3D Elevation Program and Energy for the Nation

Energy Infrastructure and High-Quality 3D Elevation Data

High resolution lidar data are used in energy infrastructure siting, design, permitting, construction, and monitoring to promote public safety through reduction of risks. For example, lidar data are used to identify safe locations for energy infrastructure by analyzing terrain parameters and identifying and analyzing geological hazards (e.g., landslide and fault locations) and their potential public safety impact on the location or design of infrastructure. Increasingly, engineering companies and regulatory agencies are using lidar and other remote sensing techniques as an efficient method to collect accurate, comprehensive data, while reducing risks to field personnel.

The USGS 3D Elevation Program (3DEP) is collecting lidar data nationwide (IfSAR in Alaska) to support a wide range of applications, including projects related to energy infrastructure construction and safety. Renewable energy resources, resource mining, and oil and gas resources were identified by the National Enhanced Elevation Assessment (NEEA; Dewberry, 2012) as business uses requiring three-dimensional (3D) elevation data.

Elevation data are critical in assessing potential sites for energy infrastructure such as pipelines, refineries, pipelines, and other facilities to mitigate risks from natural hazards. For example, the Federal Energy Regulatory Commission (FERC), an independent agency that regulates the interstate transmission of electricity, natural gas, and oil, uses enhanced elevation data to conduct National Environmental Policy Act (NEPA) compliance assessments. In the NEEA study, FERC noted that the acquisition of high resolution lidar data by the USGS 3DEP initiative helps both FERC and applicants by providing accurate and consistent data for hazards analysis by both the permit applicant and FERC, accelerating the application and review process, and avoiding the much higher costs of acquiring elevation data specifically along proposed energy facility locations and pipeline corridors.

Table 1. Conservative annual national benefits of 3DEP data related to energy (derived from Dewberry, 2012)

Business use	Conservative annual benefit (million dollars)
Water supply and quality	0.8
Resource mining	0.8
Renewable energy resources	2.6
Oil and gas resources	1.6
Infrastructure and construction management	18.1
Total	23.9

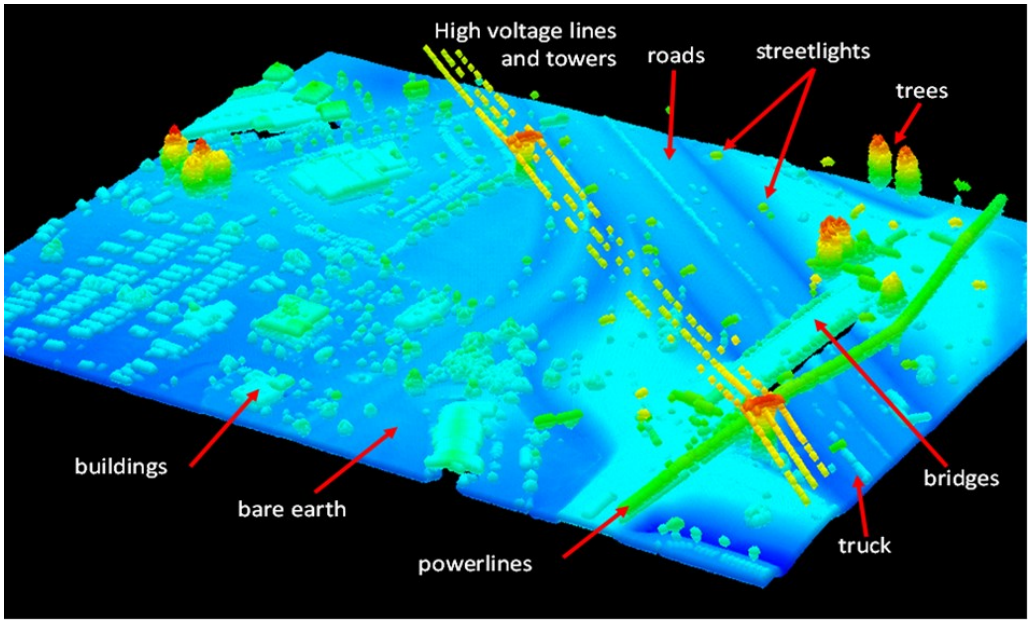

Figure 1. A lidar point cloud image that captures power transmission lines and other infrastructure. Image courtesy of J. Stoker

3D Elevation Program (3DEP)

The 3D Elevation Program (3DEP) is a program managed by the USGS to acquire high-resolution elevation data for the nation (Sugarbaker and others, 2014). It produces point clouds, bare-earth digital elevation models (DEMs), and other products.

3DEP is backed by a comprehensive assessment of lidar, interferometric synthetic aperture radar (IfSAR), and related elevation data requirements (Dewberry, 2012). The goal of this high-priority cooperative program is to acquire complete coverage of quality level 2 lidar data for the conterminous United States, Hawaii, and the U.S. territories, and IfSAR data for Alaska, by the end of 2023.

Reduced Acquisition Costs and Risks

A funded national program will provide:

- *Economy of scale* by acquiring data for larger areas and reducing acquisition costs by 25 percent.
- *Predictable, efficient, and flexible Federal investments* that reduce costs for and allow better planning by Federal, State, Tribal, U.S. territorial, and local government partners, including the option of "buying up" to acquire higher quality data.
- *Consistent, high-quality, national coverage* that (1) provides data ready for applications that span project, jurisdictional, and watershed boundaries, (2) meets multiple needs, and (3) increases benefits to citizens.
- *Simpler data acquisition* that provides contracts, published data-acquisition specifications, and specialized quality assurance and information technology expertise. Partners reduce their risks and can concentrate on their business activities.

3DEP can conservatively provide new benefits of $690 million per year and has the potential to generate $13 billion per year in new benefits through applications that span the economy (Dewberry, 2012). The shared lidar, IfSAR, and derived elevation datasets would foster cooperation and improve decisionmaking among all levels of government and other stakeholders.

High-Quality Data

For the conterminous United States, Hawaii, and the U.S. territories, the USGS and its partners acquire quality level 2 or better lidar data. Quality level 2 data have a minimum nominal pulse spacing of 0.7 meters and a vertical error of

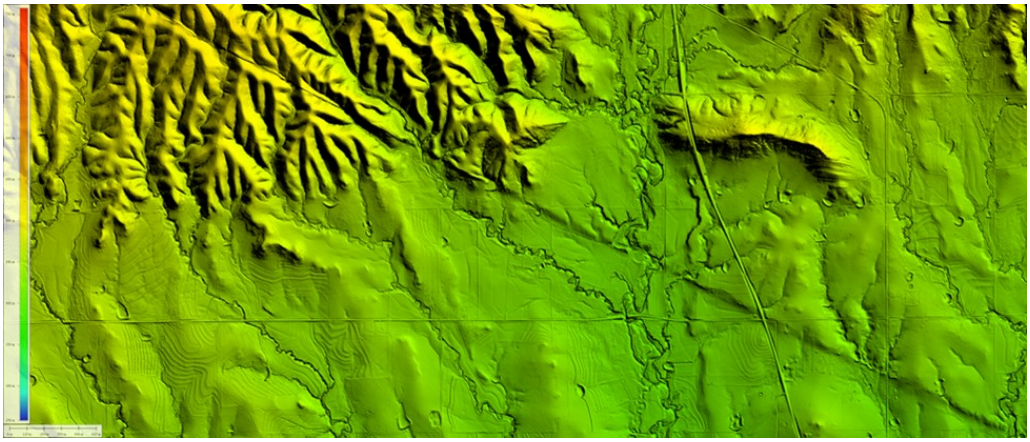

Figure 2. A 1-meter digital elevation model, created from Quality Level 2 light detection and ranging data, depicts part of the Meers Fault in southwest Oklahoma. Lidar data is used to identify and analyze geologic hazards such as landslide and fault locations to reduce risk to energy facilities and pipelines. Source: Image was derived from the Federal Emergency Management Agency Cache Creek Basin lidar project.

Uses of 3D Elevation Data in the Energy Sector

Other examples of the uses of 3D elevation data in the energy sector include:

Spill impact analysis – Lidar-based DEMs are used to model the extent of the damage caused by a pipeline leak, which is largely influenced by the surrounding terrain. Spill impact analyses can be completed for pipeline leak scenarios to predict the risks to sensitive ecosystems or populated areas.

Hydroelectric dam risk assessment– High resolution elevation data are used in flood risk mapping for hydroelectric dam failures and their potential impact to public safety and natural and built environments. Lidar and IfSAR are used to analyze dam breaks, and to better understand the effects of floods, landslides, and earthquakes on dams.

Nuclear Reactor Siting– Assessing seismic hazards is a critical component in siting nuclear power plants. Lidar data are used to refine the identification of surface faulting geologic/tectonic structures, potential liquefaction sites, potential landslide areas, karst topography, surface water drainage, coastal flooding extents and other flood prone areas that are considered in the assessment of potential sites. The use of high quality elevation data to evaluate hazards will provide better information for public health and safety decisions, allow the U.S. Nuclear Regulatory Commission to complete technical reviews with greater efficiency and effectiveness.

Solar Energy Potential– 3D elevation data are used by the solar energy industry to calculate the amount of sunlight and shading cast on a rooftop by nearby buildings, trees, and chimneys, and to evaluate roof slope and aspect. This information can be collected remotely using lidar, avoiding the need for expensive and potentially dangerous site visits to measure roof irradiance.

Power Generation and Transmission Facilities– To effectively design, site, and construct proposed infrastructure such as power generating facilities and transmission lines, utility companies require accurate topographic data. For example, The Tennessee Valley Authority (TVA) requires high quality lidar for accurate flood risk modeling for generating plants and major substations. TVA also uses lidar for the inspection of transmission line right-of-ways to maintain required clearance from trees and encroachments.

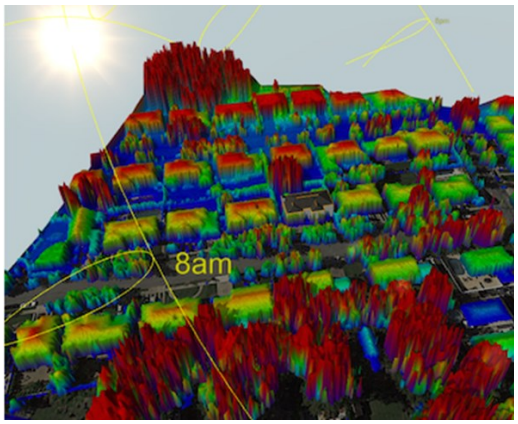

Figure 3. A lidar-based 3D model of building rooftops and surrounding trees and obstructions used to quantify the solar energy potential of a site. Image courtesy of Aurora Solar Inc.

References Cited

Dewberry, 2012, Final report of the National Enhanced Elevation Assessment (revised 2012): Fairfax, Va., Dewberry, 84p. plus appendixes, http://www.dewberry.com/Consultants/GeospatialMapping/FinalReport-NationalEnhancedElevationAssessment. (Accessed 6/12/2017)

Sugarbaker, L.J., Constance, E.W., Heidemann, H.K., Jason, A.L., Lukas, Vicki, Saghy, D.L., and Stoker, J.M., 2014, The 3D Elevation Program Initiative —A call for action: U.S. Geological Survey Circular 1399, 35 p., http://pubs.usgs.gov/circ/1399/. (Accessed 6/12/2017)

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3D Elevation Program—Continued

error of 10 centimeters, measured as root mean square error in the elevation (z) dimension (RMSEz). Statewide for Alaska, quality level 5 IfSAR data are acquired that have a vertical error of 185 centimeters RMSEz . The data must have been acquired during the previous eight years. For more information see the Lidar Base Specification available at http://pubs.usgs.gov/tm/11b4/.

Point Cloud and Derived Products

Lidar data products include the all-return classified point clouds and derived bare-earth DEMs. Each DEM dataset is identified by its horizontal resolution and is produced to a consistent set of specifications. All DEMs represent the topographic surface of the Earth and contain flattened water surfaces. Nationally seamless DEMs are produced by blending only the highest quality project data into a continuous terrain surface for the United States, and are published at resolutions of 1/3 arc-second, 1 arc-second, and 2 arcseconds. The standard 1-meter DEM dataset is seamless within collection projects but not across projects.

IfSAR data in Alaska include digital surface models, orthorectified intensity images, and 5-meter-resolution hydro-flattened DEMs. The USGS integrates the elevation model data into its national elevation data coverage, as a component of The National Map. All 3DEP products to include an elevation-point query service and bulk-point query service are components of The National Map. Data are available, free of charge and without use restrictions. To download 3DEP products visit http://viewer.nationalmap.gov/basic/.

Ways to Participate

Partners may contribute funds toward data acquisition projects managed by the USGS, or they may receive cooperative funds to manage their own acquisition projects. The Broad Agency Announcement process is the primary mechanism used to establish agreements between partners. For more information see the 3DEP Web site at http://nationalmap.gov/ 3DEP/index.html. Organizations may also access the geospatial products and services contracts and quality control services managed by the USGS to acquire 3DEP data. Organizations may contribute existing elevation data that meet 3DEP specifications. More information about using USGS contracts or about other ways to contribute is available by request through http://nationalmap.gov/3DEP/3dep_feedback.html.

Learn More About 3DEP

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