

Virtual Design and Construction  
for Renewable Energy



The foundation  
for better building

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For more information about our VDC services,  
please call **763-287-3536** or visit our website at  
**<http://www.mortenson.com/VDC.aspx>**



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*Incorporated in Minneapolis, Minnesota in 1954, Mortenson Construction is a privately-held, diversified construction company, offering services in general contracting, construction management, program management, design build, and more, across multiple industries in 48 states and international locations. With revenues surpassing \$2.4 billion, Mortenson is recognized as the 19th largest construction firm in the United States and the 10th in power construction, according to Engineering News Record (ENR) 2011 rankings.*

*As a leading contractor in the industry, Mortenson was the pioneer in the application of Virtual Design Technology (VDC) in the construction field, utilizing it in all phases, from preconstruction through operations and maintenance. By employing VDC technology, we are able to plan, estimate, communicate and construct our work in a manner that minimizes obstacles and optimizes productivity—and budgets. This integrated construction modeling adds many benefits for our customers. At Mortenson, we perform VDC for one reason only: to reduce the time and cost of design and construction.*

*Over the years, Mortenson has continued to gain recognition for its leadership position in VDC technology and, more recently for its applications within the renewable energy sector. In 2012, Mortenson was awarded the prestigious, international “Be Inspired Award” for Innovation in Land development, Engineering and Management.*

*Today, Mortenson remains committed to providing our customers with the many unique benefits that VDC technology provides.*

MORTENSON CONSTRUCTION | *Building what's next*

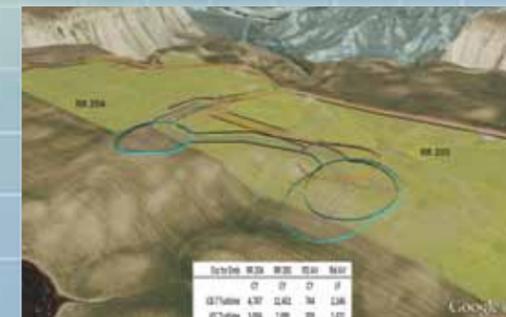


## Bringing technology and renewable expertise together

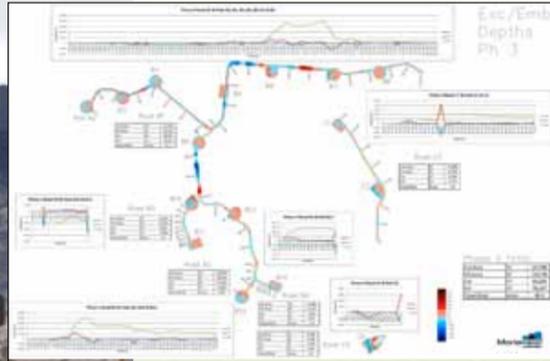
Virtual design and construction processes span the lifecycle of any project, from concept to operations and maintenance. As part of our goal to reduce the time and cost of design and construction, Mortenson leverages our expertise in virtual design and construction to deliver:

- Increased communication
- Increased efficiency
- Increased collaboration
- Lower cost
- Increased planning
- Shorter schedules

Our award winning VDC services enable a new level of transparency in the renewable industry which allows us to work in a collaborative framework to conduct more accurate constructability analyses, improve estimating, maintain greater schedule and cost control while continually improving safety, quality and efficiency. We are able to more effectively interact with our designers, consultants, subcontractors and customers with the tools and processes experienced through VDC.



## Civil construction expertise



Most renewable energy projects have a civil construction element that can be quite sizable, especially in areas of complicated terrain. By modeling the roads and sites, the earthwork component of the project can be properly accounted for with budget and equipment needs. Due to the tendency for most renewable energy projects to be located in a rural setting, roads are not always available to accommodate the size of

construction equipment and delivery vehicles that will need to make their way to or through the project. Looking ahead at this need will significantly reduce project delays. Also, the VDC model can be remotely exported to field equipment for machine-controlled grading via GPS that reduces time and unnecessary survey work.

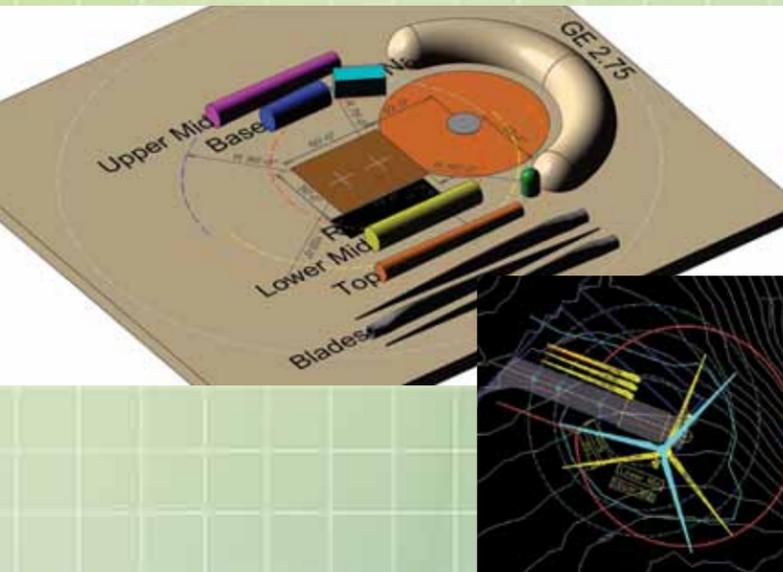
## Minimizing land impact

By designing each stage of the construction process in a workflow model, total disturbance areas are calculated. Typically, this area can be greatly reduced through accurate planning. All components of the work process need to be included including construction cranes, trucks and even employee vehicles. What was once an estimation of the acreage that should be cleared for construction is now a precise, environmentally-conscious, engineered model that eliminates unnecessary project construction limits.



## VDC technology is used to identify and solve project challenges upfront to reduce the time and cost of construction

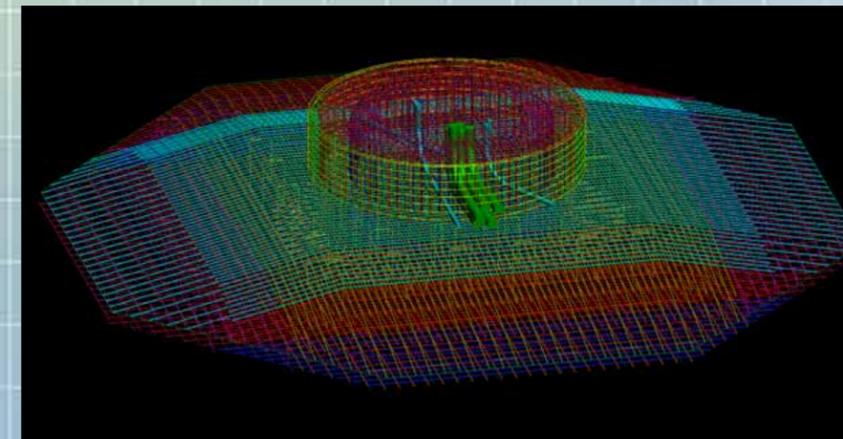
### Site logistics optimization



VDC can have a great impact on site logistics planning. During the design and construction phase, potential spatial conflicts may arise between project components that are not easy to identify or predict using 2D layouts. The model identifies various issues related to space, schedule and sequencing, and resolves them ahead of the construction process. On a wind farm project, turbine parts deliveries can be complicated due to the number of large pieces being delivered and also the expanse that is required for storage. By modeling the different components to include the location in which they are placed at delivery and the order in which they arrive on site, the optimal plan is achieved and the confidence that deliveries will go smoothly is created. Also, the VDC model verifies the size of area that needs to be created to accommodate these parts.

### Virtual coordination and prevention

Clash Detection methods are used to eliminate conflicts that may occur during construction. Using the 3D model, construction items such as rebar, electrical conduit, and existing public utilities are analyzed to understand and resolve potential conflicts. Once an in-field coordination item, a plan is created to mitigate conflicts prior to the construction process which eliminates schedule delays. The plan is used in daily Plan of the Day meetings to ensure that all construction personnel are aware of the conflicts they may encounter that day.



## WIND FARM PROJECT - NAME CONFIDENTIAL Canada

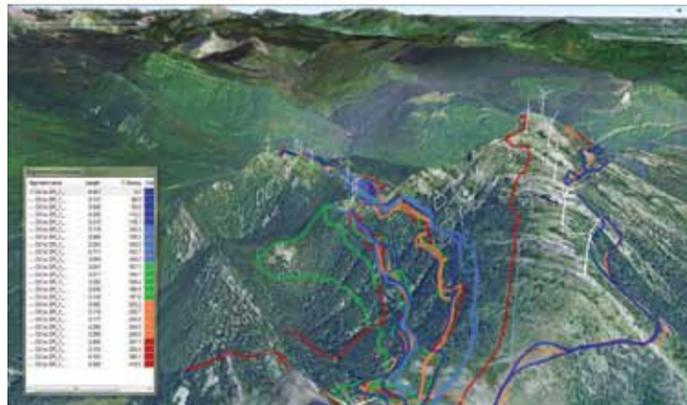
### Challenge:

Reduce the lengths of access roads on site to create a fiscally viable project.

### Solution:

Alternative analysis models were created to optimize all access roads on site. Grades, widths, and locations for each road were evaluated to achieve the best possible solution which in turn reduced the amount of overall road length by 25%. The process of creating the alternative analysis model allowed the team to connect adjacent ridge lines access roads that were not previously connected by traditional design practices. These connections significantly reduced the overall road footprint.

*Reduced overall road length by 5000m – a 13% reduction*



## BOBCAT BLUFF WIND PROJECT – ENXCO – 100 Turbines Archer City, Texas

### Challenge:

Turbine parts deliveries occurred ahead of schedule—before foundations were completed.

### Solution:

A plan for parts laydowns was developed at all turbine sites, including modeling the parts laydowns and the order in which they arrived on site to ensure deliveries would go smoothly. Adhering to the laydown plan allowed the project team to unload once and keep parts in place until erection.

*Optimized parts laydowns*



## RIM ROCK WIND PROJECT – NATURENER – 126 Turbines Kevin, Montana

### Challenge:

Mitigate the impact of a substantial change in the alignment of roads and turbines due to environmental impacts.

### Solution:

Mortenson created a 3D civil model to better understand the magnitude of the changes and continued to work without significant delay to the schedule. The project team used the model to optimize earthwork and grades of roads, crane pads and erection areas and to minimize overall project impact.

*Significantly reduced schedule delays*



## MINONK WIND PROJECT – GAMESA – 100 Turbines Minonk, Texas

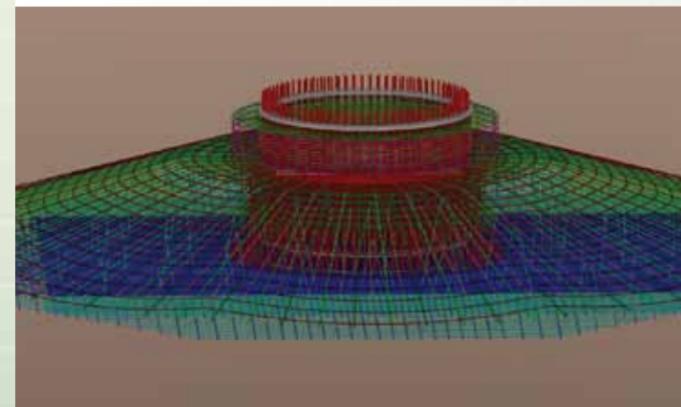
### Challenge:

Eliminate rebar and electrical conduit conflicts in the foundations.

### Solution:

A 3D model of the foundation rebar was created and electrical conduit was added to check for clashes. Conflicts were resolved prior to construction process.

*Mitigated field modifications*



## SENATE WIND FARM PROJECT – GAMESA – 75 Turbines Graham, Texas

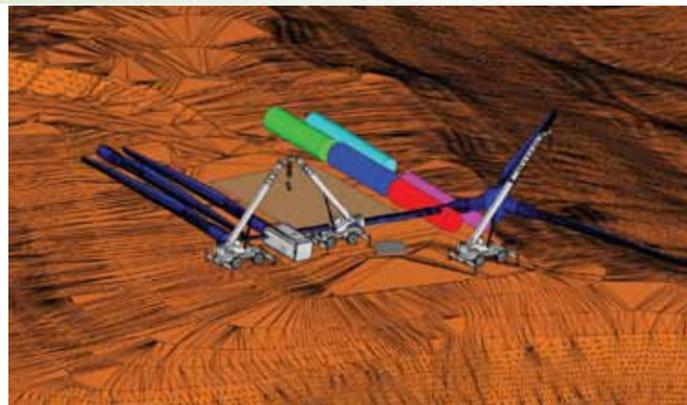
### Challenge:

17 turbine sites were identified as having constricted turnaround areas for deliveries. 33 turbine sites were identified as having challenging laydown and erection areas.

### Solution:

Each site had an individual 3D model created to ensure sufficient space. Sites were optimized based on the model. Delivery routes were analyzed and sites and roads were graded to ensure proper radii and turnaround areas. One of the reasons that Mortenson was selected for this project was the use of VDC to prove understanding of the project and on these sites in particular.

*Increased communication through visual planning*



## SPRING VALLEY WIND PROJECT – PATTERN ENERGY – 66 Turbines Ely, Nevada

### Challenge:

Reduce the impact on 7600 acres of environmentally-sensitive land managed by the Bureau of Land Management.

### Solution:

3D modeling saved 1/3 of the original turbine area from being disturbed by preplanning the turbine site area. VDC was used to model each stage of construction to optimize the layout of turbine parts and equipment. Reducing the project footprint minimized the cultural, historical, and biological impact. This project was the winner of the 2012 Bentley BE Inspired Award for Innovation in Land Development, Engineering, and Management.

*Achieved 77 acre reduction in total land impact – a 40% savings*



Be Inspired