Producing Web-based Coal Industry Maps for Kentucky

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Overview of Project Objectives

Printed maps showing the locations and summary information about a variety of infrastructure related to coal mining were formerly published by the Governor’s Office of Energy Policy and its predecessors under earlier executive administrations (Bowker and McCully, 2007; Bowker and McCully, 2008). These maps were prepared for the eastern and western coal fields and show such features as power plants, mines, preparation facilities, railroads and associated loading facilities, and river terminal facilities. Each map was periodically updated and reprinted as resources permitted. In 2009, the Kentucky Department for Energy Development and Independence issued an RFP to develop a sustainable method of distributing this information to the State’s constituents. This project proposed to develop an internet-based mapping system to display the information at a variety of map scales with customizable layouts suitable for different user needs. Using a Web-based method would eliminate the need to produce printed versions at a fixed scale, and would facilitate easier and more frequent updates of the information. Another benefit of using a Web map is the ability to access related information from other internet sites for an area or item of interest. This greatly expands the utility of the maps.

The data used to compile previous maps came from a variety of sources, some public and others private. Not all data sources include the location of the features, a required element for making any kind of map, and not all reported locations are accurate. The data for this map needed to be both current and accurate. The electronic data that had been compiled by previous workers was lost during the transition between offices, therefore all data had to be recreated from paper copies, verified, and updated. Because of the uncertainty about future funding to maintain the map site, another objective of this project was to evaluate the methods necessary for obtaining updates to each data set so that priorities could be identified.
Description of the Internet-based Coal Infrastructure Map

The Kentucky Coal Industry Infrastructure Map is located at the following Web address:

http://kgs.uky.edu/kgsmap/KYCoal/viewer.asp#

The interactive map was developed using ESRI's ArcGIS Server technology under version 9.3.x software platform. Basemap reference layers, such as roads, municipal and county boundaries, and streams were obtained from the State Office of Geographic Information KYVECTOR spatial database. Data compiled about coal infrastructure sites (those features represented by a single coordinate location) were added to a Microsoft SQL-Server database to facilitate dynamic posting on the internet map and to provide a secure and permanent data store for the information. Area-based features, such as mines, are stored in the same format as provided by the source (typically ESRI shapefiles) to simplify the update process for the information.

This map site has three main functional frames. The center frame contains the map display with built in zoom and pan controls. The left hand frame contains individual tabs that provide interactive tools and layer control for customization, as well as the results of map identify events (information about features and links to extended data). Another tab, titled Search, contains functions to create a thematic map based on county-level coal production data. The bar to the right of the map contains a duplicate set of tools used to interact with the map, so that these functions can be accessed while other tabs are being viewed. The map and information frame dimensions can be adjusted by placing the cursor at the boundary between them until a double arrow appears and dragging the border in the desired direction.

The map was designed to display at nine fixed scales using preformatted basemap configurations. This greatly speeds the drawing of the map while zooming and panning, but limits the scales and associated extents that can be viewed. It was determined that redraw speed was more important than scale customization for this application.

Map Tools Tab

Tools for interacting with the map have three main functions: 1) controlling the scale and extent of the map, 2) getting information about features on the map, and 3) printing or saving a map layout. Zoom tools change the scale of the map when a rectangle is drawn on the map by holding down the left mouse button while dragging diagonally across the screen. The Pan function moves the map in any compass direction while maintaining the same scale. These same functions can be accomplished using the controls within the map frame. Drag the slider bar in the upper left hand corner up or down to change scales, or click an arrow at the corners or sides of the map to move it in that direction.

Identify tools provide additional information about features on the map in the ID Results tab. The point and rectangle tool work similarly. Select the point tool and click the left
mouse button near a site of interest. For larger areas, select the rectangle tool, hold
down the left mouse button and drag a rectangle around an area of interest. In each
case, the focus will switch to the ID Results tab to display data about the selected sites.

The KYMAPS tool provides access to other Internet maps and databases in the state of
Kentucky. The tool displays a table of information sources categorized by theme.
Clicking on a title causes a new browser window to open the desired site zoomed to the
same extent as the current Energy Infrastructure map. Links to databases return
records that fall within the user’s map extent.

The Identify Coordinates tool returns the coordinate value of a map location when the
user clicks on the map. The default coordinate projection is Kentucky Single Zone State
Plane, and latitude/longitude can be calculated.

The print function formats a Web page that will print the viewed map fit to a single 8.5 x
11 inch page. The print pdf map function saves an Adobe PDF version of the print page
to the user’s computer.

The Layers Tab

This tab contains an explanation of symbols used on the map and allows users to
determine which dynamic features to show on the map. To turn off a layer, the green
checkmark needs to be unchecked. Some features have scale dependency assigned
so that they do not display above certain scales. At a given scale, visible layers are
show in a normal font, while hidden layers are shown in a light gray font. Scale
dependency has also been applied to basemap layers, such as streams, roads, and
municipal areas. More information will become visible as the map is zoomed to larger
scales.

Each layer has an information page (blue circle with white “i”) that explains the source of
the data and methods of preparing it for the site. The yellow folder icon with a green
arrow is a download function providing the layers data in spreadsheet and ESRI
shapefile formats.

ID Results Tab

The ID Results tab contains bars for each potential theme with additional information.
When the ID tool is used this tab opens and the first identified layer expands to display
selected site records. Most data displays are longer than the allowed space, so a scroll
bar is provided to view the entire record. Double clicking a single entry in a results
listing will highlight the feature on the map in a green color. Some ID results tables
contain links to other websites for detailed information about the energy infrastructure
site. Because the ID tools can encompass many different kinds of sites, each theme
bar must be individually highlighted to view its results. The power plant ID result table
contains a link to get information about individual generating units at the facility. Clicking this link causes a new ID results bar to be opened with that data.

**Search Tab**

The Search Tab contains database search functions to prepare summaries that can be displayed on a county map base. Currently, only one function is available—viewing coal production data by county. To use this function, zoom to the statewide extent, select the type of mine production from the first pull down menu, select the type of year range to use and enter the values for the years. Finally, click Build Map to view the classified county map. To use a different color palette, select a new base color from the pull down menu. To remove the classified map and return to viewing coal infrastructure sites, click the Clear Map button on the Search tab or the Clear Graphics tool on the toolbar.
Methods

Power Plants

This layer shows the locations of major electric generating facilities across Kentucky. It includes all coal plants as well as those using other fuels and hydro power. Most descriptive information about power plants in Kentucky was obtained from database downloads provided by the Energy Information Administration Web site. EIA maintains extensive information about power plants and not all of this data could be included in this service. Users should consult the EIA website for complete information.

http://www.eia.doe.gov/fuelelectric.html

The compiled data are associated with a variety of survey forms that utilities are required to submit to the agency. Power plants are assigned a unique numeric identifier by EIA as well as an identifier for the operator to facilitate continued updating of information. Plant addresses and earlier compilations were used to obtain coordinate locations of facilities and these were verified by inspecting recent aerial photography. Coordinate locations used for this map represent a position in the vicinity of the plant facility. Summary data were obtained for both plants and each individual generating unit in use at the facilities.

EIA Form 860 provides descriptive information about plants and their generating units. The current download is for the 2007 year and includes plant name, location, and fuel and capacity data for each generating unit.

http://www.eia.doe.gov/cneaf/electricity/page/eia860.html

EIA Form 923 provides monthly statistics on fuel consumption and electricity generation for each plant. The most recent data was for the 2009 calendar year.

http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html

EIA Form 423 provides information about the cost and quality of fuels used at each plant and was used to characterize the fuel source by coal basin, coal quality, and source state.

http://www.eia.doe.gov/cneaf/electricity/page/eia423.html

Pollution control, emissions, and boiler characteristics are available from the EPA eGRID website, however, the data have not been updated since 2005. The downloaded file does contain the EIA plant ID number, but the generating unit designators are not consistently formatted like those of EIA, so they had to be edited to facilitate linking the EPA and EIA data.
River Terminals

The 2006 and 2008 River Terminal Directories for eastern and western Kentucky, respectively, were downloaded from the DEDI website and the textual data were converted to an electronic database format. The coordinate locations provided were used to inspect aerial photographs to validate the sites and adjustments to the locations were made as necessary. All address, contact, and capacity data are unchanged from the published reports.

Western Kentucky River Terminal Directory (2008)

Eastern Kentucky River Terminal Directory (2006)

Site Bank Properties

This layer shows the locations of potential alternative energy properties that have been evaluated by the Department for Energy Development and Independence Site Bank program.

http://www.kysitebank.com/

Sites were nominated by both public and private entities and then screened for a variety of criteria related to energy development by Smith Management Group. The link included on the information tab leads to the Site Bank Web page for each property and provides all the evaluation data in separate Adobe PDF files. The locations on the map are in the vicinity of the property. Consult the Site Fact Sheet file for a map showing the property boundary.

Preparation Plants

There were four sources of data reviewed pertaining to coal preparation facilities. First, the Kentucky Division of Mine Permits provided a listing of active permit applications referencing prep plants. Each permit has an activity code that indicates whether the facility is producing coal or under reclamation (active permit, but inactive plant).

http://www.minepermits.ky.gov/sminformationsystem/

The second source was the 2007 Prep Plant Directories available on the DEDI website for eastern and western Kentucky.

http://www.energy.ky.gov/media/publications.htm
The third source is the Prep Plant Census compiled by Coal Age and published in the Keystone Coal Industry Manual (2010).

http://mining-media.com/

The fourth source is a listing of air quality permits issued by the Division of Air Quality for the facilities (10).

http://www.air.ky.gov/permitting/

Aside from the locations and data provided by the Division of Mine Permits and Air Quality, there are no publicly available data about prep plants—the other two sources obtained data through questionnaires or interviews with facility owners or operators and are reported to be incomplete.

There was no definitive way to compare information among the four sources. Operator names change frequently or are reported differently by the compilers, and there is no consistent identifier for a plant. The Division of Mine Permits assigns a permit number to an issued permit, but no other source references that number consistently. Because each list contained a different number of sites, each had to be compared using the coordinate location and any provided data. The method involved creating a GIS dataset for each source so that they could be plotted on a map. Each site was inspected using recent aerial photography as a base, and determinations were made about whether there were visible surface disturbances and structures, whether more than one source was located in proximity to each other, and whether descriptive information were sufficiently close to assume a correlation. Each source typically lists a different location for the same site.

The current data shown are the locations of active permits issued by the Division of Mine Permits. The listed permit number can be used to search the SMIS (Surface Mine Information System) to obtain more information about the permit. The Division of Air Quality listing may be the best representation of active plants, and the permits contain information about the type of facility and its individual components. These data are currently under review as a means of providing the most comprehensive listing of facilities.

**Loadout Facilities**

Loadout facilities are typically associated with coal preparation plants and are used to transfer processed coal to a rail car or truck. The sites shown on this map were obtained from records of the Division of Mine Permits (5). There were only twelve locations in this listing, so it is clearly not a complete inventory of such facilities. Air permits associated with processing facilities indicate the presence of loadout capability. A review of these documents is planned to provide a more comprehensive inventory.
Active Coal Mines

The outlines of active coal mines were obtained from the Kentucky Mine Mapping Information System website.

http://minemaps.ky.gov/

These data are maintained by the Kentucky Revenue Cabinet’s Unmined Minerals Tax program as part of their assessment methodology. Mine outlines are digitized from mine maps submitted by coal companies to the Office of Mine Licensing. Updates to the shapefiles are made continuously. Mine polygons are attributed with a permit number (SFN) that allows links to be made to the Office of Mine Licensing database of annual production data for the mines and to online scanned minemaps. The downloaded shapefile was first processed to remove inactive mines.

Because individual mines have areas appended to them over time, the result is multi-part polygons. This created an issue for displaying attribute information (a row was returned for each polygon of a single mine), therefore the shapefile was further processed to merge the parts into a single shape. For surface mines, a single permit may cover geographically distinct areas, usually where different seams are being extracted. In the case of these mines, the polygons were merged by coal seam and permit number.

Railroads

Railway information was obtained from the Kentucky Geographic Network (kygeonet).

http://kygeonet.ky.gov

The data are compiled and attributed by the Kentucky Transportation Cabinet for distribution to the public.

Navigable Rivers

There were no existing GIS data for barge-navigable rivers in Kentucky. The USGS National Hydrologic Dataset streams data for Kentucky was edited to include the following river milepoint segments:

- Ohio miles 318 to 981
- Mississippi all miles bordering Kentucky
- Big Sandy miles 0 to 10
- Licking miles 0 to 4
- Green miles 0 to 103
- Cumberland miles 0 to 102
- Tennessee miles 0 to 64
Summary and Recommendations

All data themes previously shown on the coal infrastructure maps have been successfully incorporated into the new Kentucky Energy Infrastructure website. Each data set has been reviewed to the extent possible to insure accuracy in location and inclusion of the most current information. Following are recommendations pertaining to the ongoing maintenance of the information and suggestions for improvements.

**Power Plants.** These data do not change regularly. It should be sufficient to review the EIA and EPA data on an annual basis to check for changes to facilities. A meeting with DEDI staff involved in modeling power generation and capacity is recommended to identify additional kinds of information that would be useful for the site.

**Coal Preparation Plants.** These data need much more work to improve the data set. A comprehensive inventory of active coal prep plants would be extremely beneficial, but was beyond the scope of this project. A review of Air Quality permits is recommended to establish a definitive list of active facilities. A collaborative effort among knowledgeable public and private organizations should be facilitated to obtain information about the plants and associated refuse ponds. This activity would warrant a separate project.

**Coal Loadout Facilities.** The data available from different sources was very inconsistent for loadouts. Because these are generally associated with preparation plants, the suggested project to review those data should include these facilities as well.

**River Terminals.** These sites also have a low frequency of change. An annual review of available information is suggested.

**Site Bank Properties.** Because these reviews are conducted under the jurisdiction of DEDI, any changes or updates should be provided by staff with oversight of that program.

**Mines.** These data change on a continual basis. Quarterly updates would be feasible, annual updates essential.

**County Mine Information.** Coal production data is already updated as it becomes available from the Office of Mine Safety and Licensing. KGS will meet with OMSL staff to inquire about obtaining related data such as employment and numbers of mines to enhance the capabilities of the mapping function. Other county level data from the Coal Facts publication could be added as separate mapping functions.

**Mine-level Coal Production.** While the Kentucky Energy Infrastructure site can link to data provided by the Kentucky Mine Mapping Information System to provide access to extended data about mines shown on the map, KGS does not have direct access to the databases supplying that data. If more flexible queries are desired related to coal...
production, direct access to that data by KGS would need to be authorized and established.

**Coal Resource Information.** KGS has extensive information about the coal resources of the state in the form of seam thickness and overburden maps. Including that data in this map was beyond the scope of the project and would have increased the complexity of the map. Future work could focus on finding the best method to make that information available, while maintaining the simplicity of the service.
Principal Data Sources

   http://kgs.uky.edu/kgsweb/PubsSearching/PubResults.asp?pubnum=17247

   http://kgs.uky.edu/kgsweb/PubsSearching/PubResults.asp?pubnum=17246

   http://www.energy.ky.gov/media/publications.htm

4. Kentucky Mine Mapping Information System (KMMIS)  
   http://minemaps.ky.gov/  
   contact: John Hiett (John.Hiett@ky.gov)

5. Division of Mine Permits Surface Mine Information System (SMIS)  
   http://www.minepermits.ky.gov/sminformationsystem/  
   contact: Jim Adamson (Jim.Adamson@ky.gov)

6. Kentucky Alternative Energy Facilities Site Bank  
   http://www.kysitebank.com/  
   contact: Sara Smith, Smith Management Group (Sara@smithmanage.com)

7. Department of Energy, Energy Information Administration Electricity page  
   b. http://www.eia.doe.gov/cneaf/electricity/page/eia860.html (Form 860 data)  
   c. http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html (Form 923 data)  
   d. http://www.eia.doe.gov/cneaf/electricity/page/eia423.html (Form 423 data)


9. EPA Clean Energy EGRID page  
   http://www.epa.gov/cleanenergy/energy-resources/egrid (pollution control)

10. Kentucky Division for Air Quality, air permit page  
    http://www.air.ky.gov/permitting/