Using GIS to Help Manage a National Energy Program

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The Federal Energy Regulatory Commission (FERC) has statutory oversight on key energy issues throughout the United States, including jurisdictional responsibility for non-federal hydroelectric projects. The FERC licenses approximately 1,600 hydroelectric projects and has a database of 28,000 engineering drawings that show project features and boundary maps.

In the mid 1990's, the FERC began to develop a GIS system to track and manage project boundaries associated with hydroelectric projects. The FERC began to convert its drawings to electronic format, and digitize project boundaries. This effort continues today with the help of various GIS, CAD, and imaging software packages. FERC's regulations now require electronic TIFF images for engineering drawings and GIS data for project boundaries. This encourages our licensees' to partner in the data collection and verification process, and is helping to support our efforts to develop an enterprise GIS system.

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Who is FERC?

The Federal Energy Regulatory Commission (FERC) was created by Congress in 1920 with the enactment of the Federal Power Act as an independent agency of the federal government. The FERC is presently organized under the Department of Energy, and acts independently to regulate key operating functions of the natural gas, electric utility, hydroelectric power, and oil pipeline transportation industries. The Commission's strategic direction is to maintain strong environmental and safety regulation and economic regulation so that competitive markets can evolve and satisfy our nation's energy needs.

The Office of Energy Projects (OEP) at FERC, is responsible for engineering and environmental review of hydroelectric and gas energy projects. Much of the GIS work at FERC takes place in its hydroelectric program where it has regulatory responsibility for more than 1,600 non-federal hydroelectric projects. These projects come in all sizes and shapes and are dispersed throughout the contiguous United States, Alaska and Puerto Rico. Projects vary in size from a few kilowatts occupying several acres of land to hundreds of megawatts occupying thousands of acres.

Need for GIS

FERC has broad responsibilities for regulating hydroelectric projects. Engineering staff are stationed in five regional offices and must inspect hydroelectric dams and project features. Similarly, environmental staff inspect public recreation and environmental resources associated with each project. All hydroelectric projects have a project boundary that describes and shows the lands under federal jurisdiction.

There are more than 400 hydroelectric projects located on federal lands; which are assessed approximately $7.77 million annually for the use of federal lands. The FERC works with many federal agencies to track and administer the occupancy of these lands. Issues such as land management, mining claims, threatened and endangered species, and recreation are dealt with on a daily basis. In addition, as new licenses are issued for hydroelectric projects, more emphasis is placed on balancing and managing public resources to their fullest potential.

The FERC first envisioned the development of a GIS system in the mid 1990's to assist with the review of impacts to federal lands. The goal was to begin with a small system

and focus on developing baseline data for these projects located on federal lands. Later the program would be expanded to include all hydroelectric projects under FERC jurisdiction.

Growing the GIS System

Implementing FERC's GIS system has been a slow process. We began with an initiative to inventory and develop a geo-database for 428 hydroelectric project boundaries located on 186,000 acres of federal lands. We forged ahead with procurement of a UNIX based system, started converting engineering drawings to electronic format (TIFF based raster files), and began digitizing project boundaries. Our effort included contractor assistance to scan and digitize drawings, and training for FERC staff to continue the effort.

FERC has approximately 28,000 exhibit drawings for its projects stored in aperture card (microfilm) format. Each drawing had to be converted to a raster image, and we found the scanning, geo-referencing, and digitizing process time consuming. The poor quality of many engineering drawings and the inability to achieve a reasonable accuracy when converting the project boundary raster images to vector data using a standard coordinate system hindered our progress.

By 1999, many advances in hardware and software had been made and we made the decision to switch to a Windows based GIS system. The initial learning curve for a new system was a minor setback compared to the progress we made by switching to a more up-to-date GIS system. We found that significant improvements to the Windows Operating environment brought it close to the performance of our UNIX system. At this time we also acquired a large format scanner, and peripheral hardware to run the system as an independent LAN network within our GIS lab.

In 2001, FERC advanced further in system development when we acquired a full set of 1:24,000 USGS quadrangle maps for the contiguous states. We also acquired additional software and began running a dual GIS system using GeoMedia and ArcGIS. However, our most significant GIS improvement came in 2003, by way of FERC revising its regulations for hydroelectric license applications. The new regulations (18 C.F.R. §4.38 and §4.41) require applicants to file project boundary data in a GIS format, accurate to ±40 feet (USGS quadrangle scale). This requirement has accelerated the process of building a project boundary data set, and makes our licensees' partners in the data collection and verification process. We are using GIS project boundary data to check the amount of federal lands occupied by each project so that annual charges for land use are accurate.

Now and Beyond

FERC's GIS efforts continue today with the help of various GIS, CAD, and imaging

software packages. In the three years since our regulations have changed, we are working with our licensees towards developing good location data, and are making good progress towards completing a geo-database of project boundaries. Towards this goal, we developed a guidance document that has been well received by the hydroelectric industry (http://www.ferc.gov/industries/hydropower/gen-info/guidelines/drawings_guide.pdf).

FERC has expanded the use of GIS in the review of license applications, especially in the analysis of project impacts on environmental resources. We also use GIS to assist with engineering reviews. For example, we use the U.S. Army Corps of Engineers Geo-HEC RAS model to analyze hydraulic flows in river systems below hydroelectric projects. We use SURGGO soils data to analyze erosion around the project reservoirs. Also, we use forecasting data from the National Drought Mitigation Center (http://drought.unl.edu/dm/) to assess potential impacts of droughts on resources around hydroelectric projects.

With the help of ESRI's Professional Services Group, FERC is laying the groundwork for the development of an enterprise GIS system. ESRI staff is working with FERC GIS users as well as our senior IT staff to complete a system functionality and needs evaluation. This evaluation includes a review of hardware and network communication bandwidth, existing and desired software, and a joint workshop with GIS users and IT support staff. We expect ESRI will recommend a variety of implementations to increase our GIS performance and prepare a roadmap for the future.

Suggestions for Planning a GIS System

Have a strategic plan. Developing a well thought out GIS system requires lots of hard work and planning, and will consume time and dollar resources not anticipated. Initial planning of a GIS system requires equal amounts of political and technical capital.

While developing, funding, and implementing a full fledged GIS system is highly desirable, in many instances it will overwhelm available resources. The phased development of system growth (scalable architecture) over multiple years should receive serious consideration. In addition to providing phased funding of expensive equipment, software, and training, this strategy allows the inclusion of technology advances over time and is more palatable to IT operating and maintenance budgets. A phased approach also allows for more complex or advanced computing needs to be incorporated once the basic system is up and running successfully.

Formalize requirements linked to GIS. A GIS system planner should always link GIS with organizational needs. This dependency is critical to receiving management approval and annual budget support for GIS. For example, a regulatory agency should link GIS to regulatory requirements while a government services agency should link GIS to programs that will increase services. A for profit organization will always look to build a GIS

system that will increase operating profits.

Persistence and patience pays off. GIS system planners should have a visionary plan with breakpoint goals that produce visible achievements. They should develop a game plan that includes alternate paths for growing the system. In addition, consideration should be given to critical agency functions and incorporating GIS as a dependent component. A GIS system that has been strategically planned, and has solid base will move forward and reap rewards for the organization.