Transporting one of the Vestas V112 turbine blades up to the Kingdom Community Wind Farm took careful planning to navigate the steep terrain and switchback roads.

CASE STUDY

AUTOTURN

Getting To the Mountain Top Just Got Easier

Wind energy companies are turning to technology for modeling sharp turns and complex geometry on projects across North America

By Chris Johns, Transoft Solutions

The sight of a 54-meter wind turbine blade is impressive. It's safe to say they stop traffic, literally and figuratively. Even for the wind energy companies that build the turbines and towers and for the transportation companies that move them across the continent, their sheer size does present some challenges.

Wind energy equipment is massive in scale, and it continues getting bigger. Project developers and their consultants have to turn to technology to model the vehicle swept paths and demonstrate safe clearances to freeway overpasses, roadside signs, light standards, and site access roads along their proposed routes. According to Alex Lockard P.E, civil engineer at Vestas American Wind Technology Inc., there are two pieces of equipment they worry about most.

"We have three main loads in the wind energy industry: the blades, the tower sections and the nacelle," said Lockard. "People don't generally model the hub and nacelle, but the blade and the tower sections govern the roadway design. We know that the tip of the blade overhangs quite far at the back end of the trailer. It swings way out as you go through tight radius turns, and it can hit all kinds of things like light poles, utility poles, trees, and structures. All these things have to be checked."

Trucking companies like Lone Star Transportation are responsible for obtaining permits from the local Departments of Transportation when moving large loads across state lines. Sometimes, additional permits are required to use county or municipal district roads. The governing bodies want to know if there are any hazards or dangers in moving the load through their jurisdiction. Trucking companies complete an initial transport survey, which is a run-through of the road way to identify what objects might be a problem.

"I wouldn't say specialized transport is getting more complex," said Brandon Brown, a senior project manager for Lone Star Transportation. "I've been doing it 17 years, and it really isn't that much different than it was back then. Wind energy is a whole different segment of specialized transport as far as the volumes and the site roads go. In the wind energy sector, you could definitely say that the components are getting bigger."

In 2012, Vestas and Lone Star Transportation teamed up on wind farm projects in Vermont and New York. A wind farm project in Lowell, Vermont called Kingdom Community, consisted of 21 turbines on a ridgeline of the Lowell Mountain Range. Working together with Vermont Electric Co-op and Green Mountain Power, Vestas supplied the blades and towers for the project. However, getting the equipment to the top of the mountain was an engineering challenge.

"One of the constraints we had was the 1 ½ mile road we had to travel up to the ridgeline," said Charles Pughe, project manager for Green Mountain Power (GMP) on the Kingdom Community wind energy project. "It was very steep, sometimes up in the 15 percent range, so we had traction issues in trying to get the equipment up to the site. The tower sections and nacelles were towed when they went up the hill."

Pughe continued, "We had an articulated tractor towing the prime movers going up the mountain. Most of the tower sections were on non-steerable low-boys. One of the tricks was to figure out

what the turns were going to be like. When the tractor was pulling the prime mover through the corners, the trailer wasn't tracking directly. It's like being on water skis – when the boat is pulling you, you don't ski directly behind it. The tractor was taking the corner a little wider than the truck, and it was difficult to figure that out ahead of time as the pitch of the roadway affected how far out in the corner the tractor would end up."

As we've seen, there are the clients like Green Mountain Power that own the wind farms and companies like Vestas Wind Energy that build the towers, turbines, and blades. Completing the triangle are the trucking companies like Lone Star Transportation that move the components across the country and sometimes right to the wind farms themselves. Brown has been working on specialized transport for years and he says that wind energy projects don't faze his drivers anymore.

"The Kingdom Community Project was similar to any other (wind) farm project," said Brown. "(Companies) don't want to spend money on roads and build them to what you need, so you have to make things happen in a field setting. That's a common issue in the wind industry-site roads. It's a huge cost, so the less they build, the more money they can make. It increases the likelihood they can make a project happen."

He continued, "In those cases, you rely on experience and because we have done so many (wind farm projects), our guys in the field know what they need. There are road specifications detailed into the contract that we had input previously, so we know what is required to deliver the turbines to their final destination."

Several months prior to moving the blades and tower sections, in February 2012, Vestas and Lone Star worked together with Transoft Solutions to perform a number of vehicle tests in a Vestas works yard in Brighton, Colorado. The Vestas project team wanted to know how the wind energy equipment would move when making specific turns. A driving course was built to replicate the critical roadway geometry of the planned access road for the complex terrain required in the Kingdom Community project. GPS coordinates from key points on the truck, trailer and loaded blade were recorded. Using AutoTURN from Transoft Solutions and AutoCAD software, the swept path of the simulated vehicle matched the swept path of the field test vehicle accurately, with variances consistently less than 30 centimeters.

"We took some of the geometry from the Kingdom Community Wind site access road designs," said Lockard. "I asked the customer on that project 'What curves are you most concerned about not being able to make?' The reason the geometry was so critical for this project is that they had a ridge top, mountain-side project. They were going to have to blast rock out of the way to construct the roads. Every square inch mattered to them and to us from a sustainability standpoint," Lockard continued.

"Ultimately, the software worked great. We made virtually no modifications to the road going up the hill based on our modeling of it, except filling in some ditches and giving ourselves some extra room in the corners by cutting down a tree or two."

Charles Pughe, project manager, Green Mountain Power

"Our biggest concern was getting the blades up (to the site), because they were 180 feet long," said Pughe. "We had a lot of switchback-type roads constructed to gain the elevation because we were trying to stay within a relatively small corridor."

"For the Kingdom project, GMP did upsize the turbines in the spring of 2011, after the civil engineering and associated permit applications were complete," said Pughe. "We used AutoTURN to verify that the roads would still work for the blades and the tower sections. One issue with doing this was that the blade trailer to transport the V112 blades hadn't actually been built yet. That is why it was so critical to have VESTAS do the mockup in Brighton once an actual trailer was available."

The Colorado field test served several purposes: It helped Vestas show Green Mountain Power that the road geometry would work, the test validated AutoTURN's reputation as accurate modeling software and it also helped Lockard gain some peace-of-mind that the blades would not get damaged on the way up the steep and twisting roads.

"At the time, Marble River and Kingdom were our first North American V112 projects, so we had not transported V112 blades

The exact location of the towers is determined after careful calculation of a number of factors. Coordinating the safe transportation of the turbines and towers and their placement at the site are key tasks for Vestas, Lone Star and Green Mountain Power.

The turbines required for the Kingdom Community wind farm actually stopped traffic briefly on their way to their final destination. The trucks needed both lanes of a two-lane highway to allow for the wide turns at some of the intersections.

Companies like Green Mountain Power use AutoTURN to plan exact routes with the large wind farm components, reducing costs for blasting and excavating bedrock.

before," said Lockard. "That was why we set up that exercise in Brighton, because we needed to answer that question for ourselves."

"Ultimately, the software worked great," said Pughe. "We made virtually no modifications to the road going up the hill based on our modeling of it, except filling in some ditches and giving ourselves some extra room in the corners by cutting down a tree or two. We did that just to be safe and we didn't want to find out after we bumped a blade into a tree."

The Marble River wind energy project in Clinton County, New York was also a successful collaboration for EDP Renewables, Vestas and Lone Star Transportation. Plans called for 70 Vestas V112 3-megawatt wind turbines to be installed across two upstate New York towns (16 in the Town of Ellenburg and 54 in the Town of Clinton). The 492 foot wind towers are the largest ever approved in the state of New York. The wind farm, which became operational in November 2012, is capable of producing up to 216 megawatts of power.

Just before the construction phase of the project was about to start, EDP Renewables decided to change the size of turbines to maximize the amount of energy the wind farm could generate. Before they could finalize the deal, EDP Renewables and Vestas had to make sure the larger blades could still make it through all the roadway's curves. Vestas turned to AutoTURN to answer the key questions.

Transoft engineers offered their expertise and helped Vestas with analysis of some of the key road geometry. "It was critical to us in the sales phase of that project," said Lockard. "I was being asked 'Will the geometry work?' The project was designed not for Vestas turbines but a competitor turbine with different length blades and different diameter tower sections. The client had done the original civil engineering work for a different turbine, different manufacturer, different length, different everything. It was a good win for us and my role was to make sure we could do it safely."

For Pughe, return on investment was an important consideration. If it was possible to transport the bigger turbines up to the site, he felt it would pay off in the long-term.

"We were looking to maximize the size and generating capacity of the wind turbines on the site," said Pughe. "One of the reasons we went with the Vestas V112s which had the extra big blade was we found that would be the highest yield for our footprint of construction. We would get the most energy out of them. We ended up choosing the biggest machines that were available to us at the time, knowing that it would be difficult construction to get it up there. We felt it would be worth it in the end because (the site) would yield greater energy output for the amount of construction we had to do."

There were considerable time constraints to look at all the variables on the Marble River project. Using AutoTURN, together Vestas and Transoft evaluated close to 50 intersections along with the site roads for clearance issues. Over a three-to-four week period, they collaborated to deliver the information that Lockard and his team needed to move the project forward.

The field work and research Transoft Solutions has done over the past two years with special transport stakeholders puts the company in a unique position in the transportation engineering arena. Part of the work involves getting the different groups to start speaking the same language when it comes to the challenges they face. Steven Chan, Transoft's Director of Product Management, believes that projects like Kingdom Community and Marble River show that Transoft is a reliable partner in the wind energy world.

"The turbines and blades coming from companies like Vestas present unique engineering challenges and vehicle swept path software plays an important role in solving them," said Chan. "In working with these groups, we learn how the software works in the field and the upgrades we make directly impact the civil engineering work that is done. There's lots of collaboration ahead and we're pleased that companies like Vestas, Lone Star, and Green Mountain Power have used AutoTURN successfully in their projects." ■

Photo Credit: Green Mountain Power

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