

Cleantech Redefined

Why the next wave of cleantech infrastructure, technology and services will thrive in the twenty first century

After years in development, cleantech infrastructure, technology and services are now going mainstream. Cleantech is revolutionizing how we make, grow, transport and consume things. It's helping the world meet energy demands. It's creating livelihoods and prosperity in uncertain economies. Is there still time for investors to make good returns in cleantech? Yes. Here's why.



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Foreword

The global economy is undergoing a tectonic shift as the demand for energy moves from developed to emerging markets, a growing population and a burgeoning middle class continues to deplete already strained natural resources, and climate change creates superstorms, megadroughts and wildfires that impede business and cost billions in damages. These are among the most important driving forces behind the increasing demand for greater efficiency, less waste and ‘cleaner’ inputs across the entire global economy.

These market forces have led to an inflection point for cleantech and are now pushing it into the economic mainstream. Cleantech has had growing pains and technology failures, but there have also been successes and lessons learned. This volatility, common in new markets, has ultimately strengthened many of the companies described in this report. They have built more resilient management teams and more sustainable business models that are now ready to fulfill the market demands of the 21st century and beyond.

Historically, investors’ perception of cleantech was limited to clean energy. However, growing investments in clean infrastructure, technology and services are being made across all sectors of the economy, including storage, efficiency, water, clean industry, transportation and more.

This report is intended to be a framework to help investors understand the vast opportunities that currently exist to deploy capital into these growing markets that are responding to unprecedented economic drivers. The market trends and companies discussed build efficient products that provide more output for less, harness the power of information and modern engineering and tap the infinite power of the wind and sun. They do this while reducing the growing systemic risk of generating energy with diminishing and polluting commodities, the extraction of which is increasingly difficult and costly. Cleantech investments also have the potential to have a positive impact on people in emerging markets, provide jobs in cleaner, safer industries and expand sustainable access to energy.

We encourage you to use this report as a starting point to enable your portfolio to take advantage of these growing opportunities and to build a more sustainable economy while providing strong risk adjusted returns for long-term growth.

Now is the time to go long on the future.

Andrew Behar, Chief Executive Officer, As You Sow

Dan Apfel, Executive Director, Responsible Endowments Coalition

Cleantech is now everywhere, and poised for even more rapid expansion.

Executive summary

The global economy is undergoing a fundamental change. Companies are under increasing pressure to produce and consume more efficiently. This pressure is creating innovation and, above all, opportunity in cleantech.

In recent years, the cutting edge of cleantech has received outsized investment and headlines and weathered the challenges of outsized expectations. It will continue to provide solid returns in the medium and long-term. The more important story is that of the steady, iterative advancement of products and services that improve the efficiency, waste profile and manufacturing cost of existing analogs, but are not market disruptors. This type of cleantech is becoming ubiquitous—from cheaper, more efficient lighting to advanced heating software. Cleantech in all of its forms is poised for even more rapid expansion, especially now that the largest companies in the world have discovered the opportunity and imperative of cost savings.

Reflecting these trends, capital is being invested in cleantech products and services by a variety of sources, from venture capital to cities, businesses, states, universities and individuals, among others. In 2012, cleantech attracted nearly a quarter of the venture capital (VC) available, capturing \$6.4 billion,¹ of nearly \$26 billion in VC investment across all sectors.² Adding to this, the world's largest companies are now buying their way into cleantech. Large cap firms are acquiring cleantech companies in an effort to build the portfolios of clean products and services required to remain competitive and modernize their current offerings. These are impressive achievements for an 11 year old category. What will the next decade hold for cleantech as companies rush to take advantage of new efficiencies and opportunities for bottom line improvement?

The good news is that investors haven't missed a bull run. Cleantech will continue to happen in big ways. Disruptive technologies will continue making old sectors obsolete, while well-known brands, products and companies will adopt clean technologies and products to improve their balance sheets and investors' bottom lines. The pragmatic, undeniable opportunity for savings and efficiencies that are driving cleantech's adoption today will continue to propel mass market acceptance and mainstream adoption. Fundamental drivers of change—from growing resource constraints to consumer demand—will also continue to move the market in this direction. Finally, cleantech is starting to add value at the macroeconomic level and is becoming a significant source of jobs and tax revenue for regional economies.

This paper presents the recent investment research currently available on clean infrastructure and technology investment. We have synthesized research across a number of industries and major impact areas, identifying key value drivers and market size projections for these industries. We have also included examples of products and technologies currently on the market. Finally, we highlight various large, mid and small cap firms and funds as possible points of entry for institutional and individual investors within each industry.

It's an exciting time to be investing in cleantech. The opportunities are lucrative and vast, and the potential for growth is extremely promising.

¹ Cleantech Group. "Quarterly Investment Monitor 2Q13", July 2013

² U.S. National Venture Capital Association. "MoneyTree Report", January 2013

The cleantech story

Redefining cleantech

Clean technology (or "cleantech") is an investment theme spanning many industries. It can be described as new technology and/or related business models intended to provide a diverse range of products, services and processes that use renewable materials and energy sources, while reducing the use of natural resources and cutting or eliminating emissions and wastes. It also aims to provide superior performance at lower costs.³

Institutional investor consultancy Cambridge Associates defines cleantech as "an umbrella term for a wide range of technologies and services," and it includes "companies and projects in cleantech if they develop non-fossil fuel energy sources, promote industrial efficiency by conserving resources and replacing existing processes with less-polluting alternatives, recycle waste effectively and efficiently, or provide a product or service that creates an environmental improvement."⁴

Since cleantech is the business of achieving these fundamental goals across a range of sectors—including technology, health care, energy, transportation, housing, utilities, telecommunications, agriculture and more—perhaps the best definition for cleantech is as an investment theme akin to "growth," or "value" in public equities. It is an "overlay" of investment decisions focusing on technologies that are additive to bottom lines on the basis of what they do.

Cleantech is a relatively new investment theme, only dating back to 2002.⁵

Cleantech's many drivers

Economic growth and sustainability are interdependent. With finite natural resources, ballooning population growth, increased urbanization and ageing and inadequate infrastructure, the status quo cannot be maintained and the value of investments cannot be preserved into perpetuity. Instead, companies have to respond to the need for cleaner, leaner and more sustainable products and services that will provide the best long-term shareholder value.

Cleantech's fundamental drivers are intact and fundamentally reshaping the future. The main drivers of markets for cleantech products and services include:

- Overall **population** is still expected to increase rapidly, to 9.3 billion by 2050⁶, mostly in developing regions of the world, further increasing pressure on limited resources, increasing supply challenges and creating price instability.
- As developing countries industrialize rapidly, global demand for resources is predicted to increase dramatically, leading to **increased resource scarcity**. Businesses are likely to face more trade restrictions and intense global competition for a wide range of resources that become less easily available. Scarcity also creates opportunities to develop substitute materials or to recover materials from waste.

³ Synthesis of definitions of cleantech from Kachan & Co. and Clean Edge

⁴ Cambridge Associates. "Clean Tech Company Performance Statistics", March 2013

⁵ The blog Cleantechblog.com authored what is commonly agreed to be an authoritative history of cleantech. See: <http://www.cleantechblog.com/what-is-cleantech>

⁶ United Nations. "World Population to 2300", 2014. See: <http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf>

Cleantech is an umbrella investment theme for a wide range of technologies and services.

- Increasing **urbanization** has a direct impact on how we consume resources. For example, it increases demand for electricity and leads to more stress on energy grids. By 2030 all developing regions including Asia and Africa are expected to have the majority of their citizens living in urban areas.⁷
- **Energy and resource independence** have long been strategic imperatives for many countries. Long term access to sources of energy and raw materials such as oil, minerals, metals and biomass become more acute for economic security as populations rise, energy-producing regions destabilize, supplies dwindle and national security becomes an increasing priority. Biofuels are being sought by military forces worldwide today in an effort to ensure continued national security.
- **Climate change** is a force that will exacerbate many of these drivers. Eleven weather-related disasters cost the U.S. \$110 billion in 2012.⁸ Moreover, predictions of annual output losses from climate change range between 1% GDP per year, if strong and early action is taken, to at least 5% per year if policymakers fail to act.⁹
- Consumer desire for cleaner, less toxic products has changed purchasing patterns and driven the creation of new materials. Americans are now integrating **green products** into their lifestyle, with 71% now considering the environment when they shop and 45% seeking environmental information about products they buy.¹⁰
- **Changing policy and regulatory requirements** designed to address the impacts of an increasingly industrialized world—including air pollution, water pollution, loss of habitat, climate change and resource competition, among others—influence many investments and projects. The aggressiveness of national policies influence investment trends, so while some contemplate their cleantech policy support (like the UK and U.S.), some are even today aggressively supporting new clean technologies (like China, Japan and South Korea).¹¹
- In the face of growing constraints and increasing prices, corporations and consumers are seeking increasingly **efficient ways to cut costs and increase efficiencies**, especially in periods of declining revenue. As such, demand for technologies with high return on investment (ROI) and quick payback periods will increase.
- The number of relatively **wealthy** people (the middle class, essentially) is expected to increase. Individuals with more disposable income find themselves wanting to acquire more products, which grow scarcer.
- **Risk mitigation**, as detailed in the next section, is also an important driver of cleantech infrastructure and innovation.

⁷ United Nations. Above Ibid.

⁸ U.S. National Climatic Data Center's (NCDC). "Billion-Dollar Weather/Climate Disasters", 2012. See: <http://www.ncdc.noaa.gov/billions/>

⁹ UN Habitat. "State of the World's Cities 2010/2011 – Cities for All: Bridging the Urban Divide", 2010

¹⁰ Cone Communication. "2013 Cone Communications Green Gap Trend Tracker", April 2013

¹¹ Green Alliance. "The Global Green Race", August 2013

To achieve our economic and environmental objectives, capital needs to be allocated toward products and services that can do and provide more with less.

Risk mitigation

While returns are a key consideration, risk management and mitigation are critical components of any broad investment strategy. Many investors believe they understand all of the financial risks to their portfolios, but an important gap in investment risk analysis exists, and is only now, in the face of increased volatility and uncertainty, beginning to be reconsidered.

The prevailing economic theory assumes that natural resources are abundant, that they are free or at least very cheap and that technological advancements will resolve any emergent deficiencies. But this theory is proving incompatible with existing social, economic and environmental realities. Yet unfettered economic growth in the face of ecological limits is appearing impossible. The volatility evidenced in the energy and commodities markets demonstrate this sharply.

To protect the value of their assets, investors need to understand and incorporate what has traditionally been so-called “extra-financial” information into their risk analysis and investment valuation. There is opportunity for investors to make money off this transition. In order to achieve both our economic and environmental objectives, capital will need to be allocated toward products and services that can do and provide more with less. As such, clean technologies can play an important role in portfolio risk diversification.

The realities of a resource-constrained future also have broad implications for traditional methods of risk assessment. Financial models that rely on past performance and creditworthiness are in many ways unprepared for these implications and will likely be inadequate measures for determining how to allocate capital between energy intensive investments and resource efficient ones.

Cleantech’s growth mimics the dot com curve

Transitions are never easy. Cleantech’s lifecycle has followed the trajectory of other similarly innovative, tech-rich, high barrier-to-entry growth industries, such as IT and biotech, where down-cycles shouldn’t be confused with investments having poor merit. VC-backed startups of the “Internet Bubble” era weren’t immune to hardship. The figure to the right shows that as many as 53% of all VC-backed firms failed in those heady days of 1991 to 2000. Even in a period of perceived easy money, success eluded most companies.

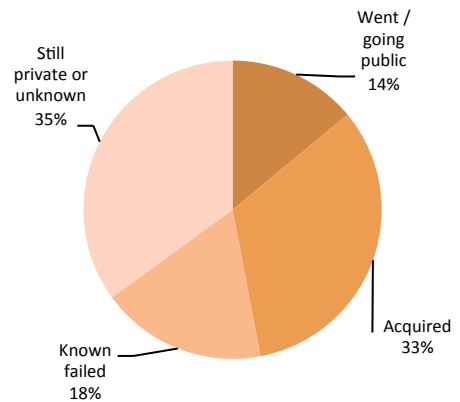


Figure 1: The fate of 11,686 VC investments from 1991 to 2000. Source: U.S. NVCA. (Note: of those “still private or unknown,” most have quietly folded)

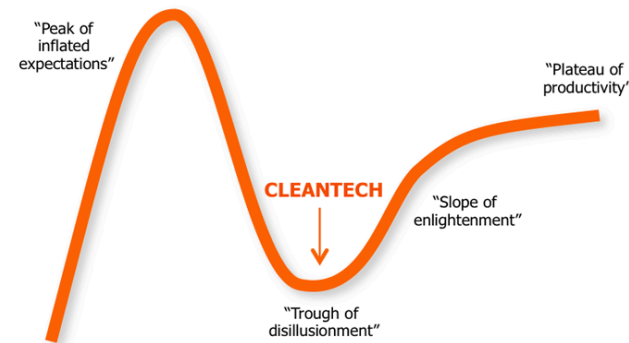
The U.S. solar firm Solyndra illustrates this lesson well. Solyndra became a political football in the 2012 election and the firm is cited by some as an example of why investment in the cleantech “sector” is risky. Yet, Solyndra’s bankruptcy was unremarkable in that it resulted from poor market timing and competition from China. The company made the incorrect assumption that the market would pay top dollar for its product at a time when panels were becoming cheaper and more plentiful from overseas manufacturing.

Solyndra’s problem wasn’t that cleantech in general is flawed, or that demand for clean industry is lacking. After the firm closed, utility-scale solar photovoltaic (PV) installations in the U.S. grew 670% from 2010 to 2012. In 2012 alone, 1,769 megawatts of utility PV was connected to the grid, 59% more than the cumulative total in all prior years.¹² Investors who believe that Solyndra—one company from one part of the cleantech realm—is a basis for not investing in cleantech as a whole are leaving massive value on the table.

Recovering from overhyped expectations and poor returns

It has not been an easy decade for clean technologies. There have been 10 years of underwhelming returns broadly across the theme,¹³ with reasons varying from uncertainty in national policies to overcapacity to overhyped technologies. A few cleantech firms have been quite successful, while many have simply survived and are

still available on stock exchanges. There have been cleantech IPOs in recent years, though mostly in China.



Cleantech of late has clearly been in what Gartner calls the “trough of disillusionment” in its widely referenced hype cycle model.¹⁴ With expectations exceeding reality in the past (as they did at the introduction of other emerging

Figure 2: Hype cycle of expectations over time related to cleantech. Source: Gartner

technologies such as IT, the web or biotechnology), market-watchers are now waiting for wide evidence of market traction before singing cleantech’s praises loudly again.

There have been bright spots. While returns were generally underwhelming for most of the last decade, some sectors, like clean power development, did comparatively well.¹⁵

And there has been a broader category recovery. Many broadly-based cleantech exchange traded funds (ETFs), after difficult years between 2008 and 2013, have displayed a return to growth. While any fund performance is a snapshot in time, exposure to “traditional” cleantech names, especially alternative energy companies and upstart carmaker Tesla, drove the performance of the top cleantech ETFs for the first 10 months of 2013. Seven of the top 10 non-leveraged sector ETFs¹⁶ have something in common: Exposure to alternative energy stocks. Whether wind or solar, or some

Clean technology has had 10 years of mostly underwhelming returns. Yet there have been bright spots. And a broad recovery seems to be underway.

¹³ Cambridge Associates. “Clean Tech Company Performance Statistics”, March 2013. Cambridge Associates’ analysis of cleantech returns from 2000 to 2011 found an average 4.9% global IRR across 1,233 investments in 652 companies from 409 funds.

¹⁴ Gartner. “Interpreting Technology Hype”. See: <http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp>

¹⁵ Cambridge Associates. Above, *ibid.* Over the same period and sample as above, global renewable power development investment received an 11.1% IRR.

¹⁶ “Best ETFs” are defined in terms of those with the best year-to-date performance.

combination of multiple clean energy themes, non-traditional energy ETFs have soared this year.¹⁷



Figure 3: PowerShares Cleantech Portfolio fund (PZD) performance, 2007 to 2013. Source: Google Finance

The lessons for cleantech are similar to those from the dot com era.

Also in 2013, there are more positives. Momentum in cleantech investment appears to be growing once again. Venture investment has taken a cautious tick upwards.¹⁸ And jobs are indeed being created; the U.S. solar industry now employs nearly twice as many people as the country’s mature coal industry.

The lessons for cleantech are similar to those from the dot com era. In the quest for revenue and investment, growth is good, but weaker and overhyped concepts deserve to be sidestepped. Both the IT and cleantech bubbles have taught markets that traditional fundamentals remain key to success: quality management and quality businesses at the right price. Great ideas come and go. But some stick. Some vertical industries or other narrowly-defined markets even flourish, and that is where cleantech is today—with survivors gaining more traction and the right companies in certain spaces finding critical capital and strategic relationships to build their businesses.

Cleantech today is transitioning to the mass market

Having transitioned through a period of unrealistic expectations, cleantech is at an exciting time in its evolution to mass market adoption. In the widely accepted technology adoption lifecycle model, a market gap exists between early adopters of new technologies and the majority of consumers. This gap is especially treacherous for companies that develop disruptive technologies, as they force a significant change to the markets they target. Only companies nimble enough to transition from the early adopter market (consumers motivated by purchasing the latest technologies for competitive benefit) to the early majority of the vastly larger mainstream market (which prefers to buy established technology) are successful.

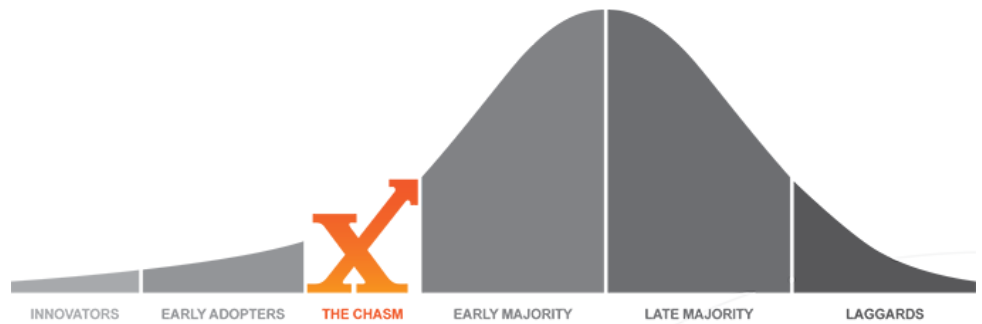


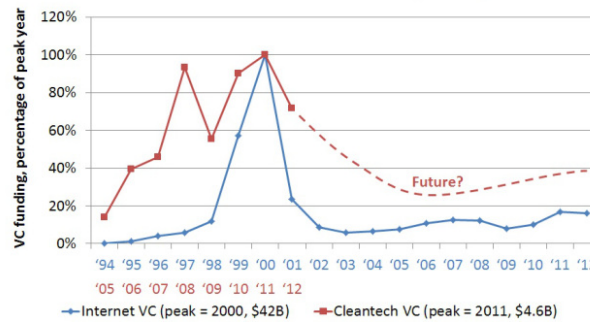
Figure 4: The technology adoption lifecycle and chasm model, Regis McKenna. Source: Joe M. Bohlen, George M. Beal and Everett M. Rogers

Different clean technologies have faced their mainstream adoption chasms at different times. For example, wind and solar energy power generation have already bridged the gap. They are now widely understood and increasingly deployed by renewable energy decision makers at power companies, and by individual businesses and homeowners. Algae fuel, for example, is on the far left side of the chart—exciting but yet to scale.

The adoption chasm of new technologies can differ substantially in magnitude. Many cleantech products have been quietly moving the needle on efficiency and waste reduction without fundamentally altering their markets. Lighting is a good example. The transition from incandescent to fluorescents to light emitting diodes (LED) happened without dramatic market disruption. Consumers had a small technology curve to overcome, but the lighting market still requires the purchase of light bulbs. We expect a significant segment of the cleantech transition will happen in this way, with cost and efficiency driving marginal, but resource-significant product changes.

Investment decisions mirror this phenomenon. A minority of venture investors support the earliest innovators. Others are more comfortable investing in second generation technologies or following the lead of other investors. Still others wait for the market to develop.¹⁹ There are now investment opportunities available to investors interested in both early ventures and established organizations. This is an exciting time to invest in cleantech because investors can position themselves to reap upside without having to suffer losses in the development stages of many technologies.

Cleantech moves beyond the venture capital bubble



Venture capital bubbles often presage investment in emerging categories, an early indicator of what Alan Greenspan termed “irrational exuberance”,²⁰ later to be replaced with more traditional levels of investment and other sources of capital as industries develop. It happened in the Internet era, and this transition has begun in cleantech as shown to the left; venture capital is playing less of a leading role in

driving cutting edge technology and is being augmented by corporate investors.

As the following chart shows, while VC investment in cleantech has fallen, overall investment in cleantech has remained the same due to new sources of capital. In California, the region that consistently receives the most cleantech venture investment in the world,²¹ VC investments accounted for 34.3% of total cleantech funding in 2012, down from 64.8% in 2008. Meanwhile, corporations bridged part of the gap, with

¹⁹ A recent reluctance of cleantech VCs to invest in early stage innovation was a panel theme at the U.S. National Clean Energy Summit in Las Vegas in August, 2013. See: <http://cleantechiq.com/2013/08/are-wussy-investors-hurting-america-and-themselves/>

²⁰ A phrase used by then-U.S. Federal Reserve Board Chairman Alan Greenspan in a speech given at the American Enterprise Institute during the Dot-com bubble of the 1990s.

²¹ Bloomberg New Energy Finance, Cleantech Group, PWC, CB Insights Analysis, Collaborative Economics

involvement in over 35% of 2012 investments, a significant growth over 2008 investments (27%). Partnerships with corporations are strategic advantages for startups since they often provide access to financing, a client, as well as a commercialization partner.

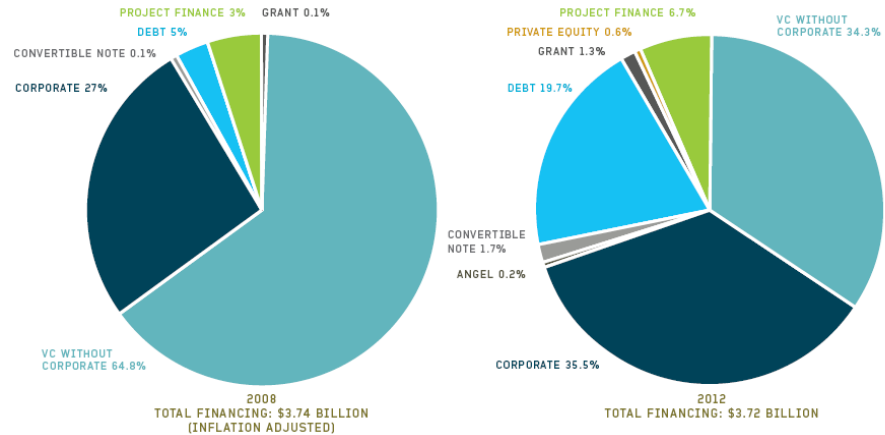


Figure 6: Sources of clean technology financing in California, 2008-2012. Source: CB Insights Analysis, Collaborative Economics

Overall, accounting for new corporate capital, investments in clean technologies remain robust. Figure 2 illustrates that investments levels stayed the same in California between 2008 and 2012 (\$3.74 billion in 2008 to \$3.72 billion in 2012), while Figure 3 illustrates that overall investment into this space (including innovation and projects) worldwide continues to grow, and has, more or less, every year since 2004.

“A shift in the sources of cleantech funding shows that the industry is changing from one that relies on seed stage venture capital to one ready for investment from major corporations.”

-Noel Perry, Next 10 founder and venture capitalist

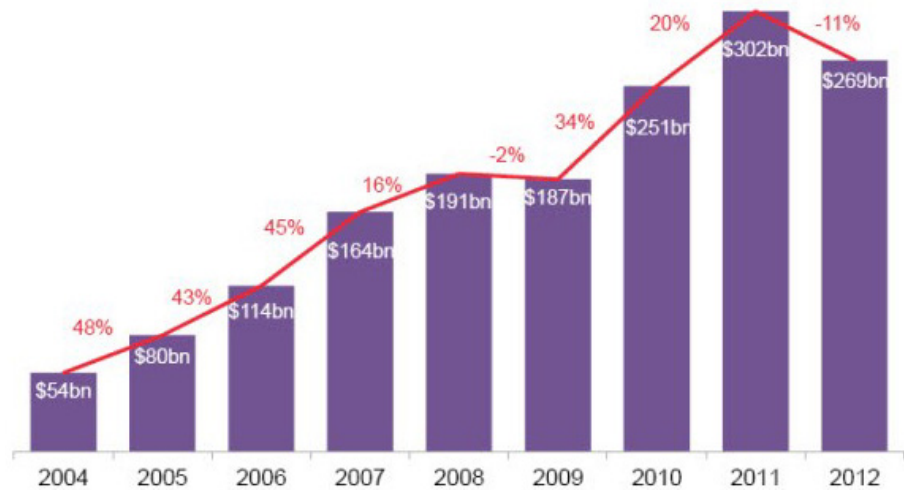


Figure 7: Global total investments in clean energy (2004 – 2012, \$B). Source: Bloomberg New Energy Finance

Cleantech investment opportunities

For some, cleantech is synonymous with renewable energy. But the cleantech theme was always intended to span a much wider set of industries, offering massive addressable markets representing opportunities to change many of the world’s major systems. Kachan & Co.’s cleantech taxonomy categorizes clean/green technology innovation into eight major areas.

For some, cleantech is synonymous with renewable energy. But there is a much wider set of industries in the cleantech theme— all of which offer huge addressable markets.



Figure 8: Eight major groupings of clean technologies. Source: Kachan analysis

The balance of this document is spent looking at each of these high level categories, defining them and exploring trends and investment opportunities. A handful of representative large cap (\$10 billion or more), smaller cap and managed funds are also identified in each category. An appendix at the back of this document lists selected private companies to watch in each of these eight categories.

Note that this document should not be viewed as offering specific investment advice or endorsing specific companies, nor all of their practices. Rather, companies identified in this document should be considered as starting points for further research.

How to stay on top of new opportunities in cleantech

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Clean energy

Clean energy definition

Clean energy generation spans conventional renewable and new emerging forms of renewable power, and includes related measurement and analysis systems. Some key technology in this segment includes solar, wind, renewable fuels, marine, geothermal and fuel cells.



Clean energy trends

Clean energy continues to draw a preponderance of clean technology investments. Solar accounted for 19.9% of venture investments for 2Q13 while biofuels accounted for 11.5%, and fuels cells 2.1%.²² Growth is expected to continue as numerous regions are

²² Cleantech Group. “Quarterly Investment Monitor 2Q13”, July 2013

mandating standards for percentages of power produced from clean energy by specific dates. Wind, solar and biofuels are currently the most viable technologies to reach renewable portfolio goals. As such, biofuel revenues are expected to grow to \$177.7 billion by 2022 (up from \$95.2 billion last year), while wind could reach \$124.7 billion (up from \$73.8 in 2012).²³

While these technologies continue to collect the bulk of media attention and investments, other technologies have started to increase in viability and draw investor attention.

Geothermal power, which leverages temperature differentials between the surface and below ground, has demonstrated robust growth, especially in the U.S., where installed capacity grew to 3,187 MW, more than a quarter of the 11,224 MW of total geothermal power installed worldwide.²⁴ One of the few renewable energies to provide constant baseload power (the other being hydroelectric), geothermal is often overlooked due to high investment cost and inherent risk, but technology improvements enabling the use of low and moderate temperature resources will create new opportunities both in the U.S. and abroad.

Marine related technologies have also demonstrated increased maturity. Tidal and wave technologies (which rely on water movements) as well as ocean thermal, long seen as peripheral technologies, are now being tested in pilot plants across the world. The U.S. DOE believes that marine technologies could play a key role in diversifying the U.S. energy portfolio, and could account for up to 15% of the nation's electricity by 2030.²⁵

Varying levels of policy support, both in the U.S. and abroad, could play a role in slowing down this industry, but could also increase the financial health of the industry, ensuring that only projects with solid ROIs go forward.

Clean energy is not exclusively the domain of energy producing utilities, but also a purview of private corporations as well. For example, Walmart plans to power itself with 100% clean energy by 2020²⁶. It is doing so to control costs and because it believes it is the most economical way to produce power in the long term.

Clean energy investing ideas

Distributed generation and management, especially in solar energy, has long been present in Europe, and has started to gain traction elsewhere. It now accounts for more than 50% of the residential and commercial market in Europe. Falling solar panel prices, coupled by the growth of the solar installing-financing industry, means that deployment in the U.S. and other markets could increase rapidly in the next five years while also impacting traditional utility companies.

Power grid efficiency and metering is necessary to ensure optimized energy usage, as the relative inefficiency of the current electric grid is creating a large market for technologies and new products. One component currently receiving attention is the smart power meter: approximately 33% of all U.S. households now have a **smart**

²³ Clean Edge. "Clean Energy Trends 2013", March 2013

²⁴ Clean Edge. Above Ibid.

²⁵ U.S. Department of Energy. "DOE Reports Show Major Potential for Wave and Tidal Energy Production Near U.S. Coasts", January 2012

²⁶ Walmart. "Walmart Announces New Commitments to Dramatically Increase Energy Efficiency and Renewables", April 15, 2013. See: <http://news.walmart.com/news-archive/2013/04/15/walmart-announces-new-commitments-to-dramatically-increase-energy-efficiency-renewables>

meter installed. Overall, the smart grid market is projected to reach \$9.6 billion by 2015, and improved data management will be needed to ensure value.²⁷

Utility-scale development and redevelopment continues, as utilities are under pressure to increase their proportion of renewable energy while upgrading existing infrastructures. This has increased the number of wind and solar energy development projects. Subsidy programs are also encouraging growth, but may raise concerns about medium to long-term viability as government aid or subsidies are withdrawn.

Asset management for renewables is a booming niche business, and a unique need compared to other power generating facilities. As fewer utilities build their own plants, preferring to reduce infrastructure investment and source production, there has been an emergence of mid-sized renewable energy management companies that sell power to utilities, often in the form of power purchase agreements. These mid-sized companies are often tasked with managing renewable assets that they either built themselves, or that were developed by a third-party.

Clean energy investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|--|-------------------------------------|
| General Electric (NYSE: GE) | Wind, other equipment |
| NextEra Energy (NYSE: NEE) | Wind, solar project developer |
| Sinovel Wind (SHA: 601558) | Wind equipment |
| Abengoa (ETR: AYO) | Biofuels |
| Shanghai Electric (SHA: 601727) | Wind equipment |
| Small cap companies | Industry |
| Solar City (NASDAQ: SCTY) | Solar installation |
| First Solar (NASDAQ: FSLR) | Solar photovoltaics |
| Ocean Power Technologies (NASDAQ: OPTT) | Marine power equipment manufacturer |
| Ormat Technologies (NYSE: ORA) | Geothermal |
| Renewable Energy Group (NASDAQ: REGI) | Biofuels |
| Investable funds | Industry |
| PowerShares WilderHill Clean Energy Portfolio (PBW) | Clean energy – broad |
| First Trust NASDAQ Clean Edge Green Energy Index Fund (QCLN) | Clean energy – broad |
| Market Vectors Global Alternative Energy ETF (GEX) | Clean energy – broad |
| Guggenheim Solar ETF (TAN) | Solar |
| Market Vectors Solar Energy ETF (KWT) | Solar |

Table 1: Representative public clean energy companies and funds. Source: Kachan analysis

Clean energy outlook

Clean energy remains the “poster child” of the clean technology theme. Technologies in this arena continue to represent a major share of retail and institutional investors’ cleantech portfolios. Many power utilities worldwide continue to be incented to generate a portion of their power from renewable sources, so expect continued innovation and investment in renewables.

Cleantech changes rapidly. Companies come and go. Follow latest trends, companies, investment ideas and more at asyousow.org/cleantech-redefined or Kachan’s cleantech data service cleantechwatch.com.

²⁷ Clean Edge. “Clean Energy Trends 2013”, March 2013

Energy storage

Energy storage definition

Energy storage encompasses technologies that preserve energy for use at a later time, with applications both in electronics and grid-scale power storage. These include batteries, thermal and mechanical storage and super/ultra-capacitors.



Energy storage trends

Energy storage is a crucial element in clean energy development due to the intermittent nature of popular clean energy sources (solar and wind). As such, money and time are spent on power storage, and specifically on enabling dispatchable—i.e. available on demand—wind and solar power.²⁸ With 13 VC-backed deals in 2Q13 alone (a 64% increase over 1Q13), there is a definite increased interest in energy storage.

Nonetheless, incumbents continue to dominate the storage market, since they have financial stability, manufacturing scalability and reliability, which are often preferred to the technical advantages of new battery players. Established original equipment manufacturers (OEMs) are often reluctant to integrate components from non-established players.²⁹

In the world of grid-level power storage, pumped-storage hydroelectricity (PSH) is the reigning most cost-effective technology. It stores energy in the form of potential energy of water, pumped from a lower elevation reservoir to a higher elevation. Low-cost off-peak electric power is used to run the pumps. During periods of high electrical demand, the stored water is released through turbines to produce electric power.

Energy storage investing ideas

Development for **next-gen batteries** for vehicles and distributed power generation are crucial. Growth in transportation is directly linked to energy storage innovation and scale-up. Some clean energies (wind and solar) are also directly influenced by development in energy storage.

There are few commercially viable alternatives to PSH for **large scale storage**, or for power storage for areas where PSH is not physically possible. Some companies propose using electric and hybrid vehicles (so-called vehicle-to-grid, or “V2G,” recharging at night during off-peak hours), but with technology being developed to enable a fast recharge cycle, this might not be a long-term solution. Efforts underway to commercialize molten salt, vanadium flow, flywheels, compressed air, ice, eutectic compounds, moving mass or other approaches have not yet scaled to economic success.

Hydrogen, as a storage medium, is promising. It can be generated by using wind or solar energy to split water molecules and then converted back into energy through fuel cells. It is currently used in limited trials in a number of municipal bus systems in Europe, Canada and China. As the only exhaust is distilled water, it meets the most stringent air quality standards. In addition, hydrogen can be produced easily and inexpensively anywhere there is water and electricity. It has potential for grid-scale storage if the cost of fuel cells can be reduced.

²⁸ Ernst and Young. “Cleantech Matters: Global competitiveness, the global cleantech insights and trends report”, 2012

²⁹ Maloney, Matt. “Energy Storage Cleantech Report: 10 Important Trends”, Silicon Valley Bank, 2013

Energy storage investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|---|--|
| Panasonic (TYO: 6752) Samsung SDI (KRX: 006400) Johnson Controls (NYSE: JCI) NEC (TYO: 6701) LG Chem (KRX: 051910) | EV batteries Grid and electric vehicle batteries EV batteries & systems Multipurpose batteries EV batteries |
| Small cap companies | Industry |
| American Vanadium (CVE: AVC) Valence Technology (OTCMKTS: VLNC) EnerSys (NYSE: ENS) Ultralife Corp. (NASDAQ:ULBI) Maxwell Technologies (NASDAQ: MXWL) | Benign aqueous hybrid ion (AHI) batteries Phosphate based lithium ion batteries Industrial batteries Industrial batteries Industrial batteries |
| Investable funds | Industry |
| Global X Lithium ETF (LIT) | Lithium, required in many batteries |

Table 2: Representative public and private energy storage technology companies and funds. Source: Kachan analysis

Energy storage outlook

Energy storage is an enabling technology for other promising technologies. Overlooked in the past, renewed investment has created an energy storage resurgence. Nonetheless, new technologies are far from mature, and long exit cycles still characterize investments. Expectations in this industry still dramatically exceed performance to date.

Efficiency

Efficiency definition

Energy efficiency technologies optimize energy usage by either curbing energy demand or optimizing its allocation, and include:

- **Green building:** design, building automation, lighting, HVAC (heating, ventilation and air conditioning) and insulation
- **Smart grid:** electrical transmission technologies, incl. demand management/response and energy management
- **Cogeneration:** including combined heat and power technologies, and
- **Data centers & devices:** better power management, server virtualization



In an attempt to reduce the production of new goods, web-based “collaborative consumption systems” have emerged, including peer-to-peer car sharing (which could reach \$26 billion in revenues in the U.S. by 2016), bike sharing and other web-based applications intended to facilitate neighbors’ sharing. With an estimated market size of \$110 billion over the next five years, collaborative consumption is already an impressive market segment.³⁰

Efficiencies are also being sought in other areas of cleantech, including water and food (we outline those efforts in the water and agriculture sections of this document.)

³⁰ Thorburn, Ross. “The Rise of Sharing”, The Daily Dish, May 2013

Efficiency is the leading cleantech theme for VC investment, claiming 18.9% of all cleantech venture capital in 2Q13, double that of any other cleantech category.³¹

Efficiency trends

Energy demand is expected to rise by a third between 2010 and 2035, and related grid infrastructure will need to be upgraded to meet anticipated requirements. Booming electricity demand, lack of capacity and ageing infrastructures provide opportunities for efficiency improvements in the energy sector.

While energy production is increasing, reducing current consumption also plays an important part of regional and national energy policies given the typical cost savings associated with saving power rather than building new power plants. This has the further benefit of reducing energy imports and pollution. Energy efficiency related investments can reduce energy use and waste by 30% to 50% by 2030-2050³², and are very popular since short term savings are easily identifiable, necessary technologies already exist and investment return is good. In essence, energy efficiency is the 'low-hanging fruit' of the clean technology investment universe.

Efficiency opportunities in buildings are among the most exciting, offering the greatest cost saving potential and reduced energy use, while showcasing demonstrable return on investment. Approximately \$296 billion per year in incremental energy efficiency investment is needed in the buildings industry to 2030 in order to be in line with the reduction targets required for a low-carbon and more efficient future.³³

Energy consumption in buildings accounts for 40% of global energy use. Heating, cooling and lighting combined account for 60% of energy consumption from both residential and commercial buildings. Adequate insulation is also a major factor in reducing energy waste. During the 2009 to 2035 period, growth in buildings' energy consumption is expected to be fueled primarily by growth in population (27% increase), households (31% increase) and commercial floor space (28% increase).³⁴

Improved energy efficiency in buildings can provide estimated costs savings of 30%, reduce energy use by 50% over the next 10-15 years³⁵ and could generate savings of U.S. \$78 billion for American home and businesses—the equivalent of the cost of 20 coal power plants.³⁶

Efficiency investing ideas

Smart grid technologies are estimated to represent a \$63 billion dollar market by 2020, with the main segment of growth coming in the grid management industry for the next 10 years, with \$494 billion in projected cumulative revenue from 2012 to 2020.³⁷ There are many companies in the smart meter, control system and nascent energy storage spaces, and large companies in the electrical equipment and services sector are expanding their exposure and gaining market share. Additionally, major equipment and software companies have been acquiring smaller companies to build out their offerings in this area.

Case study: Empire State Building energy retrofit

In 2010, \$120 million was spent on an energy efficiency retrofit of New York's iconic Empire State Building. The building's 6,500 windows were remanufactured onsite. Air conditioning operating requirements on hot days were reduced, as were heating. The retrofit is saving the building between \$2.4 and \$4.4 million a year in energy costs—cutting previous costs as much as 38%.

³¹ Cleantech Group. "Quarterly Investment Monitor media briefing, 2Q13", 2013

³² Green Growth Alliance. "The Green Investment Report: The ways and means to unlock private finance for green growth", World Economic Forum, 2013

³³ Green Growth Alliance. Above Ibid.

³⁴ United States Department of Energy (DOE). "2011 Building Energy Data Book", 2011

³⁵ Bank of America Merrill Lynch Global Research. "Global Energy Efficiency Primer – Less is More", April 2013

³⁶ Estimated cost of a coal power plant is based on 2012 EIA data for a Dual Unit Advanced PC 1,300MW.

³⁷ Navigant Research. "Smart Grid Technologies", 2013

Buildings waste over 10% of their energy consumption due to inefficient HVAC operation. **New HVAC systems** are up to 30% more efficient, making a clear case for attractive growth from upgrades. The global HVAC systems and service market is estimated at around \$180 billion.

| | |
|--|---|
| Improve insulation | Wall insulation |
| | Improved glazing of windows |
| | Floor insulation |
| | Loft insulation |
| Automation | Automation |
| | Building management systems |
| | Lighting controllers |
| Lower space & water heating costs | Replacement of fossil fuel-based boilers (oil/gas/coal) |
| | Electric boiler |
| | Heat radiator |
| | Heat pump |
| Enhance cooling efficiency | Electric |
| | Renewables |
| | Air conditioner |
| Lighting fixtures | Heat pump |
| | Replacement of incandescent bulbs |
| | Fluorescents and LEDs |

Table 3: Opportunities for end-use efficiency gains in buildings. Source: World Energy Organization (Outlook 2012); BofA Merrill Lynch Global Research and Kachan analysis

The **home automation** market is growing at a robust compound annual growth rate (CAGR) of 24.6% and should reach a global market size of \$16.4 billion.³⁸ The market is characterized by several large companies and many small innovative start-ups, such as award-winning Nest, which has designed a thermostat that not only automates energy management but also learns its users’ usage patterns.

Lighting accounts for 20% of electricity usage, worldwide and electricity consumption from lighting is expected to increase by 60% in the next 20 years.³⁹ **Light Emitting Diodes (LEDs)**—semiconductor components that emit light—can meet lighting needs sustainably. LEDs are beginning to dominate the lighting market because they use 25% of the power of incandescent, last 25 times longer (up to 50,000 hours), turn on instantly, are unaffected by on and off cycling, have no toxic materials (i.e. mercury), do not emit infrared or ultra-violet radiation and can be adjusted for color temperature.⁴⁰ Municipalities are now testing LED street lighting systems to reduce power generation and fixture maintenance costs, as well as protect wildlife by mimicking moonlight so animals are not drawn onto roadways.

High performance thermal **insulation** is vital for boilers, hot water pipes, walls and roofs; it reduces heat loss by providing an insulated barrier. In the U.S., advanced insulation can reduce energy waste significantly since an estimated 60% of homes are under-insulated, and 50% of the energy in buildings is lost due to inadequate insulation. Also, 20% to 35% of heat in homes escapes through inefficient windows and glass.⁴¹

³⁸ Transparency Market Research. “Home Automation Market – Global Industry Analysis, 2013-2019”, September 2013

³⁹ North Sky. “Investing in Resource Efficiency and Industrial Innovation”, Clean Tech Fund III presentation, p.12

⁴⁰ United States Department of Energy “Lifetime of White LEDs”, September 2009

⁴¹ United States Department of Energy “EnergySavers” brochure, December 2011

There is a green premium benefit to retrofitted, higher performance **green buildings**. They command higher rents (up to 6% according to various estimates), enjoy higher occupancy rates and sell for more on the market. Green buildings also yield tangible benefits: while they can cost about 2% more than conventional buildings, they reduce energy consumption by 33% on average.⁴²

Finally, look for more “cleanweb” innovation (i.e., web 2.0 technologies and UI metaphors used with cleantech-related data) in **collaborative consumption systems**, driven by a desire to share assets and eliminate redundancy in ownership of vehicles, tools, household goods and more. Car-sharing startups, for instance, have drawn interest from both consumers and traditional transportation players: in January 2013, Avis announced plans to buy car-sharing pioneer ZipCar for \$500 million.

Efficiency investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|---|---|
| Johnson Controls (NYSE: JCI) | Building efficiency systems |
| Honeywell (NYSE: HON) | Control & sensing for buildings, home, industry |
| Siemens (NYSE: SI) | Transmission & control products for industry |
| General Electric (NYSE: GE) | Transmission & control products for industry |
| Toshiba (OTCMKTS: TOSYY) | Efficient consumer electronic & appliances |
| Small cap companies | Industry |
| Cree (NASDAQ: CREE) | LED lighting |
| Itron (NASDAQ: ITRI) | Advanced metering infrastructure (AMI) |
| American Superconductor (NASDAQ: AMSC) | Transmission |
| Control4 (NASDAQ: CTRL) | Home automation & control |
| Sensata Technologies (NYSE: ST) | Sensors & controls |
| Investable funds | Industry |
| First Trust NASDAQ Clean Edge Smart Grid Infrastructure Fund (GRID) | Smart grid |

Table 4: Representative public energy efficiency companies and funds. Source: Kachan analysis

Efficiency outlook

There is tremendous growth potential in the global energy-efficient technologies market. The overall market is expected to increase to \$103.5 billion in 2017 (CAGR of 7.25%), an increase of more than 50% from the 2011 market value of \$67.9 billion.⁴³ Green construction materials is forecast to grow from \$116 billion in 2013 to greater than \$254 billion in 2020,⁴⁴ and the automation and control systems market is expected to grow to \$82 billion in 2016 (CAGR of 14.8%) from 2011-2016.⁴⁵

Stocks positioned to benefit from the energy efficiency theme are those that are involved in equipment, products and services such as advanced metering infrastructure (AMI), automatic meter reading (AMR), customer-side systems, distributed grid management, information and communication technology (ICT) integration, renewables integration and wide area monitoring and control.⁴⁶

⁴² North Sky. Above Ibid.

⁴³ North Sky. Above Ibid., p.69

⁴⁴ Navigant Research. “Materials in Green Buildings”, May 2013

⁴⁵ Bank of America Merrill Lynch Global Research. “Global Energy Efficiency Primer – Less is More”, April 2013

⁴⁶ Bank of America Merrill Lynch Global Research. Above Ibid.

Water

Water definition

Opportunities lie in technologies for water generation, treatment, transmission, efficiency and monitoring and compliance. Water has historically been one of the least invested categories of cleantech, hovering around 4% of all cleantech venture capital allocated⁴⁷, perhaps owing to the absence of crisis-level water events that have affected Western fund managers and investors directly.



Water trends

Global freshwater supply is declining and demand is increasing, yet current management of this resource does not emphasize its importance or increasing scarcity.

The amount of water used as a percentage of total water available is forecast to rise substantially by 2025. During the past century, global water withdrawals have increased six-fold. In fact, worldwide water demand is expected to be a full 40% above current accessible, reliable supply as soon as 2030.⁴⁸

Other resource extraction takes its toll on water. Nearly half of all new shale gas and tight oil wells—each of which require between 4 and 13 million gallons per well⁴⁹ ⁵⁰—are being developed in regions with high to very high water stress, and fracking operations have spurred technological development of tools to manage the 280 billion gallons of “produced” toxic wastewater that the process generates annually in the U.S.⁵¹

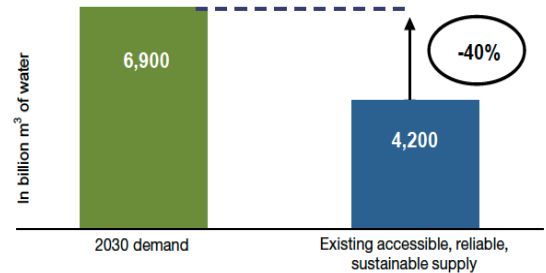


Figure 9: Water demand is set to outstrip supply dramatically by 2030. Source: North Sky Capital

The U.S. EPA estimates that 3%-4% of U.S. electricity consumption is used to provide drinking water and wastewater services each year, is equivalent of 56 billion kW, or \$4 billion. Water and wastewater utilities are typically the largest consumers of energy in municipalities, often accounting for 30%-40% of total energy consumed.⁵²

Agriculture and urbanization are also driving water demand. Agriculture uses account for 70% of all water use. Growing global affluence is increasing demand for more water-intensive foods like meat, a kilogram of which can require up to 10 times more water

⁴⁷ Cleantech Group. “Quarterly Investment Monitor: media briefing, 2Q13”, 2013

⁴⁸ 2030 Water Resources Group

⁴⁹ Freyman, Monika, and R. Salmon. “Hydraulic Fracturing and Water Stress: Growing Competitive Pressures for Water”, CERES, 2013

⁵⁰ Areas of high or extreme water stress are defined as areas where over 80 percent of available water is already being withdrawn for municipal, industrial and agricultural uses.

⁵¹ Environment America. “Fracking By The Numbers”, October 2013.

⁵² Ernst & Young. “Cleantech Matters: Global cleantech insights and trends report”, 2012

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than rice to produce.⁵³ Currently more than half of the global population now lives in cities. Urbanization, and its increased standard of living, can increase a person’s demand for water to five times that of the basic water requirement in non-urban areas.⁵⁴

As demand for water is set to outstrip availability, the need for greater efficiencies in the production, use and treatment of water is great, presenting enormous opportunity for new technologies to meet these needs and catalyzing investment across the globe.

Water investing ideas

Increasing agricultural yields will require the use of **more efficient irrigation techniques** that produce more “crop per drop.” The use of drip irrigation can increase efficiency by 50% over flooding, the most common irrigation method used in developing countries. These improvements are expected to stretch finite water supplies, offering the capability to more than double global agricultural output by 2050.⁵⁵

Innovations in **desalination technology** using more efficient membranes and energy recovery devices have been able to significantly drive down the cost of this traditionally expensive process. While largely nanotech material membrane-focused in recent years, new innovations include a biomimetic membrane that mimics the water-transport process of living cell membranes. Global desalination capacity is expected to more than double from 2009 to 2016.⁵⁶

When it comes to creating water from non-freshwater sources, **wastewater treatment** costs much less than desalination. Investment in water reuse plants is experiencing large growth, creating demand for advances in water treatment and reuse. Output from water reuse facilities is predicted to increase by 52% from 2010 to 2016.⁵⁷

Water investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|--|---|
| Suez Environnement (EPA: SEV) | Generation, treatment, transmission, efficiency |
| Veolia Environnement (EPA: VIE) | Generation, treatment, transmission, efficiency |
| China Everbright International (HKG: 0257) | Generation, treatment, transmission, efficiency |
| General Electric (NYSE: GE) | Generation, treatment, transmission, efficiency |
| Dongjiang Environmental (HKG: 0895) | Wastewater treatment |
| Small cap companies | Industry |
| BioteQ Environmental (TSE: BQE) | Mineral recovery from wastewater |
| Ecolab (NYSE: ECL) | Industrial water efficiency |
| Elster Group SE (OTCMKTS: ELTTY) | Water meters |
| HALMA Plc (LSE: HLMA) | Water sensors |
| IDEX Corporation (NYSE: IEX) | Water pumps and related equipment |
| Investable funds | Industry |
| S&P Global Water Index ETF (CGW) | Water tech & service providers |
| Global Water Portfolio (PIO) | Water tech & service providers |
| ISE Water Index Fund (FIW) | Water tech & service providers |
| Guggenheim S&P Global Water Index (CGW) | Water tech & service providers |

Table 5: Representative public water technology companies and funds. Source: Kachan analysis.

⁵³ United Nations. "World Water Day Frequently Asked Questions", March 2012

⁵⁴ Morgan Stanley Smith Barney. "Peak Water: The Preeminent 21st Century Commodity Story", November 2011

⁵⁵ Global Water Intelligence. 2010

⁵⁶ Global Water Intelligence. Above Ibid.

⁵⁷ Global Water Intelligence. Above Ibid.

Water outlook

The water industry is a \$500 billion global market. Water and wastewater infrastructure are areas where investors can make a positive impact and garner attractive returns. The OECD estimates a ratio of \$4-\$12 returns for every \$1 invested. UNEP places that estimate in the range of \$3-\$34 for every \$1 invested.⁵⁸

The global water industry must experience a drastic transformation that involves significant investment in water technology. Capital expenditures on water infrastructure are expected to increase from \$90 billion in 2010 to \$131 billion in 2016.⁵⁹ The investment is likely to be focused in areas such as efficient irrigation, advances in water treatment and reuse and cheaper desalination.

Transportation

Transportation definition

Vehicles are the most visible category within transportation, but innovation is also taking place across traffic management and next generation fueling/charging infrastructure.



Transportation trends

Global VC investment in clean transportation has dipped slightly in the last year, going from \$261.9 million in 2Q12 to \$131.9 million in 2Q13, while the number of investments climbed from 15 to 24. This indicates a tendency to spread investments in more projects to mitigate risk, and more startups are getting investments and visibility.

There is increasing traction in electric vehicles. While demand for electric cars has been lower than expected, sales patterns are exceeding those of hybrid cars in the early 2000s. For example, sales of the Chevy Volt tripled to more than 23,000 in 2012.

Traffic management has also gained attention, as recognizing traffic flow dynamics and predictive algorithms are needed to optimize traffic flows and increase transportation efficiency. Real-time data gathering of traffic flow is a key component of optimizing traffic, as drivers in urban areas spend almost a third of their time in congested traffic.⁶⁰

Finally, the clear trend towards increased investment in public transportation should not be overlooked. Multiple jurisdictions are planning projects such as light-rail or purchasing electrical buses. While these projects often require government financing, they present interesting investment possibilities, especially in supporting technologies.

Transportation investing ideas

Companies that build **mass transportation systems** such as high speed rail systems, maglev trains and other technologies could be well positioned as the price of gasoline rises. Mass transportation improvement is expected to have the largest impact for the largest number of people in dense environments.

Electric and hybrid vehicles continue to gain traction with consumers, fleets and mass transits systems. Scale (both components and assembly) is needed. Should Tesla Motors double its production from its current 21,000 cars/year to 40,000 cars/year

⁵⁸ Jeffries. "Water Q&A: Secular Themes, Tactical Opportunities", Clean Technology Primer, 2012, p.257

⁵⁹ Jeffries. Above Ibid.

⁶⁰ The Intelligent Transportation Society of America (ITS America). "Connected Vehicle Insights; Trends in Roadway Domain Active Sensing", 2013

(which it expects to do by 2015), it would require the entire existing global capacity of commodity power cells. This has prompted players like Panasonic to scale up rapidly.⁶¹

Charging technologies for plug-in vehicles are also a major investment vector. As the number of electric vehicles on the road increases, demand will increase for convenience stations with the capacity for rapid, or even wireless charging. Charging stations are being developed that are designed to charge a car in 5 to 20 minutes.

Micro-hybridization for new gas-powered fleets has been one of the hidden success stories of this industry. Micro-hybrids are also known as stop-start cars because their combustion engines turn off when the cars stop, say, at an intersection when the light turns red. Very visible in Europe (more than 40% of cars in Europe have this type of technology), their success has been eclipsed in North America by a focus on traditional EVs and hybrids. Most recent studies, however, predict that there will be 39 million micro-hybrids on the road by 2017.⁶² Current micro-hybrid technology can improve fuel economy by 5 to 10%, while future systems may achieve savings as high as 15%.

Traffic control systems are being experimented with that aim to manage urban core congestion and fuel consumption by billing drivers by time of day and location. Trials are underway with municipalities, many of whom are motivated to use satellite GPS-based systems that leverage massive amounts of individual driver data, which could possibly allow them to eliminate the traditional parking meter.⁶³

Improved long-haul fleet efficiency is another important issue, since hydrocarbons are likely to be used for years to come. There are two main opportunities for fuel efficiency: physical technologies (which include anti-idle devices, predictive cruise controls, waste heat recovery and new engine designs) and ICT technologies.

Transportation investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|---|--|
| ABB (NYSE: ABB) | EV charging |
| Schneider Electric (EPA: SU) | EV charging |
| Toyota (NYSE: TM) | Electric, hybrid electric & fuel cell vehicles |
| Nissan (TYO: 7201) | Electric, hybrid electric & fuel cell vehicles |
| Central Japan Railway (TKO: 9022) | High speed maglev rail systems |
| Small cap companies | Industry |
| BYD (HK: 1211) | EVs |
| Enova Systems (NYSE: ENA) | Electric power trains for industrial vehicles |
| Fleetmatics (NYSE: FLT) | Fleet management SAAS services |
| Infineon Technologies AG (XETRA: IFX) | EV control and other EV systems |
| Westport Innovation (NASDAQ: WPRT) | Natural gas conversion for vehicles |
| Investable funds | Industry |
| Utilities Select Sector SPDR (XLU) | Power utilities expected to benefit from EVs |
| iShares Transportation Index Fund (IYT) | Broad-based transportation index fund |
| SPDR S&P Transportation ETF (XTN) | Broad-based transportation index fund |

Table 6: Representative public transportation technology companies and funds. Source: Kachan analysis

⁶¹ Fisher, Thomas. "Will Tesla Alone Double Global Demand For Its Battery Cells?"; Green Car Reports, September 2013

⁶² Lux Research. "Micro-hybrids to Grow to 39 Million Vehicles in 2017, Creating a \$6.9 Billion Battery Market"; January 2013

⁶³ Trials by PaybySky and Applied Telematics

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Transportation outlook

Growth in the transportation sector is mirrored by growth in clean transportation technologies. While there is increased pressure to develop and improve more resource and energy efficient transportation (cleaner vehicles, public transportation), growth in ancillary industries (such as traffic management apps) can successfully improve consumer controlled efficiencies in an affordable manner. While government subsidies for larger investments encourage growth, affordable solutions for consumers and companies are a key component for this sector.

Agriculture

Agriculture definition

Clean technologies in agriculture are aimed at improving yields and quality of consumable food, and are further categorized under crop farming, animal farming, aquaculture and other areas.



Agriculture trends

Growth in agriculture is currently driven by increased population, increased protein consumption and biofuel requirements. If demographic trends continue as predicted, agricultural output will need to double by 2050.⁶⁴ Also, there is significant resource waste within the agricultural industry. These factors place a strain on an already taxed agricultural system, and future food demands are set to outstrip available supply dramatically. In order to meet our food needs, a reimagining of agricultural production methods is required. Conventional methods of farming are insufficient and unsustainable over the long term. As such, current technologies focus on increasing production, increasing efficiency and reducing toxicity.

| Sector (Size) | Components |
|--|---|
| Processing (\$639 billion) | <ul style="list-style-type: none"> Grain and oilseed processing Meat processing Fats and oils refining |
| Handling/logistics (\$297 billion) | <ul style="list-style-type: none"> Water and truck freight Livestock wholesalers Farm product wholesalers |
| Crop production (\$197 billion) | <ul style="list-style-type: none"> Farming activities Seed manufacturing Inputs manufacturing |
| Manufacturing (\$76 billion) | <ul style="list-style-type: none"> Laboratory instrument manufacturing Production/farm machinery Handling, conveying, processing equipment Preserving & storage equipment |
| Protein production (\$68 billion) | <ul style="list-style-type: none"> Dairy production Livestock production All other animal production |

Deutsche Bank Climate Change Advisors characterize the agricultural universe in North America as “large, diverse and fragmented,” with more than 8,500 U.S. firms with revenue of more than \$10 million, generating \$1.3 trillion annually. Processing is the dominant segment (\$639 billion) followed by handling/logistics and crop production.

Increased production can yield growth, reduce costs and increase cash flows. Techniques that increase precision seeding and fertilization (30% less nitrogen, 30% less diesel fuel) and advanced irrigation systems (with 60% more yield while using 30% less water) are all under development. Increased efficiency focuses on waste reduction, enhanced protection, increased

Table 7: U.S. agricultural industry sub-sectors and revenue (USD).
Source: U.S. Department of Agriculture

⁶⁴ “Sustainable Agriculture Whitepaper”, 2009; “Sustainable Agri-business opportunities in North America”, 2011

distribution by favoring smart packaging (which reduce total costs from 30%-70%, use less raw material, provide greater volumes) and improved product treatment (for example, bio-based products that leave no residues and protect food from rotting).⁶⁵

Agriculture investing ideas

Many opportunities in agriculture lie in responding to the booming consumer demand for **organic products**, both in food and personal care. Due to extensive lifestyle-based disease, linked in part to chemical-rich industrial processes, consumers are increasingly demanding organic and nontoxic products. This demand has spurred the growth of a premium market for organic products and purveyors, which in turn encourages efficiency and improvement in commercial farming practices.

Another area of investment is in meeting the rising demand for food through **increased crop yields**. The increased demand for food and the associated upward price pressures bode well for investors in this space. China has scaled up its investments in agriculture, increasing its infrastructure investing by 10% in 2012, or \$3.8 billion, and seeks to increase investment further in 2013. Similarly, Latin America and Africa have also increased their agricultural infrastructure investments. **Pest reduction** through natural biological-based compounds (i.e., non-chemical) and selectively bred improvements is also an area seeing innovation, investor attention and M&A activity.

Next-generation **aquaculture** is also playing a role in cutting distribution costs, improving freshness, nutrition and sustainability. The aquaculture industry is growing at 8-10% per year, making it the fastest growing sector of agriculture.⁶⁶ In the U.S., the White House is promoting a National Ocean Policy Implementation Plan, which includes an aquaculture component intended to foster pilot projects.

Finally, **"distributed" farming** and land management improvements result in using less fossil fuel to move produce, provide improved irrigation and minimize the use of conventional herbicides and pesticides. Distributed farming, which is the creation of networks of small-scale local farms backed by social media and innovative apps, is especially interesting in urban areas. Other variants include new, usually urban-based controlled environment agriculture innovations such as aeroponics (growing food in air, misted with nutrients), vertical farming (growing crops in buildings to maximize vertical urban space) and green roofing (cultivating on roof surfaces).

⁶⁵ "Sustainable Agriculture Whitepaper", 2009, Ibid.

⁶⁶ Food and Agriculture Organization of the United Nations. "Food Outlook", 2012

Agriculture investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|---|---|
| Whole Foods Market (NASDAQ: WFM) | Natural & organic food retailer |
| United Natural Foods (NASDAQ: UNFI) | Natural food distributor |
| Hain Celestial Group (NASDAQ: HAIN) | Natural & organic products |
| Chipotle Mexican Grill (NYSE: CMG) | Restaurant chain |
| Small cap companies | Industry |
| Marrone Bio Innovations (NASDAQ: MBII) | Biological weed, pest and disease control |
| Alterrus Systems (OTCMKTS: ASIUF) | Vertical farming |
| China Green Agriculture (NYSE: CGA) | Non-chemical fertilizers |
| Yara International (OTCMKTS: YARIY) | Non-chemical fertilizers |
| Dahu Aquaculture Co. (SHA: 600257) | Aquaculture service provider |
| Investable funds | Industry |
| IQ Global Agribusiness Small Cap ETF (CROP) | Agribusiness-specific with biofuel holdings |

Table 8: Representative public agricultural technology companies and funds. Source: Kachan analysis

Note that when seeking public agricultural investment opportunities, many existing players are heavily invested in conventional agricultural technologies and practices. No large cap (\$10 billion+) technology companies are “pure play” clean. While large agricultural companies Bayer CropScience (NSE: BAYERCROP), BASF Crop Protection (ETR: BAS) and FMC (NYSE: FMC) offer biological pest control and natural yield improvement products—often through recent acquisitions—they still offer and are best known for their conventional chemical products. Agricultural giants Monsanto (NYSE: MON) and Syngenta (NYSE: SYT) have also made acquisitions of clean agricultural technology, but don’t appear on this list because of concerns about their environmental, health and safety (EHS) impact.

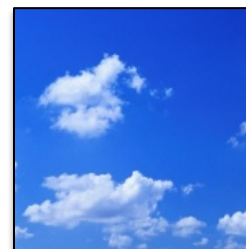
Agriculture outlook

As the world’s population grows and developing nations become more affluent, increased agricultural output and protein production will be necessary to meet demands. Issues of land and water scarcity alongside concerns about climate change and ecosystem degradation require increased emphasis on sustainability in agriculture. Consensus on the ideal form of sustainable agriculture has not been reached. There are those who support a mix of high yield, heavily managed lands interspersed with sections of land reserved as natural sanctuaries, and some support an agro-ecology approach where lands are farmed in a less productive manner while retaining ecosystem services. A plethora of agricultural cleantech innovations are emerging in the areas of crop farming, urban agriculture, sustainable forestry, animal farming and aquaculture. Venture capitalists have expressed interest in the area of agricultural cleantech, and increased investment is expected as our understanding of what truly constitutes sustainable agriculture evolves.

Air & environment

Air & environment definition

In the 1970s, air and environmental remediation technologies such as smokestack scrubbers and sorbents were what most investors considered environmental technology. These “end-of-pipe” systems were intended to capture what particulate emissions they could, like NO_x and SO_x.⁶⁷



Today, air and environment technologies include those above and more, such as emissions control, noise mitigation, bioremediation (the application of biological systems to stabilize and ultimately clean up environmental toxins), recycling and waste innovations, and hardware and software systems aimed at measuring air quality, carbon emission or other environmental monitoring and compliance.

Air & environment trends

The emerging field of biomimetics has given rise to new technologies created from biologically inspired engineering at both the macro scale and nanoscale levels. In the trend towards so-called biomimicry, scientists attempt to emulate the results of the trials and errors nature has performed over millions of years. Biomimicry is accelerating the use of natural processes in air and environmental industries.

Waste minimization (through resource optimization, reuse and better process design) is another important trend. Responding to consumer pressures for less packaging and more durable products, many companies are trying to reduce their packaging and related expenses.

The marriage of networked sensors and meters and “big data” infrastructure is driving innovation in cleanweb systems for management of emissions and monitoring of compliance.

Air & environment investing ideas

Some companies are disposing of **waste** in clean and green ways. Approaches include aerobic (i.e. not open to the air) digestion of organics like food waste and turning it into fertilizer, power and other valuable co-products. Other innovative zero waste, zero emissions processes use organic wastes as feedstock for growing insect larvae, which are transformed into animal feed, oils and natural fertilizer.

Another means of investing in waste is through large cap firms that are aggressive about **waste reduction** in their supply chains. This could include, for example, Starbucks, which is working towards recycling all the bottles and cups in its trash, Best Buy, which helped launch electronics recycling, and McDonalds, which recently eliminated Styrofoam cups.

Bioremediation is a promising, relatively efficient and cost-effective approach for pollution abatement. Examples of bioremediation approaches include phytoremediation (using plants), bioleaching (using naturally-occurring enzymes or bacteria), bioreactor (confining enzymatic or bacterial reactions to closed spaces) and biostimulation (encouraging bacteria to break down contaminants via the use of fertilizers).

⁶⁷ Nitrous oxides and sulfur oxides, respectively; two families of common pollutants.

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Noise pollution reduction technologies are also an interesting development vector. New construction materials (like sound-absorbent materials) and better insulation materials both are playing a role in reducing the impact of noise.

As in other cleantech industries, investors should **watch for me-too projects** seeking funding in the waste industry that may not be based on differentiated technology. Many projects seeking funding are essentially Fischer-Tropsch gas-to-liquid processes, a 1925-era technology,⁶⁸ and are not necessarily based on breakthrough science with unique, protectable intellectual property (IP).

Air & environment investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|--|---|
| ABB (NYSE: ABB) | Emissions control |
| Waste Management (NYSE: WM) | Waste management, waste-to-energy |
| Fluor Corporation (NYSE: FLR) | Emissions control |
| Republic Services (NYSE: RSG) | Waste management, recycling |
| Starbucks (NASDAQ: SBUX) | Retailer pursuing aggressive recycling |
| Small cap companies | Industry |
| Clean Diesel Technologies (NASDAQ: CDTI) | Emissions control for heavy duty trucks |
| Mantra Energy Alternatives (OTCQB: MVTG) | Carbon sequestration |
| Babcock & Wilcox (NYSE: BWC) | Emissions control |
| Midwest Energy Emissions Corporation (OTCMKTS: MEEC) | Mercury capture systems |
| Investable funds | Industry |
| Jupiter Ecology Fund (JUPI) | Environmental remediation focus |
| Global X Waste Management ETF (WSTE) | Waste management focus |
| iShares FTSE Environmental Technologies Index ETF | Broad focus with some air & environment |
| Market Vectors Environmental Services Index (EVX) | Environmental remediation focus |

Table 9: Representative public air & environment technology companies and funds. Source: Kachan analysis

Air & environment outlook

Policy support around the globe, like the *Clean Air Act* in the U.S., will ensure continued markets for industrial emissions control equipment—the bread and butter of the air and environment clean technology category—ensuring continued business for companies like Fluor, Alstom and Babcock & Wilcox. Continued population growth can be counted on to ensure a continued supply of waste feedstock to be recycled, or turned into power or other high value products.

⁶⁸ Emerging Fuels Technology. “Fisher-Tropsch Archive”. See: <http://www.fischer-tropsch.org>

Clean industry

Clean industry definition

Cleantech for industrial use can incorporate advanced materials, along with design innovation, equipment efficiency, production, monitoring & compliance and advanced packaging. It is aimed at making industry require less, emit less and function more efficiently.



Clean industry trends

Corporations are becoming increasingly motivated to do more with less. Margin pressure, and often policy pressure, is fueling a desire for efficiencies, and efficiencies are increasingly being wrought out of industrial processes. New generations of industrial equipment in the construction, mining and other heavy industries are coming available that use a fraction of the electrical power or diesel fuel of previous generations.

At the same time, consumers are beginning to expect products to last longer. In response, some companies are rethinking the planned obsolescence design assumption of the last 80 years and paying more attention to product design.

Materials innovation addresses scarcity of resources, offers higher performance and/or addresses unmet needs. Five major markets are driving growth in advanced materials development: energy, transport, environment, health and ICT. The total potential size of this market is roughly \$2 trillion, or 3% of the world's GDP, with \$150 billion specifically being allocated to material providers. Some current areas of materials R&D include alternative sources of carbon-based materials, new energy storage and transport systems and new technologies to scale up renewable energy solutions.⁶⁹

Clean industry investing ideas

Green (or sustainable) packaging uses sustainable components such as paper or bio-plastics. The overall market is expected to grow at a CAGR of 14% over the period 2012-2016, driven by environmental concerns. Key players have also increased R&D to identify substitutes for traditional packaging while conserving structural integrity and permeability—two key barriers to change.⁷⁰

Companies focused on developing **new materials**—ranging from carbon nanotubes to electrochromic and biochromic glass (dimming with electrical input) to new low-carbon cement or drywall—represent areas for investor attention. A vibrant set of companies are working at reinventing the building block materials required by other industries.

Design and **supply chain innovation** is also of interest. In the mid-2000s, Walmart began demanding that consumer goods suppliers worldwide reduce their packaging, rethink how products could be more effectively delivered and sought to wring new efficiencies across the supply chain. It began assessing and comparing suppliers on a Sustainability Score Card. The company is now realizing billions of dollars in savings per year.⁷¹ Patagonia's reuse program (in which consumers are encouraged to sell back Patagonia clothing they no longer use) is another prime example of sustainable

⁶⁹ Deloitte. "Reigniting Growth Advanced Materials Systems", November 2012

⁷⁰ ResearchMoz.us. "Global Green (Sustainable) Packaging Market 2012-2016", May 2013

⁷¹ Kitsler, Matt. "Wal-Mart's Sustainability 360 approach", undated. See: <http://www.awarenessintoaction.com/whitepapers/Wal-Mart-Supply-Chain-Packaging-Scorecard-sustainability.html>

processes. Other recent examples include limiting non-recyclable components during process design to encourage recycling.

Rethinking product design is another important clean industry theme. Design software leaders such as Autodesk have incorporated life cycle assessment and other green tools into their widely-used product suites. Product designers can now iterate electronically and with a far better understanding of the environmental impact of their products—without actually having to create the products. A small industry of life cycle assessment design software add-ins is now flourishing.

New industrial processes aimed at requiring less power or toxins are another theme of clean industry. In mining, for instance, new hydrometallurgical or biological approaches to separate minerals from ores can reduce the need for large amounts of natural gas or electricity traditionally used, and can minimize the need for cyanide and other toxins that are often required, reducing the associated costs of their cleanup.

Simulation is gaining ground as a cost-effective way to reduce industrial expenses and emissions. In many heavy industries, aircraft-style simulators are now used to train equipment operators. This saves costs of running the actual equipment in the training process and teaches best practices, e.g. correct braking, which leads to reduced diesel fuel expenses, emissions and equipment maintenance.

Clean industry investment opportunities

| Large cap (\$10 billion+) companies | Industry |
|--|---|
| Sandvik (STO: SAND) | More efficient mining equipment |
| Autodesk (NASDAQ: ADSK) | Design software |
| Dassault Systemes (EPA: DSY) | Design software, manufacturing optimization |
| Walmart (NYSE: WMT) | Supply chain innovation |
| Merck (ETR: MRK) | Specialty materials & chemicals |
| Small cap or private companies | Industry |
| Metabolix (NASDAQ: MBLX) | Bio-plastics |
| Symphony Environmental (LON: SYM) | Bio-plastics |
| Dais Analytic Corp (OTCMKTS: DLYT) | Nano materials for environmental applications |
| Hexcel Corporation (NYSE: HXL) | Carbon fibers and other composites |
| Gurit Holding AG (SWX:GUR) | Advanced materials |
| Investable funds | Industry |
| SPDR Industrials ETF (XLI) | Major industrials fund |
| iShares MSCI ACWI ex US Industrials Sector Index Fund (AXID) | Major U.S. industrials fund |
| EGShares Industrials GEMS ETF (IGEM) | Major industrials fund |
| iShares MSCI Gbl Metals & Mining (PICK) | Mining industry-specific ETF |

Table 10: Representative public clean industry technology companies and funds. Source: Kachan analysis

Clean industry outlook

Like energy storage technologies, clean industry is a key enabler of many key clean technologies, like clean energy and transportation. Advances in materials science will continue to be central as building blocks of clean technology. Finally, look for continued efficiency improvements and reduced toxicity in industrial equipment and processes.⁷²

⁷² Kachan & Co. "Emerging Green Mining Innovation: Managing risk and profiting from new mining technology breakthroughs", September 2013. See: <http://www.kachan.com/report/green-mining>

Conclusion

Clean technology is more than clean energy. It is a theme that spans everything from cars to houses to water to agriculture to information systems to product packaging. It is deeply integrated into our everyday lives and businesses.

With pressure from consumers, shareholders and regulators, and a growing comprehension of the material risk to operations from population growth and increased resource constraints, corporations are increasingly focusing on making their business models more sustainable. They are seeing that increased efficiency equals lowered costs and higher profits. Further, companies that internalize these measures often tend to be more transparent in their operations and are more competitive and better positioned for the future.

Going forward, the fundamental drivers behind cleantech will only intensify. Resource scarcity, energy and resource independence, climate change, as well as changing policy and regulatory requirements are not passing fads, but are now part of our global framework. The markets for clean products and services will therefore only grow.

The major categories of cleantech innovations all represent exciting investment opportunities today. They can be fundamental technologies or enabling ones; innovation is occurring on the whole spectrum, from materials science to basic component parts, up to finished commercialized products. This, in turn, should be expected to lead to job creation and revitalization of local manufacturing clusters, further demonstrating the positive impact of clean technologies on the overall economy.

As companies move into mainstream markets, new products addressing specific niches will emerge. New funding models will apply. Companies will become more adept at commercializing their technologies. And as corporations augment the funding of traditional VCs and project financiers, companies will gain additional guidance to bridge from innovative technology to mainstream product.

We are just at the beginning of this phenomenon called cleantech. The best and most exciting investment opportunities are yet to come.

The best technologies and most exciting opportunities for wealth creation in cleantech are yet to come.

There's more information to be had beyond this document. Follow latest cleantech trends, companies, investment ideas and more at asyousow.org/cleantech-redefined or Kachan's cleantech data service cleantechwatch.com.

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Appendices

Company selection methodology

Companies that appear throughout in this document were selected on the basis of a number of factors, including the strength of their technology, propositions versus competitors, strength of their brands, amount and pedigree of their funding and management and/or positive recent share price movement. Companies in both the body and appendix of this document score generally favorably when screened against these criteria.

Certain high profile public companies widely believed to be overvalued (for example, Tesla Motors (NASDAQ: TSLA)) are intentionally omitted from our lists. In some cases, OTCBB companies doing legitimate business that we've been following for some time were identified despite their junior exchange.

Note that some large cap (\$10 billion+) technology companies identified in this document are integrating clean technologies into their offerings, often through recent acquisitions, but few are "pure play" cleantech in their categories.

A reminder that companies identified in this document are presented as representative, and their inclusion does not constitute an investment recommendation.

Private equity participation

This document focuses on public investment opportunities across the cleantech space. There are additional opportunities to invest in private companies. Private equity funds, omitted from this document for the sake of scope, are a way for institutional investors to explore these opportunities.

Private clean energy companies⁷³

| Company Name | HQ |
|-----------------------------|----------------|
| AltaRock Energy | USA |
| Aquamarine Power | United Kingdom |
| AW-Energy | Finland |
| Beta Renewables | USA |
| Blacklight Power | USA |
| Bloom Energy | USA |
| BrightSource Energy | USA |
| Elevance Renewable Sciences | USA |
| Emergya Wind Technologies | Netherlands |
| Enerkem | Canada |
| eSolar | USA |
| GlassPoint Solar | USA |
| Lilliputian Systems | USA |
| Moventas | Finland |
| Oceanlinx | Australia |
| OneRoof Energy | USA |
| Pelamis Wave Power | United Kingdom |
| Quiet Revolution | United Kingdom |

⁷³ For interested readers, other recommended resources for vetted private cleantech companies include finalists of the annual Cleantech Open business plan competition (see: <http://www.cleantechopen.org>) and the Global Cleantech 100, an annual juried roundup (see: <http://www.cleantech.com/global100/global-cleantech-100/>).

| | |
|------------------------|----------------|
| Sapphire Energy | USA |
| Seajacks International | United Kingdom |
| Silicor Materials | USA |
| Sub-One Technology | USA |
| Sundrop Fuels | USA |
| Sungevity | USA |
| SunRun | USA |
| Wello | Finland |

Private energy storage companies

| Company Name | HQ |
|--------------------------|--------|
| Ambri | USA |
| Aquion Energy | USA |
| Coda Energy | USA |
| Contour Energy Systems | USA |
| Cymbet Corporation | USA |
| Enevate | USA |
| Envia Systems | USA |
| Flexenclosure | Sweden |
| Fluidic Energy | USA |
| General Compression | USA |
| Ice Energy | USA |
| Imprint Energy | USA |
| Infinite Power Solutions | USA |
| Leyden Energy | USA |
| Nexeon | UK |
| Polyera | USA |
| PowerGenix | USA |
| Sakti3 | USA |
| Seeo | USA |
| Shocking Technologies | USA |
| Sion Power | USA |
| Solicore | USA |
| SustainX | USA |
| Temporal Power | Canada |
| VYCON | USA |
| Xtreme Power | USA |

Private efficiency companies

| Company Name | HQ |
|-------------------------------|--------|
| Alarm.Com | USA |
| Aligned Energy | USA |
| Aspen Aerogels | USA |
| Blu Homes | USA |
| Bridgelux | USA |
| C3 | USA |
| Calxeda | USA |
| Delta Electronics | Taiwan |
| Digital Lumens | USA |
| DIRTT Environmental Solutions | USA |
| eASIC | USA |
| Enlighted | USA |
| FINsix | USA |
| Getaround | USA |
| Gridco Systems | USA |
| GridPoint | USA |
| Intematix Corporation | USA |

| | |
|--------------------|-------------|
| Ista International | USA |
| Lemnis Lighting | Netherlands |
| Nest | USA |
| Next Step Living | USA |
| Noesis | USA |
| Nuventix | USA |
| Opower | USA |
| OSIssoft | USA |
| SuVolta | USA |
| Tendrill Networks | USA |
| Transphorm | USA |
| View | USA |
| Vivint | USA |

Private water companies

| Company Name | HQ |
|---------------------------------------|-------------|
| Agilent Technologies | USA |
| Aqwise | Israel |
| Atlantium | Israel |
| Biowater Technology | Norway |
| BiOWiSH Technologies | USA |
| Bluewater Bio | USA |
| Clean Runner | USA |
| Desalitech | Israel |
| Emefcy | Israel |
| Envirogen Technologies | USA |
| Epuramat | Luxembourg |
| EuroDrip | Greece |
| FilterBoxx | Canada |
| HaloSource | USA |
| Miox | USA |
| NanoH2O | USA |
| Oasys Water | USA |
| Orege | France |
| Organica Water | Hungary |
| Ostara Nutrient Recovery Technologies | Canada |
| TakaDu | Israel |
| Voltea | Netherlands |
| Water Standard | USA |

Private transportation companies

| Company Name | HQ |
|---------------------------------|---------|
| Acton | USA |
| Arcimoto | USA |
| Brammo | USA |
| Clean Motion | Sweden |
| Compact Power Motors | Germany |
| EcoTality | USA |
| EnerMotion | Canada |
| Electric Vehicles International | USA |
| Govecs | Germany |
| Gridtest Systems | USA |
| Hiriko | Spain |
| Loitech | Russia |
| Lyft | USA |
| Momentum Dynamics | USA |
| PaybySky | Canada |

| | |
|---|---------|
| Protean Electric | USA |
| Proterra | USA |
| Silex Power | Malta |
| Terra Motors | Japan |
| The Green Link | France |
| Torqueedo | Germany |
| VIA Motors | USA |
| Wireless Advanced Vehicle Electrification | USA |
| Xatori | USA |

Private agriculture companies

| Company Name | HQ |
|-------------------------|-------------|
| AgBiome | USA |
| Agradis | USA |
| AgroSavfe | Belgium |
| AquaBounty Technologies | USA |
| Arcadia Biosciences | USA |
| Aseptia | USA |
| Blue River Technology | USA |
| BrightFarms | USA |
| Ceradis | Netherlands |
| Cooke Aquaculture | Canada |
| Chromatin | USA |
| DripTech | USA |
| Earth Networks | USA |
| Emerald BioAgriculture | USA |
| Exosect | UK |
| Farmigo | USA |
| Gotham Greens | USA |
| Harvest Automation | USA |
| JDC Phosphate | USA |
| Kaiima | Israel |
| Kebony | Norway |
| NewLeaf Symbiotics | USA |
| Oxitec | UK |
| Purfresh | USA |
| RelayFoods | USA |
| Roka Bioscience | USA |
| Solum | USA |
| Vestaron | USA |
| Vive Nano | Canada |
| VoloAgri | USA |

Private air & environment companies

| Company Name | HQ |
|-------------------------|-------------|
| Akermin | USA |
| Atlantic Hydrogen | Canada |
| Brighter Planet | USA |
| Calera | USA |
| CarbonCure Technologies | Canada |
| Carbonflow | Switzerland |
| Earth Networks | USA |
| Eco Power Solutions | USA |
| Econic Technologies | UK |
| EmiSense Technologies | USA |
| Enterra Feed | Canada |
| Ethera | France |

| | |
|--------------------------------|--------|
| GR Green | Canada |
| Harvest Power | USA |
| H2Scan | USA |
| Leosphere | France |
| LP Amina | China |
| Netatmo | France |
| Novinda | USA |
| Odotech | Canada |
| Oxsensis | UK |
| Paragon Airheater Technologies | USA |
| Picarro | USA |
| Plasco Energy Group | Canada |
| Rive Technology | USA |
| Rypos | USA |
| Senscient | USA |
| Skyonic | USA |
| Westec Environmental Solutions | USA |

Private clean industry companies

| Company Name | HQ |
|---------------------------------|-----------|
| American Aerogel | USA |
| ARXX Building Products | Canada |
| Cambrios Technologies | USA |
| CeramTec | Germany |
| DeepFlex | USA |
| Ecosynthetix | Canada |
| EnerG2 | USA |
| FRX Polymers | USA |
| Intermolecular | USA |
| LanzaTech | USA |
| MC10 | USA |
| Metalysis | UK |
| Momentive Performance Materials | USA |
| Nanosteel | USA |
| Nanosys | USA |
| NatureWorks | USA |
| Novomer | USA |
| Plastic Logic | UK |
| Plaxica | UK |
| Polyera | USA |
| RungePincockMinarco | Australia |
| Sefaira | UK |
| Solidia Technologies | USA |
| Sustainable Minds | USA |
| TPI Composites | USA |
| Xeros | UK |
| Yulex | USA |

KACHAN

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Kachan & Co. is a cleantech research and advisory firm with offices in San Francisco, Toronto and Vancouver. The company publishes research on clean technology companies and future trends, offers consulting services to large corporations, governments and cleantech vendors and connects cleantech companies with investors. Kachan staff have been covering, publishing about and helping propel clean technology since 2006.

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www.endowmentethics.org