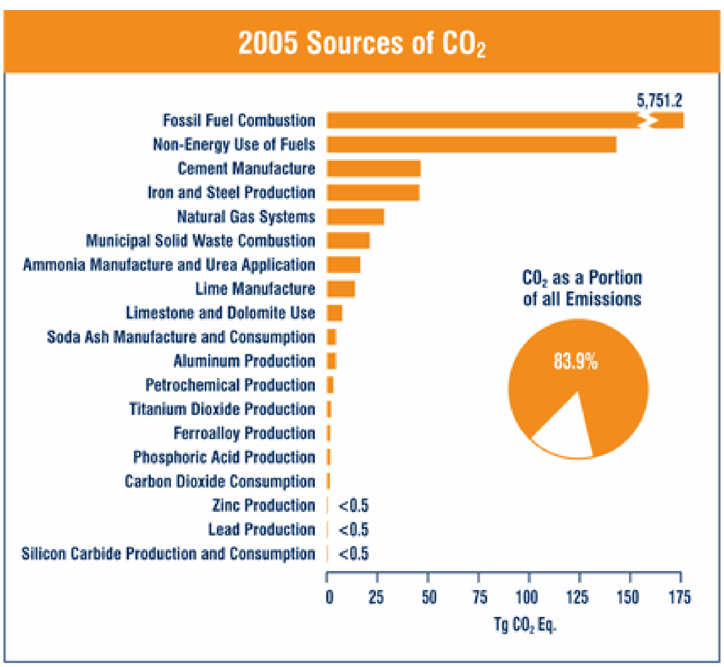
<u>Green Investing Strategies</u>

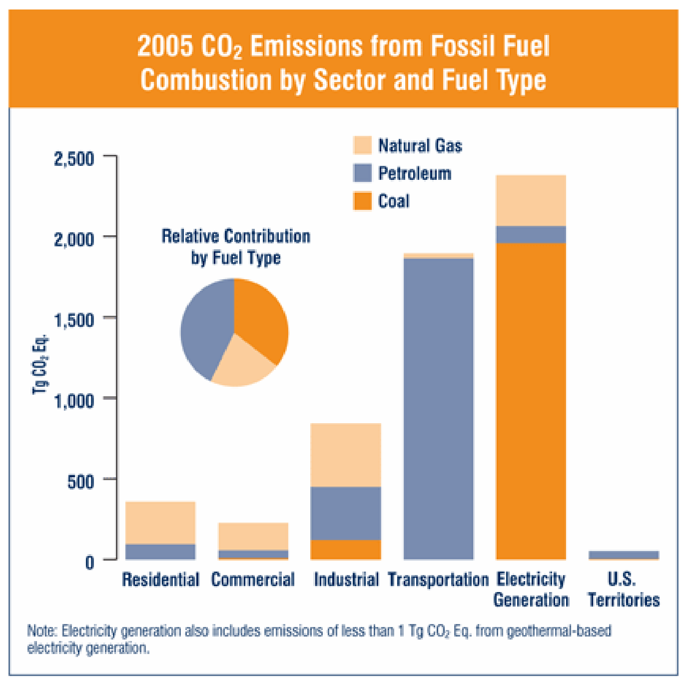
By Vinod Khosla

At Khosla Ventures, we offer venture assistance, strategic advice and capital to entrepreneurs. In particular, the firm helps entrepreneurs and supports breakthrough scientific work in clean technology areas such as bio-refineries , bioplastics, water, materials, solar, geothermal, battery, engines and many other environmental areas. From a green perspective, **there are four major areas of investments that we focus on: (1) oil use reduction (2) cleaning up coal based power generation (3) higher efficiency devices and equipment, and (4)new materials to replace petroleum based plastics, carbon intensive building materials, and clean water.**

Given the basic areas of investments, here we discuss the specific questions that we ask ourselves before any investment – and the rules that we apply in our decision making process. In the following pages, we outline Khosla Ventures' perspective and criteria for differentiating good investments from good, sustainable "climate change" solutions – in particular, detailing the quasi-checklist that we're looking for in any idea. Our goal is to tackle the major carbon dioxide emitters in the US (and the world).

<u>US Carbon Dioxide Emissions - 2005[1]</u>





[1] http://www.epa.gov/climatechange/emissions/images/ES05.gif, http://www.epa.gov/climatechange/emissions/images/EFF05.gif

Khosla Ventures' Rules of Investing

- Attack manageable but material problems
- Technologies that can achieve unsubsidized market competitiveness quickly
- Technologies that scale - If it isn't cheaper it doesn't scale
- Technologies that have manageable startup costs and short innovation cycles
- Technologies that have declining cost with scale – trajectory matters

1. Attack manageable but material problems if the goal is climate change solutions: To be climate change solutions investments must make a significant impact and go beyond being a niche solution. Good investments, even "green" ones are not always good climate change solutions. If we can find workable solutions to replacing coal in electricity generation and oil in transportation (Other areas of interest include lighting, engines, steel, and concrete) we will be tackling more than 70% of US CO_2 emissions (and a similar percentage worldwide). Today, would-be solutions like biodiesel and hybrids are more about making fashionable/environmental statements, as opposed to genuine climate-change solutions (though we should note that hybrids are an improvement on much of the current automotive fleet - and have the potential to be solid investments – we are investing in battery technology). Can they pass the "Mississippi test"? In effect, can we realistically expect the average consumer in Mississippi to pay $10,000 to $20,000 more for a plug-in hybrid? We think that plug-in hybrids are unlikely to be material (50% or more?) part of our automotive fleet in the next two decades. If they do become a large part of our fleet, will the same happen in India and China which are much more cost sensitive? We call this our "Chindia test" and for any solution to be a climate change solution India and China must be on trajectory to adopt the solution. On the other hand, biofuels (if they are cheaper unsubsidized than oil based fuels) can replace oil use. We believe solutions like biofuels have the potential to meet "carbon reduction per mile driven" needs while being a lot more affordable and hence more broadly adopted. Furthermore, with the advent of cellulosic ethanol, carbon emissions will be reduced by up to 80%, even with limited changes in cars or costs. Solutions like Flex Fuel Vehicles (FFV's – that can run on gasoline or E85) offer a material impact in reducing carbon emissions, while being entirely manageable (and cheap – roughly $35 per car) to add to the world's automotive fleets. Combined with the positive trajectories we see for ethanol and cellulosic biofuels as a whole, our investment in these technologies is a bet that material and manageable change can occur within the decade. Biodiesel on the other hand is unlikely to be material, even if it is manageable.

In electric power generation, we agree that Solar PV is a good idea, a good investment (we have investments in this area) but is it likely to replace a material (30-50-80%) portion of our coal powered generation? It seems unlikely as things stand today. There are over 200 million homeowners with self built homes in India that can barely afford a toilet; is it realistic to convince them to pay extra for solar roofs? Similarly, wind technology has significant promise and fairly good green credentials, but the issue with storing energy and generating it on demand renders it as a niche solution and immaterial to climate change. Solar PV and wind are good investments and large markets, but not material climate change solutions. We believe that thermal concentrated solar power (CSP) technology offers the potential to meet our "beat IGCC coal based power generation cost" target technology to materially counter climate change – we see it competing against the various coal technologies (be it IGCC or IGCC+CCS) as the primary means of the western world's power. It can be both material in replacing coal and yet manageable as a solution.

2. Technologies that can achieve unsubsidized market competitiveness quickly (up to 7-10 years): As a rule, we do not invest in technologies that cannot beat fossil prices within 7-10 years in their target application, on an unsubsidized basis (while accounting for an implied carbon cost). A solution must be the most economic solution; else it will not displace fossil fuels. It needs to pass the "Chindia" test – in the long run, solutions that are not adopted for the 2 billion people in these countries (which will be the world's largest economies by 2050) will not be material climate change solutions.

It is important to note that "unsubsidized" suggests a level playing field – the continual presence of billions of dollars in both oil (a 2000 GAO study estimated oil had received $130 billion in subsidies over the past 30 years[2], and there have been significant subsidies after Katrina) and coal subsidies provides a significantly distorting effect that needs to be removed in order to have genuine market competitiveness. Subsidies are a legitimate option to get alternatives started and increase competition, but not when volumes in new technology increase to significant levels. In Germany, the scale of government intervention is significant enough so as to "make the market", as opposed to providing just developmental support .Well, if everyone agrees to pay the much higher electricity rates they pay in Germany for solar power, but that is not pragmatic at a worldwide scale. There

[2] http://ethanolrfa.org/resource/facts/economy

simply isn't enough government money to keep subsidies going when volumes have scaled high enough. Take the example of vegetable oil based biodiesel. Regular biodiesel can compete today because of subsidies but is unlike to achieve unsubsidized market competitiveness. Is it realistic to provide a $1.00 per gallon subsidy when volume is in the tens or hundreds of billions of gallons? Instead, we prefer to look at the flipside – provide enough incentives to generate volume and scale on new technologies (i.e. to get past startup costs), and let the market do the rest. We believe ethanol and some other biofuels will achieve this goal but biodiesel won't. Plug-in electrics will achieve some penetration but will stay below the 10% threshold (and hence be niche solutions). For electric power generation, solar thermal and possibly geothermal technologies will start meeting this criteria and compete effectively with clean-coal based power generation, while solar PV and wind will stay a niche (below 10-15%). We believe PV and wind will eventually achieve unsubsidized market competitiveness; however, in the near term, they are unlikely to do so (primarily because of the storage challenges). We do believe both will be very attractive green investing opportunities.

<u>3. Scalability (and if it isn't cheaper it doesn't scale):</u> Can an idea or a venture go from a garage to powering a nation? The most important factor when we consider climate change technology, is its scalability. Can it be produced and disseminated on a wide enough scale to be material in carbon emissions reduction? With biofuels, a significant factor in estimating its future viability is the availability of its feedstocks. How much land will it use? Will it continue to improve its yields per acre? Can we have consistent, reliable availability as the biofuel scales to commercial production levels? Similar questions must be answered with regards to power production. A limited accessibility and specialized source will lack the ability to scale to meet commercial production needs. A large number of the potential breakthroughs that we see (or are pitched to us) rely on a market niche, and present no opportunity to ever meet 30-50-80% of the world's energy needs in that category. We don't reject the idea that a market exists for niche ideas - they serve a certain willing and able populace, and they are likely to attract capital – but they are not "climate change solutions" (though they may be good investments). The world needs energy solutions that can initially supplement but eventually replace the world's usage of fossil fuels. Personally, we might make investments (wind and solar PV for example) that are not climate change solutions just yet (we address how they could be later) but still make for large enough markets with significant growth potential, thus being justifiable as investments. Without a material change in storage technologies for electrical power, wind and solar are unlikely to be big enough sources to drastically impact coal power plants. In certain regions (wind in the Midwest, solar PV in Arizona) they can materially offset peak load requirements and make economic sense. However, they will not replace the bulk of coal and natural gas consumption for power generation. In addition to being cost competitive unsubsidized, a technology must also be able to scale. Even if biodiesel achieved this low-cost target, its land inefficiency would limit its scalability. We have had (and have now) cost effective geothermal power, but its capacity is limited. For scalability, we need the development of enhanced geothermal technologies to go beyond the 50GW or so of regular geothermal. Unless technology developments enable hundreds of gigawatts of enhanced geothermal, it will remain as a good investment but an immaterial climate change solution. Similarly, wind, despite its cost effectiveness, cannot be more than 10-20% of the electric power supply because of its unpredictability. It cannot meet the needs for dispatchable power at scale unless storage becomes a part of the solution. A solution that is not cheap at a small scale has no real ability to replace current, mature technologies (such as coal), given the widespread dissemination of the latter but beyond being cheap we need it in sufficient scale. Hydro power is available cheap enough but not in sufficient capacity.

4. Technologies that have manageable startup costs and short innovation cycles : Venture capitalists' and startups innovate and take risk. Larger, more established companies generally avoid risk. However, the startups have difficulty in getting the billion dollar projects started. In practice, this criteria is a measure of a given venture/technology to get up and running quickly – the ability to get the first plant operational, in a couple of years (for example, Range Fuels is beginning construction of its 100-million gallon cellulosic ethanol plant in 2008 – just 2 years after its founding). Innovators don't have large balance sheets – they can't build plants if the "cost of proof" is too high.

A quicker innovation cycle gives a venture the ability to seek the advantages that initial occupancy of a market bring – results (whether good or bad) are available relatively quickly. One of the reasons for our skepticism about nuclear technology is that the time for innovations to take effect is extensive – a theoretical fusion power plant is likely to take many decades to make the transition, if it works at all. Even current generation nuclear technology (today's fission and fast breeder reactors) have project timelines in the region of 15 years from conception of a new technology idea to energy generation –a plant that starts producing electricity today is likely using early 1990's technology , as compared to the 15 month cycle time of concentrated solar plants. The latter can go through ten cycles of innovation and improvement in the time frame where nuclear goes through just one. We're looking for the "quicker startup" – one that can startup and go, and then quickly iterate through problems and improvements. These startups aren't waiting around for years or decades in order to receive permits or financing, or waiting with baited breath on the slow decision making of a large company to try their technology. They control their fate, and can exist as profitable, independent entities. Given the transient nature of markets over time (the internet was almost non-existent 15 years ago!), a long innovation cycle offers significantly less flexibility as well as higher startup costs and higher financial risk, which are all significant negatives for a technology.

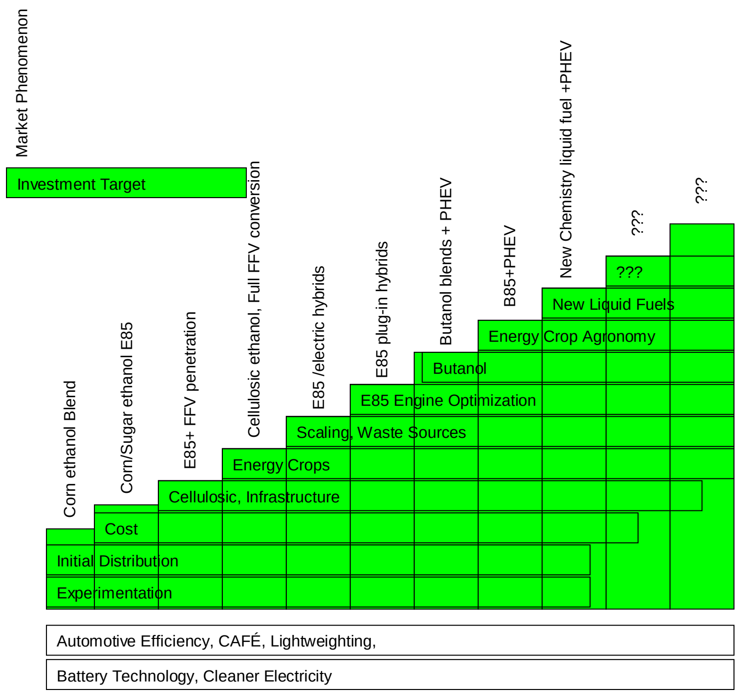
Costs are important aspect of this rule– a new coal plant will cost more than $1 billion, and a new nuclear power plant perhaps double or triple that. At those prices, financing the ideas goes beyond venture capital and into the realm of the capital markets at large. Large project financing and technical risks don't go together from Wall Street's perspective, and this alone can kill a good idea. A project that can get up and running can fix problems and iterate its way to success has a much better chance of realization. For solar thermal technology, we can demonstrate "steam generation" in smaller, repeatable lines without needing to build a large plant. This "risk reduced and proven" steam generation technology can then be deployed as part of a major power plant development because the risk associated with steam turbines (which are used in the majority of power plants worldwide) is well defined. This is the strategy that Ausra is taking - a power source like nuclear technology (to take one example) could not replicate such an approach. IGCC Coal cannot follow this approach and may take 6-12 years to realize depending on whether carbon sequestration is included. For biofuels, we believe corn ethanol dramatically reduced the introduction cycle for cellulosic technology, allowing such ventures access to capital despite their technology risk.

5. Technologies that have declining cost with scale – trajectory matters: Will the trajectory of a given technology lead to dead end in technologies (e.g. vegetable biodiesel) or better and better supply chain, yields, costs, etc like cellulosic ethanol? To take one example, there is a declining cost with scale and technology improvement for cellulosic ethanol. The biomass ecosystem is developing, with new crop rotation practices, better genetics for energy crops, better scale economics, better logistics, farming equipment, better transportation, and handling (to name a few). More importantly, the process technology to convert biomass to fuels is improving in leaps and bounds. This results in declining costs for both the feedstock and the process. The net result is that the ecosystem development drops costs for everyone, and keeps the technology on a positive trajectory with improving competitiveness. Trajectory is vital, often more than other would-be more important variables.

[Quoting from our Wired article - the trajectory that ethanol is on leads to many desirable goals.] *Like Moore's law, this trajectory tracks a steady increase in performance, affordability, and, importantly, yield per acre of farmland. A number of biohols appear along this performance curve, among them corn ethanol, cellulosic ethanol, higher-energy-content butanol, and other biomass-derived fuels that are even more energy-rich than butanol. We'll see fuels with higher energy density and better environmental characteristics, and we'll develop engines better optimized for biohols. Ethanol and the newer fuels will yield better fuel efficiency as innovations like higher compression-ratio engines make their way into vehicles. In addition, we can count on the emergence of complementary technologies like cheaper hybrid vehicles, better batteries, plug-in hybrids, and more efficient, lighter-weight cars.*

Trajectory, in effect, represents an understanding that the cost and performance profile of a given technology now does not accurately reflect its profile down the line – it is one of the reasons that we do not invest in biodiesel, to take one example. The technologies that we have chosen to invest in offer the opportunities for multiple breakthroughs dramatically impacting cost, and various approaches towards the same goal. A large part of recognizing trajectories is also recognizing the likely direction of its evolution and its impact on the technology's competitiveness. Our (sometimes) inaccuracy with predicting the path of technology breakthroughs does not mean that they will not happen. In many ways, the brick "mobile" phone of 1985 fulfilled a similar role to what corn ethanol is doing today - much as we may not have predicted exactly what the phone of 2007 would be like, we could (and did) predict the **degree** of change. Photovoltaic cells have a great cost trajectory with technology improvements but the balance of "plant" has had more limited cost declines. Wind is on a limited "declining cost trajectory" especially as the best wind sites are used up.

As an illustration, the figures below attempt to show how biofuels may "step up" along one possible path of replacing petroleum. A dominant entity in any industry (be it petroleum or coal) cannot be felled in one swoop – rather, we need a series of steps, each building upon the previous and each justifiable on its own economic merits (and thus able to attract private capital). One of the reasons for our support of corn ethanol is that it is the first step along the path below, and is vital in priming the infrastructure for the production, storage, and distribution of biohols on a large stage (as noted, we expect corn ethanol production to level of at 15 billion gallons or so). In contrast, many of the pie-in-the-sky replacements (solar powered cars, hydrogen) fail to recognize that production facilities, distribution networks, and generating demand do not simply appear out of thin air – rather, a technology must show a trajectory that mitigates risk at each step in order to attract the capital necessary.



To be sure, we have some caveats like everyone else - investments where we've been impressed by the technology or the team to a degree such that it overcomes our general investment criteria. We have also funded a few, special "science projects" of sorts as well. Like everyone else, we are open to the idea that "magic bullet" ideas exist – however, we also bet on a diverse set of alternatives when the would-be "magic bullet" is not clearly available. We also invest in technologies in general that are good investments but not climate change solutions, but we try to differentiate between the two.

The chart below provides a quick overview of various technologies commonly cited as climate change solutions, and how they rank as per our investment criteria.

Climate Change Solutions?

	Manageable but material problems	**Unsubsidized market competitiveness in 7-10 years**	**Scalability**	**Manageable startup costs – short innovation cycles**	**Declining cost with scale – positive trajectory**
Clean Coal	Yes	Maybe	High	No	No
Solar PV (without storage)	No	Peak power – Possible Baseload power - No	Low-Moderate (dependent on storage)	Yes	Yes
Wind Power (without storage)	No	Peak power – Maybe Baseload power – No	Low-Moderate (dependent on storage)	Yes	Yes
Nuclear Power	Moderate	Maybe	Medium	No	No
Geothermal	Moderate	Yes	Medium	Yes	Yes
Thermal CSP	Yes	Yes	Medium-High	Yes	Yes
Hydrogen	No	No	Low	No	Probable
Biofuels – Food Crop Based	No	Low	Low	N/A	No
Biofuels – Cellulosic	Yes	Yes	High	Yes	Yes
Plug-in Hybrid Cars	Maybe (25+ years)	No	Low (High in long run)	Medium-Low	Possible (battery limitations)
Storage with Wind & PV	Yes	Maybe	Maybe	Yes	Possible

Our four cornerstones: Oil, Coal, Efficiency, Materials

As noted previously, our focus is on areas where we can make the largest impact towards reducing carbon emissions with sustainable, long-term solutions. In the section below, we walk through each of our areas of investment with an eye towards potential material solutions to climate change and related "green technologies". As a result, the largest chunk of our portfolio is targeted at replacing the two biggest CO2 emission factors - petroleum usage in transportation as well as coal usage in coal power plants. The "War on Oil" details our investments in biofuels, ranging from ethanol to biocrude, as well as 2nd generation future fuels. In the "War on Coal Power Based Generation" we highlight various investments and related technologies that can meet utility-grade power generation needs and serve as coal replacements. In "Efficiency," we address our investments that aim to improve devices and equipment for greater cost-effectiveness and more economical energy usage, by materially changing the demand for oil and coal. Our fourth section, "Materials", outlines our investments in newer versions of basic materials that are environmentally friendly and economical.

"War on Oil"

To displace oil and gasoline use, we're looking towards economical liquid fuels in sufficient volumes that provide the ability to replace the gasoline fueled era – initially, technologies that work with the system at hand (i.e. converting a vehicle to a flex-fuel car for $35, rather than replacing all car infrastructure or adding $10,000 worth of batteries for plug-in electrics) and provide a significant reduction in carbon emissions, cost, and strategic risk (We also have investments that aim to reduce demand - Transonic is using proprietary fuel injection technology to increase the efficiency of gasoline engines by 2X – providing an immediate boost to fuel economy, and cutting consumption dramatically if their technology works). We expect this oil replacement starts with corn ethanol in the US but quickly goes to a cellulosic production technology based on biomass and eventually to cellulosic designer fuels like butanol, cellulosic diesels, and cellulosic gasoline ("cellulosic hydrocarbons"). We see a long term mix of technologies given the large size of the market and specialty uses such as gasoline fuels, diesel replacement, aviation fuels, heating oil and other specialty uses for liquid fuels.

As an overall philosophy with regards to oil replacements, we've looked towards ethanol (and other biohols down the line) because we see it as the best solution that meets our needs. Corn ethanol offers us a starting point towards better, cheaper, and more environmentally friendly fuels, in a way something like classic biodiesel simply doesn't. To revert back to Wired again:

> *"As we migrate from biomass derived from corn to biomass from so-called energy crops like switchgrass and miscanthus, I estimate that biomass yield will reach 20 to 24 tons per acre, a fourfold increase. At the same time, new technologies will enable us to extract more biohols from every ton of biomass, potentially to 110 gallons per ton. The result: We'll be extracting 2,000 to 2,700 gallons of fuel per acre (as opposed to about 400 gallons with today's technology). With better fuels and more-efficient engines improving mileage by about 50 percent, we can safely predict a seven- to tenfold gain in miles driven per acre of land over the next 25 years. Given this biohol trajectory, a future of independence from gasoline becomes not only possible but probable. And the trajectory begins with garden-variety corn ethanol."*

As highlighted above, cellulosic ethanol has significant advantages as a petroleum replacement – because of its ability to scale, and to do so with declining costs. Ethanol can be made from a variety of feedstocks (Some of the technologies use biomass crops like miscanthus, municipal sewage, industrial waste, flue gases from steel mills, and even carbon monoxide) – the principle being that the multitude of technologies and feedstock offer a multitude of opportunities. Municipal sewage is perhaps the most intriguing – a problem that is becoming an opportunity (and one that is not likely to bear any commodity risk anytime soon). There is sufficient municipal sewage and potentially waste to produce tens of billions of gallons of ethanol. Georgia, where Range Fuels is building a commercial-scale cellulosic ethanol plant, could produce 40% percent of it's gasoline needs (2 billion gallons) using forest waste (left on the forest floor today) from the state's timber operations. Forest waste in the southeast alone could produce 13 billion gallons of ethanol – about twice of all corn ethanol production in the US last year. While our estimates suggest 2,000-2,700 gallons of ethanol equivalent fuel per acre, the potential exists to more than double those yields (if certain technical approaches work) in the long run. We see 3,500 gallons or more per acre as a possibility. From a cost perspective, cellulosic ethanol can be produced at $2.00 a gallon using today's technologies. Within five years, we see costs below $1.25 per gallon (2007 dollars) and within a decade, we expect the production costs to decline to $1.00 per gallon, allowing cellulosic ethanol to compete easily with $45 per barrel oil.

Biofuels have three other advantages (as compared to hydrogen or other pie-in-the-sky ideas) that are vital. (1) They do not require a fundamental change in the infrastructure; the distribution networks used for oil can be adapted and evolved to do the same for biofuels. (2) The environmental benefits of cellulosic ethanol are immense, with projections suggesting that it can reduce greenhouse gas emissions per mile driven by 80% over gasoline if it is produced sustainably. The NRDC and the Sierra Club have come out in favor of ethanol (corn as a stepping stone to cellulosic). (3)Biofuels carry a lower commodity risk as compared to gasoline. Oil today (Mar 2008 - $101[3]) is trading almost seven times what it was 8 years ago (trading at approximately $15 in May 1999), and approximately 80% of the world's resources are controlled by government's and state entities as opposed to more predictable profit-seeking private capital. Oil price shocks have been and are likely to be a significant problem for the economy, and we continue directing resources to places where it may not be in our best interests (The Middle East? Venezuela? Sudan?).

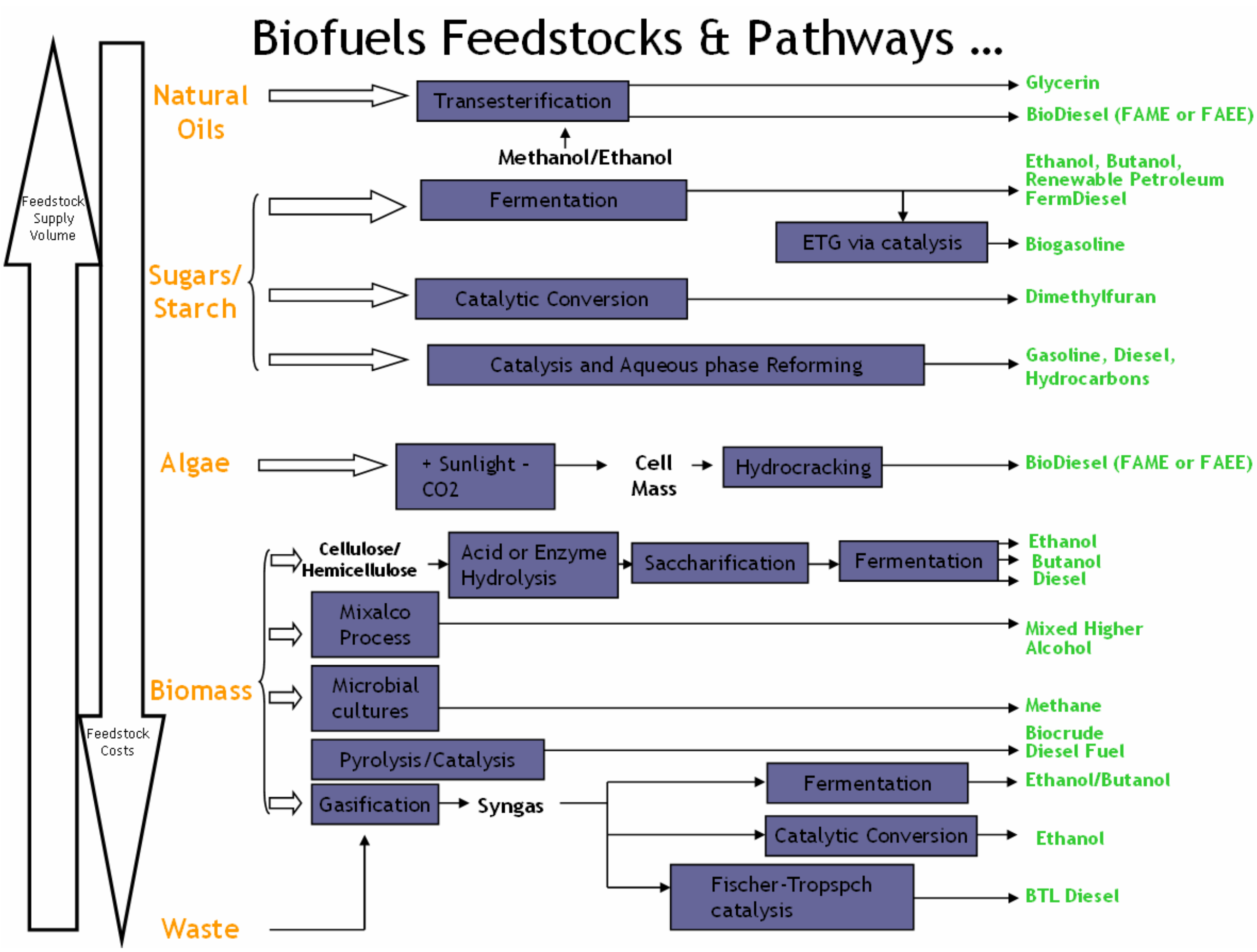
All of our biofuels investments provide what we foresee as legitimate paths towards meeting the country's need for future fuels; their utilization of common feedstocks, low-cost processes, scalable volume, multiple locations, scalable technology and environmental friendliness generally meet our investment criteria. The key reason we believe biofuels can be effective climate change solutions is the scalability and unsubsidized economic viability that can be achieve. A 7-10 fold improvement in miles driven per acre (compared to today's corn ethanol running in a 2007 engine!) is viable as energy crops are optimized and new conversion technologies are developed (as well as newer more efficient engines entering the automotive fleet). Our most critical assumption is on land efficiency – we believe yields per acre will improve 2-4 times from today's norm to 24 dry tons per acre. Our other assumptions are reasonable; achieving a cumulative 50% increase in automotive efficiency over 25 years assumes modest yearly yield improvements of a few percent per year, and our expectation of ethanol yields is an increase of about 25% over 25 years (or less than 1% per year!). Even if the efficiency and ethanol yield assumptions fail, the gains from land efficiency (and thus limited land usage) and general engines will be enough to make biofuels scalable.

Prevalent in all of this is a desire for the technologies to live up to the "green" mandate – all of the biofuels we have invested in have significantly reduced greenhouse gas emissions and cleaner environmental footprints, as a whole). Our investments are not confined to green technologies that are climate change "solutions" – but that is our biggest area of interest. Along this vein of thought,

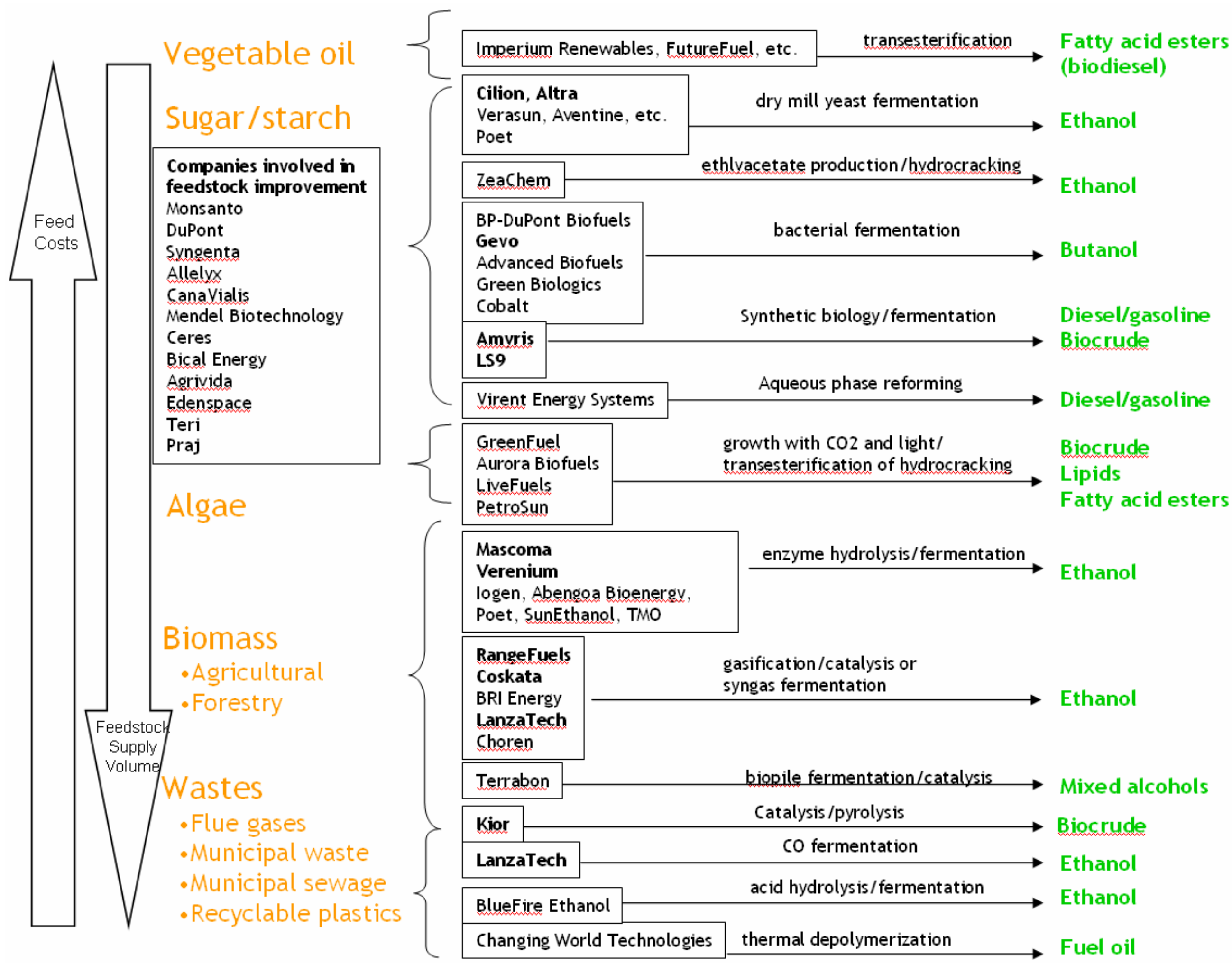
[3] http://afp.google.com/article/ALeqM5hgclL2PZ-HfgGnW_hmB2a2E-gEfQ

we separate our investments into climate change solutions, green solutions, and sustainable solutions.

One significant advantage of the biofuels innovation ecosystem that has already been kick-started is the various approaches, experiments, and technical expertise that are in the biofuels “melting pot” today. While not all of the approaches will succeed, the innovation ecosystem will allow the best methodologies and companies to rise to the top and attract the best talent to the winning technologies. The chart below highlights some of the feedstocks, technical pathways, and resulting fuels that are being developed. These are our weapons in the war on oil and they are getting technologically more sophisticated rapidly.



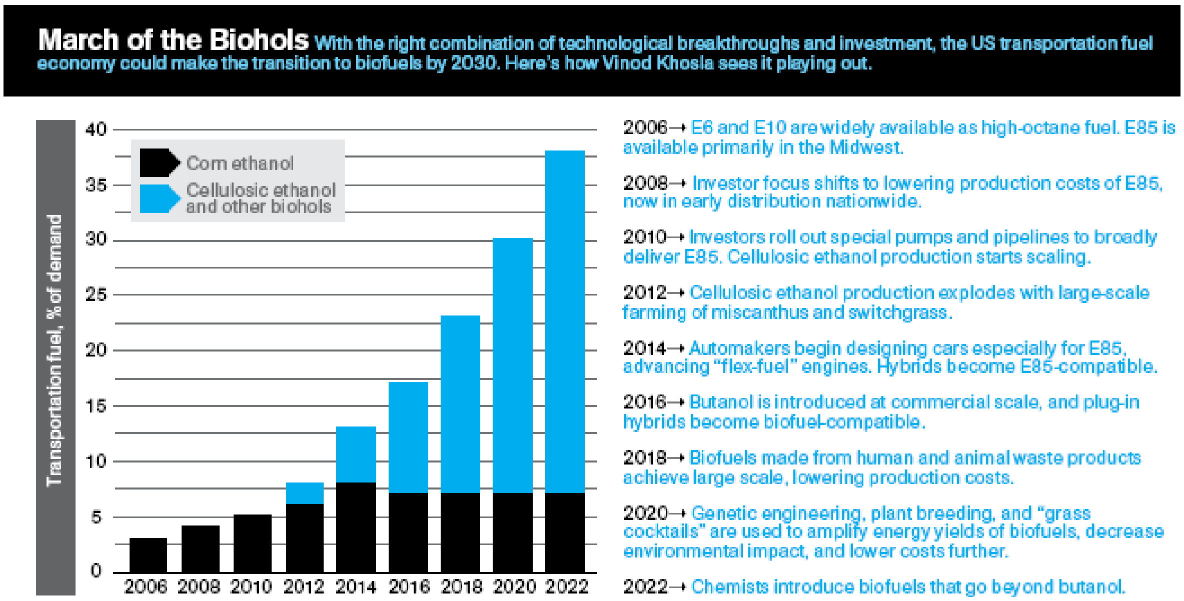
While we highlighted some of the pathways on the previous chart, that is by no means a complete list of what's available. Each of the common pathways (and many of the uncommon ones) has attracted legions of entrepreneurs – we've highlighted some of the companies working on the various pathways below.



Our chosen weapons for the war on oil use a multitude of approaches. Mascoma Corporation is developing biochemical technologies for cost-effective conversion of cellulosic biomass to ethanol using various thermophilic microbes to dramatically reduce the cost of enzymes. Range is about to build the first commercial cellulosic ethanol plant in the US using a proprietary anaerobic conversion technology to produce syngas and heterogeneous catalyst technology to produce ethanol. Coskata is commercializing a fermentation technology for the production of fuel-grade ethanol from syngas. Cilion is building destination ethanol plants, promising to be the cheapest and greenest ethanol from initially corn and incorporating cellulosic technologies as they come online. Hawaii Bio Energy is actively researching sugarcane and other potential fuel crops, processing techniques, and distribution channels for the production of renewable bio-fuels within Hawaii.

Our future fuels follow similar paths. LS9, Inc is combining synthetic biology and cellulosic feedstocks to make petroleum replacements from cellulose, using bacteria. Elsewhere, Gevo is an innovator in the bacterial production of bio-butanol from sugars and cellulose. Amyris Biotechnologies is translating the promise of synthetic biology into industrial production of fermentation diesel and jet fuel from sugars and cellulose. Kior is utilizing catalytic pyrolysis process to cost effectively convert biomass into a biocrude. And finally, LanzaTech is developing a proprietary fermentation technology to convert industrial flue gas from steel mills as a resource for bio-ethanol production. There are other weapons against oil (outside our portfolio) that show significant potential. One company has been founded by a chemical engineer with experience building plants across the world, and has developed an extremely efficient process to convert biomass into diesel.. Some companies in this innovation ecosystem will fail but some will surely succeed, out of this technology based entrepreneurial race we will certainly find something that will be a potent weapon in the war on oil. Most importantly, we believe that the innovation ecosystem will keep surprising us (positively) with new inventions, technologies, fuels, and feedstocks. This innovation ecosystem genie is now out of the bottle- and it will keep working for us. In the chart below, we've highlighted one potential pathway for the evolution of biofuels over the next 15 years.

A potential pathway for biofuels? (note that the graph is more illustrative than predictive)



We acknowledge that are plenty of risks and variables in our projections – it is worth examining some of factors that could go wrong. We're concerned that in the long run, feedstock availability will be the most significant constraint. Additionally, the oil public-relations machine is well-funded and experienced, and the political influence of big oil remains immense. In that vein, continual subsidization of oil by governments further defrays the real costs of oil and makes alternative fuels less competitive. The control of the primary distribution channels and the distribution infrastructure allows the oil industry a lock that could keep ethanol out. It's worth noting that a $4 increase in oil prices means an additional $1 TRILLION in asset value for Saudi Arabia, a country with a smaller population than California! If biofuels start to catch on and replace oil in a material way, its price will decline. We are not naive about how hard they will fight to keep oil dominant , the resources they have at their disposal, or the help they will get from the Exxon's of the world (that do not want to risk hundreds of billions of dollars in profits). To combat this, alternative fuels must have the technology trajectories that allow its costs to decline and compete with oil head-on.

“War on Coal Power Generation”

In electric generation, our expectation is a vastly reduced usage of coal as the primary source of power with a variety of approaches that offer similar, if not cheaper costs (especially with externalities priced into it) and dramatically lower environmental impact. The next decade will be a horse race between the so-called “clean coal” technologies like IGCC power plants coupled to carbon capture and sequestration (CCS) and alternatives technologies like solar thermal and enhanced geothermal power generation. We expect wind, solar photovoltaics (PV) to be specialty solutions that have the potential to supply 10%-15% each of worldwide power (with significant variations between regions) while nuclear trudges along slowly as a power source. We believe that wind and solar PV in particular will be extremely effective specialized energy solutions (and good investments), but we believe that the need for storage systems (such as Compressed Air Energy Storage- for wind or batteries) and higher efficiency solar cells for PV have a vital role to play for these technologies to advance beyond distributed or niche roles. It is possible (and we are hopeful) that the innovation ecosystem could surprise us here. It is assumed by the majority of experts that the majority of the power plants, especially incremental power plant capacity, will be built using clean coal. We believe this will be challenged only by cost effective renewable sources that meet utility needs of minimum cost, dispatchable power and high reliability. It should be kept in mind that even 10% solutions are large markets - wind and solar PV will make for great investment opportunities. PV can grow 10,000% and only be 5% of worldwide electric power. Most analysts expect PV solar to grow at 30% per year for the coming decade.

The question remains – what can we find that can scale to 30-50-80% of our electric supply? We define “PUG power” as power of utility grade that (1) costs $0.07- $0.10 per KWh, (2) is dispatchable predictably when utilities have need for power, and (3) has the reliability and uptime one might expect from a IGCC coal plant. PUG power is essential to make a large dent in the carbon emissions trajectory of coal. It must be more competitive and cleaner than IGCC+CCS to scale broadly and only solar thermal and enhanced geothermal have a high likelihood of competitiveness with fossil fuel based baseload power. We hope that solar PV with batteries and possibly wind with storage will achieve competitiveness but it is hard to predict the timeline today. Peak load power parity is possible in certain regions by 2012 but baseload parity across the nation will take a while. Even module costs of $1.00/watt are unlikely to achieve that. For distributed power in remote locations, parity could be achieved much more quickly. Any would-be replacement has to meet the needs of PUG (power of utility grade) power. When evaluating our investments in this area, we've followed some additional criteria that make more sense given the nature of large utility electrical generation.

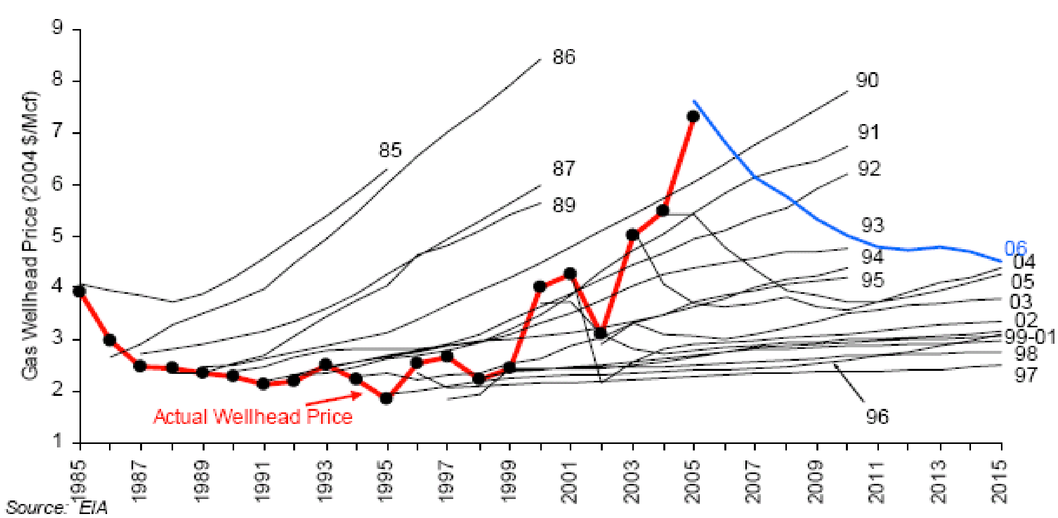
- Cost – CSP power can be produced now at below $100 MWh today in certain regions. It is reasonable to assume that with future R&D and more efficiencies, costs could fall to well below $80/MWh. Dr. David Mills of Ausra predicts that the first 700MW CSP plant will result in generation costs of $0.07 KWh. Once carbon costs are considered, we believe that IGCC will have generation costs of approximately $0.08 per KWh, and IGCC+CCS will exceed $0.10 per KWh.
- Dispatchable power- Predictable "time of day" supply: Simply put, we need an electric power source that can be delivered when the utility customers need power, and that is a predictable source. Power needs to be available when the primary customers (the utilities, and through them the consumer and industrial markets) need it – not simply when it's most convenient for the power producer to generate it – as when the sun is shining or the wind is blowing. Initially, any sort of renewable solution would do well to be able to provide power to coincide with peak loads.
- Capacity Factor- Is the ratio of the net electricity generated to the energy that could have been generated at full capacity at continuous 24 hour full-power operation – or the percentage of the maximum capacity the plant actually produces. For example, a plant running non-stop at full capacity in a period would have a capacity factor of 1, or 100%. Utility "base load plants" are designed to achieve power generation over 65% of the hours in a typical year (there is little demand for power in the middle of the night and a 100% CF is not needed). Some technologies like nuclear generate power when there is little need for power because they cannot be turned on and off easily. They run at close to 100% capacity factor. Others like wind run only when the wind is blowing, typically from 25-40% (in the most attractive wind regions).[4] Is the power available when there's peak demand, or at 4 AM when no one is using it? At the other end, there are lower capital cost and high operating cost peak load plants today (often natural gas simple cycle plants) that are less efficient plants and not economically feasible to utilize unless demand exceeds normal generational capacity ("peaking plants") – any renewable source of energy should offer the potential to offset these plants to begin with in the short term but they need to produce

[4] http://www.awea.org/faq/wwt_basics.html

power during peak demand periods in a predictable and "dispatchable when needed" manner.

- Risk- Solar technology has one clear advantage – there isn't likely to be a shortage of it for at least the next couple of billion years, give or take a few million. As our various presentations have shown, the total space required to power Europe would be equivalent to about 3% of the land of Morocco (A 100 x 100 square mile area in Nevada would power all of the US) – with no supply risk in the near future. In practice, the plants in question would be built as 1 GW or smaller distributed locations as and where they are most needed for base loads (and 100-300MW for peaking plants). From a "green" perspective, solar thermal (CSP) plants have almost no CO2 emissions (and minimal environmental footprints), and are thus a significant step towards meeting our power needs while actively combating the climate change problem. CSP power is reliable (and consistent) enough to meet all contracted needs, irrespective of supply or cost constraints as there are no commodity feedstocks involved. Since they generate steam which can be stored, power can be supplied predictably during cloudy or nighttime periods. For planning purposes, an energy source that is available without price-variability and supply-availability is at a significant advantage and helps its cost-effectiveness/risk profile. As we see with gas prices below – significant price variability can easily render a power source uneconomic. The variability of gas prices below has dramatically reduced the investment value of gas plants built in the last 10 years.

AEO projected natural gas prices versus actual wellhead prices



The Problems with Coal:

The risks and problems with coal are immense – ranging from pollution to transportation, from capital risks to carbon ones. This creates a massive opportunity for alternatives to traditional coal based power generation.

- Environmental: a typical 500MW coal plant generates 3,700,000 tons of carbon dioxide (CO2), as much carbon dioxide as cutting down 100 million trees. Additional pollutants include 10,000 tons of Sulfur Dioxide, 10,200 tons of nitrogen dioxide, as well as carbon monoxide, arsenic, lead, mercury, and cadmium.[5] The same plant can even generate up to 2.6 tons of uranium and 6.4 tons of thorium year after year! The American Lung Association (ALA) notes that a 2004 study attributed 24,000 premature deaths each year due to power plant pollution. In addition, the ALA notes that "research estimates over 550,000 asthma attacks, 38,000 heart attacks and 12,000 hospital admissions are caused annually by power plant pollution (Is coal the next asbestos?). Coal was responsible for 49.8% of the electricity generated in the United States in 2004, but produced roughly 83% of the resulting Carbon Dioxide emissions from electric power generation. On a larger scale, coal is responsible for 34% of total US Carbon Dioxide emissions. In essence, coal plants are responsible for more CO_2 emissions than every car/truck/plane/train in the US, combined. Looking at it another way, the Union of Concerned Scientists notes that one 500 MW coal plant is responsible for as much emissions as 600,000 cars (and we have a 150 new plants planned!).
- Public Opinion: A Carbon tax, or cap-and-trade scheme is inevitable – Today, multiple cap-and-trade proposals exist in the Senate, sponsored by presidential candidates on both sides (John McCain and Barack Obama – S.280). Moreover, even the private sector has come around on the issue – six (including TXU) of the nation's top 10 power companies now support CO_2 cap-and-trade regulation. A 2004 survey of power company executives suggested that 50% of them expect carbon-trading laws in place within the next 5 years. David Crane, the CEO of NRG Energy noted that "I've never seen a phenomenon take over the public consciousness" and that "This is the kind of thing that could stop coal." Gary Serio of Entergy Corp. notes that "It's very likely the investment decisions many are

[5] http://www.ucsusa.org/clean_energy/renewable_energy_basics/public-benefits-of-renewable-energy-use.html

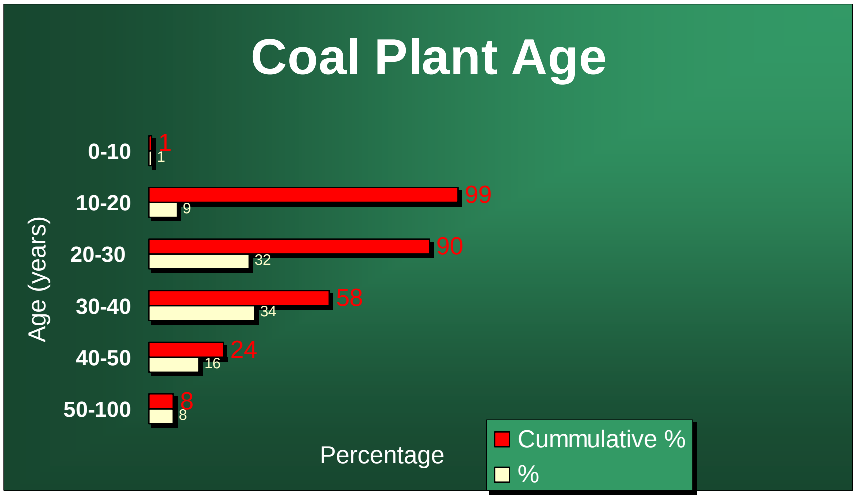
making, to build long-lived high-carbon-dioxide-emitting power plants, are decisions we'll all live to regret." As importantly, public opinion is in favor of taking action to address climate change, and coal has been recognized as a significant part of the problem. In a February 2007 press release, The Global Roundtable on Climate Change (members include NRG Energy, as well as Citigroup and Goldman Sachs) explicitly called on governments to "set scientifically informed targets for greenhouse gases and carbon dioxide (CO_2) emissions" and encourages government to price carbon emissions and set forth policies aimed at energy-efficiency and the "de-carbonization" of the energy sector. The US Climate Action Partnership, whose membership includes Alcoa, BP America, Caterpillar, Duke Energy, Du Pont, FPL, GE, Lehman Brothers, PG&E, as well as PNM Resources in partnership with various environmental groups issued similar recommendations in January 2007 - explicitly stating that any "**any delay in action to control emissions increases the risk of unavoidable consequences** that could necessitate even steeper reductions in the future." The group published *A Call to Action*, which lays out the specifics of the goals, including emissions reductions of 60% to 80% by 2050 – in line with the goals of the IPCC.

- Financial: Coal plants are 50-year, capital-intensive investments – a decision made to build a plant today makes assumptions of the operating environment for 50 years, with limited ability to react to macroeconomic changes. The cost of coal plants being constructed has continued to rise, above and beyond initial expectations – the planned Cliffside plant in North Carolina has seen capital costs rise to $3,000 per kW (including financing) without any provision or estimation of carbon dioxide emission costs. Other plants such as Mesaba, Westar, Big Stone II, FPL Glades, and AEP's West Virginia effort further highlight the trend. Marc Bremmer, head of Innovest Strategic Value Advisors, said that "It's the definition of financial insanity to invest in a new coal plant." (Costs of some recently discussed coal plants are listed below)

Type	Install Date	Capital Cost ($/Kw) – 2006$
B&V Projected – New Coal (SC)	2005	2,120
B&V Projected – New Coal (SC)	2010	2,180
B&V Projected – New Coal (SC)	2020	2,240
B&V Projected – Coal - IGCC	2005	2,750
B&V Projected – Coal – IGCC	2010	2,840
B&V Projected – Coal – IGCC	2020	2,840

Big Stone II, South Dakota (Otter) - PC	Construction starts mid-2008	2,168
Kansas (Westar)– PC	Cancelled	2,333
Springfield, IL – PC		2,500
Cliffside, North Carolina (Duke) - IGCC	Reduced Approval granted	3,000
West Virginia (AEP) – IGCC	Commence ops in 2012	3,500
Mesaba (Excelsior) – IGCC	Review on hold	3,593
FutureGen – near zero emission demo plant	Commence ops 2012 (at earliest)	6,000+

- Referring back to the carbon dioxide taxes mentioned earlier, would-be price estimates of CO2 credits have ranged from $8-10 on the low-end, to close to a $100 on the high end. These are costs that many companies have yet to quantify on their balance sheets. It does not seem out of line to imagine a future where a law requiring firms to disclose their potential future pollution obligations (much like the stock options expensing currently in place) – ahead of any explicit carbon cap-and-trade scheme. Today, this information is rarely gathered by the companies in question – let alone reported. When CO_2 emission credits do appear, even a conservative price estimate will be catastrophic – a $20 per ton CO_2 emission price would increase the price of coal by 2-4X. In addition to the risk of coal itself, there are the costs of transporting coal – prices have risen 20-100% over the last couple of years, and coal is singularly dependent on the railroads. The 2006 EIA Energy Outlook and Modeling Conference notes that in the recent past, railroad transportation contracts have taken on new characteristics, including higher rates, shorter terms, and unilaterally imposed service terms. There is also the commodity price risk of coal itself- coal prices were near 50-year lows from 2000-2004, and have been increasing ever since. As noted above, 10 years of variability in natural gas pricing has drastically reduced the investment value of recently built natural gas plants (built with low-price expectations). Can we imagine the commodity price risk when the asset life (of coal plants) exceeds 50 years?



- Clean Coal is problematic: Much of what has been touted with regards to clean coal is anything but: IGCC is a significant expense, with limited emission reductions (no CO_2 emission reductions!) unless coupled with carbon capture and sequestration (CCS). CCS technology offers potential, but is far from deployment and requires specific types of geological formations (much of the Carolina's where coal is mined does not have suitable geology – and thus any CCS scheme would require the carbon dioxide to be piped elsewhere) and still have the liability of leakage. As per the wedge theory put forth by Professors Socolow and Pacala, burying 1 billion tons of carbon by 2050 (or approximately 3.6 billion tons of CO_2) would contribute one-seventh of the emissions reduction needed in that time. What would this entail? "Lynn Orr, a petroleum engineer who directs the Global Climate and Energy Project at Stanford University, estimates that to store a billion tons of carbon underground every year, the total inflow of CO2 [into the ground] would be roughly equal to the total outflow of oil and gas today." [6] This is a humongous quantity and the logistics of this are almost unthinkable and definitely risky, even if appropriate sites can be found. And the risk of escape is a humongous financial liability.

Conventional wisdom seems to suggest that the widespread availability and low prices of coal make clean coal the only real viable option. We at Khosla Ventures disagree. Solar thermal technology has rapid and cost-effective innovation cycles without any commodity/emission risk, while delivering energy cheaply and consistently, with the ability to maximize production when demand is highest. As previously discussed, we foresee the near future as a horse race between clean coal (whether using IGCC or IGCC+CCS technology), and thermal CSP, the dark horses like

[6] http://www.thenation.com/doc/20070507/goodell

natural gas and nuclear, with useful roles to be played by hydro, wind, enhanced geothermal, and traditional solar PV power.

A word about nuclear and geothermal power – the ability of both technologies to generate electricity continuously (i.e., they are "always on" as a power source) gives them an advantage over technologies that are dependent on storage. As a result, they have the potential to be base-load power replacements. While the cost of generating nuclear-power is relatively cheap, the risks associated with it are enormous – high capital costs, radioactive waste storage, the continual presence of commodity risk (we have perhaps 50 years of uranium left, unless we want to use weapon-grade reprocessed plutonium), as well as the risks of nuclear proliferation. Nuclear technology's long build time and slow fifteen year innovation cycles (versus months for solar thermal technologies) also serve as negatives. Nuclear energy will be part of the horse-race to replace conventional coal, but the risks make current versions of it an unlikely winner in the race.

Geothermal energy is cleaner than fossil fuels, with limited environmental impact for the surrounding areas. Since geothermal energy is generated on a continuous basis (day and night), it is a very good base load technology. The current limitations of geothermal energy are in the number of locations where it can be utilized. However, a recent study (the first in 30 years) has highlighted significant potential for enhanced geothermal energy (EGS) - – in the US, there are **1,250 GW of geothermal resources that could be produced at less than $0.10 KWh**[7] Meanwhile, total US electrical generational capacity in 2005 was 978GW.[8] As a whole, EGS offers significant potential because it can provide base-load power (to potentially work in conjunction with other renewables), produce almost no greenhouse gas emissions, and not be subject to any commodity, transportation, or supply risks (unlike coal). In additional, EGS systems can be scaled up or down to meet a multitude of needs, from serving as distributed power sources to base-load behemoths. We are investing in this next generation "enhanced geothermal" technology, and we believe it can participate in the horse-race.

[7] http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf, Matthew Cline - Black Mountain Technology
[8] http://www.eia.doe.gov/neic/quickfacts/quickelectric.html

Standard & Poor's Assessment of Capital Costs [9]

	Pulverized Coal	Gas (CCT)	IGCC - Eastern Coal	IGCC - PRB Coal	Wind	Nuclear	**Ausra** (KV Estimate)	**Altarock** (KV Estimate)
Capital Cost ($/Kw)	2,438	700	2,795	2,925	1,700*	4,000	3,000	4,000
Total Cost (cents / KWh)	5.8	6.8	6.8	6.5	7.1*	8.9	7-11	5-10
CO_2 Capture Cost ($Kw)	940	470	450	450	-	-	-	-
Cost for CCS (cents/ KWh)	6.2	2.8	3.4	3.6	-	-	-	-
Total cost with CCS (cents/KWh)	**12.0**	**9.6**	**10.2**	**10.1**	**7.1**	**8.9**	**7-11**	**5-10**
Total Cost w/ credits @ $30/ton (cents/KWh)	**7.9**	**7.7**	**8.7**	**8.4**	**7.1**	**9.1**	**7-11**	**5-10**

*S&P notes that there are disadvantages with wind that are not explicitly modeled - high transmission costs (because wind has limited availability), low capacity factors (30-35%), and unpredictability (leading to a greater need for backup/reserve power) and limit wind from serving as a base-load power source.

Having discussed the potential of nuclear and geothermal energy, we turn back to a promising "clean coal" technology. This approach is seen in one of the DOE's pilot programs – SECA (Solid State Energy Conversion Alliance) fuel-cell coal based systems. The goal of the program is to develop and display fuel cell technology for power plant applications to produce "affordable, efficient, environmentally-friendly electricity from coal. The new program leverages the advances made in solid oxide fuel cell (SOFC) technology under the SECA Cost Reduction

[9] Which Power Generation Technologies will take the Lead in Response to Carbon Controls", S&P, May 11, 2007; Jim Harding

program, extending coal-based SOFC technology to large central power generation."[10] The goal of the program is the ability to have more than 50% efficiency in converting the coal to electric power on the grid, the capture of 90% of the carbon contained in the coal and to do this all for approximately $400 per KW (about one-tenth of today's rates), making it competitive with gas turbine and diesel generators. Given that fuel cells are accepted as the most environmentally friendly use of fossil fuels (reducing CO_2 emissions by up to 60% for coal, and 25% for gas powered plants), encouraging their usage leverages our natural resources in a more efficient manner. Bloom Energy, a solid state fuel cell company generates energy from various fuels like natural gas and diesel (and could use natural gas from coal with CCS as a fuel!) The idea of using natural gas from coal is not new, but it has not historically been a cost-effective process We believe that solid oxide fuel cells will be the most cost effective yet environmentally sound way to do distributed power generation and combined heat and power (CHP) versions of the technology will approach 90% efficiency. With further cost reductions, technologies like Bloom may make natural gas based power generation cost effective even for utility applications.

Coal to Natural Gas technology has been discussed before, but has often been underused due to presumed high costs. Great Point Energy changes that, by reducing the number of required steps to produce methane by using a specially developed catalyst to combine gasification, water gas shift and methanation all in a single gasification reactor operating at low temperature. This approach has significant advantages – elimination of the expensive and parasitic oxygen plant, higher efficiency due to lower internal power consumption, and a more efficient methanation process overall. In addition, nearly all contaminants, such as sulfur, nitrogen, arsenic, mercury, and particulates contained in coal and other feedstocks are eliminated or safely removed and recovered as saleable byproducts (e.g., sulfur as elemental sulfur, nitrogen as fertilizer-quality ammonia, mineral matter as a useful road bed material, and CO2 for enhanced oil and natural gas recovery). The GreatPoint technology reduces CO2 emissions by over 10-20% without sequestration versus conventional coal technology (depending on the coal plant and type of coal) due to the ability to utilize highly efficient combine cycle power generation technology. Given that GPE product gas must meet pipeline quality specifications, GPE will always produce a EOR/sequestration-ready stream of CO_2, that can result in emission reductions of approximately 40% (if sequestered).

[10] http://www.fossil.energy.gov/programs/powersystems/fuelcells/

Efficiency

Another target for Khosla Ventures is the improvement of many existing devices by raising efficiencies: a re-thinking of the classic combustion engine, building better homes, better water desalinization techniques, higher efficiency lighting, better batteries (to improve hybrid performance and other uses), and higher efficiency standards as a whole. As with our other areas of investments, we have specific criteria for our efficiency investments. We're looking for large markets ($1 billion plus in size) that have easily accessible distribution channels, that lack entrenched traditional competitors (thus having lower barriers to entry), as well as clear buyer pain points or coming regulation in the market that might spur active changes. We prefer investments with strong IP, as well as technologies that can be adopted to serve multiple markets. In particular, we believe improving engines (as well as motors and compressors) and lighting efficiency are vital in making a material impact on climate change. Lighting utilizes about 22 percent of the electricity consumption in the U.S and only 5% of energy is turned into light; Professor Steve Denbaars notes that if 25% of the conventional light bulbs were to switch to high efficiency LED's or other equivalent technologies (which generate 150 lumens per watt), carbon emissions would be reduced by 258 million metric tons and consumers would save $115 billion[11].

As mentioned before, Transonic is using proprietary fuel injection technology to increase the efficiency of gasoline engines by 2X – providing an immediate boost to fuel economy. Ecomotors is working on developing high efficiency diesel engines that they project at reaching 100 miles per gallon. Tula Technologies is applying digital technology to sharply improve the fuel efficiency of engines in both the existing and future fleet. Elsewhere, Lumenz, Group IV and Topanga are science experiments in solid state lighting. Kaai and Soraa are working on high efficiency GaN based laser diodes. Nanostellar attempts to improve the performance of diesel emission control catalysts. Living Homes is in the process of building cleaner, cheaper, LEEDS qualified homes using a modular system. Seeo is an early science project looking to produce batteries with significantly better energy density than traditional lithium-ion batteries. PAX Streamline is an engineering research and development firm using fluid dynamics modeled on bio-mimicry of natural systems to improve efficiency.

[11] http://news.com.com/2100-1008_3-6132427.html

Materials

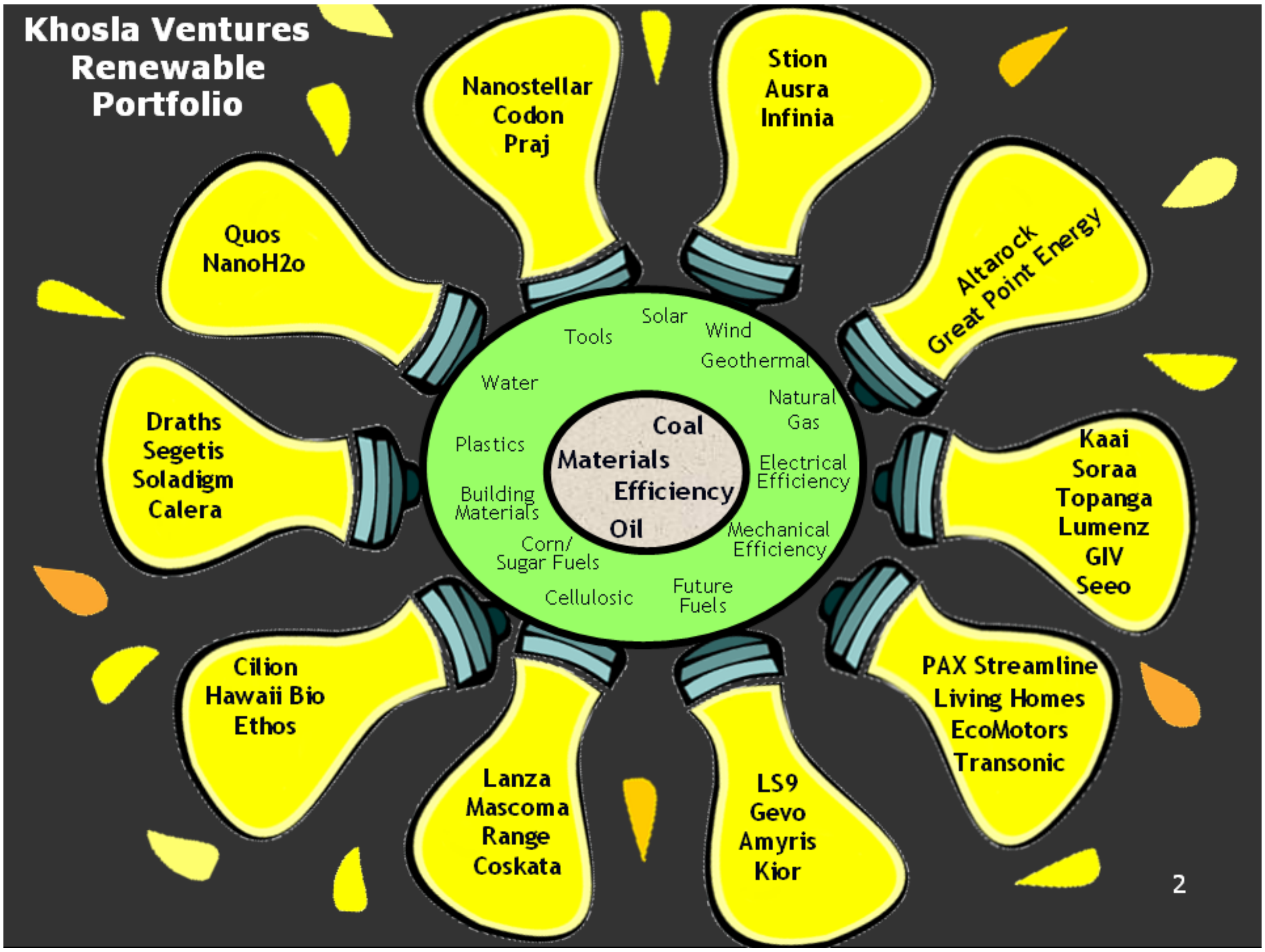
The last of our four key initiatives is improving the basic materials used in everything from construction to plastics. We look at it from an environmental perspective but keeping economic sensibilities in mind: from building renewable (and hopefully biodegradable) plastics, having greener and more energy efficient cement, to supplying clean water. In terms of material climate change solutions, we're looking at greener and less energy intensive cement manufacturing (1 ton of cement results in approximately 0.5 tons of CO_2 emissions[12] (up to 0.8 worldwide) - it was responsible for approximately 1.8 billion metric tons worldwide[13]) and better building materials. We're also increasing our focus on increasing the availability of clean water through improved desalination techniques to mitigate the effects of climate change (melting glaciers affect a significant portion of our freshwater supplies), while substantially reducing the energy used in desalination.

Calera is developing new, environmentally-friendlier cement for use in construction. Soladigm is developing a new, switchable electrochromic glass technology that will be utilized for highly energy efficient windows thus reducing electricity usage. We are also focused on water purifying technologies and renewable methods to produce industrial chemicals. NanoH20 is developing proprietary membranes for existing reverse osmosis desalination plants which will increase flow and reduce energy usage by at least 50% while reducing the cost of water. Quos is developing a proprietary process for water desalinization which in the lab shows advantages over reverse osmosis. Segetis is developing a variety of bio-based chemical products using renewable agricultural and forestry feedstocks. We're also looking at tools that can help technologies scale and accelerate the pace of innovation. PRAJ, a public company based in India, has built over 300 plants in 30 countries and has global scale execution capability. It is working to provide technology and design engineering for ethanol plants across the world.

[12] http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html
[13] http://www.iea.org/Textbase/npsum/tracking2007SUM.pdf

Khosla Ventures Renewable Portfolio

Below, we have an illustration of our strategy in action – our "green" portfolio consists of approximately 30 companies. Descriptions can be found in Appendix A.



The Role of Wind, Solar PV, BioDiesel and Hybrids

Wind is a wonderful technology and a great investment. It is very appropriate for certain locations and would benefit a lot from a national high voltage electric grid so it could be transported to where it is needed (as would all sources of electricity, renewable or not). It is a classic technology that started with high costs but was on a rapidly declining cost trajectory and is now cheaper than fossil power generation in some locations. The devil lies in the details; power is only available when the wind blows and storage is difficult and expensive. Compressed air energy storage (CAES) offers one potential solution to the "storage" problem, but the technology is still in the early developmental phase. Most utilities don't need power in the middle of the night but are forced to take it today. It is "off and on" power generation at highly variable levels, though it can be averaged across multiple locations. In the short to medium term, it is unlikely to scale beyond about 10-20% of our grid electricity needs partly because of its high variability and other technical issues. That is a good step, but not nearly enough (by itself) to wean the global power generation system away from coal. Nonetheless, we are intrigued by the potential of developments such as new, more efficient turbines, or even potential new storage technologies (such as CAES).We believe the market will grow significantly by 2020 – hence, it clearly offers good investment opportunities. However, we don't believe that wind alone is a material climate change solution till such time that low cost electricity storage is available. Our focus in the wind area is on flow cell electric storage.

Solar photovoltaic (PV) cells and the vision of self contained homes with PV on their roofs are a great dream and less variable (more predictable) source of electricity than wind power. However, today its costs are higher than that of wind power. Solar PV makes sense in many remote locations and in areas where peak sun coincides with peak power demand. This is true of many parts of the US (and the world). But grid independent homes powered by solar power alone are blue sky dreams. Unfortunately, while a small percentage of the populace may be willing to live without power when the sun is not shining and enjoy the romance of sustainable living – most people want 24 hour power. Currently, the 2-3X greater capital costs of solar photovoltaic (as compared to CSP technology) and the fact that we will still need the grid investment makes it expensive. We will still need what the utilities call "spinning reserve" power plants (and their associated capital investment which somebody will have to pay for), so that a rainy day or week doesn't cause us to miss out on our NFL. Solar PV without battery storage can grow dramatically and can be a great investment, but is unlikely to meet PUG power needs of $0.07/KWh and dispatchability. Khosla Ventures has investments in solar PV technologies –we think they offer the potential for rapid market growth. The market is so large that a 10,000% growth in the market will make PV about 5% of worldwide electric generation. Our bet is on solar PV cells that have improved efficiencies resulting in reduced total system costs, rather than a race to the lowest cost lower efficiency panels. Overall, we view solar PV cells as a great investment opportunity in a very successful and fast-growing and large niche within the overall electricity market, but not a climate change solution unless electric storage breakthroughs happen.

What will solve the storage bottleneck and allow PV and wind to compete for PUG power needs? We think that the advent of technologies such as flow-cells will make solar PV and wind viable options for PUG power, once we reach capital costs of $250/KW and costs of $75/KWh for flow cells. At this level wind and solar power can start to be predictable yet economic sources of electricity. In our estimation, we can achieve this within the decade, and we are looking at opportunities within this segment. In summary, both PV and wind technology have a few significant steps and additional risks (primarily the storage issue) before they become full-scale commercial technologies. Nonetheless, even before the widespread availability of fuel cells, there will still be significant specialty markets for wind and PV. By any metric, solar and wind technology both present large and significant opportunities, even if they don't meet all mainstream utility power needs (yet). Again, both wind and solar PV highlight an important point: only when we meet utility grade power will green technologies start to replace fossil electricity at any scale.

Biodiesel is an environmentally friendly fuel, much in demand for all of Europe’s cars. It has a substantially better energy balance than ethanol, causes a dramatic reduction in carbon emission per mile driven relative to petroleum based diesel, is 100% renewable, and it can go into existing diesel engines without modifications - so what is there not to like? Nonetheless, Khosla Ventures has not been investing in this great fuel. From our perspective, vegetable biodiesel is an uncertain investment. One of our primary reasons for this belief is that even though it’s currently greener than ethanol, it appears to violate one of our key rules for “climate change” solutions – a positive long-term trajectory. Trajectory matters – it represents the understanding that a technology’s profile now does not always reflect its profile in the long run. For classic biodiesel, neither the trajectory of land efficiency nor cost per gallon is positive. Therefore, we have come to the conclusion that the current approaches are non-economic, subsidy dependent, spot solutions for overall diesel replacement.

Classic biodiesel has a few significant problems: (1) it fails to be good climate change solutions because of land inefficiency in gallons produced per acre, hence failing the scalability test. The government should not be spending our tax dollars on a non-scalable technology unless the incentives are directed towards cellulosic diesel which is more scalable. (2) There are consistency problems when utilizing different feedstocks (soy, palm oil) resulting in biodiesel with varying properties, quality, and consistency. At the Alternative Energy NOW conference in February 2007, Teresa Alleman of NREL reported that 50% of the B100 samples they tested from around the country failed the ASTM D6751 standard (although this survey was not volume weighted). This is a major impediment in persuading car/truck companies to warranty an engine for them (3) It fails the investment test because it fails to achieve unsubsidized market competitiveness within 7-10 years and is uneconomic if oil prices decline to $45. It should not be attracting capital. (4) It is a technology that does not have declining cost with technology improvements and hence does not have declining risk (5) The business models do not work unsubsidized. A good trajectory on technology, cost, and land efficiency is key to this – classic biodiesel fails on all counts. The last two reasons suggest that investors interested in this market should direct investment to the cellulosic hydrocarbon technologies that will benefit from the lower cost of the energy crops ecosystem as it develops.

	"Classic" Biodiesel	Ethanol	Cellulosic Diesel
Carbon Reduction – 2006	80%	20-30%	Not Available
Carbon Reduction – 2010	80%	80%	80%
Scalability (2030-gallons per acre)	600-900	2,500 (cellulosic)	2,500 (cellulosic)
Sustainability Potential (2030)	Poor	High	High
Product Quality	Poor	Good	Good
Unsubsidized 10yr Market Competitiveness Potential	Poor (@$45 oil price)	Good (@$45 oil price)	Good (@$45 oil price)
Production Cost (2010)	High	Med-Low	Med-Low
Technology	Static	Active Development	Nascent

Hybrids have recently received significant media attention as potential climate change solutions. We disagree – in the near future, we think they are limited to a niche role. A common media refrain on corn ethanol is that its environmental benefits are "limited", and that its adoption has more to with politics than science. Meanwhile, hybrids-vehicles have captured the media imagination as an environmentally friendly technology – even though corn-based ethanol offers the same "carbon emission per mile driven" benefits (in a flex-fuel vehicle) as the usage of hybrids, at $1/100^{th}$ the cost per car.

Car	CO2 emissions – grams/ mile	Monthly Cost (Car+Fuel)
Toyota Prius - (1.6kwh, $21,200)	238	$490
Toyota Corolla -(Hypothetical FFV ,Cellul E85, $14,500)	88	$490
Honda Civic Hybrid - (On Gasoline, $22,600)	260	$524
Honda Civic - (FFV – On Cellulosic E85, , $15,110)	260	$372
GM Volt (16kwh, $30,000) - Electricity	144	$623
GM Volt - (16kwh, $30,000) - Cellulosic E85	55	$641
Public Transportation – US “Heavy Rail” (Subway) System	157	N/A

Hybrids and Plug-In Electric Hybrids (PHEV’s) are extremely expensive solutions and are not likely to achieve sufficient penetration to be material– especially in India and China (two of the largest and fastest growing markets). More efficient batteries are vital to the growth and development of hybrids; however, batteries are not showing the same rapidly improving cost/performance curve as other technologies. This is a significant area of investment for us.

The Role of Policy

It’s worth acknowledging the role that public policy has in creating and defining markets (for better or for worse at times) – and our investments reflect that belief to a degree. Politics can create markets through mandates. It can make technologies cost effective (through incentives, subsidies, production and investment tax credits). It can be used for good and bad purposes and generate business profitability or foreclosures. For example, we believe a Renewable Fuels Standard (RFS) of some level is needed (and likely), along with the likely passage of higher CAFE standards and the eventual adoption of some sort of carbon taxation scheme. Another important regulation is the implementation of a federal renewable electric power standard (RPS), similar to the various state-wide programs and a complement to the RFS liquid fuel standard. This will have the effect of encouraging further investment in renewable energy sources. A federal RPS would also act as a market signal and guarantee of market size, helping all renewable power generation technologies.

At a macro level, one significant problem for all of these energy technologies (especially newer, less capitalized ones) is the inability to take energy from alternative energy sites to load centers where the power is used. Our proposal is a high voltage DC grid akin to the national highway system, with government capital to throw open the doors to private initiative. DC grids have significant advantages – they can carry higher power loads and reduced line losses and costs. Similar to the concept of toll roads, such a grid could in effect, rent out its capacity to the various power solutions while not subjecting any one source to the complete capital risk, and without being accused of "picking winners." Such a grid is a national imperative and a boon to all (renewable and conventional) power generation technologies.

We understand that the "Saudi Arabia" of coal (as the U.S has often been described because it has the world's largest coal reserves) is unlikely to wean itself of coal completely – politics will always play a role in determining the specificities of a given market place. At the federal level, we need to kick start the alternatives that exist . Managing to these expectations, regulations, and political realities remains another factor in our strategy for a cleaner future.

Conclusion

Our faith in the innovation ecosystem is an important reason for our belief in the eventuality of an environmentally friendlier and yet cost effective future – and the transition period has already begun. There are lots of new areas and the best and brightest scientists, technologists, and entrepreneurs are being attracted to the field. We do make an effort to separate good investments from climate change solutions – clearly, the latter set is a subset of the former. We are constantly funding a wide variety of ideas and principles – and are attracted to the idea of technology disrupting comfortable, cozy markets that have failed to innovate. Our role is less as exit-seeking investors and more as company builders and mentors (we wish to be to entrepreneurs what McKinsey is to the Fortune 500 companies), nurturing the brilliant ideas into workable, economically viable, and genuinely material solutions.

Appendix A:

Corn/Sugar Fuels:

Cilion: Cilion is building destination ethanol plants, promising to be the cheapest and greenest ethanol from initially corn and incorporating cellulosic technologies as they come online.

Hawaii Bio: Hawai‘i Bioenergy’s mission is to determine the feasibility and viability of locating and operating integrated ethanol bio-refinery plants in the Hawaiian Islands.

Ethos: Ethos is developing sugarcane and cellulosic biofuels in Latin America (excluding Brazil.

Cellulosic Fuels:

Range Fuels: Range is building the first commercial cellulosic ethanol plant in the US using a proprietary anaerobic conversion and heterogeneous catalyst technology.

Mascoma: Mascoma Corporation is leading the development of proprietary bioprocess technologies for cost-effective conversion of cellulosic biomass to ethanol, drastically reducing the need for external enzymes.

Coskata: Coskata is commercializing a fermentation technology for the production of fuel-grade ethanol from syngas.

Lanzatech: LanzaTech is developing a proprietary fermentation technology to convert industrial flue gas from steel mills as a resource for biofuels production.

Future Fuels:

LS 9: LS9, Inc., the Renewable Petroleum CompanyTM, is combining synthetic biology and cellulosic feedstocks to make petroleum replacements from bacteria using fermentation.

Gevo: Gevo is developing technologies for the bacterial production of biobutanol from sugars and cellulose.

Amyris: Amyris Biotechnologies is translating the promise of synthetic biology into industrial production of fermentation diesel and higher alcohols from sugars and cellulose.

Kior: Kior is using its patented Biomass Catalytic Cracking (BCC) process to convert biomass into a bio-oil useable as crude oil.

Efficiency:

Transonic: Transonic is using proprietary fuel injection technology to increase the efficiency of gasoline engines.

Ecomotors: Ecomotors has a uniquely designed diesel engine that can generate significantly more power while utilizing less space.

Tula Technologies: Tula Technologies is applying digital technology to sharply improve the fuel efficiency of engines in both the existing and future fleet.

Pax Streamline: Streamline is an engineering research and development firm using fluid dynamic modeled on a natural system to improve efficiency.

Living Homes: Living Homes builds greener, cheaper, LEEDS qualified homes using a modular system.

Group IV Semiconductor: Group IV Semiconductor is an experiment in solid state lighting.

Seeo: Seeo, an early stage company is developing polymers that allow them to develop batteries with high energy density and high cyclability.

Kaai/Soraa: Kaai and Soraa are working on high efficiency GaN based laser diodes.

Lumenz: Lumenz is developing high efficiency Zinc Oxide based LED's.

Topanga: Topanga is working to develop better high intensity discharge lighting.

Electrical Power:

Ausra – Ausra is developing Concentrating Solar Power (CSP) power stations, which uses the heat of the sun to drive steam turbine power stations, and produce renewable power at low cost.

Altarock: Altarock develops and commercializes enhanced geothermal technology (EGS) for producing 100% clean, renewable baseload power.

Great Point Energy: GreatPoint Energy is commercializing a process for converting coal into high value clean, pipeline quality natural gas.

Stion: Stion is a 4^{th} generation photovoltaic company developing high-efficiency, low cost thin-film modules.

Infinia: Infinia is developing proprietary stirling-engine technology for concentrated solar power and other applications.

Tools:

Nanostellar: Nanostellar's Rational Catalyst Design methodology unites two disciplines – computational nano-science and advanced synthetic chemistry – to speed the pace of development for nanoscaled catalytic materials for diesel emissions control.

Codon Devices: Codon Devices is focused on enabling commercial applications of synthetic biology.

Praj: PRAJ, a public company based in India, has built over 300 plants in 30 countries and has global scale execution capability. It is working to provide technology and design engineering for ethanol plants across the world.

Water:

Quos: Quos is developing a proprietary process for water desalinization which shows many advantages over reverse osmosis.

NanoH20: NanoH20 is developing proprietary membranes for existing reverse osmosis desalination plants which will increase flow and reduce energy usage while reducing the cost of water.

Materials:

Soladigm: Soladigm is developing a new, switchable electrochromic glass technology that will be utilized for highly energy efficient windows.

Calera: Calera is developing new, environmentally-friendlier cement for use in construction.

Segetis: Segetis is developing a variety of bio-based plastics using renewable agricultural and forestry feedstocks.

Draths: Draths uses biotechnology and chemistry to convert renewable resources to industrial chemicals.