KANSAS

CLEANTECH STRATEGIC PLAN

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Introduction

As the global economy struggles to recover and unemployment rates remain stubbornly high, governments at all levels must address large budget deficits driven by decreasing revenue from economic activity. Against this backdrop, many states are also examining clean energy as the next wave of innovation and growth for their economies. The cleantech sector has emerged as a potential new job creator in the midst of a prolonged recession. While the industry's expansion faces many obstacles in terms of financing and market development, cleantech is regarded by many industry analysts as a future economic bright spot that will help stimulate innovation and provide high quality job opportunities.

The state of Kansas and Kansas-based businesses can reap many benefits from successfully competing in emerging cleantech markets. The simplest rationale for this effort is that it makes strong business sense. While some cleantech markets are currently volatile, the long-term trends all appear to be quite positive. Analysts project significant growth across a variety of cleantech-related industries. As smart grids and other cleantech-related infrastructure come on line, and traditional energy sources continue to be depleted, market demand for cleantech products, services, and technologies should grow rapidly.

Additional benefits accrue from the wide diversity of cleantech markets. While all of these sectors have a sustainability focus, they represent a broad set of industry sectors and clusters. Water management, waste reduction technologies, green building design, and wind power are all considered cleantech sectors. Yet, their markets are quite different and distinct. Moreover, these sectors can provide a diverse array of jobs in services, manufacturing, and operations/maintenance. As such, growth of cleantech can help create a more diverse and resilient business base as well as a new set of employment generators for Kansas.

Finally, and perhaps most importantly, support for cleantech sectors makes sense on policy grounds. If Kansas, and the US as a whole, hope to achieve a more secure energy future and address the challenges of climate change, "business as usual" is no longer sufficient. New industries must emerge and create products, services, processes, and technologies that meet market demands in more sustainable manner. Kansas has the capacity to be a national leader in this effort.

Methodology

In September 2010, the Kansas Technology Enterprise Corporation (KTEC) embarked on a project to complete a cleantech assessment and strategy for Kansas. The project's overall objective was to identify where Kansas has comparative advantages in markets and enabling technologies relating to cleantech, and to recommend preliminary strategies that the state might deploy to accelerate growth in these markets.

Cleantech markets are broadly defined. Clean Edge, a cleantech research firm, defines it as "a diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and cut or eliminate emissions and wastes."[1] In late September 2010, the US Bureau of Labor Statistics (BLS) released its own definitions that will be used to

1 www.cleanedge.com

guide government policy toward the green economy in the future, encompassing 333 different industry categories.[2]

We grouped cleantech segments into four major categories consistent with those used by the BLS and national cleantech organizations.

- Water and Environmental Management (including solid and hazardous waste, testing, remediation, pollution prevention, etc.)
- Renewable Energy Generation, Storage and Transmission (wind, solar, geothermal, energy storage systems, smart grid, etc,)
- Energy Efficient and Bio–Based Products (building materials and lighting, bio plastics and biodegradable materials, etc.)
- Clean Transportation and Fuels (vehicle technologies, batteries, ethanol, biodiesel, etc.)

Table 1: Cleantech Market Categories

	Examples of Key Markets	Participating Industry Sectors
Water & Environmental Management	▪ Water (management, distribution and treatment) ▪ Irrigation systems ▪ Waste management & minimization; ▪ Waste to energy recovery ▪ Environnemental remediation & compliance; pollution prevention ▪ Sustainable site design, analyses, and construction	▪ Engineering services ▪ Environmental services ▪ Analytic and testing services ▪ Machinery and equipment mfg ▪ Chemical mfg ▪ Agriculture and natural resource management ▪ Fertilizer, pesticides and agricultural chemicals
Renewable Energy Generation, Storage and Transmission	▪ Renewable generation ▪ Energy transmission ▪ Smart grid ▪ Demand/response management ▪ Storage and battery technologies	▪ Utilities ▪ Energy ▪ Agriculture ▪ Engineering services ▪ Geophysical services ▪ Machinery and equipment mfg. ▪ Electrical components and systems mfg. ▪ Information technology and communications
Energy Efficient and Bio-based Products	▪ Energy efficient/green building materials ▪ Low energy lighting ▪ Monitoring and control systems ▪ Biochemicals and bioproducts ▪	▪ Utilities ▪ Energy ▪ Architectural and engineering services ▪ Chemical mfg ▪ Measurement & test systems ▪ Engineered wood products ▪ Electrical components and systems mfg
Clean Transportation and Fuels	▪ Electric vehicles ▪ Hybrid vehicles ▪ Fuel cells for vehicles ▪ Clean fuels	▪ Transportation equipment mfg. ▪ Machinery mfg. ▪ Chemical mfg. ▪ Agricultural crop production

2 More information on these Bureau of Labor Statistics findings can be accessed at: www.bls.gov/green

Phase I: Identify Opportunities

The project sought to address the following questions:

- What cleantech markets best align with the research and industry assets in Kansas?
- What are other states doing to grow cleantech industries and what challenges does Kansas face?
- What can Kansas do to more rapidly commercialize research and grow new jobs and businesses in cleantech sectors?

To answer these questions, we first gathered information on domestic and international market and trends for various cleantech segments. We then analyzed Kansas' existing cleantech landscape by industry job and firm growth, occupational data, patent data, venture capital investments, university research and related information. We added a set of qualitative data points gathered from a survey sent to Kansas companies currently in or expanding to cleantech markets, and also gained input from over seventy interviews conducted in person and by phone. As a final step, we compared market trends data with our assessment of Kansas' cleantech strengths and weaknesses to better understand the potential for the state.

Figure 1: Potential Cleantech Market Opportunities for Kansas

We identified five areas (Figure 1) where Kansas appears to be positioned to capitalize on the growth of cleantech markets: wind energy, next generation biofuels, bioproducts and bioprocesses, information and communication systems, and integrated engineering services.

This combination of sectors offers economic opportunities at various stages of industry development: the development of new products, the production of goods, and the deployment of technologies and services. This continuum of jobs beyond research is important since the majority of new jobs will likely be created by the deployment, rather than the development, of technologies.

Phase II: Developing Strategies for Seizing Cleantech Opportunities

After completing this initial market assessment, the project team then worked to develop strategies that could assist Kansas-based firms in capitalizing on these emerging opportunities. This assessment examined innovative public policies and support programs already operating in Kansas, across the US, and abroad. We reviewed successful initiatives with a specialized focus on cleantech and green-related industries, as well as efforts that target technology-based sectors more generally. We also assessed lessons learned from ongoing and past technology programs operated by KTEC and other Kansas-based organizations.

We supplemented this review with interviews of key stakeholders to gain their perspectives on how KTEC and Kansas can best support new start-ups and existing businesses seeking to enter or expand into cleantech markets. These ideas and recommendations were then vetted by an advisory group of more than 25 key partners convened by KTEC in late 2010.

The work of this project is highlighted in this strategy document and an accompanying ***Findings Memo***. The Findings Memo provides a detailed analysis of national and global markets for cleantech; evaluations of patents, venture capital investment and Kansas' workforce; as well as an assessment of university research related to cleantech being conducted in the state. This strategy document summarizes previous findings into a strategy framework, which can help KTEC and its partners pursue opportunities for growing cleantech research and companies. It is divided into two parts:

Part One: Kansas' Cleantech Opportunities

- A review of Kansas' assets and challenges related to cleantech
- A market summary that associates Kansas' assets with different cleantech opportunities

Part Two: Kansas' Cleantech Strategy Framework

- Highlights of programs and policies being used by other states to understand the scale of competition
- Recommendations for moving ahead

Kansas' Cleantech Assets and Challenges

Kansas is already home to many cleantech jobs. A 2008 US Conference of Mayors report predicted that by 2038, Kansas' five largest metropolitan areas would be home to 31,399 workers in cleantech industries.[3] In 2009, the Pew Charitable Trusts identified 8,017 green jobs in Kansas and noted that, between 1998 and 2007, green jobs had grown by 51 percent while statewide employment dropped 0.3 percent. [4] Kansas' annual green job growth rate of 4.7 percent ranked as the sixth highest growth rate in the US. The most recent (and most thorough) analysis can be found in the *2009 Kansas Green Jobs Report* produced by the Kansas Department of Labor which identified over 20,000 Kansas-based cleantech jobs across an array of industries.[5]

Identifying opportunities to accelerate that cleantech job growth and attract a more robust supply chain of related manufacturing and professional services, requires an understanding of the state's assets and challenges, especially in areas where Kansas has strong assets. This section reviews Kansas' cleantech landscape based on interviews, surveys and research conducted in the state. Details and additional data analysis can be found in the Findings Memo.

Assets

Kansas' industry and workforce base is well suited for multiple cleantech markets

Cleantech encompasses a variety of industry sectors, many of which not only exist in Kansas, but have high concentrations of employment and/or skilled workers that can be an attractor for companies. For instance, the state's natural assets in wind capacity and feedstocks for biofuels have played a significant role in the development of energy and fuel markets. The state is home to international leaders in engineering services and has high concentrations of agricultural, civil, and mechanical engineers and technicians. These occupations support the development of biofuels, water conservation and infrastructure replacement, site planning and construction for energy projects, integrated building systems management, etc. Information technology and communications' growing role is equally disbursed among cleantech sectors supporting smart grid, smart metering, remote resource management systems, demand-response systems and more. Not only does Kansas have twice the national employment rate in telecommunications, it has the array of highly skilled workers to support information technology opportunities, and a significant amount of industry R&D and patent development. As Figure 2 indicates, cleantech related firms are located in regions across the state.

The state's manufacturing sector can also play a pivotal role in cleantech. Kansas' manufacturing sector is 40 percent more concentrated than the national average. More impressively, these occupations enjoy higher than average employment rates. Precision manufacturing occupations are widespread in Kansas with numerical control and process control programmers 2.5 times more concentrated than the US average. Assemblers of electrical systems, tool and die makers, CNC machine operators, fabricators and engine and machine assemblers are all more concentrated than US averages.

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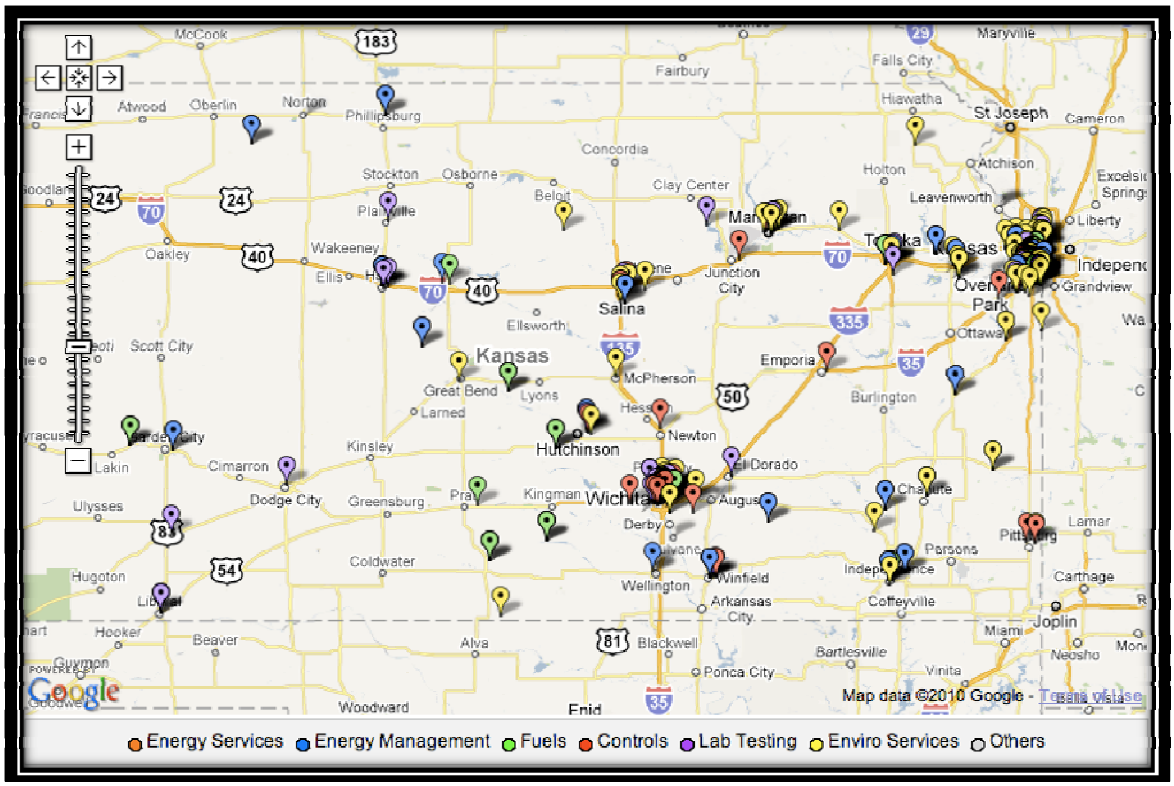
3 US Conference of Mayors, *Green Jobs in U.S. Metro Areas.* (Washington DC: USCM, October 2008).

4 Pew Charitable Trusts, *The Clean Energy Economy, Repowering Jobs, Businesses and Investment Across America*, (Washington, DC: Pew Charitable Trusts, 2009).

5 Kansas Department of Labor, *2009 Kansas Green Jobs Report*, (Topeka: Kansas Department of Labor, 2010).

Figure 1: Distribution of Kansas Cleantech Industry Sectors[6]



Kansas' research institutions have leading edge R&D initiatives

Throughout the state, there are examples of leading edge research related to cleantech. This is especially true in biofuels and vehicle performance with biofuels; biochemicals and bioproducts; composites and advanced materials; information technology, data processing and communications platforms; and water conservation and resource management systems. In many sectors, research exists in multiple institutions providing opportunity for larger scale projects and collaboratives that would be attractive to federal and private sector funding. Several research initiatives have progressed along the commercialization pathway and hold strong patent positions.

Of particular interest to this project is the high level of industry engagement in research through sponsored research and advisory councils, thereby highlighting the commercial potential associated with this research. While some of the companies engaged in university research are resident in Kansas, most are not. This could present an opportunity to engage companies in prototype and manufacturing facilities in Kansas. Research is also supported by testing and modeling facilities like the Advanced Manufacturing Institute (AMI), the Transportation Research Institute (TRI), National Institute for Aviation Research (NIAR) and the Information Technology and Telecommunication Center (ITTC).

[6] Firm location data was developed by review of businesses listed in the InfoUSA database.

Kansas' overall business climate provides a positive foundation for growth

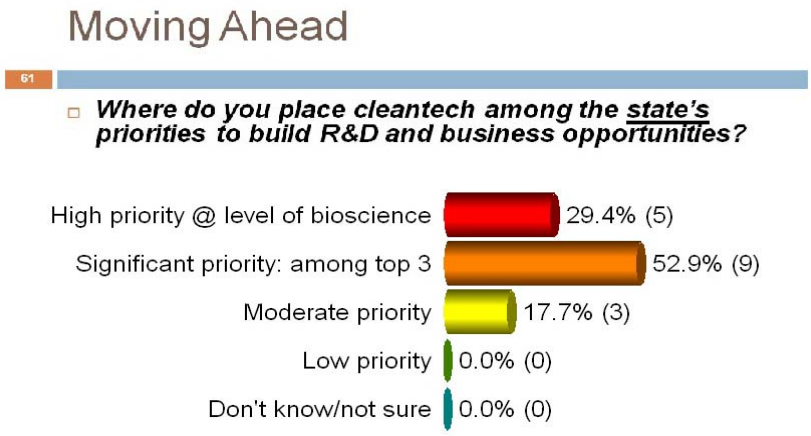
Our interviews and survey results indicate that Kansas has an overall positive business climate for companies. For its size, the state has a highly skilled workforce as documented by the concentration of professional and technical occupations, and the above average number of science and engineering doctorates awarded in the state. There are a number of well-established state programs and incentives for workforce development, manufacturing incentives, and facility and equipment expansion and retooling. For example, site selection consultants recently ranked Kansas as the third best state in the US for the quality and attractiveness of its workforce development incentives.[7] Similarly, Kansas ranked number ten in the US in the latest *Forbes* ranking of the "best states for business."[8]

Kansas' cohesive leadership around other sectors provides a strong working model for Cleantech

Kansas has shown the ability to rally leadership and resources behind a cohesive economic strategy for job growth. This occurred in biosciences and within the subsector of biofuels. In a recent strategy session for cleantech, key economic development and research organizations from around the state noted that because of the strong job growth potential in various industries and given the array of worker skills, cleantech should be one of the state's top three priorities. Furthermore, these organizations identified themselves as a key partner or champion for various programs within a statewide strategy. This is an important indication of the willingness for organizations to make this a priority and be an active part of a statewide effort.

Figure 2: Priority of Cleantech as a State Strategy

(As prioritized by economic and business groups, government agencies, and universities)



7 Geraldine Gambale,"Top States for Doing Business: A Survey of Site Selection Consultants," *Area Development Magazine*, September 2010.

8 "The Best States for Business," *Forbes*, October 13, 2010.

Challenges

Kansas support for commercializing research is not competitive and can limit cleantech and other technology-based opportunities

Kansas universities have well established research programs in cleantech fields from biofuels, to advanced materials, biochemicals, water conservation, information technology, and more. Yet, throughout this project there were examples of commercialized research efforts stagnating because of insufficient proof of concept funds, and technology transfer offices thar had limited resources to develop the potential intellectual property coming from this research.

In addition to our findings from interviews and site visits, national data also reinforces the fact that commercial potential for research is being under-realized. Kansas' is strong in academic R&D per gross domestic product and the state has above average performance in the number of science and engineering doctorates conferred. Yet, the state's performance in translating this research to patents in well below the national average. Only 47.2 percent of the state's academic funding came from federal sources, ranking Kansas 44th among all states in the percentage of university research from federal funding.[9] If the percentage of federal R&D funds were raised to the US average of 60.2 percent, this would equate to an additional $62 million annually for state research.

Table 2: Academic R&D Measures

	Year	Kansas	US Avg.
Academic R&D per $1,000 of Gross Domestic Product	2008	3.29	3.66
S&E Doctorates Conferred per 1,000 S&E Doctorate Holders	2006	63.5	46.9
Academic S&E Article Output per $1 Million of Academic R&D	2008	3.2	3.24
Academic Patents Awarded per 1,000 S&E Doctorate Holders in Academia	2006	1.5	11.6

Source: National Science Foundation

Commercializing research is not limited to universities; industry conducts on average ten times more research than universities each year.[10] Much of the funding for this research comes from the federal government that has long been a primary funder of research and new applications of technologies. Kansas R&D support from federal sources is very weak. In Kansas, federal R&D obligations per worker and per individual in science & engineering occupations are approximately one-fifth of the US average, while state support of R&D is above the US average.

9 National Science Foundation, *State R&D Profiles*. Available at: http://www.nsf.gov/statistics/states/

10 Calculations using data from the National Science Foundation State R&D Profiles

Table 3: Industry R&D Measures

	Year	Kansas	US Avg
R&D as Share of Gross Domestic Product	2007	1.45	2.62
Federal R&D Obligations per Civilian Worker	2007	174	764
Federal R&D Obligations per Individual in S&E Occupation	2007	4,936	19,888
State Agency R&D Expenditures per $1 Million of Gross Domestic Product	2007	100	89
State Agency R&D Expenditures per Civilian Worker	2007	8.28	8.42
State Agency R&D Expenditures per Individual in S&E Occupation	2007	235	219
Business-Performed R&D as Share of Private-Industry Output	2007	1.3	2.2

Source: National Science Foundation

Kansas companies are not pursuing and winning federal Small Business Innovation Research (SBIR) awards at the same rate as other states. In 2009, Kansas received 14 Phase I awards or .3 percent of the total for all states; one-third the US average for states. Many states have structured and ongoing programs to assist companies in understanding and pursuing SBIR awards. Kansas, however, has very limited assistance for companies seeking SBIR funding.

Kansas support structure for entrepreneurs is in place, yet not positioned to scale

Kansas was one of the first states to embrace technology-based economic development, and established KTEC in 1987 to spur the growth of high value research and companies. Over time, other states have developed similar structures and have funded these efforts at a level per capita that now exceeds Kansas' recent investments. While Kansas does invest considerable amounts in biosciences, the amount for other technology-based sectors (which comprises the majority of tech-based employment) is small in comparison. There is a real potential advantage for Kansas to increase investment in sectors like cleantech since many of the opportunities can be brought to market sooner than most biosciences and often require less startup capital to reach profitability.

Throughout the state, there are organizations and programs in place, yet they operate at a scale that reaches only a limited number of businesses or entrepreneurs. These include KTEC's award-winning Pipeline program, KTEC's incubators and entrepreneurial centers, Mid-America Manufacturing Technology Center (MAMTC), and Advance Manufacturing Institute (AMI). In our interviews, companies spoke highly of the quality of services provided by and coordination among these organizations. Given that many states similar in size to Kansas do not this breath of services, this could be a real advantage for the state in their quest to seize new market opportunities.

Availability of capital continues to be a challenge, especially for start-ups and small firms

The availability of capital is a critical factor for business development and growth. These capital needs range from proof of concept funding that helps move promising research to marketable products, to seed funding for start-up businesses backed by public and angel investors, to early stage growth funding provided by sources such as venture capital. Kansas has a competitive angel tax credit, and by most accounts, a fairly strong angel investment network. Yet funding prior to and following this seed stage investment is lacking in Kansas.

Proof of concept and pre-seed funds are important because they prime the pump and build a pipeline of deals to attract angel and other private investment. Without this funding, the deal flow remains low and

the ability to then attract angel, let alone larger venture funding, is even more restricted. If there is one area of funding where the state could have significant impact on the growth of cleantech and related firms, it would be to increase the level of proof of concept and seed funding that is available for sectors outside of biosciences. These funds have shown impressive leverage in Kansas and in other states—typically attracting 10-20 times the amount of private follow-on investment for every state dollar.

Policies and incentives are in place for sectors like biofuels, yet are not competitive for other cleantech sectors

While there is an extremely competitive international leadership race in cleantech, there is an equally (if not more) competitive race among the states – one in which Kansas is only minimally involved despite its vast potential. According to many assessments, Kansas is lagging in the development of key cleantech sectors such as renewable energy and smart grid technologies. For example, the American Council for an Energy-Efficient Economy recently ranked Kansas 46th in the US in its ranking of the most energy efficient states.[11] Similarly, the American Wind Energy Association ranks Kansas as number two in the nation in terms of wind energy capacity, yet the state ranks 14th in actual wind energy production.[12]

Within the US, those states with aggressive incentives linked to renewables and energy efficiency are gaining competitive advantages in business development and job creation. While the top tier[13] of states who are seeing cleantech job and investment growth have an average of thirty-two financial incentives for wind and solar renewable energy generation, Kansas only has seven; that same top tier of states has an average of eleven government and utility rules, regulations and policies that promote wind and solar, whereas Kansas has only five.[14]

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11 American Council for an Energy-Efficient Economy, *The 2010 State Energy Efficiency Scorecard*, (Washington, DC: ACEEE, October 2010).

12 Steve Everly, "Kansas Slips a Notch in State Rankings of Wind Energy Production," *Kansas City Star*, April 15, 2010. Available at: http://blog.climateandenergy.org/2010/04/15/kcstar-kansas-slips-a-notch-in-state-rankings-of-wind-energy-production/

13 2010 top tier states, defined by Clean Edge, Inc. based on the competitiveness of state incentive and support programs, are AZ, CA, CO, CT, FL, IL, MA, MD, MN, NJ, NY, OR, PA, TX and WA. Rankings can be found in Clean Edge, Inc, *A Future of Innovation and Growth: Advancing Massachusetts' Clean Energy Leadership*. Report prepared for Massachusetts Clean Energy Center, April 2010.

14 Database of State Incentives for Renewables and Efficiency, 2010. Available at: http://www.dsireusa.org/

Market Overview

This section highlights market trends in cleantech and connects these trends to the assets and challenges in Kansas, focusing on the five identified opportunity areas. A more detailed analysis of these markets can be found in the Appendix and the November 2010 Findings Memo.

Our findings indicate that cleantech markets are being driven by three factors: 1) the need for new energy sources, 2) increasing consumer demand, and 3) government regulations. These factors affect an array of sectors and are projected to drive market growth worldwide. Examples of these macro trends include the following:

- Between 2008 and 2035, US domestic energy consumption is expected to grow by an additional 14 percent.[15] According to the Energy Information Administration, in 2008, fossil fuels accounted for 84 percent of total energy use. They are projected to account for 78 percent of total energy use by 2035. Renewable energy sources will be the primary new source of energy production during this time frame.[16]
- Industry analysts have estimated that global sales in the water sector reached $475-500 billion in 2008, with $100 billion in industrial segments; additionally, growth rates in China, India, Brazil and Russia were occurring at two to three times the industry average.[17]
- The US green building market value is slated to balloon from $71.1 billion this year to $173 billion by 2015, according to a recent study by Environmental Leader, Inc.[18] Commercial green building is expected to grow by 18.1 percent annually during the same time period—from $35.6 billion to $81.8 billion.

Cleantech growth is also being fueled by a combination of government, corporate and venture capital investments. For example, approximately $100 billion of the $787 billion US stimulus package in 2009 was awarded to cleantech projects.[19] China has committed to spending between $440 billion to $660 billion toward its clean-energy build out over the next ten years.[20] According to Deloitte & Touche, corporate investment announcements for cleantech reached a new high of $5.1 billion in the first half of 2010, a 325 percent increase from the same period in 2009. Finally, venture capital investments saw record highs in the first two quarters of 2010 (approximately $2 billion per quarter worldwide), followed by a significant drop in the third quarter as investors supported fewer and smaller deals.

As cleantech markets begin to mature, and technologies move from pilot stages to scalable projects, we are seeing consolidation and thinning out of companies, especially in the energy sectors of wind and solar. As sector specific technologies are put in place (e.g. wind generation), it pushes the development for technologies that cut across sectors, like information technology platforms for "smart" applications. These trends are also pushing the need for integrated design and engineering solutions such as projects that seek to address both energy and water issues together. The need for both cross-platform technologies and integrated engineering solutions play to Kansas' strengths.

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15 U.S. Energy Information Administration, *Annual Energy Outlook 2010* (Washington, DC: US Department of Energy, 2010).

16 Ibid, p. 56.

17 Environmental Business Journal, 2010 Environmental Services Industry

18 Environmental Leader Insights, July 2010 www.environmentalleader.com/2010/07/01/green-building-market-to-hit-173-5-billion-by-2015

19 Pew Center for Global Climate Change," US Department of Energy's Recovery Act Spending", December 2009.

20 Robert D. Atkinson et al. "Rising Tigers, Sleeping Giant," (Washington, DC: Information Technology and Innovation Foundation, November 2009). Available at www.itif.org.

Wind Energy

In 2009, the size of the global wind sector was $63.5 billion.[21] According to Clean Edge, Inc., the global wind power market could grow from $63.5 billion in 2009 to $114.5 billion in 2019.[22] As the most mature renewable energy source, wind energy is enjoying high growth in locations where there is a combination of capital, national standards, and incentives. US domestic growth has slowed this past year due to lower capital availability and uncertainty surrounding national standards and incentives. The industry is also heavily dependent on federal standards and funding for help with critical infrastructure development such as recent federal investments in transmission development and smart grid integration for rural energy generation to access population centers.

Kansas is recognized as the #2 state in the nation for wind energy generation potential.[23] Kansas also is home to wind energy research capacity with the Wind Applications Center at KSU and the National Institute for Aviation Research at WSU. Additionally, Kansas has abundant skilled labor in key professions critical for the industry's growth: manufacturing, utilities, communications, electronics and engineering. Companies who have significantly invested in Kansas wind opportunities include Siemens, Acciona, Clipper Windpower, GE Energy, Nordex, Suzlon, Vestas, Enertech and Westar Energy.

Even though Kansas has significant wind opportunities, the state falls short of its job creation and energy generation potential in this sector. Kansas is ranked #14 in the nation for wind power production despite its strong capacity for generation. Factors influencing this shortfall include its current renewable energy incentives and standards, a lack of capital for new projects, and the lack of grid connectivity to major markets.

Biofuels

The United States is second in the world in the production of biofuels. Sales reached $44.9 billion in 2009 and are projected to grow to $112.5 billion by 2019. Worldwide, the United States, Brazil, and the European Union are the three largest biofuels markets in terms of volume. Biofuels now provide more than 50 percent of the fuel by volume that powers Brazil's road transportation vehicles with gasoline engines. The US is the second largest producer of biodiesel in the world, producing 17.7 percent of the world's biodiesel output in 2009.[24] The EPA announced in October that it would increase the allowable ethanol content of gasoline to 15 percent for newer vehicles produced since 2007, which industry analysts believe will spur even faster growth. Furthermore, the US military has set a biofuel target of 50 percent usage by 2016, which will be a major consumer and catalyst for biofuels.[25]

Nationally there are over 200 biofuel refineries producing ethanol. In 2009, these refineries produced 10.6 billion gallons and used 3.8 billion bushels of corn from farmers. To put this in perspective, Kansas ranks eighth in the US for production of biofuels with 12 Ethanol and 3 biodiesel plants (and 3 new ethanol plants currently under construction). Leading companies in biodiesel and ethanol production include Abengoa, Conestoga, East Kansas Agri-Energy, Everton, Kansas Ethanol, Western Plains Energy,

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21 Ron Pernick, et al. 2010, *Clean Energy Trends 2010.*

22 Clean Edge, Inc., "Clean Energy Trends 2010" (March 2010)

23 US Department of Energy, *80-Meter Wind Maps and Wind Resource Potential* .2010. Available at: http://www.windpoweringamerica.gov/wind_maps.asp

24 Energy Information Administration, *Annual Energy Outlook 2010.*

25 US Department of Defense, *"DOD Goes Green"* http://www.defense.gov/home/features/2009/0809_green/archive.html (2010)

US Energy Partners, and POET Ethanol. Kansas' ability to produce significant quantities of corn, soybeans, and sunflowers enables this industry to have ample raw material for biofuels production.

Kansas has an above-average concentration of agricultural production and an array of chemical manufacturers. Kansas is also home to many industry leaders in supporting industries such as Colwich-based ICM, which is one of the world's largest designers and builders of biofuels facilities. Additionally, the Center for Sustainable Energy at Kansas State University, the Transportation Research Institute (TRI) at the University of Kansas and the Center for Environmentally Beneficial Catalysis (CEBC) at the University of Kansas give the state an intellectual advantage in research focused on next generation fuels, engine performance and the developing of high value products from biorefining.

The challenge for Kansas will be maintaining a leadership position by encouraging significant R&D investment and making sure that there is an ample supply of the capital for large project financing.

Bioproducts & Bioprocesses (including Carbon Mitigation/Sequestration)

Many market analysts are bullish on future markets for biochemicals and bioplastics. A 2009 study projects that 3 percent (about $100 billion)[26] of the world chemical market is now based on bio-based feedstock or on technologies that use fermentation, enzymatic conversion, or some combination of them. However, by 2025, this proportion is expected to jump to 15 percent of the total market due in large part to increasing demand for the application of novel materials for removal of toxic substances and sequestration of CO2.[27]

Bioproducts currently in production experiencing include high value alcohols, resins, chemicals and bioplastics. Chemical biorefineries based on various platforms such as cellulose, oil, glycerin and algae are currently in the pilot stage. Bioprocesses being explored include ways in which manufacturing processes can significantly lower energy use through biological agents, as well as ways to capture and store carbon. Given the growing concern about climate change, bioprocesses will be at the forefront of solutions.

Kansas enjoys assets that are critical for establishing leadership in the bioproducts and carbon mitigation field: large agriculture industry for feedstock, a higher than average concentration of manufacturing workforce and businesses with chemical manufacturing expertise. In addition, Kansas' Universities conduct leading-edge research in bioproducts and bioprocesses: The University of Kansas houses both the Center for Environmentally Beneficial Catalysis (CEBC) and the Bioengineering Research Center. Kansas State University is home to the Bioprocessing and Industrial Value Added Program Pittsburgh State University houses the National Polymer Research Center

However, Kansas has two critical challenges if this industry is to achieve its potential. It needs to better connect industry sponsored research to long-term production opportunities within the state, and help provide the proof of concept funding that will continue to attract corporate investment.

Information & Communication Technologies

As smart monitors and integrated communication systems are increasingly combined with design and engineering solutions, the outlook for this market is relatively healthy. Information and communication technologies are playing a more central role in a variety of cleantech sectors, including smart grid

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26 Chemical and Engineering News, July 2009, p. 26-28.

[27] ibid, p. 26

applications, energy monitoring of buildings, mobile and onsite water treatment, smart appliances, and more. Global investment in smart grids, including smart meter implementations as well as upgrades to the transmission and distribution infrastructure, will approach $46 billion by 2015, according to the latest forecasts from ABI Research.[28] Pike Research estimates $200 billion in cumulative investment between 2010 and 2015 when equipment and installed services are considered.[29] Lux Research reports that the measurement and communication segment is expected to top $5 billion by 2015. The analysis and services segment is poised to grow from the current $1.4 billion to $6.7 billion by 2015. Led by demand response applications, analysis and services revenues could make up the largest piece of the smart grid pie by 2015, according to Lux Research.[30]

Kansas is well positioned in this market. The state's telecommunication industry has more than twice the employment per capita than the national average. Communication and data processing patents by Kansas industry was the highest of all patent categories with over 890 patents between 2005 and 2009. The industry also has significant levels of existing workforce strengths in this field highlighted by a high concentration of jobs in electrical engineers, network and computer systems and computer programmers. Kansas' Universities host the intellectual capital to support this sector at two nationally recognized research facilities: The Information and Telecommunication Technology Center (ITTC) at the University of Kansas researches many areas of interest in this field, including high-capacity networks, optical systems, software-defined radios, innovative transmitter and receiver design and robust mobile networks; and the Power Systems Group at Kansas State University is engaged in several initiatives related to power systems, such as more efficient energy transmission from renewable energy sources.

Since this sector is attracting large amount of private capital, yet takes less capital and time to reach market than biosciences, information and communications technologies can be a strong complement to current state investments. To take full advantage of this sector, Kansas should consider ways to provide greater support for development and testing of new technologies, and provide more focused seed and early stage funding for new companies.

Environmental & Engineering Services

In recent decades, global water demand has increased at a rate twice that of global population growth, creating new markets for effective water management and conservation systems and technologies.[31] Industry analysts have estimated that global sales in the water sector reached $475-500 billion in 2008, with $100 billion in industrial segments alone. In the US, the Environmental Protection Agency estimates that the cumulative water infrastructure investment could reach $170-$500 billion through 2025.[32] The Environmental Business Journal[33] estimates that, in 2008, environmental services including solid waste management, testing, pollution prevention, remediation, and hazardous waste management generated approximately $170 billion in revenues in the US.

Kansas is well positioned in this industry due to its high concentrations of electronic, mechanical, and civil engineers, as well as support skills including GIS, mapping and surveying. Kansas is also headquarters for international companies in engineering services such as Black & Veatch, Burns & McDonnell and others already working in energy, water, and telecommunications sectors.

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28 ABI research, "Smart Grid Applications: Smart Meters, Demand Response, and Distributed Generation", July 2010

29 New Energy World Network, "Lack of definition means smart grid market size still up for debate," September 6, 2010

30 Lux Research, "Smart Grid Opportunities Set to Explode", February 2, 2010

31 McKinsey & Company, *Charting Our Water Future*, , 2009

32 United States Environmental Protection Agency, *Clean Watersheds Needs Survey Overview*, 2008

33 Environmental Business Journal, *US Environmental Industry Overview Report*, 2010

While R&D applications are fewer than other sectors, engineering services has strong conditions for high-wage job growth and application of cleantech systems, especially for industrial and municipal markets. Unlike other cleantech opportunities, this sector is less dependent on investment capital and incentives, being more dependent on municipal and state spending on infrastructure and regulation of land use and environmental conditions.

Table 4: Summary of Kansas' Cleantech Opportunities

	Wind Energy	Next Generation Bio-Fuels	Biochemicals and Bioprocesses	Information & Communications Technologies	Integrated Engineering Services
Market Trends	International growth is high in locations where there is a combination of capital, national standards and incentives. US domestic growth has slowed this past year due to less capital availability and uncertain standards and incentives. New transmission grid development and smart grid integration are enabling rural production access to larger population centers.	Biofuels reached $44.9 billion in sales in 2009 and are projected to grow to $112.5 billion by 2019. The EPA has a goal of 36b gallons of biofuels in the market by 2022. EPA announced in October that it would increase the allowable ethanol content of gasoline to 15% for newer vehicles produced since 2007, which industry analysts see as a precursor to growth.	National and international pressures on carbon footprints are directing R&D toward bio-based chemical and plastics; costs of energy and high carbon emitting industries like chemicals and refineries are looking for production processes that require much less energy and produce fewer toxic by-products.	Smart grid, utility and water metering, remote resource management systems, demand-response controls and other advances in cleantech will require the integrated of information and communication systems. Significant interest by venture capital and corporate investors.	Large and steady markets for water/waste water infrastructure; growing markets for integrated energy-water solutions; alternative energy deployment will require significant assessment, engineering and project management work; Environmental solutions moving form end-of-pipe treatment to in-process prevention and control.
Innovation/ R&D	The Kansas Wind Applications Center at KSU does research in wind energy generation efficiency, applied computer and electric engineering, electric power systems. WSU's NIAR has research in wind energy composite manufacturing, nanocomposites and nanocoatings and health monitoring of composite structures.	Next generation biofuels in three platforms: alcohols synthesis from syngas; refining biomass pyrolysis oils, and catalytic reforming of lignocellulosic carbohydrates Ability to refine, model and test different fuels and blends; test fuels in various engine designs, and measure efficiency and emission of fuels.	Strong university research in bio-chemicals and catalysis; research in thermochemical processes that reduce energy in production processes Design and application of novel materials for removal of toxics and sequestration of CO2 Good patent positions for multiple research platforms.	Kansas' leading sector for industry R&D (over 890 patents between 2005-2009). Development, test and modeling on high capacity networks, optical systems, and mobile networks across a wide range of mediums. Conducts research in radar and other electromagnetic sensing, processing, and simulation.	Growing connection between engineering companies and university research at both KU and K-State for advancements in environmental and mechanical systems.
Available Workforce skills	Strong workforce skills in manufacturing, electronics and engineering.	Agricultural production and chemical manufacturing are strengths for Kansas.	Manufacturing workforce available; Below average employment in chemical & materials engineers;	Above average concentration of network professionals and IT related computer systems; high number of telecom line installers and other deployment skills.	High concentrations of electronic, mechanical, and civil engineers, as well as support skills including GIS, mapping, surveying, etc.

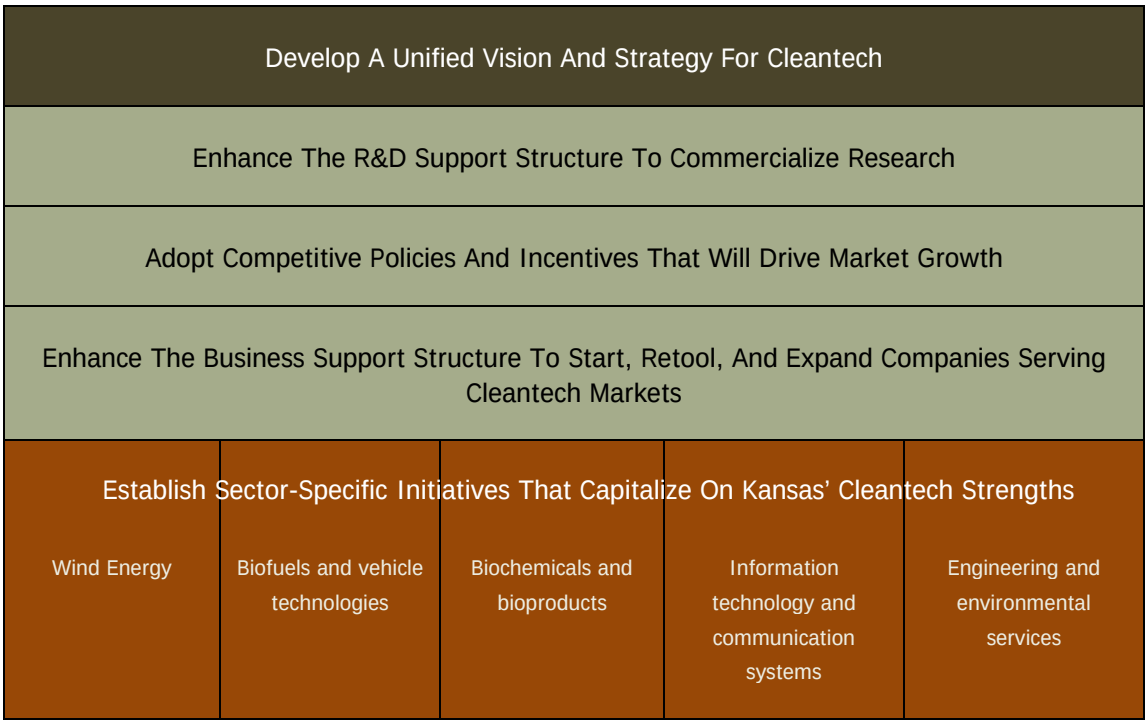
	Wind Energy	Next Generation Bio-Fuels	Biochemicals and Bioprocesses	Information & Communications Technologies	Integrated Engineering Services
Critical Mass of Companies	Currently seven major wind turbine manufacturers within a 500-mile radius of Kansas. Companies invested in Kansas wind opportunities include Siemens, Acciona Clipper Windpower, GE Energy, Nordex Suzlon, Vestas, Enertech and Westar Energy.	Kansas has 12 Ethanol and 3 biodiesel plants, with 3 new ethanol plants under construction. Leading companies in biodiesel and ethanol production include Abengoa, Conestoga, East Kansas Agri-Energy, Everton, Kansas Ethanol, Western Plains Energy, US Energy Partners, and POET Ethanol.	Large agriculture industry with feedstock; Higher than US average concentration of petroleum, plastics & related manufacturing; some chemical manufacturing.	Twice the US average in telecom; Leading companies in integrated communication systems (Sprint, Garmin, etc.) ; also home to software, data processing and networking companies	Kansas is headquarters for international companies in engineering services (Black & Veach, Burns & McDonnell, etc.); energy construction, water, and building systems expertise.
Supply Chain/Support Industries	Higher than US average concentration of machinery, utilities and information services.	Agricultural producers of corn, soybeans, and sunflowers primarily.	Chemical, plastics and nonmetallic manufacturing companies	Supporting companies in test/ measurement, electronics	Most OEMs are national or international, yet there is potential to connect leading OEMs to Kansas suppliers.
Competitive Policies and Incentives	Wind energy is dependent of incentives and policies. Kansas has below average incentives. Kansas has bond financing, tax abatements, tax credits and sales tax exemptions related to wind projects, but would benefit from the establishment of a Kansas Closing Fund, enhanced tax credits and demand-side incentives.	Kansas has a wide variety of incentives for the entire value chain of Ethanol and Biodiesel production including direct incentives, tax credits, tax exemptions, loans and workforce training.	Kansas has few incentives to attract bio-chemical processing or product manufacturing. The establishment of a Kansas Closing Fund could improve job creation efforts in this field. Additionally, Kansas would be better positioned to take advantage of its competitive position by increasing the funding for university research commercialization tied to cleantech opportunities	Jobs-based and R&D incentives more critical than project or production-based incentives. Increasing the funding for university research and commercialization tied to cleantech opportunities would position Kansas more strongly as an intellectual leader in this space.	More dependent on municipal and state spending on infrastructure and regulation of land use and environmental conditions than incentives.
Capital: Need for venture capital (VC), project financing, etc.	Capital intensive (VC and project financing); Industry consolidation underway.	Fuels require significant R&D investment and large project financing.	Bio-based products requires significant equity or corporate investment; Some angel and VC capital in Kansas with bio focus.	Requires VC/strategic investment for high growth, yet modest investment levels compared to bio or energy; some angels & VC capital in region with IT focus.	Low dependency on equity capital; merger and acquisition tend to drive company growth.

	Wind Energy	Next Generation Bio-Fuels	Biochemicals and Bioprocesses	Information & Communications Technologies	Integrated Engineering Services
Bottom Line	Given the natural features for wind in Kansas, there is significant potential in Kansas. Yet, these will require more aggressive policies and incentives to attract the array f research, manufacturing and installation jobs that are possible in the state.	With the increase of the Renewable Fuel Standard, the Department of Defenses' goals for renewable fuels and the Federal Government's desire to have at least 36 billions of biofuels in the US fuel mix by 2022, Ethanol is positioned to be a growth industry for years to come. With Kansas research in biofuels and the existing production infrastructure, the Statewide employment possibilities in agriculture, manufacturing & R&D may be significant.	A natural extension of the state's biotechnology efforts--high value bio-products could be a strong niche play for Kansas, setting itself apart from the more commodity driven bio-fuels. Interest from multi-national corporations for bio-products can attract inward investment; Kansas has unique R&D capabilities along with supporting manufacturing and agriculture in place.	Have very favorable conditions in Kansas for the development, manufacturing and deployment/service of communications equipment and software related to cleantech applications. This may be a sector that offers one of the biggest opportunities for both R&D and supply chain jobs in cleantech.	This sector has well-known international companies located in Kansas, and market projections call for steady growth of high-wage jobs. As a service sector, entry to market is often less costly and requires fewer large scale statewide incentives, making it a good fit for Kansas. With limited R&D this may be an economic expansion strategy rather than a focus for KTEC.

Part 2: Kansas' Cleantech Strategy Framework

Combined with the findings in Part One of this report, the final section provides recommendations for KTEC and its partners to grow research and companies in cleantech markets. Taking advantage of cleantech opportunities, especially in the areas where Kansas has competitive research and assets, will require a combination of strategies that support both the basic foundation for turning new ideas into products and businesses, and the sector-specific strategies that address the unique challenges of different cleantech sectors. The recommended approach combines these cross-cutting and vertical strategies into a framework with five specific objectives.

Figure 4: Kansas Cleantech Strategy Framework



While Kansas lacks several programs and incentives used by other states, the state has a significant number of programs that can be expanded and used to grow cleantech markets. The fact that these programs exist means that Kansas does not have to invest in development and start-up costs associated with new programs. Yet many of these existing programs lack sufficient funding to scale to a level that would allow them to reach a critical mass of companies or entrepreneurs; this limits their ability to create the desired economic impact and attract a more robust supply chain of cleantech companies.

Based on our research findings and feedback from key stakeholders, the project team developed recommendations for actions that KTEC and other stakeholders should consider pursuing as part of a strategic framework that better positions Kansas-based businesses to succeed in growing cleantech markets. We recognize that the current state budget environment is quite challenging, and have thus sought to present a mix of recommendations that include relatively low cost initiatives along with others that might require significant new investments. Some recommendations may not require new funding, but might include estimates for reprogramming of existing programs, staff, or resources.

Highlights of Promising Practices in Other States

We examined various programs and policies in other states to gain additional insight into what is working elsewhere and what scale of investment Kansas would need to make to seize opportunities in a highly competitive environment. We focused our examination on practices that were identified as critical gaps in the state and on strategies where there was strong consensus for action.

Strengthening Academic Technology Transfer

Commercializing research from universities is a critical component of an economic strategy. Cleantech research collaborations and individual research projects at universities will require significant support for commercialization activities including patent applications, licensing agreements, and spin-off support. To maximize the economic potential of this research and turn discoveries into businesses and jobs for Kansas will require that the universities have competitively funded technology transfer and business development offices, as well as policies that make it easy for industry to work with the university on technology and product development.

Since costs to commercialize various discoveries and technology vary greatly (e.g. bio and life science patent applications can be much more costly than IT or mechanical systems), universities need to have adequate resources to support the commercialization efforts managed by their technology transfer offices (TTOs). When TTOs do not have adequate resources they are forced to limit the number of technologies they can serve. When the number of patent applications and license agreements are limited, the future revenue streams from these efforts are also reduced and technology commercialization is further constrained.

Universities across the country are altering their policies for technology transfer offices, providing them a business model that allows a split of revenues derived from licenses, royalties and equity to more fully fund and sustain their operations. For example, universities such as Iowa State, University of Arizona, Baylor, Stanford and MIT first allocate 15% of revenues directly to their tech transfer offices (gross distribution) before distributing the remainder using the typical overhead allocation that their university employs. Other universities including Wayne State University, University of Virginia, Johns Hopkins, Yale and Vanderbilt charge a net service fee of between 10-40%. The University of Wisconsin has the most aggressive technology transfer funding model with 80% going to the technology transfer office.

Funding University Proof of Concept Efforts

In addition to funding technology transfer offices, universities must have proof of concept funds available to support further commercialization efforts that can attract industry partners and spin-off companies. Almost all research universities provide some funding for commercialization activities, including those in Kansas. The challenge for many universities is to provide funds at a scale consistent with the pipeline of research. Examples of leading practice include the University of Colorado allocating more than $11 million in proof of concept grants since 2002, and Colorado State University awarding more than $3.5 million through nearly 100 proof-of-concept grants to university-generated technologies since 2007.

Adjusting for the size of research in Kansas, an additional $2-4 million per year would be needed to help research institutions in the state be more competitive in their commercialization efforts. Additional proof of concept funding does not need to rely solely on state general funds. Other states have changed

university overhead policies to allow for more funding (see above), while some state have tapped into alumni or other contributions for funding. Examples of the later include:

Oregon's University Venture Fund is funded through state income tax credits given to individuals that contribute to the universities efforts to commercialize research and spinout companies. The legislature has authorized state-supported universities to receive a total of $14 million in tax credit eligible donations for university venture development funds. Each university's share of this total is based on a number of variables, including the size of its research enterprise.

Purdue University Emerging Innovations Fund is a philanthropic initiative supported by University alumni and private donors. It is designed to provide financial support for startup companies that work with University technologies so that the discoveries and technologies can be moved to commercialization. Initial capitalization is $1.5 million, expected to grow to $5 million. Initially the fund is expected to support 5-7 grants annually ranging from $20,000 to $200,000

University of Wisconsin-Madison - First Look Investor Forums sponsors bi-monthly forums for investors specifically focused on early-stage opportunities. The forums allow University faculty, researchers, and entrepreneurs to discuss their research and preliminary business concepts with representatives from the investment community to gain feedback on how to convert technology innovations into business propositions.

Capturing Economic Opportunities from University Research

Universities across the country, especially notable research institutions like Stanford and MIT, have large cleantech initiatives. Other campuses are not only conducting their own research, but are also looking to leverage this research in new ways that can spur economic activity.

The **University of Michigan in Ann Arbor** takes specific steps to connect research with its Zell Lurie Institute for Entrepreneurial Studies in the Business School, the Center for Entrepreneurship in the College of Engineering, and the student organization MPowered. The student-led Wolverine Venture Fund and the Frankel Commercialization Fund managed by the Zell Lurie Institute make investment in cleantech spinouts.

University of Colorado at Boulder has created a new joint energy institute with the National Renewable Energy Laboratory (NREL). The new institute, The Renewable and Sustainable Energy Institute (RASEI), partners leading researchers from CU-Boulder and NREL on cross discipline research across multiple areas. Currently there are 19 major corporations that sit on the RASEI leadership council and dozens of companies are involved in collaborative research with the university and its partners across several major cleantech initiatives.

University of Wisconsin at Madison may have one of the nation's oldest cleantech programs and is a good example of a university that can obtain significant federal funding. The Solar Energy Lab, founded in 1954, is the oldest of its kind. More recently, the university has become a focal point for research in bio-energy and is home to one of three DOE-funded Bio-energy Research Centers and the only one based at an academic institution. The University received 10 of 71 funding awards from the U.S. Department of Energy for advanced nuclear research, totaling more than $5 million.

Cornell University is tapping into its research expertise in the physical sciences, engineering and nanotechnology fields to develop opportunities in cleantech. And Cornell is leading New York State's task force to promote high-tech development through industry-higher education partnerships. Cornell's

campus wide Center for a Sustainable Future is unique in fostering innovative multi-disciplinary research into new energy sources, environmental and biodiversity initiatives, and economic development projects for global implementation of these programs.

Washington State University is using its expertise in agriculture, power and applied engineering to build its cleantech program. Plant science is the engine behind the opening last year of the Bioproducts Science and Engineering Laboratory, Battelle's Pacific Northwest National Laboratories and the recently funded Washington State Algae Alliance. One of the main objectives is the commercialization of aviation biofuels with partner Boeing Commercial Airlines. Notable cleantech spinouts include: GoNano, Ajuga Biosciences, BioGasol, Schweitzer Engineering Labs, and Integrated Engineering Solutions.

Establishing Multi-institutional Commercialized Research Initiatives

The rise of cross-disciplinary projects and discoveries occurring at the intersection of research fields and federal research programs has led to the formation of new collaboratives to integrate expertise and facilities across institutions and research disciples. Throughout the country, institutions like MIT and Penn State, and state university systems in Oregon, Oklahoma, Kentucky and Maine have formed collaborative research programs among universities and industry; many with federal lab participation. They provide proof of concept gap funding, federal cost sharing funds, support eminent scholars, and assist with enhancing testing and prototype facilities.

An example of this includes Oregon's three signature research centers: The Oregon Translational Research & Drug Development Institute (OTRADI); the Oregon Built Environment & Sustainable Technologies Center (Oregon BEST), and the Oregon Nanoscience & Microtechnologies Institute (ONAMI). Each of these centers pull expertise from the state's various universities, actively engage industry groups and leading companies, and work collaboratively with the nearby national lab in Washington. ONAMI, the first center, has leveraged over $107 million in federal and private funding with $18 million of state funds since 2005.

The Georgia Research Alliance supports the **VentureLab program**. According to GRA, VentureLab helps create early-stage businesses that are ready to advance into traditional technology business incubators. VentureLab reduces both the costs and risks associated with technology transfer through one-stop centers that serve as advocates for faculty researchers through technology assessments, commercialization grants, and a Fellows program that connects faculty researchers with experienced entrepreneurs and professional managers who serve as coaches and drive the commercialization process forward. VentureLab is currently advising a number of cleantech startup companies and has some notable cleantech spinouts: Suniva, RideCell, and CoolClouds.

Connecting Industry and Universities

Efforts like Kansas Bioscience Authority's voucher program seek to connect industry with university research within their state. In cleantech, the ability to develop and test prototypes is essential and voucher type programs could be beneficial to a statewide strategy. Other examples of these programs include:

The goal of the **Maryland Technology Transfer and Commercialization Fund** (MTTCF) is to provide funding for Maryland companies who wish to develop technology-based products and/or services in collaboration with the Universities and/or Federal Laboratories in Maryland. To be eligible for the program, a company must be collaborating with a Federal Laboratory or university in Maryland or be

located or be an affiliate of an incubator company in the state. MTTCF awards are non-equity investments up to $75,000 per award.

The **Georgia Research Alliance** (GRA) provides grants to fund university-industry partnerships in targeted technology areas. Grants were made up to an amount of $100,000 and all investments required the involvement of at least one active industry partner. Projects have to be within three targeted technologies areas including: advanced communications, computing and content, bioscience, nanoscience and advanced materials. The program provides targeted focus on state strengths while fostering university and industry relationships.

Increasing SBIR and Federal R&D Funding

States with active assistance programs and matching dollars have a higher rate of SBIR awards per capita and more companies participating in R&D. For example **North Carolina** received 94 Phase I SBIR awards in 2009. Their state program matches 100% or up to $100,000 for Phase I awards to help make them more competitive to receive larger phase II commercialization grants. **Michigan** provides $1.4 million each year and matches 25% of Phase I and Phase II; in 2009, the state received 87 Phase I SBIR awards. Other states like **Kentucky** match 100% of SBIR awards, spending up to $6 million a year in state dollars to grow and attract technology companies. They have found that their matching program not only significantly increased the number of companies doing research in Kentucky, but it also attracted new companies to move to the state. **Minnesota** provides assistance for both Phase I and Phase II applications and have seen a steady rise in awards.

Expanding Early-stage and Demonstration Funding for Companies

Providing funds that help companies launch a business and bring a technology to advanced stages of commercialization is critical for attracting angel and venture capital. KTEC's early stage investment program that was initially funded at $1.5 million per year, and now much less, is an example of this type of funding. The growing trend in early stage funding, supported by research[34], is to connect investment with hands-on advisory services to ensure the business model and management team is being effectively developed alongside the technology.

JumpStart Ventures in Northern Ohio provides hands-on early-stage investment from $250,000 - $600,000, allowing innovative companies to complete product prototypes, conduct early marketing campaigns, and add key team members. Along with funding, the company receives in-depth advisory services from a team of professionals (Venture Partners) who help advance innovation-oriented entrepreneurs through growth stages of the business, and attract follow-on funding.

i2E's Technology Business Finance Program (TBFP) and Seed Fund are two technology funds that help entrepreneurs acquire the critical early stage funding that can help them move their business concept and product to a stage that is attractive to private investment. The award-winning TBFP distributes approximately $1 million each year through awards of up to $100,000 for companies in pre-seed or proof of concept stage. The $19 million Seed Fund, ($9 million in previous funding and $10 million for the next several years) provides early stage equity investments to companies. Both funds are attached to i2E's advisory services that provide entrepreneurial advisors and mentoring alongside the capital.

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34 Patricia Scruggs and Wayne Embree, *The Impact of Equity Capital in Rural and Underserved Regions*, A project of the Ford Foundation, April 2010.

The Massachusetts Sustainable Energy Economic Development (SEED) Initiative provides financial assistance to support renewable-energy companies in the early stage of development. Applicants are companies that generally have a unique technology but have not yet demonstrated commercial viability to an extent sufficient to attract venture capital. Awards of up to $500,000 are available as a convertible loan on a competitive basis.

The Connecticut Clean Energy Fund (CCEF) created the Operational Demonstration Program in August 2005 to enable early-stage companies to demonstrate the effectiveness of their own near-commercial, clean-energy technologies. The program supports proposals for demonstration projects that have a high likelihood of developing into a commercial product within a reasonable period of time. Funding for the Operational Demonstration Program is provided in the form of an unsecured loan, with repayment contingent upon the product achieving "commercial success." The CCEF will also collect an additional percentage of product revenues for products that exceed a higher revenue threshold. The maximum amount of funding for each individual award is $500,000. The CCEF is financed by a surcharge on ratepayers' electric bills, and is managed and administered by Connecticut Innovations. The current program budget is for another $4 million through June 2012.

Supporting Business Competitions

Business competitions can be another way to raise awareness inside the state for cleantech opportunities. Other states hold their business competitions around targeted clusters, and Kansas could hold a business plan competition for the array of cleantech sectors in the state. Two examples for business competitions for companies include:

Accelerate Michigan Innovation Competition is an international business plan competition, which highlights Michigan as a robust and vibrant venue for innovation and business opportunity. The competition targets mid-to-late-stage business start-ups with potential to generate an immediate impact on Michigan's economy, as well as student concepts with longer-term business viability. With more than $1 million in cash winnings, plus in-kind awards of services, staffing and software, the Accelerate Michigan Innovation Competition is the world's largest business plan competition.

Georgia Business Launch Competition is run jointly by **t**he Georgia Research Alliance (GRA) and the Technology Association of Georgia (TAG) to support the creation and growth of new companies that will strengthen and expand Georgia's strategic high-tech clusters. The Business Launch Competition is an event designed to motivate and support entrepreneurs in creating new high-tech businesses in Georgia, and foster greater awareness within the investment community that Georgia is a great place to launch and grow high-tech businesses. The winner received over $200,000 worth of services, with each of the other three finalists receiving $70,000 in services, for a total of $400,000 in services for the finalists.

Establishing Statewide Cleantech Councils and Alliances

The **Colorado Cleantech Industry Association (CCIA)** was formed in 2008 to serve as a statewide advocate for Colorado's cleantech related businesses. The association sponsors networking and education efforts, and also plays an active role in disseminating data on the industry and advocating for its support with federal, state and local policymakers. CCIA recently published a statewide action plan to help build on Colorado's important cleantech-related assets. CCIA now has more than 200 members and is viewed as Colorado's key advocate for cleantech.

The **New England Clean Energy Council** was formed in 2007 to accelerate New England's clean energy economy and elevate it to a position of global leadership by building an active community of stakeholders and a world-class cluster of clean companies. The council represents nearly 150 members, comprising clean energy companies, venture investors, major financial institutions, local universities and colleges, industry associations, area utilities, labor and large commercial end-users. Its ranks include more than 50 clean energy CEOs, representatives from most of the region's top 10 law firms, and partners from over a dozen of the region's top venture capital firms (with a total of over $8 billion under management.) Working with its stakeholders, the council develops and executes an array of programs in five key focus areas: Innovation, Growth, Education & Training, Adoption, and Policy.

CleanTECH San Diego is a coalition seeking to harness the opportunities of an estimated 650 cleantech companies in the region. Led by an initiative of San Diego Mayor Jerry Sanders, CleanTECH San Diego has developed a comprehensive one-stop-shop ecosystem for clean tech companies to accelerate their growth.

Ontario Clean Water Initiative is a collaboration of organizations dedicated to developing Ontario as a global center of expertise for safe, clean, affordable and sustainable water and sanitation solutions. Ontario is capitalizing on its considerable water related assets: one of the largest bodies of fresh water in the world, a strong regulatory regime, an internationally recognized research community, and over 300 local companies that develop wastewater, water treatment and filtration related products and services. The province is home to 230 relevant university and college programs that produced over 8,200 university graduates related to water sciences in 2007. Entrepreneurs have access to R&D tax credits and specialized water investors such as XPV Capital Corporation, Sustainable Development Technology Canada and Emerald Technology Ventures.

Expanding Cleantech Incentives and Policies

Closing funds are an important factor in cleantech because they are used as economic development tool to attract new jobs and investments. A majority of states have closing funds and are able to make highly competitive offers to companies who are looking to expand or develop new capacities.[35]

The Texas Enterprise Fund (TEF) is the largest "deal-closing" fund of its kind in the nation, and has been used to bring more than 52,000 new jobs to the state and generated more than $14.3 billion in capital investment.[36] The fund is a direct appropriation from the General Fund and used only as a final incentive tool where a single Texas site is competing with another viable out-of-state option. Additionally, the TEF will only be considered to help close a deal that already has significant local support behind it from a prospective Texas community. Each applicant to the fund undergoes a thorough an 11-step due diligence process. Award dollar amounts are determined using a standardized analytical model applied uniformly to each TEF applicant. This model assures that the State of Texas will see a full return on investment from TEF awards through increased sales tax revenues projected as a result of a new project. Variations in award amounts are influenced by the number of jobs to be created, the expected timeframe for hiring, and the average wages to be paid.

Florida's Quick Action Closing Fund (QAC) enables the state to respond quickly to extraordinary economic opportunities and compete for projects that involve significant capital investment and the creation of high-wage jobs. In fiscal year 2008-09, these projects led to the creation/retention of 25,610 jobs at an average annual wage of $51,503. The revenue source for this fund is the state General Fund.

35 , Kansas, Inc "Analysis of State-Level Economic Development Contingency Funds" 2009.

36 Texas Enterprise Fund, 2010, http://www.texaswideopenforbusiness.com/

Demand-side policies help to incent consumer and business demand for renewable energy. Among the demand side policies recommended for Kansas is a feed-in tariff. Two examples include:

Hawaii established a feed-in tariff which is offered by the three investor-owned utilities. The state's Public Utility Commission set the rates for the feed-in tariff, schedule, and standard interconnection agreements were approved on October 13, 2010. Several renewable energy technologies are eligible for the feed-in tariff, including solar photovoltaic's (PV), concentrating solar power (CSP), on-shore wind and in-line hydropower. Under this program, qualified projects will receive a fixed rate over a 20-year contract.

Oregon has created a pilot feed-in tariff program in which systems are paid for the kilowatt-hours (kWh) generated over a 15 year period, at a rate set at the time a system is initially enrolled in the program. This program must be offered by the three investor-owned utilities in Oregon and will be administered by the utilities, though the PUC will periodically re-evaluate rates. The program costs are recoverable in utility rates and utility-owned systems are not allowed to receive the incentive.

Tax credits are used to help to spur business growth by creating funding options for renewable energy businesses that may have a difficult time finding adequate capital. Tax credits are often sold by early-stage companies to existing companies with a tax burden, enabling both companies to see a benefit without a disruption to the tax system. Several examples of these tax credits include:

Virginia's green jobs tax credit gives companies a $500 income tax credit for five years for every green job created with a yearly salary of $50,000 or more. "Green jobs" are defined as jobs in the manufacturing and operation of renewable or alternative energy products and technologies used to generate electricity and energy. The Office of Commerce and Trade has created a full list of jobs eligible to qualify for the tax credit. Companies will be allowed tax credits for up to 350 green jobs created. If the taxpayer does not have enough tax liability to take the full credit, it may be carried forward for up to 5 years.

Oregon's Business Energy Tax Credit (BETC) is for investments in energy conservation, recycling, renewable energy resources, sustainable buildings, and less-polluting transportation fuels. The up to $20 million dollar tax credit equals 50% of the construction costs of a facility that will manufacture renewable energy systems, and includes the costs of the building, excavation, machinery and equipment that is used primarily to manufacture renewable energy systems. The credit may also be applied to the costs of improving an existing facility when it will be used to manufacture renewable energy systems. The 50% credit is taken over the course of five years, at 10% each year.

Economic Development for a Growing Economy (EDGE) programs in Indiana and Illinois let companies retain part of the income tax withheld from new employees instead of remitting it to the state. This payment vehicle has limited administrative overhead and leaves employees unaffected, but it also ensures that the state only gives up money that is directly attributable to those new jobs.

KTEC CLEANTECH RECOMMENDATIONS

A. Make Cleantech a Statewide Economic Development Priority

Cleantech-related industries offer great potential for supporting economic development objectives because these sectors offer a very broad range of research and job opportunities that can employ a range of skills across the state. In recognition of this potential, economic development, industry associations, and research organizations engaged in this process have identified cleantech as a strategy that should be among the state's top three economic priorities.

Kansas has proven it can rally behind and coordinate a statewide strategy based on emerging markets. The state has done so with biosciences, and among cleantech sectors, biofuels. There is a strong need to not only create a statewide strategy and vision, but to establish more structured means by which state and regional partners can effectively coordinate and leverage efforts to help Kansas seize new market opportunities. [Note: we found that the term "cleantech" did not resonate with many traditional industries in Kansas. Therefore, the term may need to be changed in support of a statewide strategy.]

Recommendation

- Establish a cleantech strategy and brand image for the state that clearly identifies opportunities and provides a pathway for coordinating and leveraging the resources and programs to establish a more competitive position for Kansas. Use this strategy as a basis to enhance and communicate the assets and opportunities that exist in Kansas, targeting outreach to companies and research institutions inside and outside the state.
- Within KTEC, establish a "Cleantech Council" composed of industry, university and government representatives to act as a coordinating and advisory body for a statewide cleantech strategy. The Council would help to build Kansas' image both inside and outside the state; review new or enhanced policies and incentives; and ensure coordination and leveraging of cleantech resources and programs.
    - Establish industry committees with the Council (information technology & communications, biochemical's/bioprocesses, wind, etc.) to help guide research programs, identify in-state supply chain opportunities, and identify new opportunities that would benefit Kansas. Where possible, committees could be chaired by existing industry organizations (SITAKS, MAMTC.).
    - The Council would publicize opportunities through newsletters, social media, and sponsored events, such as an annual Kansas Cleantech Summit or the annual Kansas Energy Conference. The Council would help sponsor and promote business participation at critical national and international tradeshows.
- Establish a position within KTEC dedicated to the advancement and promotion of cleantech industries and next generation technologies that would maintain an inventory and mapping of assets including research, companies, government programs and other activities related to cleantech; m anage the work of the Cleantech Council.; and work with KTEC's network of service providers to ensure they and their clients understand the opportunities within cleantech sectors.

Lead Organizations	Estimated Resources
KTEC and KTEC affiliates	A dedicated staff person and $150,000-$250,000 operating budget

B. Enhance the Ability to Conduct and Commercialize Cleantech Research

Kansas is home to leading edge cleantech research ranging from biofuels to biochemicals and bioprocesses, to information technology and telecommunications to advanced materials. This research exists in universities and in industries across the state. Products and services commercialized from this research can expand opportunities for:

- Chemical, plastics, polymers, composites, aerospace, and precision manufacturing,
- Professional and scientific service companies in agricultural resource management, environmental services, engineering services, and testing labs,
- Agricultural production and processing,
- Telecommunication and network companies,
- Energy sectors including natural gas as well as renewable energy sources, and
- Water and waste management.

B-1 Provide Essential Gap or Proof of Concept Funding to Move Research from Universities into Kansas Companies

Kansas-based researchers are creating new technologies, but have had limited success in moving this work from the lab to the marketplace due to inadequate levels of proof of concept funding. This funding fills the gap from when federal research dollars end and when private investors or companies are wiling to take on the risk. While Kansas has a robust program for biosciences, it has provided very modest funding for other industries—leaving immediate opportunities wanting. *This funding is necessary to start new companies, attract higher levels of private investment, and help existing firms (especially manufacturers) adopt new technologies that can expand their markets*.

Recommendation (High Priority)	
▪ Provide adequate funding for technology transfer offices (TTO) to fully service the pipeline of patents and licenses. Update business and funding models to be in line with best practices. ▪ Establish a proof of concept fund for Kansas research universities that will provide funds for commercializing cleantech research. Funding should be available for existing research programs at universities and for competitive multi-institutional research efforts. Based on benchmarks from other states, an appropriate fund would be about $2 million per year. ▪ Utilize the industry committees within the recommended Council to help guide and prioritize commercialized efforts. ▪ Establish a more standardized agreement for industry sponsored research and intellectual property development.	
Lead Organizations	**Estimated Resources**
KTEC and University Research Offices	TTO base operation funding to be determined based on projected pipeline; $2 million per year for proof of concept funding

B-2 Secure Additional Federal Funding That Accelerates Product Development and Business Growth in Kansas

Kansas also has an opportunity to increase the inflow of federal research dollars into both companies and universities. Currently, Kansas falls below national averages in the amount of federal funding it receives for academic institutions and industry. This is primarily due to the lack of knowledge about federal funding opportunities, or in some cases the lack of resources to pursue these efforts. The good news is that it does not require large amounts of resources to pursue federal funding, and state dollars can typically be leverage by a ratio of more than ten to one.

Recommendation	
▪ Establish a Federal Liaison and SBIR Program, and provide pilot funding for three years. This program would actively seek to: o Develop a strategy that connects the state's industry and academic strengths in cleantech with specific federal agencies and programs. This can start as a single position, supplemented by a contract with a professional firm in Washington DC that specializes in connecting states and regions to targeted funding sources. [Note: this is not lobbying congress for earmarks; this is working directly with the agency programs that administer funds for specific economic and research activities.] o Significantly expand the current SBIR assistance to establish a comprehensive and competitive effort within KTEC that aggressively markets and holds workshops for SBIR, utilizing regional economic partners to reach companies that could benefit from this program; provides assistance to companies for SBIR applications (at least 30 companies per year); and provide a match of between 25-50% of Phase I funding to help companies bridge the funding gap between Phase I and Phase II awards.	
Lead Organizations	**Estimated Resources**
KTEC and KTEC affiliates	A dedicated staff person and at least $400,000 operating budget per year (without matching funds) and $1,000,000 per year with matching funds.

C. Adopt Competitive Policies and Incentives That Drive Market Growth

Many sectors within cleantech are centered on or enhanced by policies and incentives used to attract new companies or to accelerate the pace by which existing companies and consumers adopt clean technologies and practices. While the regulatory environment and programs developed at the federal level provide the basis for this policy framework, states are increasingly adding incentives to the mix to provide a comparative advantage for their region.

Kansas has developed targeted incentives for areas such as biofuels, but less so for wind energy—even though the state has the US' second largest wind energy capacity. Unlike other states, there is no closing fund to help seal the deal for company recruitments. Kansas-based cleantech companies also noted the importance of demand-side incentives to spur market development such as consumer rebates, net metering or feed-in tariffs to promote the adoption of energy and resource-efficient products like LED lighting or smart appliance meters. In many states these policies create a stronger market for advanced energy products and services, which will in turn encourage the growth of local workforce and investment. Finally, surveys and interviews noted the lack of an overall strategy for state government to "walk the talk" through procurement contracts, facilities upgrades, and new construction projects—all of which could use and give preference to Kansas cleantech companies.

Recommendation	
▪ Establish a strategic "closing fund" of $15-20 million to help compete with other states for the recruitment of job-producing companies, with a minimum amount set aside for advanced energy companies. ▪ Educate the state's leadership on successful demand-side policies in other states that encourage business and residential purchases of advanced energy products and services. ▪ Benchmark state procurement, facilities and construction criteria used to promote the use of cleantech products and practices, and update state policies and procedures to reflect these best practices. ▪ Inventory and organize state policies, incentives and programs in a way that businesses can easily access; communicate these to regional economic development organizations, industry groups, and KTEC network affiliates throughout the state so organizations can cross-promote the benefits of doing business in Kansas	
Lead Organizations	**Estimated Resources**
KTEC and KTEC economic development partners	$15-20 million for an Advanced Energy closing fund (option 1) $75,000-150,000 for options 2-4

D. Enhance the Business Support Structure to Start, Retool, and Expand Companies Serving Cleantech Markets

Because the term cleantech spans a wide variety of industries and market segments, there is no one-size-fits-all strategy for supporting cleantech businesses. In some sectors, like green IT, firms can start up with limited resources and may be able to ramp up operations in a fairly rapid manner. In other market segments, such as wind generation and energy transmission, huge infrastructure investments are required. These capital requirements may restrict market access to larger firms or incumbents such as major utilities. In other cases, existing firms in traditional industries like manufacturing may need assistance in retooling for entry into cleantech markets.

While KTEC lacks the resources and capacity to meet all the needs of each of these market segments, it can support targeted investments and programs on issues related to KTEC's core expertise such as access to capital, business development, and business incubation.

D-1 Help Companies Secure Needed Start-up Funds and Business Assistance (High Priority)

KTEC has long managed an investment fund that has allocated roughly $1.5 million per year to support Kansas-based start-ups and early stage ventures. Unfortunately, the fund's investment levels and funding to other seed funds have been cut over the past several years. Now only a handful of companies in all technology sectors receive this critical early stage capital. This capital is critical because it helps to build a pipeline for angel and venture capital funding, thus taking advantage of the state's foresight in passing a competitive angel tax credit. *Without this seed funding, the number of companies able to secure capital and be successful will be limited.* Such funds in other states are significantly larger than in Kansas. Kentucky allocated approximately $21 million to their seed fund, while Oklahoma has invested $9 million with $10 million more allocated over the next few years. Funding levels are even more robust in more populous states. For example, New York recently allocated $150 million in equity funds targeted to cleantech companies.

Recommendation	
Increase the amount of funding for the KTEC and affiliated seed funds, and focus investments on promising cleantech technologies with likely follow-on funding sources: ▪ To be competitive with other states, Kansas will need to not only reinstate KTEC's early stage equity investment fund to previous levels, but also increase the fund to be more competitive with other states. Ideally, funding should range from $3-4 million per year. ▪ Funds should also be connected to advanced advisory and mentoring services to ensure that start-up businesses build companies that are attractive to follow-on funding and growth.	
Lead Organizations	**Estimated Resources**
KTEC and KTEC affiliate seed funds	$3-4 million per year.

D-2 Connect Entrepreneurs to Cleantech Opportunities

Future opportunities in cleantech will also depend on the quality and capabilities of Kansas' entrepreneurs. KTEC should consider developing a series of initiatives to help build the state's pipeline of cleantech entrepreneurs. This effort would supplement other initiatives targeting established firms by publicizing cleantech opportunities and encouraging new and aspiring entrepreneurs to pursue the cleantech market. This work could be especially important in rural Kansas where many entrepreneurs operate in sectors such as energy and agriculture, but may not consider themselves as operating in the cleantech marketplace.

Recommendation	
Establish a entrepreneurial outreach and support strategy for cleantech: ▪ Work through KTEC partners (entrepreneurial centers, incubators, and other affiliates) to promote cleantech opportunities to Kansas entrepreneurs. Structure a series of primer workshops with an exclusive focus on cleantech-related opportunities. ▪ Develop a formal partnership with the Kauffman Foundation's Energy Innovation Network (http://www.energyinnovationnetwork.org/). This effort should also include aggressive outreach to help encourage Kansas-based students to participate in the Foundation's annual Green Entrepreneurship Academy (http://entrepreneurship.ucdavis.edu/green.php) ▪ Sponsor and promote statewide participation in the annual Cleantech Open, a competition for the best ideas in cleantech entrepreneurship. (www.cleantechopen.com)	
Lead Organizations	**Estimated Resources**
KTEC and KTEC partners	$75,000-150,000 per year.

D-3 Promote Market Opportunities and Supply Chain Development For Manufacturers

Research efforts, like those at the Center for Environmentally Beneficial Catalysis, the National Institute for Aviation Research, and the Kansas Polymer Research Center have built significant partnerships with firms located outside of Kansas. These target firms—that are seeking to commercialize technologies and materials into new products—could offer manufacturing opportunities for companies inside the state. Furthermore, many manufacturers within the state are seeking new market opportunities, yet are unsure of how to explore or access the cost-benefit of other options. Greater alignment and communication between research efforts and AMI, MAMTC and economic development agencies could enhance opportunities for downstream job development and increase corporate cleantech investment into Kansas. A growing number of states of using their MEP programs to help companies conduct assessments for cleantech opportunities. Loans, like those provided in Wisconsin and other states, could help manufacturers retool for cleantech opportunities.

Recommendations	
Establish a program that specifically works to connect commercialized university research initiatives with Kansas' manufacturers. ▪ Inventory and catalog manufacturing capabilities, facilities and capacity. ▪ Conduct periodic meetings between research organizations and state and regional economic development partners to identify, prioritize and pursue corporate investment and expansion efforts associated with R&D initiatives. (This should be coordinated with the industry committees within the cleantech council) ▪ Hold workshops and other informational sessions with manufacturers to increase awareness about new market opportunities and available resources to assist with pursuing these markets. ▪ Provide state funding (to leverage federal funding) for the Manufacturing Extension Partnership (MEP) program to expand assistance to manufacturers with assessment tools, like those used in other states that identifies cleantech opportunities. ▪ Provide low-interest loans/grants to support small and medium size manufacturing companies to expand, retool, or retrofit operations for cleantech products.	
Lead Organizations	**Estimated Resources**
AMI, MAMTC and University Research Centers	$100,000 per year for Research/Manufacturing coordination and outreach (inventories, workshops and joint strategy sessions) $400,000 per year for MEP program to assist manufacturers with assessing cleantech opportunities

E. Establish Sector-Specific Initiatives that Capitalize on Kansas' Cleantech Strengths

Kansas' cleantech assets point to opportunities to develop industry leadership in several sectors that have been identified in this study: wind energy, next generation biofuels and vehicle applications, biochemicals and bioproducts, information technology and communications (green IT) and integrated engineering services. Developing strong alignment between industry and research, and connecting efforts to build scale will be important for Kansas as the state works to build a competitive advantage in these targeted areas.

E-1 Build Top-tier Multi-institutional and Industry Research Collaboratives (HIGH PRIORITY)

Federal research funding and corporate investments are increasingly being allocated to commercial research programs that connect and leverage the facilities and expertise of multiple institutions. A collaborative approach has shown to more rapidly build the necessary scale and recognition to be competitive. The Center for Environmentally Beneficial Catalysis at KU is an example of multi-institutional collaboration with institutions in other states. However, few other examples of multi-institutional collaborative among in-state institutions presently exist. With efforts at multiple institutions in next generation biofuels, biochemical's and advanced materials, and information technology such collaboratives could accelerate the state's position in cleantech research, take new products to market, and attract companies and researchers to the state.

Recommendation	
Promote cleantech signature research collaboratives that are multi-institutional with active industry engagement. These collaboratives could pursue larger scale federal funding and more activity engage with industry by offering a single point of contact for research and testing within specific fields or disciplines. Funding for these efforts should include: ▪ Cost-sharing funds to pursue federal grants ▪ Recruitment funds for eminent scholars ▪ Cost matching for equipment and facilities upgrades ▪ Coordination, marketing and outreach to industry There would be a strong connection between industry committees of the recommended Cleantech Council, ensuring direction of research is aligned with an overall state strategy, and a specific set aside of university proof of concept funds to be used for collaborative efforts. As in other states, it is recommended that limited funding be used to develop a very limited number of collaboratives at a time (perhaps one or two), rather than spreading funds across multiple projects and diluting the ability to achieve nationally recognized scale.	
Lead Organizations	**Estimated Resources**
KTEC, University Research Offices, and the Cleantech Council	$4-10 million per year, per collaborative

E-2 Promote the Adoption of Cleantech Technologies Developed in Kansas

Surveys and interviews identified several other challenges that impeded companies and utilities from adopting clean technologies, especially those developed in Kansas. First, many companies and industry groups in Kansas are unaware of the testing, modeling and prototype capabilities within the state's research institutions. Second, some new technologies require a level of assessment and piloting (upfront) costs that prevents many small companies and utilities from adopting these advancements. Finally, compared to other states, Kansas does not appear to aggressively pursue federal funding sources that could help offset the costs to upgrade or use more energy and resource efficient technologies.

Recommendation	
Establish a program that specifically works to connect commercialized university research initiatives with Kansas' companies. ▪ Work with industry advisory councils to promote testing and modeling capacities at universities and research facilities within the state. ▪ Aggressively seek federal program funding that helps deploy clean technologies into the market place, and actively pursue Kansas companies to carry out the work. ▪ Help reduce the risk or initial retooling cost by providing a pilot or early adoption voucher to small and medium size companies or small utilities that encourage them to use technologies or advanced processes developed by Kansas universities or companies. (This is a modified version of KBA's voucher program) ▪ Identify and fill gaps in prototyping facilities related to Kansas signature research programs in cleantech.	
Lead Organizations	**Estimated Resources**
KTEC, University Research Offices, and the Cleantech Council; Engaging utilities, manufacturing groups and industry associations related to cleantech	Coordination and outreach would fall within KTEC and the new Cleantech Council $2 million for vouchers capped at $50,000 per company and $100,000 per utility could serve approximately 30 projects

Table 5: Summary of Preliminary Cleantech Recommendations

Recommendation	Status
A. Developing A Unified Vision And Strategy For Cleantech	
A-1 Adopt a statewide strategy shared by KTEC and partners; define clear goals and establish visible outreach inside and outside the state; establish a position with the responsibility of overseeing this strategy.	Does not exist
A- 2 Establish a Kansas Cleantech Council to promote industry opportunities, guide commercialized research efforts, and coordinate business expansion and recruitment efforts across the state.	Does not exist
B. Enhancing The R&D Support Structure To Commercialize Research	
B-1 Fund university technology transfer to support the current and anticipated levels of intellectual property and technology development	Exists but not competitive
B-2 Establish a federal liaison program to identify and obtain federal R&D awards and contracts for industry and universities, including small business innovation research (SBIR) assistance focused on cleantech opportunities	Federal Liaison does not exist; SBIR limited
C. Adopting Competitive Policies And Incentives That Will Drive Market Growth	
C-1 Enhance incentives and policies for renewable energy generation	Exists but not competitive
C-2 Strengthen demand-side and efficiency incentives and policies for utilities, business, and consumers	Exists but not competitive
C-3 Increase business development support for cleantech including loans, demonstration funds, etc.	Exists but not competitive
D. Enhancing The Business Support Structure To Start, Retool, And Expand Companies Serving Cleantech Markets	
D-1 Significantly increase early-stage funding of cleantech and connect funding to advanced and comprehensive advisory services	Exists but not competitive
D-2 Establish a cleantech entrepreneur program including a focused Pipeline efforts, participation in national networks and competitions (Kauffman, Cleantech Open, etc.)	Does not exist
D-3 Promote market opportunities and supply chain development for Kansas manufacturing companies	Does not exist
E. Establishing Sector-Specific Initiatives That Capitalize On Kansas' Cleantech Strengths	
E-1 Establish a multi-institutional Cleantech Signature Research Collaborative that builds leading-edge research by leveraging significant federal and private funding	Current funding at individual program level
E-2 Enhance prototyping, pilot and test facilities for commercialization, including demonstration funds for Kansas companies to pilot Kansas technologies	Exists but not competitive

Appendix A: MARKET OVERVIEW BY SEGMENTS

Water & Waste Water Systems and Management

In recent decades, global water demand has increased at a rate twice that of global population growth. Until recently, water resource availability has been sufficient to keep pace with population growth. However, danger signs are emerging as rapid population growth and development pressures place strains on water supplies in both developed and developing economies. These pressures are creating new market demands for effective water management and conservation systems and technologies.

Industry analysts have estimated that global sales in the water sector reached $475-500 billion in 2008, with $100 billion in industrial segments, and growth in China, India, Brazil and Russia at is occurring at two to three times the industry average rate.[37] In the US, the Environmental Protection Agency (EPA) estimates that the cumulative water infrastructure investment in the US could reach anywhere from $170 to$500 billion through 2025.

The water sector is growing for two primary reasons. First, developed economies must upgrade and maintain aging water and sewer infrastructure. For example, the EPA estimates that 25 percent of current US water pipes are in poor or very poor condition, as compared to just 10 percent in such as state in 1980. It is estimated that 45 percent of the existing water infrastructure in the US will need replacement by 2020. Investments in new wastewater treatment systems could more than double these investment estimates. At the same time, worldwide demand by developing countries is expected to rise sharply, especially in China and India. This means opportunities for companies that manufacture or supply pipes, valves, and filtration systems.

While infrastructure replacement will be significant, some of that infrastructure will be replaced or paired with decentralized or on-site systems and processes. These decentralized water technologies can provide dramatic benefits. For example, when commercial operations such as shopping centers, retailers, and office buildings recycle potable water on site for use in toilets and irrigation, 70 to 85 percent of the potable water can be saved. Other savings accrue by reducing the amount of energy required to deliver, process and dispose of that water. Many analysts predict that these decentralized technologies will offer some of the greatest growth opportunities for the market. [38]

Several technology product opportunities offer promise for the water industry:[39]

- Real-time monitoring technologies to improve infrastructure and water quality at the point of use. Smart meters coupled with appropriate pricing strategies can significantly reduce consumer water use. Several opportunities are generating much market activity: turnkey solutions for water metering, and software that helps utilities charge for both volume and application. Advanced water metering, and smart irrigation technologies appear to be favorites among analysts.
- Wastewater reclamation, which includes technologies for on-site real-time water monitoring for pathogens, on-site wastewater recycling for industrial and commercial applications, and stormwater and rainwater harvesting.

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37 Environmental Business Journal, 2010 Environmental Services Industry

38 Jefferies & Companies, Clean Technology Primer, November 2008

39 Sources includes Environmental Business Journal 2010 Industry Outlook, Jefferies & Company 2008 Cleantech Primer, and Global Water Intelligence 2010 Market Trends

- Disinfection: New solutions using ultraviolet systems and ozonation, in addition to chlorination, with the fastest growing markets projected in decentralized or on-site disinfection.
- Filtration technologies including reverse osmosis, thermal desalination, microfiltration and ultrafiltration.

Environmental Management and Remediation (Except Water)

The environmental management and remediation industry includes the array of environmental and engineering services, solid and hazardous waste management, remediation services, instruments and information systems, testing and analytical services, air pollution control equipment, and process and prevention technology. The Environmental Business Journal[40] estimates that, in 2008, these sectors generated approximately $170 billion in revenues in the US, with a total of almost $300 billion when water segments are included.

The environmental industry derives a significant portion of revenues from public sector customers, with municipalities being the largest source of public billings. Within the private sector markets, approximately two-thirds of revenues are derived from industrial sectors and one-third derived from commercial and other markets. The primary industrial clients include companies in utilities, chemical manufacturing, plastics, petroleum and rubber manufacturing, metals and component manufacturing, and transportation equipment.

Projected Market Growth Summary for Targeted Segments

- Testing and analytical services are a relatively small segment of the industry with just under $2 billion in revenues in 2010.[41] The long term projection for testing and analytical services will be flat to a modest decline as more testing functions will be performed onsite, replacing the need for off-site laboratories.
- Solid waste management accounted for $53 billion in US revenues in 2008.[42] Consolidation of firms continues as more stringent landfill regulations have forced small operators to close or sell. Growth projections for this segment are three percent over the next few years, and relatively flat in out-years.
- Remediation and industrial services are those that conduct physical cleanup projects including abatement, industrial, or site remediation. While federal spending through EPA Superfund programs has declined, state, local and private activity has grown in recent years. The EPA estimate identifies some 294,000 domestic sites requiring cleanup at an estimated total cost of $210 billion.[43] This clean-up backlog suggests a steady future market, even in the face of slow real estate markets and a slow growth economy.
- Consulting and engineering includes services related to permitting and compliance, pre-planning, design and construction management, facility audits, analyses, and engineering related problems. While Federal environmental mandate have been the prime drivers of past market growth, today's industry is tightly woven into infrastructure and land development, the siting of energy generation projects, and urban planning/building projects with low carbon footprints.

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40 Environmental Business Journal US Environmental Industry Overview Report, 2010

41 IBID

42 IBID

43 USEPA—www.epa.gov/superfund/sites/npl/index.htm

- Environmental equipment segments have been driven largely by regulatory policies and end-of-pipe solutions that were large scale and labor intensive. While markets will remain for these projects (e.g. EPA's projection of $277 billion in drinking water infrastructure needed over the next 20 years), the greatest growth is projected to be in equipment that serves onsite, source-specific, and portable/mobile solutions.
- Environmental instrumentation and information systems are projected to follow a similar pathway as equipment; moving primarily from off-site labs to onsite and portable solutions. This segment of environmental services is one of the most global segments with roughly half of revenues from top companies being generated through international markets. As smart monitors and integrated communication systems are embedded with design and engineering solutions, the outlook for this market is relatively healthy.[44]
- Process and pollution prevention technology seeks to remove contaminants prior to release, reducing the need for remediation and cleanup. Advances in biological solutions, waste recovery, filtration, or separation systems are driving new products and services into the market. EPA estimates that domestic markets will grow from approximately $2.5 billion in 2010 to $3.5 billion in 2020.[45]

Renewable Energy Overview

The global energy business is booming, and continued growth is expected in coming years. According to the US Energy Information Administration,[46]worldwide energy demand will soon resume its pre-recession pace and ultimately increase by 49 percent by 2035. This rapid growth will also generate significant carbon emissions. According to the EIA, world energy-related carbon dioxide emissions are expected to rise from 29.7 billion metric tons in 2007 to 42.4 billion metric tons in 2035.

These growth patterns are generating significant momentum for new clean energy technologies and carbon mitigation initiatives. When it comes to clean energy generation, significant growth is already underway. In 2009, new investments boosted wind global capacity by 31 percent, solar by 47 percent and biofuels by 21 percent.[47].

While private dollars are flowing into renewable energy, public investments dwarf these private totals. For example, approximately $100 billion of the $787 billion 2009 stimulus package in the US was awarded to cleantech projects.[48] China has committed to spending between $440 billion to $660 billion toward its clean-energy build out over the next ten years.[49] Collectively, China, South Korea, and Japan are expected to invest $509 billion in clean technology-related projects between now and 2013.[50]

Climate change and energy insecurity have been the current drivers for the US renewable energy market, but future market growth will be increasingly tied to policy decisions. Renewable portfolio standards, renewable fuel standards, building codes and energy efficiency regulations all work together to create price certainty in the marketplace. These standards, when linked with incentives, create an investment

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44 Cleantech Group, "Ten *Clean Technology Predictions for 2010*, November 30, 2009. Available at: http://cleantech.com/news/5342/ten-cleantech-predictions-2010

45 EPA Estimates cited by Environmental Business Journal's 2010 Environmental Services Industry Outlook

46 US Energy Information Administration, *International Energy Outlook2010*. (US Department of Energy, April 2010).

47 U.S. Department of Energy, Global Renewable Energy Development, 2009 Renewable Energy Databook, August 2010

48 Pew Center for Global Climate Change," US Department of Energy's Recovery Act Spending", December 2009.

49 Robert D. Atkinson et al. "Rising Tigers, Sleeping Giant," (Washington, DC: Information Technology and Innovation Foundation, November 2009). Available at www.itif.org.

50 Ibid

environment that funds large-scale generation projects, manufacturing facilities, consumer demand, and job creation.

Renewable Energy Generation

In 2009, the size of the global wind sector was $63.5 billion.[51]Wind energy is on track to meet 12 percent of global power demand by 2020, and up to 22 percent of demand by 2030.[52] Wind generation technologies are fairly mature, but continuous improvements in design, composite integration, geo-modeling, smart grid integration and scalability are leading to designs that would create turbines with five times the current generating capacity.

Wind power can be developed in a very wide range of locations, and at many scales – from one or two turbines to hundreds. Optimizing the siting can make a big difference to the power output from a wind turbine, and this is greatly magnified over a turbine's operating lifetime of twenty or more years. However, the rate of deployment of wind power by country has largely been dependent on the presence of public subsidies as opposed to direct market demands or on the presence of major local wind capacity. In Germany, for instance, public funding has stimulated large-scale deployment of wind power, even though its wind energy generating potential is lower than in many of its fellow EU countries (who have fewer wind facilities installed).[53]

China has similarly offered major public subsidies to build domestic wind generation capacity. In 2009, China's Permanent Committee of the National People's Assembly passed a revised law that required energy distribution companies to purchase all the electricity produced by the renewable energy sector. As a result, China has installed new wind generation at a rate triple that of the US and will likely become the largest generator of wind energy by 2011.[54]

America's wind generation capacity is similarly driven by the presence of market subsidies. 2009 saw rapid increases in domestic production with over 10MW of wind generating capacity (with more than 10MW installed) thanks to two primary factors: 1) extension of the Federal Production Tax Credit and the Investment Tax Credit for wind through 2012 and 2) an assumption that the US would adopt a national Renewable Portfolio Standard (RPS) and create other renewable energy incentives. This latter expectation proved false, and wind energy advocates thus expect a market slowdown in coming years. For example, the American Wind Energy Association estimates that, in 2010, newly installed wind capacity will be only half of that installed in 2009 (5MW).[55] As noted earlier, AWEA ranks Kansas as the #2 state in the nation for wind generation potential. Yet, it is the #14 state in the nation for installed wind generation. This situation contrasts with that of biofuels energy, where incentives have helped ensure that where Kansas' production capacity exceeds its ranked potential.

These investments, by the US and other nations, are occurring in response to a major projected increase in global wind energy markets. According to Clean Edge, Inc., the global wind power market could grow from $64.5 billion in 2009 to $114.5 billion in 2019.[56] Because of significant capital costs associated with many wind energy projects, large multinational corporations, such as Vestas, GE, and Siemens, hold

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51 Ron Pernick, et al. 2010, Clean Energy Trends 2010

52 Global Wind Energy Council, "Global Wind Energy Scenarios 2010," (Brussels: GWEC, 2010).

53 Danyel Reiche (ed.), Handbook of Renewable Energies in the European Union II, (Berlin: German Wind Energy Association, 2007). "Handbook of Renewable Energies in the European Union II", 2007,

54 American Wind Energy Association "Q3 2010 Market Report," Available at www.awea.org.

55 IBID

56 Clean Edge, Inc., "Clean Energy Trends 2010" (March 2010)

dominant positions in many key markets. Many of these firms have set up operations in Kansas, and elsewhere across the Midwest and Great Plains. In addition, many analysts have bullish expectations for US firms producing for the small wind market. According to AWEA, two-thirds of all small wind systems used around the world in 2009 were produced by American manufacturers.[57]

Solar and geothermal energy have also shown robust growth in the recent years. Future market growth should be accompanied by lower costs, as technologies continue to improve and installation processes become more refined. Projected growth rates for both sectors are quite robust. For example, Clean Edge Inc. estimates that the global solar photovoltaic industry could triple in size by 2019, growing from $30.7 billion today to nearly $100 billion. [58] The solar thermal industry is slated for similar rapid growth, expanding from a 2008 market size of $8 billion to $20 billion in 2014.[59]

Among renewable, wind energy is the most established sector in Kansas and across the US. In the US, the wind energy sector has about ten times the installed generation capacity and employment impact of both solar and geothermal combined (though solar is currently growing at a faster pace). Both solar and geothermal energy generation are dependent, just like wind energy, on public subsidies and incentives.

National policies and initiatives are only part of the incentive for renewable energy generation installations, however – state policies have spurred renewable energy development in the US for the past 30 years. Currently 38 states currently have Renewable Portfolio Standards, for example. Other policies and incentives that closely correlate with a higher frequency of renewable energy installations in a state include Public Benefit Funds, robust renewable energy access laws, green construction and design policies, renewable energy contractor licensure, green power purchasing goals and utility mandates to offer customers green power options.[60]

Renewable Energy Storage and Transmission

Between 2008 and 2035,US domestic energy consumption is expected to grow by an additional 14 percent. [61] According to the Energy Information Administration, in 2008, fossil fuels accounted for 84 percent of total energy use. They are projected to account for 78 percent of total energy use by2035. Renewable energy sources will be the primary new source of energy production during this time frame.[62]

As renewable become a more sizable portion of US energy production, US distribution systems will face pressure to “tune” power generation with consumer and business demand. Both generation and demand for electricity fluctuates dependent on time of day, week and year, so developing the infrastructure to deliver this energy and enabling storage technology are critical elements of a more efficient electrical grid.

High voltage power electronics, such as switches, inverters, and controllers, allow electric power to be precisely and rapidly controlled to support long distance transmission. This capability will allow the electrical grid to respond effectively to disturbances and to operate more efficiently, thereby reducing the need for additional infrastructure.

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57 American Wind Energy Association, AWEA Small Wind Turbine Global Market Study. (Washington, DC: AWEA, 2010).

58 Clean Edge, Inc., “Clean Energy Trends 2010” (March 2010)

59 CC Research, Global Markets for Residential and Commercial Solar Thermal Technologies (2009).

60 Database of State Incentives for Renewables and Efficiency, 2010

61 U.S. Energy Information Administration, Annual Energy Outlook 2010 (Washington, DC: US Department of Energy, 2010).

62 Ibid, p. 56.

However, energy currently cannot be stored to any scale needed by utilities to keep a baseline of energy commensurate with demand. Recognizing this problem, the US Department of Energy has recently invested$3.375 billion for Smart Grid research and pilot programs attempting to use new storage and distribution technologies**.** Storage options being researched include batteries (both conventional and advanced), flywheels, electrochemical capacitors, superconducting magnetic energy storage (SMES), power electronics, and control systems.

Green Building Materials & Systems/Energy Efficiency

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and deconstruction. Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using resources, protecting occupant health and reducing waste, pollution and environmental degradation. [63]

The 2009 Green Building Market and Impact Report found LEED registered green building activity has grown to a cumulative total of more than 7 billion square feet worldwide since the LEED standard was launched in 2000 — with more than 40 percent growth in 2009 alone. The US green building market value is slated to balloon from $71.1 billion now to $173 billion by 2015, according to a recent study by Environmental Leader, Inc.[64]Commercial green building is expected to grow by 18.1 percent annually during the same time period--from $35.6 billion to $81.8 billion. LED lighting, home based metering systems, and building products from renewable and nontoxic materials are also expected to grow and attract growing investor interest. Other products that promote both energy efficiency (e.g. highly efficient insulation) and water efficiency (e.g. low flow shower heads and toilets) also target these markets.

In Kansas, green building activity is poised for rapid growth. A 2009 Kansas Corporation Commission study identified only nine LEED certified buildings across the state.[65] Meanwhile, the Great Plains Chapter of the US Green Business Council, which serves Kansas and the Kansas City metro area, has identified fifty completed LEED projects and another 250that are awaiting certification.

Biochemicals and Bioplastics

Many market analysts are bullish on future markets for biochemicals and bioplastics. A
A 2009 study projects that 3 percent (about $100 billion) of the world chemical market is now based on bio-based feedstock or on technologies that use report (fermentation, enzymatic conversion, or some combination of them.[66] However, by 2025, this proportion is expected to jump to 15 percent of the total market.

The future biochemical market is being developed via three processes: direct production using

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63 US Green Building Council at www.usgbc.org

64 Environmental Leader Insights, July 2010 need full cite

65 LEED Certified Buildings in Kansas, April 2009. Available at:
http://www.kcc.state.ks.us/energy/charts/EE_LEEDCertifiedBuildingsinKansasApril2009.pdf

66 C&News, July 2009, p. 26-28. Need cite

conventional thermochemical and catalytic process, biorefining, and expression in plants.[67] At present, both direct production and expression in plants are being used to produce diverse products such as inks, resins, and chemicals. [68]Chemical biorefineries, on the other hand, based on various platforms such as carbohydrate/ cellulose, oil, and glycerin, a co-product of biodiesel production, and algae are in the pilot stage.

Bioplastics, a form of plastics derived from renewable biomass sources, represent another growing market. From an international capacity of 150,000 tons in 2006, world bioplastics output is expected to rise to two million tons in 2011.[69] Bioplastics are ideal for use as medical implants, where they can dissolve in the body, or compostable mulch films for agriculture. However, the largest growth rates have occurred in the automotive and electronics industries. A May 2009 industry study found that, in the past eight years alone, consumption of biodegradable plastics based on starch, sugar, and cellulose has increased by 600 percent. [70]Starch-based plastics currently dominate in Europe, and polylactic acid is considered to be particularly promising.[71]

Clean Transportation and Fuels

Transport systems have significant impacts on the environment, accounting for between 20 percent and 25 percent of world energy consumption and carbon dioxide emissions. Moreover, greenhouse gas emissions from transport are increasing at a faster rate than any other energy-using sector.[72] Road transport is also a major contributor to local air pollution and smog.

According to the American Public Transportation Association, the public transit bus, clean truck, passenger and transit rail industries currently support nearly 50,000 US manufacturing jobs throughout their supply chains.[73] Jobs in these supply chains are spread across all 50 states, among more than 320 existing companies that could scale up to meet expanded demand. Filling the current backlog of public transit capital investment needs alone - estimated at more than $75 billion - would dramatically expand the market for new public transit vehicles, systems and their component parts. Over the next six years, an estimated 27,600 transit buses, 4,000 passenger rail cars and locomotives, and 220 light rail cars will need to be replaced.[74]

Moreover, freight sector demand for cleaner trucks and rail services is poised to grow as a result of continued growth in freight shipping tonnage combined with new freight efficiency policies, such as the tighter fuel economy standards for heavy-duty vehicles expected in the fall of 2010 and pending legislation that would expand incentives for heavy-duty electric and natural gas trucks. Even without new regulations or incentives, the market for medium to heavy-duty hybrid, plug-in hybrid and full-electric trucks is expected to increase by 63 percent per year over the next five years.

The market for clean transportation is not limited to the production of electric cars or cleaner busses - the aerospace industry has set a course to become a more clean industry as well. The International Civil

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67 Bhima Vijayendran, “Bio Products from Bio Refineries: Trends, Challenges and Opportunities,” Journal of Business Chemistry, September 2010. Available at: www.businesschemistry.org/article/?article=121

68 Ibid

69 European Bioplastics, “3rd European Bioplastics Conference Confirms Positive Climate for Bioplastics”, November 10, 2008

70 Ceresana Reserarch report cited in cite?

71 Bioplastics24.com

72 Intergovernmental Panel on Climate Change (2007). "IPCC Fourth Assessment Report: Mitigation of Climate Change”

73 American Public Transportation Association. 2010. “2010 Public Transportation Fact Book: Appendix A: Historical Tables.”

74 Economic Policy Institute “Impact of Alternative Public Transit and Rail Investment Scenarios on the Labor Market” October 2010.

Aviation Organization has set two primary goals--that by 2020 it should stop increasing its greenhouse emissions, and that by 2050 it should cut its emissions by 50 percent compared to 2005 levels. To that end, the FAA and USDA have just signed an interagency agreement on the development of jet fuel alternatives. Most experts agree that airlines would only need to transition 1.0 to 1.5 percent of their total fuel consumption to biofuels in order to reach sufficient demand for biofuels to attain commercial viability and entice suppliers to make necessary investments in scalability and infrastructure to meet airline needs.

Biofuels

The global biofuel industry has been witnessing sustainable growth and developments against the backdrop of depleting fossil fuels and degradation of environmental conditions. Therefore, many economies have turned their attention towards biofuels. Countries are supporting the biofuel industry in the form of subsidies and tax incentives and many governments have mandated the use of biofuel blends with conventional fuel as a means to stimulate market demand.

Biofuels commonly refer to bioethanol, an alcohol commonly derived from corn, and biodiesel, a fuel made from oils. Less common alcohol base fuels are propanol and butanol. Biobutanol (also called biogasoline) is often claimed to provide a direct replacement for gasoline, because it can be used directly in a gasoline engine (in a similar way to biodiesel in diesel engines).

The US Government has long provided various incentives and subsidies for biofuel production and use. These incentives include the Renewable Fuel Standard 2 (RFS) program that required the use of 11.1 billion gallons of renewable fuels in 2009. These mandated levels will continue to grow, reaching thirty-six billion gallons by 2022. The US Energy Information Administration projects that annual biofuels production could grow from 12 billion gallons in the US in 2008, to over 42 billion gallons by 2035.[75] Worldwide, the United States, Brazil, and the European Union are the three largest biofuels markets in terms of volume. Biofuels now provide more than 50 percent of the fuel by volume that powers Brazil's road transportation vehicles with gasoline engines. The US is the second largest producer of biodiesel in the world, producing 17.7 percent of the world's biodiesel in 2009. While currently only a small fraction of the US (10.6 billion gallons of biofuels out of 140 billion gallons of all fuels in 2009[76]) and EU total transportation fuels markets, these regions lead Brazil in the overall potential size of their respective biodiesel and ethanol markets.

Other reports note similar growth patterns. Pike Research, a leading cleantech market intelligence firm anticipates that, spurred by innovations in feedstocks such as waste grease, algae, and jatropha, biodiesel revenues will increase to $71.0 billion worldwide by 2020, up from $18.4 billion in 2010.[77] HART Energy reports that global biofuels demand is still projected to grow by an impressive 133 percent by 2020-largely driven by public subsidies and market mandates. However, given the current production capacity in the market, biofuels supply will be short by more than 32 billion liters (8.5 billion gallons) over the same period.

Research trends in the field of biofuels not only include how to develop fuels from various feedstocks, but also how to find high value uses for refining by-products which can have as much or more economic value as the fuel. Currently, ethanol is widely produced in the US using corn, however biofuel growth from non-food feedstock is rapidly gaining traction. Fuels from cellulosic feedstocks, biomass and algae

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75 Energy Information Administration, *Annual Energy Outlook 2010.*

76 Renewable Fuels Association, *Climate of Opportunity, 2010 Ethanol Industry Outlook.* (Washington, DC: RFA, 2010).

77 Pike Research, *World Biodiesel Market*, February 22,2010

are under development and being piloted. Analysts predict that the majority of biofuels growth will come from these next generation technologies.[78]

Nationally there are 200 biorefineries producing ethanol. In 2009, they produced 10.6 billion gallons and used 3.8B bushels of corn from farmers. Kansas ranks eighth among states for production capacity at 511 million gals of nameplate capacity and 436 under operation.[79] While states like Iowa have large biofuels programs, Kansas has some significant research on next generation fuels, their performance in engines, and the development of high value products from biorefining. In addition, Kansas is home to many industry leaders in related industries. For example, Colwich's ICM is one of the world's largest players in the construction of ethanol facilities. ICM's leadership currently estimates that the firm is engaged in 2/3 of all ethanol plant construction projects now underway in the US.[80]

78 Jefferies & Companies, Cleantech Primer, November 2008

79 According to the Renewable Fuels Association, major Kansas-based companies include Abengoa Bioenergy, Bonanza Energy, Gateway Theanol, and East Kansas Agri-Energy.

80 http://www.icminc.com/about/faqs/

Appendix B: The Kansas Cleantech Landscape

This section summarizes the various attributes of the Kansas economy that could position the state for growth in the cleantech markets described above. In other words, given the trends in the marketplace and in enabling technologies, where is Kansas well positioned and where are the key challenges? We examined the concentration and growth of industry segments related to cleantech, occupations, investment trends, patent alignment, and perceived strengths and weaknesses gathered directly from Kansas businesses and economic development agencies through interviews, meetings, and via an on-line survey. A more detailed analysis of these elements is found in the Appendix.

EMPLOYMENT IN INDUSTRIES WITH CLEAN TECH MARKETS

Over the past several years, a number of studies have attempted to quantify the size and scope of Kansas's green economy. While the analyses all present slightly different numbers, they all agree that Kansas can expect steady growth in the number of green or cleantech-related jobs found in the state. For example, a 2008 US Conference of Mayors predicted that, by 2038, Kansas' five largest metropolitan areas would be home to 31, 399 workers in cleantech industries.[81] In 2009, the Pew Trusts identified 8,017 green jobs in Kansas and noted that, between 1998 and 2007, green jobs had grown by 51 percent while statewide employed dropped 0.3 percent. [82] Kansas' annual green job growth rate of 4.7 percent ranked as the six highest growth rate in the US.

The most recent, and the most thorough, analysis can be found in the *2009 Kansas Green Jobs report* produced by the Kansas Department of Labor. This study identified over 20,000 Kansas-based cleantech jobs within an array of industries. [83] The highest concentrations of green jobs were found in energy efficiency, construction, agriculture, and key service sectors. Energy efficiency comprised 52.7 percent of jobs, agriculture and natural resources conservation accounted for 19.4 percent of jobs, pollution prevention and environmental clean-up for 16.4 percent of jobs, clean fuels and transportation for 4.4 percent and renewable energy for 7.1 percent of cleantech jobs. While energy efficiency dominated the green jobs landscape in Kansas with over 8,200 jobs, more than 2,300 of those jobs were outside of construction in professional services and manufacturing.

Overall, green jobs represent approximately 1.5 percent of the state's covered employment.[84] This figure corresponds to results found in other studies at both the national and state level. At the national level, the US Department of Commerce has estimated that green jobs account for anywhere from 1.5 percent to 2.7 percent of total US private sector employment, and roughly 1-2 percent of total private business activity.[85]

Studies from Kansas and other states also yield another consistent conclusion about green and cleantech jobs. Most cleantech jobs are located in existing business sectors and are not located in new, pure-play

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81 US Conference of Mayors, *Green Jobs in U.S. Metro Areas.* (Washington DC: USCM, October 2008).

82 Pew Charitable Trusts, *The Clean Energy Economy, Repowering Jobs, Businesses and Investment Across America*, (Washington, DC: Pew Charitable Trusts, 2009).

83 Kansas Department of Labor, *2009 Kansas Green Jobs Report*, (Topeka: Kansas Department of Labor, 2010.

84 Ibid

85 Data are for 2007. See US Department of Commerce, Economics and Statistics Administration, *Measuring the Green Economy*, April 2010.

cleantech industries. Instead, existing firms, in areas such as construction or manufacturing, employ workers in green jobs while also employing others in more traditional activities.

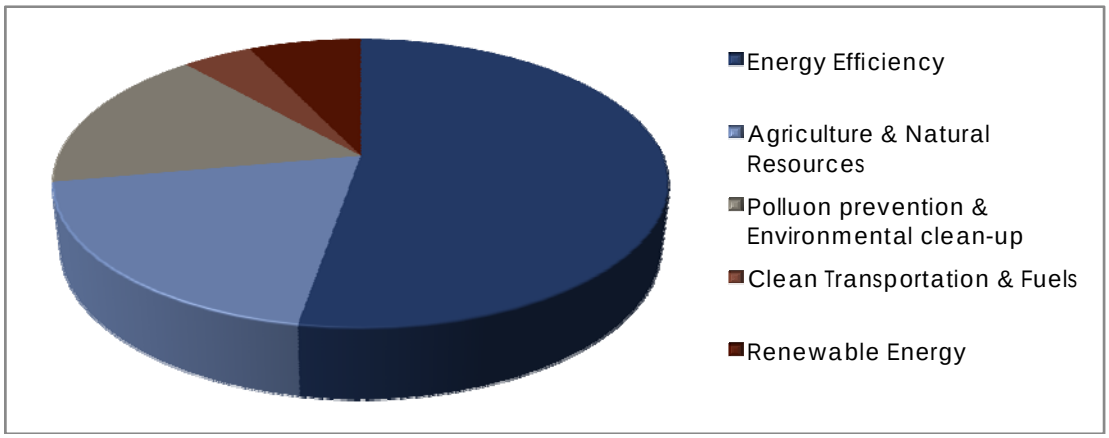
TABLE B-1: KANSAS GREEN (CLEANTECH) JOBS BY INDUSTRY

NAICS	Industry	Total Green Jobs	Total Industry Employment	Green Jobs as a Percent of total Employment
	Total Green Jobs	20,047	1,357,342	1.5%
238	Specialty Trades Contractors	4,228	39,328	10.8%
246	Construction of Buildings	2,685	12,150	21.5%
561	Administrative Services	2,428	68,138	3.6%
541	Professional & Technical Services	1,682	61,753	2.7%
325	Chemical Manufacturing	1,192	7,070	16.9%
423	Merchant Wholesales, durable goods	892	28,098	3.2
237	Heavy & Civil Engineering Construction	815	11,057	7.4%
327	Nonmetallic Mineral Product Mfg	752	5,990	12.6%
441	Motor Vehicle & Parts Dealers	693	17,747	3.9%
326	Plastics & Rubber Manufacturing	485	9,513	5.1%
336	Transportation Equipment Mfg	483	52,914	0.9%
921	Executive, Legislative & Government Support	450	51,487	0.9%
111	Crop Production	379	2,469	15.4%
444	Building Materials & Garden Equipment Dealers (retail)	331	11,733	2.8%
333	Machinery Manufacturing	307	18,568	1.7%
321	Wood Products Manufacturing	304	1,936	15.7%
562	Waste & Remediation Services	246	3,246	7.6%
311	Food Manufacturing	224	31,177	0.7%
332	Fabricated Metal Products	171	15,648	1.1%
611	Education Services	156	145,223	0.1%
	All other industries	1,143	761,736	

Source: Kansas Department of Labor, 2009 Green Jobs Report

Chart A presents the distribution of green jobs by job activity. The Kansas Department of Labor estimated that more than half of current green jobs (11,863) were in deployment sectors (those providing secondary services or products) of construction, administrative services, or wholesale and retail jobs, while just over 8,100 were in sectors that produced or designed clean tech goods and services including manufacturing, professional services, and scientific industries.

Chart B-1: Distribution of Kansas Cleantech Jobs by Application



Source: Kansas Department of Labor

Kansas' current green economy strengths tend to align with more traditional industry strengths. Utilities, gas and oil refining, and information services are also more concentrated in Kansas. The local presence of large utilities and information services firms, especially in telecommunications, may point to growing opportunities in smart grid and other markets where communication and data processing of multiple locations will be required. Similarly, existing manufacturing strengths may indicate that Kansas is well positioned for the production of cleantech products and components

Further examination of key manufacturing and service sectors associated with cleantech markets show that Kansas' manufacturing strength is quite broad, with transportation equipment (e.g. aerospace), food, machinery, plastics, non-metallic, and fabricated metal manufacturing sectors all having more concentrated employment than the US The following section on Kansas' occupational mix also suggests that these sectors employ a highly skilled workforce. In addition, there are over 18,000 additional jobs in electronic components, chemical and electronics manufacturing. And, while the US lost manufacturing jobs in almost every category, half of the ten manufacturing segments listed below actually added jobs in Kansas between 2004 and 2009.

Telecommunications employment in Kansas, with more than 21,000 jobs statewide, is two times higher than national averages. As many cleantech products and services depend on sophisticated communications technologies, this highly concentrated industry may be an advantage for Kansas. Kansas is also known for its headquarters of key engineering firms, and expertise in large engineering projects in energy, water, and industrial systems. With over 12,000 jobs in architectural and engineering services and a steady growth rate in firms and jobs, this sector may also be a foundation for the state's cleantech opportunities. Scientific services are less concentrated in Kansas than elsewhere is the US, however, the growth rate of jobs since 2004 was the largest of all sectors at 22 percent per year. This sector is closely tied to biotechnology markets and may point to the growth potential that can occur when there is a focused economic strategy.

TABLE B-2: GROWTH IN SELECTED CLEANTECH SEGMENTS IN KANSAS

NAICS	Industry	2009 LQ	2004 firms	2004 jobs	2009 Firms	2009 Jobs	Growth in firms	Growth in Jobs
	All Firms		81,481	1,296,618	87,522	1,317,794	1.43%	0.32%
Mining & Utilities								
211	Mining: Oil & Gas	1.52	373	2,050	422	2,435	2.47%	3.44%
213	Support Activities for oil/gas/mining	1.7	429	3,895	570	4,657	5.68%	3.57%
221	Utilities	1.38	245	7,206	237	7,725	-0.66%	1.39%
Manufacturing								
336	Transportation Equipment	3.32	261	44,543	257	45,412	-0.31%	0.39%
311	Food Manufacturing	2.11	331	31,981	311	30,530	-1.25%	-0.93%
324	Petroleum Products	1.69	38	1,810	56	1,930	7.76%	1.28%
333	Machinery Mfg	1.59	404	16,352	370	16,149	-1.76%	-0.25%
327	Non-metallic Mineral Products	1.44	239	6,310	232	5,586	-0.59%	-2.44%
326	Plastics & Rubber Mfg	1.36	140	10,020	129	8,496	-1.64%	-3.30%
332	Fabricated metal products	1.01	485	12,701	543	13,104	2.26%	0.62%
335	Electrical Equipment & Components	0.97	56	4,309	59	3,596	1.04%	-3.62%
325	Chemical Mfg	0.88	154	6,930	167	6,994	1.62%	0.18%
334	Computer & Electronics Mfg	0.7	136	7,005	115	7,904	-3.35%	2.41%
Service & Support Industries								
517	Telecommunications	2.16	600	25,688	650	20,922	1.60%	-4.10%
5413	Architecture & Engineering	0.93	987	10615	1074	12281	1.69%	2.92%
5415	Computer Systems	0.68	1333	9059	1766	9612	5.63%	1.19%
5417	Scientific & Technical Services	0.41	120	815	138	2481	2.80%	22.26%
562	Waste management/remediation	0.87	237	3,519	258	3,016	1.70%	-3.08%
237	Heavy & Civil Engr. Construction	1.21	687	10,843	661	10,265	-0.77%	-1.10%

Source: Bureau of Labor Statistics, QCEW data

OCCUPATIONS SUPPORTING CLEANTECH

The *2009 Green Jobs Report* by the Kansas Department of Labor details the wide array of occupations in cleantech markets, from construction workers to machine operators to scientists and engineers. Building on this study, we analyzed the degree to which key occupations were more or less concentrated in Kansas as compared to the national average. In other words, did the state have any comparative advantages in these occupations? Focusing on Kansas' ability to develop and produce cleantech products and professional services, we analyzed three occupational segments: professional and technical occupations, productions occupations, and repair and maintenance occupations. Because the employment for constructions workers was on par with national averages, we did not include those occupations in our analysis.

Professional and Technical Occupations: The concentration of professional jobs in Kansas clearly underscores the important potential role that the state's traditional industries and professional service industries could play in developing new cleantech market opportunities.

- When compared to national averages, Kansas has more than five times the concentration of agricultural engineers. Agricultural engineers are engaged in a variety of cleantech areas, including enhancements of machinery and water systems, and the development of bio-based products and bio-energy systems. Soil and plant scientists are also increasingly engaged in bio-product development and low impact food production. These occupations are 2.6 times more concentrated in Kansas than in the US as a whole. While total employment numbers are small, these current employment concentrations can be attractors for specialized niches.
- Kansas is home to some of the world's leading engineering firms. This fact is reflected in the large number of jobs and higher than average concentrations in civil engineering technicians, electrical engineers, mechanical engineers, surveying and mapping technicians, and surveyors.
- Expertise in telecommunications and controls is highlighted by a high concentration of jobs in electrical engineers other than computers, network and computer systems and computer programmers.
- Looking at technical and scientific occupations where Kansas has a lower than average employment concentrations, we find fewer chemical engineers, material scientists and engineers, geoscientists, bio-technicians, microbiologists, computer hardware engineers, and physical scientists.

Production Occupations: Many cleantech market segments, such as wind power transmission, are dominated by large global players like GE or Denmark's Vestas. Intense market competition may make it difficult for new entrants to succeed in such markets, but there are numerous business opportunities as suppliers and partners with larger multinationals. Kansas is well positioned to succeed in many of these areas with larger manufacturing supply chains. The state has 30 percent more production workers per 1,000 jobs, than the US average.[86] And, many of these jobs reside in advanced or precision occupations that support production of cleantech products such as wind turbines, water systems, and electronic communications equipment for grid and utility metering.

- The most concentrated production occupation in Kansas is the highly skilled occupation of numerical control and process control programmers. These occupations are 2.5 times more concentrated than the US average.
- Patternmakers, tool and die makers, CNC machine operators, fabricators and engine and machine assemblers are all more concentrated than US averages.
- Assemblers of electrical systems are 30 percent more concentrated in Kansas.
- Kansas tends to have fewer production jobs in more general machine operation occupations including cutting, finishing operations, chemical plant operators, and general assemblers.

Installation and Maintenance Occupations: As cleantech products and services are deployed, demand will increase for workers skilled in repair and maintenance of systems and controls. Overall, Kansas has slightly more jobs per capita in repair related occupations, and, not surprisingly, many are associated with aerospace. Jobs in telecommunication and power-line installers, as well as machinery and heavy equipment maintenance repair are slightly more prevalent in Kansas and could support installations of cleantech projects.

86 Data from the Bureau of Labor Statistics

KANSAS UNIVERSITY R&D SUPPORTING CLEAN TECH

Kansas universities are engaged in a variety of research and modeling activities in cleantech. In many cases, this research involves industry partners in Kansas and throughout the country. Patent positions and licenses indicate that there may be commercial potential for some of these R&D efforts. Table 4 highlights the key cleantech research efforts at universities throughout the state.

TABLE B-3: UNIVERSITY CLEAN TECH RESEARCH HIGHLIGHTS

Research Center/Activity	Key Aspects of Research
Center for Environmentally Beneficial Catalysis (CEBC) at the University of Kansas	The mission of CEBC is to use catalytic science and reaction engineering to develop new technologies to sustainably produce chemicals and fuels. ▪ Renewable chemicals based on bio-feedstocks ▪ Next generation biofuels in three platforms: alcohols synthesis from syngas; refining biomass pyrolysis oils, and catalytic reforming of lignocellulosic carbohydrates ▪ Reducing the carbon footprint of large volume chemical manufacturing processes ▪ Design and application of novel materials for removal of toxics and sequestration of CO2 ▪ Examples include catalytic processes in which conventional organic and chlorinated solvents are either totally eliminated or replaced by benign solvents; processes in which liquid acids are replaced by solid acids; processes where biocatalysts (enzymes/microbial cells) replace heavy metal or strong acid/base catalysts; or processes that utilize traditional and renewable raw materials efficiently in their conversion to desired products. ▪ CEBC has an active industry advisory council and has been conducting research for ADM and other international companies
The Information and Telecommunication Technology Center (ITTC), University of Kansas	The ITTC has several areas with cleantech applications. The Bioinformatics and Computational Life-Sciences Laboratory (BCLSL) advances methods and tools geared to biological, biochemical, and medical applications. The Communications and Networking Systems Laboratory works on high-capacity networks, optical systems, agile and software defined radios, innovative transmitter and receiver design, and reliable and robust mobile networks to deliver reliable communications to user applications. Recent projects involve radio design, Bluetooth and RFID evaluation, optical sensors, and radio spectrum measurement and management. The Intelligent Systems Laboratory (ISL) advances knowledge in artificial intelligence, intelligent agents, information retrieval, data mining, and robotics. ISL is customizing IT services, creating smarter and user-friendlier environments and devices. The Radar Systems and Remote Sensing Laboratory (RSL) conducts research in radar and other electromagnetic sensing problems, including advanced system concepts, radar image formation, adaptive radar signal processing, and radar simulation. ITTC conducts sponsored research, testing and modeling for industry, with support from companies like Sprint.
Transportation Research Institute (TRI) University of Kansas	KU TRI provides an organizational framework that focuses on six interrelated areas: vehicle technologies and alternative fuels; safety and human factors; information systems and logistics; transportation infrastructure; socio-political and economic issues; and, environmental assessment.

	The Feedstock to Tailpipe Initiative develops fuels and blends from different feedstocks and then tests the fuels for engine performance and environmental impact. Other transportation projects include: Ionic Liquid/Refrigerant Absorption Refrigeration/Air Conditioning System for Increased Fuel Efficiency and Reduced Emissions Determining the Oxidation Stability of Biodiesel Produced from High Stability Oils Dual Cycle Exhaust Energy Recovery for Internal Combustion Engines Emissions Testing and Performance Evaluation of Aircraft Diesel Engines Plug-In Hybrid Electric Emissions Characterization & Demonstration TRI also has research projects in transportation materials, composites for bridges, pavement materials) as well as research and modeling in environmental assessments related to run-off and bio-retention methods TRI conducts applied research and model with industry, including Smith Electric Vehicles.
Bioengineering Research Center, University of Kansas	The efforts within the Bioengineering Research Center at the University of Kansas are focused on performing innovative research to address issues relating to the integration of engineered materials into human physiology and to the development of novel technologies for early-stage diagnosis and management of disease.
Center for Sustainable Energy, Kansas State University	Focused on R&D in host of energy related areas including biomass, solar energy, hydrogen, and others. Examples of current research projects include: ▪ Assessing the use of ocean algae as biofuel. ▪ Study of photosynthetic processes that might contribute to the development of new photovoltaic devices that turn sunlight into energy ▪ The impact of biofuels on groundwater ▪ Soy-protein-based adhesives and biocomposite materials ▪ Water conservation, purification, and recycling
Konza Prairie Biological Station	Tallgrass Prairie Reserve supporting research into ecology and prairie ecosystems.
Power Systems Group, Kansas State University	KSU engineering faculty is engaged in several R&D initiatives related to power systems. One project examines how to design transmission systems so that power flows more efficiently. The Wind Applications Center is support small wind projects and also manages the NREL-backed Small Wind Test Center in Colby.
Bioprocessing and Industrial Value Added Program, Kansas State University	BIVAP focuses on developing new technologies for biomaterials processing in food, feed, and industrial markets. Among other areas, BIVAP researchers are researching new conversion processes for cellulosic biomass.
National Agriculture Biosecurity Center, Kansas State University	Supports R&D on how best to protect agriculture and economic assets from biological threats. Will be part of new National Bio and Agro Defense Facility now being developed in Manhattan.

National Institute of Aviation Research, Wichita State University	Provides research, design, testing and certification to the aviation manufacturing industry, government agencies, and educational entities. NIAR is a Center of Excellence for General Aviation Research (CGAR) and is the headquarters for the Center of Excellence for Composites and Advanced Materials (CECAM). Additional recognition comes from NASA, who sponsors the National Center for Advanced Materials Performance (NCAMP), located within NIAR, and the National Science Foundation has named WSU/NIAR as a Center for Friction Stir Processing (CFSP). The cleantech application of this technology is in fuel efficiency from better aerodynamics and lighter materials. Additionally, there are many cleantech applications outside of aeronautics that can use FSW such as electric vehicles and wind generation equipment.
National Polymer Research Center, Pittsburgh State University	The National Polymer Research Center specializes in vegetable oil-based polymer research and development as it works with industrial partners, state and federal agencies, and producer associations on developing and commercializing intellectual property. Specialty areas include Polyurethanes, unsaturated polyesters and epoxies, elastomers and gels, polymer blends, liquid crystallines, plastics, adhesives, polyglycerin, coatings, polycarbonates, pre-polymers, polymeric oils, solvents and vinylated oils One example of the cleantech application for their work is the development of new biopolymers that are better than plastics for biodegradability, low toxicity, and use of renewable resources and require less chemical processing than current biomass-based polymers.

INDUSTRY PATENTS

An analysis completed by Foley & Lardner LLP, showed that in 2009, 823 US patents were issued in eleven different cleantech segments (solar, wind, geothermal, hydro/wave/tidal, biomass/biofuels, hybrid vehicles, fuel cells, nuclear, smart grid, utility metering, and CO2 storage and sequestration). Solar (31%) wind (18.7%) and hybrid vehicles (14.6%) topped the list with over half of all patents and a total of over 9,000 claims. Utility metering and biofuels made up the second tier of patents accounting for approximately 13 percent of patents.[87]

The Clean Energy Patent Growth Index (CEPGI) tracks the granting of US patents for the following sub-components: Solar, Wind, Hybrid/electric vehicles, Fuel Cells, Hydroelectric, Tidal/wave, Geothermal, Biomass/biofuels and other clean renewable energy. The second quarter 2010 components breakdown of the CEPGI shows fuel cells, solar and wind at record levels while hybrid/electric vehicle patents fell. Fuel cells were up 40 granted patents relative to the fourth quarter at 248 and continue to dominate the other components of the CEPGI in absolute numbers. Granted solar patents (76) continued to climb topping wind (33) for the third straight quarter defying a long history of losses to wind prior. Solar patents were up 9 compared to the first quarter of 2010 and up 40 relative the second quarter of 2009. Wind patents were up 20 relative to the first quarter and up 12 compared to a year prior. Hybrid/electric vehicle patents (33) were down 17 from the first quarter to return to fourth quarter 2009 levels and were up 13 over the second quarter of 2009. Biofuel patents (12) were down dropped slightly from the previous year.[88]

Patents issued to individuals may indicate areas where corporations have opportunities to license existing technologies to enter or expand markets. In 2009, more than 18 percent of cleantech patents were issued to individuals, far exceeding the overall portion of patents (11%) awarded to individuals. In cleantech segments, utility metering, biofuels, geothermal, and hydro technologies had a higher percentage of individual patent holders. In contrast, to high cost or capital intensive sectors such as nuclear and vehicles had fewer individual patents.

Patenting patterns also differ greatly by region. The West Coast receives the most patents in solar-related fields, but while the East Coast leads patents for wind, wave/tidal, geothermal, smart grid and nuclear. The Midwest region leads in patenting related to biomass/biofuels, hybrid vehicles, CO2 storage and sequestration[89]

Kansas' Patent Landscape

According to the US Patent Office, Kansas companies, individuals and research institutions were awarded 2,613 patents between 2005 and 2009. When compared to the state's population, Kansas ranked third out of six regional states (Table B-4).When compared to regional neighbors, Kansas' share of patents from corporations and individuals were average, however, patents from universities were below average, with only 1.7 percent of all patents coming from university and research institutions (Table B-5).

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87 Foley & Lardner LLP, *Cleantech Energy Patent Landscape*, 2010

88 Heslin Rothenberg Farley & Mesiti P.C., *Clean Energy Patent Growth Index,* 2010.

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TABLE B-4: KANSAS PATENTS COMPARED TO NEIGHBORING STATES

	Patents 2005-2009	Population	Patents per 1,000 residents
Colorado	10,140	5,024,748	2.02
Iowa	3,400	3,007,856	1.13
Kansas	2,613	2,818,747	0.93
Missouri	4,120	5,987,580	0.69
Nebraska	1,138	1,796,619	0.63
Oklahoma	2,460	3,687,050	0.67

Source: US Patent Office

TABLE B-5: KANSAS PATENTS BY SOURCE COMPARED TO NEIGHBORING STATES

	Patents from Corporations	% from Corps.	Patents from Individuals	% from Individuals	Patents from Universities/ Research Inst.	% from University/ Research Inst.
Colorado	9,055	89.3%	977	9.6%	108	1.1%
Iowa	2,899	85.3%	302	8.9%	199	5.9%
Kansas	2,240	85.7%	329	12.6%	44	1.7%
Missouri	3,315	80.5%	665	16.1%	140	3.4%
Nebraska	806	70.8%	261	22.9%	71	6.2%
Oklahoma	1,869	76.0%	460	18.7%	131	5.3%

Source: US Patent Office

Companies in the telecommunication and related IT sectors dominated the number of patents awarded to Kansas companies. Following this sector, patent distribution varied among aerospace, biosciences, equipment manufacturers, and others.

TABLE B-6: COMPANIES WITH 10 OR MORE PATENTS 2005-2009

First-Named Assignee	2005	2006	2007	2008	2009	Total
SPRINT COMMUNICATIONS COMPANY L.P.	35	73	64	77	84	333
~INDIVIDUALLY OWNED PATENT	78	78	66	56	51	329
SPRINT SPECTRUM L.P.	22	68	59	60	57	266
GARMIN LTD.	41	22	17	13	15	108
LSI LOGIC CORPORATION	22	34	17	12	18	103
BOEING COMPANY	13	21	9	15	16	74
COLEMAN COMPANY INC.	11	8	9	3	2	33
HONEYWELL INTERNATIONAL INC.	2	4	7	6	5	24
UNIVERSITY OF KANSAS	3	0	3	4	13	23
GARMIN INTERNATIONAL, INC	6	3	1	5	2	17
HONEYWELL FEDERAL MANUFACTURING & TECHNOLOGIES, LLC	1	3	8	2	2	16
AGCO CORPORATION	1	3	0	6	4	14
FLINT HILLS SCIENTIFIC, L.L.C.	3	2	2	3	4	14
WARD/KRAFT, INC.	3	4	2	2	3	14
GENERAL ELECTRIC COMPANY	0	2	2	6	3	13
CARGILL, INC.	1	3	3	4	0	11
KANSAS STATE UNIVERSITY RESEARCH FOUNDATION	2	2	2	3	2	11
SCRIPTPRO L.L.C.	2	3	4	2	0	11
BE INTELLECTUAL PROPERTY, INC.	3	2	3	0	2	10
HALLMARK CARDS INCORPORATED	1	1	2	4	2	10
POLYMER GROUP, INC.	0	2	3	4	1	10
SPX COOLING TECHNOLOGIES, INC.	0	4	2	4	0	10

Source: US Patent Office

The patent classification system does not have a specified grouping for cleantech; so existing data does not allow a simple categorization of Kansas-based cleantech patents. However, we did seek to track patenting trends in industries with close connections to cleantech: Chemical processes and compounds, IT and communications, transportation, energy and electrical systems, mechanical and industrial systems, and measurement and test.

A large amount (over 850 patents) in **IT and communications** may have relevance for cleantech products and markets. Telecommunications and multiplex applications topped patents in IT and communications, with a significant number of patents in areas such as navigation and location tracking, data processing for measuring and calibration, and error detection and correction. These technologies are all widely deployed in areas like smart grid, utility metering, and remote resource monitoring.

Patent activity in **chemical processes and compounds** was modest (approximately 190 patents analyzed) and focused in areas of molecular biology, organic compounds, and purification and separation. A smaller number of patents were awarded for coatings, adhesives, bonding, and similar processes.

Mechanical and industrial systems represented another 190 patents with a wide distribution among 39 different patent classes. Patents in this category appear to reflect the state's advanced manufacturing capacities. A number of fluid handling, pipes, values, pumps, hydraulic equipment patents indicate local

technology and know-how that could be applied in water infrastructure markets, including those in industrial, municipal and agriculture segments.

There were approximately 130 patents analyzes within **transportation** classes, including aeronautics, electric transmission systems, and engines and motors. Only six patents in the past five years were related to fuels and related compositions.

Over 130 patents were analyzed in **measurement and test** classes that included electrical test communication, illumination, and general measuring and testing applications. While these types of patents can have application in clean technology products and processes, there were no clear areas of specialization.

VENTURE CAPITAL & CORPORATE INVESTMENT TRENDS

For the past several years, cleantech has been the "hot" sector in venture capital circles, with many new funds targeting these industries. In 2008 and 2009, cleantech venture capital investments grew rapidly. However, 2010 has been a sobering year. While cleantech investment levels remained high in early 2010, the year's third quarter witnessed a large-scale drop in deals and dollars invested. Both the Cleantech Group LLC and Deloitte & Touche noted a 55 percent drop in third quarter investments.[90]

Venture industry analysts do not expect a quick turnaround, with many predicting a significant consolidation and shakeout as investors look for exits. As Jennifer Kho, a GigaOM analysts reports:

> Traditional capital has become harder to get at all stages: Companies are seeing lower valuations, higher milestone requirements and more time required to close funding at every stage, from seed and angel capital to private equity and project financing. Gaps between the stages are growing wider, with earliest- and latest-stage companies in greatest danger of falling in. Investors have been trapped by a lack of exits: Liquidity events, including initial public offerings and acquisitions, have slowed dramatically in the United States and Europe, and startups at that exit stage have had to wait for better market conditions. That has resulted in venture capitalists and others having to reserve more money for their existing investments, even as it's become more difficult to raise money from capital-constrained banks and institutional investors. Meanwhile, offerings in China have soared, boosting interest in investments in Asia.[91]

Investors note the importance of market differentiation as this consolidation occurs, so one can likely expect to see more write-offs and failures as pressures to find market leaders grow. Organizations tracking cleantech investments appear to have similar projections about growth in equity-backed deals.[92] Among these projections are:

- Renewable energy generation moving to larger scale projects and therefore larger investments.
- Information and communication technologies (ICT) playing a more central role in a variety of cleantech sectors including not only smart grid applications, but also energy and water management

92 Sources include Cleantech Group LLC 2010 Investment trends, Deloitte & Touche Quarterly Cleantech Venture Capital Summaries, GigaOm, and Venture Beat market updates

of buildings, mobile and onsite water treatment, distributed energy and water systems, smart appliances and more.

- Energy and power storage, especially distributed systems will receive more attention from investors.
- Electric vehicles technologies will remain attractive as major carmakers compete for plug-in electric hybrid and all electric vehicles needing battery technologies that can support various operating conditions.
- Energy efficiency will continue to have strong growth with venture funding likely focused on product development (e.g. monitoring systems, LED/OLED lighting).
- Interest remains strong in next generation biofuel development with lower carbon footprint.

Growth in Corporate and Utility-based Investments

Corporate activity around cleantech innovation has continued to play an important role in generating new investments. Corporate investors are becoming key participants in many of the largest venture and growth capital investment rounds. Strong corporate involvement was evident again in recent deals: Intel Capital, GE Capital, Shell, Google, Votorantim (Brazilian conglomerate), Alstom (French power and rail infrastructure company) and Cargill Ventures all contributed, the latter two making their first publicly disclosed venture-stage investments in cleantech.

As capital investment requirements grow, many projects and industries may need to turn to other sources of outside finance. Utilities or corporations can play a variety of roles in cleantech; as investor, partner, customer, acquirer, or competitor. The level of activity and type of role they play are a key indicator of the health and growth for clean technology products. According to Deloitte & Touche, corporate investment announcements for cleantech reached a new high of $5.1 billion in the first half of 2010, a 325 percent increase from the same period last year.

The increasing importance of corporate and utility investment into the cleantech sector is a positive sign beyond the direct benefits of additional capital in-flows. Large corporate players are also critical to ensuring the adoption of clean technologies at scale.[93] For example, many energy efficiency technologies will not succeed in the marketplace unless adopted by major corporate customers. Similarly, as more states introduce Renewable Portfolio Standards, utilities will be further pressured to make additional investments in these technologies, products, and services.

Meanwhile, as noted by Deloitte & Touche's Scott Smith, "the largest global companies are seeing the business case for operational cleantech integration, leading to record corporate investment. This uptick was driven by companies looking to improve energy efficiency and reduce carbon emissions in order to reduce operational costs, mitigate energy price volatility risk, drive sustainable growth, and comply with existing and pending regulations around carbon and climate change risk disclosure."[94]

Kansas VC Investments

Since 2001, Kansas has averaged approximately $30 million of reported venture capital investments, with an average of thirteen deals per year. Like most states with modest levels of VC investment, levels ebb and flow year to year, as one or two companies receive a large influx of capital.

[93] Cite Deloitte piece here.
[94] Ibid

TABLE B-7: KANSAS VENTURE CAPITAL BY YEAR

	VC Investment	# Deals
2001	$40,264,200	10
2002	7,123,000	7
2003	25,807,000	12
2004	45,651,200	14
2005	1,437,000	4
2006	20,986,100	8
2007	76,351,100	16
2008	44,794,900	23
2009	7,916,000	18
1H2010	7,659,000	14
TOTAL	$277,989,500	126
AVERAGE	29,262,053	13

Source: PWC MoneyTree

Kansas VC Investments by Sector

There is little indication that major cleantech equity deals are emerging in Kansas. Biotechnology firms have been the largest recent investment targets. Since 2007, venture capital deals in Kansas in segments where cleantech companies can be found were limited Using segments such as industry/energy, networking and equipment, and instruments as an indicator for cleantech companies, very few deals or dollars have been invested in these areas—especially when compared to biotechnology or software.

TABLE B-8: KANSAS VC INVESTMENT BY SEGMENT: 2007-2010

	VC Investment ($m) 2007-1H2020	# of Deals 2007-1H2010
Industry/Energy	8	4
Networking & Equipment	1	1
Electronics & Instruments	3	3
Computers	2	2
Software	28	10
Biotechnology	68*	17

Source: PWC MoneyTree

Biotech total includes a single quarter investment of $51 m, which was 10x, the average level of investment

According to MoneyTree's 2010 analysis, Kansas saw there fourteen deals (for a total of $8 million) between January and June. As Table A-9 indicates, none of these firms appear to operate in cleantech related markets.

TABLE B-9: KANSAS VC INVESTMENTS FIRST HALF 2010

Company	Industry	Stage of Development
Edenspace Systems Corporation	Biotechnology	Later Stage
Novita Therapeutics LLC	Biotechnology	Startup/Seed
TVAX Biomedical LLC	Biotechnology	Early Stage
Data Locker, Inc.	Computers and Peripherals	Expansion
AthletixNation, Inc.	Media and Entertainment	Expansion
KCBioMediX, Inc.	Medical Devices and Equipment	Early Stage
Matrix Electronic Measuring, Inc.	Software	Later Stage
RevitalVision LLC	Software	Later Stage

Source: PWC MoneyTree

In general, data on recent equity investments does not suggest a huge untapped demand for these dollars among Kansas' cleantech-related businesses. In general, VC deals in Kansas are smaller than US averages, and this gap is even larger in the cleantech arena. In the second quarter of 2010, the average solar deal was over $30 million, while biofuels and smart grid companies received over $20 million per deal. Meanwhile, the average VC deal in Kansas has been around $2 million per company. This may suggest that Kansas firms are not of sufficient scale to attract larger venture investments, or that VCs doing business in Kansas lack the resources to make large cleantech-related investments. While a major uptick in cleantech-related VC investing is unlikely, we might expect a future pattern where a handful of Kansas-based firms succeed in attracting new venture capital investments each year. This pattern would mimic the experience of Kansas-based IT and biotech firms in past decades.

At the same time, cleantech firms should not focus solely on VC firms as an investment source. With the state being home or having locations for multi-national corporations, Kansas may be better positioned for attracting corporate investment for cleantech companies.

SUMMARY OF COMPANY SURVEY

Cleantech is an emerging sector where industry definitions and processes are new and uncertain, and where traditional data sources and market analyses do not yet capture a full and accurate picture of what is happening in the field with entrepreneurs, companies, and communities. In an effort to better understand cleantech industry trends in Kansas, we supplemented our other analysis with a survey of Kansas businesses and with a series of interviews with industry leaders, experts, and other key stakeholders across Kansas.

Our survey of Kansas businesses was conducted between September 23 and November 1, 2010. This survey was distributed through state and local economic groups, including KTEC, KTEC's network affiliates and the Department of Commerce. The survey sought to identify emerging centers of cleantech activity, to gather market trends data, to identify the state's competitive strengths, and to identify gaps in Kansas' support infrastructure for cleantech entrepreneurs. We sought input from high-level management at the state's cleantech firms. Over 66 percent of respondents were current company CEOs, Founders, Partners or Board members, with more than 58 percent of their companies employing more than 10 employees.

Insights gathered from this survey include:

- Over 45 percent of respondents depend on cleantech products or services for 10 percent or more of their revenue. Core markets for these businesses cut across the continuum: Industrial (30%), Commercial (16%), Government (16%), Consumer (12%), Agriculture (7%) and Utility (7%)
- Respondents were bullish on their business' revenue outlook for the next five years, with over two-thirds anticipating growth rates in excess of 20 percent in that time period, and more than 40 percent anticipating growth rates exceeding 50 percent
- When asked to select the key technological advancements that will affect their business' innovation capacity, respondents selected:
    - Smart Technology (i.e. sensors, monitors, etc. - 36%),
    - Materials (i.e. nano, material, composites, etc. - 35%),
    - Energy Storage and Fuel Cells (32%) and
    - Energy Conversion or Waste-to-Energy Processes (23%)
- 72 percent of respondents cited Kansas as a "good" or "excellent" location for their business in terms of cost.
- A plurality of respondents thought that the cleantech business climate in Kansas was only mediocre compared to other regions, citing a need for policies that improved incentives, created better access to capital, streamlined permitting, and that provided tax credits/incentives to support the growth of businesses in this sector.
- Key policy issues affecting their business growth in cleantech included:
    - Availability of Capital (47%),
    - Regulatory Environment (40%),
    - Incentives and Tax Credits (36%) and
    - Workforce Development (30%)

The results of this survey have helped define the marketplace and highlight areas of policy development that will stimulate growth of these companies. We will conduct a second survey in November that will explore these topics for even more granularity and strategic direction regarding these issues.

INTERVIEW SUMMARY WITH KANSAS COMPANIES & ORGANIZATIONS

The team completed interviews with over 70 key stakeholders and industry experts across the state of Kansas. Interviewees included many key partners of KTEC, other lead agencies (such as staff from Kansas Department of Commerce), and various industry leaders. Our interviews covered a wide range of topics with a particular focus on several key themes and concepts:

- Where are cleantech related activities already underway in Kansas? Where are promising R&D efforts, new technology developments, and exciting cleantech related business opportunities?
- What assets are in place to help Kansas develop a strong cleantech capacity?
- What obstacles are impeding this work? What's missing?
- What are potential next steps? For KTEC? For Kansas?

Kansas Cleantech Opportunities

Our interviewees identified hundreds of individual bright spots for cleantech across Kansas in the form of new business ventures, promising university R&D efforts, or exciting projects. But, as a whole, most agreed that Kansas was not home to a world-class cleantech sector. With the exception of wind power and biofuels, few of Kansas' emerging cleantech opportunities appear to be located in what we might call "pure play cleantech," i.e. sectors that traditional rank near the top when the general public thinks of green or cleantech industries. Examples of such "pure play" opportunities might include solar power or advanced battery technologies.

In contrast, many of Kansas' emerging opportunities appear to be linked to existing areas of competitive advantage in fields such as agriculture, energy, communications, or engineering services. We will provide more detail on these potential opportunities below. However, a strong consensus emerged about seeking to expand on existing assets in areas such as university research in carbon mitigation, utilization and sequestration; the strong communications and engineering services capabilities located in the Kansas City metro area; composites and advanced materials firms in the Wichita metro area; and opportunities related to the agriculture sector across the state, including biofuels and bioproducts.

Current Kansas Assets

Kansas has a host of competitive advantages that KTEC can build upon in developing any new cleantech-related initiatives. Some of the leading factors cited by interviewees are described below. First, Kansas' overall business climate was regularly cited by many interviewees. The cost of doing business and the cost of living are relatively low in Kansas when compared to other regions of the US. Kansas also enjoys a well-deserved reputation as a "business-friendly" state.

Second, Kansas does have some strong support program infrastructure in place. In addition to KTEC and its network, other programs, such as Network Kansas and Kansas Commerce's suite of support programs, are in place to provide needed support to new and growing cleantech businesses. Our interviewees also noted that many programs, while high quality, were small in scale and reached only a limited number of companies or technologies.

Third, Kansas is home to a number of research centers operating in cleantech-related fields. For example, Wichita State's National Institute for Aviation Research (NIAR) is a world-class center for aviation research in many fields of applied research, including composites, friction stir joining and aerodynamic testing, which are currently advancing new flight platforms such as electrical aircraft and suborbital space tourism. At KU, the Center for Environmentally Beneficial Catalysis is creating new transformational technologies for the chemical industry. At Kansas State, the Bioprocessing and Industrial Value-Added Program (BIVAP) is pioneering new approaches to biomaterials processing. All of these initiatives offer potential investment and support opportunities.

Fourth, Kansas is home to a number of leading clusters that could serve as either leading customers for cleantech-related products or services or as developers of such items. Commonly cited examples include the aviation cluster around Wichita and the engineering services and information technology/telecommunication firms located around Kansas City. Interviews also noted a perception that Kansas has strong manufacturing capabilities distributed across the state.

Finally, Kansas can and should capitalize on existing assets that derive from its physical setting or historical legacies. Many interviewees cited the dominant position of agriculture as an economic driver

across the state. Similarly, many also noted Kansas long experience with issues related to energy generation and transmission. Kansas' position as a leading center for wind power was also widely acknowledged. Some interviewees also suggested that KTEC consider supporting different experiments, such as the ongoing green architectural design projects in Greensburg that make Kansas an internationally recognized site for the testing and vetting of new cleantech concepts.

Cleantech Gaps and Missing Pieces

When asked to identify cleantech opportunities, interviewees noted a vast array of possibilities. Their input related to challenges facing KTEC and Kansas was less wide-ranging. Instead, a strong consensus identified the following key gaps in the Kansas cleantech landscape.

Lack of coordination

Weak coordination and the absence of strong partnerships were the most frequently cited challenges impeding the further development of cleantech opportunities in Kansas. Interviewees frequently made comments such as: "Kansans are independent pioneers and don't collaborate well." For example, while Kansas has a higher than average concentration of manufacturing jobs compared to the US, there is no statewide alliance of manufacturers (typically found in other states) and little information that is readily available about specific manufacturing capabilities by sector or region.

Interviewees regularly spoke of various "pockets of excellence," i.e. leading companies or research efforts underway in various parts of the state. Yet, in the same breath, they also noted that that these pockets were often quite isolated and rarely connected to other related activities elsewhere in Kansas. These divisions exist across different companies, across geographies, and even across industry sectors or academic disciplines. There appears to be little cross-pollination or any organized efforts to create important and potentially transformational cross-disciplinary partnerships.

One of our observations related to the lack of coordination is the absence of industry intermediaries or organizations in Kansas. Unlike other states, there are no technology councils, manufacturing alliances, energy associations, or other groups that are aligned by industry or markets and which can work collaboratively with each other, and with universities and government agencies. This means connections must be made one-by-one which is resource and time intensive.

Lack of Strategy/Vision

A related concern was expressed regarding the absence of an overriding vision or strategy for future statewide directions in cleantech, or, in more specific sectors such as energy. Some early planning efforts, such as the Kansas Energy Council, began with some promising work but follow-on efforts have not moved ahead. A number of interviewees suggested that Kansas needs a statewide "champion" for cleantech. Others suggested initiation of a major campaign akin to that developed for the 2004 Kansas Economic Growth Act (KEGA) and the subsequent creation of the Kansas Bioscience Authority. In this view, cleantech opportunities deserve the same level of attention accorded to life sciences in the aftermath of KEGA's enactment.

Lack of Visibility

The absence of statewide vision or strategy is further reflected in the lack of visibility for cleantech industries and opportunities across Kansas. With the possible exceptions of wind power and biofuels, few other cleantech business opportunities or benefits appear to be well understood by Kansans. The wind

sector has received extensive support from the Kansas Department of Commerce, via its Wind Energy Initiative, and other key players. Meanwhile, other potential cleantech opportunities are not on the "radar screens" of key policy makers.

This lack of visibility is present on the business side as well. Kansas is home to only a few very small green business networking efforts, and these emerging networks do not appear to be well connected to other statewide business networks such as those promoted by KTEC and others. Similarly, Kansas does not have a state Technology Council or similar network to help publicize these opportunities.

Nearly all of this limited activity occurs in either Wichita or the Kansas City metro area. Other parts of the state, especially Western Kansas, are not presently engaged in the discussion. Interviewees from less populated parts of Kansas suggested that local businesses and residents do not yet understand the wide range of potential cleantech opportunities, especially those that are tied to traditional anchor industries like energy and agriculture.

Missing Support Tools

Finally, most interviewees noted that Kansas faces some gaps in its current support structure for the cleantech sector. The relatively small size of Kansas' cleantech sector means that the state is not home to a large base of management talent with deep roots and wide national and international networks within the industry. However, Kansas' strengths in energy, communications, and engineering services do suggest that this challenge is not insurmountable.

Many interviewees noted that limited access to capital poses a significant obstacle. Kansas is home to a small, yet active angel investor community, and also operates a number of innovation finance programs via KTEC, KBA, and others. Yet, these finance programs are small in scale compared to other states and may not be well suited for some cleantech investment opportunities, which may require long-term infrastructure finance. In addition, many cleantech sectors depend on incentives. While Kansas has some tools for this purpose, but does not provide the wide array of incentives found in competing states.

TABLE B-10: SUMMARY OF KANSAS CLEANTECH STRENGTHS & WEAKNESSES

Strengths	Weaknesses
Industry: Strong engineering and project management expertise High concentration of telecommunication employment and occupations (networking, computer programming) High concentration of aerospace engineering and advanced aerospace manufacturing (engines, turbines, etc.) Strengths in development and manufacturing of composites, especially for aerospace High concentration of advanced manufacturing workforce (e.g. CNC operators, numerical controls, fabrication, etc.) Strong background in energy industry, with expertise in both generation and transmission Strong heritage in agriculture and related support industries and research Research & Development High levels of patents in telecommunication and IT systems Strengths in development of composites, especially for aerospace Recognized research in biochemicals and bioenergy focused on reducing the use of energy, fossil-based feedstocks and hazardous solvents Integrated research that can model commercial applications of various R&D value chains ▪ Biofuels and vehicle performance (integrated modeling of "feedstock to tailpipe") ▪ Smart electrical grid modeling of various power flows to determine instantaneous efficiencies ▪ Biosecurity ▪ Waste management, utilization, and minimization	Industry: Lack of adequate early stage capital for entrepreneurs to adequately fund new technologies and product development. KTEC's level of funding is not competitive with other states. While entrepreneurial programs are well respected (KTEC Pipeline, ECJC and others), the number of entrepreneurs served is not adequate to research scale in any focused area. Lack of intermediaries such as industry groups that serve as networks to connect companies to each other and to markets. Manufacturing capacity and expertise not well known or organized statewide, so opportunities are lost to neighboring states. Lack of venture capital to fund technologies and companies needing large infusions of capital. Limited understanding of cleantech opportunities in many regions and industry sectors. Research & Development Lack of adequate gap funding at universities to commercialize non-bioscience research. Lack of "wholesale" channels such as industry associations for universities to understand and work with needs of market/industry segments in addition to individual companies.

APPENDIX C: DATA TABLES and BIBLIOGRAPHY

OCCUPATIONAL TABLES

TABLE C-1: RELATED CLEANTECH KANSAS TECHNICAL AND SCIENTIFIC OCCUPATIONS

Code	Occupation Description	Kansas Employment	Jobs per 1,000	National Employ	Jobs per 1,000	Occupation LQ
00-0000	All Occupations	1348710	1000.000	130647610	0.00	
17-2021	Agricultural engineers	140	0.105	2620	0.02	5.2
17-2011	Aerospace engineers	3320	2.462	70570	0.54	4.6
19-1011	Animal scientists	90	0.064	2190	0.02	3.8
19-4011	Agricultural and food science technicians	610	0.455	18490	0.14	3.2
15-2011	Actuaries	540	0.398	17940	0.14	2.9
19-1013	Soil and plant scientists	310	0.231	11830	0.09	2.6
19-1012	Food scientists and technologists	280	0.205	10790	0.08	2.5
17-3022	Civil engineering technicians	1710	1.271	82690	0.63	2.0
19-2021	Atmospheric and space scientists	140	0.101	8320	0.06	1.6
17-3012	Electrical and electronics drafters	490	0.361	30590	0.23	1.5
17-2072	Electronics engineers, except computer	2120	1.571	135990	1.04	1.5
17-3013	Mechanical drafters	1100	0.815	71890	0.55	1.5
15-1071	Network and computer systems administrators	4420	3.277	338890	2.59	1.3
15-1021	Computer programmers	4520	3.352	367880	2.82	1.2
17-2071	Electrical engineers	1790	1.324	151660	1.16	1.1
17-3031	Surveying and mapping technicians	700	0.518	62940	0.48	1.1
17-1022	Surveyors	550	0.411	50360	0.39	1.1
17-2141	Mechanical engineers	2560	1.896	232660	1.78	1.1
17-2199	Engineers, all other	1710	1.265	159680	1.22	1.0
19-2041	Environmental scientists and specialists, including health	880	0.651	83530	0.64	1.0
15-1051	Computer systems analysts	5140	3.814	512720	3.92	1.0
15-1041	Computer support specialists	5390	3.995	540560	4.14	1.0
19-2031	Chemists	780	0.575	79910	0.61	0.9
19-4031	Chemical technicians	620	0.457	64420	0.49	0.9
19-1029	Biological scientists, all other	150	0.114	16260	0.12	0.9
17-3026	Industrial engineering technicians	610	0.455	65460	0.50	0.9
15-1061	Database administrators	1000	0.739	108080	0.83	0.9
17-3027	Mechanical engineering technicians	400	0.294	43580	0.33	0.9
19-0000	Life, physical, and social science occupations	11890	8.818	1308380	10.01	0.9
15-1081	Network systems and data	2050	1.521	226080	1.73	0.9

	communications analysts					
19-1031	Conservation scientists	150	0.113	16810	0.13	0.9
17-3023	Electrical and electronic engineering technicians	1390	1.029	154050	1.18	0.9
17-1011	Architects, except landscape and naval	890	0.663	101630	0.78	0.9
17-2051	Civil engineers	2210	1.640	259320	1.98	0.8
17-3011	Architectural and civil drafters	890	0.660	105320	0.81	0.8
17-2111	Health and safety engineers, except mining safety engineers and inspectors	200	0.148	24070	0.18	0.8
17-2112	Industrial engineers	1710	1.266	209300	1.60	0.8
17-2081	Environmental engineers	390	0.292	50610	0.39	0.8
19-1042	Medical scientists, except epidemiologists	770	0.571	101760	0.78	0.7
17-2131	Materials engineers	170	0.126	22510	0.17	0.7
15-1032	Computer software engineers, systems software	2870	2.126	385200	2.95	0.7
19-4099	Life, physical, and social science technicians, all other	440	0.328	59530	0.46	0.7
19-4041	Geological and petroleum technicians	100	0.075	14460	0.11	0.7
17-3025	Environmental engineering technicians	140	0.106	20630	0.16	0.7
19-4021	Biological technicians	520	0.382	74560	0.57	0.7
17-1012	Landscape architects	130	0.095	18940	0.14	0.7
19-1099	Life scientists, all other	80	0.059	12320	0.09	0.6
19-2042	Geoscientists, except hydrologists and geographers	200	0.152	31860	0.24	0.6
19-4091	Environmental science and protection technicians, including health	200	0.145	30870	0.24	0.6
15-1031	Computer software engineers, applications	3090	2.291	495500	3.79	0.6
19-1022	Microbiologists	140	0.103	22860	0.17	0.6
17-3029	Engineering technicians, except drafters, all other	410	0.303	69070	0.53	0.6
15-2031	Operations research analysts	360	0.267	60960	0.47	0.6
17-2041	Chemical engineers	170	0.125	29000	0.22	0.6
19-2099	Physical scientists, all other	150	0.109	25310	0.19	0.6
19-2032	Materials scientists	50	0.036	8880	0.07	0.5
19-3051	Urban and regional planners	200	0.149	38950	0.30	0.5
17-2171	Petroleum engineers	120	0.089	25540	0.20	0.5
15-1099	Computer specialists, all other	820	0.609	195890	1.50	0.4
17-3024	Electro-mechanical technicians	50	0.040	15640	0.12	0.3
15-1011	Computer and information scientists, research	80	0.062	26130	0.20	0.3
17-2061	Computer hardware engineers	150	0.108	65410	0.50	0.2

TABLE C-2: RELATED CLEANTECH PRODUCTION OCCUPATIONS

Code	Occupation Title	Kansas Employment	Jobs per 1,000	National Employ	Jobs per 1,000	Occupation LQ
.	Production occupations	118,580	87.924	8927130	68.33	1.3
51-4012	Numerical tool and process control programmers	390	0.293	15480	0.12	2.5
51-4062	Patternmakers, metal and plastic	120	0.093	5220	0.04	2.3
51-8093	Petroleum pump system operators, refinery operators, and gaugers	1110	0.822	46230	0.35	2.3
51-4035	Milling and planing machine setters, operators, and tenders, metal and plastic	520	0.385	23770	0.18	2.1
51-8013	Power plant operators	790	0.582	36860	0.28	2.1
51-2031	Engine and other machine assemblers	700	0.522	34080	0.26	2.0
51-2041	Structural metal fabricators and fitters	1950	1.443	96870	0.74	1.9
51-9032	Cutting and slicing machine setters, operators	1310	0.969	70700	0.54	1.8
51-9195	Molders, shapers, and casters, except metal and plastic	630	0.468	35430	0.27	1.7
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	1420	1.055	81610	0.62	1.7
51-9121	Coating, painting, and spraying machine setters, operators, and tenders	1490	1.108	89430	0.68	1.6
51-4011	Computer-controlled machine tool operators, metal and plastic	2120	1.573	129780	0.99	1.6
51-9111	Packaging and filling machine operators	5320	3.945	338920	2.59	1.5
51-4111	Tool and die makers	1160	0.857	73640	0.56	1.5
51-9022	Grinding and polishing workers, hand	500	0.368	32350	0.25	1.5
51-4121	Welders, cutters, solderers, and brazers	5430	4.024	357740	2.74	1.5
51-9191	Cementing and gluing machine operators	240	0.178	16190	0.12	1.4
51-2091	Fiberglass laminators and fabricators	330	0.242	22360	0.17	1.4
51-9196	Paper goods machine setters, operators	1360	1.011	94210	0.72	1.4
51-9041	Extruding, forming, pressing, and compacting machine setters, operators, and tenders	1030	0.760	72770	0.56	1.4
51-2021	Coil winders, tapers, and finishers	250	0.185	18730	0.14	1.3
51-7011	Cabinetmakers and bench carpenters	1320	0.982	99870	0.76	1.3
51-2022	Electrical and electronic equipment assemblers	2500	1.853	193570	1.48	1.3
51-4071	Foundry mold and coremakers	170	0.129	13550	0.10	1.2
51-9122	Painters, transportation equipment	600	0.445	46810	0.36	1.2
53-7081	Refuse and recyclable material collectors	1640	1.217	128940	0.99	1.2
51-9023	Mixing and blending machine setters, operators, and tenders	1640	1.219	129250	0.99	1.2
51-8031	Water and liquid waste treatment plant and system operators	1350	1.004	109090	0.83	1.2
51-4122	Welding, soldering, and brazing machine setters, operators, and tenders	510	0.379	41580	0.32	1.2
51-4031	Cutting, punching, and press machine setters,	2570	1.902	209730	1.61	1.2

	operators, and tenders, metal and plastic					
51-2099	Assemblers and fabricators, all other	3260	2.415	267780	2.05	1.2
51-8091	Chemical plant and system operators	520	0.388	45750	0.35	1.1
51-8099	Plant and system operators, all other	130	0.093	11050	0.08	1.1
51-9061	Inspectors, testers, sorters, samplers, weighers	4850	3.596	430450	3.29	1.1
51-4041	Machinists	4240	3.141	380720	2.91	1.1
51-4033	Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders,	900	0.667	81740	0.63	1.1
51-9083	Ophthalmic laboratory technicians	330	0.242	30580	0.23	1.0
51-4022	Forging machine setters, operators, and tenders, metal and plastic	260	0.193	24590	0.19	1.0
51-8092	Gas plant operators	140	0.107	14040	0.11	1.0
51-4034	Lathe and turning machine tool setters, operators, and tenders, metal and plastic	490	0.362	51260	0.39	0.9
51-9194	Etchers and engravers	80	0.059	8920	0.07	0.9
51-4191	Heat treating equipment setters, operators, and tenders, metal and plastic	160	0.122	20420	0.16	0.8
51-9021	Crushing, grinding, and polishing machine setters, operators, and tenders	310	0.227	38360	0.29	0.8
51-9051	Furnace, kiln, oven, drier, and kettle operators and tenders	160	0.117	19900	0.15	0.8
51-4032	Drilling and boring machine tool setters, operators, and tenders, metal and plastic	220	0.164	28140	0.22	0.8
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal &plastic	990	0.738	126840	0.97	0.8
51-7042	Woodworking machine setters, operators, and tenders, except sawing	560	0.414	72560	0.56	0.7
51-4193	Plating and coating machine setters, operators, and tenders, metal and plastic	260	0.191	34310	0.26	0.7
51-9011	Chemical equipment operators and tenders	360	0.264	48360	0.37	0.7
51-4194	Tool grinders, filers, and sharpeners	100	0.075	13740	0.11	0.7
51-4081	Multiple machine tool setters, operators, and tenders, metal and plastic	530	0.396	76130	0.58	0.7
51-9199	Production workers, all other	1620	1.202	239550	1.83	0.7
51-4061	Model makers, metal and plastic	40	0.029	7710	0.06	0.5
51-8012	Power distributors and dispatchers	50	0.036	10000	0.08	0.5
51-9012	Separating, filtering, clarifying, precipitating, and still machine setters, operators	150	0.115	37490	0.29	0.4
51-8021	Stationary engineers and boiler operators	120	0.091	37270	0.29	0.3
51-2023	Electromechanical equipment assemblers	150	0.112	56460	0.43	0.3

TABLE C-3: RELATED CLEANTECH INSTALLATION AND MAINTENANCE OCCUPATIONS

Code	Occupation Description	Kansas Employment	Jobs per 1,000	National Employ	Jobs per 1,000	Occupation LQ
49-0000	All installation, maintenance, and repair	58320	43.238	5114150	39.14	1.1
49-2091	Avionics technicians	740	0.548	17960	0.14	4.0
49-3011	Aircraft mechanics and service technicians	2910	2.156	112130	0.86	2.5
49-9095	Manufactured building and mobile home installers	140	0.107	6780	0.05	2.1
49-9051	Electrical power-line installers and repairers	1760	1.304	108980	0.83	1.6
49-9043	Maintenance workers, machinery	1000	0.741	66390	0.51	1.5
49-9044	Millwrights	580	0.431	41640	0.32	1.4
49-3031	Bus and truck mechanics and diesel engine specialists	3240	2.402	232810	1.78	1.3
49-9097	Signal and track switch repairers	90	0.065	6450	0.05	1.3
49-2097	Electronic home entertainment equipment installers and repairers	440	0.328	34200	0.26	1.3
49-9041	Industrial machinery mechanics	3550	2.629	276230	2.11	1.2
49-9052	Telecommunications line installers and repairers	1800	1.337	162400	1.24	1.1
49-3042	Mobile heavy equipment mechanics, except engines	1330	0.989	120450	0.92	1.1
49-2094	Electrical and electronics repairers, commercial and industrial equipment	730	0.544	72520	0.56	1.0
49-9042	Maintenance and repair workers, general	12420	9.205	1268930	9.71	0.9
49-2011	Computer, automated teller, and office machine repairers	1020	0.756	111600	0.85	0.9
49-3023	Automotive service technicians and mechanics	5460	4.048	606990	4.65	0.9
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	2170	1.612	244410	1.87	0.9
49-9069	Precision instrument and equipment repairers, all other	110	0.082	13240	0.10	0.8
49-9012	Control and valve installers and repairers, except mechanical door	350	0.259	42180	0.32	0.8
49-9062	Medical equipment repairers	200	0.151	34550	0.26	0.6
49-2093	Electrical and electronics installers and repairers, transportation equipment	80	0.057	13900	0.11	0.5
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	90	0.069	22870	0.18	0.4

PATENT TABLES

Table C-4: COMMUNICATIONS & INFORMATION TECHNOLOGY PATENTS

CLASS	DESCRIPTION	Patents: 2005-2009
455	Telecommunications	199
370	Multiplex Communications	127
701	Vehicles, Navigation, and Relative Location (Data Processing)	84
379	Telephonic Communications	61
709	Multicomputer Data Transferring (Electrical Computers and Digital Processing Systems)	60
702	Measuring, Calibrating, or Testing (Data Processing)	33
342	Communications: Directive Radio Wave Systems and Devices (e.g., Radar, Radio Navigation)	32
714	Error Detection/Correction and Fault Detection/Recovery	31
711	Memory (Electrical Computers and Digital Processing Systems)	29
705	Financial, Business Practice, Management, or Cost/Price Determination (Data Processing)	27
707	Database and File Management or Data Structures (Data Processing)	25
717	Software Development, Installation, and Management (Data Processing)	18
700	Generic Control Systems or Specific Applications (Data Processing)	17
715	Presentation Processing of Document, Operator Interface Processing, and Screen Saver Display Processing (Data Processing)	16
704	Speech Signal Processing, Linguistics, Language Translation, and Audio Compression/Decompression (Data Processing)	14
343	Communications: Radio Wave Antennas	12
375	Pulse or Digital Communications	12
710	Input/Output (Electrical Computers and Digital Processing Systems)	11
348	Television	10
398	Optical Communications	10
713	Support (Electrical Computers and Digital Processing Systems)	10
726	Information Security	9
703	Structural Design, Modeling, Simulation, and Emulation (Data Processing)	8
345	Computer Graphics Processing and Selective Visual Display Systems	6
706	Artificial Intelligence (Data Processing)	5
719	Interprogram Communication or Interprocess Communication (Ipc) (Electrical Computers and Digital Processing Systems)	5
381	Electrical Audio Signal Processing Systems and Devices	4
365	Static Information Storage and Retrieval	3
708	Arithmetic Processing and Calculating (Electrical Computers)	3
725	Interactive Video Distribution Systems	3
341	Coded Data Generation or Conversion	1
347	Incremental Printing of Symbolic Information	1
369	Dynamic Information Storage or Retrieval	1
716	Design and Analysis of Circuit or Semiconductor Mask (Data Processing)	1
718	Virtual Machine Task or Process Management or Task Management/Control (Electrical Computers and Digital Processing Systems)	1

Table C-5: CHEMICAL PROCESSES AND COMPOUNDS PATENTS

Class	Class Title	Total
435	Chemistry: Molecular Biology and Microbiology	17
532	Organic Compounds (includes Classes 532-570)	17
210	Liquid Purification or Separation	16
261	Gas and Liquid Contact Apparatus	15
156	Adhesive Bonding and Miscellaneous Chemical Manufacture	12
264	Plastic and Nonmetallic Article Shaping or Treating: Processes	12
800	Multicellular Living Organisms and Unmodified Parts Thereof and Related Processes	9
95	Gas Separation: Processes	8
134	Cleaning and Liquid Contact with Solids	8
228	Metal Fusion Bonding	8
422	Chemical Apparatus and Process Disinfecting, Deodorizing, Preserving, or Sterilizing	8
427	Coating Processes	7
106	Compositions: Coating or Plastic	6
55	Gas Separation	5
520	Synthetic Resins or Natural Rubbers (includes Classes 520-528)	5
34	Drying and Gas or Vapor Contact with Solids	4
241	Solid Material Comminution or Disintegration	4
423	Chemistry of Inorganic Compounds	4
96	Gas Separation: Apparatus	3
299	Mining or In Situ Disintegration of Hard Material	3
184	Lubrication	3
252	Compositions	3
118	Coating Apparatus	2
510	Cleaning Compositions for Solid Surfaces, Auxiliary Compositions Therefor, or Processes of Preparing the Compositions	2
530	Chemistry: Natural Resins or Derivatives; Peptides or Proteins; Lignins or Reaction Products Thereof	2
588	Hazardous or Toxic Waste Destruction or Containment	2
208	Mineral Oils: Processes and Products	2
585	Chemistry of Hydrocarbon Compounds	2
117	Single-Crystal, Oriented-Crystal, and Epitaxy Growth Processes; Non-Coating Apparatus Therefor	1
202	Distillation: Apparatus	1
203	Distillation: Processes, Separatory	1
216	Etching a Substrate: Processes	1
266	Metallurgical Apparatus	1
429	Chemistry: Electrical Current Producing Apparatus, Product, and Process	1
430	Radiation Imagery Chemistry: Process, Composition, or Product Thereof	1
436	Chemistry: Analytical and Immunological Testing	1
438	Semiconductor Device Manufacturing: Process	1
502	Catalyst, Solid Sorbent, or Support Therefor: Product or Process of Making	1
508	Solid Anti-Friction Devices, Materials Therefor, Lubricant or Separant Compositions for Moving Solid Surfaces, and Miscellaneous Mineral Oil Compositions	1

TABLE C-6: MECHANICAL & INDUSTRIAL SYSTEMS PATENTS

CLASS	DESCRIPTION	Patents: 2005-2009
72	Metal Deforming	17
52	Static Structures (e.g., Buildings)	16
56	Harvesters	13
219	Electric Heating	11
172	Earth Working	11
137	Fluid Handling	10
166	Wells (shafts or deep borings in the earth, e.g., for oil and gas)	9
62	Refrigeration	8
414	Material or Article Handling	8
249	Static Molds	7
285	Pipe Joints or Couplings	6
366	Agitating (e.g., of articles and materials)	6
405	Hydraulic and Earth Engineering	6
417	Pumps	6
451	Abrading	6
239	Fluid Sprinkling, Spraying, and Diffusing	5
454	Ventilation	5
432	Heating	4
81	Tools	4
83	Cutting	4
403	Joints and Connections	4
251	Valves and Valve Actuation	3
242	Winding, Tensioning, or Guiding	3
122	Liquid Heaters and Vaporizers	2
126	Stoves and Furnaces	2
74	Machine Element or Mechanism	2
175	Boring or Penetrating the Earth	2
254	Implements or Apparatus for Applying Pushing or Pulling Force	2
409	Gear Cutting, Milling, or Planing	2
415	Rotary Kinetic Fluid Motors or Pumps	2
138	Pipes and Tubular Conduits	1
416	Fluid Reaction Surfaces (i.e., Impellers)	1
431	Combustion	1
141	Fluent Material Handling, with Receiver or Receiver Coacting Means	1
164	Metal Founding	1
173	Tool Driving or Impacting	1
384	Bearings	1
408	Cutting by Use of Rotating Axially Moving Tool	1
470	Threaded, Headed Fastener, or Washer Making: Process and Apparatus	1

TABLE C-7: TRANSPORTATION PATENTS

CLASS	DESCRIPTION	Patents: 2005-2009
244	Aeronautics and Astronautics	29
307	Electrical Transmission or Interconnection Systems	20
290	Prime-Mover Dynamo Plants	19
280	Land Vehicles	16
123	Internal-Combustion Engines	15
296	Land Vehicles: Bodies and Tops	9
310	Electrical Generator or Motor Structure	7
404	Road Structure, Process, or Apparatus	7
44	Fuel and Related Compositions	6
410	Freight Accommodation On Freight Carrier	5
180	Motor Vehicles	4
303	Fluid-Pressure and Analogous Brake Systems	3
187	Elevator, Industrial Lift Truck, or Stationary Lift for Vehicle	2
188	Brakes	2
238	Railways: Surface Track	2
305	Wheel Substitutes for Land Vehicles	2
440	Marine Propulsion	2
298	Land Vehicles: Dumping	1
301	Land Vehicles: Wheels and Axles	1

TABLE C-8: MEASUREMENT & TEST PATENTS

CLASS	DESCRIPTION	Patents: 2005-2009
340	Communications: Electrical	35
73	Measuring and Testing	24
362	Illumination	17
324	Electricity: Measuring and Testing	10
382	Image Analysis	9
359	Optical: Systems and Elements	5
33	Geometrical Instruments	4
356	Optics: Measuring and Testing	4
177	Weighing Scales	3
378	X-Ray or Gamma Ray Systems or Devices	3
385	Optical Waveguides	3
257	Active Solid-State Devices (e.g., Transistors, Solid-State Diodes)	3
374	Thermal Measuring and Testing	2
236	Automatic Temperature and Humidity Regulation	1
353	Optics: Image Projectors	1
368	Horology: Time Measuring Systems or Devices	1
330	Amplifiers	1

Examples of Kansas Companies With Potential Markets in Cleantech Industries

The following tables represent various companies in Kansas with skills or processes that are found in cleantech markets. They include both manufacturing and service related companies. These lists were compiled from ReferenceUSA, a provider of business search using 12 proprietary databases with information on more than 14 million businesses in the US. Note that many companies have more than on market segment in cleantech, however, the primary market segment listed by ReferenceUSA is used to classify the company.

Table C-9: EXAMPLES OF KANSAS' ENVIRONMENTAL & WATER SYSTEM MANUFACTURERS

Company	City	Product
Aero-Mod, Inc.	Manhattan	Waste water processing equipment
Air Technologies, Inc.	Ottawa	Air filters
Bennett-Rogers Pipe Coating	Kansas City	Pipe coatings
Burger & Brown Engineering, Inc.	Olathe	Flowmeters
CAMCORP Clean Air Management	Lenexa	Dust collectors
Catalytic Industrial Group	Independence	Industrial Process-Furnaces/Ovens (Mfrs)
Cook Pump Co., Inc.	Coffeyville	Pumps
Cross Manufacturing Inc	Pratt	Valves & Pipe Fittings NEC (Mfrs)
Custom Metal Fabricators, Inc.	Herington	Dust collection equipment
Engineered Air	De Soto	Air Conditioning/Htg/Refrig Equip (Mfrs)
Filter Service Of KS Inc	Lyndon	Fan filters
Grundfos Pumps Corp.	Olathe	Environmental pumps
Hydro-Flex Inc	Topeka	Fluid Power Valves/Heat exchangers
Hyspeco Inc	Wichita	Valves & Pipe Fittings NEC (Mfrs)
IMS	Prairie Village	Hydraulic dredging equipment
Ketch	Wichita	Air Cleaning & Purifying Equipment-Mfrs
Kice Industries, Inc.	Park City	Air purification equipment
Marley Cooling Technologies, Inc.	Overland Park	Cooling towers
M-E-C Co	Neodesha	Industrial dryers
Metal-Fab, Inc.	Wichita	Air purification equipment
Mid America Pipe Fabricating	Scammon	Pipe fabrication services
Midway Manufacturing Inc	Kinsley	Industrial/Coml Machinery/Equip NEC (Mfrs)
Oxion, Inc.	Hugoton	Natural gas filters
Piping & Equipment	Wichita	HVAC Equipment
Polaris Electronics Corp.	Olathe	Moisture monitoring equipment
Spx Cooling Technologies	Overland Park	Geothermal Htg/Cooling Equip/Systs-Mfrs
Tech Air Inc	Shawnee Mission	Dust Collecting Systems (Whls)
Torotel Inc	Olathe	Fans-Industrial & Commercial-Mfrs
Trimac Industries LLC	Bonner Springs	Infrared heaters and ovens
U S Filter-Jet Tech	Kansas City	Waste water processing equipment
Webco Manufacturing	Olathe	Communications tower components
Western Hydro Corp	Garden City	Pumps & Pumping Equipment (Mfrs)

Source: ReferenceUSA

Table C-10: EXAMPLES OF KANSAS' CHEMICAL MANUFACTURERS

Company Name	City	TECHUSA Description
Air Products & Chemicals Inc	Haysville	Industrial Gas Manufacturing
Airosol Company Inc.	Neodesha	Pesticides
Alpha-Omega Geotech, Inc.	Kansas City	Materials test/evaluation services
American Sealants Co	Clay Center	Sealants
American Sealants Co	Clay Center	Adhesive Manufacturing
Astaris	Lawrence	Phosphate chemicals
Barton Solvents Inc	Valley Center	Synthetic Organic Dye & Pigment Manufacturing
Charloma Inc	Cherryvale	Plastics Material & Resin Manufacturing
Chemtrade Logistics, Inc. Phosphorous Pentasulphide Division	Lawrence	Phosphorous pentasulfide
Columbian Chemicals Co	Ulysses	Carbon black dispersions
Columbian Chemicals Co	Ulysses	Carbon Black Manufacturing
Compass Minerals International, Inc.	Overland Park	Road de-icing chemicals
Cross Pacaking	Kansas City	Petroleum Lubricating Oil & Grease Mfg
Degussa Corp. Jayhawk Fine Chemicals Division	Galena	Polyimide plastic intermediates
ECS Inc	Olathe	Piezoelectric crystals
Ese Alcohol Inc	Leoti	All Other Basic Organic Chemical Mfg
EvonikJayhawk Fine Chemicals	Galena	All Other Basic Inorganic Chemical Mfg
Flint Hills Resources, LP	Wichita	Refined petrochemicals
Forbo Adhesives LLC	Kansas City	Plastics Material & Resin Manufacturing
Frontier Ag Inc	Colby	Nitrogenous Fertilizer Manufacturing
Frontier El Dorado Refining Co	El Dorado	Paint & Coating Manufacturing
Futures Unlimited Inc	Wellington	Gum & Wood Chemical Manufacturing
G T Midwest	Wichita	Adhesive Manufacturing
Helena Chemical Co	Garden City	Nitrogenous Fertilizer Manufacturing
Hodgdon Powder Co.	Shawnee Mission	Smokeless powder substitutes - Pyrodex(R), Hodgdon(R), IMR(R)
IMC Chemicals, Inc.	Overland Park	Soda ash
Industrial Gases of Wichita	Wichita	Industrial gases
Jacam Chemicals Inc	Sterling	Oil field chemicals
Jayhawk Fine Chemicals	Galena	Chemical synthesis services
K.C. Abrasive Company, LLC	Kansas City	Aluminum oxide abrasive powders
Kalo Agricultural Chemicals	Shawnee Mission	Agricultural chemicals
Kansas Ethanol LLC	Lyons	All Other Basic Organic Chemical Mg
Koch Nitrogen Co.	Wichita	Fertilizers/nutrients
Lubrication Engineers Inc	Wichita	Petroleum Lubricating Oil & Grease Mfg
Lubriplate Lubricants	Overland Park	Petroleum Lubricating Oil & Grease Mfg
Monsanto Co	Wichita	
Nanoscale Materials, Inc.	Manhattan	Reactive nanoparticles

Pbi Gordon Corp	Kansas City	Pesticide & Other Agricultural Chemical Mfg
Peak Sulfur, Inc.	Lenexa	Sulfuric acid recovery services
Petronomics Industrial Prods	Hutchinson	Petroleum Lubricating Oil & Grease Mfg
Pq Corp	Kansas City	All Other Basic Inorganic Chemical Mfg
Professional Products of Kansas, Inc.	Wichita	Silicone water sealant/graffiti barrier
Research Products Co	Salina	All Other Basic Inorganic Chemical Mfg
Spurrier Chemical Co Inc	Wichita	All Other Basic Inorganic Chemical Mfg
Surfaces Research and Applications, Incorporated	Lenexa	Materials research and development services
Thermo Dynamics, Inc.	Mission	Pure-Z quartz
Univar USA	Wichita	All Other Basic Inorganic Chemical Mfg

Source: ReferenceUSA

Table C-11: EXAMPLES OF KANSAS' CONTROLS & RELATED PRODUCT MANUFACTURERS

Company Name	City	
A & B Machine Inc	Salina	All Other Misc Manufacturing
Accurate Industrial Controls	Salina	Automatic Environmental Control Mfg
American Control & Engineering	Rose Hill	Electric Equip & Wiring Merchant Whls
Automation-Plus Inc	Wichita	Marking Device Manufacturing
Control Vision Corp	Pittsburg	Industrial Process Variable Instruments
Dynamic Control Systems	Wichita	Electric Equip & Wiring Merchant Whls
Economy Power & Instrument Inc	Shawnee Mission	Electric Equip & Wiring Merchant Whls
Experitec	Lenexa	Automatic Environmental Control Mfg
Fluid Kinetics Corp	Winfield	Misc General Purpose Machinery Mfg
Geoprobe Systems	Salina	Measuring/Controlling Devices NEC (Mfrs)
Integrated Controls	Olathe	Automatic Environmental Control Mfg
Interactive Design	Overland Park	Automatic Environmental Control Mfg
ITT Corp	Wichita	Automatic Environmental Control Mfg
Johnson Controls Inc	Junction City	Automatic Environmental Control Mfg
Logic Inc	Olathe	Electric Equip & Wiring Merchant Whls
Nova Tech LLC	Lenexa	Automatic Environmental Control Mfg
Powerhouse Electric Inc	Gardner	Automatic Environmental Control Mfg
Sandifer Engineering	Goddard	Electric Equip & Wiring Merchant Whls
SOR Inc	Shawnee Mission	Switchgear & Switchboard Apparatus Mfg
Superior Boiler Works	Hutchinson	Heating Equip Except Warm Air Furnaces
Superior Control Concepts Inc	North Newton	Automatic Environmental Control Mfg
Total Electric	Wichita	Automatic Environmental Control Mfg

Source: ReferenceUSA

Table C-12: EXAMPLES OF KANSAS' AEROSPACE/AVIATION COMPANIES

Company Name	City	
Aero-Mach Labs Inc	Wichita	Aircraft Equipment Parts &Supls-Mfrs
Aeroflex Inc	New Century	Aircraft Equipment Parts &Supls-Mfrs
Aerospace Products Inc	Augusta	Aerospace Industries (Mfrs)
Aerospace Turbine Rotables Inc	Wichita	Aircraft Engines & Engine Parts-Mfrs
Airbus North America Holdings	Wichita	Engineers-Aeronautical
Alcoa Aerospace Ctr	Hutchinson	Aerospace Industries (Mfrs)
B/E Aerospace Consumables Mgmt	Wichita	Aerospace Industries (Mfrs)
Bombardier Aerospace	Wichita	Aerospace Industries (Mfrs)
Composite Engineering Inc	Wichita	Engineers-Aeronautical
Cox Machine Inc	Wichita	Sheet Metal Fabricators (Mfrs)
Darcorporation	Lawrence	Engineers-Aeronautical
DESE Research Inc	Leavenworth	Aerospace Industries (Mfrs)
Dixie Aerospace	Wichita	Aerospace Industries (Mfrs)
Global Aerospace Enterprise	Wichita	Aerospace Industries (Mfrs)
Goodrich Aircraft Wheels &Brk	Wichita	Aerospace Industries (Mfrs)
ICE Corp	Manhattan	Current-Carrying Wiring Devices (Mfrs)
Kohlman Systems Research Inc	Lawrence	Engineers-Aeronautical
Leading Technology Composites	Wichita	Space Components & Systems (Mfrs)
Mid Continent Instruments	Wichita	Aircraft Equipment Parts &Supls-Mfrs
Mid-Central Mfg Inc	Wichita	Aircraft Components-Manufacturers
Mini-Mac Inc	Wichita	Aircraft Equipment Parts &Supls-Mfrs
Nex-Tech Aerospace	Wichita	Aerospace Industries (Mfrs)
NMF America	Wichita	Aerospace Industries (Mfrs)
Professional Machine & Tool	Valley Center	Machine Shops (Mfrs)
S Y Technology	Shawnee Mission	Aerospace Industries (Mfrs)
Selex Systems Integration Inc	Shawnee Mission	Airport Equipment & Supplies (Mfrs)
Sigma Tek Inc	Augusta	Aircraft Equipment Parts &Supls-Mfrs
Stol-Craft Inc	Wellington	Metal Doors Sash Frames & Trim (Mfrs)
Sunflower Army Ammunition	De Soto	Aerospace Industries (Mfrs)
TECT Aerospace	Wichita	Airport Equipment & Supplies (Mfrs)
Tran Aerospace	Wichita	Aerospace Industries (Mfrs)
Trio Machine Inc	Wichita	Machine Shops (Mfrs)
United Instruments Inc	Wichita	Aircraft Equipment Parts &Supls-Mfrs
Victory Aerospace LLC	Wichita	Aerospace Industries (Mfrs)
Wolfe Machine Inc	Mulvane	Machine Shops (Mfrs)

Source: ReferenceUSA

Table C-13: EXAMPLES OF KANSAS' CUSTOM & SPECIALIZED MANUFACTURERS

Company Name	City	TECH USA Description
Aero-Ceramics, Inc.	Lenexa	Custom casting services
Aerospace Manufacturing Corp.	Fredonia	Custom machining services
Burnham Composites Inc	Wichita	Composites machining services
C&R Manufacturing, Inc.	Shawnee	Robotic welding services
Coffeyville Sektam, Inc.	Coffeyville	Custom machining services
Conrad Machine Shop	Pittsburg	Custom machine fabrication services
Control & Drive Systems, Inc.	Olathe	Custom electrical control panels
Cox Machine, Inc.	Wichita	Close tolerance components machining services
Exacta Machine, Inc.	Wichita	Machining services
Exline Inc	Salina	Manufacturing services
Harlow Aircraft Manufacturing, Inc.	Wichita	CNC turning services
K&B Machine Shop, Inc.	Olathe	Contract machining services
Ledford Gage Lab, Inc.	Mulvane	Manufacturing equipment calibration services
M&W Mfg., Inc.	Iola	Metal processing services
Metlcast Products, Inc.	Salina	Custom machining services
Midwestern Metals, Inc.	Topeka	Custom fabrication services
Milling Precision Tool Corp.	Wichita	Custom machining services
Rickman Machine Co., Inc.	Wichita	Machining services
Steve Johnson Companies	Wichita	Custom metal products manufacturing services
Sunnyside Machine Shop	Wichita	Commercial machining services
Taylor Forge Engineered Systs	Paola	Steel forgings
Technics 2000, Inc.	Olathe	Machining services
Thyssen Krupp Rubber Machinery	Topeka	Mixing equipment
Topeka Metal Specialties, Inc.	Topeka	Custom metal component manufacturing services
Webco Manufacturing Inc	Olathe	Steel-Structural (Mfrs)

Source: ReferenceUSA

Table C-14: EXAMPLES OF KANSAS' ENVIRONMENTAL & RELATED SERVICES

Company Name	City	
A Pex Co LLC	Lenexa	Environmental & Ecological Services
Accelerated Remediation Tech	Overland Park	Environmental & Ecological Services
Air Chem Radon	Andover	Insulation Contractors-Cold & Heat
Air Quality Assessment	Olathe	Mold Mildew Moisture Control & Abatement
Airsource Technologies	Shawnee	Environmental & Ecological Services
Allied Environmental Cnsltnts	Wichita	Engineers-Consulting
American Water Purification, Inc.	Wichita	Water recycling systems
Andax Environmental Corp	St Marys	Environmental & Ecological Services
Apex Environmental Consultants	Lenexa	Asbestos Removal Service
Applied Ecological Svc	Lawrence	Environmental & Ecological Services
Arcadis Inc	Shawnee Mission	Engineers-Environmental
Associated Environmental Inc	Manhattan	Environmental & Ecological Services
ATC Associates Inc	Lenexa	Environmental & Ecological Services
Below Ground Surface Inc	Lawrence	Environmental & Ecological Services
Blendco	Kansas City	Environmental & Ecological Services
Cadence Environmental Energy	Chanute	Environmental & Ecological Services
Cape Environmental	Shawnee Mission	Environmental & Ecological Services
CDM	Wichita	Engineers-Environmental
CERAM Environmental Inc	Overland Park	Environmental & Ecological Services
Clean Harbors Environmental	Wichita	Environmental & Ecological Services
Conestoga Rover & Assoc	Topeka	Environmental & Ecological Services
DPRA Inc	Manhattan	Environmental & Ecological Services
EAC Inc	Edwardsville	Environmental & Ecological Services
Ecology & Environment Inc	Overland Park	Engineers-Environmental
EMR Inc	Lawrence	Engineers-Environmental
Enviro Tech Services, Inc.	Glasco	Pollution control consulting services
Enviroklean Inc	Kansas City	Waste Disposal-Hazardous
Environmental Assessment Svc	Shawnee Mission	Environmental & Ecological Services
Environmental Manufacturing	Manhattan	Environmental & Ecological Services
Environmental Priority Svc	Salina	Environmental & Ecological Services
Environmental Spills Protect	Kansas City	Environmental & Ecological Services
Environmental Works Inc	Bonner Springs	Environmental & Ecological Services
Eplus Environmental Solutions	Shawnee Mission	Environmental & Ecological Services
ERM Group	Overland Park	Environmental & Ecological Services
Erosion Control Inc	Olathe	Erosion Control
Fine Environmental Inc	Shawnee Mission	Environmental & Ecological Services
Forrester Group	Overland Park	Environmental & Ecological Services
Franklin Associates LTD	Prairie Village	Environmental & Ecological Services
GBA	Lenexa	Land Planning Services
Geo Stat Environmental	Mc Pherson	Environmental & Ecological Services

Geocore Inc	Salina	Water Well Drilling & Service
Geotechnical Services Inc	Wichita	Engineers-Environmental
Haz-Mat Reponse	Great Bend, Olathe	Waste Disposal-Hazardous
Hydrogeologic	Overland Park	Environmental & Ecological Services
Innovative Solutions Cnsltng	Overland Park	Environmental & Ecological Services
Integrated Solutions Inc ISI	Wichita	Asbestos Removal Service
January Environmental Svc	Kansas City	Environmental & Ecological Services
Kleinfelder	Shawnee Mission	Engineers-Geotechnical
Layne Safety & Environmental	Kansas City	Environmental & Ecological Services
LeggetteBrashears& Graham	Kansas City	Environmental & Ecological Services
Marshall Miller & Assoc Inc	Mission	Environmental & Ecological Services
Miles Environmental	Shawnee Mission	Septic Tanks/Systems-Cleaning/Repairing
MWH America	Wichita	Environmental & Ecological Services
PSI	Kansas City	Asbestos & Asbestos Free Prods (Mfrs)
RADIOFREQUENCY Safety Intl	Kiowa	Environmental & Ecological Services
Rail Logistics	Shawnee Mission	Environmental & Ecological Services
Razer Environmental LLC	Louisburg	Environmental & Ecological Services
RCI	Horton	Environmental & Ecological Services
Reddi Irrigation	Wichita	Waste Disposal
Remediation Services Inc	Independence	Environmental & Ecological Services
Roth Environmental Consultants	Leawood	Environmental & Ecological Services
Seagull Environmental Tech	Shawnee Mission	Environmental & Ecological Services
Ses Inc	Merriam	Environmental & Ecological Services
Shaw Group Inc	Overland Park	Environmental & Ecological Services
Soy Environmental Products	Shawnee Mission	Environmental & Ecological Services
Systech Corp	Fredonia	Environmental & Ecological Services
Trinity Consultants Inc	Lenexa	Environmental & Ecological Services
Ultrasystems Environmental	Leawood	Environmental & Ecological Services
US Salt Creek Watershed	Barnard	Water Conservation
Verwater Environmental	Salina	Environmental & Ecological Services
Winters Excelsior	Hutchinson	Erosion Control

Source: ReferenceUSA

Table C-15: EXAMPLES OF KANSAS' ENGINEERING SERVICES COMPANIES

Company Name	City	Primary SIC Description
Affinis Corp	Overland Park	Engineers-Professional
Agricultural Engineering Assoc	Uniontown	Engineers-Consulting
Allenbrand-Drews& Assoc Inc	Olathe	Engineers-Civil
Alpha-Omega Geotech Inc	Kansas City	Engineers-Geotechnical
Apex Engineers Inc	Mission	Engineers-Professional
Aquaterra Environmental Sltns	Overland Park	Engineers-Professional
Austin Miller PA	Wichita	Engineers-Consulting
B C Engineers	Shawnee	Engineers-Professional
B G Consultants Inc	Lawrence	Engineers-Civil
Bachelor Controls Inc	Sabetha	Engineers-Control Systems
Bartlett & West Engineers Inc	Topeka	Engineers-Professional
Bartlett & West Inc	Lawrence	Engineers-Civil
Baughman Co PA	Wichita	Engineers-Civil
Bhc Rhodes	Overland Park	Engineers-Civil
Black & Veatch Holding Co	Overland Park	Engineers-Professional
Blot Engineering Inc	Shawnee	Engineers-Consulting
Ch2m Hill	Lawrence	Engineers-Consulting
Composite Engineering Inc	Wichita	Engineers-Aeronautical
Continental Consulting Engrs	Shawnee Mission	Engineers-Professional
Control Systems Intl	Lenexa	Engineers-Professional
Cook Flatt&Strobel Engineers	Topeka	Engineers-Consulting
Corporate Energy Consultants	Shawnee Mission	Engineers-Professional
CSC Consulting Inc	Overland Park	Engineers-Consulting
Darcorporation	Lawrence	Engineers-Aeronautical
David Anthony Group	Emmett	Engineering
Delich Roth &Goodwillie	Bonner Springs	Engineers-Professional
Dressler Consulting Engineers	Shawnee Mission	Engineers-Professional
Du Pont Refinery Solutions	Leawood	Engineers-Professional
Etelligent Consulting Inc	Overland Park	Engineers-Consulting
Evans-Bierly-Hutchison & Assoc	Great Bend	Engineers-Civil
Finney &Turnipseed	Topeka	Engineers-Structural
GBA	Lenexa	Engineers-Professional
Geotechnology Inc	Shawnee	Engineers-Professional
Goedecke Engineering Co	El Dorado	Engineers-Civil
Gpw& Assoc LLC	Lawrence	Engineers-Professional
Greenhorne& O'Mara	Shawnee Mission	Engineers-Consulting
HDR Archer	Prairie Village	Engineers-Consulting
Henderson Engineers	Shawnee Mission	Engineers-Professional
HNTB Corp	Overland Park	Engineers-Professional
Hoss& Brown Engineers Inc	Lawrence	Engineers-Consulting

Kaw Valley Engineering Inc	Junction City	Engineers-Consulting
Kiewit Power Engineers Co	Lenexa	Engineers-Professional
Larson Binkley Inc	Leawood	Engineers-Professional
Latimer Sommers& Assoc	Topeka	Engineers-Consulting
Millennium Concepts Inc	Wichita	Engineers-Professional
MKEC Engineering Consultants	Wichita	Engineers-Consulting
Needham & Assoc	Lenexa	Engineers-Professional
Olsson Associates	Overland Park	Engineers-Consulting
Peridian Group	Lawrence	Engineers-Civil
Phelps Engineering Inc	Olathe	Engineers-Professional
Professional Engineering	Wichita	Engineers-Consulting
Research Concepts Inc	Shawnee Mission	Engineers-Professional
S K Design Group	Shawnee Mission	Engineers-Professional
Schwab-Eaton	Manhattan	Engineers-Consulting
Sega Inc	Stilwell	Engineers-Professional
Selective Site Consultants	Shawnee Mission	Engineers-Professional
Shafer Kline & Warren Inc	Lenexa	Engineers-Professional
Terracon Consultants Inc	Lenexa	Engineers-Geotechnical
Tetra Tech	Kansas City	Engineers-Professional
Transystems Corp	Wichita	Engineers-Consulting
URS Corp	Overland Park	Engineers-Consulting
Wilson & Co Engineers &Archt	Salina	Engineers-Architectural

Source: ReferenceUSA

Table C-16: EXAMPLES OF KANSAS' TESTING & ANALYSIS COMPANIES

Company Name	City	
Allied Laboratories	Wichita	Engineers-Testing
Alpha Omega Geotech Inc	Kansas City	Laboratories-Testing
ALTECA Limited	Manhattan	Laboratory Analytical Instruments (Mfrs)
Analytical Management Lab Inc	Olathe	Laboratories-Testing
Arrow Laboratory	Wichita	Laboratories-Testing
Associated Environmental Inc	Manhattan	Environmental & Ecological Services
Cad Cam Laboratory	Wichita	Laboratories
Cadence Environmental Energy	Chanute	Environmental & Ecological Services
Central Plains Laboratories	Hays	Laboratories-Medical
Central State Testing	Sublette	Laboratories-Testing
Certified Natural Laboratories	Wichita	Laboratories
Continental Analytical Svc	Salina	Laboratories-Analytical
DBI	Overland Park	Inspection Service
EMR Inc.	Lawrence	Water analysis services
Inno Labs LP	Winfield	Laboratories
JCB Laboratories	Wichita	Laboratories
Kansas Pathology Svc	Hays	Laboratories-Testing
Kcas LLC	Shawnee	Laboratories-Analytical
KTI Kruger Technologies Inc	Shawnee Mission	Engineers-Inspecting
Lab Corp	Wakefield	Laboratories-Testing
Laboratory	Plainville	Laboratories
M 2 Technologies	Manhattan	Laboratories-Research & Development
M.D. Chemical & Testing, Inc.	Topeka	Soil analysis services
Magellan Analytical Svc	Kansas City	Laboratories-Testing
Marshfield Food Safety LLC	Dodge City	Laboratories-Testing
Med Express Labs	Leawood	Laboratories-Testing
Pace Analytical Svc Inc	Lenexa	Laboratories-Analytical
Perfect Seal Labs	Wichita	Laboratories
Plains Environmental Svc	Salina	Laboratories-Analytical
Point Inc	Shawnee Mission	Laboratories-Research & Development
Prairie Land Environmental Remediation, Inc.	Garden City	Radon testing and mitigation services
SDK Laboratories	Hutchinson	Laboratories-Testing
Surfaces Research	Lenexa	Laboratories-Testing
Team Industrial Svc Inc	El Dorado	X-Ray Laboratories-Industrial
Terracon Consultants Inc	Topeka	Engineers-Geotechnical
Terracon Consultants Inc	Wichita	Asbestos Removal Service
Tetra Tech	Kansas City	Engineers-Geotechnical
Thurmond-Mc Glothlin Inc	Liberal	Gas Measurement Service
Trinity Analytical Labs Inc	Mound Valley	Environmental & Ecological Services
United States Test Laboratory	Wichita	Laboratories-Testing

Source: ReferenceUSA

Table C-17: EXAMPLES OF KANSAS' ENERGY SERVICES COMPANIES

Company Name	City	
A C Energy Controls	Overland Park	Energy Conservation & Mgmt Consultants
ABC Property Inspection LLC	Shawnee Mission	Energy Conservation & Mgmt Consultants
American Energy Guard	Salina	Energy Management Systems & Products
American Energy Solutions Inc	Leawood	Energy Management Systems & Products
Atmos Energy Corp	Independence	Energy Management Systems & Products
Building Controls & Svc Inc	Wichita	Controls Control Systs/Regulators
Chevron Energy Solutions	Overland Park	Energy Conservation & Mgmt Consultants
Colt Energy	Cherryvale	Energy Management Systems & Products
Colt Resources Corp	Spivey	Energy Conservation & Mgmt Consultants
Conedison Solutions	Overland Park	Energy Conservation & Mgmt Consultants
Conestoga Energy Partners	Liberal	Energy Management Systems & Products
Conestoga Energy Partners LLC	Garden City	Energy Management Systems & Products
Crown Energy Consultants	Winfield	Energy Management Systems & Products
Custom Energy Svc LLC	Overland Park	Energy Conservation & Mgmt Consultants
Dynamic Resource Solutions	Wichita	Energy Conservation & Mgmt Consultants
East Kansas Agri Energy	Garnett	Energy Management Systems & Products
Energy Management & Control	Topeka	Air Balancing
Energy Masters Intl	Shawnee Mission	Energy Conservation & Mgmt Consultants
Energy Reduction Consultants	Independence	Energy Conservation & Mgmt Consultants
Eott Energy Wolf Station	Deerfield	Energy Conservation & Mgmt Consultants
J W Prairie Wind Power LLC	Lawrence	Wind Energy Systems (Whls)
Light Bulbs Etc Inc	Shawnee Mission	Light Bulbs & Tubes (Whls)
Mid Plains Energy	Jennings	Energy Management Systems & Products
Midcoast Resources	Raymond	Energy Conservation & Mgmt Consultants
ONEOK Energy Marketing Co	Hays, Topeka	Gas Companies
Osage Resources LLC	Medicine Lodge	Energy Conservation & Mgmt Consultants
PPM Energy	Latham	Energy Management Systems & Products
Prairie Horizon Agri-Energy	Phillipsburg	Energy Management Systems & Products
Professional Energy Mgmt	Leawood	Energy Management Systems & Products
Propane Resources LLC	Mission	Energy Conservation & Mgmt Consultants
Sek Energy LLC	Benedict	Energy Management Systems & Products
Solar Heat Exchange Mfg	Perry	Solar Energy Equipment-Manufacturers
Sunshine Energy	Olathe	Energy Management Systems & Products
Trade Wind Energy	Shawnee Mission	Energy Management Systems & Products
Tyr Energy	Overland Park	Energy Management Systems & Products
Unicom Energy Svc Inc	Merriam	Energy Conservation & Mgmt Consultants
US Energy Svc	Overland Park	Energy Management Systems & Products
West Con Energy Svc	Kansas City	Energy Management Systems & Products
West Wind Energy LLC	Otis	Energy Management Systems & Products
Westar Energy Inc	Hutchinson	Energy Management Systems & Products
Western Resources	Partridge, Russell	Energy Conservation & Mgmt Consultants
Wind So Hy	Overland Park	Energy Management Systems & Products
X L Weather & Energy Inc	Overland Park	Energy Conservation & Mgmt Consultants

Source: ReferenceUSA

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