

North Carolina

# Economic Developer's

GUIDE TO THE RENEWABLE ENERGY INDUSTRIES

Spring 2009 | Vol. 3

**GREEN:** Real, Right Now

**A GREEN ENERGY  
ADVANTAGE IN  
EVERY COUNTY**



State Energy Office

**ENERGY**

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"Ensuring a sustainable energy future"

# INTRODUCTION

The green economy is today's growth economy. Since our current economic recession officially began in late 2007, unemployment in North Carolina is well over 10% statewide with some counties experiencing rates in excess of 15%. There is however, an exception to this trend – the green energy sector. With over 2,200 new jobs announced, about 40% of which are permanent manufacturing or operations jobs, and nearly \$800 million in private investment, green energy is a bright spot in this dim economic time.

The imperative from our newly elected leadership at both the state and national levels could not be clearer – green energy technologies such as renewable energy and energy efficiency are crucial growth opportunities for economic recovery. This third volume of the *North Carolina Economic Developer's Guide to the Renewable Energy Industries* is focused on leveraging green energy growth to drive North Carolina's economic recovery.

North Carolina does not have to look far for its green economy. The Green Economy section includes a review of recent studies highlighting green energy's economic potential in the state. Selected news briefs from the past year show a variety of NC industries expanding to serve green energy markets.

North Carolina's astounding growth in the green energy industries is, in part, due to many policies put in place during the 2007 legislative session, including the Renewable Energy Portfolio Standard and new business development programs such as the Green Business Fund and the Biofuels Center of North Carolina. Many of the state's economic development assets have embraced the green energy area, including community groups, universities and community colleges, non-profit organizations, and the state's many geo-political sub-regions.

Green energy is urban and rural, high-technology and historical, and clean and available everywhere – every community in North Carolina has green collar job opportunities as well as idled workers awaiting new job opportunities. The feature section of Volume 3 is entitled Directions as it provides insight into the state's economic specialties where economic development efforts could have the greatest impact in counties across the state, and concludes with an overview of how green growth can impact the state's diverse economic areas.

Following the featured section are the usual industry pages covering the green energy technology production industries from bio-energy to wind turbines. New to Volume 3 is an industry section on hybrid electric vehicles. Finally, the Guide concludes with a brief overview of incentives and policies available for communities and companies across the state.

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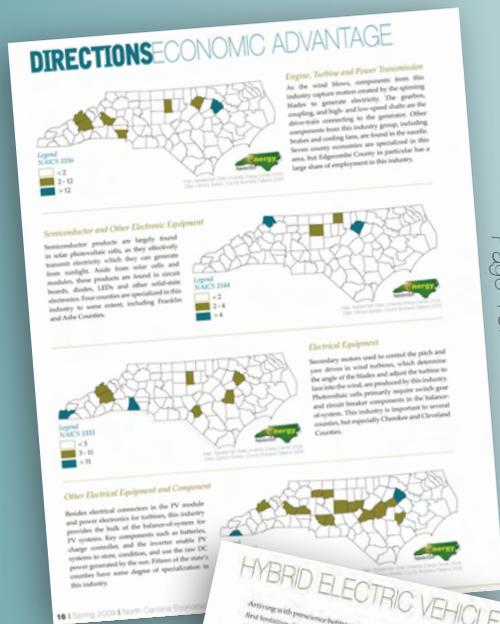
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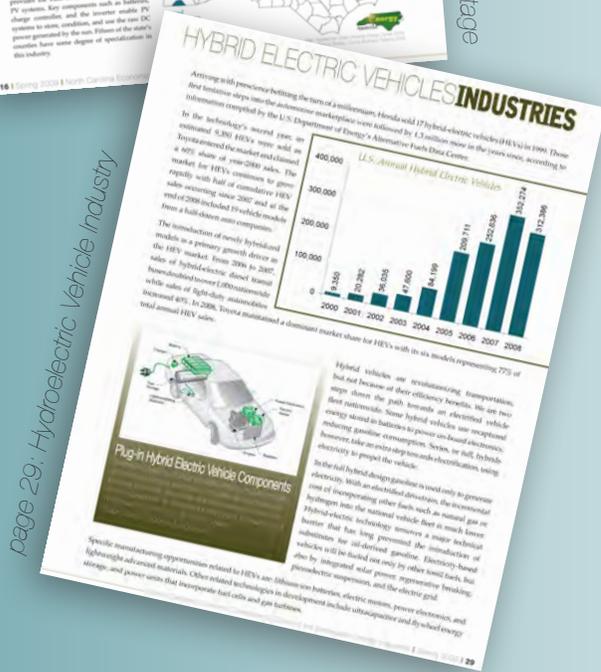
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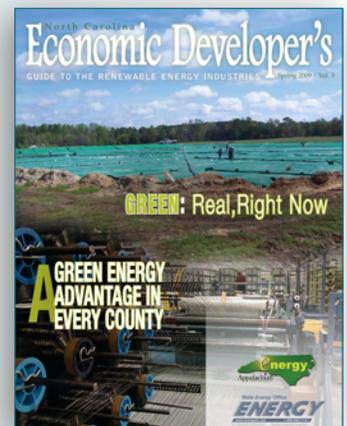
Page 29: Hydroelectric Vehicle Industry

## On the cover

**Top Image:** Energy-rich methane gas is captured from a hog-waste lagoon in eastern North Carolina – providing a low-cost source of local energy, additional revenue to the farmer, and significantly reducing the environmental risk associated with hog waste management. This innovative system however, was not installed to capture hog methane for energy; the system was developed and capitalized by Environmental Credit Corp. for its greenhouse gas reduction potential.

**Lower Image:** Specialized textile materials used in wind turbine blades are manufactured in Rutherford County by 3-TEX, Inc., a Cary, N.C.-based company. This innovative three-dimensional textile process, developed at N.C. State's College of Textiles, is used to braid and weave both carbon and glass fibers, providing reinforcement materials that offer greater strength and lighter weight than other fiber reinforcements.

Images courtesy of Environmental Credit Corp. and 3-TEX, Inc.



## About

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# GREEN ECONOMY REAL, RIGHT NOW

## Understanding the Green Energy Reality

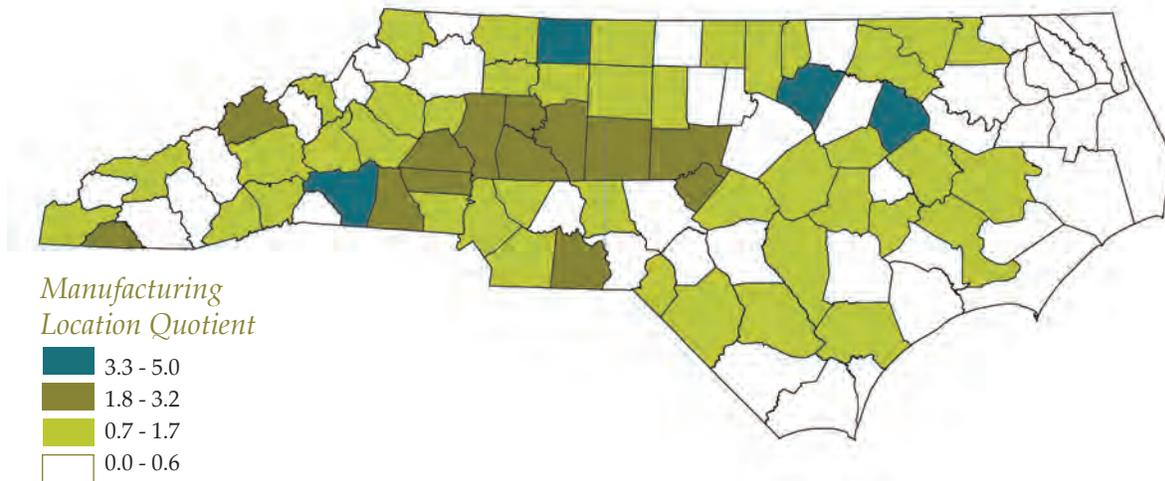
One-year three-months and counting since the national economic decline officially began. Over 491,000 North Carolinians were unemployed as of February 2009 – more than twice the number from a year earlier. With the fourth-highest unemployment rate in the nation at 10.7%, North Carolina's labor force hasn't been this idle in over a quarter century – in the aftermath of the last energy crisis.

Newly elected Governor Beverly Perdue made clear to the audience of the N.C. Economic Developer's Association 2009 Conference that creating and sustaining jobs was her top priority. One sector in particular, the industries of renewable energy and energy efficiency, has shown its resilience to the broader economic trend.

Since the official start of the national recession, nearly 2,000 new jobs have been announced by green energy companies in North Carolina alone – over 800 of which are permanent production or operations positions. More than a dozen companies announced manufacturing expansions to produce a wide spectrum of products, including char-coal fuel from wood waste, hybrid-electric buses, LED lights, photovoltaic cells, advanced textiles, and energy electronics.

Over \$31 million in venture funding was invested in NC-based clean technology companies during 2008, according to WRAL news, with nanotechnology and semiconductor companies capturing a large share. The state's universities provided a key component of green economy growth as

*Concentrations of Manufacturing Industry Employment  
in Renewable Energy Supply Chain Industries*



While 58 county economies in North Carolina have some degree of specialization in the manufacturing industries of the renewable energy supply chain, four counties in particular - Edgecombe, Franklin, Rutherford, and Stokes - are highly specialized in these industries. New jobs from manufacturing renewable energy components will be of greatest benefit to counties where a larger-than-average portion of local employment is found in industries with the technical potential, as defined by the North American Industry Classification System, to manufacture products for renewable energy markets. The degree of specialization is calculated using the location quotient technique, comparing county and national employment data from the Census Bureau's County Business Patterns release for the aggregate renewable energy supply chain industry groups identified in U.S. Department of Energy-funded renewable energy manufacturing reports prepared by the Renewable Energy Policy Project ([www.repp.org](http://www.repp.org)).

# REAL, RIGHT NOW GREEN ECONOMY

technology development and commercialization activities being undertaken in conjunction with private industry as Duke University, NC A&T University, NC State University, UNC-Chapel Hill, and Wake Forest University are effectively moving green energy innovation from the laboratory to the marketplace.

Renewable energy generation has also firmly established itself in the state. In one short year, NC's market for photovoltaic installations emerged with over 11 megawatts announced – making NC the sixth-largest market in the country in 2008. A wind project in rural Carteret County is aiming to install three large-scale wind turbines with a total generation capacity of 4.5 MW. Poultry waste-fueled electricity facilities with an estimated combined capacity of 150 MW have been announced by Fibrowatt in Sampson, Surry and Montgomery counties. The state's two largest utilities have also made significant strides into the green economy with record-setting smart meter deployment, experimenting with biomass supplements to coal, and developing a significant portfolio of renewable energy generation assets across the country.

## Going Green, Generating Growth

Evidence of the potential for green technology to lead an economic recovery in North Carolina is abundant. An estimated 62,000 jobs could be created with North Carolina's \$2.9-billion share of a \$100-billion national green energy-based economic recovery program, according to a Sept-2008 report prepared for the Center for America Progress.

Over 61,000 people in North Carolina were employed in manufacturing jobs similar to those required for producing wind turbines, solar photovoltaic panels, as

well as geothermal- and biomass-electricity equipment. In 2008, these workers were employed by just over 1,300 firms, according to an Aug-2008 report prepared by UNC-Greensboro for the Institute for Emerging Issues that identified the potential supply-chain manufacturers in the state based on North American Industrial Classification System (NAICS) industries that serve renewable energy markets.

Industry surveys released in late 2008 by the N.C. Sustainable Energy Association (NCSEA), revealed 2,144 jobs – over 70% of which are manufacturing jobs – at

161 renewable energy and energy efficiency businesses across the state during 2008. Furthermore, these respondents reported an increasing rate of job growth expected in 2009, rising from 18% employment growth last year to 24% in 2009 to reach a projected 2,660 employees at these companies.

**2,000+**

new jobs announced by green a 2007 start of the national recession

**2,660**

total 2009 jobs in green energy according to NCSEA survey, up 24% from 2008 employment

**1,300**

firms identified by UNC-Greensboro study with "technical potential" to manufacture green energy components

The Renewable Energy & Energy Efficiency Portfolio Standard (REPS), which became law in 2007, is projected to result in a net gain of over 2,000 jobs per year by 2021 from increased in-state renewable generation and energy efficiency, according to a Nov-2008 study performed by LaCapra & Associates for the NCSEA.

Renewable energy and energy efficiency industries in North Carolina span the state's economy from agriculture to biotechnology, from textiles to nanoscale composite materials, and from electronic to advanced electrochemical devices. A variety of plentiful opportunities for a green-energy powered economic recovery exist in every community in the state. Capitalizing on this potential requires understanding not only the opportunities themselves, but also their fit with and potential to impact a local economy.

# GREEN ECONOMY NEWS-HEADLINES

## **Nanotechnology patent for thermal management**

Nextreme Thermoelectric was recently awarded a patent for their super-thin thermoelectric cooling technology. The company is commercializing energy efficiency-increasing nanotechnology developed at Research Triangle Institute. A venture investment in early summer 2008 is expected to be sufficient to fund the company through the duration of 2009.

- *NanotechWire/News & Observer*

## **Saran-wrapped solar pv**

The Wake Forest University nanotechnology center, in partnership with the Indian Institute of Technology in Kharagpur, has developed a Saran wrap-based polymer-nanotube composite for use in the ultraviolet-light-shielding encapsulant layer for organic solar cells.

- *NanoWerk*

## **Energy applications explored for nano-materials**

NC A&T and nanotechnology company nCoat have formed a research partnership to develop advanced composites and nanotechnology for solar cells and generating turbines.

- *CNN.com*

## **NCSU biofuel catalyst licensed**

Diversified Energy Corp. licensed Centia biofuel technology from NC State University. Based on a university-developed proprietary catalyst, the technology uses renewable sources of oil to make

jet, diesel, and gasoline fuel. Crude glycerin, a by-product of biodiesel production, is used as heating fuel in a specially adapted combustion unit.

- *Reuters*

## **Quantum dot solar venture investment**

Raised \$2.8 million first-round venture investment for high-efficiency quantum dot-based solar cell. Company is commercializing technology developed at Duke University, in part with facilities at NC State.

- *TechJournalSouth*

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## **Production agreement for Microcell**

Microcell Corp. has agreed to produce fuel cell products for Curtiss-Wright Flow Control which can now "produce, market, and sell Microcell-based power generation systems aimed at telecommunications and utility back-up power systems worldwide."

- *Microcell Corp.*

## **Hybrid bus manufacturing facility in Charlotte**

DesignLine International announced the opening of a production facility in Charlotte to produce hybrid buses featuring their unique electric drivetrain. The buses will be outfitted with a small diesel generator to recharge the batteries in the company's 100,000 sq.-ft. facility. The company was founded in New Zealand, but was relocated

to Charlotte after being purchased in 2006.

- *Charlotte Chamber*

## **LED lighting company headquarters in Cary**

JuiceWorks LLC is partnership between United Kingdom-based Juice Technology Ltd. and Generation Brands for development of LED products in the decorative lighting market.

- *G-Biz*

## **Expanding enzymes for ethanol**

Novozymes, a Danish biotechnology company with North American headquarters in North Carolina, will expand to produce more efficient enzymes used in cellulosic ethanol.

The company has matched a Dept. of Energy contract for a two-and-a-half year project to double enzyme efficiency and reduce production costs substantially, representing a total investment of \$25 million. Cellulosic ethanol is the company's largest technology research and development focus ever, with over 100 employees allocated to the effort.

- *Biofuels Center of North Carolina*

## **PV manufacturing in Queen City**

Sencera International is opening a production facility near the Charlotte airport. The \$36-million facility is expected to create 65 jobs paying over \$73,000 on average - 150% more than typical wages in the county. The facility will produce thin-film silicon wafer modules on a production line with a projected initial capacity of 7.7MW per year expanding to 38MW over time. The company received

\$3.6 million investment from The Quercus Trust of Newport to build a pilot production line, and has been seeking additional capital.

- *News & Observer*

### **Battery producer expanding**

PolyPore is expanding their current South-Charlotte facility, and will add 40 new jobs to increase production of the Celguard battery separator product used in a variety of technologies including hybrid-electric vehicles and supercapacitors.

- *Charlotte Chamber*

### **Cree acquires LED Light Fixtures**

Cree extended their vertical integration with the acquisition of LED Light Fixtures, a maker of technology enabling LED bulbs to be used in existing sockets.

- *LEDs Magazine*

### **Raleigh lands Optimal expansion**

Optimal Technologies, a developer of energy efficiency products, relocated to Raleigh from Canada, bringing at least a projected 325 jobs paying an average wage of \$71,250. Recent economic turmoil has resulted in recent layoffs as the company seeks to stretch a \$25-million investment made by Goldman Sachs in October 2007.

- *TechJournal South*

### **International smart grid HQ**

An NC State research center received \$28.5 million award from the National Science Foundation for a research initiative to create a "smart grid" out of today's

outdated electric grid. The center will research technology to store electricity generated by renewable energy for use when these sources are unavailable, and will operate in conjunction with 65 utility companies and partners from 28 states and 9 countries.

- *News & Observer*

### **Record-setting smart meter installation**

Progress Energy set a new record with ambitious install of over 2.7 million solid-state next-generation electric meters in a period of 18 months. Using over 300 installers, demanding three shifts seven days a week from S.C.-based manufacturer Itron, Progress Energy rolled out this retrofit in record time. Progress Energy expects to save about \$21 million per year from reduced operational expenses, and cut meter-related billing problems by half.

- *Transmission & Distribution World*

### **Asheville incubator generating growth**

AB Tech Clean Energy Business Incubator houses 41 startup companies which saw a total of \$4 million in revenue during 2007. With \$2 million in total investment, these companies created 51 jobs with an average age of \$32,000.

- *Asheville Citizen-Times*

### **NC facilities go solar**

In Edgecombe County, home-shopping network QVC announces

installation of solar photovoltaic panels with a megawatt of capacity.

The company's 1.5-million square-foot distribution facility employs 1,300 people. The SAS Institute also announced a megawatt of PV to be installed at its Cary campus.

- *News & Observer*

### **Duke forms joint venture for waste-wood power**

Adage, a joint venture between Duke Energy and French biopower firm Areva, will develop wood waste-fueled electricity plants in the U.S. A typical facility is estimated at about 50 MW and would use wood resources from within a 50-mile radius.

- *CleantechGroup*

### **Acquisition increases wind portfolio**

With the acquisition of Catamount Energy for \$240 million in Fall 2008, Duke Energy increased their operational portfolio of wind generators to 500 MW of capacity and is currently developing wind projects totaling 5,000 MW in 12 states.

- *RenewableEnergyWorld*

### **Utilities commission approves wind project conditionally**

three-1.5 MW turbine project proposed, given conditional approval in April 2008 from NCPUC pending county approval and FAA approval, county is adopting siting regulations.

- *News & Observer, Winston-Salem Journal*

## Green Business Fund

There is perhaps no better demonstration of green energy's potential to grow North Carolina's economy than the success of the Green Business Fund. In its inaugural year, 2008, the Fund received 85 applications from small businesses requesting nearly \$7 million in funding to support expansion into green markets.

Following the award of only 15% of requests in 2008, the million-dollar fund is significantly more competitive in 2009 with 299 pre-proposals submitted in January totaling an estimated request of \$25,155,425.

"We have all the right assets to be a leader in going green in North Carolina - great agricultural diversity, a booming biotech sector, and world-class entrepreneurs and researchers," said then-Lt. Governor Bev Perdue as the first round of companies was announced in June 2008.

The Green Business Fund was authorized in 2007 (GS 143B-437.4) and was appropriated \$1 million per year for FY2008 and FY2009. Over 80% of the pre-proposals submitted in 2009 were from for-profit companies, about 11% were from government agencies and the remainder

were from non-profit organizations. Of the three priority areas, nearly 47% of pre-proposals were submitted under the area of clean conscious/renewable energy, over 36% were submitted under green building, and about 16% were submitted under biofuels.

After an initial review by the Department of Commerce's Board of Science and Technology, full proposals were invited from 40% of pre-proposal submissions, with a total estimated request of more than \$10 million. Award announcements are anticipated in June 2009.

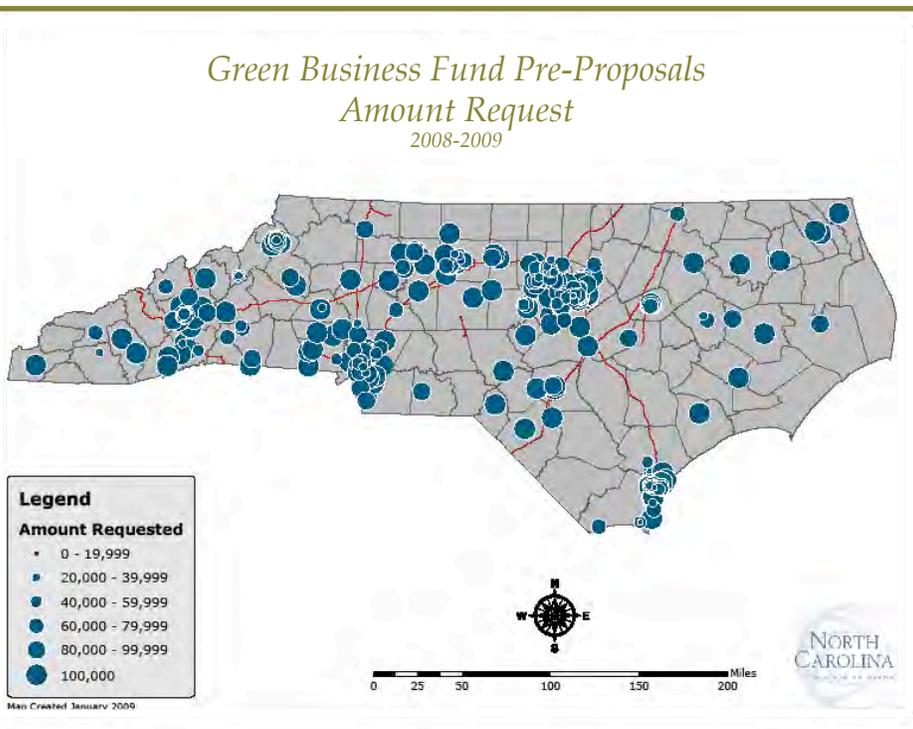
## Biofuels Center Grants

May 9th of 2008 marked the grand opening of North Carolina's latest venture in bio-based technology - the Oxford-based Biofuels Center of North Carolina. The center was incorporated in 2007 to implement the state's Strategic Plan for Biofuels Leadership.

Towards the purpose of producing 10 percent of the state's liquid fuels from fibers, waste or crops (other than corn) within the next 10 years, the Biofuels Center supports this growth industry through a variety of mechanisms including research support, workforce training programs, and business development funding.

Emphasizing the immediacy and importance of its purpose, the center announced its inaugural list of grant award winners a month before its doors were officially open. Over \$2.5 million was awarded to 15 projects impacting 27 counties in the 2007-2008 funding cycle.

Leading the way in this first funding cycle was Wake County and NC State University with a half-dozen projects and over \$1.1 million in awards. Projects' impacts were felt across the state by a block of 11-counties in the west, and several projects in the east spanning from the Virginia to the South Carolina border.



*“We have all the right assets to be a leader in going green in North Carolina...”*

*- then-Lt. Gov. Bev Perdue*

While about half of the first year’s awards featured biofuel processing and workforce training projects, the 2009 solicitation emphasizes feedstock diversity and supply. Some specific cost-effective alternatives to traditional feedstock mentioned in the solicitation are algae, other feedstock plants for both traditional and cellulose ethanol technology, and the development of economic models for dedicated energy crops.

In 2009, the center anticipates funding 15-20 projects totaling \$2.25 million. The maximum award is \$200,000 and projects featuring collaboration and broad geographic impacts are encouraged.

## Government Incentives

The creation of nearly 900 new jobs announced during the recession by the green energy industries in North Carolina is due, in part, to about \$65.5 million in taxpayer incentives given to expanding or relocating businesses. Projects receiving incentives from local, state, and federal government sources announced over \$585 million in new facilities investment – about 11¢ worth of incentive funding per dollar of investment on average.

The majority of incentives – 74% – were received by manufacturing projects, one-fifth were received by Fibrowatt for electricity generation projects, and the remainder were distributed through other business development programs. In addition to the highest rate of funding per job created, manufacturing facilities also promised the most new jobs. The power generation segment however, received the fewest incentive dollars per dollar of investment, and is expected to create most jobs per incentive dollar, albeit at lower wages than in manufacturing.

## University Labs Innovate & Grow Green Business

North Carolina’s universities play an ever-important role in green technology development and innovation. There are several instances of technology emerging from a university laboratory under license by a new North Carolina-based company. Of even greater promise, is the expansion of these companies into manufacturing, which has turned innovation in a NC lab into new, well-paying jobs for rural economically distressed areas.

Some instances during the past year and before include:

Wake Forest University: Saran wrap-based polymer-nanotube composite, in partnership with Indian Institute of Technology

NC A&T: advanced composites and nanotechnology for solar cells and generating turbines, in partnership with nCoat

NC State University: licensed biofuel catalyst to Diversified Energy Corp.

Duke University: quantum dot nanotechnology for solar cells being developed by NanoLume

NC State University: charred wood coal supplement being commercialized by Integro Earth Fuels

UNC-Chapel Hill: polymer technology with potential fuel cell applications under development by Liquidia Technologies

NC State University: College of Textiles’ 3-dimensional weaving technology commercialized by 3-TEX at Cary headquarters, and manufactured in Rutherford County

### More Information:

NC Green Business Fund - [www.ncscitech.com](http://www.ncscitech.com)

Biofuels Center of NC - [www.biofuelscenter.org](http://www.biofuelscenter.org)

NC Biotechnology Center - [www.ncbiotech.org](http://www.ncbiotech.org)

NC State Energy Office - [www.energync.net](http://www.energync.net)

# GREEN ECONOMY MARKET GROWTH

## Setting a Record Pace

With a combined global market value estimated at \$116 billion in 2008 according to Clean Edge Inc's Clean Energy Trends 2009, major renewable energy markets - biofuels, solar power, and wind power - grew over 50% last year. Despite expectations for economic conditions to stall growth in 2009, the research group predicts these markets will nearly triple to \$325 billion over the next decade.

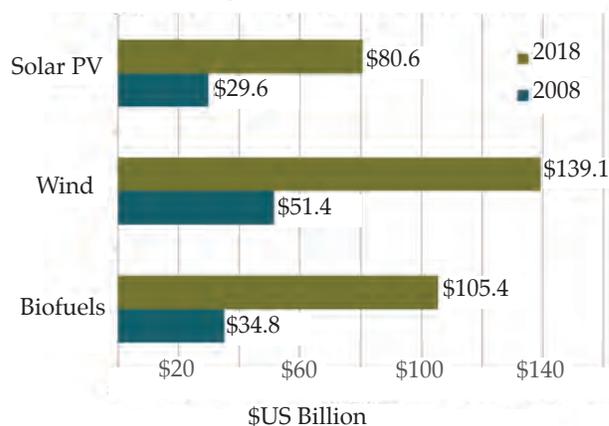
Wind power, projected to grow from \$51 billion in 2008 to over \$139 billion in 2018, is expected to create about 900,000 new direct and indirect jobs during this same period, totaling over 1.3 million wind power jobs worldwide by 2018 - more than triple 2008's employment estimate of 413,522. About the same number of solar power jobs are projected to exist worldwide in 2018, but the industry is expected to create over 1.1 million new jobs as the solar market grows from about \$30 billion today to over \$80 billion during the coming decade, according to estimates by Clean Edge.

Business investment by venture capitalists across a broad spectrum of green energy companies also continued to demonstrate the sector's strength. According to New Energy Finance, venture capitalists invested over \$3.3 billion in energy technology companies out of total venture investments \$28.3 billion during 2008. More importantly, is the continuation of a decade-long trend during which venture capitalist investment in energy technology companies has risen from less than 1% of all venture investments to nearly 12% in 2008.

## Market Drivers

Supporting this growth in the U.S. is a combination of factors, green energy technology's "perfect storm" perhaps. While public-policy requirements mandating use of green energy buttress the industry against market uncertainties, the underlying driver of green energy growth is and has been fundamentally driven by technology cost reductions and performance improvements. Simultaneously, the competitiveness of new energy technologies has been bolstered as fossil fuels continue to demonstrate both price and availability risks, lowering the cost and performance bar for new technology.

*Projected Global Market Growth in Clean Energy Technologies, 2008-2018 (\$bill)*



Source Clean Edge, Inc. Clean Energy Trends 2009

*The global market for PV, wind, and biofuels was worth nearly \$116 billion in 2008 - more than 50% greater than in 2007, according to CleanEdge, Inc.*

The use of renewable electricity is now public policy in two-thirds of the states, 85% of which require a minimum amount of electricity be renewable, according to the March-2009 update of the U.S. Department of Energy-funded Database of State Incentives for Renewable Energy (DSIRE) managed by the NC Solar Center. The Department of Energy's Alternative Fuels Data Center reports, as of February 2009, that 33 states require the use of alternative fuels - mostly biofuels.

Renewable energy is getting cheaper, improving its competitiveness as a substitute for traditional carbon-based energy. The largest renewable energy market, wind power, has become a very competitive source of electricity as the industry has achieved performance enhancements by doubling the average turbine size during the past decade to 1.65 MW, according to the American Wind Energy Association. In 2007, Lawrence

### More Information:

Clean Edge, Inc. - [www.cleandedge.com](http://www.cleandedge.com)

RenewableEnergyWorld - [www.renewableenergyworld.com](http://www.renewableenergyworld.com)

Dept. of Energy, Energy Efficiency & Renewable Energy (EERE) - [www.eere.energy.gov](http://www.eere.energy.gov)

# MARKET GROWTH GREEN ECONOMY

Berkeley National Laboratory (LBNL) reports the average price of wind-fueled electricity was about 4¢/kWh while a block of wholesale electricity sold for between 10% and 80% more.

Solar power has experienced even greater cost reductions during the past decade. The average installed cost of photovoltaic cells declined from about \$12 per watt to about \$8 per watt in 2007, according to a recent study by LBNL. While incentives continue to represent significant portion of solar power's value

proposition for most installations, LBNL reports that during the period from 2001-2007 the average pre-tax cash incentive for solar power declined by over 33% while at the same time installed solar capacity in the U.S. grew exponentially with 2007 growth bringing the cumulative total to nearly 37,000 installed systems with over 363 MW of generating capacity.

## NC's Renewable Portfolio Standard

The 2007 passage of the Renewable Energy and Energy Efficiency Portfolio Standard (REPS), a law requiring North Carolina's electric providers to supply green energy, changed the course of the state's energy markets. Most notable in the state's requirements for a more diverse electricity supply portfolio are increasingly common clauses specifying energy efficiency and solar allocations, as well as rather unique requirements for hog and poultry waste – an abundant fuel willingly contributed by farmers – to be used for electricity generation.

Attributable to these requirements are announcements of several hundred-million dollars in new investment, nearly 1,000 construction jobs over the next few years and hundreds of permanent operations jobs. In addition to several MW-scale projects announced by the state's utilities, Duke Energy announced the nation's then-largest photovoltaic installation during 2008, and while the project has since been scaled back by half, even at a reduced 8 MW of capacity it remains one of the largest projects in the nation.

While early development ensues, the NC Public Utilities Commission continues to implement REPS-bill directives. Foremost among these at present is the development of the tracking system for compliance "permits" known as Renewable Energy Credits (RECs). This system will enable certified generators to accumulate RECs in an account and will serve as the underlying accounting registry for future trading of RECs.

For electric consumers whose prices continue to rise, energy efficiency and low-cost renewable energy are an increasingly important part of the supply mix. For electric cooperatives especially, energy efficiency measures have little downside as customer-owners have nothing to lose and everything to gain from reducing power consumption in the face of rising power prices. Consumers have a variety of options to take advantage of utility programs such as automated peak load switches for water heaters in the Progress Energy service area or purchasing energy efficient products at discounted prices through electric cooperatives.

## Public Utilities Commission Docket Reference

Docket filings available from the Utilities Commission at [www.ncuc.commerce.state.nc.us](http://www.ncuc.commerce.state.nc.us)

NC GreenPower - *Docket No. E-100, Sub 90*

Net Metering - *Docket No. E-100, Sub 83*

Renewable Energy Portfolio Standard Final Rules  
*Docket No. E-100, Sub 113*

Electric Utility Integrated Resource Planning  
*Docket No. E-100, Sub 114*

# GREEN ECONOMY CARBON MARKETS

## Carbon Markets in Carolina

Market for greenhouse gas (GHG) reductions, called carbon markets, have become increasingly formalized within the regulated Kyoto Protocol framework and increasingly widespread within the patchwork of voluntary and regulated frameworks at local, state, regional, and national levels in the U.S.

Concerns over uncertainty about future regulations and market requirements are reflected in price volatility on the Chicago Climate Exchange (CCX) which saw both an all-time high price above \$7/MtCO<sub>2</sub>e and the lowest price in five years within about six months time.

### Putting the Lid on Carbon

The United States stands alone as the one exception to ratification of the global agreement to address the impacts of climate change threats posed by human-caused releases of greenhouse gases, but a new proposal for U.S. climate change policy could bring a cap on carbon emissions within the next few years.

In the Feb-2009-proposed federal budget, revenue from the auction of GHG-emission permits, called allowances, is expected by 2012. The proposal, yet to be debated, provides a strong indication that a regulated market for carbon credits will emerge in the U.S. during the next few years.

The budget proposal calls for a 14% reduction in GHG emissions from 2005 levels by 2020, according to the Forbes website. The proposed program would distribute all allowance permits through auction starting in 2012 and reduce the number of allowances available for auction in each successive year. Regulated entities – including power plants, fuel companies, and engine manufacturers – will also be able to purchase emission reductions, called offsets, in a commodity-like market to meet a portion of their obligation.

However, if investment and development of GHG reductions is any indicator, the industry is certain that there will be a carbon market of some sort in the U.S. going forward. North Carolina is rich in high-value sources of GHGs, from old closed landfills to large animal farm operations.

Investors have poured over \$1 million into North Carolina projects during the past year to install methane capture systems at both landfills and hog farms. While these sources of methane – a potent GHG – are not of sufficient size to be economically feasible for energy alone, leveraging the value of GHG reductions has enabled the capture of this local energy resource.

Further increasing the value of these projects are local initiatives developing uses of the methane to support local job creation and industry expansion in industries such as biotechnology, horticulture, traditional arts, food processing, and animal farming, among others. In addition to the economic benefits using the gas can provide, the farmers and counties that typically own these energy resources also earn revenue from sales of the emission reductions.

Today, many other opportunities exist for carbon markets to benefit North Carolina's economy, especially in agriculture-related industries. An acre of Loblolly pine forest earns 24 MtCO<sub>2</sub>e over the first 10 years – worth about \$50/acre total at early 2009 prices on the CCX, but worth nearly \$340/acre based on Dec. 2012 futures prices on the European Climate Exchange in late February 2009.

#### *More Information:*

EPA Climate Change Site - [www.epa.gov/climatechange](http://www.epa.gov/climatechange)

Chicago Climate Exchange - [www.chicagoclimatex.com](http://www.chicagoclimatex.com)

NYMEX, Green Exchange - [nymex.greenfutures.com](http://nymex.greenfutures.com)

NC Climate Change Advisory Group - [www.ncclimatechange.us](http://www.ncclimatechange.us)

Regional Greenhouse Gas Initiative - [www.rggi.org](http://www.rggi.org)

# CARBON MARKETS GREEN ECONOMY

## Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is the country's first mandatory cap-and-trade program. The 10-state program held its first carbon auction on Sept. 25, 2008 during which 12.6 million tons of CO<sub>2</sub> were auctioned at a price of \$3.07 per ton.

RGGI caps greenhouse gas (GHG) emissions at 10% below 2009 levels, and requires fossil fuel-fired electric power facilities with 25 MW or more of capacity to stabilize emissions between 2009 and 2014 (188 million tons of CO<sub>2</sub>), and to reduce emission by 2.5% per year through 2018.

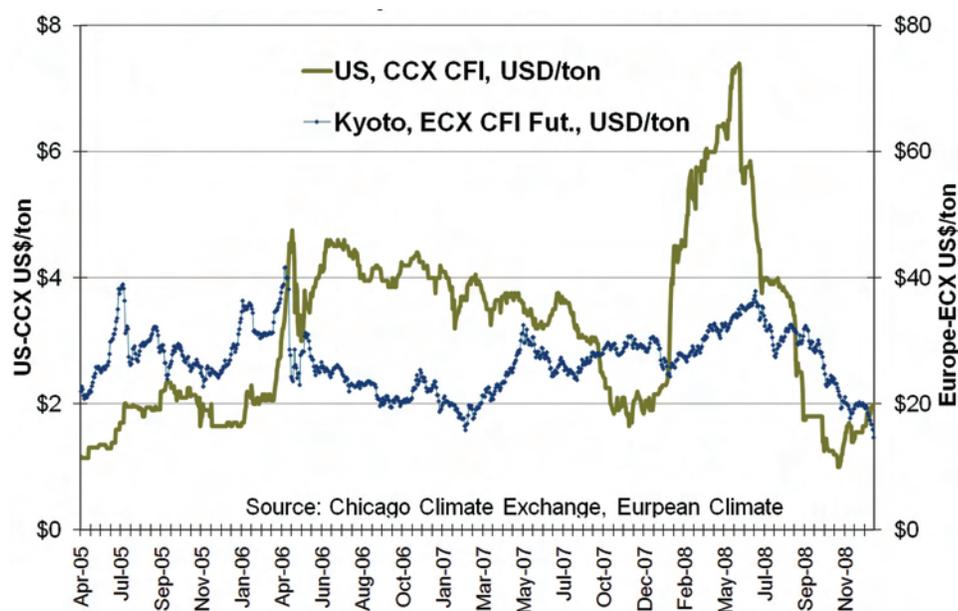
To minimize compliance costs, RGGI allows GHG emission reductions from third-party projects, called offsets, to be purchased by regulated facilities. Eligible offset-earning

projects include: landfill methane, reductions in sulfur hexafluoride, carbon sequestration in forests, switching to less-carbon-intensive fuels, and agricultural manure management that reduces methane emissions.

Another mechanism to lower costs for regulated companies is a market for trading RGGI allowances. Between Aug. 2008 and Jan. 2009, a relatively small number of allowances were traded, with average volumes nearly doubling from 155,000 per day at the start to 330,000 per day.

Allowances trade using futures contracts as well as call and put options. According to RGGI market reports, the majority of option contract trades were by firms seeking protection against unexpected drops in allowance prices at auction.

U.S & European Carbon Market Prices



## Carbon Market Terms

**Allowance** - permit representing right to emit one ton of greenhouse gases; the total number of allowances is the "Cap"

**Offset** - equals one ton of GHGs emissions prevented; offsets are sold to companies who have more emissions than allowance permits, called the "Trade" in the "Cap-and-Trade" schema

## Carbon Market Prices

The chart shown compares carbon credit prices on the European Union's regulated-market exchange on the right axis (converted to dollars) and the U.S. voluntary market exchange, the Chicago Climate Exchange (CCX), on the left axis. Especially on the CCX, prices have been highly volatile, rising and falling hundreds of percent in short periods. The most recent large movement on the CCX occurred during the first half of 2008, as the market reached all-time highs after regulations were proposed in the U.S. Congress, and then fell to three-year lows after the proposal failed to pass. Similar markets for carbon credits have also emerged recently in Canada and China as the Montreal Climate Exchange and the Tianjin Climate Exchange, respectively.

## Green Comparative Advantage

The challenge of a green economic recovery is not finding green opportunities, but rather directing limited resources towards the most advantageous green opportunities – those that create well-paying permanent jobs, increase local competitiveness and support broad-based economic growth.

A local economy can be green in many ways, but economic growth is nearly always achieved the same way – through a strong economic base. Having a large portion of local economic activity serving demand from outside areas, or exporting goods or services not only brings wealth into the local area, but also increases demand for supporting activities.

This ripple effect, called the multiplier effect, is the source of broad-based job creation and economic growth. Nearly a century of research and study, highlighted in a 1992 Economic Review article by Andrew Krikelas, has established that an increase in economic activity for export creates an increase in economic activities supporting these export producers which, in turn, induces additional

growth in the most basic economic activities found in every economy.

While virtually every economy exports to some degree, the most prosperous local economies – those which export more than most – tend to specialize. A common method used to measure local economic specialization, called the location quotient technique, compares a particular good's or service's share of local economic activity with its share of economic activity in a broader economic area such as the nation or world.

Economic development however, as described in a recently published article co-authored by Christian Ketels of the Harvard Business School's Institute for Strategy and Competitiveness, requires more than an understanding of how a local economy specializes – efforts to drive long-term prosperity require an equally long-term strategic approach to developing and maintaining a specialized position within the constantly fluctuating global economic environment.

## Manufacturing Specialties for Green Energy

Because manufacturing facilities tend to produce goods for sale outside the local area, a new job created in manufacturing or a similarly exporting production or service industry results in multiple jobs being created throughout the local economy. To the extent possible, in every local economy, green recovery efforts should be targeted at job creation opportunities for exporting industries in which the economy has an emerging or existing specialization.

Economic development efforts that target non-exporting jobs, e.g. equipment installers, at the expense of efforts targeting export jobs decrease the effectiveness of any recovery program, and if continued will likely erode local economic competitiveness. Green energy offers a double-sided opportunity to a local area's economic base.

The most significant and direct opportunity is the production and export of green energy products and

## NC Leading Supply Chain Industries

<b>14,710</b>	employment by 230 firms in Plastics Products industry
<b>4,611</b>	employment by 186 firms in Fabricated Structural Metal industry
<b>4,254</b>	employment by 61 firms in Misc. Electrical Equipment industry
<b>2,876</b>	employment by 62 firms in Plastics Material and Resin industry
<b>2,271</b>	employment by 45 firms in Semiconductors & Related Devices industry

source: Report for the Institute for Emerging Issues by Dr. Keith Debbage at UNC-Greensboro, released Aug. 2008

technologies, which creates new jobs as suppliers grow to meet new market demand. Local economies which are not specialized in an industry related to the green energy supply chains may still be able to grow the local economic base by using renewable energy and energy efficiency technologies to reduce both operating costs and market risks while increasing productivity and profitability.

The maps on the following pages show the location quotient (LQ) for manufacturing industry groups that

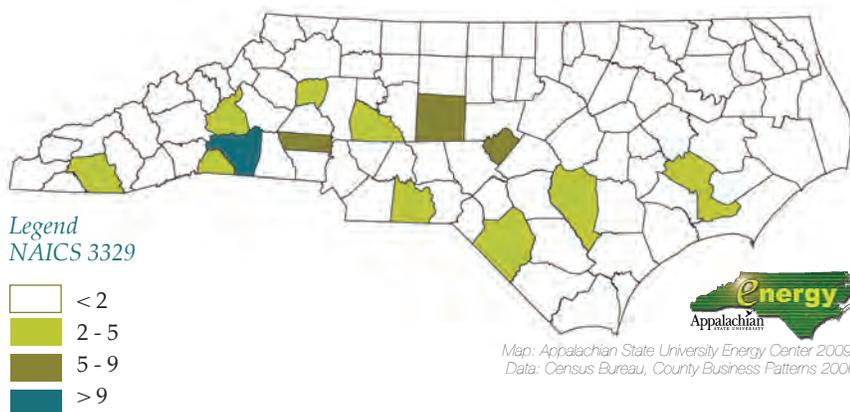
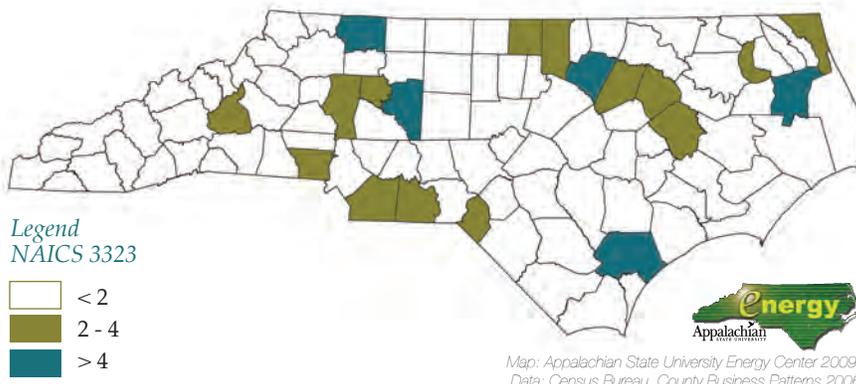
produce a variety of components for wind turbines, solar cells, and biomass and geothermal power plants. The greater the LQ for an industry in a county, the greater the county's degree of specialization in that industry. Local industries with an LQ of less than one represent a smaller share of the local economy than in the national economy, with the implication that some key factor(s) of competitiveness for that industry is more readily available elsewhere.

## County-Level Concentrations of Manufacturing Employment for Selected Renewable Energy Supply Chain Industry Groups

For each of the major supply chain areas for selected renewable energy technologies, North Carolina counties whose economies are the most-concentrated are shown below. This indicates that there is potential for manufacturing expansion in these supply chain areas from either existing or new companies, based on the fact that employment in the county is already specialized in this industry. Although there are many products produced by these industries, renewable energy components may not always be a good fit, depending on how well a facility's capability matches with the requirements for any particular component.

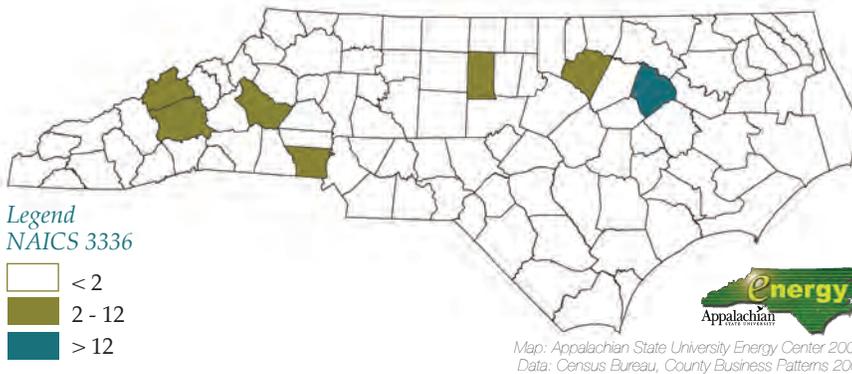
### Structural Metals

Structural metals are used in the frame of photovoltaic cells and wind turbine towers. While products for solar power are relatively undifferentiated and could be widely available, wind turbine towers require pre-fab tower sections that can be as long as 30 feet. The weight and size of these turbine components presents difficulty not only in manufacturing, but also in transportation.



### Fabricated Metal Product

Metal products, especially bearings, are essential in all mechanically driven electricity-generating machinery, including turbines powered by wind or steam from biomass combustion. A new \$17-million, Houston, TX facility will make wind turbine bearings from 8-feet to 14-feet in diameter. Several county economies have high concentrations of bearing manufacturer employment, especially Rutherford County.

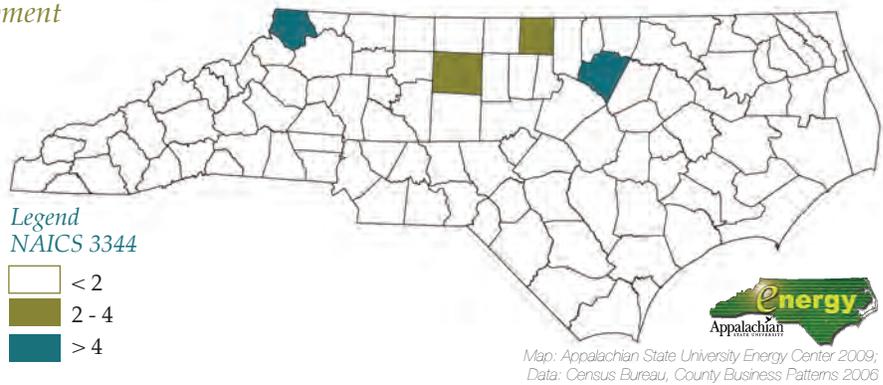


## Engine, Turbine and Power Transmission

As the wind blows, components from this industry capture motion created by the spinning blades to generate electricity. The gearbox, coupling, and high- and low-speed shafts are the drive-train connecting to the generator. Other components from this industry group, including brakes and cooling fans, are found in the nacelle. Seven county economies are specialized in this area, but Edgecombe County in particular has a large share of employment in this industry.

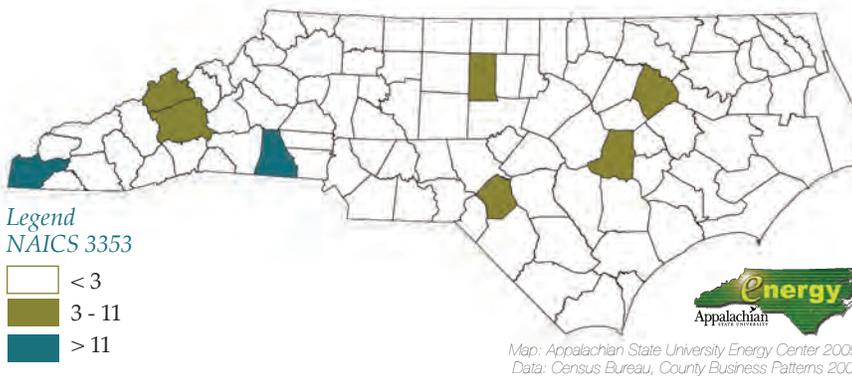
## Semiconductor and Other Electronic Equipment

Semiconductor products are largely found in solar photovoltaic cells, as they effectively transmit electricity which they can generate from sunlight. Aside from solar cells and modules, these products are found in circuit boards, diodes, LEDs and other solid-state electronics. Four counties are specialized in this industry to some extent, including Franklin and Ashe Counties.



## Electrical Equipment

Secondary motors used to control the pitch and yaw drives in wind turbines, which determine the angle of the blades and adjust the turbine to face into the wind, are produced by this industry. Photovoltaic cells primarily require switch gear and circuit breaker components in the balance-of-system. This industry is important to several counties, but especially Cherokee and Cleveland Counties.



## Other Electrical Equipment and Component

Besides electrical connectors in the PV module and power electronics for turbines, this industry provides the bulk of the balance-of-system for PV systems. Key components such as batteries, charge controller, and the inverter enable PV systems to store, condition, and use the raw DC power generated by the sun. Fifteen of the state's counties have some degree of specialization in this industry.



# ECONOMIC ADVANTAGE DIRECTIONS

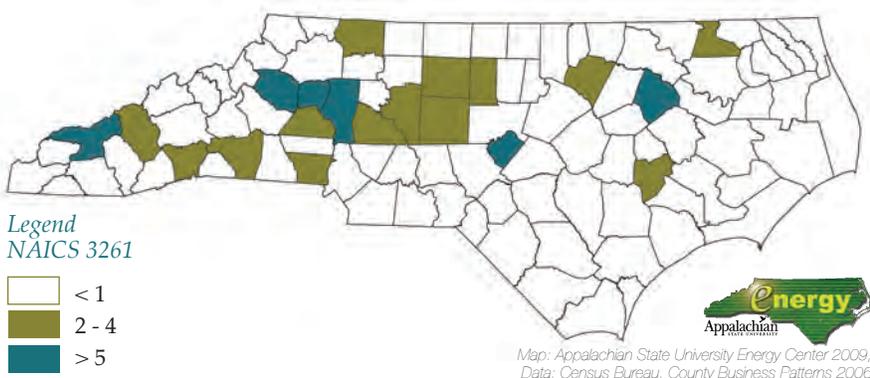
## Resin, Rubber, and Synthetic Fibers and Filaments

The precursor to final plastics products such as turbine blades, materials produced by companies in these industries are the building blocks of many high-performance materials. In solar panels, this industry directly provides the encapsulant, a module component critical for adhering solar cells to the backing material as well as resisting water vapor transmission.



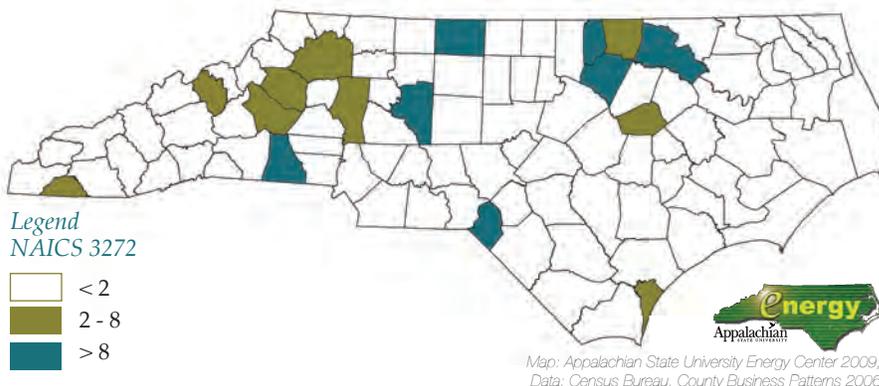
## Plastics Product

Plastics are a major component throughout the supply chain of renewable energy technologies, including major components such as the nacelle case and a large portion of turbine blades for wind turbines, as well as the rear surface that holds together the semiconductor cells in the PV module. Over 20 counties have some specialization in plastics, about 5 of which have a relatively high concentration of employment in this industry.



## Glass & Glass Products

Glass products are significant components of both wind turbine blades and photovoltaic modules. Glass fibers are coupled with polymers to make wind turbine blades. For solar power devices, plate glass is used to cover and protect the semiconductor cells, and in more modern designs glass lenses focus sunlight onto specially designed semiconductors. Seven county economies are highly specialized in this industry.



## Foundries

Foundries produce key structural components for wind turbines, including the rotor hub, blade extenders, nacelle frame and tower flange. Components used in wind turbines are both remarkably large and extremely heavy, have highly engineered requirements such as high-impact strength in extreme low temperatures, and are of limited availability as few facilities have production capabilities.



## The Value of a Green Job

Not all green jobs are created equal. A region's economic base - facilities serving external demand - creates local wealth, drives economic growth, and supports job growth throughout an economy. While economic base jobs are the foundation of any economy, jobs supporting increased competitiveness of the economic base can also drive a green recovery.

Job creation efforts focused on the installation of renewable energy and energy efficiency technologies will only grow the state economy to the extent that

these services are either performed outside the state, or performed to reduce energy-related costs or risks at in-state facilities serving external demand.

A targeted approach that supports green job creation in proportion to each job's economic value will support economic recovery efforts and maximize the state's return on investment. Understanding the economic relevance of jobs is the first step towards creating jobs that will serve the state over the long-term, and limit the opportunity cost of job creation investments.

## Re-Training NC's Workforce for New Energy Technology

As demand for green energy technology continues to increase across North Carolina, skilled installation and maintenance workers are in short supply. Deployment of green energy technology is largely constrained by the state's training capacity.

The North American Board of Certified Energy Practitioners (NABCEP) certifies both photovoltaic installers as well as training programs, and the Institute for Sustainable Power Quality Accreditation (ISPQ),

employs a rigorous process to award accreditation to training programs. NABCEP-certified training courses are available from Appalachian State University's Dept. of Technology, Central Carolina Community North Carolina Solar Center at NC State University.

Transportation training programs include: Advanced Vehicle Research Center provides hybrid vehicle and hydrogen energy education programs. Piedmont Biofuels offers courses on biodiesel production and

fuel quality testing. Other programs offering or developing green energy curricula are: AB Tech, Cape Fear Community College, Caldwell CC, Central Piedmont CC, Gaston College, Southeast Piedmont CC, Southeastern CC, Wake Tech, Wayne CC, and Wilson Tech.

### More Information:

Interstate Renewable Energy Council (IREC) [www.irecusa.org](http://www.irecusa.org)

North American Board of Certified Energy Practitioners (NABCEP) - [www.nabcep.org](http://www.nabcep.org)

Institute for Sustainable Power Quality Accreditation (ISPQ) - [www.ispqusa.org](http://www.ispqusa.org)



Workshop attendees work on a small-scale wind turbine atop Beech Mountain, NC. At the Small Wind Test Site, wind turbines up to 20 kW are tested for durability and power output. Image courtesy of Appalachian State University Department of Technology

## Turning Our Collars Green

The renewable energy and energy efficiency workforce, composed of so-called green collar jobs, includes scientists and engineers who develop the technologies, production workers in manufacturing and farming, construction trade specialists, jobs in equipment maintenance and operations.

According to the NC Employment Security Commission, construction industry employment declined more than 15% from January 2008 through January 2009. These idled workers are the green energy installation workforce, and their training, especially in energy efficiency retrofits, offers an economy-wide return in the form of reduced energy costs and decreased risk exposure.

## Managing Economic Risks

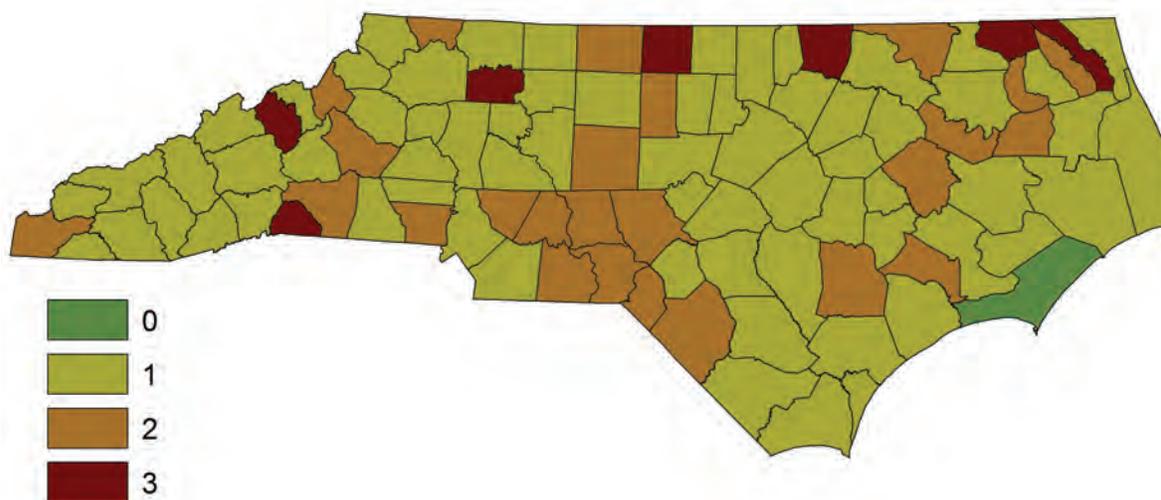
As the fastest growing source of energy in the world over the past decade according to the Energy Information Administration, renewable energy sources are firmly entrenched in a growth mode. Continuation of this trend represents job creation and investment opportunities for many local economies in North Carolina.

Green energy market growth is a signal, more ominous than promising overall. Growing markets for green energy are a reflection of fossil fuels' decline in relative value from factors such as price increases, high market volatility, uncertain supply reliability and availability,

cumulative environmental and health impacts, as much as this growth represents greater performance and lower costs for renewable energy.

Energy market changes affect the competitive position of North Carolina's industries. Whether these changes prove favorable or detrimental to the state's economic future is entirely dependent on the success of adaptive measures – the degree to which the adoption of new energy technologies systematically reduces exposure to energy-market risk, minimizes operating costs, and improves the competitive position of business across the state.

*Local Manufacturing Employment Concentrations in Coal-Intensive Industries*



*Aside from opportunities to expand production and gain jobs from renewable energy and energy efficiency market growth, the rise of green energy markets threatens to change the competitiveness of industry from region to region. Carbon markets, in particular, pose a significant financial risk over the long-term to industry facilities which are fossil-fuel intensive. Counties with high concentrations of local employment in coal-intensive manufacturing, as shown in the map above, specialize in greenhouse gas-intensive production. Cost-effective efficiency measures, technical assistance to facilitate the transition to less carbon-intensive fuel such as natural gas or biomass, or assistance developing greenhouse gas emission reduction projects to offset industry emissions are economic preservation strategies, and this expertise could be leveraged into growing the local share of the national industry if a region successfully leverages reductions in carbon intensity as a source of competitiveness.*

# INDUSTRIES BIOMASS

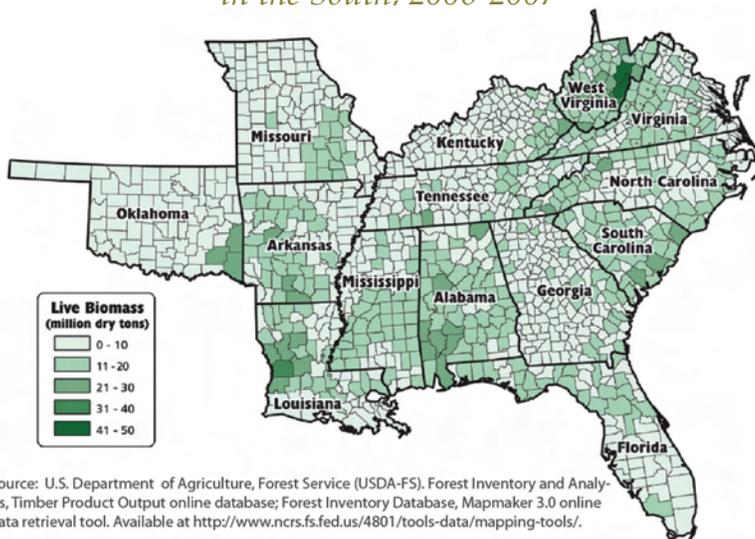
Biomass energy uses plants and natural materials as fuel. Biomass can be combusted in a dedicated generator plant or used to supplement coal in large-scale utility plants. Plant materials, especially crop and forestry waste, when subjected to a variety of chemical, thermal, and biotechnology processes can be converted to fuels that are close matches to coal, oil, natural gas, and even pure hydrogen.

Biomass power commonly faces both technical and scale barriers. The primary cost driver of most biomass energy is transporting often bulky raw materials to a

central processing or power generation facility. For many high-technology processing methods, large-scale cost effectiveness has yet to be achieved, although a great deal of progress continues to be made.

Because bio-based energy is considered carbon-neutral, meaning greenhouse gases released during consumption are mostly re-absorbed as new plants replace those consumed. Biomass power is most available to areas with a significant forestry or paper industry, as well as crop-farming intensive areas.

## *Inventory of Live Biomass on Forestland in the South, 2006-2007*



## Developments

### Using wood waste as fake coal

Using Integro Earth Fuels' wood charring technology, Progress Energy is testing the viability of wood-char as a supplemental fuel for coal-fired power plants. Plans for a Person County facility manufacturing the coal supplement would draw wood waste from a 40-mile radius. A competing technology from a S.C.-based company plans to open a facility in eastern NC by 2010.

- News & Observer

### Fibrowatt facility sites selected

Chicken litter will fuel about 150 MW of electricity generation at three Fibrowatt facilities to be located in Sampson, Surry and Montgomery Counties. The power plants, expected to come online during 2011 and 2012, will generate about 300 construction jobs as well as about 100 permanent operating jobs – about 70% of which are truck-transportation jobs. Fibrowatt will use a unique waste collection and treatment process to transform over a million tons of animal waste per year into a combustible fuel.

- News & Observer

*Biomass inventory from the Southern Bioenergy Roadmap produced by the Southeast Agriculture & Forestry Energy Resources Alliance (SAFER) and the University of Florida. The top two weaknesses and threats for southern bioenergy, according to the report were Feedstock and Policy.*

### *More Information:*

Southeast Agriculture & Forestry Energy Resources Alliance - [www.saferalliance.net](http://www.saferalliance.net)

NC Biomass Roadmap - [www.energync.net](http://www.energync.net)



Closed landfill cells are tested for methane content and impurities in the gas stream that may affect the viability of end uses for the county's landfill gas resource. Rockingham County is preparing an RFP for development of its landfill gas resources in partnership with the Appalachian State University Energy Center's CommunityTIES Project. The recovered energy resource will be used to drive job creation in the county.

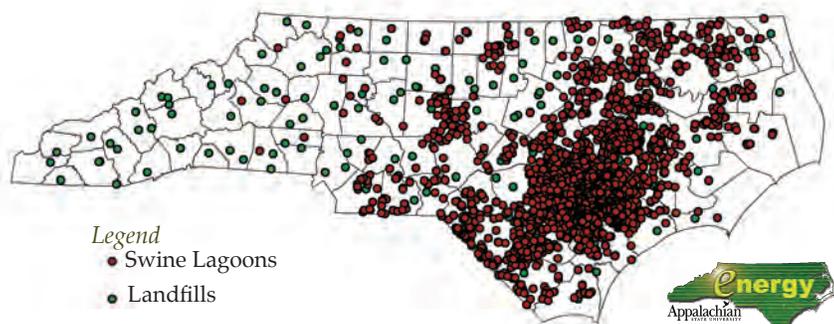
Photo courtesy of Rockingham County Business & Technology Center

Biogas is methane – the primary energy component in natural gas. Unlike biomass resources, biogas is only available in isolated locations, typically landfills, wastewater treatment facilities, and animal waste sites.

Historically, recovered biogas comes exclusively from landfills, and is typically burned in engines for electricity or used to fuel boilers for heat. However, innovations in the collection of biogas, especially from hog waste, are making many more sources of biogas potential energy reserves.

Much of the hog-related biogas innovation is occurring in North Carolina, partly due from state policies to reduce the environmental risk and impact of hog farming, but also due to the increase in value of collecting and destroying this gas from the rise of carbon markets. Newer technologies that purify and store biogas as either compressed natural gas (CNG) or liquefied natural gas (LNG) are emerging as options to enable transport and may increase the value of biogas sources further.

## Potential Biogas Sources, swine lagoons and landfills



Legend  
 ● Swine Lagoons  
 ● Landfills

Map data files from NC OneMap  
 Map generated by Appalachian State University Energy Center

## Developments

### Paying a green dime

Energy-rich gas from the City of Durham's closed landfill will be used to fuel a 2 MW electricity generating engine. According to Duke Energy, which will purchase the generation, the extra cost from this renewable energy will be about a dime 10¢ - per year for an average customer.

- RenewableEnergyWorld

### Carbon credits fund landfill gas collection

Landfill gas collection systems in Columbus and Edgecombe Counties are being installed by a carbon investor. Both counties are planning to use low-cost energy as well as income from the sale of carbon credits to support economic development projects.

- Whiteville News Reporter, Rocky Mount Telegram

### More Information:

EPA Landfill Methane Outreach Program - [www.epa.gov/lmop](http://www.epa.gov/lmop)

EPA AgSTAR - [www.epa.gov/agstar](http://www.epa.gov/agstar)

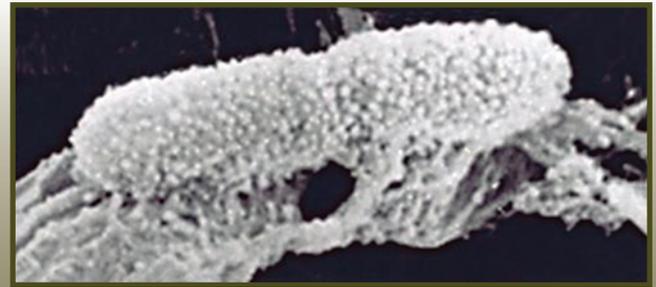
NC DENR Pollution Prevention - [www.wastenotnc.org](http://www.wastenotnc.org)

# INDUSTRIES ETHANOL

The ethanol industry's 156 operating facilities have a 10.5 billion-gallon-per-year (bg) production capacity, and as of early 2009 an additional two billion gallons of capacity were under construction. Despite an annual production growth rate of 20%, ethanol imports have risen substantially from about 2% of production in 2003 to about 7% in 2007.

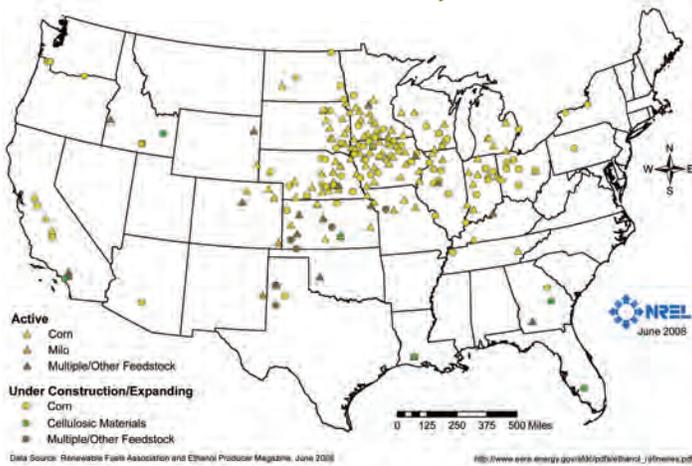
The U.S. was the leading producer of ethanol in the world during 2007, and together with Brazil represented about 88% of global production. Ethanol production now occurs in 26 states, and although the industry is branching out, the vast majority of production remains concentrated in the mid-west.

An estimated 190,000 people were employed in ethanol production operations during 2007, and another 81,277 people were employed in ethanol plant construction. About 70% of ethanol production-operations employment was related to raw materials, wholesale trade, or transportation. Including construction and production-operations jobs, the ethanol industry accounted for over \$12.3 billion in wages during 2007.

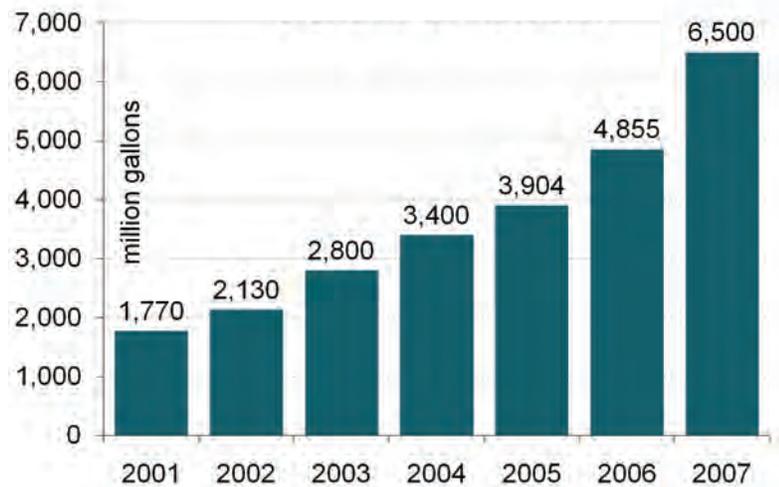


*Microscopic image of Acetivibrio cellulolyticus bacterium, showing cellulosomes. Each spherical shape on the surface of this Acetivibrio cellulolyticus bacterium is a cellulosome containing several different enzymes active in breaking cellulose down to its component sugars. With new Bioenergy Science Center funding, NREL researchers can research the overall action of the cellulosome in a way that they have not been able to before.*  
Image Source: NREL PIX

## U.S. Ethanol Biorefineries



## U.S. Ethanol Production



## Ethanol Production in NC

Clean Burn Fuels LLC is developing what will likely be North Carolina's first ethanol production facility at a site in Raeford, Hoke County. The facility uses a process from Katzen Inc. and was designed by Biofuels Design, according to Ethanol Producer Magazine.

After a May-2008 groundbreaking, the 60-million gallon per year facility expects to use corn as raw material feedstock after its expected July-2009 opening. Earlier this year another large ethanol facility was cancelled after project developer Xethanol, facing financial difficulty, sold off its properties.

### More Information:

- Renewable Fuels Association [www.ethanolrfa.org](http://www.ethanolrfa.org)
- American Coalition for Ethanol [www.ethanol.org](http://www.ethanol.org)
- National Biodiesel Board [www.biodiesel.org](http://www.biodiesel.org)
- Alternative Fuels Data Center [www.afdc.energy.gov](http://www.afdc.energy.gov)
- Triangle Clean Cities Coalition [www.triangletcleancities.org](http://www.triangletcleancities.org)
- Centralina Clean Fuels Coalition [www.4cleanfuels.com](http://www.4cleanfuels.com)

# BIODIESEL INDUSTRIES

As of Sept. 2008, the National Biodiesel Board reported 176 biodiesel production facilities in 41 states with a total production capacity of 2.6 billion gallons per year. Actual production however, remained less than 30% of capacity for the second straight year at only 700 million gallons.

Biodiesel growth is slowing as the industry approaches federally mandated consumption levels of about 1 billion gallons per year. In Sept. 2008 expanding capacity was about 33% of existing capacity, down from 75% in 2007 and 200% at the end of 2006. Exports – nearly all to the EU – outpaced imports by about 3:1 during 2008. Biodiesel is distributed in all 50 states from over 2,600 distribution outlets – 1,500 of which are bulk distribution outlets.

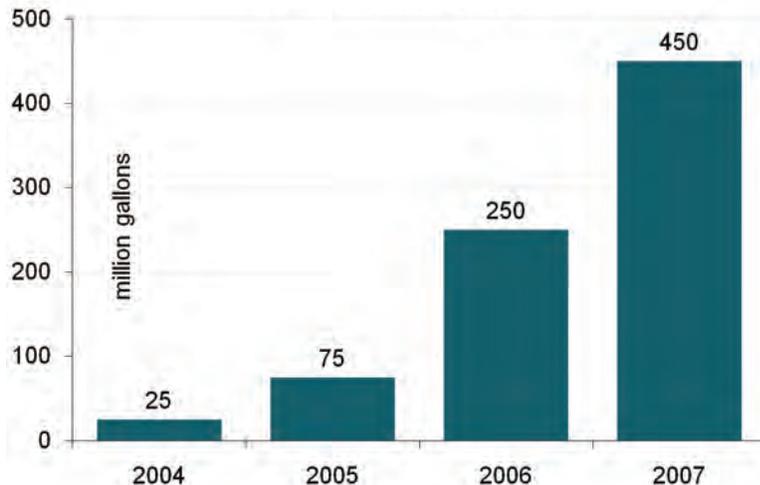
Soybean oil continues to represent the bulk of raw material from which biodiesel is refined. Producers in 2008 greatly diversified raw material, cutting the market share of refined soybean oil by about half to 34%. The use of crude soybean oil nearly doubled to 31%, use of other oils and fats increased 50% to a quarter of the feedstock market, and use of inedible tallow and grease feedstock doubled to over 10% in 2008.

An estimated 21,800 people were employed in the U.S. as a result of the biodiesel industry during 2007. Raw materials accounted for nearly 90% of this employment. Including glycerin by-product sales, the biodiesel industry accounted for \$4.1 billion of GDP and \$958 million in household wages during 2007.

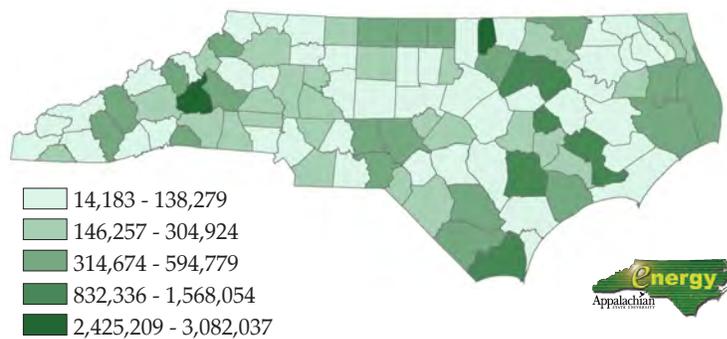


*Biodiesel tank installation at Appalachian State University. Biodiesel fuel is used in the school's buses, called the Appalcart, funded in part by a student-funded program to install renewable energy equipment on campus.*

## U.S. Biodiesel Production

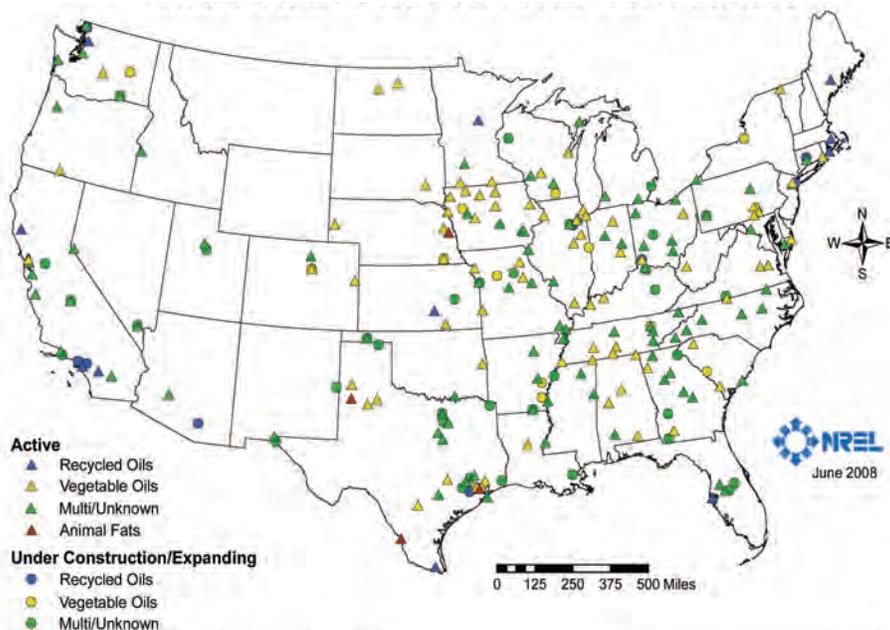


## Gallons of Waste Oil, by county



Map Source: Appalachian State University Energy Center  
Data collected in annual survey of waste cooking oil, conducted by Appalachian State University Energy Center

## U.S. Biodiesel Production Facilities



Data Source: National Biodiesel Board and Biodiesel Magazine, June 2008

[http://www.eere.energy.gov/afdc/pdfs/biodiesel\\_plants.pdf](http://www.eere.energy.gov/afdc/pdfs/biodiesel_plants.pdf)

# INDUSTRIES ENERGY EFFICIENCY

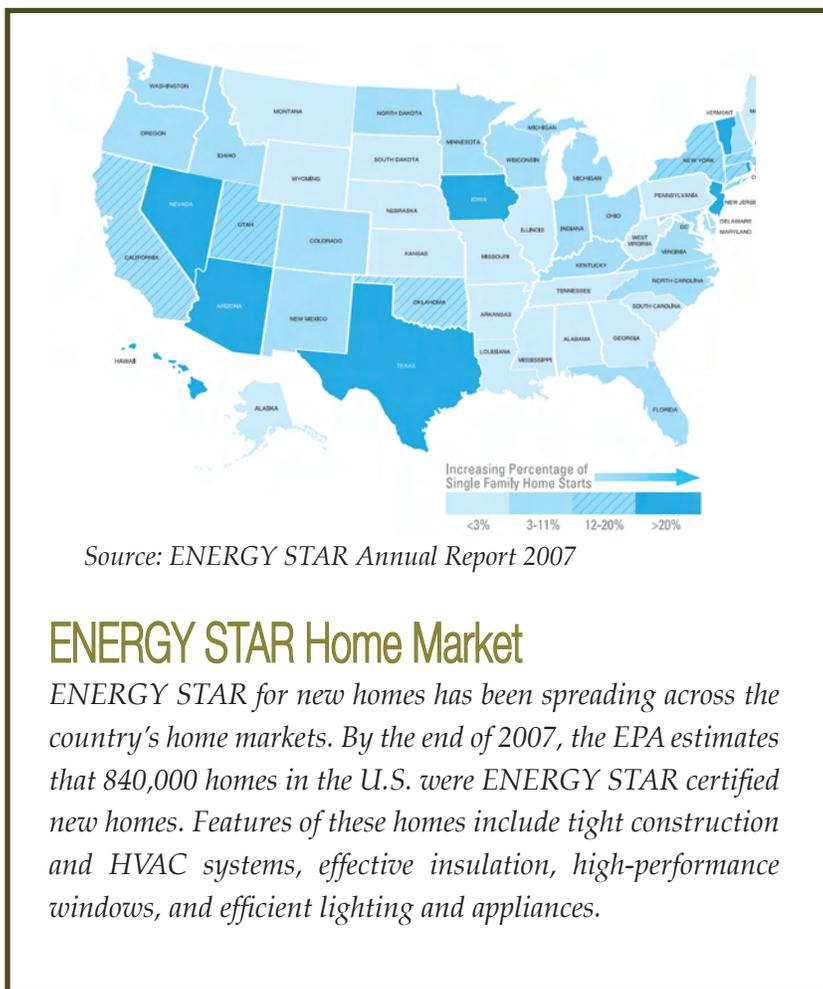
Energy efficiency is a crucial, but invisible, component of the U.S. energy supply. The impacts of demand for energy-saving products and equipment ripple through every industry and basic economic activity.

The American Council for an Energy Efficient Economy (ACEEE) estimated market demand for energy efficient products across all economic sectors at over \$300 billion - \$43 billion of which is considered the efficiency premium, or the additional cost of products with higher efficiency.

Buildings accounted for nearly 40% of energy use and represented about 60% of energy investment. Also in 2004, industrial applications used about a third of total U.S. energy and represented 25% of efficiency investments. Transportation represented 28% of energy use, but received only about 11% of efficiency investment.

An estimated 1.6 million people were employed in the efficiency industry in 2004, 15% of which are counted in the efficiency premium.

While North Carolina is a leader in efficiency within southeastern states, the state lags behind the nation in efficiency measures, according to the ACEEE scorecard. Up one ranking place from 2006, North Carolina was ranked 29th in efficiency measures among the states in 2007, with building codes the highest-scoring category.



## ENERGY STAR Home Market

ENERGY STAR for new homes has been spreading across the country's home markets. By the end of 2007, the EPA estimates that 840,000 homes in the U.S. were ENERGY STAR certified new homes. Features of these homes include tight construction and HVAC systems, effective insulation, high-performance windows, and efficient lighting and appliances.

## Facts & Stats

**455** ENERGY STAR-registered home builders in North Carolina as of mid 2008

**4,437** total ENERGY STAR labeled homes in NC

**53** Home Energy Rater companies in NC

**35** rank of North Carolina in per capita energy consumption

**10** state ranking for growth rate of energy consumption

**29%** of energy consumed in NC is for transportation - the leading energy consumption sector

### More Information :

ENERGY STAR [www.energystar.gov](http://www.energystar.gov)

American Council for an Energy Efficient Economy [www.aceee.org](http://www.aceee.org)

National Association of State Energy Offices [www.naseo.org](http://www.naseo.org)

NC ENERGY STAR Homes [www.ncenergystar.org](http://www.ncenergystar.org)

US Green Building Council [www.usgbc.org](http://www.usgbc.org)

North Carolina Green Building Database [www.ncgreenbuilding.org](http://www.ncgreenbuilding.org)

HealthyBuilt Homes [www.healthybuilthomes.org](http://www.healthybuilthomes.org)

# HYDROGEN FUEL CELLS INDUSTRIES

Development has continued at a strong but steady pace in the industries of hydrogen and fuel cells. The introduction of consumer leases for fuel cell vehicles and the emergence of fuel cells as a competitive option for niche transport vehicles (e.g., lift trucks) during the past year is an important milestone for an industry striving for sales.

A recent Department of Energy report estimates that by 2050 fuel cells will power between 38% and 96% of all vehicles, consuming between 30 billion and 64 billion gallons-of-gasoline-equivalent hydrogen fuel.

While the industry only employed about 8,700 people in 2006, over 540,000 hydrogen- and fuel cell-related jobs are likely to exist by 2035, rising to 809,000 by 2050. The majority of these new jobs and replacement jobs will be in the automotive dealer and repair industries – a potentially significant workforce skill upgrade requirement.

While fuel cell technology is largely in the R&D stage, niche products are commercialized. The industry is growing rapidly however, as evidenced by the number of companies shipping both more than 100 units and less than 5 units doubling last year, according to industry surveys from Fuel Cell Today.

The intense research focus produced at least 1,788 patents in the last three months of 2008 alone – nearly a third from Japan, led by Toyota with three times the number of patents as the nearest competitor, Honda. Five of the top seven awardees of fuel cell patents in the fourth quarter of 2008 were automobile companies, according to a report by Fuel Cell Today. Research investments were also more than double the value of sales in 2006 at \$829 million, according to the U.S. Fuel Cell Council.

## NC fuel cells light National Zoo exhibit

Over a three-day period, Microcell Corp.'s unique tubular fuel cell design powered the "Zoolights" exhibit entrance at the Smithsonian National Zoo in Washington, D.C. The installation was sponsored by Potomac Electric Power Company and the hydrogen storage and infrastructure was managed by Maryland-based havePOWER LLC.

- Company Press Release

## Home of Hydrail

Charlotte, NC is the home of a global initiative to bring hydrogen-powered trains to the world's transit systems.

The International Hydrail Conference returns from Europe to host the fifth annual event on the campus of UNC-Charlotte in June 2009 before venturing to Canada in 2010 and South Korea in 2011.

Hydrail, short for hydrogen train, offers all the benefits of electrified rail - zero emissions, quiet operation, high-speed mass transit - without the added cost of overhead catenary wires.

These self-electrified locomotives are used for clean urban transit, in light rail and streetcar applications, called hydrolleys.



## Hydrogen Road Tour

Hydrogen-powered vehicles from 9 automakers completed an historic two-week tour across the country during Summer 2008. The tour made 31 stops in 18 states from Maine to California, including two stops in North Carolina.

"The technology necessary to put these cars on the road, and keep them moving, exists today," said Administrator Paul Brubaker of the U.S. DOT's Research and Innovative Technology Administration (RITA). "The question is not if hydrogen powered vehicles will be available commercially, but when." - U.S. Department of Transportation Press Release

### More Information:

National Hydrogen Association [www.nha.org](http://www.nha.org)

International Hydrail [www.hydrail.org](http://www.hydrail.org)

Federal Hydrogen Portal [www.hydrogen.gov](http://www.hydrogen.gov)

US Fuel Cell Council [www.usfcc.org](http://www.usfcc.org)

# INDUSTRIES SOLAR ELECTRICITY

The solar electricity industry continued growing at a breakneck pace in 2007, with a year-over-year employment increase of 50%, a domestic production increase of nearly 70%, and domestic market growth of over 30%. The industry remains relatively specialized with 60% of the 46 companies active in 2007 earning 90% or more from photovoltaic (PV) sales.

Silicon supply shortages in recent years didn't stall growth so much as drive innovation in non-silicon-based technology,

## Facts & Stats:

**6** NC rank in 2008 PV markets

**6,170** PV industry employment in 2007, a 50% increase over 2006

**1,000%** industry growth since 1998

**42%** increase in import share of domestic shipments since 1998

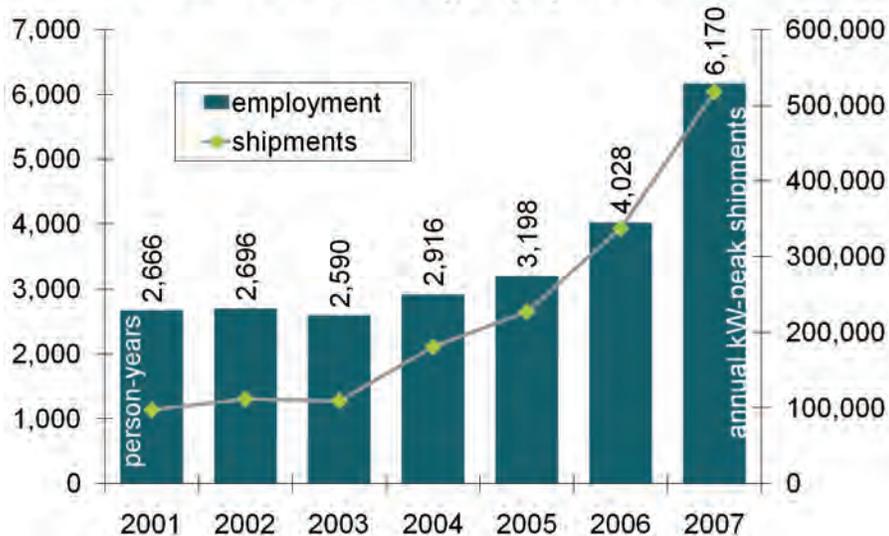
such as thin-film and most recently concentrator technology. Shipments of thin-film technology have doubled each year since 2005, and represented 40% of all domestic shipments in 2007 – largely exports.

Exports dominated US production from 1997-2004 with export averaging five times imports, but in the past three years the growth in imports has consistently outpaced exports. Germany alone accounted for 64% of US exports in 2007, and combined with Spain and Italy accounted for 80% of US PV exports.

Domestically, two states – California and Nevada – received 75% of domestic shipments, while the top five states together received 86% of domestic shipments in 2007. With double the share of any other market segment, commercial markets continued to dominate the domestic market.

After growth in domestic manufacturing stalled for a brief period, 2007 saw a resurgence in domestic activity as the

*U.S. Photovoltaics Industry, Employment and Shipments*



number of manufacturers increased 50% to 24. Ohio manufactured 42% of domestically produced PV, and combined with Michigan and California represented 73% of domestic shipments in 2007. A total of 22 companies intended to introduce new products during 2008.



## Solar Optical Furnace

A highly efficient optical furnace, developed at the National Renewable Energy Laboratory (NREL) to fabricate solar cells for manufacturing, can reach temperatures of up to 800-degrees Celsius. NREL has partnered with Applied Optical Systems to commercialize thin-film silicon solar cell production, and estimates costs could drop several times today's costs to \$0.80 per Watt. "We'd like to develop thin-film silicon solar cells with higher efficiencies, up to 15 to 18 percent, and we believe this furnace will enable us to do so," says A. Rangappan, founder and CEO of Applied Optical Systems.

Image Source: NREL PIX

# SOLAR THERMAL INDUSTRIES



## Evacuated Tube Collector

A medium temperature evacuated tube solar thermal collector used as a design element by the University of Texas at Austin as part of a house designed for a solar competition hosted by the U.S. Department of Energy.  
Image Source: NREL PIX

The solar thermal industry set many records in 2007 – the industry’s shipment volume fell 27%, employment fell 36%, and revenue was cut in half. Surprisingly enough, these are indicators of an industry fueling itself for rapid growth.

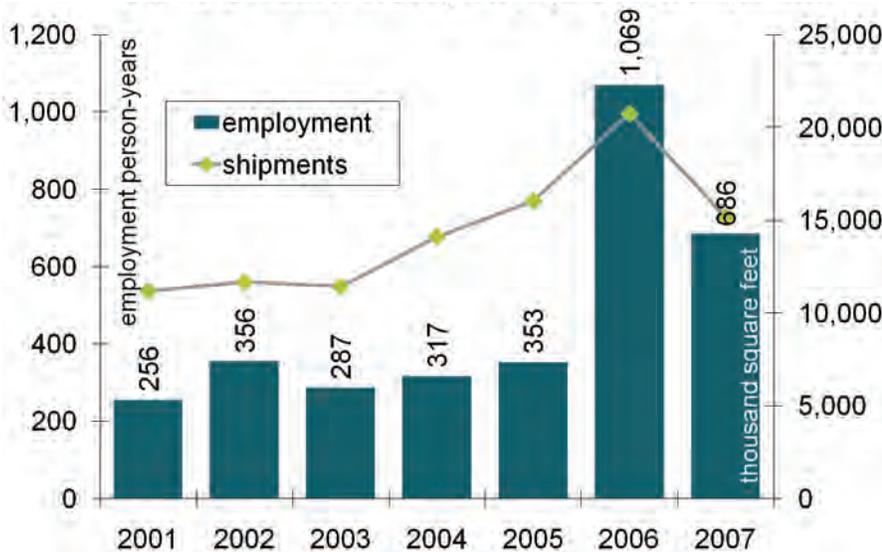
The source of 2007’s decade-high drop in annual shipment volume is largely the result of the prior year’s 2,363% increase in the installed capacity of high-temperature solar technology. Innovation is driving volume growth in solar thermal shipments, as evidenced by 2007’s 30% growth in shipments of medium-temperature technology. Growth in shipments of new technologies is directly reflected by the 140% increase in the number of companies in the industry since 2005.

That the solar thermal industry even had 383 jobs to lose in 2007 is significant considering that from 1997 until 2005 the industry only employed an average of 281 people per year and never more than 356 people. Even after losing over a third of its workforce in 2007, the industry still employs 94% more people than in 2005.

Excluding high-temperature systems, solar thermal revenue has increased in each of the past three years as shipments of more advanced technology have increased the average price by 34% from \$2.86/sq.-ft. in 2005 to \$3.84/sq.-ft. in 2007.

These potentially disturbing indicators are matched by other signs of the industry gaining momentum as well. In 2007, the industry consisted of 60 companies – 35 more than in 2005. Solar companies are also becoming more specialized with over half of new companies reporting that solar accounts for 90%-100% of revenue – in total, 75% of companies in the industry get at least half their revenue from solar.

U.S. Solar Thermal Industry, Employment and Shipments



## Facts & Stats

**91%**

Exported share of solar thermal shipments

**97%**

Growth in shipments of medium-temp. flat-plate collectors from 2005-2006

**342%**

Growth in shipments of medium-temp evacuated-tube collectors from 2006 to 2007

# INDUSTRIES WIND TURBINES

The wind energy industry experienced another boom year in 2008 increasing cumulative installed capacity by 50%. With \$17 billion invested and over 8,358 MW installed wind power represented 42% of all electric generator installations in the U.S. during 2008, on par with natural gas.

With over 25,000 MW of wind capacity online at the end of 2008, the U.S. now accounts for the largest share of global wind installations, surpassing Germany. While the U.S. grew the most, China grew the fastest doubling its wind capacity last year, according to the Global Wind Energy Council. Globally, wind power is picking up speed, and in 2008 was a \$47.5 billion industry with an annual growth rate of 28.8%.

Wind technology continues to progress with European countries planning to increase offshore turbine installations from 1,471 MW at the start of 2009 to 37,442 MW in 2015, according to the European Wind Energy Agency. In Europe more wind power was installed in 2008 than any other electricity generating technology.

The U.S. wind industry is estimated to employ about 85,000 people, including about 8,000 in turbine construction, according to the American Wind Energy Association. Currently about 50% of manufacturing for the U.S. market is performed domestically, up from only 30% in 2005.

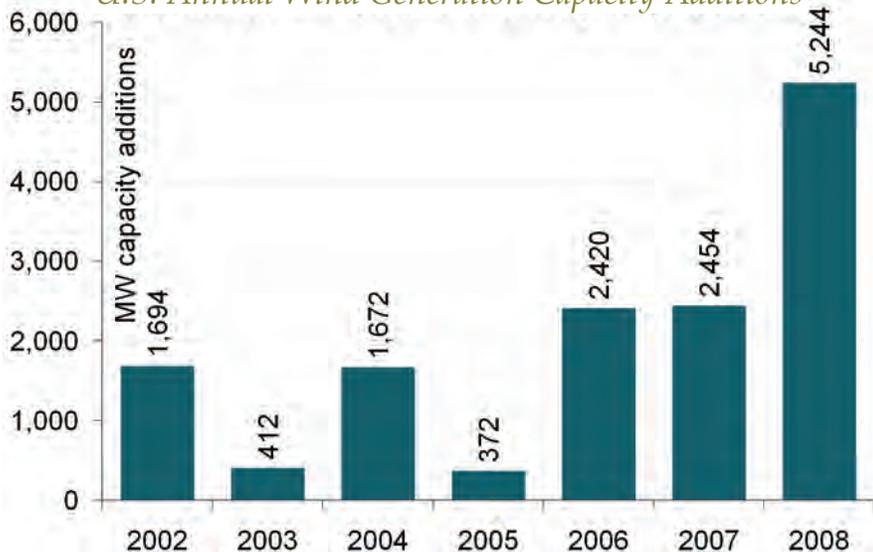
Over 70 new or expanded manufacturing facilities have added an estimated 13,000 new jobs during the past two years. These facilities are mostly in metal and plastics industries producing an estimated 2.25 million fasteners, nearly 25,000 miles of rebar, and 77.6 thousand tons of composite materials in 2008 alone.

Some key needs for continued industry growth are in the manufacture and transport of very large and extremely heavy components and subassemblies, especially for forged and cast parts. Other specific industry needs are for increased supplies of rare earth magnet raw materials, and expanded transmission capacity.

## Coastal Wind Resources

*North Carolina's top wind resources are found offshore and along the coast. Several offshore wind projects are planned in the U.S., including one near the South Carolina-Georgia border. After a few pilot projects, European Union countries are pursuing offshore wind development earnestly. Offshore turbines with generating capacity of about 5MW are being built - more than 30% larger than the largest land-based designs. The larger size and consistently strong wind resource make offshore turbines highly attractive for development, although electricity transmission can be challenging in rural locations, such as eastern North Carolina, where demand is some distance away from the turbine location.*

*U.S. Annual Wind Generation Capacity Additions*

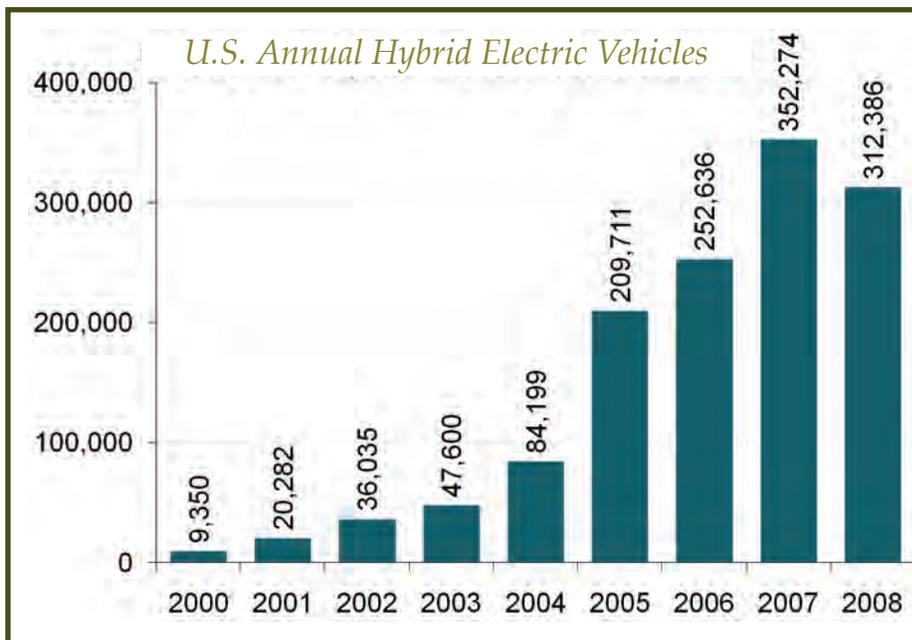


# HYBRID ELECTRIC VEHICLES INDUSTRIES

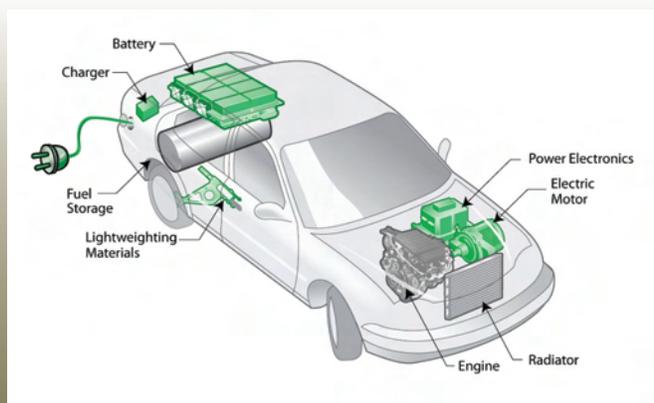
Arriving with prescience befitting the turn of a millennium, Honda sold 17 hybrid-electric vehicles (HEVs) in 1999. Those first tentative steps into the automotive marketplace were followed by 1.3 million more in the years since, according to information compiled by the U.S. Department of Energy's Alternative Fuels Data Center.

In the technology's second year, an estimated 9,350 HEVs were sold as Toyota entered the market and claimed a 60% share of year-2000 sales. The market for HEVs continues to grow rapidly with half of cumulative HEV sales occurring since 2007 and at the end of 2008 included 19 vehicle models from a half-dozen auto companies.

The introduction of newly hybridized models is a primary growth driver in the HEV market. From 2006 to 2007, sales of hybrid-electric diesel transit buses doubled to over 1,000 nationwide while sales of light-duty automobiles increased 40%. In 2008, Toyota maintained a dominant market share for HEVs with its six models representing 77% of total annual HEV sales.



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## Plug-in Hybrid Electric Vehicle Components

Several key features of plug-in hybrid vehicles include the electric motor and power electronics of traditional hybrid vehicles, but plug-in hybrids specifically require a charger unit which is often coupled with an expanded battery pack to enable 30 or more miles of continuous all-electric power.

Image Source: Argonne National Lab

Hybrid vehicles are revolutionizing transportation, but not because of their efficiency benefits. We are two steps down the path towards an electrified vehicle fleet nationwide. Some hybrid vehicles use recaptured energy stored in batteries to power on-board electronics, reducing gasoline consumption. Series, or full, hybrids however, take an extra step towards electrification, using electricity to propel the vehicle.

In the full hybrid design gasoline is used only to generate electricity. With an electrified drivetrain, the incremental cost of incorporating other fuels such as natural gas or hydrogen into the national vehicle fleet is much lower. Hybrid-electric technology removes a major technical barrier that has long prevented the introduction of substitutes for oil-derived gasoline. Electricity-based vehicles will be fueled not only by other fossil fuels, but also by integrated solar power, regenerative braking, piezoelectric suspension, and the electric grid.

Specific manufacturing opportunities related to HEVs are: lithium-ion batteries, electric motors, power electronics, and lightweight advanced materials. Other related technologies in development include ultracapacitor and flywheel energy storage, and power units that incorporate fuel cells and gas turbines.

## Federal Incentives & Policies

### *Efficient Commercial Buildings Tax Deduction*

A corporate tax deduction for investments in commercial facilities is authorized in 26 USC § 179D. Depending on technology and expected energy savings, the credit value ranges between \$0.30 and \$1.80 per square foot. Modeling guidelines to determine savings were published in Feb. 2007 in report NREL/TP-550-40228.

### *Bonus Depreciation for Renewable Energy Equipment*

Authorized in Feb-2009 legislation under 26 USC § 168 and 26 USC § 48, a wide variety of renewable energy equipment is eligible for accelerated depreciation in the five-year property class. Also extended through the end of 2009 is the eligibility of selected systems to claim 50% bonus depreciation in the first year.

### *Tax Exemption for Energy Conservation Subsidies*

For both residential and corporate taxpayers, energy conservation subsidy payments made either directly or indirectly by public utilities are nontaxable income, according to IRS Code Section 136.

### *Investment Tax Credit for Business Energy Investment*

A corporate tax credit of 30% for solar, fuel cells and small wind; and 10% for geothermal, microturbines and CHP systems of limited size may be claimed for eligible systems placed in service prior to 2016. Taxpayers eligible for claiming this investment tax credit may opt, irreversibly, to receive a grant from the U.S. Treasury instead.

### *Tax Credit for Manufacturers of High-Efficiency Products*

Manufacturers of high-efficiency residential clothes washers, refrigerators, and dishwashers may be eligible to claim a tax credit for products produced during the

next few years, under 26 USC § 45M. The value and length of time credits may be claimed is determined for each product group based on the level of efficiency. Each manufacturer may claim a maximum of \$75 million under this provision.

### *Efficient Home Construction Tax Credit*

Producers of site-built homes and manufactured homes are eligible to claim a tax credit for up to \$2,000 per home depending on home type and efficiency level. Credits are claimed using IRS Form 8908: Energy Efficient Home Credit.

### *Production Tax Credit*

A corporate tax credit is available for the first 10 years of renewable electricity generation for facilities placed in service prior to the end of 2013 for most technologies and Dec. 2012 for wind. Geothermal, closed-loop biomass and wind are eligible to claim a credit of 2.1¢/kWh, and all other technologies are eligible to claim a credit of 1¢/kWh. Taxpayers eligible for the Production Tax Credit (26 USC § 45) may opt to claim either the federal business energy Investment Tax Credit or irrevocably select to receive a grant from the U.S. Treasury.

### *U.S. Treasury Renewable Energy Grants*

Taxpayers eligible for either the federal Investment Tax Credit or the Production Tax Credit may permanently opt to receive a grant from the U.S. Treasury valued at 30% of the installed cost for technologies including fuel cells, solar, and small wind; and 10% of the installed cost for all other technologies. Grants will be paid within 60 days of the application date for operating facilities, or within 60 days of the facility's placed-in-service date. More information is available from <http://www.treas.gov/recovery/>.

## *Advanced Energy Project Investment Tax Credit for Manufacturers*

An investment tax credit is available for investments that establish, re-equip or expand a manufacturing facility to produce renewable energy, energy efficiency and renewable fuel products and equipment. The credit is valued at 30% of the investment, and is subject to U.S. Treasury certification – after which the manufacturer must provide full documentation within one year and place the project in service within three years. The total allocation under the program is capped at \$2.3 billion, and the Department of Energy is required to develop specific program guidelines and the application process by the middle of Aug. 2009.

## *Advanced Technology Vehicle (ATV) Manufacturing Incentives*

Vehicle and component manufacturers may be eligible for direct loans of up to 30% of the cost of re-equipping, expanding or establishing manufacturing facilities used to produce technology for advanced vehicles, under Public Law 110-140, Section 136. The U.S. Department of Energy determines performance requirements.

## *Alternative Fuel Infrastructure Tax Credit*

50% of the cost of installing alternative fueling equipment, up to \$50,000, is available for fuel station owners through 2010 for most fuels and through 2015 for hydrogen fuel. Requirements and additional information are available from 26 USC § 30C.

## *Biodiesel Income Tax Credit*

Businesses users and retail sellers of 100% biodiesel, called B100, may be eligible for a nonrefundable income tax credit of \$1.00 per gallon, under 26 USC § 40A. A certificate certifying EPA registration from the fuel providers is required to claim the credit.

## State Incentives & Policies

### *Renewable Energy Tax Credit*

A tax credit equal to 35% of the installed cost may be claimed by individual or corporate taxpayers for the installation of selected technologies under N.C. Gen. Stat. § 105-129.15 et seq. Residential incentives are capped between \$1,400 and \$10,500 depending on the technology, and commercial installations are capped at \$2.5 million. The credit is available for a variety of technologies, and the amount claimed may not exceed half of taxpayer liability in any year. The credit is taken in five equal installments, and is considered taxable income for federal tax purposes.

### *North Carolina GreenPower Production Incentive*

North Carolina GreenPower provides a per-kWh payment that varies by technology to small renewable energy producers in the state. The program was established under NCUC Order, Docket No. E-100, Sub 90.

### *Energy Improvement Loan Program*

The North Carolina State Energy Office manages the Energy Improvement Loan Program, which provides loans of \$500,000 or less for the installation of renewable energy or energy efficiency equipment to for-profit, non-profit and governments in the state, under N.C. Gen. Stat. § 143-345.18. These subsidized loans are available for a maximum term of 10 years, and feature interest rates of 1% for renewables and 3% for efficiency projects.

# WHERE TO GO FOR MORE INFORMATION

## North Carolina Resources

NC State Energy Office | [www.energync.net](http://www.energync.net)  
NC Solar Center | [www.ncsc.ncsu.edu](http://www.ncsc.ncsu.edu)  
NC A&T CERT | [cert.ncat.edu](http://cert.ncat.edu)  
Appalachian State Energy Center | [www.energy.appstate.edu](http://www.energy.appstate.edu)  
Duke University School of the Environment | [www.nicholas.duke.edu](http://www.nicholas.duke.edu)  
UNC-Chapel Hill Institute for the Environment | [www.ie.unc.edu](http://www.ie.unc.edu)  
NC State Animal and Poultry Waste Management Center | [www.cals.ncsu.edu](http://www.cals.ncsu.edu)  
Central Carolina Community College, Biofuels Curriculum | [www.cccc.edu](http://www.cccc.edu)  
Cape Fear Community College | [energy.cfcc.edu](http://energy.cfcc.edu)  
NC Small Wind Initiative | [www.wind.appstate.edu](http://www.wind.appstate.edu)  
Triangle J Clean Cities Coalition | [www.trianglencleancities.org](http://www.trianglencleancities.org)  
Centralina Clean Fuels Coalition | [www.4cleanfuels.com](http://www.4cleanfuels.com)  
NC Biotechnology Center | [www.ncbiotech.org](http://www.ncbiotech.org)  
NC Green Power | [www.ncgreenpower.org](http://www.ncgreenpower.org)

## National Resources

US Dept. of Energy, Energy Efficiency & Renewable Energy | [www.eere.energy.gov](http://www.eere.energy.gov)  
National Renewable Energy Laboratory | [www.nrel.gov](http://www.nrel.gov)  
Renewable Energy Policy Project | [www.repp.org](http://www.repp.org)  
American Wind Energy Association | [www.awea.org](http://www.awea.org)  
Solar Energy Industries Association | [www.seia.org](http://www.seia.org)  
US Fuel Cell Council | [www.usfcc.com](http://www.usfcc.com)  
American Council for an Energy Efficient Economy | [www.aceee.org](http://www.aceee.org)  
National Biodiesel Board | [www.biodiesel.org](http://www.biodiesel.org)  
Renewable Fuels Association | [www.ethanolrfa.org](http://www.ethanolrfa.org)  
Chicago Climate Exchange | [www.chicagoclimatex.com](http://www.chicagoclimatex.com)

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