provide a safety net for green-tech investments, politics just might. At Kleiner, you rarely go a day without hearing how new federal laws that put a price on carbon emissions, for example, and that mandate levels of renewable electricity production could speed the adoption of green energy. The partners often made the case to me that if our national science budget for renewables and efficiency (about $1 billion annually) were brought in line with that of the National Institutes of Health (about $29 billion), a torrent of projects and jobs would be unleashed. So it's no surprise, of course, that partners like Doerr, Lane and Denniston have sought meetings with senators and governors, testified before Congress and pushed their message through lobbying channels like the National Venture Capital Association. Kleiner's partners told me that their portfolio could be very profitable without any public-sector policy changes, but it's hard to see how that could be the case. A price on carbon could, in one quick stroke, make Ausra's carbon-free solar electricity even cheaper than coal- or gas-powered electricity, which would both rise in cost because they produce CO2; as a result, there would be virtually no limit to the demand for Ausra power. That's how you get a green-tech Google.

To be sure, Kleiner is hardly alone in its agitation for new energy policies. Many of this country's largest corporations — G.E., G.M., Dow Chemical, DuPont — now support cap-and-trade laws on carbon. The presidential candidates' energy ideas differ in significant ways, yet Obama and McCain both back legislation to control carbon emissions. When I asked Robert Socolow — a physicist at Princeton who helped create an influential framework, known as stabilization wedges, for steadying global carbon emissions — which was more important, new technologies or new policies, he challenged my premise. "You can't separate the two," he told me. "The policy elicits the technology. The interactions are fundamental." Jeffrey Sachs, an economist and the head of Columbia University's Earth Institute, put it this way: "I think the private-sector investments that are being made are going to make a very big difference, but one can see where the bottlenecks will come if this is only left to private capital." Sachs notes that putting a price on carbon is a crucial action. But it's not the only one. The electricity grid, he says, would almost surely need to be rebuilt as the country switched to renewables, a change requiring federal financing and policy action in land use, interstate law and liability.

It's worth asking, perhaps, if new energy legislation could spark a tulipmania-like bubble in green tech. At the moment, amid the suffering economy, public stock offerings are at a standstill, and green technologies remain a risk mainly for V.C.'s and investment bankers. But fond memories of the Internet era remain fresh at Kleiner. Doerr told me he remembers being in a grocery-store line in 1995, in Colorado, a few days after Netscape went public. To his surprise, several people in line were discussing Netscape's share price. "For it to have penetrated the national consciousness?" he recalled. "It was a large step forward that said, Hey, there was a gold rush on with respect to the Internet." In his

view, bubbles — Doerr affectionately calls them booms — often have a way of building up a useful infrastructure, even when they expand too far. Energy would be a far bigger market than the Internet, meaning a much bigger boom.

Doerr expects several Kleiner green-tech ventures to have I.P.O.'s within the next few years. But he dismissed the possibility that his enthusiasm for the energy sector might already be overheated. "I believe what we're investing now," he told me, "is a pittance in comparison to the size of the opportunity and the size of the problem."

When I later parsed what Doerr was saying, I could see that on this occasion, as in others, he had woven the financial and redemptive strands of green tech together. At times, this tendency leads to controversy. When Doerr made an impassioned speech at a 2007 technology conference urging the business community to recognize that confronting global warming was a route to both salvation and profits, the idea was subject to mockery in some quarters of the business community. "Clean tech brings out a really emotional response in people in the valley," Paul Kedrosky says. "They react strongly to the idea that this has to succeed because it's really important, because it's too big to fail. Because that has nothing to do with whether or not you can make money on it." From some of Kleiner's competitors I heard criticisms that Doerr was betting the firm on perhaps an idealistic quest. But there doesn't seem to be much truth to the claim. In dozens of interviews at Kleiner it seemed clear that Doerr and his colleagues were not, despite their concerns about climate change, basing decisions on where they could do the most good. They were chasing the best returns. If you look back at more than a decade's worth of Doerr's interviews, you'll see that he has always called attention to the byproducts of his investments — namely, new jobs and new technologies — in an effort to stir up excitement, business prospects and perhaps benevolent public policy. Climate issues are merely the latest addition to his sales pitch about the social value of venture capital. When I asked Doerr whether he was investing to save the environment, he said, "We are ruthlessly single-minded about our job, which is to make a lot of money for our investors." In his view, the process of making that money could change the world. But the firm was not directly pursuing a "cause." If some of Kleiner's investors — colleges, foundations and philanthropists — wanted to do that with their profits, he added, then that was up to them.

Al Gore, Environmental Optimist?

If Kleiner's best investments were to overcome their technical and financial risks — and if they got a boost from new federal policies — would they clear a quicker path to energy independence? Or have a sudden impact on carbon emissions? At a talk on green tech at M.I.T. last April, Doerr said: "To get solutions at scale, we're going to have to find answers that are economic for all people everywhere. We've got to use policy to harness innovation to make sure that the right thing to do is a profitable thing to do — so it becomes the probable thing to have happen." In his folksy manner, this was his way of expressing how green tech could infiltrate our businesses and culture. Academics sometimes call this process the diffusion of technology. Diffusion can go very fast, as has been the case with personal computers or with Web applications like Facebook. But in

the field of energy, history is less encouraging: new technologies have moved quite slowly into the mainstream. It has been 54 years, for instance, since the silicon solar cell was invented in New Jersey at Bell Laboratories. A front-page article in this newspaper heralded the breakthrough as something that promised to revolutionize the world. It hasn't yet, of course.

Perhaps the most challenging aspect of Kleiner's endeavor, then, is for green tech to expand into the markets more rapidly than any energy technology has done before. In a conversation I had with Al Gore in early September, I asked how that would be possible. Gore shows up at Kleiner's offices several times a month to share his political and environmental insights. (When I asked Gore what he thought he brings to Kleiner, he quipped, "I think it's my knowledge of subatomic physics.") He became involved in private-sector climate solutions because, he said, "more money is allocated in the private markets in one hour than in all of the budgets of all of the governments of the world in a year's time." The trends that have governed the development of alternative-energy technologies till now, he said, aren't a result of some natural scientific law. Echoing a point Bill Joy made to me a few months earlier, Gore said cheap oil had made renewable technologies less appealing as investments, which in turn had made it difficult to bring clean-energy costs down through mass production. Gore used the example of digital products: prices have come down, even as sophistication has gone up, thanks to Moore's Law, which describes how computer chips double in capacity every two years or so. "How slowly these technologies have been developed in the past," Gore said of green tech, has "limited bearing on how quickly we could deploy them in the future, if we wanted to." Solar-thermal companies like Ausra could soon be competitive with coal-based electricity production, he said. And when the governments of the world assign a price to carbon, he added — as he believes they will within a year or two — demand for carbon-free electricity will explode.

From Gore, a bearer of bad tidings when it comes to climate news, this seemed to strike a more hopeful tone. "My previous optimism involved an act of will that occasionally was hard to reconcile with the worsening reality," he told me. His optimism had recently grown considerably, partly because of the prospect of new policies on carbon emissions, and partly because of innovations he'd seen at Kleiner. Some of these were green-tech companies, Gore said, that were in "deep, deep stealth"; they were known to no one except for a few V.C.'s and the entrepreneurs themselves. I heard a similar point elsewhere. John Doerr's speech last spring at M.I.T., for instance, was notably more upbeat than the emotional one he gave at the 2007 technology conference, where he said, "I don't think we're going to make it." I recently asked Doerr how he felt now. "I'm more optimistic about the innovation that will occur," he replied. "I'm more humbled by the scale of what has to be done. Or more sober. And I'm particularly concerned about the speed." The green-energy technologies Kleiner was investing in, Doerr continued, "won't impact the problem at scale in the next five years, just because they have long development times associated with them. In the 5-to-15-year period of time, I think they'll demonstrate, and clearly point the path to, lower costs than we would have otherwise imagined possible."

The difficulties along the way can't be understated. Many green-tech companies are building products that require entirely new industrial processes, which might trap them in a kind of innovator's paradox. At Ausra or Bloom, for instance, it will be challenging, early on, to reach the stage of mass production because there aren't enough buyers willing to pay for the costly products. On the other hand, the products are so costly because they are not being mass-produced. Historical patterns of innovation suggest that novel products succeed in the marketplace by exploiting a niche as their sales steadily expand and as their performance improves and costs go down. Ausra has the good fortune to have contracts with California electricity providers. But the company intends to stake out other niches too — selling solar-thermal installations to companies that require large quantities of steam for food production or oil production, for example, or to coal-fired power plants to supply some of the steam that runs their turbine generators. The latter use has the potential to reduce a coal plant's carbon footprint more cheaply than buying equipment to capture smokestack emissions.

At Bloom, K. R. Sridhar told me he considers his challenge akin to what cellphone makers encountered a few decades ago. Cellphones were initially balky and expensive; they created a niche market of users in the developed world who appreciated the phones for their portability. In developing countries, governments and entrepreneurs found it cheaper to build cellular networks than land lines. Eventually costs decreased, reliability improved and sales soared. In several conversations, Sridhar advanced this process as a model for Bloom. In the U.S. and Europe, he told me, Bloom has to be just as reliable as the power grid and priced competitively. In areas where the grid is stressed and utilities are reluctant to build expensive new power plants, he could sell his fuel cells to new hospital buildings, big-box retail stores and computer-data centers. "In the developing world," Sridhar said, "we don't have to compete with the grid price of electricity." The biggest hurdle, as he saw it, would be up-front capital costs — helping energy entrepreneurs finance the purchase of a Bloom box, for instance, so they could create a "microgrid" that serves several hundred homes and stores. This is Sridhar's dream for civilization. Ultimately, the Bloom box could offer low-emission, 24-hour-a-day power to villages in Asia and Africa that have never possessed modern appliances or to cities that have never experienced reliability.

His immense ambitions were not unlike those of Amyris, a biofuels company in Kleiner's portfolio located in Emeryville, Calif., next to Oakland. Amyris is synthetically engineering new strains of yeast that will convert organic matter — Brazilian sugar cane, initially — into renewable fuels for automobiles, trucks and jets. Its diesel has a carbon footprint 80 percent smaller than that of regular diesel. "Between now and 2020, here's what we think is possible," John Melo, Amyris's C.E.O. told me. "Somewhere around 20 percent to 30 percent combined jet fuel and diesel" will be produced globally through a renewable process like the Amyris technology. Without impinging on rain-forest land or food production, Melo maintained, Brazil could produce 100 billion gallons of biofuel annually from cane; Africa could produce a slightly smaller amount. (Last year, U.S. drivers consumed 140 billion gallons of gasoline.) Melo, who used to be president for U.S. fuel operations for BP, told me the first niche market for Amyris would be tractors and trucks at sugar mills in Brazil in 2010; U.S. trucking fleets and diesel cars would

follow in 2012. In the meantime, the company would be working on a product for military and commercial jets. How much could he produce renewable diesel for? “Our cost in Brazil is about $1.80, $1.85 a gallon,” he said. Transport costs would add another 40 cents per gallon. At the time, the wholesale cost of diesel in the U.S. was around $4 gallon. “So this is profitable venture,” Melo concluded. “By 2012 to 2013, our profits could be higher than many Fortune 500 companies.”

As with most of Kleiner’s green-tech ventures, it was a financial outcome that wasn’t yet certain in a future that wasn’t yet real. And would it even get the chance? There were impediments for sure — Brazil’s regulatory ministries might not like the idea of genetically engineered yeast, or a competitor to Amyris might dominate the market. So maybe it wouldn’t work. Or maybe it would. Melo and I were talking in a conference room with panoramic views of the East Bay. It was hot outside and warm inside; an assistant had brought in water, and the ice was melting quickly in our glasses. Seen out the window, the freeways were jammed. Oil was more than $100 a barrel. But for a brief moment, at least, in the realm of the venture capitalists, this particular idea, like so many of the others I’d heard, seemed bright with possibility, and I understood why Doerr and Gore had given in a little bit to hope. Almost anything seemed possible.

PHOTOS: Off the Grid: Bloom Energy’s fuel cells, a low-emission, “fuel flexible” power source — and one of Kleiner Perkins’s biggest green-tech bets. (pg.MM55); Ausra, a start-up in Palo Alto, Calif., uses mirrors to concentrate solar energy on water pipes to produce steam and, ultimately, electricity. The first installation, in 2011, should power more than 100,000 homes. (pg.MM57); A fermenter in a lab at Amyris, a California company that plans to use synthetic yeast to convert sugar into diesel and jet fuel. The potential market is huge, but its success is hardly guaranteed. (pg.MM58); Miasolé, one of five solar photovoltaic companies in Kleiner’s green-tech portfolio, creates “thin film” solar cells at its factory in Santa Clara, Calif. (pg.MM61) (PHOTOGRAPHS BY MITCH EPSTEIN)

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