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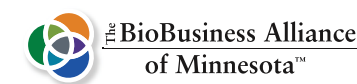
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**Destination 2025 is an initiative of The BioBusiness Alliance of Minnesota in collaboration with Deloitte Consulting LLP to develop a roadmap for the bioscience markets in Minnesota.**



The Destination 2025 project examines six markets of the bioscience industry: Animal Health, Food, Medical Device, Biologics and Biopharmaceutical, Renewable Materials, and Renewable Energy.

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# Destination 2025 Focus on the Future of the Renewable Energy Industry



We have identified leading trends and technologies that are expected to significantly affect the renewable energy industry globally over the next two decades.

## Executive Summary February 2009

Destination 2025 - a collaboration between The BioBusiness Alliance of Minnesota and Deloitte Consulting LLP

### Executive summary

The trends and technologies identified, and opportunities in the industry, are likely to realign to different levels of importance over time.

Using the Strategic Flexibility Framework, we performed a scenario-based planning exercise to evaluate a range of different future scenarios. This allowed us to determine which of these trends and technologies are likely to have the greatest impact in the development of the industry.

The review of trends and technologies suggests that opportunities exist to develop new products and solutions. Moreover, existing markets and products may experience flux due to new trends and technologies. Strategies must evolve to benefit from opportunities and threats. Decision makers in academia, government, and industry can use the Strategic Flexibility Framework to develop strategies based on individual constraints and objectives.

### Market definition

The renewable energy market includes various sources of renewable energy for the transportation, electricity, residential, commercial, and industrial sectors. Examples of renewable energy sources include ethanol (including non-cellulosic ethanol made from such feedstocks as corn and sugar cane and cellulosic ethanol made from switchgrass, corn stover, and other plant matter), biodiesel, combustible biomass, wind, hydrogen, solar, and geothermal. Although the Destination 2025 report is focused on life science industries, non-biobased sources of renewable energy were included in this white paper because of the interdependence of renewable energy markets and technologies, and of investment and policy decisions that affect them.

The full white paper on the future of the biologic and biopharmaceutical industry is available for download at [www.deloitte.com/us/d2025](http://www.deloitte.com/us/d2025)

# Focus on the Future of the Renewable Energy Industry

## Emerging and future trends

The following trends are expected to influence the industry in the next 20 years.

**Public policy is expected to support ongoing renewable energy development and demand.** However, policy may favor different renewable energy sources based on the policy orientation and relative priorities of governments in agriculture, energy, economic development, and environmental protection. Uncertainty surrounding U.S. production and investment tax credit availability has decelerated industry growth in America in the past. Carbon controls may accelerate demand for alternative energy sources. Changes in public policy, such as greater focus on promoting cheap, safe, and reliable availability of food, or greater emphasis on life cycle analysis, may affect subsidies to biofuel feedstocks and biofuel production. Net metering policies need to be consistent and effective at the state and federal level to accelerate growth in distributed generation.

**Improvements in transmission infrastructure technology, availability, and capacities are important for the proliferation of renewable energy.** Growth in distributed energy production is expected to be high in the coming years. However, the grid is not yet ready to handle proliferation of distributed power, because it was designed to receive base-load power from centralized facilities.

**Consumers' shift toward green and energy efficient construction and utilities is expected to drive demand for renewable energy.** Green power credits have become increasingly popular, and growth is expected to continue if climate change concerns remain strong. Increased awareness of the environmental impact of individual and corporate actions and the economic attractiveness of the response have translated to the greening of construction practices. There has been a rise of solar companies owning, building, and operating solar panels on residential houses and selling the electricity to the home and to the grid.

**The push toward alternative energy is strong in the transportation sector because of increasing demand in the long run.** Growth in the global automobile fleet is expected to push demand for fuels in the long run, but increasing fuel efficiency of the vehicle fleet is expected to moderate growth in transportation fuel demand.

**Demand for biomass is constrained by pressures on inputs to agriculture and biomass production.** Feedstock production is susceptible to fertilizer price pressures and increasing competition for land and water resources.

**Supply chain constraints are likely to affect the development of the renewable energy industry.** Biomass demand for energy applications is expected to increase in combustion, conversion to transportation fuels, and biogas production through anaerobic digestion. The harvest of biomass remains a costly endeavor, and sustainability issues are a concern. There is a need for better information about biomass location, quality, and availability. Improvements in transportation and storage infrastructure for biomass, such as satellite centers or portable biomass processing units, densification of biomass, portable biorefineries, and chemical pre-treatment of biomass are required.

**Solutions to supply chain constraints are likely to evolve from strategies for managing value addition and product diversification.** This includes diversification into biochemicals, cellulosic ethanol, and other products.

**Emerging economies are playing an increasingly important role in renewable energy industry development.** Energy costs and biofuel economics are increasingly driven by emerging economies. Emerging economies are expected both to generate more demand and produce more renewable energy products in the future. The share of biomass utilization in modern, cleaner stoves and heating units is on the rise.

**High energy prices in the long term could accelerate development of the renewable energy industry.** High energy prices have recently been an effective motivation for expanding renewable energy production and achieving energy efficiency improvements. Volatility in oil prices can jeopardize the long-term viability of the industry, thus renewable energy producers need a flexible business model that is not solely dependent on replacing petroleum products.

**Public concern and perception are important for industry development.** There is a high degree of public concern for the environment and resistance to local coal and nuclear energy production. A strong agricultural lobby has led to subsidies for agricultural products and biofuels, which in the absence of more rigorous life cycle analysis or the development of next-generation biofuels are likely to continue.

**Concerns for climate change and environmental protection are key to driving industry development.** Increased emphasis on life cycle analysis is expected. This may rank biofuels and other materials differently from the current, short-term policy preferences, and it creates the potential for some biofuels to be preferred over others. The current interest in carbon sequestration and carbon dioxide emissions reduction is likely to increase in the future if extreme weather events become more frequent and negative effects, such as the disappearance of polar ice caps, becoming more apparent. Concerns about water availability are expected to lead to increasing pressures to manage water availability, quality, pricing, and distribution. Climate change scenarios and the potential implications for water use in agriculture highlight increasing uncertainty for planning. Increasing scarcity of water is likely to focus attention on soil management to improve water retention and use, particularly in conjunction with irrigation programs. Diversion of cropland to production of biofuels has worldwide implications that require attention and action.

**Demographics are expected to affect industry development.** The proportion of college graduates receiving science and engineering degrees has remained flat in the United States, while educational capacity in these disciplines is growing rapidly in many European and Asian nations. This could hamper U.S. industry's relative ability to build complex

institutional structures required for a thriving renewable energy industry. The continuation of this trend could concentrate technological development and manufacturing expertise elsewhere, as has already happened with wind power manufacturing.

**Next steps**  
The review of trends and technologies suggests that opportunities exist to develop new products and solutions. Moreover, existing markets and products may experience flux due to new trends and technologies. Strategies must evolve to benefit from opportunities and threats. Decision makers in academia, government, and industry can use the Strategic Flexibility Framework to develop strategies based on individual constraints and objectives.

## Emerging and future technologies

Market segment	Technologies
Biomass opportunities	<ul style="list-style-type: none"> <li>Crops designed for biorefinery operations</li> <li>Algae as a feedstock</li> <li>Densification of biomass</li> <li>Fractionation of biomass</li> <li>Carbohydrate-based biorefineries</li> <li>Oil-based biorefineries</li> <li>Omnivorous biorefineries that use multiple forms of biomass</li> </ul>
Biochemical conversions	<ul style="list-style-type: none"> <li>New enzymes for enzymatic conversion</li> <li>Anaerobic digestion</li> <li>Catalytic processes</li> <li>Bio-based approaches for fuel cells</li> </ul>
Thermochemical conversions	<ul style="list-style-type: none"> <li>Commercial pyrolysis-based plants</li> <li>Biomass liquefaction</li> <li>Biomass gasification</li> <li>Fischer-Tropsch catalysis</li> <li>Syngas fermentation</li> </ul>
Fuel products	<ul style="list-style-type: none"> <li>Advanced biofuels beyond ethanol</li> </ul>
Solar	<ul style="list-style-type: none"> <li>Solar thermal</li> <li>Conversion of solar energy to chemical fuels</li> <li>Thin film solar technologies</li> <li>Multi-layer semiconductors</li> <li>Alternatives to silicon</li> <li>Nanomaterials in photovoltaic cells</li> <li>Organic materials for producing photovoltaics</li> <li>Dye-sensitized solar cells</li> <li>Built-in PV in construction of home and businesses</li> <li>Concentrated solar power</li> <li>Space-based solar energy</li> </ul>

Market segment	Technologies
Wind	<ul style="list-style-type: none"> <li>Wind power integrated into buildings</li> <li>High-altitude wind power system</li> <li>Offshore wind</li> <li>Rotor improvements</li> <li>Wind blade improvements</li> </ul>
Hydrogen	<ul style="list-style-type: none"> <li>Electrolysis</li> <li>Thermochemical water splitting</li> <li>Photolytic processes</li> <li>Hydrogen storage</li> <li>Hydrogen-based internal combustion engines</li> <li>Hydrogen fuel cells</li> <li>Hydrogen-powered fuel cells for small-scale applications</li> <li>Hydrogen-powered vehicle fleet</li> <li>Hydrogen for large-scale applications</li> <li>Hydrogen-powered gas turbine</li> </ul>
Geothermal	<ul style="list-style-type: none"> <li>Hydrothermal geothermal systems</li> <li>Enhanced geothermal systems</li> <li>Geothermal power conversion</li> <li>Geothermal heat pumps</li> </ul>
Hydro	<ul style="list-style-type: none"> <li>Ocean-based energy production</li> </ul>
Transmission and storage	<ul style="list-style-type: none"> <li>Smart grid</li> <li>Improved storage systems</li> <li>Development of transmission lines using carbon nanotubes</li> </ul>