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Some Factual Perspectives on the Future, Viability of the U.S. Coal Industry

By Steven J. Storts
Dublin, Ohio

ONE of the more contentious, and yet inviting, issues of the 2016 political campaign last fall was the impending revitalization (or demise) of the U.S. coal mining industry, particularly that of the Appalachian region in states such as Kentucky, Pennsylvania, and West Virginia. The political rhetoric was quite polarizing. On one end of the campaign spectrum was Donald Trump's vow to bring back coal mining jobs and expand current domestic energy development; on the other end, Hillary Clinton was on record for wanting to end coal mining and replace it with workforce retraining, favoring cleaner energy alternatives and extending the Obama administration's directives in curbing electricity generation via coal-fired power plants.

The U.S. Energy Information Administration estimates that coal production declined 18 percent in 2016, the lowest level of coal produced since 1978. EIA's forecast this year, however, calls for modest growth in coal-fired electricity generation, which is expected to lead to a seven percent increase in U.S. coal production.

Actually, the forecast may be better than projected. As of mid-January, EIA's reported production estimate was 14.1 percent higher than the first week of 2017, and 13.4 percent higher than the production estimate in the comparable week of last year. Another hopeful sign is that year-to-date coal production is 9.2 percent higher than the comparable year-to-date production figure in 2016.

On a related front, coal consumption in the electric power industry,

which accounts for more than 90 percent of the total U.S. coal market, is estimated by EIA to have declined by eight percent last year, mostly attributed to competition with low-priced natural gas, the fracking boom, and reduced overall electricity demand due to relatively mild weather conditions.

Other commonly cited reasons for the downturn include declining international coal demand, legal challenges from environmental advocacy groups, and sweeping environmental regulations under the Obama administration making it more difficult for utilities to justify further capital expenditures in coal-fired plants.

However, because of recent rising natural gas prices and increasing electricity generation, coal consumption in the power sector is forecasted to increase by six percent in 2017. A reverse of this trend, though, is expected in 2018, leading to a small one percent decline in coal consumption by the power industry. EIA also estimates that the delivered coal price last year averaged four percent lower than in 2015, but that coal prices are projected to modestly increase both this year and in 2018.

Of course, it should be pointed out that any significant resurgence of the coal mining industry will tend to more heavily favor the Western and Interior coal regions first, followed by the Appalachian states, based on current coal production and consumption figures. Total coal production in 2018 is expected to increase only slightly, according to EIA projections, with the Western region showing the most gain, offset by small declines in the Interior and Appalachian regions.

Still, any improvement in coal mining nationwide would have a residual positive effect on the Appalachian region, albeit to a lesser degree. Western coal is generally lower in sulfur content and otherwise cleaner-burning than coal from Appalachian mines, making it a desirable choice for power companies operating under stringent Clean Air Act regulations.

Five states account for about 70 percent of total U.S. coal production: Wyoming, West Virginia, Kentucky, Pennsylvania, and Illinois. The North Antelope Rochelle and Black Thunder mines in Wyoming each yield about as much coal as West Virginia, the second-largest coal-producing state. In 2014, Wyoming produced 73 percent of the coal mined in the Western coal region. In fact, eight of the top 10 producing coal mines in the United States are located in Wyoming. Illinois, the largest coal producer in the Interior coal region, accounts for more than 30 percent of the region's coal production and six percent of total U.S. coal production. Underground mines supply the majority (more than 70 percent) of the coal produced in the Appalachian region, whereas surface mining produces about 90 percent of the coal in the Western region and is considered more efficient.

The Daily Caller news service reports that market changes are contributing to the recent rise in coal prices, with global coal prices more than doubling over the past 12 months. For instance, the price of coal in Australia and China has soared by 150 percent from November 2015 to November of last year, according to Bloomberg news sources.

The Caller's energy and science reporter, Andrew Follett, contends that

such massive price fluctuations are due to regulatory changes in the Chinese steel industry and increased demand in India, which caused coal prices to rise by 20 percent in a single week last September. He notes that rapidly rising coal prices have prompted companies to invest \$90 million into a pair of new coal mines in Virginia and West Virginia, creating about 400 jobs in counties where unemployment is almost three times the national average.

From a different perspective, Jason Hayes, associate director of the American Coal Council, says “the industry’s downturn is bigger and more unusual than previous ones,” but he expects coal to make a comeback as prices for natural gas inevitably start to rise, according to a *Casa Grande Dispatch* article “Coal Expected to Make a Comeback.”

As reprinted online by CoalZoom.com, Hayes, a Casa Grande, Arizona resident and editor-in-chief of *American Coal* magazine, attributes coal’s current decline to market pressures from the effects of lower energy demand — a trend observed since the Great Recession. “People aren’t using things the way they did before,” he says. “They’re saving instead of buying.”

Another factor hindering the growth in coal, Hayes points out in the *Dispatch* article, are regulations that make it difficult for facilities to stay compliant with the government’s expectations. “There is definitely reason to be concerned in the sense of how the industry is being treated by the federal government,” he emphasizes.

The *Dispatch* further notes that the U.S. Supreme Court is reviewing rules

set by the U.S. Environmental Protection Agency, requiring all states to submit new carbon-reducing plans that meet rate-based goals by 2030. Twenty-nine states, many of which are dependent on the coal industry, have rallied together to legally challenge the EPA rules.

Finally, Hayes comments that coal companies in bankruptcy court does not indicate a complete shutdown of the industry, as companies will continue operating despite the higher costs it takes to extract and deliver coal. “It is not unusual given the current state of our markets right now,” he says. “It’s also not the end of the world.”

January 2017

Coastal Restoration, Protection Projects Help Reduce Disaster Losses

By Steven J. Storts
Dublin, Ohio

LAST year's flooding and storm-battering of several Southern and Eastern seaboard states serves as a reminder of how fragile coastal and river shoreline ecosystems can be during extreme weather conditions. Natural disasters, though, can also serve as viable proving grounds for the construction challenges of shoreline restoration and erosion mitigation.

At \$17 billion, the total flood loss in 2016 was six times greater than the overall flood damage experienced in 2015, according to CoreLogic, Inc., property information analysts based in Irvine, Calif. Five major events in 2016 shared the bulk of that devastation: the Louisiana flood in August; Hurricane Matthew in October; the Sabine River Basin flood in East Texas and Louisiana in March; the Houston flood in April; and West Virginia's flash and riverine flooding in June.

CoreLogic further states that overall hurricane activity in the Atlantic coastal region was slightly higher than average in 2016, with 15 named storms, including eight tropical storms and seven hurricanes. Three of the latter were major hurricanes identified as Category 3 or greater.

ConstructionDive.com notes that the residential construction market has continually researched and developed methods to mitigate the impact of severe weather and natural disasters. For instance in December, researchers at the Massachusetts Institute of Technology Concrete Sustainability Hub showcased an estimating tool for developers that helps in determining initial investments when designing structures to be more

resilient and to lower the risk of future natural disaster damage. Another measure aimed at reducing the risk of weather-related damage includes a plan announced last summer by the U.S. Federal Emergency Management Agency. It proposes that most federally funded construction projects be constructed two feet above a 100-year floodplain in the wake of flooding damage from hurricanes Katrina and Sandy in 2005 and 2012, respectively.

In a regional resource report issued by the Southern Legislative Conference of the Council of State Governments, SLC policy analyst Anne Roberts points out that since the throes of Hurricane Katrina, much attention has focused on the rehabilitation of the area's homes, businesses, and infrastructure, but less attention has been directed toward the reconstruction of the coastlines of Alabama, Mississippi, and Louisiana.

"In order to maintain a sustainable Gulf Coast, investments in sound redevelopment and restoration practices, balancing the critical natural resources of the Gulf Coast with the equally vital economic drivers in the region, are critical to full recovery and necessary to weakening future natural disasters," she contends. The report, *SLC State Efforts to Rebuild the Coastline*, highlights recent projects undertaken by southern states to rebuild their coastlines, specifically the communities of Dauphin Island, Alabama; Pascagoula, Mississippi; and the metropolitan area of New Orleans.

Roberts says that although levees and structural protections are important components of mitigating damage from hurricanes and floods, they are most effective when coupled with natural forms of mitigation. In the wake of Hurricane Katrina, many

coastal communities have turned to coastal and wetland restoration as an additional mitigation measure, she adds.

"Though Alabama, Mississippi, and Louisiana are Gulf Coast neighbors with similar resources, they have prioritized different forms of economic development and have divergent hurricane mitigation approaches," Roberts explains. Louisiana and, specifically, the New Orleans metropolitan area, has long relied on a series of levees for protection from river- and hurricane-related floods, she says, whereas Alabama and Mississippi have emphasized structural protection, such as seawalls and elevated buildings, that do not impede ocean-front access.

For example, in Alabama, building codes require beachfront structures to be built high on pilings. Hurricane mitigation trends also include installing hard structures, such as bulkheads, seawalls, or "rip-rap" on the shoreline to protect waterfront property from erosion and storm surge. Rip-rap is simply a foundation or sustaining wall of stones or chunks of concrete amassed without order. In Mississippi, Roberts notes, experiences with storms prior to Hurricane Katrina have resulted in modifications to building codes and land use specifications, including the early creation of a 26-mile, 10-foot-high seawall designed to act as a storm barrier.

Spearheading restoration and protection projects in Louisiana is the Coastal Protection and Restoration Authority, which has identified specific projects that address the root causes of land loss. Since 2007, the state has increased its financial commitment to the coastline, yielding substantial progress. CPRA has built or

improved about 250 miles of levees — benefitting more than 25,700 acres of coastal habitat — and secured \$18 billion in state and federal funding for protection and restoration projects. Also noteworthy, the agency has moved more than 150 projects into design and construction, constructed projects in 20 parishes, and constructed 45 miles of barrier islands and berms.

CPRA's targeted projects encompass bank stabilization, barrier island/headland restoration, channel realignment, waterway diversions, hydrologic restoration, marsh creation, oyster barrier reefs, ridge restoration, and shoreline protection. The latter comprises near-shore rock breakwaters to reduce wave energies on shorelines in open bays, lakes, sounds, and bayous, in addition to project work on navi-

gation channels. CPRA's protection projects utilize concrete walls, earthen levees (both linear and circular in design), floodgates, and pumps for enclosed-risk reduction systems.

The agency also addresses structural resiliency as an essential part of coastal restoration and protection, focusing primarily on the options of elevation and flood-proofing. The elevation option involves raising residential structures so that their lowest floors are higher than projected flood depths, ranging from three feet to 14 feet. The other option refits structures so they can be resistant to flood damages; commercial flood-proofing has been considered for areas with projected flood depths of three feet or less.

NOLA.com and *The Times-Picayune* report that Louisiana could spend \$663 million on coastal restoration and levee

projects in fiscal year 2018, with 56 percent of the money used for construction, according to a draft annual plan under consideration by CPRA. The proposal would also create 800 square miles of additional coastal wetlands over a 50-year period. CPRA's annual plan acts as the budget for the state's master plan for coastal restoration and hurricane storm surge protection, both of which will be subject to public hearings across Louisiana.

January 2017

Lead Contamination of Drinking Water Extends Well Beyond Michigan's Woes

By Steven J. Storts
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IN LIGHT of the lead-in-water crisis that pervaded Flint, Mich. earlier this year, should other municipalities be concerned about possible lead contamination of their drinking water? Although the Flint controversy continues to dominate many news headlines, the Natural Resources Defense Council reports that lead contamination in other community water systems could be more prevalent than originally thought because many water systems are not flagged as having lead violations in the government database, which was designed to track and document such problems.

Research by NRDC scientists and health experts indicates that more than 5,300 community water systems serving 18 million Americans in 2015 violated federal lead and copper regulations issued by the U.S. Environmental Protection Agency. The violations included failure to mitigate lead levels, failure to monitor for lead, and failure to report test results to the public or government officials.

The NRDC report *What's In Your Water: Flint and Beyond* notes that not every person served by these systems is known to have excessive lead in their water because only a small percentage of homes were tested and lead levels can vary from home to home. However, industry estimates claim that 15 million to 22 million Americans receive their drinking water delivered through lead service lines that can release lead into tap water.

One of the prominent researchers who played a major role in exposing the lead-in-water crises in Flint last

year and in Washington, D.C. in the early 2000s is Marc Edwards, Ph.D., a professor of civil and environmental engineering at Virginia Tech. More than a decade ago, the *Washington Post* published a series of articles documenting the extent of the lead problem in the nation's capital and detailing how it had been ignored.

Edwards, while studying premature pipe corrosion for the District of Columbia Water and Sewer Authority, determined that lead levels were at least 83 times higher than the accepted safe limit. His research cited the change from chlorine to chloramine as a water treatment chemical as the cause for the spike in lead levels. Regarding Flint's lead-contamination problem, Edwards says corrosive water basically "ate up every metallic pipe" in the water-delivery system, with plastic pipe being the only material immune to such corrosive elements.

Erik Olson, NRDC's health program director, contends, "Shoddy data collection, lax enforcement of the law, and cities gaming the system have created a potent brew of lead violations and unsafe drinking water from the water supplies used by millions of people across the nation." Moreover, he adds, nine out of 10 of these water rule violations never faced *any* formal enforcement and, in fact, states and EPA authorities sought penalties against only three percent of lead rule violators.

Not surprising, Olsen says the EPA's drinking water tracking data show no record of Flint as having violations for lead, suggesting that millions more Americans could be at risk of drinking unsafe water. NRDC sources

further point out that EPA audits have continually found that many drinking water violations do not show up in its database.

Another issue highlighted by the NRDC peer-reviewed report is that water systems can use questionable testing methods to avoid detecting lead problems. In cities like Flint, Chicago, and Philadelphia, where localized lead spikes may put the public at risk, officials allegedly have "gamed" water testing in ways that may obscure lead contamination.

For example, systems can monitor in locations less likely to have lead problems rather than in the highest risk homes or can use water sampling methods that minimize the chance of finding higher levels of lead. After years of complaints about these questionable techniques, the EPA issued a guidance document last February discouraging these methods.

For instance, a recent August *New York Times* article reports that a review of how water testing was conducted at more than 1,500 city school buildings suggests that the amount of lead in the water consumed by students could be greater than the results indicate because of a testing practice known as "pre-stagnation flushing." This practice, which called for every water outlet in each school to be turned on fully for two hours the night before the samples were taken, cleans most soluble lead and lead particles from pipes, thus reducing lead levels temporarily.

However, the EPA's new guidance document recommends not using pre-stagnation flushing when sampling water in homes, stating that the step "may potentially lower the lead lev-

els as compared to when it is not practiced.”

The *Times* article further notes that because the EPA does not regulate the testing of water in schools, its guidance on pre-stagnation flushing does not apply directly to New York’s procedures. Still, the agency’s voluntary guidelines for schools do not recommend such flushing and generally direct schools to mimic normal consumption patterns when taking samples.

An August *Chicago Tribune* article also backs up the premise that the testing methods for lead in drinking water “could significantly underestimate consumers’ exposure to the toxic metal,” as high lead levels were found in drinking water in seven of 38 Chicago homes tested by federal regulators this past spring. EPA officials are still analyzing the results, but there is concern, the *Tribune* points out, particularly in older cities and suburbs where lead pipe and solder are common.

Under federal law, local utilities must test water in a relatively small sample of homes. If lead concentrations exceed 15 parts per billion in more than 10 percent of the sampling, the utilities must alert residents and try to lower levels. The city of Chicago has not exceeded the lead limit in nearly 20 years, according to the *Tribune*. The allowable amount of lead was established in the 1990s, based on a level that utilities could feasibly monitor and treat. However, it is not a health-based standard, and many health and environment experts believe the level allowed is too high.

Not all municipalities or states are playing defense, though. The Greater Cincinnati Water Works, in light of recent lead contamination findings in Ohio and nearby states, is assuring its customers that providing and maintaining safe drinking water is the No. 1 priority.

GCWW’s Ohio River treatment plant in California, Ohio, uses sand filtration, granular activated carbon,

powdered activated carbon, and ultraviolet light to remove and treat for natural and man-made contaminants in drinking water. The facility is one of the first in the nation to use a combination of all four treatment methods. As an additional safeguard, the agency deploys a specific lead corrosion control treatment process to minimize the amount of lead that may leach into the drinking water through home plumbing.

And back in April, the Wisconsin Department of Natural Resources announced that it will target low-income areas statewide with \$11.8 million in new grants to replace aging pipes made of lead that supply water to homes. It is estimated that at least 176,000 homes and businesses in Wisconsin receive water from lead service lines, with about 70,000 of those lines in Milwaukee alone.

October 2016

New Federal Policy Preps U.S. Industry For Production of Automated Vehicles

By Steven J. Storts
Dublin, Ohio

IN A MOVE largely anticipated by the U.S. automotive industry, the federal government recently issued a new policy for automated vehicles, laying the groundwork for their testing and future deployment. The Federal Automated Vehicle Policy, released in September by the U.S. Department of Transportation, sets a proactive approach toward providing safety assurance and facilitating innovation in several ways.

For instance, the new DOT vehicle performance guidance uses a 15-point safety assessment to set clear expectations for manufacturers developing and deploying automated vehicle technologies. Also included is a model state policy section delineating federal and state roles in regulating highly automated vehicle technologies aimed at building a consistent framework of laws to govern self-driving vehicles.

Finally, the policy outlines options regarding the use of current federal authorities to expedite the safe introduction of highly automated vehicles into the marketplace and discusses new tools that may be necessary as the technology evolves and is deployed more widely.

A recent study by the John A. Volpe National Transportation Systems Center notes that current Federal Motor Vehicle Safety Standards do not directly address automated vehicle technologies and often assume the presence of a human driver. Traditionally, those standards can take years to develop and are usually implemented after the new technologies have made significant market impact.

More importantly, existing FMVSS language could create certification challenges for automated vehicle manufacturers choosing to pursue certain vehicle concepts. The new policy, though, envisions greater transparency as DOT works with manufacturers to ensure that safety is appropriately addressed on the front-end of development.

Overall, the Volpe study reveals that there are few barriers for automated vehicles to comply with FMVSS, as long as the vehicle does not significantly diverge from a conventional vehicle design. However, standards for theft protection, roll-away prevention, and light vehicle braking systems were identified as having potential issues for automated vehicles with conventional designs.

“Ninety-four percent of crashes on U.S. roadways are caused by a human choice or error,” says Mark Rosekind, administrator of the National Highway Transportation Safety Administration. “We are moving forward on the safe deployment of automated technologies because of the enormous promise they hold to address the overwhelming majority of crashes and save lives.”

The NHTSA administrator’s remarks come in the wake of the May crash of a Tesla Model S on a divided highway in Williston, Fla., near Gainesville. The driver, Joshua Brown, 40, a technology entrepreneur from Canton, Ohio, was using Tesla’s signature Autopilot system at the time of crashing into the side of a tractor-trailer. The vehicle’s camera system failed to distinguish between a bright sky and a white tractor-trailer and, consequently, failed to automatically ac-

tivate the braking system. The Tesla accident is the first U.S. fatality in a wreck involving a car in self-driving mode.

Transportation Secretary Anthony Foxx points out, “Public input has been essential to getting this right. There has been a strong call from state and local governments, industry, safety experts, mobility advocates, and average Americans to establish a clear policy for the deployment of automated vehicles on our roads.” He further adds, “There are huge upsides and significant challenges that come with automated vehicle technology, and we will continue the conversation with the public over the coming months and years as this technology develops.”

Although the primary focus of DOT’s new policy is on highly automated vehicles, those vehicles that can take full control of the driving task in at least some circumstances are addressed, too. There are also portions of the policy that apply to lower levels of automation, including some of the driver-assistance systems already being deployed by automakers today.

Simultaneously with the Federal Automated Vehicle Policy, NHTSA is releasing a final enforcement guidance bulletin clarifying how its recall authority will also apply to automated vehicle technologies. Specifically, the agency emphasizes that semi-autonomous driving systems that fail to adequately account for the possibility that a distracted or inattentive driver-occupant might fail to retake control of the vehicle in a critical situation may be defined as an unreasonable risk to safety and subject to recall.

In a statement following Brown’s death, Tesla stressed both the impor-

tance and uncertainty regarding its new Autopilot system, emphasizing that drivers still have to manually enable it. According to Tesla's statement, Autopilot is an "assist feature" requiring a driver to keep both hands on the wheel at all time. Drivers are told they need to "maintain control and responsibility" for their vehicles while using the system, and they have to be prepared to take over at any time.

The Associated Press reports that automatic braking systems have malfunctioned in other vehicles, too, and several have been recalled to correct problems. Last fall, Ford recalled about 37,000 F-150 pickups because they braked with nothing in the way. The company stated that the radar system could become confused when passing a large, reflective truck.

Industry analysts point out that warning technologies rely heavily on

multiple cameras, radar, lasers, and computers to sense objects and determine if they are in the vehicle's way. Unfortunately, these systems are not yet sophisticated enough to overcome deficiencies such as subtle color variations or blindness from bright or low-contrast light.

One of the more overlooked ironies during the evolution of self-driving vehicles is the fact that last year, the 2015 American Customer Satisfaction Index found that satisfaction with automobiles dropped for the third straight year (nearly four percent) to the lowest level since 2004. Automakers recalled a record 64 million vehicles for problems such as exploding air bags and ignition switches that can unexpectedly cause engines to stall — all problems that can lead to fatalities. Fortunately, this year's survey shows a 3.8 percent re-

bound in customer satisfaction, up from 79 to 82 out of ASCI's scale of 0 to 100.

Mass-market vehicles have made considerable headway in 2016, according to ASCI data, and while drivers report that their quality has improved, lower prices have also contributed to the rise in buyer satisfaction. Incentives increased by 13 percent during the first two quarters of 2016, more than offsetting impacts from recalls. ACSI data also indicate that nearly the same percentage of survey respondents reported recalls this year as in 2015, yet overall customer satisfaction with the auto industry is up.

October 2016

U.S. Nuclear Power Generation Makes A Return After a Two-Decade Hiatus

By Steven J. Storts
Dublin, Ohio

EVERY now and then, an event comes along in the power industry that bears repeating and further examination. That event is the first nuclear reactor to go online in the United States in two decades. The Tennessee Valley Authority's Watts Bar Unit 2, which achieved its first sustained nuclear fission reaction in late spring, recently connected to the national electrical grid in June. Commercial operations are expected to be at full capacity later this summer.

The reactor is currently operating in a stable condition at low-power levels. With the plant systems and controls under continual monitoring, power levels will be slowly increased up to 100 percent as part of scheduled power ascension testing. TVA will repeat these tests multiple times to ensure the entire system operates safely as designed. Once all tests have been completed successfully, Unit 2 will provide a sustained 1,150 megawatts of lower-cost, carbon-free electricity to the Tennessee Valley.

"This is another major step in fully integrating Watts Bar Unit 2 as the seventh operating unit in TVA's nuclear fleet," says TVA Chief Nuclear Officer Joe Grimes. "It is rewarding to see TVA taking the lead on delivering the first new nuclear unit of the 21st century and providing safe, affordable, and reliable electricity to those we serve." The key word is "safe," as Unit 2 is the first to meet new safety regulations implemented after the formidable meltdown of the Fukushima Dai-ichi nuclear plant in Japan in 2011.

Like its sister, Watts Bar Unit 1, the nation's former newest reactor that came online in 1996, Unit 2, produces electricity using controlled nuclear fission to generate heat, which is then used to produce steam to turn turbines and a single large generator. Combined with Unit 1, the plant will eventually supply 2,300 megawatts of electric power to about 1.3 million homes in the TVA service area.

The Watts Bar plant is located on 1,700 acres on the northern end of the Chickamauga Reservoir near Spring City in eastern Tennessee. Watts Bar once held the distinction of being the only U.S. power installation to generate electricity using hydroelectric power, fossil fuel (retired), and nuclear technology.

Although often termed a "new" reactor facility, Watts Bar is actually one of the longest construction projects in U.S. history, spanning more than four decades. Construction of the nuclear generating plant began in 1973, six years after TVA announced its ambitious plan for 17 new nuclear reactors in Alabama, Mississippi, and Tennessee. However, economic issues in the 1980s and high construction costs caused TVA to drop almost half of those projects. Nevertheless, construction on Watts Bar continued at a slow pace, delayed by regulatory issues, until Unit 1 was finally completed, licensed, and operational in 1996.

Unit 2 also incurred construction and regulatory delays, including cost overruns, until construction finally resumed on the Westinghouse pressurized water reactor in 2007 after years of the project being mothballed. The U.S. Nuclear Regulatory Commission

(NRC) issued an operating license for Unit 2 last October.

On the cost side, Unit 2's completion budget rose to \$4.7 billion, higher than expected but still below the projected expense of reactors being built at TVA's Vogtle plant facility in Waynesboro, Ga., which are currently slated to top \$10 billion. The additional costs for Unit 2 were attributed in part to delays in completion, extra flood controls, and emergency equipment required to prevent nuclear accidents like those at Fukushima Dai-ichi.

On a lighter note, there has always been some mystique surrounding the Watts Bar namesake, for which there are two competing theories. The area surrounding Watts Bar was inhabited by the Cherokee, Creek, and Choctaw Native American tribes during the late 18th century. The first theory emanates from some of the descendants of Meigs County's original settlers, who claim that the area was named from a Native American named Wattsi and that the Watts Creek was formerly known as Wattsi Creek.

The second theory derives from historical records showing that the territory surrounding Watts Bar during the latter part of the 18th century belonged to John Watts, a Choctaw chief, famous for his ability as a warrior and leader. No direct connection has been found linking his name with Watts Bar, thus leaving open another speculative theory.

Regarding safety concerns, Watts Bar is not without some controversy, according to the *Chattanooga Times Free Press*. Plant employees have alleged more safety problems already this year than at any other nuclear power plant in the country, the NRC

reports, bringing the total to nearly 55 complaints made to regulators during the past three years. Only the Millstone Nuclear Power Station, the largest power plant in Connecticut, has logged more safety complaints from its employees since 2012.

However, NRC sources note that the seriousness of allegations is more important than the quantity, “so just adding up the number may not indicate how serious a problem there may or may not be.” The NRC further adds that when more workers are at a nuclear plant, as they have been during final construction of the Unit 2 reactor at Watts Bar, there are often more concerns voiced by employees.

Still, the *Free Press* points out that regulators have concluded that TVA has a problem with employee safety concerns and the way they are being handled at the Watts Bar twin-reactor

facility. More importantly, NRC has determined that a “chilled work environment” exists within the operations staff at the Watts Bar plant, where some employees may not have felt free to raise safety concerns, and some licensed operators may have been unduly influenced and directed by sources external to the control room.

TVA spokesman Jim Hopson says the utility takes NRC’s determination “very seriously” and is working to respond to employee concerns while trying to improve the plant’s work environment. “We have a robust employee concerns program and continue to actively encourage employees to raise concerns, including reporting them to the NRC,” he emphasizes.

In terms of external safety, industry sources note that Watts Bar has been designed and constructed to withstand

earthquakes, any huge dam failures, hurling objects from tornados, and even airplane crashes. The two cooling towers are 506 feet high with a base diameter of 405 feet and a water flow rate of 410,000 gallons per minute. Primary containment has an inside height of 197 feet and an inside diameter of 115 feet. The reactor vessel is almost 44 feet high with an inside diameter of 14 feet and steel thickness of more than nine inches. The reactor core holds 193 fuel assemblies, each containing 264 fuel rods.

July 2016

Industrial Modernization En Route With Additive Manufacturing Processes

By Steven J. Storts
Dublin, Ohio

THE buzz regarding additive manufacturing — often referred to as 3-D printing, rapid prototyping, or direct digital manufacturing — is an interesting phenomenon to say the least. However, AM technologies are certainly not new by today's standards, having been extensively researched and developed for commercial use in the 1980s. Perhaps what is more revolutionary (or evolutionary) is the wide range of AM applications coming to fruition.

Thought improbable just a few decades ago, additive manufacturing is now fabricating products for use in aircraft, dental restorations, medical implants, automobiles, and the fashion industry. Foreseeable projects could benefit the construction industry in support structures as well as industrial machine fabrication and open the doors for basic consumers to create, customize, or repair their own personal products.

In its most basic form, AM is described by California-based Amazing AM, the online publisher of AdditiveManufacturing.com, as a series of technologies that builds 3-D objects by adding layer-upon-layer of material, whether the material is plastic, metal, ceramic, concrete, or perhaps one day, human tissue aimed at producing human organs.

For example, instead of milling a workpiece from a solid block, using a more traditional machining process, AM builds up components layer-by-layer using available materials. As its key advantages, additive manufacturing allows for quality fabrica-

tion of parts with very complex geometries, all without tooling, fixtures, and producing any waste material.

Common to all AM technologies is the use of computers, 3-D modeling or computer-aided design software, machine equipment, and layering material. Once a CAD schematic is produced, the AM equipment reads in data from the CAD file and lays down or adds successive layers of liquid, powder, sheet material or other composites, in a layer-upon-layer fashion, fabricating a 3-D object. Depending on the material used, components can be manufactured using stereolithography, laser sintering, or 3-D printing.

Amazing AM notes that although the layer-upon-layer approach is somewhat simplistic in nature, there are numerous degrees of sophistication that exist within AM technology applications to meet a wide range of needs. Some of these include visualizing a tool in design or industrial tooling, creating highly customized products for both consumers and professionals, and producing small lots of production parts.

The benefits of AM applications are also numerous: reduced weights for new designs; mass customization of new delivery models; cost savings on custom tooling; reduced assembly steps and improved quality control; reduced inventory due to on-demand production; and faster delivery times to market.

Well-known industry consultant and analyst Terry Wohlers of Denver, Colo., who keynotes numerous events for the Society of Manufacturing Engineers and other organizations worldwide, states in one of his reports, "Additive manufacturing

technologies create a world of possibilities that can take an organization in an entirely new direction and help launch new businesses and business models. 3-D printing and 3-D imaging are causing design and manufacturing professionals to rethink their approach to new product development."

Manufacturing engineers are also extending their design capabilities as advancements in AM technologies offer more complexities, geometric shapes, and features. "Low-cost 3-D printers are affecting both the professional and consumer markets," Wohlers says. "The increased sale of these machines over the past few years has taken additive manufacturing mainstream more than any other single development. As new additive manufacturing systems and materials become more widely adopted, I expect to see new designs that previously would have been very difficult or too expensive to manufacture."

One of the more innovative applications of AM technologies is currently underway at General Electric Aviation in Cincinnati, Ohio. Making a radical departure from its traditional manufacturing platform, GE is producing a fuel nozzle for a new aircraft engine by 3-D printing the part with lasers, rather than casting and welding the metal. GE chose the additive process for the project because it uses less material than conventional techniques, thereby reducing production costs and yielding significant fuel savings because of the lighter material weight.

The initial challenge for GE was to eliminate as many unknowns as

possible, starting with the material. “When we designed the nozzle, we wanted to make it from an alloy that was mature, well-known and thoroughly tested, nothing exotic,” says Todd Rockstroh, a GE laser processing expert.

Rockstroh and his team settled on cobalt-chromium alloys, which have been used for decades for human joint replacements and dental implants. Light, tough, and corrosion-resistant, these alloys can operate in temperatures as high as 1,800 degrees Fahrenheit and are relatively inexpensive. Because the AM process requires powdered metal, specialty smelters are being deployed that can turn molten alloys into powder through gas atomization, mechanical milling, spray forming, and other advanced methods.

A computer file of the digitized drawing of the nozzle guides the 3-D printer’s high-powered fiber op-

tic laser across the powder bed, much like a painter moves a brush across the canvas. The laser then fuses successive layers of powder — each 20 microns thick — to the desired shape. The end result is a fuel nozzle that is 25 percent lighter and as much as five times more durable than the current nozzle made from 20 different smaller parts welded together.

Although AM technologies are trending upward in manufacturing, surprisingly, many companies are still unaware of additive manufacturing’s projected potential over the next decade, according to the New York-based management consulting firm McKinsey & Company. A McKinsey survey of leading manufacturers earlier this year showed that 40 percent of the respondents were unfamiliar with AM technology “beyond press coverage.” An additional 12 percent indicated that 3-D printing might be relevant but more

information is needed to make a determination.

Many companies in the McKinsey survey also admitted they were ill-prepared to undertake a cross-organizational effort to identify the opportunities. In fact, two-thirds of respondents said their companies lacked a formal, systematic way to catalog and prioritize emerging technologies in general.

Nevertheless, 10 percent of those executives surveyed consider AM technologies “highly relevant.” They see 3-D printing’s ability to increase geometric complexity and reduce time to market as the key business benefits, closely followed by reduced tooling and assembly costs and reduced inventories of spare parts.

April 2015

Construction Industry Reaping Major Dividends from Investment in BIM

By Steven J. Storts
Dublin, Ohio

THERE is little doubt that the Digital Age is carving its brand on the construction industry, particularly in the area of building information modeling. And why not? For those organizations taking advantage of what BIM brings to the project table, the future may be brighter.

In a study released last year by McGraw Hill Construction, contractors in nine of the world's top construction markets using BIM reported that digital modeling helps them to improve productivity, efficiency, quality, and safety on their projects, in addition to boosting their own competitiveness. *The Business Value of BIM for Construction in Major Global Markets* reveals that businesses in markets with well-established BIM use — including Canada, France, Germany, the United Kingdom, and the United States — are seeing a positive return on their technology investments.

Moreover, the study notes that construction markets that are still in the initial stages of BIM adoption — Australia/New Zealand, Brazil, Japan, and South Korea, for example — are experiencing benefits, too, such as reduced errors and omissions, improved collaboration among project team members, and an enhanced organizational image.

Through digital information networking and management in a team environment, BIM creates measurable value by combining the efforts of project stakeholders, process, and technology. Essentially, BIM is a clearinghouse for every component

of the built structure, making it possible for any project team member to access information for any purpose. The process integrates different aspects of the project design more effectively, reducing the potential risk for mistakes, discrepancies, or conflicts during the delivery process. As its core advantage, BIM data can be used to illustrate a building's entire life-cycle from inception and design to demolition and materials reuse. Spaces, systems, products, and sequences can be exhibited and compared in relative scale to each other and, in turn, relative to the entire project.

The McGraw Hill study demonstrates that businesses deploying BIM achieve more benefits and realize a stronger return on their technology investment than those less engaged. Half of those organizations highly engaged in BIM report returns in excess of 25 percent on their technology investment. Much of that return on investment is due to significantly reduced rework on projects. The study results also forecast exponential growth in BIM use in the near future. Over the next two years, contractors expect the percentage of their work involving BIM to increase by 50 percent on average.

In a separate analysis, Massachusetts-based Fast Market Research Inc., an online aggregator and distributor of market research and business information, forecasts the BIM market to grow from \$2,640.12 million in 2013 to \$8,646.47 million by 2020 at a compound annual growth rate of 16.72 percent. FMR points out that newer applications and uses are continuously being devised for

this technology, which will further propel the market in the coming five years, with much of the expected growth due to the expanding industrial sector for the BIM market.

"As greater industry demands unfold, BIM is emerging as a vital process to promote efficiency and leaner operations throughout a construction project's life-cycle," says Lisa Campbell, vice president of industry strategy and marketing at Autodesk, the McGraw Hill study's premier partner. She further notes that construction organizations with very high BIM engagement levels are heavily investing in mobile devices, demonstrating that BIM's future for contractor use lies in getting it more widely used in the field.

Additionally, the study demonstrates the broad range of BIM use globally, including how use varies by specific markets. For example, while 82 percent of U.S. contractors use BIM for multitrade coordination, leading the global market in this area, Brazilian contractors notably lag in this area, with only 25 percent using BIM for the purpose. On the other hand, contractors from Brazil lead in the integration of 4-D scheduling, a practice only used by 21 percent of U.S. firms. Aside from the project construction phase, BIM is gaining attention in the preconstruction and postconstruction phases. One emerging area is project management for the owner beyond closeout, a trend showing strength in Asia and Europe but only moving slowly in North America.

In actual practice, a BIM object can be a combination of many things: information content that defines a product; product properties; or ge-

ometry representing a product's physical characteristics. Among its more familiar functions, BIM provides 3-D visualization data giving an object a recognizable appearance and exhibits functional data, enabling an object to be positioned or repositioned and then viewed throughout various applications.

Many construction stakeholders are coming to the realization that BIM technology may be far superior to shop drawings in terms of actual building representation. Because 3-D objects are machine readable, spatial conflicts in a building model can be tracked automatically. And by integrating this capability at all phases of project delivery, errors, omissions, and change orders due to internal causes can be greatly reduced. Proponents also contend that BIM im-

proves overall productivity due to easier retrieval of information and increases coordination of construction documents, thereby increasing speed of delivery and reducing delay costs. To that end, BIM quickly embeds and links vital information into its model, including suppliers for specific materials, location details, and the quantities required for estimation and procurement.

National Building Specification, an informative arm of RIBA Enterprises Ltd., which is wholly owned by the Royal Institute of British Architects, publishes annual research into BIM adoption in the United Kingdom. A survey of 1,000 U.K. construction professionals last year revealed that BIM engagement had increased from 13 percent in 2011 to 54 percent in 2014.

NBS suggests that organizations interested in pursuing or honing BIM strategies need to perform five initial tasks: establish an existing BIM maturing level (knowledge base and/or learning curve); examine current client base needs for best practices; review technological nature of current projects; forecast future work sector plans and ambitions; and assess the skill sets of existing staff. Regarding the latter, NBS emphasizes that BIM encompasses more than just knowledge about the latest 3-D imaging or CAD software; a wide range of technical, communicative, and leadership skills is required for a successful BIM project.

January 2015

U.S. Geological Effects of Hydraulic Fracturing Need More Study, Research

By Steven J. Storts
Dublin, Ohio

ONE of the great debates surrounding the oil and natural gas extraction process of hydraulic fracturing, commonly known as “fracking,” centers on alleged geological side effects, namely the recent rise in earthquakes in states such as Arkansas, Colorado, Kansas, Ohio, Oklahoma, and Texas. Not surprising, this issue could also prove as contentious as discussions regarding man-made global warming (climate change) due to a lack of sustained, conclusive scientific research. The question, of course, still remains: Are earthquakes occurring naturally or coincidentally in regions where fracking is underway or are they being caused or exacerbated by fracking or its residual wastewater injection through underground wells?

Extracting oil or natural gas from certain formations deep underground, including shale, tight sandstones, and coal beds, requires drawing the resource through openings about one-half the width of a human hair. The process uses water pressure and a sand-and-chemical mixture to produce a myriad of hairline fractures within the underground rock formations through which oil or natural gas can flow. The contaminated water returns to the surface, requiring treatment, and then disposal through a wastewater injection well, designed specifically for this purpose. It is the large volume of discharged wastewater, not the fracking itself, which is being targeted as the primary source for triggering earthquakes by pressuring and lubricating geological faults.

The U.S. Geological Survey and Oklahoma Geological Survey report that the state experienced more than 180 quakes of 3.0 magnitude or greater from October 2013 to early May of this year. Most were too weak to cause any property damage or endanger lives. Nevertheless, the recent number of quakes contrasts sharply with an average of only two such events from 1978 to 2008. For reference purposes, a 3.0 magnitude earthquake is described by USGS as causing “vibrations similar to the passing of a truck.” More recently in July, during a span of only 14 hours, USGS recorded seven small quakes ranging from magnitude 2.6 to 2.9, all centered in the Guthrie, Jones, and Langston areas, 15 miles to 30 miles northeast of Oklahoma City. Those quakes followed four others a day earlier, including a magnitude 4.3 tremor near Langston and the other three ranging in magnitude from 2.9 to 3.2.

Near Azle, Texas, Southern Methodist University researchers have recorded more than 300 quakes since December last year and are studying the premise of whether wastewater disposal wells in Azle and around North Texas are stimulating fault activity or if earthquakes are occurring naturally. USGS reports that North Texas has had 70 earthquakes since 2008, compared with just a single quake recorded in 1950 before then. SMU researchers also studied two other earthquake sequences in North Texas and concluded there was a plausible link between the quakes and nearby injection wells. Other seismologists, however, note that a clear correlation has not been established, aside from a conten-

tion that injection well operators could simply be pumping either too much water into the ground or pumping it at exceedingly high pressures.

Still, because the earthquake rate in Oklahoma has risen by nearly 50 percent since October 2013, both USGS and Oklahoma Geological Survey emphasize that the recent increase is not due to typical, random fluctuations in natural seismicity rates. Instead, the agencies indicated earlier in May that a likely contributing factor to the notable seismic activity is deep-injection wastewater disposal. Consequently, Oklahoma recently enacted new testing and monitoring regulations for injection wells that require well operators to collect daily information on well volume and pressure, instead of monthly. The state has also increased the number of seismic monitoring stations and now operates a network of 15 permanent stations and 17 temporary stations.

Back in the Midwest in Ohio, a geological investigation into five small tremors in the Youngstown area last March found a probable link to hydraulic fracturing caused by increased pressure on a small, unknown fault in a Utica Shale bed. While earlier studies had linked minor quakes in the same region to wastewater injection wells, this marks the first time that tremors have been tied directly to fracking, according to the Oil and Gas Resources Management Division of the Ohio Department of Natural Resources.

In response to Ohio’s recent seismic events, the state has issued new permit conditions. All new drilling sites within three miles of a known fault or seismic activity of 2.0 magnitude or

higher will be conditional on the installation of sensitive seismic-monitoring equipment. The results will be directly available to regulators, so the state will not be reliant on drilling operators providing the data voluntarily. If seismic activity of 1.0 magnitude or greater is felt, drilling will be paused for evaluation, and if a link is found, the operation will be halted. Ohio has also imposed an indefinite drilling moratorium at the site of the March quakes but is allowing oil and natural gas extraction to continue at five existing wells at the site.

Part of the reluctance toward labeling fracking as the sole cause for recent earthquake activity is the fact that the process is not new. In fact, this year the American Petroleum Institute is celebrating the 65th birthday of hydraulic fracturing. From an industrial perspective, hydraulic fracturing has been used on more than a million wells nationwide and already accounts

for the majority of U.S. natural gas production. And according to the Society of Petroleum Engineers, of the more than 150,000 Class II injection wells in the United States, only about 40,000 are waste fluid disposal wells for oil and gas operations, with only a handful having been proven to induce quakes that are large enough to concern the general public.

Preliminary findings of ongoing USGS research indicate that hydraulic fracturing itself does not appear to be linked to the increased rate of magnitude 3.0 and larger earthquakes in the United States. And although wastewater injection has not yet been linked to large earthquakes of magnitude 6.0 or higher, engineers and scientists cannot eliminate the possibility, USGS notes. For instance, there is consensus that wastewater disposal induced the magnitude 5.3 earthquake in Raton Basin, Colo., and the magnitude 5.6 quake

in Prague, Okla., both in 2011. However, USGS researchers have also found that earthquakes induced by fluid-injection activities are not always located close to the point of injection. In some cases, the induced quakes have been located as far as six miles from the injection well.

Currently, there are no methods available to anticipate whether a planned wastewater disposal activity will trigger earthquakes that are large enough to be of concern, the U.S. Department of the Interior points out. Evidence from some case histories suggests that the magnitude of a quake tends to increase as the total volume of injected wastewater increases. Injection pressure and rate of injection may be factors, too, but more research is needed for conclusive results.

October 2014

Green Energy Project Development Shows Steady Utility Increase in U.S.

By Steven J. Storts
Dublin, Ohio

AS the Obama administration deliberates on the controversial Keystone XL pipeline crossing the U.S. border from Canada, the industrial pursuit of domestic green energy — hydropower, wind, and solar projects — continues at a modest pace, with hydroelectricity generation still leading the renewable pack.

North American hydroelectric consumption, however, did see a slight decline of 6.3 percent in 2012, according to Plunkett Research Ltd., attributed to a below-average year due to widespread droughts.

The U. S. Energy Information Administration reports that renewable energy sources provided about 12 percent of total U.S. utility-scale electricity generation in 2012, up slightly from 11.83 percent in 2011, and 10.7 percent in 2010. The largest share of the renewable-generated electricity derives from hydroelectric power (56 percent), followed by wind (28 percent), biomass wood (8 percent), biomass waste (4 percent), geothermal (3 percent), and solar (1 percent). Coal (37 percent), natural gas (30 percent), nuclear power (19 percent), and petroleum (2 percent) remain the other primary sources of domestic energy production.

Wind power in the United States has grown dramatically from 11,187 megawatts of electricity in 2003 to 140,089 MW in 2012. Nationwide, investors directed \$25 billion into wind energy in 2012, with U.S. wind farms reaching 60 gigawatts of capacity, according to the American Wind Energy Association (AWEA).

In 2013 alone, construction began on wind projects across 13 states, slated to generate more than 2,300 MW of electricity. Texas remains firmly entrenched as the leader in wind power development, with seven of the 10 largest wind farms in the nation, according to the U.S. Department of Energy, followed by Iowa, California, Minnesota, and Washington, with additional projects in Alaska, Colorado, Kansas, Massachusetts, Michigan, Minnesota, Nebraska, North Dakota, Oregon, and South Dakota.

The Maine Public Utilities Commission recently voted in favor of an offshore pilot wind project that, hopefully, will lead to commercial scale, floating offshore wind farms. Pending with the project is a \$46 million DOE grant aimed at creating large offshore wind farms that can produce power at competitive rates. Farther south, the New Jersey Board of Public Utilities is deciding whether to approve a 25-MW demonstration wind project about three miles off the coast of Atlantic City, the state's first offshore wind venture and the forerunner of a more expansive wind farm in federal waters.

In Missouri, Element Power US, owner and developer of the Mill Creek Wind Farm, and Kansas City Power & Light's Greater Missouri Operations recently entered into a power purchase agreement for the 200-MW wind energy facility being constructed in Holt County. Once operational, the wind farm will be the largest in Missouri. And in the Blue Mountains of Utah, construction began in early December on an 80-MW wind facility, a project that qualified for \$42 million of investment tax credits.

Utilities are poised to invest in more wind power because "it's the smart thing for their ratepayers and their bottom lines," says Emily Williams, AWEA senior policy analyst. "Xcel Energy, Detroit Edison, Austin Energy, Omaha Public Power District, and American Electric Power's Public Service Company of Oklahoma have all pursued contracts in excess of their initial requests for more wind power generation because wind is saving their consumers money."

On the solar energy front, both photovoltaic and concentrated solar power/thermal plants are experiencing significant technological innovation, including the use of polymers leading to more flexible solar panels and advanced nanotechnology. In 2012, CSP-generating units were the main source of electricity at 12 power plants in the United States — 11 in California and one in Nevada.

According to the Solar Electric Power Association's annual megawatt production rankings, Pacific Gas and Electric Co. in northern California led all utilities nationally in 2012 and installed more than 800 MW, an 80 percent increase over 2011. Its portfolio included nearly 630 MW of large-scale projects of which 50 MW were utility-owned. PG&E also interconnected more than 17,500 net metered systems in 2012.

Southern California Edison ranked second with more than 190 MW of new solar power generation, driven primarily by 15,000 residential and nonresidential projects accounting for more than 150 MW.

Public Service Electric and Gas Co. in New Jersey rounded out the top three utilities, and along with Jersey

Central Power & Light and Progress Carolinas, was one of three utilities from the East Coast in SEPA's top 10 rankings.

Sacramento Municipal Utility District, the only municipal utility to gain a national ranking, secured the ninth spot with nearly 70 MW of new solar power generation. Its portfolio was backed by the utility's procurement of more than 50 MW of large-scale photovoltaic projects. Other utilities in SEPA's top 10 rankings for 2012 included the Arizona Public Service Co., NV Energy, Tucson Electric Power Co., and the Hawaiian Electric Co. Utilities in the megawatt category were generally large, with a median of 1.1 million customers, compared to the median size of 300,000 for the top 100 utilities that participated in the survey.

With hydropower facilities generating 100,000 MW of renewable energy from coast to coast, the United

States is the fourth largest producer of hydroelectricity in the world after China, Canada, and Brazil. The Grand Coulee Dam remains the fifth largest hydroelectric power facility in the world, and another six U.S. hydropower plants, including Hoover Dam, are among the 50 largest in the world. The top 10 hydropower-generating states continue to be Washington, Oregon, New York, California, Alabama, Idaho, Tennessee, Montana, Arizona, and North Carolina.

The U.S. Army Corps of Engineers also recently identified 223 potential sites for additional hydro development nationwide, based on criteria that a site must be capable of generating 1 MW or greater of hydroelectric power. According to the USACE study, the sites could combine for a cumulative output potential of 6,256 MW, although the Corps noted that only 2,818 MW of those would likely be

economically feasible under assumptions made in the report.

To further bolster hydropower production, two bills were signed into law last August: the Hydropower Regulatory Efficiency Act (H.R. 267) and the Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act (H.R. 678). The former promotes the development of small hydropower and conduit projects and aims to shorten regulatory timeframes for some low-impact hydropower projects, such as adding power generation to existing non-powered dams and closed-loop pumped storage. H.R. 678 authorizes small hydropower development at existing U.S. Bureau of Reclamation-owned canals, pipelines, aqueducts, and other manmade waterways.

January 2014

Oil Shale Garnering More Industry Attention, But Still Has Obstacles

By Steven J. Storts
Dublin, Ohio

IT is estimated that the oil shale potential in the western United States could yield an amount of oil greater than the proven petroleum reserves in the Middle East. And if fully developed, oil shale could supply the current U.S. consumption of oil for more than 70 years. Some studies forecast even higher estimates. A Rand Corporation report points out that the current domestic demand for petroleum products is about 20 million barrels per day. If oil shale could be used to meet a quarter of the daily demand, the recoverable resources could last for more than 400 years.

Consequently, the magnitude of this energy resource potential is making it attractive for some energy industry stakeholders to invest in its development, or at least take a second look at its viability — something that was briefly explored and then abandoned in the early 1980s due to excessively low oil prices and a lack of advanced cost-effective technologies. Estonia and China already have well-established oil shale industries, and Brazil, Germany, and Russia currently utilize oil shale for various uses. Australia recently commissioned its pilot demonstration oil shale plant in Queensland to begin the production phase.

The largest known oil shale deposits in the world are in the Green River Formation, an area spanning portions of Colorado, Utah, and Wyoming, with earlier oil estimates ranging from 1.5 to 1.8 trillion barrels. In 2011-2012, though, the U.S. Geological Survey increased its es-

timate of the amount of oil shale contained in the region to more than four trillion barrels, but not all resources in place are recoverable. Rand notes that potentially recoverable oil ranges roughly from 1.1 trillion barrels on the upper scale to about 500 billion barrels on the lower side. However, the research organization emphasizes that for policy planning purposes, any amount of oil in this range is very substantial and worthy of consideration for development.

Low-cost oil shale commercialization would, of course, yield tangible benefits, including reduced world oil prices, increased employment, and bolstered national security due to less dependence on foreign oil imports. Additionally, direct economic profits could range as high as \$20 billion annually for an oil shale industry producing just three million barrels per day. Rand reports that through lease bonus payments, production royalties, and corporate income taxes, roughly half of these profits would likely go to federal, state, and local governments, thereby broadly benefitting the public at large.

The National Oil Shale Association admits that commercial operations cannot occur over night, but they could evolve in a methodical manner over years to achieve production levels in the range of 1.5 to 3.0 million barrels per day, which translates upwards to 40 percent of the U.S. oil imports from OPEC countries in 2012 and 100 percent of the oil imported from the OPEC Persian Gulf countries. NOSA adds, however, there are critical issues that must be addressed before successful commercialization of

oil shale can be realized cost effectively. Some of these include land use and ecological impacts, air quality, greenhouse gas emissions, water quality and consumption, socioeconomic impacts, leasing restrictions, and market risks.

Additionally, some confusion exists among the general public and the media regarding the term “oil shale,” which is often used synonymously — and sometimes incorrectly — with “shale oil,” also called “tight oil” or crude oil. Oil shale contains an organic chemical compound known as kerogen, from which liquid hydrocarbons called shale oil can be extracted via high temperatures and vaporization, using either surface or underground retorting technologies. Oil-bearing shale (shale oil), on the other hand, actually contains petroleum elements or crude oil, which is extracted through an underground hydraulic fracturing process.

Shale oil is often found near drilled wells or known oil reserves, with significant deposits located in Saskatchewan, Canada, and extending southward through Montana, the Dakotas, Nebraska, Kansas, Oklahoma, and into Texas. Ohio and other Midwest regions have documented large shale oil deposits, too.

Water management is a key element in the oil shale landscape because direct consumptive water requirements range from one to three barrels of water for every barrel of oil shale produced, depending upon the recovery technology being employed. However, NOSA points out that the quality of the required water also varies for commercial oil shale projects, and much can come from

non-potable sources. For instance the waste water currently produced from the oil and natural gas wells and coal-bed methane wells may be treated and used for various uses within an oil shale complex.

Moreover, the amount of water necessary for oil shale development compares favorably with other energy sources, according to NOSA. The consumption is much less than ethanol produced from irrigated crops and not significantly greater than fuel generated from conventional petroleum resources. Also, the required amount of water will likely be less as more advanced technologies evolve and alternative sources of water are developed.

Perhaps the greatest challenge for the oil shale industry currently lies in leasing rights and restrictions. The U.S. Bureau of Land Management controls more than 70 percent of the western oil shale resource. In

2008, BLM published a Programmatic Environmental Impact Statement that amended 10 resource management plans in Utah, Colorado, and Wyoming to make about two million acres of public lands potentially available for commercial oil shale leasing and development and 430,000 acres potentially available for tar sands leasing and development.

However, in spring 2011, BLM initiated a new planning effort to reassess the appropriate mix of public lands to be made available for oil shale and tar sands leasing. In November last year, new PEIS regulations for eight land use plans in Colorado, Utah, and Wyoming were issued. BLM's preferred alternative now reduces the leasing acreage available for new oil shale development projects to 676,967 acres and to 129,567 acres for tar sands development. Also, the new regulations only authorize research,

development, and demonstration projects, which can be later converted to commercial leases when all conditions and regulations of the RD&D lease have been satisfied and all further environmental reviews and public comment periods have been conducted.

Currently, there are oil shale projects or applications under operation or development by American Shale Oil, AuraSource, Colorado Energy Research Institute, ConocoPhillips, Enefit American Oil, Energy Dynamics Laboratory, Enshale, Exxon Mobil, Genie Energy, Hatch, Idaho National Laboratory, Natural Soda Holdings, Red Leaf Resources, Sage Geotech, Shell Mahogany Research, and Total.

January 2013

Overhaul of U.S. Patent System Creates Better Path for Innovation

By Steven J. Storts
Dublin, Ohio

THE America Invents Act, recently signed into law by President Obama, ends a nearly 60-year drought for enacting major reforms to the nation's patent system. Moreover, the new statute ends six consecutive years of congressional debate aimed at streamlining operations at the U.S. Patent and Trademark Office (USPTO) and improving the overall quality of patents that are granted.

The U.S. House of Representatives' version of the legislation (H.R. 1249) passed last June, which was identical to the Senate's measure (S. 23) adopted a few months earlier in March, was approved by the Senate in September. "We cannot stand on a 1950s patent system and expect our innovators to flourish in a 21st century world," says Sen. Patrick Leahy (D-Vt.), the bill's main Senate sponsor. "The America Invents Act will keep the nation in its longstanding position at the pinnacle of innovation."

In terms of the broad expectations for the new law, Rep. Lamar Smith (R-Texas), the legislation's main House sponsor, notes, "It is impossible for any one group to get everything it wants. Inventors, businesses, and other groups interested in patent reform don't agree on every issue that we've debated for the past six years. But our patent system doesn't affect an individual or company in the same way because each one uses the patent system in many different ways."

The recent legislation represents a fair compromise and creates a bet-

ter patent system than exists today for inventors and innovative industries, says Smith, pointing out that frivolous lawsuits and uncertainty regarding patent ownership have dragged down the nation's outdated patent system. He also says that unwarranted lawsuits, some costing as much as \$5 million for defense litigation, prevent legitimate inventors and industries from creating new products and generating jobs.

Leahy emphasizes that the patent system reforms will "improve patent quality and limit unnecessary and counterproductive litigation costs, while making sure no party's access to court is denied." Perhaps most significant, the new legislation will convert the nation's patent system to a first-inventor-to-file operation and provide USPTO with the necessary financial resources to improve quality and efficiency by providing the agency with fee-setting authority, subject to congressional oversight.

"The patent system envisioned by our founders focused on granting a patent to be awarded to the first inventor to register an invention, as long as it was not in public use when the inventor conceived of the invention," Smith explains.

Provisions of the 152-page America Invents Act were also crafted to address "true patent certainty and ensure that small businesses are able to compete with the larger companies on a global scale," which the current patent system does not encompass. Specifically, USPTO will establish a Patent Ombudsman Program to provide services to small business concerns and independent inventors on matters regarding patent filings.

Of interest to manufacturing and technology industries, the new law addresses preissuance submissions by third parties, introduces enhanced post-grant review procedures within USPTO, establishes special post-grant review for business method patents, and extends the deadlines for filing post-grant opposition. The threshold for instituting inter partes reexamination will also be modified, according to intellectual property attorneys Finnegan, Henderson, Farabow, Garrett & Dunner L.L.P., headquartered in Washington, D.C., with offices in California, Georgia, Massachusetts, and Virginia, and in Europe and Asia.

The new threshold, Finnegan notes, calls for a finding "that there is a reasonable likelihood that the requester would prevail with respect to at least one of the claims challenged in the request." Equally notable, the U.S. Court of Appeals for the Federal Circuit will serve as the only appeal route for ex parte reexamination decisions.

Although the America Invents Act was enacted September 16 of last year, numerous provisions will not be effective for as long as 18 months after enactment, requiring USPTO to promulgate regulations for implementation. However, already in effect is a 15 percent increase of all USPTO fees, but the agency does have some discretion in offering a new "micro entity" discount of up to 75 percent.

Finally, under the patent system reforms, Finnegan cites "substantial changes to the false marking statute," but also says patent holders may now use virtual marking via a Web site.

Also noteworthy, patent challengers who file proceedings may no longer rely on “best mode” as a defense to infringement.

How the new legislation will mesh with the intellectual property perspectives of NSPE’s Professional Engineers in Industry interest group remains to be seen. PEI’s past policies primarily have addressed intellectual property agreements or relationships between an employee and his or her employer (company). In summary, the following have become basic tenets for professional practice:

- The professional employee should cooperate fully with the employer in obtaining patent protection for any inventions.
- The professional employee should not divulge proprietary information.
- The employer should clearly identify proprietary information and should release those inventions and information generated by the employee, which are not useful to the employer.
- The employer should have an established method and formula for

compensation over and above salary and fringe benefits for the professional employee who generates inventions, patents, and other proprietary information for the employer.

- The employer should provide for accelerated promotion and extra compensation for superior performance and/or special accomplishments, including generation of proprietary information and patents.

March 2012

Mt. Rushmore: A Technically Skilled, Creative Release for a Restless Soul

By Steven J. Storts
Dublin, Ohio

TO gaze upon the majestic granite facade of Mt. Rushmore nestled in the Black Hills of South Dakota, one would not suspect that its sculptor, Gutzon Borglum, bore a restless youth. But this is often the case with creative genius. He once said, “American art ought to be monumental in keeping with American life, and Rushmore ought to be colossal in keeping with American achievements.”

Borglum, too, was colossal. When he died suddenly in 1941 at the age of 74, he left a lasting legacy of creating more art displayed in the nation’s capital than any other artist. As another sign of his artistic prominence, Borglum designed the flickering flame on the Statue of Liberty’s torch. Not only a prolific and talented artist, he was also an active political figure throughout his life.

Born in 1867 to Danish immigrants on the untamed frontier near Bear Lake, Idaho, Borglum became fiercely independent and rebellious at a young age. His restless spirit found peace only when he discovered his father’s artistic abilities at the age of 14. When Borglum arrived in the Black Hills in the early 1920s, he was 57 years old, but he fell in love immediately with the area, pointing out that the granite in the mountains was “exactly what he was looking for.”

Wanting to prepare something that future generations forever would be able to enjoy, the carving of Mt. Rushmore became the focus of his life for 17 years until his death. In fact, he died as the final dedication of the monument was being planned.

Borglum’s son Lincoln, who oversaw the carving when his father was away, completed the monument upon Borglum’s death.

America’s shrine to democracy was carved in stone as a record and celebration of the nation’s achievement, growth, and spirit. The four presidents chosen—George Washington, Thomas Jefferson, Abraham Lincoln, and Theodore Roosevelt—symbolized the birth and growing pains of a new nation, each representing a different stage of development. The mountain chosen for the monument’s construction was dedicated on August 10, 1927. The groundbreaking ceremony was symbolized by a set of drill bits handed to Borglum by President Calvin Coolidge.

The original surface of the mountain was soft and cracked, and nearly half-a-million tons of rock had to be removed to reach granite solid enough to begin carving. The actual carving time of Mt. Rushmore was six-and-half years spread over a 14-year period. Work was halted when funds diminished, or when weather became too severe.

Borglum developed the engineering techniques for mountain carving while working on the Confederate Memorial at Stone Mountain, Georgia. On both carvings, measurements of models were multiplied by a factor of 12 and transferred to the mountain via a boom and plumb line. Nine models were made before a grouping was found that would not be affected by the granite’s deep cracks. For example, Borglum originally specified Jefferson’s head to be on the left side of Washington’s (looking toward the monument) instead of his right.

Also, Washington’s nose had to be modified slightly, carved a little longer than earlier planned. And Roosevelt is tucked away in the corner of the monument because of the solid granite located there.

Still considered by many as an unsurpassed feat of technical skill, nearly 90 percent of Mt. Rushmore was carved using dynamite. During construction, most of the workers hung over the side of the mountain face in a type of chair with a swing-seat and harness, using their drills, air-hammers, and chisels. They were raised and lowered from the top of the mountain by cables attached to a winch. As workers neared completion, the surface of the rock was honey-combed with holes that weakened the surface rock, making it easier to knock off large sections of rock to do the final shaping of the monument faces with hand chisels. Air-hammers and grinders later helped to make the final surface smooth like a sidewalk.

According to original specifications, Mt. Rushmore was to display full-bust figures of the four presidents, but when Borglum died unexpectedly and Lincoln took over the project, it was decided that future blasting should be halted to avoid any damage to what already had been carved. Therefore, shortly after Borglum’s death in 1941, the monument was officially dedicated. And in what perhaps could be regarded as a final tribute to Gutzon Borglum and his engineering prowess, no fatalities were incurred while constructing Mt. Rushmore, only a few minor accidents with no serious injury.

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