



The Environmental Synopsis

A Monthly Update from the Joint Legislative Air and Water Pollution Control and Conservation Committee

AUGUST 2017



The Chairman's Corner Senator Scott E. Hutchinson

A few months ago, I read an article in the Philadelphia Inquirer about an entrepreneur looking to convert an abandoned strip mine in Schuylkill

County into a giant liquid battery. Yes, it sounds like something from a science fiction movie, but “pumped storage hydropower” has been a proven energy source for decades, and is now seeing renewed interest, even as a potential use for some of Pennsylvania’s legacy coal mines.

The June 16 article focuses on a proposed project at the Shen Penn mine pit near Shenandoah. The 40 acre, 230-foot-deep mine was abandoned in the 1960s, and has since filled with water. It was long considered a public nuisance, until it caught the eye of a Bucks County energy firm. Merchant Hydro Developers LLC is considering Shen Penn, along with 20 other properties in Pennsylvania, for use as pumped storage hydropower stations, which support the electric grid during peak demand. A few of the sites are located near abandoned mines to utilize the existing reservoirs.

So, what is pumped storage and how does it work? It really boils down to two key components: geography and water. The system consists of two reservoirs, one at a higher elevation, along with a pumping and generating station. Water is released from the upper reservoir, through

the generator, to the lower reservoir, creating electricity much like conventional hydropower. The advantage is that the energy is on-demand, and can stabilize the electric grid on short notice.

Pumped storage is typically utilized during peak demand, giving the grid a much-needed boost of electricity. At night, when electricity is cheaper, the water is pumped back to the upper reservoir so the process can be repeated. Pumped storage stations are often located near wind turbines, where renewable energy is used to further offset the cost of pumping large volumes of water. Such is the case with the Shen Penn project, which is located near two large wind farms.

Overall, pumped storage stations are a net energy consumer due to their power-intensive water pumping process.

What makes them profitable, however, is their ability to sell wholesale electricity during peak demand, when electric rates

Continued on page 8



IN THIS ISSUE

August 2017
Volume 18, Number 8

The Chairman's Corner.....	1
Notes from the Director	2
Research Briefs	3
• Mississippi River Plagued by Nitrogen, Phosphorus	
• Turning Harmful Algae into Clean Energy	
• Rising Temps Could Ground More Flights	
• PA Struggling to Kindle Green Energy Markets	
On the Horizon.....	7
This Month In Conservation History.....	7

Notes from the Director

Tony M. Guerrieri, Executive Director

As I mentioned in last month's column, Henry David Thoreau loved walking through the woods with no destination in his mind at all. He was a serious walker. Actually, he liked to call it sauntering. Thoreau didn't just walk through the forest, he sauntered. Today, the ability to saunter slowly through a forest is considered a valuable component of quality-of-life. In fact, there is a Japanese concept called *shinrin-yoku*, which translates roughly as "forest bathing," or basking in the forest atmosphere, which says that when you are feeling stressed, one of the best things you can do is go for a walk in the forest. So what exactly is forest bathing, and what are its benefits?

Forest bathing was developed in Japan in the 1980s specifically to combat stress. This mind-body fitness trend involves using the revitalizing effects of time spent in nature to promote physiological and psychological health. We're not talking about a vigorous hike or sneaking in a cardio session. The increasing popularity of *shinrin-yoku*, particularly in California, echoes the adoption of other east-to-west health trends, such as yoga and meditation.

In this Japanese practice, the participant goes into the woods in a meditative and reflective mindset. An ideal forest therapy session is about two hours per week spent meandering through a wooded area with no particular destination in mind. The aim of forest bathing is to slow down and become immersed in the natural beauty



and stillness of the woods. It's about taking solitary walks through the trees and using your five senses to reconnect with nature. It is a time to tune into the smells, textures, tastes and sights of the forest – the flutter of birds, the gentle gurgle of water flowing over rocks and the swaying of trees back-and-forth in the wind.

Forest bathing is a form of Japanese therapy that encourages participants to immerse themselves in nature. Several studies show the idea isn't as far-fetched as you might think.

Scientists are now trying to pinpoint the positive effects of being in nature and understand the mechanisms that drive them. In recent years, Japanese researchers have suggested that walking in the forest can lower levels of salivary cortisol, a hormone that is associated with stress, when compared with those who walked through a city setting. It lowers heart rates and blood pressure; increases parasympathetic nervous system activity, which is associated with relaxation; and reduces sympathetic nervous system activity, which is associated with stress and the well-known "fight or flight" response.

Other experts highlight the olfactory benefits of walking near trees. Studies have shown for example, that phytoncides – antimicrobial compounds released into the air from plants and trees for pest control – can lead to decreased levels of stress hormones and increased natural killer cells (a type of white blood cell that fights infected or tumor cells). It is considered so effective that it is covered by health insurance in Japan.

Japan has designated close to 50 forest therapy trails for *shinrin-yoku*. An official

forest therapy trail must meet certain criteria to be recognized by the government, including scientific evaluation of its healing ability. In America, however, there are no set guidelines for what constitutes a forest bathing environment, mainly because it is not recognized by mainstream medicine.

While the exact mechanisms of *shinrin-yoku* remain largely unknown, the practice itself continues to spread. The phenomenon is starting to gain traction in the U.S. For example, in 2012, the San Francisco-based Association of Nature & Forest Therapy was created to promote forest bathing. One of its goals is to encourage health care providers in the U.S. to incorporate forest therapy as a stress-reduction strategy. There is no question that stress and anxiety take a terrible toll on health in the U.S.; a 2015 study found work-related stress accounts for up to \$190 billion in health care costs.

So how does one practice a session of forest bathing? It is actually very easy:

- Go for a walk in the woods (or saunter if you prefer).
- Leave all your digital devices behind so that you can be fully present in the experience.
- Wander around. Let curiosity be your guide.
- Pause from time-to-time and soak in the natural environment.
- While walking slowly, try to use all five senses.
- Find a good spot to sit comfortably and listen to the sounds around you.

The other great part about *shinrin-yoku* is that Pennsylvania is an ideal place to practice. With more than 100 state parks and conservation areas and 2 million acres of state forests, there are endless opportunities to go out and reconnect with nature and yourself.

Research Briefs

Each month, the committee's staff researches and prepares a number of "briefs" on several topics relevant to the committee's mission. Very often these briefs include references to reports and further research on the topics so that readers may pursue issues on their own. Please note that the information and opinions expressed in the Research Brief articles do not necessarily represent the opinions or positions of the Joint Legislative Air and Water Pollution Control and Conservation Committee, nor those of the Pennsylvania General Assembly.

Strategy to Improve Mississippi River Off to Slow Start

Tony M. Guerrieri, Executive Director

The Mississippi River begins at Lake Itasca in northwestern Minnesota. Flowing south, over its 2,300-mile course, the river touches 10 states before entering the Gulf of Mexico. It forms the boundary or part of the boundary of nine of those states. It serves as a source of drinking water for 18 million Americans in 50 cities. Funneling fresh water into the Gulf, the Mississippi sustains robust fisheries, which provide food, jobs and economic security to millions of people.

Each year, heavy rains and melting snows wash massive amounts of nutrients – mostly nitrogen and phosphorous – from sewage treatment plants, farms and other sources into the Mississippi. The nutrients flow downriver posing health hazards to the people and wildlife that rely on the Mississippi, as well as considerable economic risk to the communities along the way.

Every summer, nutrients are responsible for the Gulf of Mexico hypoxia zone. Commonly called the dead zone, this is a massive area of water – nearly the size of Rhode Island and Connecticut combined – that chokes marine life, hampers recreation and tourism, and jeopardizes the region's \$2.8 billion a year fisheries.

The good news is that water pollution from phosphorus and nitrogen is preventable, but it takes cooperation, regulation, enforcement and public support to keep sources of pollution in check.

According to a report by the Mississippi River Collaborative (MRC), the U.S. Environmental Protection Agency (EPA) and the states that border the Mississippi River are not doing nearly enough to protect the waterway and its tributaries from pollution and contamination.

The report, entitled *Decades of Delay*, examines federal EPA clean-water efforts for the Mississippi River along with the 10 river states – Arkansas, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Tennessee and Wisconsin.

The Mississippi River is the economic lifeblood of many communities in the South and Midwest. Nitrogen and phosphorus pollution pose a significant threat to river-reliant industries.

The EPA has called on states to address the matter and in 2011 recommended eight policies to help curb pollution from excess nutrients like nitrogen and phosphorus. The MRC report argues that the federal agency has offered no enforceable regulations, deadlines for improvements or funding to implement their proposals. And, because the EPA's recommendations were voluntary, no state has implemented more than two of the eight proposals.

The report found that no state has numeric limits for nitrogen and only Minnesota and Wisconsin have limits for phosphorous, a nutrient from wastewater treatment plants and agriculture that pro-



duces algae blooms that can kill aquatic life and contaminate drinking water. Other findings show that only 1.6 percent of rivers and streams in the 10 states are tested for phosphorous and less than 1 percent for nitrates. Only 3.7 percent are tested for dissolved oxygen, an indicator of nutrient pollution.

Lakes and reservoirs in the 10 states fared better, but their testing rates were still low. Only 26.3 percent were tested for phosphorous, 4 percent for dissolved oxygen and less than 2 percent for nitrogen. No Mississippi River border states use a permitting system to limit nitrogen discharges from sewage plants and other industrial sources. Nearly 62 percent of permits that regulate phosphorus discharges have neither limits nor requirements for monitoring.

Few water body clean-up plans – none in six Mississippi border states and just 5 percent in the four remaining states – include provisions addressing pollution from direct discharges and runoff. Among clean-up plans that included efforts to reduce pollution from runoff, 92 percent lacked follow-up to see if the reductions were reached.

Because states are either unwilling or unable to solve the pollution problems, the MRC report argues that the EPA must set actual pollution limits and provide the regulatory framework and enforcement to back them up. The report highlights six specific steps the EPA can take to protect human health and water quality in the Mississippi River.

Recommendations include setting numeric limits of allowable nitrogen and phosphorous in state waters, assessing water quality for nitrogen and phosphorus pollution that created impaired waterways, and ensuring states develop nutrient reduction strategies with specific implementation plans and adequate funding.

Meanwhile, the EPA extended its deadline for reducing the Gulf of Mexico's dead zone from 2015 to 2035.

The Mississippi River Collaborative is a coalition of 13 state and national environmental and legal organizations dedicated to protecting "America's Great River." The report, *Decades of Delay: EPA Leadership Still Lacking in Protecting America's Great River*, is available for download at: <http://www.msrivercollab.org/wp-content/uploads/Decades-of-Delay-MRC-Nov-2016.pdf>.

Scientists Aim to Harness Energy from Algae

Coleen P. Engvall, Research Analyst
Algal blooms have been making headlines more often over the last several years. Depending on the size and species of algae, these blooms can do much more than interrupt swimming. In the Gulf of Mexico, along California's coasts and even in our own Lake Erie, algae have been thriving to the point of harming the environment, infrastructure and human health. These events have been happening more frequently, due in part to the agricultural runoff and warmer water temperatures.

Nutrients such as phosphorus and nitrogen are used as fertilizer for crops, but they

are also food for algae and can help exacerbate blooms. Many of these blooms are so large they can even be seen from space. One of the characteristics that make algae such a pest in water systems is its ability to double its population in less than a day, under the right conditions.

Small blooms can become harmful by creating hypoxic areas and suffocating fish and other aquatic life. Toxins released by algae can poison other wildlife, such as birds and amphibians, and can even reach humans via insufficiently treated water or direct contact.

Researchers with Sandia National Laboratories have been working to see if these dangerous, costly blooms can be utilized for beneficial purposes. The two properties listed above – appetite for nutrient loads and exponential reproduction – have been the basis for their experiments.

Researchers with Sandia National Laboratories designed new methods of harvesting algae that produce efficient biofuels and clean pollutants from the water.

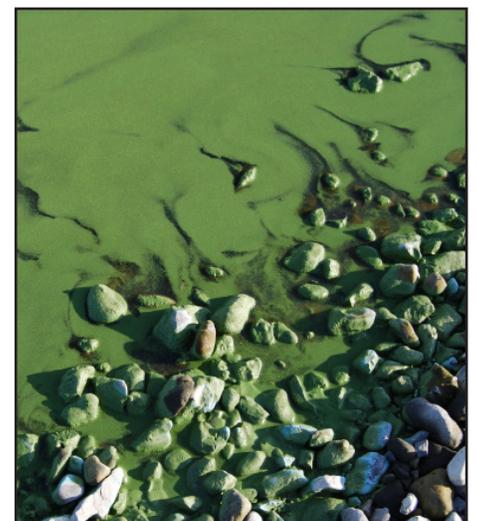
Algae are already grown to produce materials such as beta carotene, and more importantly to this study, biofuels. The Department of Energy cites research that shows that algae can be anywhere from 10 to 100 times more productive than other biofuel sources due to its rapid growth in relatively small areas. Once harvested, the algae can be processed into energy-dense fuels. Currently, it's produced in farms that resemble large ponds or racetracks, however these are difficult and expensive to manage and can fall victim to pests and disease. Another concern is the amount of water it takes to produce viable amounts of the algae, and the need for clean water and costly fertilizers.

The Sandia researchers sought to improve on this system, recognizing that the fertilizers algae have an appetite for already exist in large quantities in many lakes. They focused their efforts near the Salton Sea, a polluted lake in California, which has seen harmful algal blooms from nearby agricultural industries. Fish and bird deaths have been recorded each year from hypoxic areas and from toxins released by the algae.

By using water from this lake, there was no need to add expensive fertilizer for optimal algae growth. In fact, the water that leaves the system is cleaner than the original lake water. So, while the process is still water-intensive, a common criticism of the project, researchers argue that the polluted water is useless and even dangerous in its current state. Many other industries add impurities to the water used in the manufacturing process, but the algae consume the pollutants.

The Sandia Laboratories process has also shown that it can make substantial harvests of locally occurring algae, unlike the traditional process. Local algae are more resilient to any pests or diseases which may have destroyed an entire harvest of imported algae species. This may improve the economic viability of the process.

In the future, researchers hope that algae's ability to double its weight several times per day, consuming polluting nutrients, may make it eligible for



water-quality trading programs, further increasing profitability. Additionally, its use as a carbon-consuming biofuel may make it eligible for air-quality trading. The researchers hope that their study and future research will improve the outlook of algae as a biofuel stock.

To read the laboratory's initial press release, go to: https://share-ng.sandia.gov/news/resources/news_releases/salton-algae/#.WYxSgFWGNhG.

Climate Change, Hotter Temps Could Affect Airplane Takeoff

Tony M. Guerrieri, Executive Director

According to a study from Columbia University's Earth Institute, rising temperatures due to climate change could make it increasingly difficult for planes to take off without shedding extra weight. The study, *Impacts of Rising Temperatures on Aircraft Takeoff Performance*, concludes that in the coming decades, during the hottest parts of the day, 10 to 30 percent of fully-loaded planes may have to remove some fuel, cargo or passengers, or else wait for cooler hours to fly.

Researchers are just beginning to explore how climate change affects aviation and planes' ability to fly. In the aviation business, really hot days are called "weight restriction days," because when it is hot, heavy planes can't get off the ground.

As air gets hotter, it spreads out, and its density declines. In thinner air, wings generate less lift as a plane races along a runway. Thus, depending on aircraft model, runway length and other factors, a packed plane may be unable to take off safely if the temperature gets too high. Weight must be dumped, or else the flight delayed or canceled.

Average global temperatures have gone up nearly 1.8 degrees Fahrenheit since 1980, and this may already be having an effect. Over three days in June 2017, American Airlines canceled more than 40 flights out of Phoenix, Arizona, when daytime highs of nearly 120 degrees made

it too hot for smaller regional jets to take off. Worldwide, average temperatures are expected to go up as much as another 5.4 degrees by 2100. The flights affected by the heat tend to be on smaller regional carriers, which use planes that operate under lower maximum temperatures.

That is only part of the story; heat waves will probably become more prevalent, with annual maximum daily temperatures at airports worldwide projected to go up 7.2 to 14.4 degrees by 2080, according to the Columbia study. These heat waves may produce the most flight disruptions.

Most studies thus far have focused on how aviation may affect global warming. Aviation is a major producer of global greenhouse gas emissions, responsible for about 2 percent of human-made emissions each year. A handful of studies, however, have warned that a warming climate may increase dangerous turbulence along major air routes. It is predicted there will be more incidents of severe clear-air turbulence, which typically comes out of the blue with no warning, occurring in the future as climate change takes its effect in the stratosphere.

In 2015, Columbia climatologists published a smaller-scale study, predicting up to four times more future temperature-related takeoff problems for the common Boeing 737 at Phoenix, Denver, New York's LaGuardia and Washington's Ronald Reagan.

The study focused on these four high-risk airports: Phoenix, for its high summer temperatures; Denver, because of its elevation and thinner air; and New York's LaGuardia and D.C.'s Reagan airports, because they have short runways relative to other major airports. The new study projects the effects on a wide range of jets at these, plus 15 of the other busiest airports in the U.S., Europe, Middle East, China and Southeast Asia.

It is estimated that if carbon emissions continue

unabated, fuel capacities and payload weights will have to be reduced by as much as 4 percent on the hottest days for some aircraft. If the world somehow manages to sharply reduce carbon emissions, such reductions may amount to as little as 0.5 percent, according to the study. Either figure is significant in an industry that operates on thin profit margins. For an average aircraft, a 4 percent weight reduction would mean 12-13 fewer passengers on an average 160-seat plane. This does not count the major logistical and economic effects of delays and cancellations that can instantly ripple from one hub to another.

If carbon emissions continue unabated, up to 30 percent of fully-loaded airplanes may have to shed fuel, cargo or passengers to facilitate take-off in high temperatures.

Some aircraft with lower temperature tolerances will fare worse than others, and certain airports – those with shorter runways, in hotter parts of the world or at higher elevations, where the air is already thinner – will suffer more.

For instance, facing LaGuardia's short runways, a Boeing 737 may have to offload weight half of the time during the hottest days. Dubai, in the United Arab Emirates,



might be worse; its runways are long, but its temperatures are already very high. Airports likely less affected because they are in temperate regions and have long runways include New York's JFK, London Heathrow and Paris's Charles de Gaulle.

The heat can also create issues for ground crews, where pavement temperatures can reach more than 150 degrees, creating life threatening conditions if workers are exposed for too long.

The Columbia University study, which is the first such global analysis, appears in the journal *Climate Change*. The study, *The Impacts of Rising Temperatures on Aircraft Takeoff Performance*, is available at: <https://link.springer.com/content/pdf/10.1007%2Fs10584-017-2018-9.pdf>.

Addressing Barriers to Pennsylvania Green Energy Markets

Coleen P. Engvall, Research Analyst

The global energy market has experienced a great deal of change over the last few decades. New technologies are allowing us to unlock electricity from unconventional sources. Biofuels are being extracted from agricultural by-products, solar cells are becoming more efficient and, as seen in our own state, hydraulic fracturing is allowing access to large stores of natural gas. These are just a small sample of how



scientists and energy providers are revolutionizing the markets.

With these new possibilities, some states are asking what balance they should be striving for. Some cities and states have committed to carbon-free sources, while others are looking for a mix to maximize savings for businesses and citizens while minimizing pollution. Grid reliability and cyber security are also emerging priorities for state and local governments.

The Nature Conservancy (TNC), along with the Coalition for Green Capital, published an analysis of Pennsylvania's energy economy in February. The report focused on how the state's energy sector could be maximizing its potential for clean energy investments. It also summarized the amount of clean technologies and markets already in use.

Last month, a follow-up analysis was released, the Pennsylvania Energy Investment Partnership Report. This installment delved deeper into the specific mechanisms and structures that would be needed to realize Pennsylvania's full clean energy potential. They note that, currently, Pennsylvania generates only 4 percent of its electricity from renewable sources. Aside from creating air pollution and emitting greenhouse gases, they argue this is a missed opportunity for investments.

Before identifying potential clean energy solutions, the report details what it believes are the current gaps in the market. For example, solar power and energy efficiency in low-income households, small businesses and industries were identified as underdeveloped markets by contractors, investors and other stakeholders. The report defines "underdeveloped" as markets where consumer and private investment lags behind potential. Residential solar, for example, is financially viable for many consumers, yet few people actually own solar panels. This discrepancy may be caused by lack of financing mechanisms. Without these mechanisms, the initial investment may make the technology seem inaccessible

to many consumers, and local contractors cannot remain competitive with national installers.

Pennsylvania is already a national leader in energy efficiency jobs, with over 50,000 people employed by the industry. However, the TNC argues that whole-home energy efficiency has been overlooked, with the majority of the efforts focused on cleaner-burning fuels for heating. Other improvements could include better sealing and insulation. Again, the researchers argue this lag could be helped by better financing mechanisms. There are a few loans and rebates currently available, but homeowner awareness is low, resulting in underwhelming participation.

The Nature Conservancy identified the lack of financing mechanisms and consumer awareness as two main reasons for Pennsylvania's lackluster green energy market.

For most of the problems highlighted in the report, the TNC points to a lack of financing options, consumer awareness and ease-of-access to government help and programs. They note that other states have alleviated some of these deficiencies with Energy Investment Partnerships (EIPs), public private partnerships dedicated to financing green and renewable projects. Their funds can come from a variety of sources, state and federal allotments, as well as the private sector investors, credit unions and other institutions.

To read the full report, go to: <https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/energy-investment-partnership-report-2.pdf>.

Committee Chronicles

A review of memorable Committee events

Monday, October 16, 12 p.m.

Environmental Issues Forum

Room 8E-A, Capitol East Wing, Capitol Complex, Harrisburg

Joining us for the October forum will be representatives from the Department of Conservation and Natural Resources who will discuss their new initiative, "Penn's Parks for All—Planning for the State Parks of Tomorrow." The department is updating their state park master plan for the first time in 25 years, incorporating a more modern approach to park management. Presenters will discuss their efforts in depth, including a new public survey launched this summer.

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You can now receive updates on committee events, new research and more by following the Joint Legislative Conservation Committee on social media.

You can find us on Facebook at www.facebook.com/jointconservationcommittee, or on Twitter at www.twitter.com/PA_JLCC. Take a moment and follow us today for the latest on issues related to Pennsylvania's diverse natural resources.

This Month in Conservation History

Exploring the Evolution of Environmental Stewardship

296 Years Ago

On August 26, 1721, Provincial Governor Sir William Keith enacted Pennsylvania's first game law, setting a deer season from July 1 to January 1. The fine for hunting in the off-season was 20 shillings; however, Native Americans were not subject to the law. Today, the firearms season for antlered deer is much shorter – less than two weeks – but it continues to be a popular pastime. An estimated 550,000 hunters participated in the season's opening day last year.



96 Years Ago

Ralph W. Abele was born on August 13, 1921, on a farm just outside of Pittsburgh. Abele is widely considered one of the most important figures in Pennsylvania's conservation history. As the first director of the Joint Legislative Conservation Committee, he crafted some of the state's first air and water pollution control laws. Perhaps Abele's most notable accomplishment was the adoption of the Conservation Amendment to the Pennsylvania Constitution in 1971, which guarantees the public right to a clean and healthy environment. Ralph passed away in 1990 at the age of 69.

Image retrieved from witf.org

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The Chairman's Corner

continued from page 1

are at their highest. As energy consumption continues to climb in the U.S., investors are beginning to see value in this proven technology.

Nationwide, there are 42 pumped storage hydropower stations currently in operation, according to the U.S. Department of Energy (DOE). One of these facilities, the Seneca Pumped Storage Generating Station, is located in my district near the Kinzua Dam in Warren County. Together, our nation's facilities can produce over 21,600 MW of electricity, roughly a fifth of the nation's total hydroelectric capacity.

It may not seem like much until you consider that pumped storage accounts for over 95 percent of the nation's utility-grade power storage facilities. These stations play a key role in keeping electricity flowing to homes and businesses across the country.

Pumped storage is not unique to the U.S.; other countries are rapidly seizing the opportunity that these facilities create for energy production and grid stability. Europe and Japan are leading the charge, together accounting for over 60 percent of the world's pumped storage hydropower.

Despite its potential for energy storage and production, pumped storage hydropower does face several significant hurdles. For one, the regulatory process is extremely complex. The permitting timeline averages about five years, which can discourage many potential investors.

According to the Inquirer, the Federal Energy Regulatory Commission (FERC) has only approved two pumped storage facilities in recent years. There are currently 60 projects in FERC's queue awaiting licensing and permitting, including 17 of Merchant Hydro Developers projects here in Pennsylvania.

Industry advocates, including the National Hydropower Association, have argued that FERC and other regulators should consider an expedited permitting process for less invasive projects, such as off-river, closed loop systems, like Shen Penn. This would allow developers to take advantage of financial incentives geared toward more short-term projects and get more generating capacity online.

Pumped storage hydropower produces a fifth of the nation's hydroelectric generating capacity, and it is receiving renewed attention as a way to stabilize the electric grid during peak demand.

Another potential disadvantage is the upfront cost. The DOE estimates that pump storage projects cost over \$2,500 per kilowatt to develop. That means even a smaller, 430 MW facility like Seneca would total more than \$1 billion in capital expenditures. The industry argues a solution would be to offer tax credit opportunities like other renewable energy projects. This could help stabilize the market and provide certainty to would-be investors.

As the U.S. continues to grapple with the energy challenges of the 21st century, will pumped storage hydropower be part of the solution? It is still too early to tell, but I believe it should be considered part of our nation's energy portfolio, particularly if it has the potential to re-purpose legacy resources. If developed responsibly, it is a clear win-win situation for Pennsylvania.