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Geographic Information System Technology for Small Wind Energy Operations

Once the domain of highly trained technical specialists, GIS has finally come down to earth and wind energy companies of every size and scope are realizing its benefits.

A simple definition of a geographic information system, or GIS, states that it is a method for studying data in its geographical context that typically includes computer hardware and software, which are used to display or process relevant data into layers. These overlaid layers of information expose patterns and relationships within the data that might otherwise go unnoticed.

GIS technology is ideally suited for the business of wind energy utilization and management because virtually all of the relevant data is geographically based. For every stage of the development of a wind energy project, from initial site determination to output analysis, a well-organized GIS is an indispensable tool. It can provide timely information, steer the decision-making process, and, ultimately, save money.

The use of a well-organized GIS can help you determine the optimal location for a wind farm project by incorporating such data layers as wind resources, terrain, property ownership, existing electric transmission lines, access roads, surface and subsurface geology, environmentally sensitive areas, avian migration routes, and much more. With all of this data concurrently influencing site selection process, it is difficult to imagine managing a project without the aid of a GIS.

For an organization considering the development of a GIS, a few factors must be considered before the decision is made to proceed. First and, perhaps, foremost, it is wise to compile a list of requirements that outline the functions you expect your GIS to fulfill. This list might include locating suitable project sites, gauging environmental impact, and identifying adjacent property owners. Next, you should consider what level of GIS is appropriate. Do you anticipate applying complex spatial analysis techniques or are you simply looking for a data visualization tool? Then you should ascertain how much your budget can afford. Can you justify hiring a dedicated staff member to manage your GIS or will you delegate a member of your current staff to oversee its implementation and management? You will also need to determine who will have access to the data and in what form. And so on.

Unfortunately, many would-be GIS adopters neglect this initial self-assessment process and jump headlong into purchasing the first GIS software that grabs their attention, only to be disappointed when their chosen solution fails to yield the expected results or is much too complicated for their needs. A wrong decision can be a frustrating, time-consuming, and expensive mistake. For GIS novices, there are numerous inexpensive alternatives to more established names in the GIS industry that usually provide an appropriate level of functionality. As well as comparing products based on a list of features and functions, it is a good idea to ask each provider about the availability of support and/or training on the use of the product, if the software will run on your existing computers, and about other wind energy companies that are using the product in question.

One of the most common questions posed by GIS novices is, “Where do I begin?” You have learned what a GIS can do for your business; you have studied all of the product literature; you have made your product selection; and you may even have perused the user guide for your chosen software, but that nagging question still reverberates, “What next?”

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For convenience, the implementation of a GIS can be broken into three stages. The first stage, quite simply, is to determine the source or sources of your data. The second stage is to process your data in such a way as to expose and utilize its geographical characteristics. The third stage, often overlooked, is to develop a procedure for sharing your data or making it available to your target audience.

GIS Implementation Stage One – Data Sources

A fully functional GIS offers mechanisms for incorporating or converting data from a wide variety of sources and in many different formats. Some data types will already be in a format that your GIS software supports while others will require a little work on your part.

A solid foundation for any wind energy project is a suitable base map, preferably one that shows topography. The provider off your GIS software can often offer such a dataset. Recent aerial or satellite imagery adds further value by affording a level of accuracy for points or locations that a conventional map cannot match.

With the proliferation of GIS over the last decade, many agencies and organizations have created vast archives of data, much of which is readily accessible to GIS users. An online search might reveal downloadable data relevant to your project, such as wind potential, property parcels, or protected areas. Usually, incorporating this data into your GIS is as simple as following the import steps, which result in the points, lines, or polygons appearing as a layer on the map and as a collection of records in your database.

A more challenging process is to integrate data from a non-GIS source, such as a spreadsheet listing the names and addresses of the property owners near your planned development. Creating a GIS layer from this data and thereby assigning each object to the correct location on the map involves a process called geocoding, in which each address is matched to a street name and house number contained in the base map layer.

Paper maps present an additional challenge for the development of a wind energy GIS. A surprisingly large percentage of relevant spatial data is available in print form only, especially in more remote areas. Converting hard copy map prints into usable GIS layers usually involves scanning the map into a digital image format and registering the image by tagging specific points with known coordinates. This procedure creates a raster layer, which in GIS terms is a geographically referenced image. If needed, you can use point, line, or polygon tools to trace the relevant data from the imported map, creating individual records in a GIS database. This procedure creates a vector layer from which you can assign unique attributes to each object on the map.

While much of the GIS data that you use to plan and manage a wind energy project is already available, the most important data layers are created as the project evolves. You can generate layers onsite from GPS observations that show specific turbine sites, planned access roads, and other infrastructure features or derive them from analysis of existing layers or aerial imagery. Geometric and attribute editing tools in the GIS software make the process of creating these and other layers as simple as drawing with your computer's mouse.

GIS Implementation Stage Two – Data Processing

In GIS, displaying an object on the screen is only half of the story. Embedded in each object is a potential wealth of data which, when effectively managed, can convey much more than location.

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As a starting point, processing your GIS data might entail simply customizing its appearance in such a way as to distinguish it from other data types. A layer that contains transmission lines might appear as dashed red lines while a layer showing property boundaries might be assigned a yellow color. With this simple step, you immediately start to see your data in a more organized way.

Within each layer, you can adjust the appearance of objects to reflect a particular attribute or characteristic. For example, you can shade wind resource polygons using a sequential color pattern to show areas with the lowest to highest average wind velocity. This process is referred to as classification, which involves grouping objects in a layer based on a common value or range or values.

Another method for focusing on a particular element of your data is through querying. You can create queries that isolate objects within a layer based on attribute or geographic characteristics or both. For example, you can conduct a query on a property layer to determine which properties are defined as residential, and then apply a further query to create a list of those residential properties that are within a certain distance of your turbine sites.

GIS Implementation Stage Three – Data Sharing

Ultimately, a GIS is a communication tool. Data that has been imported and processed is, more often than not, presented in a particular fashion to a target audience. This audience might be your colleagues, customers, clients, or the community. Although this aspect of GIS development is often relegated to an afterthought, it merits attention at every stage of the process. Knowing that your data will eventually be accessed by others, you should strive to ensure that it is well structured, efficiently organized, and clearly presented.

In many cases, sharing GIS data necessitates little more than printing a map containing the relevant layers. Printed maps are often used for community outreach or wind farm project presentations. Another method for data exchange is interoperable file transfer within or between organizations or companies. Some GIS software titles have automated the process of facilitating the distribution of digital data by using advanced database administration tools. In other cases, simply exporting and e-mailing a file achieves the same result.

Finally, the Web is increasingly used as a medium for viewing GIS data layers in a fully interactive setting. Visitors to a GIS Web site can often control the view settings of the data layers and can zoom in to see more detail for a particular area. Some software developers have included the necessary Web publishing tools within their GIS programs.

With so much spatial data under consideration, GIS technology has become an essential tool for managing wind energy projects at every level. Indeed, there are few other industries for which GIS is more ideally suited. Fortunately, this technology has become more accessible in recent years so that any wind energy company, regardless of scale, can now apply spatial technology to every aspect of its workflow.

About the Author: David McKittrick has worked for DeLorme, a Maine-based mapping and GIS company, since 1997. During this time, he has served in several capacities including, most recently, as a trainer responsible for the design and delivery of GIS instruction programs to a variety of industries and businesses.