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NUCLEAR POWER: WEATHERING THE STORMS

NWI

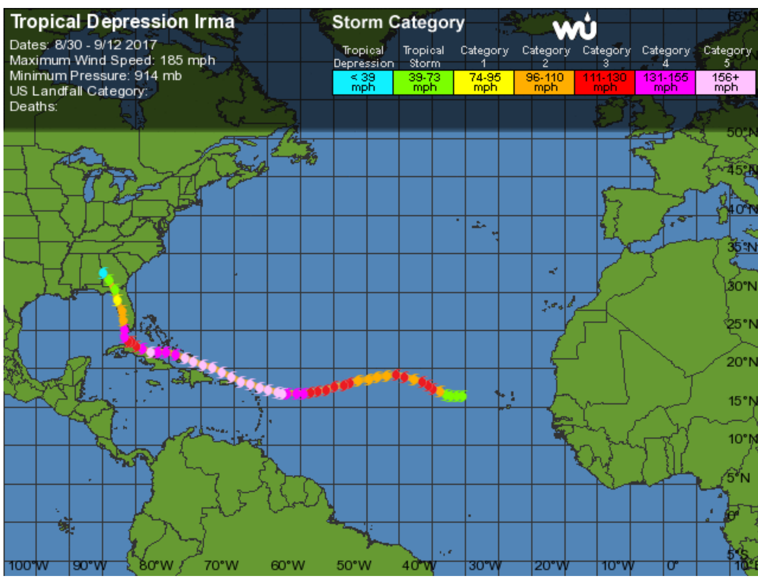
Nuclear Power: Weathering The Storms

HURRICANE IRMA CAUSED ONE OF THE LARGEST NATURAL DISASTER POWER OUTAGES IN US HISTORY

11 September 2017 - Two nuclear units at St Lucie were able to continue operating as Hurricane Irma made landfall in Florida. One unit at Turkey Point was shut down as a precaution in advance of the storm as nuclear operators and regulators put storm preparation procedures into action, while the other shut down automatically because of a valve-related issue. Two Florida Power & Light (FPL) plants - Turkey Point and St Lucie - lay in the direct path of the hurricane as it approached the continental USA after causing extensive damage in the Caribbean.

The company on 7 September declared an "unusual event" - the lowest of the US Nuclear Regulatory Commission (NRC) emergency classifications - at Turkey Point after the US National Weather Service issued a hurricane warning for the area, and on 9 September "conservatively" shut down one of the plant's two reactors.

As Irma's path changed, the decision was made to leave the second Turkey Point reactor online, as hurricane force winds were no longer expected at the site. Unit 4 shut down automatically on the evening of 10 September due to a "valve issue", the NRC said.



Wind and rain have diminished at the site such that Turkey Point staff exited their declaration of an "unusual event" earlier today.

No plans were put in place for closures at St Lucie, where projected wind speeds remained below the hurricane level, but the NRC on 11 September said operators were reducing power on unit 1 due to salt buildup on insulators in the switchyard that supplies offsite power. The unit was subsequently shut down, with St Lucie 2 remaining at full power.In preparation for the hurricane, staff at Turkey Point, St Lucie and other nuclear plants in the south-eastern USA worked through severe weather procedures, including ensuring that all loose debris and equipment had been removed or secured and conducting walk-downs of important systems and equipment. Preparations were verified by NRC inspectors.

The NRC dispatched additional inspectors to Turkey Point and to St. Lucie, and on 10 September the regulator activated its Region II Incident Response Center in Atlanta, Georgia. The incident response centre is now monitoring potential effects from Irma, now classed as a tropical storm, on the Hatch plant in southern Georgia and the Farley plant in southern Alabama.

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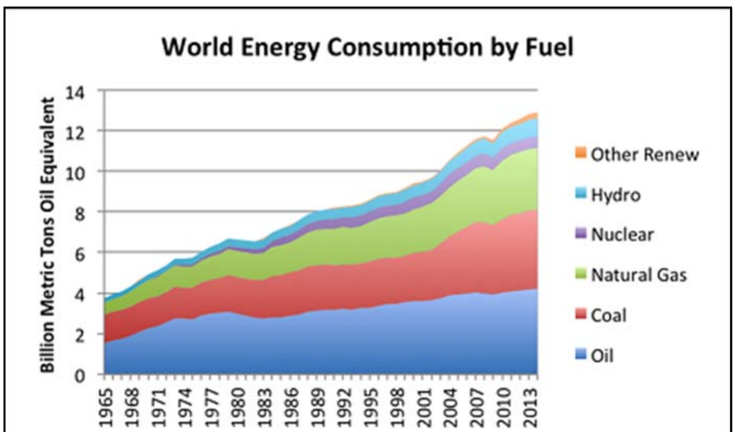
As well as making preparations at its operating nuclear plants at Vogtle and Hatch, Georgia Power also put took action at the Vogtle nuclear construction site, where two AP1000 reactors are being built. In addition to walk-downs of the site to identify and secure potential hazards that could result from heavy winds, crane booms were lowered, pumps delivered to help mitigate flooding in critical areas, and weather plans put in place to ensure the safety of the site and employees, the company said. Hurricane Irma initially made landfall in the Caribbean as a Category 5 hurricane with sustained wind speeds of more than 185 miles per hour, which made it the second-largest hurricane ever recorded. It made landfall in Florida on 10 September as a Category 4 hurricane. More than 4.6 million customers were left without power as the storm worked its way through the state. The US National Hurricane Center said on 11 September that Irma had weakened to a tropical storm, but was still producing some wind gusts near to hurricane force. The centre of the storm was forecast to move into southern Georgia later that day, continuing into southwestern Georgia and eastern Alabama. FPL president and CEO Eric Silagy said yesterday the company had experienced over 5 million power outages as a result of Irma, the first storm ever to impact all of its service areas across the state of Florida. A team of more than 19,000 workers is now working to restore power supplies.

(Researched and written by World Nuclear News)

How Much Fuel Does It Take To Power The World?

Sep 20, 2017 - Artificial lights strongly overlap with the concentrations of Earth's population, showing the locations of light pollution, but also showcasing how widespread our energy use is. Over the past few centuries, the quality of life for the overwhelming majority of the world has increased precipitously. Amenities brought by the widespread availability and distribution of electricity have brought us into the industrial and then the information age. Every day, billions of people access computers, lighting, rapid transportation, phones and innumerable other technologies and conveniences made possible only by using energy. Yet at its core, the energy we access and use simply arises from the conversion of some sort of potential energy. **While there are renewable sources such as hydroelectric, wind, and solar, most of our energy comes about by burning fuel.** There are many different sources available for this — some practical, some possible, some only theoretical — that illustrate just how much, or how little, the world actually needs. According to the United States' Energy Information Administration, one of the major world sources that gathers information about the world's energy use, **the amount of energy supplied by all the sources of energy across the world is tremendous: 155,481 TeraWatt-hours as of 2014, the latest year on record.** Different fuel sources have different efficiencies for conversion into power and for long-and-short-range transport, so the total amount of energy consumed by households, industries, and businesses is a bit less: only about 70% of that. But the amount of energy the world needs to generate — the equivalent of 5.60×10^{20} Joules — is pretty hard to fathom. So let's break it down a little differently, and look at the amount of fuel needed to provide that much power.



Gail Tverberg / Our Finite World, World energy consumption by fuel, based on BP Statistical Review of World Energy 2015.

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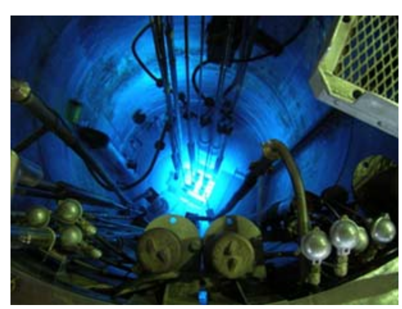
Coal**: First used as a heat source due to its compact nature, coal is a form of carbon which can be burned, in the presence of oxygen, to release energy. This is how all fossil fuels, or any carbon-based fuel, works on Earth, where oxygen is abundant in our atmosphere.* ***For every kilogram of coal that gets burned, a total of 2.312 × 10^7 Joules of energy gets released, meaning we need to burn a total of 24 billion tonnes of coal in order to meet Earth's energy needs. *As it is, coal is responsible for about a third of our world's current energy production, which means that 8 billion tonnes of highly-polluting coal gets burned every single year.*

Oil**: This includes diesel, gasoline, heavy fuel oil, and liquified petroleum, among others. While coal was the dominant fuel of the 18th and 19th centuries, oil rose to prominence in the 20th century with the advent of the automobile and the airplane. Like coal, oil relies on combustion; unlike coal, oil will net you more energy for the same mass of fuel.* ***For every kilogram of oil (in the form of gasoline) that gets burned, a total of 4.64 × 10^7 Joules of energy is liberated, which would mean 12 billion tonnes of oil are needed to power the planet in a given year. *Since oil first entered widespread use in the 1850s, it's estimated we've burned somewhere between 100 and 135 billion tonnes of oil, with another 4 billion tonnes burned every year at the present rate.* The KEPCO Tanagawa No2 Oil-fired power plant, one of many oil-fired power plants in the world. Much of the oil used, however, goes to mobile sources rather than stationary ones, as depicted on the right.

Gas**: You've likely heard that replacing other fossil fuel sources with liquid natural gas (LNG) has brought about the greatest reduction in environmental pollution in recent years. It's true;* ***LNG now supplies over 20% of the world's energy needs, is more fuel-efficient than both coal and oil, and has fewer toxic pollutants in it than either one. For every kilogram of LNG that undergoes combustion, 5.36 × 10^7 Joules of energy can be gained, meaning it would take a mere 10.4 billion tonnes of gas to power the world. *These are still huge numbers, though, and there is no reduction in terms of one important pollutant — Carbon Dioxide — to be gained by choosing gas over coal or oil. To achieve that goal, we need to look away from carbon-based fossil fuels. LNG tanks of cruise ferry MS Viking Grace owned and operated by Finnish shipping company Viking Line Abp. The LNG tanks are located outdoors on the rear deck. Viking Grace is the world's first large passenger ship that uses liquefied natural gas (LNG) as its fuel.*



***Nuclear**: Instead of using carbon-based fuel, we could instead look to the heavy, fissionable elements present on Earth: elements like uranium or thorium. Uranium breeder-reactors take advantage of the fact that when U-235, the second-most common isotope of uranium, is hit with a slowly-moving neutron, it absorbs it and splits apart into lighter elements, releasing further neutrons and enabling a chain reaction to be set off. Nuclear reactors successfully control the*

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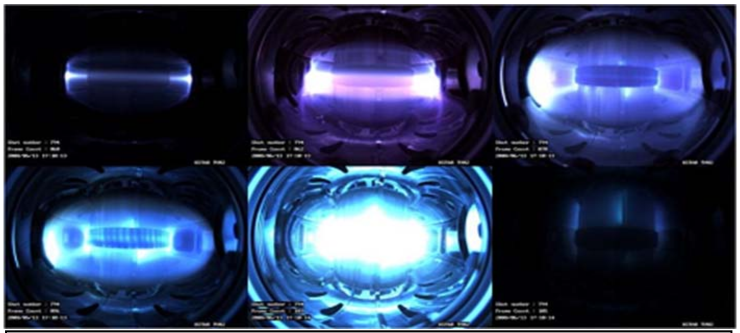
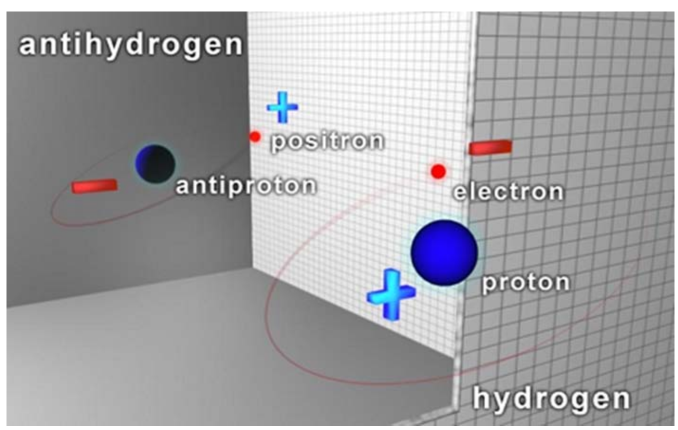
rate of reaction, allowing the rate of energy production to be tuned as well. Although U-235 is far less abundant than coal, oil, or gas, and requires heavy refining to produce reactor-grade fuel, ***nuclear power is far more efficient, with 8.06 × 10^{13} Joules of energy released for every kilogram of uranium in a breeder reactor. To power the world, it would only take 7,000 tonnes of uranium fuel each year.*** *Nuclear power currently provides only a few percent of the world's energy, with 444 reactors currently operating and another 62 presently under construction. Picture of Reactor nuclear experimental RA-6 (Republica Argentina 6), en marcha. As long as there's the right nuclear fuel present, along with control rods and the proper type of water inside, energy can be generated with only 1/1,000,000th the fuel of conventional, fossil-fuel reactors.*



PPPL management, Princeton University, the Department of Energy, from the FIRE project
A fusion device based on magnetically confined plasma. Hot fusion is scientifically valid, but has not yet been practically achieved to reach the 'breakeven' point.

Nuclear fusion: We don't presently have this technology as a viable power source on Earth, but nuclear fusion is one of the holy grails of the energy world. Abundant, light elements (like hydrogen and its isotopes) can be fused together into heavier elements, releasing a tremendous amount of energy in the process. This is the energy process that powers the Sun, where the heavier elements actually have less mass than the lighter elements that went into creating them; the release of energy via Einstein's $E = mc^2$ is where nuclear energy comes from. **Even more efficient than fission, nuclear fusion would liberate 6.46 × 10^{14} Joules of energy per kilogram of hydrogen fuel, meaning it would take a mere 867 tonnes of hydrogen to power the world.** The abundance of hydrogen, the lack of atmospheric pollution, and the controllable nature of radioactive products to come out of fusion makes it the most promising energy source of the future.

__Antimatter__: Why not dream of the ultimate energy source: antimatter! If nuclear fission and fusion reactions both enable the release of a substantial fraction of a particle's mass in the form of energy, why not simply convert the whole thing? When you collide an antimatter particle with its matter counterpart, that's exactly what you get. ***A perfect conversion of antimatter-and-matter into energy releases 8.99 × 10^{16} Joules of energy per kilogram of combined matter/antimatter, which means you only need 3.1 tonnes of antimatter (and another 3.1 tonnes of matter) to power the whole world for a year.*** *On a daily basis, that would be a meager 8.5 kilograms of antimatter; too bad that even the largest production facilities of antimatter — particle accelerators — can only produce about a microgram's worth per year.* Neutral antimatter, like antihydrogen, could be stored and collided with matter to produce pure energy in the most controlled fashion possible: on a per-particle basis.



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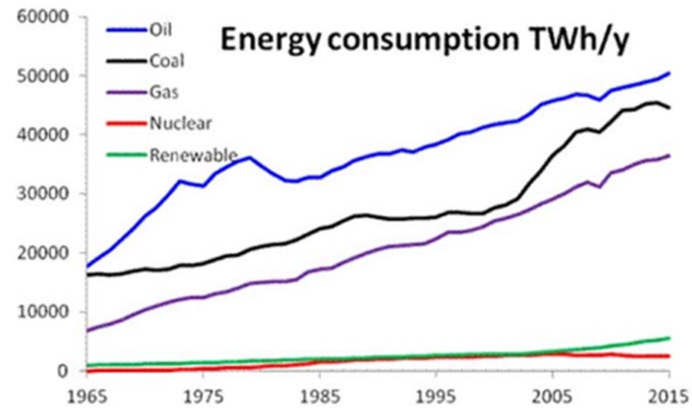

On Earth, we're currently burning more than ten billion tonnes of fossil fuels per year worldwide, supplying some 80% of our energy needs through those methods. Unfortunately, air-and-water pollution, along with vast atmospheric changes, have arisen from this. **Renewable sources of energy are one potential (although, arguably only a partial) solution, but nuclear power — if it can be done safely — could solve our fossil fuel problem today, with current technology alone. With the amount of fuel it presently takes to power the world, the cost of doing nothing is not only far too high, but will be borne by humanity for generations to come.** The world's energy consumption for a variety of sources, in TeraWatt-hours per year, according to BP for 2016.

Astrophysicist and author Ethan Siegel is the founder and primary writer of Starts With A Bang! His books, Treknology and Beyond The Galaxy, are available wherever books are sold.

(FORBES / ENERGY, Ethan Siegel , Contributor)

Uranium Prices US Nuclear Plants Pass Major Test

September 11, 2017 - The Fukushima nuclear disaster brought to the forefront how much damage Mother Nature could inflict on nuclear plants, and prompted a global nuclear safety review. **Stateside, these new safety measures have so far passed a major test – withstanding damages as Hurricane Irma barreled into Florida over the weekend.** Hurricane Irma was seen as the toughest test for the nuclear industry since Fukushima. Had something gone wrong – it could have easily sent uranium demand expectations into a tailspin, halting the anemic price recovery. The Florida coast is home to two nuclear power plants that were in the possible path of the storm. According to Florida Power and Light, both plants were designed to withstand storms stronger than any ever recorded in the region, but the design is one thing – reality is another. U.S. nuclear operators have taken steps to improve preparations for disasters since Fukushima with the U.S. Nuclear Regulatory Commission requiring plants to install portable pumps and generators to keep water moving over fuel rods and the spent fuel pool even if the offsite power supply was lost. In Japan, the Fukushima disaster occurred as disrupted power supplies caused the fuel in some units to meltdown. If a similar occurrence would happen again, it would offer an even bigger setback to the industry. When it came to Fukushima faulty design was partly to blame. If proper design still resulted in a nuclear meltdown, then you could bet that this would cause almost everyone to rethink their nuclear plans. **Fortunately, this did not happen, and so far the nuclear plants escaped any serious damages, a positive development for the nuclear industry because it shows that proper design can result in safe nuclear power generation, even during natural disasters.**

(Leia Toovey, ECONOMIC CALENDAR)

Edison Proceeds With Plans To Bury Nuclear Waste At San Onofre Site

Above: Google Earth image showing new location of nuclear waste storage site at the San Onofre Nuclear Power Plant (bottom left corner).

September 18, 2017- **Southern California Edison said it will start burying spent nuclear fuel from the now-closed San Onofre Nuclear Generating Station by the end of this year.** Opponents of the decision, at a Sept. 14 meeting of the San Onofre Community Engagement Panel, said Edison should wait till after a strategic plan for the waste is done. A legal settlement adopted in August requires Edison to develop a strategic plan for how and where to store the nuclear waste from San Onofre. Ray Lutz, of the group "Citizens Oversight," was a plaintiff in the lawsuit. He said Edison should delay its plans to bury tons of spent nuclear fuel to canisters 100 feet from the ocean. **"The settlement calls for them to hire experts and come up with a strategic plan for how they're going to develop another offsite location," Lutz said. "We want to have that settlement done before they start mindlessly moving the fuel." Lutz said it would be better to keep the waste in spent fuel pools until a permanent site is found for it elsewhere.** "Because there is an option — a load-and-go scenario — where the waste would be loaded onto a train and onto another site," Lutz said. "The less handling you can get involved, the better." **But Tom Palmisano, chief nuclear officer for San Onofre, said the new onsite storage system is now ready and he will start moving the spent fuel by the end of this year. "A spent fuel pool is not the best choice for storage of fuel at a decommissioning plant," he said. "Dry cask storage — when the fuel is ready to move to it — is a better choice, and we're committed to that."** Palmisano said the recent legal settlement has no bearing on his existing plans to move the fuel into canisters buried in concrete on site. "The settlement is not tied to moving spent fuel from spent fuel pools to dry cask storage," he said. "That is not part of the settlement." There is no time line in the settlement for when the strategic plan should be complete. Finding an alternative site to store the waste could take years. Inspecting the canisters - One change to Edison's plans that was agreed to in the settlement was a commitment to develop an inspection and maintenance plan for the stainless steel canisters by 2020. That is two years earlier than Edison committed to in 2015, when the California Coastal Commission granted the company the permit to bury the waste.

The technology to inspect the canisters had not yet been fully developed. The task of checking for cracks is made more difficult by the small space between the canister's stainless steel walls and the surrounding concrete. Without a permanent storage site, tons of nuclear waste already sit in about 50 horizontal canisters at San Onofre. The storage system, designed by Areva, will need re-licensing in 2022. Lisa Edwards, senior project manager of Radiation Safety at the nonprofit Electric Power Research Institute, spoke at the Community Engagement Panel meeting. She described ongoing research into how to conduct Aging Management Plans for the storage systems. She described using micro robots to test the most susceptible areas, using technology like acoustic emissions and "Eddy currents," an electromagnetic current like a sonogram.

"Think of this as a starting point" she said. Edison plans to add 73 vertical canisters, filled with 3.6 million pounds of spent fuel, to its existing onsite storage system of 50 horizontal canisters. The process of moving them out of the spent fuel pools and into Holtec's dry-cask storage system is expected to start at the end of this year and take about 18 months.

(By Alison St John , KPBS.ORG)

Diversity key to US grid resilience

25 September 2017 - **Policy-driven market distortions are leading to a loss of diversity in the US electric supply portfolio, which will cause higher costs for consumers as well as a loss of resilience to supply disruptions, according to a new study by IHS Markit. A less diverse portfolio will also likely mean little or no reduction - and possibly increases - in electricity sector carbon dioxide emissions, the report finds.**

Ensuring Resilient and Efficient Electricity Generation: The value of the current diverse US power supply portfolio assesses the impact on consumers and the US economy of current trends moving the US power sector toward a significantly less efficient mix of fuels and technologies for power production. The study compares the actual industry performance of recent years (2014-2016) with that of a less efficient diversity portfolio case over the same time period. **s are precipitating a move towards a less diverse system with no meaningful contribution from nuclear** The current diversified US electric supply portfolio lowers the total cost of electricity production by around $114 billion per year, and lowers the average retail price of electricity by 27%, the report found. It also reduces the variability of consumer bills, and provides resilience against low-probability but high-impact constraints on power delivery, including extreme weather events like the polar vortex cold weather phenomenon of early 2014 and more recent hurricanes as well as infrastructure failures. The current diverse set of generating technologies provides US consumers with a reliable, resilient and cost-effective electric supply portfolio, but current policy-driven market distortions are precipitating a move towards a less diverse system with no "meaningful" contribution from coal or nuclear resources, and a smaller contribution from hydroelectric resources. Some parts of the country could within a decade find themselves with such a portfolio, relying on a tripling of wind, solar and other intermittent renewables from a current 7%, and on natural gas to provide the majority of their generation, the report says. The increase in retail prices resulting from such a portfolio could have macroeconomic impacts including a 0.8% decline of real US gross domestic product, equivalent to $158 billion, as well as job losses and a reduction in household disposable income.

Premature retirement - A lack of harmonisation between policy initiatives and wholesale electricity market operations distorts the wholesale electricity market, the report notes, with further problems caused by an "accumulation of federal state subsidies and mandates for specific technologies." Such mandates on carbon emissions reductions are "often at odds" with their objective, it says. "In particular, nuclear power resources are similarly situated to other non-CO2-emitting resources such as wind, solar, and geothermal in the supply portfolio." However, it says, policies that suppress market-clearing prices cause disproportionate cash flow suppression for the high-utilization generating technologies required to cost-effectively supply stable, constant base-load demand. This results in wholesale price suppression, which "disproportionately harms" nuclear power resources and "causes premature retirement and replacement by a mix of renewable and natural gas resources with a higher CO2 emission profile", it says. Eliminating policy initiatives that cause significant market distortions would be the most straightforward way to preserve the benefits of a diverse generating portfolio, the report says. "However, implementing such an approach to harmonise policy initiatives and market operations may be politically unfeasible," it acknowledges. An alternative approach could involve regulatory approval and implementation of offsetting market interventions, such as changes to market rules to accurately reflect the cost of electric reliability and resilience in market prices, and payments for cost-effective generation attributes, such as contributions to power system resiliency and environmental attributes. To do this requires appropriate changes in operating and planning rules and standards at the federal and state level, it says. "It is easy to take the cost-effective diversity of the current US electric supply portfolio for granted," IHS Markit chief power strategist and lead author of the study Lawrence Makovich said. "Ironically, addressing climate change concerns with federal and state policies to subsidise and mandate wind and solar electric generation produced the unintended consequence of distorting wholesale electricity market clearing prices and driving the uneconomic closure of nuclear power plants - a zero-emitting source. The result has been some power system carbon dioxide emissions remaining constant or increasing," he said. IHS Markit's research was supported by the Edison Electric Institute, the Nuclear Energy Institute (NEI), and the Global Energy Institute at the US Chamber of Commerce. The IHS Markit study makes many of the same points that appeared in the US Department of Energy's *Staff Report to the Secretary on Electricity Markets and Reliability*, published in August, the NEI said. That report suggested low-cost abundant natural gas and the growth of renewable energy are accelerating the premature retirement of baseload power plants, particularly coal and nuclear, and putting the reliability of the electricity grid at risk.

NEI Senior Director of Policy Development Matt Crozat commended the IHS Markit study, noting that public policies can create "unintended market distortions" by suppressing the power prices for all of generators. "If plants close, this ultimately results in higher emissions, higher prices and less reliability. New York and Illinois have already acted to prevent such closures and we urge other states and jurisdictions to act before it is too late," he said.

(Researched and written by World Nuclear News)

America's Next Energy Crisis

July 10, 2017 - Some disasters arise unexpectedly, like an earthquake or massive storm. Others seem inevitable. Who didn't see the 2008 financial crisis coming? In hindsight, most of us.In reality, most crises that seem inevitable after the fact often catch nearly all of us by surprise when they occur. The factors were obvious enough, but few people saw them coming together. There's a potential crisis that will seem predictable, after the fact. It's better to take thoughtful consideration and positive action now and not say "I told you so" later.

Our electrical grid is being stretched to the brink. The U.S. is making itself less resilient against catastrophic failure from a major weather event or terror attack every day. Our infrastructure increasingly depends on much less secure, resilient and reliable sources of energy, like wind, solar or even natural gas. These sources do not provide the dependable availability of nuclear or coal. During the polar vortex in 2014, coal and nuclear power plants in the Midwest and Northeast had to run at full capacity to ensure tens of millions of Americans didn't lose power or heat. The output was a testament to a system that included the resilience of those power plants. What's worrying is that many of those coal and nuclear plants are no longer operating. Many more will be phased out soon. These closures are the result in part of a regulatory framework that imposes much higher burdens on these pillars of our electrical-power grid than the less secure sources to which we're now calling "our future." We anticipate growing by subtracting resilient energy sources, and the math doesn't work.

Most Americans don't think much about electricity. It charges our phones and turns the lights on when we flick a switch. When it works, there isn't much reason to think about it. We have been lucky to avoid a major catastrophe, but we're mixing in more and more ingredients for an outage that could disrupt life for millions, particularly in the Northeast or Midwest. Not thinking about it creates a dangerous blind spot. Because most of us take electricity for granted, very few Americans understand our electricity supply is steaming toward this crisis. And, like most crises, we will be wishing we had done something earlier to prevent it.

Thankfully, the Department of Energy under Secretary Rick Perry is examining the problem. The department is expected to release a report later this month that details these concerns with the existing power grid and the value of so-called "baseload power" – coal, nuclear and hydro-electricity. As a former assistant secretary of energy for fossil energy during Barack Obama's presidency, I am encouraged by the department's review, particularly its focus on the reliability and resilience of the electricity grid and the benefits of coal and nuclear power.

Coal and nuclear plants are unmatched in their ability to generate reliable energy under all circumstances, but these plants are being retired at an alarming rate because of a combination of punitive regulations, low natural gas prices, and government subsidies and mandates for renewables.

Perhaps the bigger concern is the "magical thinking" behind some analysis trying to wish our electricity system into resiliency and reliability without these traditional base-load power plants. It can be uncomfortable to face facts honestly.

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America's Next Energy Crisis

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There is no reliable way to store meaningful amounts of electricity today. It must be produced when it is needed. That is a big problem for renewable energy sources, like wind and solar, that only produce power under the right circumstances – when the sun is shining and the wind is blowing. Even natural gas is less secure than coal and nuclear power because it relies on pipeline supply of fuel on demand.

A base-load power plant typically stores in excess of a 30-day supply of coal on site, enough to outlast potential disruptions. Natural gas plants require a constant on-demand supply of gas to continue producing electricity. Under normal circumstances, that is a predictable process. But a weather shock, pipeline repair, unforeseen human mistake or a terror attack can quickly disrupt operations at those plants. One 500-megawatt plant generates enough electricity to power roughly 350,000 homes. Would the electrical grid be able to adapt, if three, four, or more plants on that same gas line went down at once? Unlikely.

Diversifying our energy supply also means keeping plants that generate the most consistent power. Our inability to do so as a country has put us at risk of disaster. We are at a crisis point. We can't predict when a sudden circumstance will test our ability to adapt, but we can act now to strengthen the ability of our electrical grid to adapt and recover rapidly.

Our economic and national security depend on it.

(FORBES / REAL SPIN, Guest post written by Charles McConnell, Mr. McConnell is executive director of Rice University's Energy and Environment Initiative.)

NWI Products and Services

FALL 2017

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NWI News Board

The following key activities are being conducted by NWI professionals...

- Entergy Corp.—Nuclear Sustainability Project
- Entergy's ANO-Performance Improvement/CAP, Work Management, Operations, NOS
- Entergy's Grand Gulf Nuclear Station
- EPRI Programs Engineering Guide
- NWI Training Academy

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