

Energy Innovations: The Race to Reduce Waste

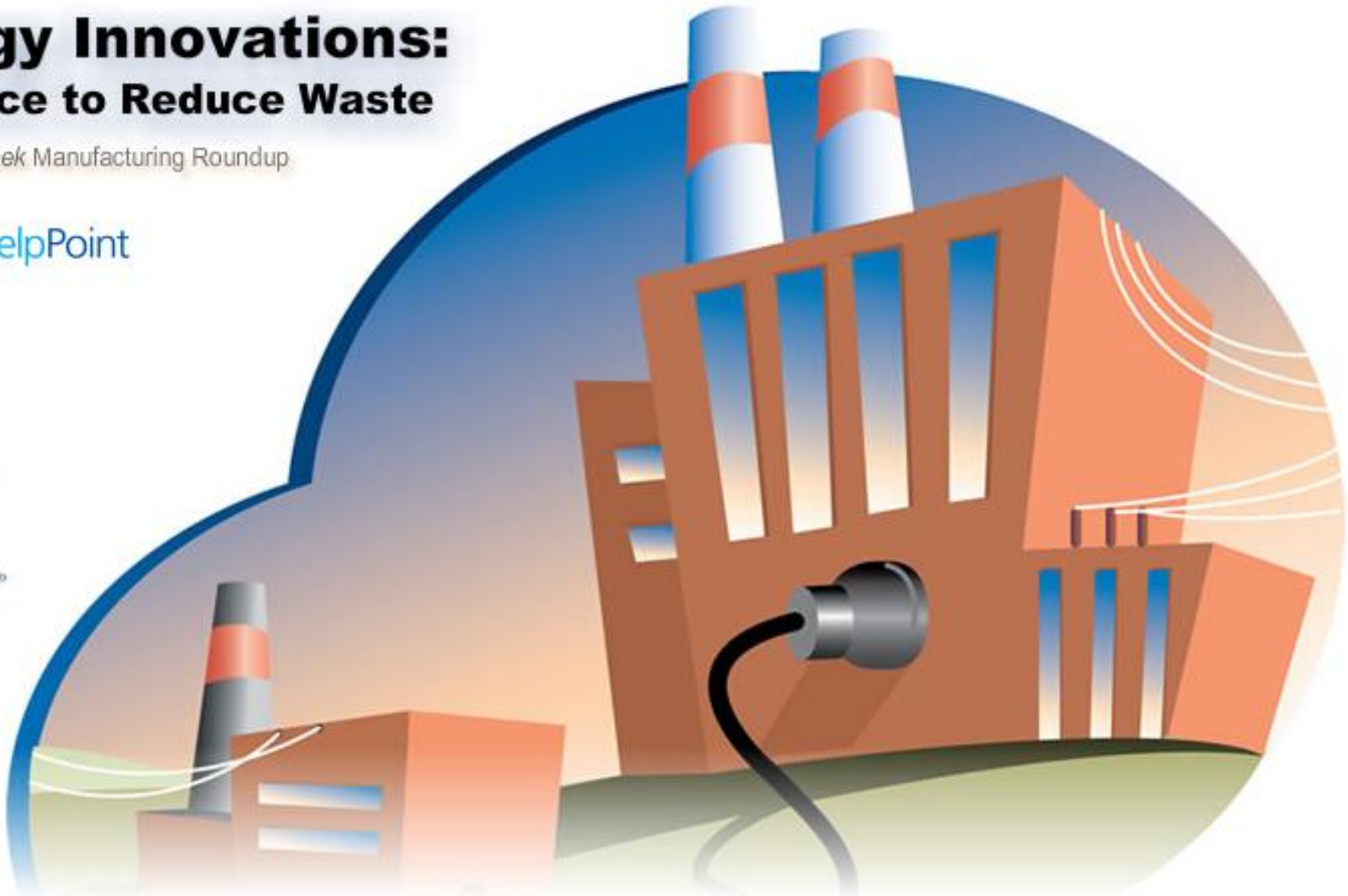
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How to Win the Energy Race

Overcoming risks to the supply chain will be key to energy and green initiatives.

By David Blanchard

What does it mean when the federal government announces a "voluntary" partnership with its suppliers to create a greener, more energy-efficient supply chain? Manufacturers are about to find out.

As part of the Obama administration's GreenGov initiative, the General Services Administration (GSA) has introduced a supply chain partnership and small-business pilot program aimed at promoting clean energy while cutting waste out of the federal supply chain. Key to the effort will be tracking reductions of greenhouse gas emissions.

According to Energy Secretary Steven Chu, the United States faces a Sputnik-like moment, only this time instead of a space race it'll be an energy race. "We are no longer leaders in manufacturing, but even more startling, we are no longer the leaders in high-technology manufacturing," Chu observes. The energy race, however, poses an opportunity for the United States to re-assert its innovation leadership, but only if we take action right away, he says.



GreenGov is just one of a number of supplier-qualification and scorecard programs that are based on measuring carbon footprints and resource use throughout a product's lifecycle, beginning with the sourcing of raw materials to the ultimate waste disposal by the end user. And it's got a lot of manufacturers confused about what exactly the ultimate endgame of all these initiatives and programs might be.

"Supply chain and environmental professionals share a common goal: to reduce waste," explains Steve Starbuck, Americas leader, climate change and sustainability services, with consulting firm Ernst & Young. "While these supplier programs could be seen as a burden, they are actually great opportunities to cut costs while reducing an organization's environmental footprint. The risks -- once identified and managed for an individual organization -- can help foster customer relationships and yield competitive advantages."

To help manufacturers manage their operations throughout these many and varied green initiatives, Ernst & Young has identified five climate-change and sustainability risks that



Energy Secretary Steven Chu: *"We are no longer leaders in manufacturing, but even more startling, we are no longer the leaders in high-technology manufacturing."*

companies should consider as they respond to demands to eliminate waste from their supply chains and to report on these initiatives:

- 1. Strategic.** The supply chain offers manufacturers an opportunity to improve their competitive advantage while reducing cost and waste. This will become increasingly important as stakeholders become more interested in social and environmental costs.
- 2. Compliance.** Manufacturing companies that are required to comply with green supplier programs also need to track data on energy use and make that information available for audits. For those OEMs that have green supplier programs of their own, they'll require processes to track and monitor supplier compliance.
- 3. Financial.** There are any number of ways supply chain operations impact a company's bottom line, from cash management to liquidity implications to due-diligence requirements for acquisition targets.
- 4. Reputational.** Supplier-qualification programs often are used to ensure companies are doing business with suppliers that share their values, minimizing the risk to their brands and reputations. To that end, companies are starting to conduct regular audits of suppliers, which includes compliance with emissions, waste and safety guidelines.
- 5. Operational.** From a supply chain operations standpoint, efficiency efforts run the gamut from spare-parts inventory management, manufacturing equipment utilization, reduction



in manufacturing waste, transportation, logistics and facilities management.

"As organizations across the public and private sector decrease their environmental footprints by focusing on supply chain operations, many find they need to influence operations that fall outside the direct control of a single business unit or enterprise," says Eric Olson, Ernst & Young's climate change and sustainability supply chain leader. "As a result, supply chain leaders need up-to-date sustainability information that meets the growing demand for transparency and accuracy from customers and suppliers alike. Many companies are already taking a full lifecycle approach to improve the environmental impact of their products and services."

Ernst & Young recommends that manufacturing and supply chain decision-makers focus on the following areas:

- Assess climate-change and sustainability reporting needs, including evaluating the integrity and alignment of data across the supply chain.
- Monitor and assess existing or potential government regulations on the entirety of the supply chain.
- Review the corporate risk register and risk-management policies for appropriate inclusion of climate-change and sustainability risks associated with the supply chain.



Energy's New Class of Innovators

Small- and medium-sized manufacturers are bringing innovation and value-added to the renewable markets. But will it pay off?

By Peter Alpern

Dowding Industries didn't need to witness the collapse of GM and Chrysler before deciding the time was right to exit the automotive sector. For more than a decade, the family-run manufacturer had witnessed the sinking of too many links within the auto supply chain.

As more and more small- and medium-sized manufacturers fell by the wayside, undermined by the narrow margins and inherent inefficiencies of the car business, Dowding saw potential in new areas, such as components for off-road vehicles, rail cars and wind turbines.

Determined to forge ahead into a green future, Dowding borrowed \$12 million to build a 38,000-square-foot state-of-the-art facility and furnished it with advanced new machinery to produce the necessary parts to fit a wind turbine. But within months of the grand opening, the Eaton Rapids, Mich.-based manufacturer was hit by something it could never have foreseen: the worst economic recession in 30 years.



It's a familiar storyline for many small- and medium-sized enterprises (SMEs) that have made the transition to the renewables market in recent years. As demand for wind blades plummeted two years ago, Dowding pieced together business by making parts for satellites, dump trucks and subway cars. Along the way, it had to cut its workforce by nearly half.

"We made that investment and it was an all-out push," says Jeff Metts, president of Dowding Industries. "It's a little scary sometimes, because we're still waiting for the market to get there. Looking back, I probably would have done things differently. But it's all going to work out in the long run."

The contraction of the automotive sector, combined with the promise of an emerging renewable energy market, has inspired a wave of SMEs to make bold, even risky, investments. Some, like Dowding Industries, leveraged their assets to transform themselves for a new industry. Others fell into green quite by accident. Over a dozen companies that spoke to **IndustryWeek** for this article cited the tantalizing opportunity of the renewable market, but also its inherent



A break press operator at Dowding Industries bends a part that will ultimately go into a wind turbine. Dowding Industries has invested heavily in repositioning itself for the wind industry.

uncertainty -- and the impact it has had on their businesses.

Unlike large OEMs, such as GE, Siemens and Vestas, which have vast sums of resources to cultivate a market and wait (sometimes years) for it to flourish, SMEs have more limited means. Surprisingly, that often works to their advantage.

According to Dan Radomski, managing director at Kinetik Partners, a clean energy consultancy group, smaller sized companies, because they are agile and can respond to the market quickly, play a critical role in the manufacturing development of the renewable industry, bringing innovation to production processes, tapping new materials and uncovering niche markets.

"To be successful in this, SMEs have to approach the market not only as a service provider, but also as an innovation provider," says Radomski. "They have to bring forth new ideas, new components, new technologies, new manufacturing methods and new machining methods."

Specification Changes

For all the enthusiasm the renewable market has generated, it is still one that is evolving at a rapid rate. Specifications of components, from their weight, to tolerances, are changing, while reliability has become an increasingly troublesome issue.



The wind industry, for example, is trying to address the quality of wind gearboxes and turbine blades. Experts in the field have reported that turbines need to operate efficiently for at least 15 years in order to be cost-competitive. However, wind operators are reporting system failures within six to 10 years.

The dependability issue has opened the door for smaller players offering innovative technologies. Take Danotek Motion Technologies, based out of Canton, Mich., which develops and manufactures permanent magnet generators, power control electronics and brushless motors for a variety of industries.

When Danotek was first founded in 2001 by three former GE engineers, its primary technological achievement was permanent magnet generators: a more efficient generator, with a higher power density, that replaced copper windings with powerful magnets.



An operator at Cardinal Fastener & Speciality heat treats a fastener, which will be used to hold together wind tower segments.

Danotek initially sold the technology to equipment manufacturers, specifically eyeing niche markets where weight and energy savings would be highly valued. The automotive sector, for electric and hybrid vehicles, is a core piece of business, along with cogeneration and industrial markets. But Danotek sees its growth in wind. Over the next five months, the company will begin producing a line of products specifically designed for the industry.

"It's a good fit because our technology can help benefit in a turbine's efficiency gain, weight and reliability," says Daniel Gizaw, chief technology officer at Danotek.

The problem, he says, is the industry is still profoundly behind the technological curve in recognizing how to produce a quality, efficient product at a reasonable price.

"Wind turbines largely use components that are not designed for wind turbines," says Gizaw. "You have variable speed wind: The speed is constantly changing. So you can't use a fixed-speed gear box or fixed-speed clutches and generators. By doing that, you're wasting a lot of energy and a lot of equipment."

Many OEMs, he says, were consumed with the euphoric march toward a green revolution and only now are learning that wind -- with its own unique demands and tolerances -- requires a deeper understanding of the engineering.

"There's so much learning and so many good ideas coming," says Gizaw. "The challenge for us is we want to be up and running as soon as possible. But those changes are affecting



our ability to start manufacturing quickly. Specifications as we speak change from customer to customer every six months. That's an extremely challenging situation to be in as a manufacturer."

Nuts and Bolts

John Grabner came to realize the significance of his company's push into the wind market when on a cold, dreary morning in early January 2009, he was informed that president-elect Barack Obama would be visiting Cardinal Fastener & Specialty.

Obama made a nationally publicized stopover at Grabner's facility just days before his inauguration, using the visit to highlight manufacturers who have reinvented themselves.

Cardinal Fastener is an intriguing case in point. For 26 years, the company had fashioned itself as a high-throughput producer of bolts for off-road equipment and machinery for heavy manufacturers. But three years ago, one of its fastener distributors in Iowa put in a fast-turnaround order for several dozen large bolts. When asked where it was going, Grabner learned it was headed to wind turbine OEM Clipper Windpower.

Grabner's curiosity was piqued. Over the next year, Cardinal Fastener repositioned itself for the wind sector -- an area few U.S. bolt manufacturers were addressing -- earning ISO 9001-2008 certification, while adopting a rigorous lean program.

The fasteners, which hold together wind tower segments and the nacelle on top, require special codings and hold strict dimensional, chemical and mechanical properties.

"One of the biggest differences about working with wind companies is that your calling card is who you are doing business with," says Grabner. "If I go to a Caterpillar and I tell them I'm doing business with Komatsu, they get upset with that. But if Vestas sees I'm doing business with Gamesa, they think that's great."

Last year, about 12% of Cardinal Fastener's total volume came from the wind sector. This year, that number is expected to soar to 50%, and with contracts coming in for the next 18 months, Grabner estimates 2011 will see it account for 70% of its business.

According to Grabner, almost all of his fasteners for wind will go toward domestic installations. With so much focus going into establishing the wind industry in the U.S. market, many of the largest foreign OEMs, such as Siemens and Vestas, are looking to establish local supply chains.

"Right now, there's already so much here," he says. "If you think that [OEMs] have been supplying this product from overseas facilities and they're only now just starting to bring that supply chain to the U.S., we've got enough for the next four or five years to really grow our business significantly. It's a huge opportunity."



Seeing the Light

Inspiration often begins with a question. For Dr. Osbert Cheung, it began by pondering the nature of glass. Why, he wondered, does the solar industry, which invests so much time and resources into cells, use such a heavy, ultra-fragile and inefficient material as glass for its panels?

Cheung launched SBM Solar in 2002, designing and manufacturing non-glass, rigid, crystalline silicon photovoltaic solar panels for commercial and residential buildings. Cheung's product weighs as much as 50% less than glass panels and can be designed for any shape, allowing it to be used in niche markets, such as marine, military, industrial and transportation-related applications.

But according to Cheung, the only way to make these panels cost-effective is through incorporating automation into the manufacturing process. To automate means investing heavy upfront dollars into capital equipment.

"For the last eight years, we've basically been an R&D shop," says Cheung. "Most of our machinery -- just about our whole process -- has been manual."

SBM Solar, based out of Concord, N.C., recently purchased a \$500,000 tabber stringer machine and will next be looking to complement it with an automated laminating machine and sun simulator for testing. But according to Cheung, capital



purchases of this nature have been extraordinarily difficult to pull off.

"That's something we didn't foresee," he says. "One of the things I assumed was we would get, at the very least, some government help. But I haven't seen this at all."

It's a familiar plight. Xunlight, a manufacturer of thin, flexible solar panels in Toledo, Ohio, is scaling up its production by investing \$25 million to build an automated front-end processing line using wide-web roll-to-roll processing. When completed, it will allow Xunlight to manufacture solar cells by the mile.

"The challenge we've had is we're competing against larger manufacturers, so it requires constant innovation to drive the cost down," says Xunming Deng, the founder and CEO of Xunlight. "We have limited cash and we have to build the production line. Unfortunately, those cost a tremendous amount of money. We have a rule around the offices here: We buy used furniture, but we buy new machines. Sometimes you have to save money on the other end so you can build the best production equipment."

The Element of Risk

It takes more than investment and capital for SMEs to be successful in the renewables market. Kinetik Partners' Radomski says one of the most vital points often overlooked by smaller companies is that it takes time and resources to cultivate a niche in the industry.



Familiar ways of doing business, such as looking at the blueprint for a component and providing a quote, aren't enough, says Radomski. SMEs have to be able to identify where inefficiencies are in the way OEMs are producing their products, and provide alternatives through innovations, production techniques or new materials.

"If you're going to approach these markets, whether it be wind, solar or advanced batteries, you need to take a careful look at what the value chain looks like, from raw materials to finished products," says Radomski. "You need to look at how products are manufactured, where it's done and through what processes. It's only then that you see the white spaces: where the high-margin items are and what kind of innovation that you can bring forward that's going to be dramatically different than competitors. If you truly want to make a difference and create a long-term business advantage, you're going to have to bring more than just your typical service."

Which is why Dowding Industries, for all the pain it has gone through, taking out millions of dollars in loans only to witness a harrowing economic contraction, still believes its investment will pay off.

Dowding has partnered with MAG Automation Systems to develop a machine tool that can dramatically reduce the cycle time it takes to machine hubs for the wind industry. What had previously taken a 36-hour cycle time has been reduced to five hours.



"I don't know if this whole investment will turn out to be right, wrong or what," says Metts. "It's a gamble. We won't know for five years if this idea worked or not. If it did, we're geniuses."



Is Green the New Gold?

Despite the recession, solar and wind energy markets continue to show compelling growth. Manufacturers have taken notice.

By Peter Alpern

Like many manufacturers in recent years, Hydro Aluminum expanded its repertoire beyond just the automotive, construction and consumer goods markets and made the leap into the green future. But Hydro Aluminum's foray had nothing to do with strategic planning, guts, shrewdness or foresight.

To be honest, says Allan Bennett, the company's vice president for solar market development, Hydro Aluminum landed in the clean tech sector quite by accident.

Back in 2005, the aluminum component producer had taken on a modest job building support structures for a gun range in California. Pleased with the work, the company Hydro Aluminum had partnered with, Gossamer Space Frames, suggested they help out on another project: building massive support structures for concentrated solar panels at a Nevada site.



Over the next several months, Hydro Aluminum began producing 40,000 pounds of aluminum components each day out of its Phoenix facility, building structures to house the panels for Nevada Solar One, the world's third-largest solar-energy field.

Soon, more project requests followed from destinations such as Florida, Colorado, Spain, the Middle East, India and Australia. Hydro Aluminum, like many other companies that have made the shift, has found the clean tech industry to be a highly lucrative portion of their business and among the strongest areas of their portfolio for long term growth.

That growth comes in large part due to subtle shifts taking place in the price for clean energy. In several regions of the U.S., particularly in the Southwest and along the Atlantic coast, the price per kilowatt hour for solar and wind power has trended downward to the point where they are increasingly competitive with natural gas. The government, meanwhile, has offered production and investment



Siemens has been an active developer in the area of concentrated solar power. According to experts, the market for solar thermal power plants will show double-digit annual growth until 2020.



incentives to spur renewable energy technologies in the U.S., creating a viable opportunity for manufacturers to produce an array of components needed to meet increased demand.

"There's a lot of growth and potential in these markets," says Bennett. "When you compare it with other markets, it's very different. So people are looking for new opportunities where they might leverage their technologies into another market. They want to diversify and this is one that has a lot of growth in it."

Natural Transition

Among its many product lines, United Technologies happens to be the world's largest manufacturer of elevators and air conditioners. So what would compel the diversified manufacturer to invest more than \$270 million for a 49% share in Clipper Windpower, a small California-based producer of wind turbines?

For starters, it's a logical transition.

According to United Technologies CEO Louis Chênevert, the shift into clean energy is helped because the wind turbines draw on many of the same technologies the company has long used in its jet engines and helicopters. "The skill set that we've developed over decades because of our base of businesses applies to wind turbines," says Chênevert. "It's a high-growth

segment and it allows us to leverage our expertise in blade technology, turbines and gearbox design."

United Technologies' approach follows similar footsteps other multinational corporations have taken, using financial might to acquire a smaller entity and thereby absorb their specialties and technologies in a new application. Siemens, for instance, made its first foray into the wind energy market in 2004 by acquiring Bonus Energy, which was at the time Denmark's second largest wind turbine manufacturer.

"It's not that easy to get started in the wind industry," says Jan Kjaersgaard, Siemens Energy's vice president and general manager for wind power in the Americas. "You see more companies trying. For Siemens, what we needed to figure out was whether we wanted to start in wind from scratch or just buy a company with a strong technology to get a head start."

Since Siemens entered the wind market in 2004, the company has become one of the largest players in the sector with roughly 7% of the market. That number pales next to rivals such as GE Energy and Vestas, which control approximately 18% and 19% market shares, respectively. But Siemens has focused much of its investment in the Americas, citing its fertility for growth.

The company anticipates that over the next 20 years the percentage of global power generation arising from renewable sources will grow from less than 5% now to about 17% by 2030. And nearly half of that, Siemens says, will come from wind power.



Extra Incentive

Like many manufacturers in the clean tech sector, Merrill Technology Group has expanded its production for the alternative energy market with the help of government funding.

Once entirely focused on the automotive industry, the Saginaw, Mich.-based manufacturer does machining of components for small and large wind turbines, along with the development of solar energy process equipment, including fabrication, machining and complex assembly of vacuum chambers.

Merrill Technology Group earlier this year received \$22 million in tax credits as part of the American Recovery and Reinvestment Act and is investing \$73 million in advanced manufacturing equipment to support the production of nacelles for a series of new utility-scale wind turbines.



The American wind power industry grew at a blistering pace in 2009, adding 39% more capacity. Above, a facility manufactures blades for Vestas wind turbines.



The 2009 economic stimulus package created two key programs, the clean energy manufacturing tax credit and Section 1603, which allows grants for renewable projects. According to Senator Jeff Bingaman, D-N.M., chairman of the committee on energy and natural resources, these programs were instrumental to spurring the solar and wind industry's growth.

"These credits for the first time [creates incentives for] companies to manufacture clean energy technologies in the United States by allowing them to write off 30% of the cost of creating, expanding or re-equipping their facilities," says Bingaman.

The clean energy manufacturing tax credit was funded at \$2.3 billion last year and was exhausted within a matter of months, but it leveraged nearly \$7.7 billion for 183 cleantech manufacturing projects in 43 states.

"That's a powerful demonstration of the potential for clean energy manufacturing in our country," says Bingaman. "I've proposed expanding this credit and President Obama has endorsed this expansion, calling for an additional \$5 billion for the 2011 budget."

Is it Sustainable?

The question, then, is whether government funding is establishing an expensive, passing fad or whether cleantech has shifted from the idealistic to a truly lucrative opportunity for U.S. industry.



Despite a recession and crippling credit markets, the cleantech industry enjoyed banner years in 2008 and 2009. The American wind power industry, for instance, grew at a blistering pace in 2009, adding 39% more capacity. Much of that growth was helped last year by government grants, which helped circumvent a banking sector that had frozen tax equity lending. Today, the U.S. is close to the point where 2% of its electricity will come from wind turbines. While that is still a miniscule share, it is up from virtually nothing just a few years ago. Similarly, the U.S. solar power industry saw substantial gains, with the nation's generating capacity growing by 37% in 2009, pushing through the 2,000MW barrier for total output.

But perhaps the best signal comes from simply following the money. More than \$5.6 billion in venture-capital investment went to clean-tech firms -- including solar, wind, energy efficiency, transportation and biofuels -- last year, according to data from market researcher Cleantech Group and accounting firm Deloitte.

"The industry is transitioning and the cost curve is coming down," says Brian Anderson, chief executive at Amonix, a solar technology firm based in Southern California. "Solar, for instance, has gone from being a subsidized industry that faced significant economic obstacles of cost to one that's now an attractive purchase on its own." Proof of that was seen earlier this year when Amonix landed one of the biggest green technology deals of 2010. Silicon Valley venture capital firm Kleiner Perkins Caufield & Byers made a \$129.4 million



investment in Amonix, which produces concentrated photovoltaic power systems -- essentially gigantic solar panels that have a plastic lens which focuses the sun on tiny but highly efficient solar cells to generate more electricity than conventional photovoltaic panels.

To build this product, Amonix, like other large-scale solar providers, tap into a supply chain based around the locale of the solar field. To hold the panels, metal structures are necessary in volume, in complicated shapes, with exacting tolerances for correct alignment and assembly. Both aluminum and steel manufacturers, such as Hydro Aluminum, have taken advantage.



A worker examines a completed hub for Vestas wind turbines. The U.S. currently gets only 2% of its electricity from wind, just a miniscule share, but up from virtually nothing just a few years ago.

Hydro Aluminum's energy division has specialized in producing frames composed of 45 different parts, each requiring heavy amounts of fabrication. What the company didn't anticipate, says Bennett, Hydro Aluminum's vice president for solar market development, was the challenge of producing at such a large scale in a short span of time.

"If we're looking at 7.5 million pounds for an eight or nine month period, there's a ramp-up at the beginning and some



very intense activity," says Bennett. "If you're coordinating this much metal, it means getting it all to the site in proper order, machined and manufactured correctly, and labeling all the parts so they can be assembled properly. It goes from extremely intense to a dramatic fall-off, then very intense again with new projects coming in."

A Question of Scale

Back in its heyday, the auto industry was producing about 17 million cars a year. Last year, the wind industry produced and assembled about 5,600 utility-scale turbines. For all the enthusiasm garnered by the cleantech market, it won't ever come close to sustaining U.S. manufacturing the way the auto industry did in generations past.

But that doesn't take away from the inherent opportunity, says Matthew Kaplan, a senior analyst for Emerging Energy Research.

"The wind industry, for example, has been scaling very, very rapidly and this growth isn't just for project developers, but also for the wind project supply chains," says Kaplan. "So you have OEMS, such as GE, Siemens, Mitsubishi and Exelon, to the suppliers of blades, towers and gear boxes. They've all had to scale their domestic manufacturing capabilities to keep up with the rapid rate of growth in the industry."



Northern Power Systems has been producing equipment for the wind industry for nearly three decades. Last year, the company manufactured just under 100 utility-scale wind turbines. But with orders slated to far surpass that number in 2010, the company hired Taylor Robinson to adopt many of the quality and supplier integration systems other industries have utilized.

Robinson says he hears the automotive comparison frequently against cleantech but says it inherently misses the point. A more appropriate comparison, he says, is to the aerospace sector.

"You're talking much lower volume, but very, very robust designs," he says. "It requires highly sophisticated manufacturing systems -- and that's something we have in the United States. Look, automotive margins are extremely tough to find, no matter what you do. But with its growth and potential, a lot of manufacturers see the wind and solar markets as a winner."



Photo courtesy of Northern Power Systems
A finished wind generator is placed on a crane by turbine manufacturer North Power Systems. The company has begun adopting quality and supplier integration systems from other industries.

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