BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of a Determination of Special Contemporary Resource Planning Issues to be Addressed by Union Electric Company d/b/a Ameren Missouri in Its Next Triennial Compliance Filing or Next Annual Update Report	)))))	Case No. EO-2020-0047

PUBLIC COUNSEL'S SUGGESTED SPECIAL CONTEMPORARY ISSUES

COMES NOW the Office of the Public Counsel and, in response to the August 23, 2019, order in the above-captioned case opening it and ordering, "Any party wishing to suggest a special contemporary issue that Union Electric Company d/b/a Ameren Missouri should consider in its next annual update report shall file its written suggestion no later than September 15, 2019," in the attached verified memorandum the Office of the Public Counsel suggests certain special contemporary issues that Union Electric Company d/b/a Ameren Missouri should consider in its next annual update report.

Respectfully,

/s/ Nathan Williams

Nathan Williams
Chief Deputy Public Counsel
Missouri Bar No. 35512

Office of the Public Counsel
Post Office Box 2230
Jefferson City, MO 65102
(573) 526-4975 (Voice)
(573) 751-5562 (FAX)
Nathan.Williams@ded.mo.gov

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing have been mailed, hand-delivered, transmitted by facsimile or electronically mailed to all counsel of record this 16th day of September 2019.

/s/ Nathan Williams

MEMORANDUM

To: Missouri Public Service Commission Official Case File,
Case Nos. EO-2019-0047

From: Geoff Marke, Chief Economist
Missouri Office of the Public Counsel

Subject: Special Contemporary Topics for Ameren Missouri

Date: September 16, 2019

Topic 1: Stacking Concrete Blocks w/ Cranes

The Office of the Public Counsel ("OPC") is resubmitting its request for consideration of concrete block storage technology as a supply-side candidate in a utility's resource planning models. In last year's special contemporary topics, OPC cited "Energy Vault" as a potential energy storage option for consideration. Since that time, Energy Vault has secured over $100 million in Series B funding from investors,[1] was awarded the 2019 World Changing Idea Award from *Fast Company* magazine,[2] and was most recently referenced in Time Magazine's 2050: The Fight for Earth issue under the "Tech Innovations We Need to Happen If We're Going To Survive Climate Change"[3]

Based on recent conversations with Energy Vault, OPC has learned that the first full scale commercial plant is in manufacturing now and expected to be completed and operational in the fourth quarter of 2019. Additionally, two utilities will begin breaking ground in the first quarter of 2020.

Background:

Intermittent generation produces varying amounts of power based on the vagaries of the weather. There might be violent winds one day, and calm skies the next; broiling sunshine on Monday and 100% cloud cover on Tuesday. Peak energy demand, whether for heating or cooling, can be as much as 20 times the energy consumed on an average day. Moving forward, cost-effective energy storage needs to be considered otherwise the value of intermittent generation is considerably minimized. IOU's should investigate low-cost emerging technologies in response to energy generation exceeding demand. OPC suggests future IRP filings investigate the viability of utilizing concrete blocks and cranes as a cost-effective storage option as recently announced by a Swiss start-up Energy Vault. According to *Quartz*:

---

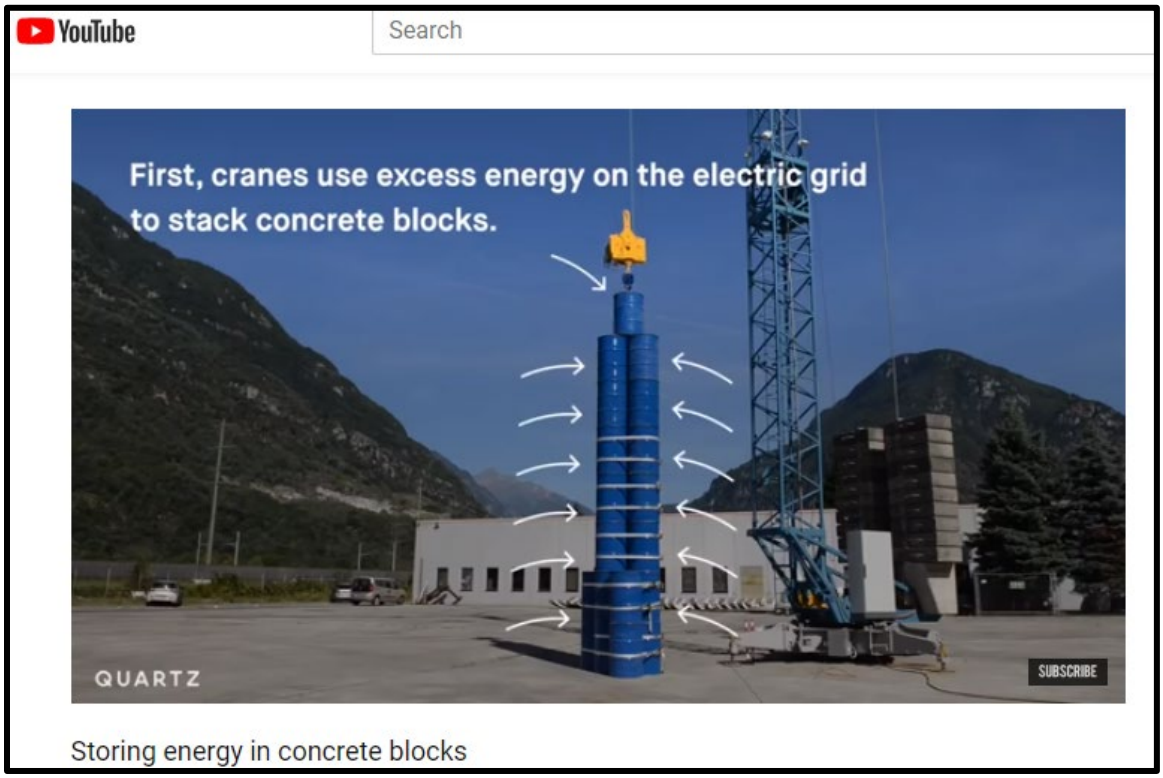
[1]Mai, HJ (2019) Gravity over lithium-ion: SoftBank invests over $110M in Swiss storage company Energy Vault. *UtilityDive*. https://www.utilitydive.com/news/gravity-over-lithium-ion-softbank-invests-110-million-in-swiss-storage-co/561060/

[2] Clendaniel, M. (2019) World Changing Ideas 2019: 17 winning solutions that could save the planet. *Fast Company* https://www.fastcompany.com/90329204/world-changing-ideas-2019-17-winning-solutions-that-could-save-the-planet

[3] Blum, A. (2019) The tech innovations we need to happen if we're going to survive climate change. *Time Magazine*. https://time.com/5669039/technology-fight-climate-change/

The science underlying Energy Vault's technology is simple. When you lift something against gravity, you store energy in it. When you later let it fall, you can retrieve that energy. Because concrete is a lot denser than water, lifting a block of concrete requires—and can, therefore, store—a lot more energy than an equal-sized tank of water.[4]

Figure 1: Screenshot of Energy Vault demonstration plant on YouTube[5]



The Energy Vault system works as follows:

A 120-meter (nearly 400-foot) tall, six-armed crane stands in the middle. In the discharged state, concrete cylinder's weighing 35 metric tons each are neatly stacked around the crane far below the crane arms. When there is excess solar or wind power, a computer algorithm directs one or more crane arms to locate a concrete block, with the help of a camera attached to the crane arms' trolley.

Once the crane arm locates and hooks onto a concrete block, a motor starts, powered by the excess electricity on the grid, and lifts the block off the ground. Wind could cause the block to move like a pendulum, but the crane's trolley is programmed to counter the movement. As a result, it can smoothly lift the block, and then place it on top of another stack of blocks—higher up off the ground.

[4] Rathi, A. (2018) "Stacking concrete blocks is a surprisingly efficient way to store energy." *Quartz*. https://qz.com/1355672/stacking-concrete-blocks-is-a-surprisingly-efficient-way-to-store-energy/

[5] Quartz (2018) Storing energy in concrete blocks. *YouTube*. https://www.youtube.com/watch?time_continue=75&v=mmrwdTGZxGk

The system is "fully charged" when the crane has created a tower of concrete blocks around it. The total energy that can be stored in the tower is 20 megawatt-hours (MWh), enough to power 2,000 Swiss homes for a whole day.

When the grid is running low, the motors spring back into action—except now, instead of consuming electricity, the motor is driven in reverse by the gravitational energy, and thus generates electricity.

Suggested Recommendation

1.) Include concrete block storage as a supply-side resource candidate in resource planning and modeling scenarios.

Topic 2: Additive Manufacturing ("AM" or "3D Printing")

OPC is resubmitting its request to include consideration of additive manufacturing technology as a cost-saving tool for resource planning purposes.

Additive manufacturing (AM) is the process of producing objects from computer-aided design (CAD) model data, usually adding layer upon layer, in contrast to conventional subtractive manufacturing methods that involve the removal of material from a starting work piece. AM is also called 3-D printing, additive fabrication, or free-form fabrication. Once employed purely for prototyping, AM is now increasingly used for spare parts, small series production, and tooling. The continued proliferation of AM can provide utilities (and other industries in general) new design flexibility, reduced energy use, and shorten time to market. The number of materials and complexity that AM can handle is constantly expanding and is already a reality in many industries as seen in Figure 1 from a recent McKinsey Consulting white paper:

Figure 1: Examples of current AM applications[6,7]

Aerospace	Industrial	Healthcare
• Fuel nozzle for flight engines • 5x more durable, 25% lighter	• Repair of burner heads for gas turbines • Reduction of repair time from 44 to 4 weeks	• Hearing aids • Mass production of highly customized parts
• Thrust chamber for aerospace rocket engine. More reliable, robust, and efficient	• Printing of industrial filters with geometrical optimization • 15% pumping energy reduction	• Model to aid tumor surgery • Reduction of surgery time and complications
• Metal brackets designed for additive manufacturing • Resulting in up to 50% less weight and less raw material input	• Increase of machine parts performance through special design • Reduction of production time from days to hours	• Artificial limbs constructed in 2 weeks, replacing lower half of left leg • Perfect physical fit with aesthetic components

[6] Kelly, R. & J. Bromberger (2017) "Additive manufacturing: A long-term game changer for manufacturers." *McKinsey Consulting*. https://www.mckinsey.com/business-functions/operations/our-insights/additive-manufacturing-a-long-term-game-changer-for-manufacturers

[7] See also GM-1 for printout of Siemen's Additive Manufacturing breakdown.

In principle, additive technologies are able to produce almost every part that can be produced by means of traditional procedures. The increase of AM will no doubt have cost and operational implications on an investor-owned utility's cost of service that should begin to be considered as a relevant input in future planning scenarios. Such examples include but are not limited to:

Generation construction of wind turbines (or other production plant parts):

The enormity of wind turbines (blades and tower segments) makes it both difficult and expensive to transport materials on the highway to project sites. 3D printing could enable construction at the project site which should result in increased financial savings. Most recently, a California startup (Reinforced Concrete Additive Manufacturing "RCAM" Technologies) was awarded a grant from the California Energy Commission ("CEC") to develop and test AM printing technology of concrete for turbine towers on-site in the hopes of boosting capacity factors and lowering overall costs.[8]

Lower costs, quicker delivery of spare parts for grid reliability:

Simplification of the supply chain necessary to support grid reliability can be improved by eliminating the need to produce components at different sites or having to store excess distribution and transmission investments in warehouses. With AM, "on-demand" products/parts could be manufactured in proximity to the impacted area following both low-impact, high frequency events (e.g., a power outage from a blown transformer) and high-impact, low frequency events (e.g., severe weather events, earthquake, electromagnetic pulses). In theory, AM could provide a cost-effective alternative to securing long-lead-time transmission and distribution equipment.

Load forecasting implications:

If AM technology were to be adopted and utilized on a macro-scale it could have profound implications on the entire economy. AM has already created homes,[9] cars,[10] and homes + cars.[11] Verhoef, et al (2018) estimate that AM could lead to a 5-27% reduction in global energy use by 2050 primarily from "material savings, transportation savings, production savings, savings in the

[8] Gerdes, J. (2017) Is 3-D printing the solution for ultra-tall wind turbine towers? GTM. https://www.greentechmedia.com/articles/read/is-3d-printing-the-solution-for-ultra-tall-wind-turbine-towers#gs.uTRrnsU

[9] Cowan, M. (2018) The world's first family to live in a 3D-printed home. BBC. https://www.bbc.com/news/technology-44709534

[10] Hanley, S. (2018) LSEV 3D-printed electric car costs just $7,500. How is that possible? *Clean Technica* https://cleantechnica.com/2018/03/19/lsev-3d-printed-electric-car-costs-just-7500-possible/

[11] Oak Ridge National Laboratory (2018) ORNL integrated energy demo connects 3D-printed building, vehicle. https://www.ornl.gov/news/ornl-integrated-energy-demo-connects-3d-printed-building-vehicle see video at: https://www.youtube.com/watch?v=RCkQBlFJRN4&feature=youtu.be

use phase and in operation and maintenance."[12] Table 1 provides a U.S. Department of Energy assessment of AM impact attributes on both product offerings and supply chain structures.

Table 1 Impact of AM on product offerings and supply chain:[13]

AM Attributes compared to traditional manufacturing	Impact on product offerings	Impact on supply chains
Manufacturing of complex-design products	●	◉
New products that break existing design and manufacturing limitations	●	◉
Customization to customer requirements	●	◉
Ease and flexibility of design iteration	◉	○
Part simplification/sub-parts reduction	○	○
Reduced time to market	○	○
Waste Minimization	○	○
Weight reduction	○	○
Production near/at point of use	○	●
On-demand manufacturing	○	●

Key: ● Very High ◉ High ○ Medium ○ Low

Suggested Recommendation

1.) Analyze and document the feasibility and cost saving implications (if any) in adopting AM technology to maintain present-day and future supply-side investments.
2.) Analyze and document the feasibility and cost saving implications (if any) in adopting AM technology to maintain present-day and future transmission system investments.
3.) Analyze and document the feasibility and cost saving implications (if any) in adopting AM technology to maintain present-day and future distribution system investments.

OPC does not presently recommend modeling a high-AM adoption scenario in the IOU's load forecasts but would not be opposed to such modeling considerations either.

[12] Verhoef, L.A., et al (2018) The effect of additive manufacturing on global energy demand: An assessment using a bottom-up approach. *Energy Policy* 112. p. 349-360. https://www.sciencedirect.com/science/article/pii/S0301421517306997

[13] US Department of Energy. (2015) Quadrennial Technology Review 2015 Chapter 6: Innovation Clean Energy Technologies in Advanced Manufacturing. https://www.energy.gov/sites/prod/files/2015/11/f27/QTR2015-6A-Additive%20Manufacturing.pdf

Topic 3: Virtual Power Plant

Background:

A virtual power plant ("VPP") is a cloud-based distribution power plant that aggregates the capacities of heterogeneous distributed energy resources ("DERs") (e.g., many rooftop solar units) for the purposes of enhancing power generation, as well as trading or selling power on the market. Examples of virtual power plant partnerships include Hawaiian Electric Company ("HECO"), Open Access Technology International, and Sunrun[14] as well as demonstration projects in Sunverge and Consolidated Edison ("Con Ed") and Sunverge and Puget Sound Energy.[15]

Suggested Recommendation

1.) Include a virtual power plant option as a supply-side resource candidate in resource planning and modeling scenarios.

Topic 4: Aggressive Customer-Side Renewable Scenarios

To date, IRP modeling has centered primarily on utility-owned and procured renewable resources to: meet statutory mandates (RES compliance, see Ameren Missouri, et al.), for resource adequacy (see KCPL-GMO), or for speculative merchant generation investments (see Empire).

However, the increased cost of service (e.g., Empire's failure to secure contracts with long-term wholesale customers) and the subsequent decrease cost of customer-side renewable generation (e.g., rooftop solar) has the potential to exacerbate fixed cost recovery and impact future resource planning needs.

To date, there has not been significant modeling conducted to examine the impact of aggressive customer-side renewable adoption on customer rates and future resource acquisition.

Suggested Recommendations

1.) Model a low (e.g., 3%), medium (e.g., 6%) and high (e.g., 12%) customer-side renewable adoption scenario in the Company's load forecast;
2.) Describe and document future resource acquisition strategy selection in light of a low, medium and high customer-side renewable adoption load forecast scenario;
3.) Describe and document annual average rates under a low, medium and high customer-side renewable adoption load forecast scenario for non-renewable customers.

[14] Gheorghiu, J. (2019) Sunrun partnership enhances HECO's ability to tap into DER systems when power demand spikes. *UtilityDive*. https://www.utilitydive.com/news/sunrun-partnership-enhances-hecos-ability-to-tap-into-der-systems-when-pow/562733/
[15] See GM-2.

Topic 5: Rush Island and Labadie Environmental Retrofit Scenarios

Background

On June 7th, 2019 in Case No: EO-2019-0314, OPC filed comments alleging that Ameren Missouri's IRP is deficient in its modeling for potential costs and subsequent resource planning modifications associated with pending court ordered remedial actions for the Rush Island and Labadie Power Plants.

OPC reasserts those deficiencies and subsequent recommendations here in the Special Contemporary Topics for 2020 as the appropriate docket for the Commission to order Ameren Missouri to be in compliance with the Commission rules.

Ameren Missouri should be modeling scenarios related to Rush Island and Labadie based, in part, on the Company losing its appeal and exhausting the appeal process. Given the order of magnitude of potential non-compliance costs, based on Ameren Missouri's own projections, the absence of any alternative resource plan that attempts to consider scenarios regarding its litigated power plants is a clear deficiency and in non-compliance with the Commission's IRP rules.

Suggested Recommendations

Ameren Missouri should develop alternative resource plans that consider, at a minimum, a range of high, medium, low remedial cost scenarios related to Rush Island. For example, based on the aforementioned remedial recommendations proposed, costs could include variations of remedial retrofit scenarios including flue gas desulfurization equipment ("FGD" or "scrubbers") or dry sorbent injection equipment ("DSI"). The former (FGD) would represent a "high" cost scenario and the latter (DSI) a "med" cost scenario. A "low" cost scenario could reasonably be understood as Ameren Missouri's proposed remediation recommendation that past pollution should be offset by Ameren turning over "allowances" it won for emissions reductions elsewhere. It is important to note, that the inclusion of these scenarios should impact decisions and timing throughout the rest of Ameren Missouri's integrated resource planning. It's all interdependent.

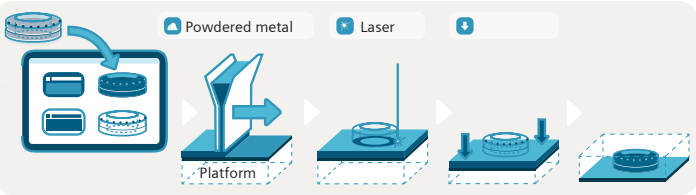
GM-3 includes OPC's filed Notice of Deficiency to Ameren Missouri's IRP update which provides greater background on the issue, deficiency rationale, and pending costs. To be clear, the estimated cost impact has already been conducted by Ameren Missouri (or a third-party contracted by Ameren Missouri), but neither these modeled costs nor the subsequent impact on resource planning are currently accounted for in Ameren Missouri IRP filings with the Commission.

Additive Manufacturing

SIEMENS
Ingenuity for life

Additive Manufacturing (AM) refers to a production process in which components are created layer by layer on the basis of digital 3D design data.[1)]

How Additive Manufacturing works



Drivers to leverage Additive Manufacturing

Lead time reduction & life cycle improvement for complex parts

- Lead time reduction
- Reduced number of process steps
- Saving of material
- Eliminated tools
- On-demand

Improved efficiency thanks to almost unlimited possibilities to design internal passages and structures

- Better heat transfer
- Improved cooling duct design
- Improved mixing of fuel and air
- Processing of new alloys

Improved efficiency thanks to:

- Bionic structures e.g. load optimized structures
- Integrated design
- Weight reduction

Challenges for Additive Manufacturing technologies in power generation

- High temperatures
- High centrifugal forces
- High velocities

Technological challenges for gas turbines

- Thermal loading is close to the melting point of the used metals. For example in the case of iron 1636°C
- The centrifugal force affecting the blades is 10,000 times the net weight force
- The blade tips reach almost sonic velocity

Technological challenges for steam turbines

- Components require a long operational lifetime under high mechanical and thermal load

Areas of application

Rapid Prototyping

75% development time reduction

Prototypes produced with AM are increasingly used for production development to test certain properties before series production begins. As production with AM is much faster than conventional manufacturing, testing and development time of components are accordingly reduced. Early validation of new designs is possible.

Rapid Manufacturing

85% faster manufacturing of complete burner set

AM technology industrialization enables new opportunities for spare part and supply chain enhancement such as the manufacturing of spare parts on demand and even close to site. Currently, Siemens uses AM for rapid manufacturing of Siemens gas turbine components.

Rapid Repair

60% faster repairs of SGT-700 and SGT-800 burners tips

Replacement of conventional repair processes with Additive Manufacturing technologies provides not only a significant reduction in repair time, but also an opportunity to modify repaired components to the latest design.

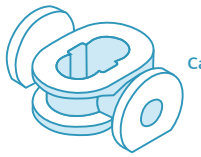
Spare parts on demand

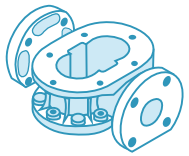
40% lead time reduction

Printed spare parts on demand mean reduced lead time, higher engine availability and fast technology validation for the customer. In June 2016, Siemens has put into commercial operation the first printed spare part on demand for large gas turbines.

Design for additive manufacturing

Design evolution from Casting to Additive Manufacturing





Design for Additive Manufacturing focusses the development and implementation of design philosophies into the product development and engineering processes. Each 3D-printing technology has its own set of demands and possibilities, and it is our task to transform parts from their conventional manufacturing history into the AM design accordingly. Typically, geometric features like cavities, drilled holes, thick walls and overhanging edges get remodeled and enhanced, while weight reduction, added functions and integrated design become a reality.

The value of Additive Manufacturing in facts and figures

- **65%** less resources in production process
- **75%** reduction of development time
- **∞** flexibility for design of parts
- **60%** faster repairs
- **50%** reduction of lead time
- **H_2 60%** hydrogen in the fuel mix

Status of Additive Manufacturing in the power generation at Siemens

- First industrial Siemens facility for power generation components
- Gas turbine components incommercial production
- Innovation frontrunner on steam turbine additive
- Development of specific steam turbine alloys for AM
- In preparation for commercialization of steam turbine components

Sources
1) International Committee F42 for Additive Manufacturing Technologies (ASTM)
2) http://www.rolandberger.com/media/pdf/Roland_berger_Additive_Manufacturing_2013119.pdf

US utilities eyeing virtual power plants as emerging assets

Wednesday, August 14, 2019 10:01 AM CT

By Garrett Hering
Market Intelligence

Sunverge Energy Inc. is one of numerous companies offering software to aggregate distributed energy systems, such as this rooftop solar array being installed in Hawaii, into virtual power plants.
Source: Associated Press

Disrupted in recent years by an uncoordinated rollout of distributed energy resources across their service territories, U.S. electric utilities are increasingly exploring how to benefit from rooftop solar arrays, batteries and other small-scale resources by combining them into virtual power plants.

If unsuccessful, utilities and their regulators "will continue to plan on traditional fossil fuel-based generation," said Martin Milani, CEO of Sunverge Energy Inc., a developer of cloud-based energy management systems that control distributed renewable energy resources and tie them into grid operations, enabling their broad participation in wholesale power markets.

"We have the ability to actually respond in real time, in nanoseconds," Milani said in an interview.

To facilitate its supply of virtual power plant software, the California-based company raised $11 million in an investment led by venture capital fund the Ecosystem Integrity Fund, with participation from venture capital affiliates of Midwestern U.S. utility Evergy Inc. and Norwegian energy giant Equinor ASA, Sunverge disclosed Aug. 7. Founded in 2010,

Sunverge has raised roughly $65 million, including from investment arms of Siemens AG and TOTAL SA, according to S&P Global Market Intelligence data.

The latest capital injection will help Sunverge enhance its offering and expand its business with utilities, who "are looking at [virtual power plants] as something they want to control for grid services beyond peak shaving," Milani said. Sunverge's utility and grid services platform also offers demand response, frequency regulation, voltage management, operating reserves and time-shifting of variable solar resources.

'The right investment'

Sunverge is collaborating in demonstration projects in New York with Consolidated Edison Inc. and Washington with Puget Sound Energy Inc., the company announced in early 2019. Other utilities on its client roster include Arizona Public Service Co., the Sacramento Municipal Utility District and the Glasgow Electric Plant Board in Kentucky.

"All the programs we are doing will expand over the next 18 months," Milani said.

While Sunverge first developed software to manage its energy storage system hardware, its future growth will center on software for utilities, the CEO said. The company's new investors appear sold on that strategy.

"We believe the Sunverge platform can play a critical role in transitioning our existing power system from fossil fuel to reliable and clean distributed generation," Geoff Eisenberg, partner at the Ecosystem Integrity Fund, said in a news release.

The platform "proves the value of the baseload power generated by [distributed energy resources] and will ultimately help utilities convince both public utilities commissions and consumers that assets like solar and energy storage are the right investment for the future of our energy markets," added Gareth Burns, managing director at Equinor Energy Ventures.

Several other California companies are also ramping up efforts to squeeze more value out of distributed resources through virtual power plants.

Sunrun Inc. is setting up residential virtual power plants in Northern California and New England, while Advanced Microgrid Solutions is supplying a network of battery-backed commercial buildings in Southern California. Stem Inc. has also developed a software platform for solar-plus-storage arrays and virtual power plants.

Looking abroad

In addition to expanding its business with U.S. utilities, Sunverge is looking to demand for virtual power plants abroad, especially in Europe and Japan, according to Milani. The company already has a foothold in Japan, supplying its software in a pilot project with Kyushu Electric Power Co. Inc. Project participant Mitsui & Co. Ltd. is also an investor in Sunverge.

With its dense population, limited domestic energy resources and ongoing questions related to its reliance on nuclear power, Japan may become "a major hotbed of [virtual power plant] innovation," according to a recent Navigant Research white paper commissioned by Vancouver, British Columbia-based virtual power plant technology supplier Enbala Power Networks Inc.

Another software developer, AutoGrid Systems Inc., in June announced it was working with ENERES Co. Ltd. on a sprawling virtual power plant project in Japan, involving the addition of more than 10,000 distributed energy assets between 2020 and 2021, including behind-the-meter solar, energy storage and combined heat and power resources, and electric vehicles.

Australia is emerging as another early hotbed. Tesla Inc. is building a virtual power plant consisting of up to 250 MW of solar power and 650 MWh of energy storage on 50,000 homes in South Australia. Enbala is supplying its cloud-based platform for a project in South Australia with AGL Energy Ltd.

Virtual power plants in the Asia-Pacific region as could grow to roughly 12,637 MW by 2029, up from about 1,045 MW in

2019, making it the world's fastest-growing market for the technology, according to Navigant.

This article was published by S&P Global Market Intelligence and not by S&P Global Ratings, which is a separately managed division of S&P Global.

MEMORANDUM

To: Missouri Public Service Commission Official Case File,
Case No. EO-2019-0314

From: Geoff Marke, Chief Economist
Office of the Public Counsel

Subject: Notice of Deficiency to Ameren Missouri's IRP update

Date: June, 7th 2019

Summary

As presently submitted, Ameren Missouri's IRP is deficient in its modeling for potential costs and subsequent resource planning modifications associated with pending court ordered remedial actions for the Rush Island power plant (and potentially, the Labadie power plant[1]). Ameren Missouri should be modeling scenarios related to Rush Island (and potentially, Labadie) based, in part, on the Company losing and exhausting its appeal process. Given the order of magnitude of potential non-compliance costs, based on Ameren Missouri's own projections, the absence of any alternative resource plan that attempts to consider scenarios regarding its litigated power plants is a clear deficiency and in non-compliance with the Commission's IRP rules.

Recommendations

Ameren Missouri should develop alternative resource plans that consider, at a minimum, a range of high, medium, low remedial cost scenarios related to Rush Island. For example, based on the aforementioned remedial recommendations proposed, costs could include variations of remedial retrofit scenarios including flue gas desulfurization equipment ("FGD" or "scrubbers") or dry sorbent injection equipment ("DSI"). The former (FGD) would represent a "high" cost scenario and the latter (DSI) a "med" cost scenario. A "low" cost scenario could reasonably be understood as Ameren Missouri's proposed remediation recommendation that past pollution should be offset by Ameren turning over "allowances" it won for emissions reductions elsewhere. It is important to note, that the inclusion of these scenarios should impact decisions and timing throughout the rest of Ameren Missouri's integrated resource planning. It's all interdependent.

The rest of this memorandum summarizes the deficiencies and recommends actions for Ameren Missouri to undertake in its future triennial IRP. OPC's recommendations will enable Ameren Missouri to fulfill the fundamental objective of resource planning of providing the public with energy services that are safe, reliable, and efficient; at just and reasonable rates; in compliance

[1] The Sierra Club has sought a Court-ordered injunction against Ameren Missouri's Labadie power plant that would require Ameren Missouri "to limit the emissions from Labadie going forward" in its proposed conclusions of law—remedy phase.

with all legal mandates; and in a manner that serves the public interest and is consistent with state energy and environmental policies.

Background

On April 12, 2019, Ameren Missouri ("the Company") filed its 2019 Integrated Resource Plan (IRP) Annual Update Report in File No. EO-2019-0314 pursuant to the requirements of 4 CSR 240-22.080(3)(B).

On April 25, 2019, OPC submitted questions to Ameren Missouri and stakeholders in response to the Company's filed 2019 IRP Annual Update (see GM-1). Including the following question:

. Rush Island: A recent article in the St. Louis Post Dispatch stated that:

Either Ameren's failure to install pollution controls on its Rush Island coal-fired power plant near Festus caused the premature death of hundreds of people by releasing 160,000 tons of sulfur dioxide into the air, or the emissions had no measurable health impact and a remedy could cost each Ameren ratepayer at least $1,345.[2]

Q. Does Ameren Missouri believe IRP-impacted scenarios should be modeled in which Ameren Missouri would have to provide remedial actions related to Rush Island? If not, why?

On April 30, 2019, Ameren Missouri hosted its 2019 IRP Annual Update workshop with its stakeholder group pursuant to 4 CSR 240-22.080(3).

On May 10th, 2019, Ameren Missouri filed its post-workshop summary report providing written responses to OPC's and other stakeholders' inquiries. In its report, Ameren Missouri indicated that it would not be making any changes to its Annual Report in response to the workshop. Including the following response to the aforementioned question posed regarding Rush Island:

Question: Does Ameren Missouri believe it should model scenarios in which Ameren Missouri would have to provide remedial actions related to Rush Island?

Answer: This litigation matter is still pending before the trial court. The parties are in the process of briefing the issues and no decision on remedy has been issued. In addition, the Company intends to appeal the court's decision when finalized. As part of that appeal, it would seek to stay any judgment issued by the trial court.

OPC is filing this memorandum pursuant to 4 CSR 240-22.080(5)(B) which states:

Within thirty (30) days of the last stakeholder group meeting pursuant to subsection (5)(A) of this rule, any stakeholder may provide the utility and other stakeholders with a written statement summarizing any potential deficiencies in or concerns with the utility's proposed

[2] Patrick, R. (2019) St. Louis judge holds fate of pollution controls at two area Ameren coal-fired power plants. *St. Louis Post-Dispatch*. April 15, 2019. https://www.stltoday.com/business/local/st-louis-judge-holds-fate-of-pollution-controls-at-two/article_10c1de51-828f-58f6-8103-b36a7e2ce7f9.html. See also GM-2

compliance with the electric resource planning rules. The utility has the opportunity to address the potential deficiencies or concerns identified by any stakeholder in its preparation of the triennial compliance filing.

Deficiency Rationale

The Commission's IRP rule, 4 CSR 240-22.010 (2)(C) states:

> Explicitly identify and, where possible, quantitatively analyze any other considerations which are critical to meeting the fundamental objective of the resource planning process, but which may constrain or limit the minimization of the present worth of expected utility costs. . . . These considerations shall include, but are not necessarily limited to, mitigation of:
>
> 1. Risks associated with critical uncertain factors that will affect the actual costs associated with alternative resource plans;
> 2. Risks associated with the new or more stringent legal mandates that may be imposed at some point within the planning horizon; and
> 3. Rate increases associated with alternative resource plans.

Additionally, 4 CSR 240-22.060 (3)(C) states:

> The utility shall include in its development of alternative resource plans the impact of—
>
> 1. The potential retirement or life extension of existing generating plants;
> 2. The addition of equipment and other retrofits on generation plants to meet environmental requirements;

As the remainder of this memorandum explains, the potential consequences of an unfavorable decision from the courts merits analysis of the impacts and exploration of potential mitigating factors in Ameren Missouri's resource planning analysis.

Rush Island Background

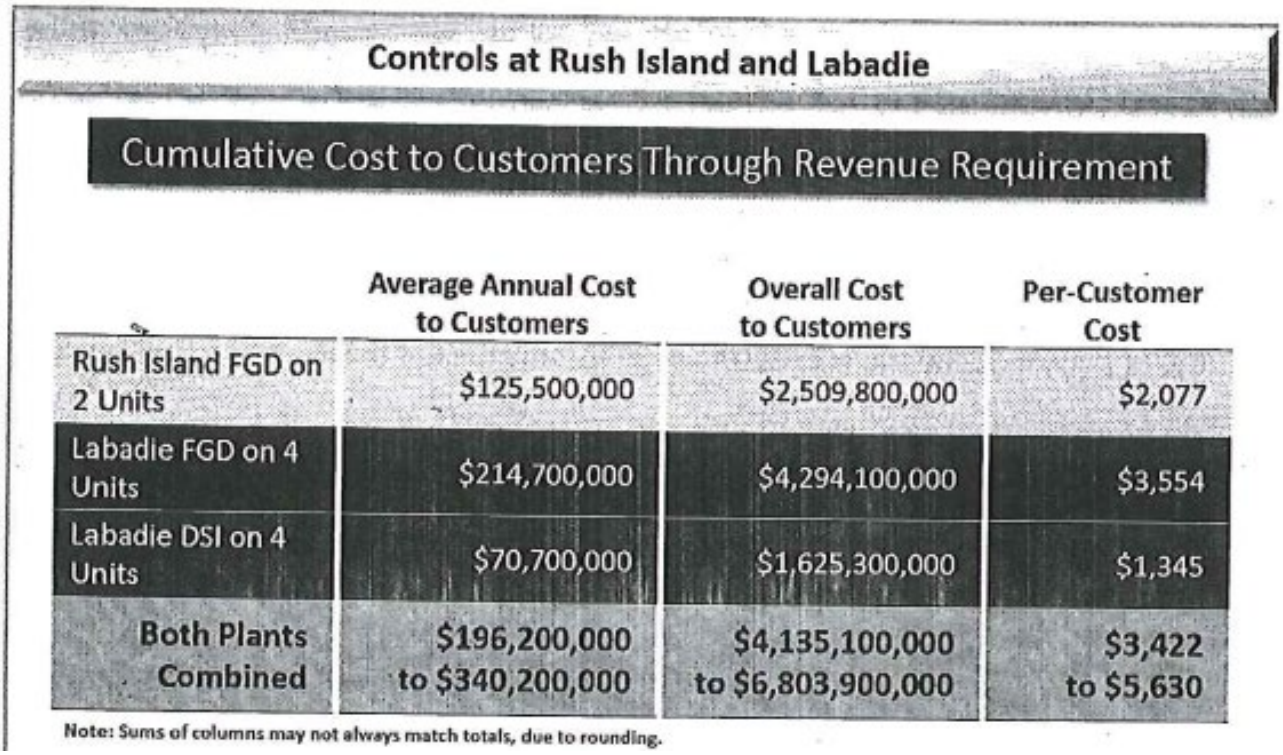
The U.S. Justice Department, on behalf of the U.S. Environmental Protection Agency (EPA), filed suit against the Ameren Missouri eight years ago. Officials with the federal agency alleged that, in 2007 and 2010, Ameren illegally installed boiler equipment at two units of its Rush Island Power Plant in Jefferson County without required permits. The EPA alleged that under the Clean Air Act, such modifications are considered new sources of air pollution, and should have been subject to stricter emissions limits.

The EPA requires power plants to obtain a "Prevention of Significant Deterioration" or PSD permit to prevent increases in air pollution from new sources, which the Rush Island plant did not. Such permits must be acquired before beginning construction on a major project. The EPA claimed that the new equipment enabled the facility to burn more coal and therefore emit more sulfur dioxide.

On January 23, 2017, the US District Court, Eastern District of Missouri found Ameren Missouri's Rush Island power plant to be in violation of the PSD regulations of the Clean Air Act's New Source Review Program.[3]

On May 23, 2019, parties filed their proposed findings of facts and conclusions of law to US District Judge Rodney Sippel. Responses to each other's filings will occur on June 23. Figure 1 contains Ameren Missouri's projected average annual, overall and per customer estimated costs associated with environmental compliance at Rush Island and Labadie. Compliance costs include the addition of flue gas desulfurization equipment ("FGD" or "scrubbers") or dry sorbent injection equipment ("DSI").

Figure 1: Ameren Missouri's average annual, overall and per customer estimated costs associated with environmental compliance at Rush Island and Labadie[4,5]



Controls at Rush Island and Labadie

Cumulative Cost to Customers Through Revenue Requirement

	Average Annual Cost to Customers	Overall Cost to Customers	Per-Customer Cost
Rush Island FGD on 2 Units	$125,500,000	$2,509,800,000	$2,077
Labadie FGD on 4 Units	$214,700,000	$4,294,100,000	$3,554
Labadie DSI on 4 Units	$70,700,000	$1,625,300,000	$1,345
Both Plants Combined	**$196,200,000 to $340,200,000**	**$4,135,100,000 to $6,803,900,000**	**$3,422 to $5,630**

Note: Sums of columns may not always match totals, due to rounding.

[3] *U.S. v. Ameren Missouri*, 4:11 CV 77 RWS (E.D. Mo.). https://www.moed.uscourts.gov/sites/moed/files/documents/news/Ameren-Memorandum-and-Order.pdf

[4] Ameren Missouri's proposed findings of fact—remedy phase Page 41.

[5] Source listed in brief is as follows: "Slides 15 and 22; Celebi Report pp. 31-33 & Fi. 17; Celebi_EXP_0000023 (Fig 16, 17, 18, 28—RevReq & Rate Impact Model_FINAL.xlsx)"

Additional Pending Costs

As the Commission is well aware, Ameren Missouri is planning a large amount of plant investment in the near future. Ameren Missouri filed notice of its 5-year "Smart Energy Plan" which includes over $5 billion in capital investment as seen in Figure 2.

Figure 1: Ameren Smart Energy Plan (SB 564 proposal) to the MO PSC Commissioners—Agenda, February 20, 2019[6]

Smart Energy Plan 5YR Total Capital Overview (Thousands $)

Ameren MISSOURI

A 5-year average of 37% of capital investments will go toward grid modernization

	2019	2020	2021	2022	2023	Grand Total
Smart, Reliable Grid Operations	$335,042	$451,058	$406,117	$391,472	$360,506	**$1,944,195**
Smart Meter Program	$30,034	$54,870	$51,966	$55,995	$52,117	**$244,982**
Non-Nuclear Generation & Environmental	$186,348	$176,756	$182,326	$196,643	$226,609	**$968,682**
Nuclear Generation	$74,684	$65,896	$61,411	$76,451	$73,984	**$352,426**
Hydro Generation	$34,825	$33,627	$43,395	$33,499	$14,955	**$160,301**
Renewable & Gas Turbine Generation	$11,948	$21,782	$20,104	$25,732	$19,339	**$98,905**
Secure & Reliable Transmission	$141,184	$135,658	$153,958	$148,264	$154,070	**$733,134**
Cyber & Technology Upgrades	$88,542	$89,955	$89,849	$89,877	$89,873	**$448,096**
Operational & Customer Support Facilities	$54,393	$96,518	$58,560	$50,817	$53,505	**$313,793**
Innovative Opportunities	$14,302	$9,064	$5,799	$4,947	$3,852	**$37,964**
Grand Total - Capital	**$971,302**	**$1,135,184**	**$1,073,485**	**$1,073,697**	**$1,048,810**	**$5,302,478**
Wind Asset Acquisition (two sites)		$1,000,000				$1,000,000
Grand Total, Including Wind	**$971,302**	**$2,135,184**	**$1,073,485**	**$1,073,697**	**$1,048,810**	**$6,302,478**

5

Costs not included in the Smart Energy Plan include, but are not limited to:

- An additional $1 billion for 550MW associated with two wind farm projects (Case Nos: EA-2018-0202 and EA-2019-0021);
- An as yet undetermined dollar amount for an additional wind farm of approximately 300 MW (Case No: EA-2019-0181);
- Over $300 million (conservatively) in planned MEEIA investments over the next two-and-half years (Case No: EO-2018-0211);
- Potentially two additional utility-scale solar projects (Case Nos: EA-2019-0371 and EA-2019-0209);

[6] Ameren Missouri's proposed findings of fact—remedy phase Page 41.

- Future environmental costs associated with compliance for the Coal Ash Residual Rules including ash pond costs (closure) and landfill cell costs that will be in service after 2023; and
- The hundreds of millions of dollars in AMI technology that cannot be recovered through its Smart Energy Plan (Case No. EO-2019-0044).

If Ameren Missouri is already modeling billions in unplanned costs as a potential outcome in a case already decided before the Eastern District, surely such modeling is relevant for the Commission and stakeholders' consideration through the IRP process. It would also appear reasonable to assume that if those multi-billion dollar non-compliance costs materialize during Ameren Missouri's planning period, it would materially impact future planned investment and resource planning. The absence of such consideration in the IRP is a clear deficiency.

Conclusion

OPC agrees with Ameren Missouri in that the appeals process associated with Rush Island (and potentially Labadie) will likely continue well into the future. However, we do not believe the appeal process would reasonably extend beyond the IRP's planning period (20 years). Therefore, the potential impacts of an unfavorable decision needs to be considered in conjunction with Ameren Missouri's projected "Smart Energy Costs" and other planned capital expenditures.

That is, the Company should be transparent about its risk exposure and consider, at a minimum, future scenarios in which remedial costs are imposed on Ameren Missouri. No doubt, further "likely" outcomes can be modeled as the litigation process moves forward and the range of uncertainty over the fate of its current investments becomes more definitive. Finally, OPC wishes to make it clear that we are making no recommendation on the prudency of any action/inaction associated with historical environmental investments.

Marke, Geoff

From: Marke, Geoff
Sent: Thursday, April 25, 2019 4:36 PM
To: Fortson, Brad; 'Berk, S Hande'; Michels, Matt R; Johnson, Paula; Tatro, Wendy K; Andrew Linhares; Ashok Gupta; Meisenheimer, Barb; bamorrison@greatriverslaw.org; Kelley, Cherylyn; Beck, Dan; Eaves, Dana; Roos, David; David Woodsmall-MECG; Deidre Hirner; Henry Robertson; Luebbert, J; Robinett, John; Lewis Mills; Kremer, Lisa; Hyman, Martin; Maurice Brubaker; Sean Brady; Kroll, Sharlet; Dottheim, Steve; Terry Jarrett; Whitworth, Steve C; Jenkins, Rex W; Davis, William R; Brown, Brad
Cc: Boustead, Kory; Gateley, Curtis; Elliott, Jordan
Subject: Re: Ameren Missouri 2019 IRP Annual Update Workshop
Attachments: IRP questions.docx

Hande, et al:
Attached our OPC's questions.

Thanks,
Geoff

From: Fortson, Brad
Sent: Thursday, April 25, 2019 3:01:23 PM
To: 'Berk, S Hande'; Michels, Matt R; Johnson, Paula; Tatro, Wendy K; Andrew Linhares; Ashok Gupta; Meisenheimer, Barb; bamorrison@greatriverslaw.org; Kelley, Cherylyn; Beck, Dan; Eaves, Dana; Roos, David; David Woodsmall-MECG; Deidre Hirner; Marke, Geoff; Henry Robertson; Luebbert, J; Robinett, John; Lewis Mills; Kremer, Lisa; Hyman, Martin; Maurice Brubaker; Sean Brady; Kroll, Sharlet; Dottheim, Steve; Terry Jarrett; Whitworth, Steve C; Jenkins, Rex W; Davis, William R; Brown, Brad
Cc: Boustead, Kory; Gateley, Curtis; Elliott, Jordan
Subject: RE: Ameren Missouri 2019 IRP Annual Update Workshop
Staff would like a short discussion on the avoided costs Ameren used in the annual update. Thanks.

From: Berk, S Hande [mailto:HBerk@ameren.com]
Sent: Monday, April 22, 2019 9:15 AM
To: Michels, Matt R; Johnson, Paula; Tatro, Wendy K; Andrew Linhares; Ashok Gupta; Barb Meisenheimer; Fortson, Brad; Bruce Morrison-NAACP; Cherylyn Kelley; Beck, Dan; Eaves, Dana; Roos, David; David Woodsmall-MECG; Deidre Hirner; Geoff Marke; Henry Robertson; Luebbert, J; John Robinett; Lewis Mills; Lisa Kremer; Martin Hyman; Maurice Brubaker; Sean Brady; Sharlet Kroll; Dottheim, Steve; Terry Jarrett; Whitworth, Steve C; Jenkins, Rex W; Davis, William R; Brown, Brad
Cc: Boustead, Kory; Gateley, Curtis; Elliott, Jordan
Subject: RE: Ameren Missouri 2019 IRP Annual Update Workshop

All,
To use our time efficiently in the workshop next week, please send us your questions about the 2019 IRP Annual Update Report by 12pm, Thursday, April 25.
We plan to go over the submitted questions first and any additional questions if time permits.
Thanks,
Hande

-----Original Appointment-----
From: Berk, S Hande

Sent: Friday, March 29, 2019 3:31 PM
To: Berk, S Hande; Michels, Matt R; Johnson, Paula; Tatro, Wendy K; Andrew Lindhares; Ashok Gupta; Barb Meisenheimer; Brad Fortson; Bruce Morrison-NAACP; Cherylyn Kelley; Dan Beck ; Dana Eaves ; David Roos ; David Woodsmall-MECG; Deidre Hirner; Geoff Marke; Henry Robertson ; J Luebbert; John Robinett; Lewis Mills; Lisa Kremer; Martin Hyman; Maurice Brubaker ; Sean Brady; Sharlet Kroll; Steve Dottheim; Terry Jarrett-MJMEUC; Whitworth, Steve C (SWhitworth@ameren.com); Jenkins, Rex W; wdavis2@ameren.com; Brown, Brad
Cc: Boustead, Kory; Gateley, Curtis; Elliott, Jordan
Subject: Ameren Missouri 2019 IRP Annual Update Workshop
When: Tuesday, April 30, 2019 1:00 PM-3:00 PM (UTC-06:00) Central Time (US & Canada).
Where: CORPORATE PLANNING CONF ROOM W231

Based on the replies received to date, April 30 seems to be the day most are available.
This will be a Skype meeting, but if you would like to join in person in our St. Louis office, please let me know, so we can arrange your entrance into the building.
Thanks,
Hande

Join Skype Meeting

Trouble Joining? Try Skype Web App

Join by phone

(800) 258-2477 (MO) English (United States)
(314) 554-4025 (MO) English (United States)
(800) 258-2477 (MO) English (United States)
confline (MO) English (United States)

Find a local number

Conference ID: 8578172
Forgot your dial-in PIN? | Help

MEMORANDUM

To: Missouri Public Service Commission Official Case File,
Case No. EO-2019-0314

From: Geoff Marke, Chief Economist
Missouri Office of the Public Counsel

Subject: 2019 Integrated Resource Plan Update Questions

Date: April 25, 2019

The Office of the Public Counsel ("OPC") appreciates the opportunity to provide questions regarding Ameren Missouri's most recent IRP update. We look forward to the Company's response.

Questions:

1. Rush Island: A recent article in the St. Louis Post Dispatch stated that:
   Either Ameren's failure to install pollution controls on its Rush Island coal-fired power plant near Festus caused the premature death of hundreds of people by releasing 160,000 tons of sulfur dioxide into the air, or the emissions had no measurable health impact and a remedy could cost each Ameren ratepayer at least $1,345.[1]

   Q. Does Ameren Missouri believe IRP-impacted scenarios should be modeled in which Ameren Missouri would have to provide remedial actions related to Rush Island? If not, why?

2. Future Environmental Costs
   Q. Does Ameren Missouri's SB 564 include any of the roughly ½ billion in costs estimated for future environmental compliance as identified in Ameren Missouri's 2019 IRP update. If yes, please identify which ones.

3. Microgrid
   Q. Please provide more detail around Ameren Missouri's referenced SB 564 microgrid pilot project (who, what, when, where, how and why). Please use the Ameren Illinois microgrid project as a contrast if applicable.

   Q. What is the learning objective (if any) of the microgrid pilot project? How does it differ from the lessons already learned from the Ameren Illinois microgrid project?

[1] Patrick, R. (2019) St. Louis judge holds fate of pollution controls at two area Ameren coal-fired power plants. *St. Louis Post Dispatch.* https://www.stltoday.com/business/local/st-louis-judge-holds-fate-of-pollution-controls-at-two/article_10c1de51-828f-58f6-8103-b36a7e2ce7f9.html

4. Filing of Stakeholder Comments
   Q. Please indicate what date Ameren Missouri believes formal comments are due for its 2019 IRP update filing from stakeholders in EFIS.

BUSINESS

https://www.stltoday.com/business/local/st-louis-judge-holds-fate-of-pollution-controls-at-two/article_10c1de51-828f-58f6-8103-b36a7e2ce7f9.html

St. Louis judge holds fate of pollution controls at two area Ameren coal-fired power plants

By Robert Patrick St. Louis Post-Dispatch Apr 15, 2019

ST. LOUIS • Either Ameren's failure to install pollution controls on its Rush Island coal-fired power plant near Festus caused the premature death of hundreds of people by releasing 160,000 tons of sulfur dioxide into the air, or the emissions had no measurable health impact and a remedy could cost each Ameren ratepayer at least $1,345.

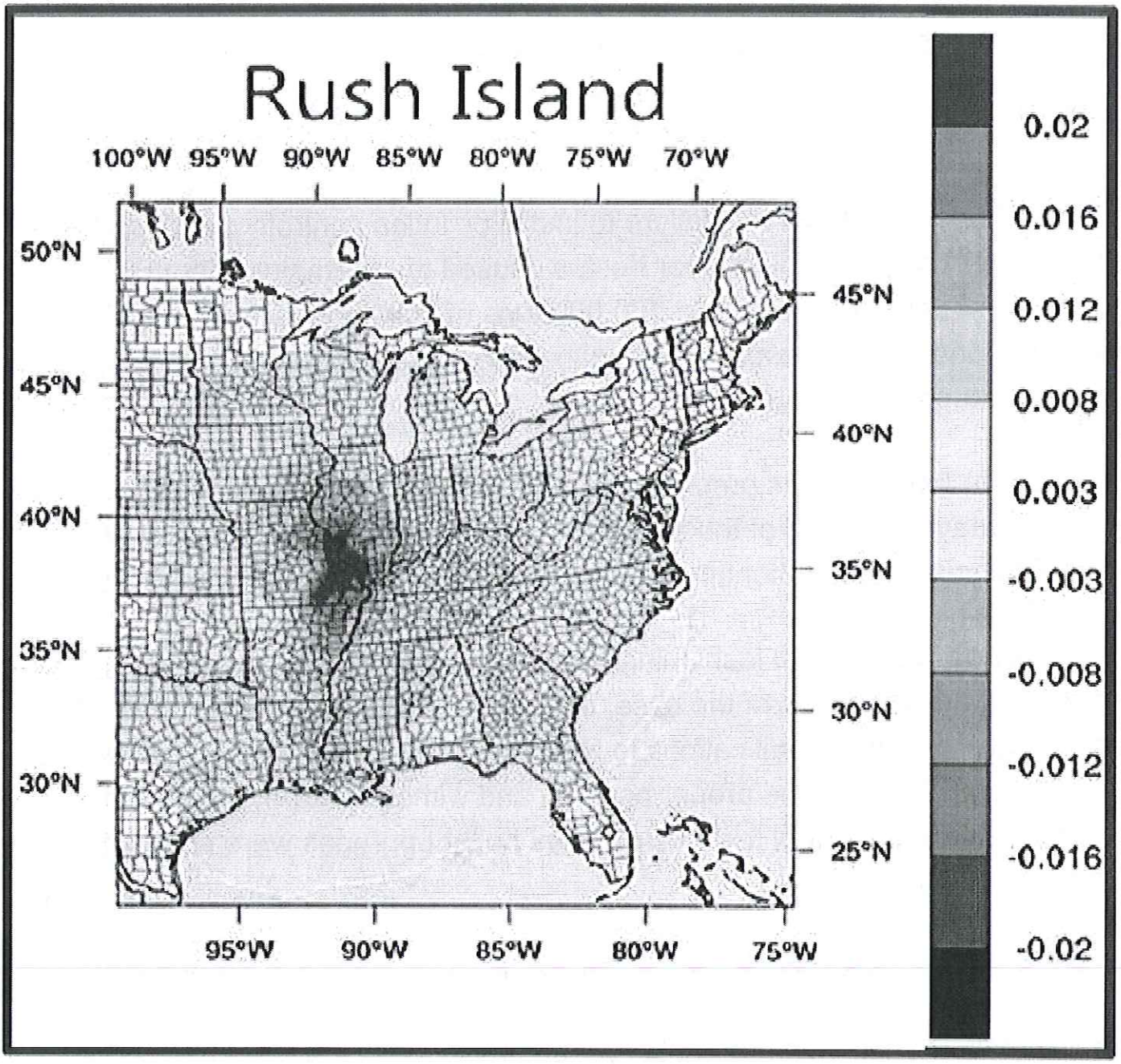
Those were the two sides presented to U.S. District Judge Rodney Sippel in court Monday at the end of the second phase of a lawsuit that was filed more than eight years ago on behalf of the U.S. Environmental Protection Agency.

Sippel is now tasked with fashioning a remedy after ruling in January 2017, at the end of the first phase of the case, that Ameren had violated the Clean Air Act by making major modifications to Rush Island without reporting the work to the EPA and obtaining the proper permits, and without installing the "best-available pollution control technology." The boiler upgrades were completed in 2007 and 2010.

Since that time, lawyers on both sides have fought over the appropriate fix.

On Monday, Justice Department lawyer James W. Beers Jr. said that Sippel should order Ameren to apply for a permit under the Clean Air Act and install pollution controls that would bring it into compliance in three years.

Each year of delay, Beers said, represents another 16,000 tons of sulfur dioxide released by the plant, adding to the 160,000 pounds released since Ameren's failure to install pollution control equipment when the plant modifications were made. That pollution, he said, affected most of the eastern seaboard of the U.S. and areas from Texas to Michigan, resulting in between 600 and 880 premature deaths.



An image from a court filing by lawyers for the U.S. Environmental Protection Agency shows an estimate of downward impact of sulfur dioxide emissions from Ameren's Rush Island coal-fired power plant near Festus. The graphic was prepared by a witness for the EPA, air quality modeling expert Lyle Chilken, the filings says.

Sulfur dioxide can cause breathing problems, including exacerbating asthma in children, and other health problems.

Power plants are a major source, and Beers said that 80 percent of coal-fired plants have scrubbers to help remove the pollutant.

Beers said the cost would be reasonable for a company with $1 billion in cash flow and $400 million in dividends a year. Those costs stem from decisions made by Ameren, not actions taken by the EPA or Sippel, Beers said, adding that Ameren does not have to seek a rate increase to pay for the fix.

Beers also said that the best way to make up for Rush Island's past pollution would be to reduce the emissions of a plant in the same area, Ameren's Labadie coal-fired plant in Franklin County.

Benjamin J. Blustein, a lawyer for the Sierra Club, spoke briefly, asking Sippel for steeper caps on emissions.

"Like a good neighbor, Ameren should clean up the mess it made … as soon as possible," Blustein said.

Ronald S. Safer, a lawyer for Ameren, instead argued that past pollution should be offset by Ameren turning over "allowances" it won for emissions reductions elsewhere. Safer said scrubbers to remove the sulfur dioxide would cost billions of dollars and require Ameren to run Rush Island for 30 more years to maximize the return on investment for ratepayers. He said installing a less expensive technology, dry sorbent injection, would save money and allow Rush Island to be closed if more energy efficient options became available.

(The EPA says that dry sorbent injection is less efficient at removing sulfur dioxide pollution than using scrubbers.)

Safer said that the past amounts of sulfur dioxide emitted by the plant were so low that they did not pose a threat, and are less dangerous than the pollution caused by traffic.

"No one believes these tiny increments cause a health impact. Nobody," he said.

Both sides have until May 23 to file their proposed findings of facts and conclusions of law to Sippel, and an additional four weeks to respond to each others' filings.

After the first nonjury trial was held in August 2016 and lawyers filed their post-trial briefs, Sippel released his 195-page opinion and order in January of 2017.

Robert Patrick

Robert Patrick is a reporter for the St. Louis Post-Dispatch.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

AFFIDAVIT OF GEOFF MARKE

STATE OF MISSOURI)
) SS.
COUNTY OF COLE)

COMES NOW GEOFF MARKE and on his oath declares that he is of sound mind and lawful age; that he contributed to the foregoing *PUBLIC COUNSEL'S SUGGESTED SPECIAL CONTEMPORARY RESOURCE PLANNING ISSUES* and that the same is true and correct according to his best knowledge and belief.

Further the Affiant sayeth not.

Geoff Marke
Chief Economist

JURAT

Subscribed and sworn before me, a duly constituted and authorized Notary Public, in and for the County of Cole, State of Missouri, at my office in Jefferson City, on this 16th day of September, 2019.

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JERENE A. BUCKMAN
My Commission Expires
August 23, 2021
Cole County
Commission #13754037

Jerene A. Buckman
Notary Public

My Commission expires August 23, 2021.