DIALOGUE

# LOCAL ENVIRONMENTAL IMPACTS OF DATA CENTER PROLIFERATION


## SUMMARY

Demand for data centers is increasing worldwide, raising questions about the electric grid, the transition to renewable energy, and distribution infrastructure. Northern Virginia is home to data centers that process nearly 70% of global digital traffic, leading officials to call for construction, at ratepayers' expense, of new power plants and new transmission lines across four states, as well as the continued operation of coal-powered plants that had been scheduled to go offline. On December 6, 2024, the Environmental Law Institute and the Network for Digital Economy and the Environment co-hosted a panel of experts who examined the environmental impacts and policy implications of data center growth and the consequences for residents of Virginia and nearby states. Below, we present a transcript of that discussion, which has been edited for style, clarity, and space considerations.



**Reid Lifset** (moderator) is a Research Scholar at the Yale School of the Environment.
**Pranava Raparla** was a Presidential Innovation Fellow at the U.S. Department of Energy.
**Amy Stein** is the Cone Wagner Professor of Law at the University of Florida Levin College of Law.
**Lauren Bridges** is an Assistant Professor in Media Studies at the University of Virginia.
**Jim McElfish** is a Senior Advisor at the Environmental Law Institute.
**Tim Cywinski** is Communications Director at the Virginia Chapter of the Sierra Club.


**Reid Lifset:** Increasing digitalization of our economy and the dramatic development of artificial intelligence (AI) have produced rapid growth of data centers and an attendant increase in demand for electricity. This, in turn, has engendered debate and concern about the adequacy of energy supply and the contribution of data centers to greenhouse gas emissions.

This has prompted national and international research and policy attention. Local environmental impacts arising from the growth of data centers—including air pollution, water consumption, and land use—despite expanding press coverage, have not been extensively explored. To take just one example, in reviews of academic research literature, only a very small handful of studies of local environmental impacts of data centers were found.[1]

This webinar has been organized by the Network for the Digital Economy and the Environment[2] and the Environmental Law Institute (ELI) to increase understanding of the local environmental issues related to data center proliferation. We focus on Northern Virginia because of the density and increase in the number of data centers there. Today, we've assembled a very impressive group of experts on the topic of local impacts.

We're going to start with Pranava Raparla, who will provide an introduction to the growth in data centers in the United States. That will be followed by Prof. Amy Stein, who will give an overview of the energy situation related to data centers. Prof. Lauren Bridges will discuss the local environmental impacts as related to water. Jim McElfish will describe emerging trends regarding approaches that local governments are taking on land use regulations and other considerations relating to siting of data centers. Tim Cywinski will provide an advocacy perspective.

**Pranava Raparla:** I am a fellow with the U.S. Department of Energy (DOE). I'm split between, first, the Office of Policy, where I focus on supporting our data center engagement team at DOE to help build more and promote the growth of data centers in the United States powered by clean energy, and making sure that they are built

*Author's Note: Pranava Raparla's statements do not necessarily represent the official views of the U.S. Department of Energy or the federal government.*

1. *See* Network for the Digital Economy and the Environment, *Bibliography*, https://bit.ly/nDEE-bibliography (last visited Mar. 13, 2025).

2. The Network for the Digital Economy and the Environment is a joint initiative of ELI, the Yale School of the Environment, and the Center for Law, Energy, and the Environment at the University of California, Berkeley. Its goal is to catalyze and disseminate research on the environmental impacts of the digital economy and to bridge the gap between research findings and their translation into policy. The network started in 2018 and is supported by the Internet Society Foundation, the U.S. National Science Foundation, and the Alfred P. Sloan Foundation. *See* Network for the Digital Economy and the Environment, *Home Page*, https://www.networkdee.org/ (last visited Mar. 13, 2025).

with community input in mind and ensuring that we're not passing those additional costs on to other ratepayers and communities.

Second, in my other capacity, I'm working on using AI tools to help deploy more clean energy that can then build more tools that can help us permit a site to employ faster, cleaner energy so we can support more growth of such technologies. Today, I'm going to introduce some of the statistics and numbers of where data center load growth has been in the United States, and then share a bit about DOE's approach to this and what we have coming next.

Looking at load growth by the numbers, in 2023, data centers accounted for around 4% of total U.S. electricity demand. It's projected to grow to 9% of total U.S. electricity demand. So, not only is it growing in general, but it's also growing as an increasing share of all electricity demand growth in the country—about 15% to 20% projected over the next decade. This demand is a little unprecedented, but we've had low growth spikes in the past. The way we've approached it is with technological advancements, energy efficiency, and in some ways decreasing certain industrial processes too.

In the past, we've met the challenges, and today we think we have the tools to continue to meet the challenges. We have more tools with both financial and technical resources and broader industry partnerships and engagements to figure out how to build these in the right places and with clean energy in mind. I'll talk about what we've been doing recently.

A lot of data centers are not new. They've been around for a while and large-load facilities have been around for a while. What's new is that in 2024, we had a lot more engagement with data center developers, utilities, state and local officials, community organizations, and other stakeholders. We've been trying to get a lay of the land of the different challenges folks are facing with building.

There are some communities where there are lots of data centers. They're sort of encroaching upon communities and are being built where people might not necessarily want them. There are also other challenges where there are certain communities and locations where data centers would be a good fit, but it's harder to build there. So, we've been trying to get a lay of the land by talking to all of these stakeholders.

In the summer, we published a bunch of our resources to help build data centers and other large-load facilities.[3] A lot of these include specific technical assistance for state and local officials so they can study the problem in their particular regions. They are also for utilities so they can study the problem in their regions and then get support to figure out how to build in the right place with all of the stakeholder and community input in mind.

We convened further with the industry this past fall. One of the things to highlight would be that in September, the White House held a meeting with DOE and the U.S. Department of Commerce on critical AI infrastructure. While we're thinking about load growth in general across electrification of vehicles, manufacturing, more onshore manufacturing, and more data center load growth, the priority for the Joseph Biden Administration coming out of that meeting was a focus on building domestically all of the pieces that are critical for AI infrastructure.

That's manufacturing chips and silicon that go into data centers in the United States, especially through the CHIPS Act.[4] That also includes making sure that the data centers, which are going to be training the next generation of models, are built domestically in the United States. That's a national security priority as well.

We've held a few workshops as well, and other challenges include thinking about how we can get flexible, like with flexible loads for AI training, and how we can deal with that with the industry. We've also had a couple of workshops around nuclear with Idaho National Laboratory as another way to have carbon-free opportunities and high baseload power. We've met with our Office of Fossil Energy and Carbon Management. They're thinking about how we can build more capacity within existing energy assets. We've also been showing up in a lot of the convenings hosted by industry partners and state and local and community partners.

In December, DOE announced the release of a report from the Lawrence Berkeley National Lab on data center load growth from 2014 through 2028.[5] The report provides more data to assess where we are today both as a share of total demand and as a share of growth in particular regions and sectors. We're also spending more time researching tariffs and rate design.

This is really important because as we build more data centers, as we build more energy generation, we want to make sure that those costs are appropriately shared and that we're not passing them back on to everyday people, ratepayers, and communities. Whoever is looking to build these data centers should be paying the share for what they need. That's an overall view of what we've been doing.

I'll share a couple highlights of our solution areas to support so that we can build. First, we want to revitalize existing infrastructure. There are a lot of what we call "energy communities"[6] across the United States where we have retired or retiring assets—retired or retiring coal plants, nuclear plants, and other manufacturing facilities. These are important because they are interconnected to the grid. The communities are hungry for some development. There is also a lot of infrastructure in place on-site that

3. DOE, *Electricity Demand Growth Resource Hub*, https://www.energy.gov/policy/electricity-demand-growth-resource-hub (last visited Jan. 29, 2025).

4. CHIPS and Science Act, Pub. L. No. 117-167, 136 Stat. 1366 (2022).

5. Press Release, DOE, DOE Releases New Report Evaluating Increase in Electricity Demand From Data Centers (Dec. 20, 2024), https://www.energy.gov/articles/doe-releases-new-report-evaluating-increase-electricity-demand-data-centers; Arman Shehabi et al., Lawrence Berkeley National Laboratory, 2024 United States Data Center Energy Usage Report (2024), https://eta-publications.lbl.gov/sites/default/files/2024-12/lbnl-2024-united-states-data-center-energy-usage-report.pdf.

6. Uma Outka, *Implementing "Energy Communities,"* 55 ELR 10029 (Jan. 2025), https://www.elr.info/articles/elr-articles/implementing-energy-communities.

can be used to build a new data center or build new clean energy generation.

Our Pacific Northwest National Lab has published a lot of resources around converting retired or retiring coal assets to new technology. That would be to nuclear, geothermal, and solar and wind with on-site storage. We have a lot of push around that. There's a deep partnership with communities to make sure that the right solution fits their needs.

There is a lot of behind-the-meter flexibility. I mentioned load, and the workshop that we held around that with one of our labs, but also, a lot of these data centers will come with a lot more of their own generation on-site. Some of it will have to come from the grid, but a lot will be "bring your own power to your solution." There's a lot of investment in that space. The Lawrence Berkeley National Lab in January released a technical brief on rate and regulatory designs.[7] That's a really important one.

Second is committing to the long-term technologies we need not just in the next few years, but as we look 5, 10, 15 years out. As we see even more growth in data centers for AI and other cloud growth, we need more of these technologies across the board. A lot of these technologies take planning and investment today so that they're realized and available 10 years from now.

Third is building more clean energy generation on DOE lands. Basically, we have a lot of federal lands, especially sites where there are national labs. There are tons of opportunities to build solar, wind, and nuclear on these lands. We're spending a lot of time thinking about how to put that to use to increase capacity for the grid. They're usually large sites. Some are up to 80,000 or 90,000 acres. Not all of these will go to data centers. Some will go back to the grid to decarbonize the grid as well.

**Amy Stein:** I'm going to introduce you to some of the key energy and climate implications of data centers. Before we can understand the energy implications, we first need to get an understanding of our electricity profile for the United States more generally. If we were all together in one room, I would start by asking you all, what resource powers the largest portion of the electric grid in the United States? I would get some blank stares. I would get a variety of uncertain answers—Coal? Solar? Wind? But as many of you already know, the answer is natural gas.

As a nation, we are dependent on natural gas for more than 40% of the electricity we generate.[8] You may also know that coal was a historical leader for decades until 2016, when our fracking shale revolution pushed it out.[9] Data from the U.S. Energy Information Administration (EIA) provides us with a lot of useful information for today's discussion.[10]

I'll draw your attention to four facts. One, renewables have come a long way. I have been teaching energy law for 15 years. I practiced for almost a decade before that. Renewables used to be a barely perceptible thin line on the graph. Now, they've reached over one-fifth of our electricity supply.[11]

Two, nuclear also provides almost one-fifth of our electricity supply.[12] It has remained relatively constant over the years. This segment is becoming increasingly relevant to data center discussions, as many of you may have seen, with Microsoft's recent power purchase agreement with Constellation Energy to restart Three Mile Island's Unit 1 reactor.[13]

Three, despite all the press around solar, wind provides almost three times as much electricity for the nation. And four, I want to note oil's role in our electric grid—it is almost nonexistent.[14] When we talk about energy, it's useful to keep in mind that there are two primary sectors: the electric grid and transportation. Petroleum dominates transportation discussions, providing approximately 90% of the nation's transportation needs but less than 1% of the nation's electricity.[15]

It is also important to note that this data reflects the national average. It does not reflect the wide diversity in sources that vary by region across the United States. Because today's focus is on local impacts, let's also look at the variety of electricity profiles across regions.

A snapshot from the EIA provides a little flavor of this variety.[16] The EIA tallied renewable generation over the past decade by region. As of 2023, the Northwest and Rockies region and California are in the lead, followed closely behind by the middle swath of the country, with a shoutout to New York for also beating the national average.

This is consistent with the wide variation in natural resources around the country. Think of the Pacific Northwest and all of its hydropower. It's also consistent with wide variation in various state and local laws incentivizing renewables. Think about California and other states with their 100% clean energy mandates and other factors that shape each state's unique electricity profile.

If you're interested in the rate of growth, the middle of the country wins, with Texas on an enormous boom in

7. Andrew Satchwell et al., Lawrence Berkeley National Laboratory, Electricity Rate Designs for Large Loads: Evolving Practices and Opportunities (2025), https://eta-publications.lbl.gov/sites/default/files/2025-01/electricity_rate_designs_for_large_loads_evolving_practices_and_opportunities_final.pdf.
8. U.S. Energy Information Administration (EIA), *Frequently Asked Questions (FAQs): What Is U.S. Electricity Generation by Energy Source?*, https://www.eia.gov/tools/faqs/faq.php?id=427&t=3 (last updated Feb. 29, 2024).
9. EIA, *Natural Gas Expected to Surpass Coal in Mix of Fuel Used for U.S. Power Generation in 2016* (Mar. 16, 2016), https://www.eia.gov/todayinenergy/detail.php?id=25392.
10. *See supra* notes 8-9; *infra* notes 15-17.
11. EIA, *supra* note 8.
12. *Id.*
13. Press Release, Constellation Energy, Constellation to Launch Crane Clean Energy Center, Restoring Jobs and Carbon-Free Power to the Grid (Sept. 20, 2024), https://www.constellationenergy.com/newsroom/2024/Constellation-to-Launch-Crane-Clean-Energy-Center-Restoring-Jobs-and-Carbon-Free-Power-to-The-Grid.html.
14. EIA, *supra* note 8.
15. EIA, *Use of Energy Explained: Energy Use for Transportation*, https://www.eia.gov/energyexplained/use-of-energy/transportation.php (last updated Aug. 16, 2023).
16. EIA, *EIA Expects Renewables to Account for 22% of U.S. Electricity Generation in 2022* (Aug. 16, 2022), https://www.eia.gov/todayinenergy/detail.php?id=53459.

both wind and solar. Electricity consumption is growing fastest there.

Local impacts will differ depending on the choices that each state makes to respond to this projected growth. Obviously, a natural gas plant has different environmental impacts on a local community than a wind farm.

If you're interested in more of this information, I would encourage you to check out EIA's state-by-state electricity profiles.[17] But this is all important because as data centers, and particularly hyperscalers, look to set up shop, the availability of sufficient electricity is one of many important factors they will consider.

As Pranava has indicated, all predictions are pointing to growing demand from data centers. Lawrence Berkeley National Lab completed a study in 2016 on data center electricity use looking at servers, storage, network equipment, and infrastructure over a 20-year period.[18] In 2014, data centers in the United States consumed an estimated 70 billion kilowatt hours, representing 1.8% of total U.S. electricity consumption.[19]

But current projections tell a different story from estimates back then, which found that by 2020 we were only going to be at maybe 73 billion kilowatt hours.[20] But as Pranava has just described, we're already at 4% of total U.S. electricity demand. Perhaps you've seen it in your newsfeeds that Electric Power Research Institute recently predicted data centers could consume 9% of electricity by 2030.[21] Grid Strategies predicts a 16% surge over the next four years, 90 gigawatts by 2029.[22]

I like to keep my eye on utility integrated resource plans (IRPs). In 2023, Dominion Energy's IRP predicted a quadrupling of demand in the next 15 years.[23] These are some eye-popping numbers, and that makes many people skeptical. Forecasts are notoriously temperamental and elusive. It's important to know that not all data centers are alike in their electricity needs. They vary drastically in size, scope, and purpose. Data centers are just part of this growing demand story that we're seeing. There's also demand coming from electric vehicles, crypto, and general efforts around the country to promote electrification.

The International Energy Agency predicts that electricity consumption from data centers' AI and crypto is expected to double by 2026.[24] But if we see a growth in AI-dedicated data centers, for instance, we might see a large portion of that dedicated to models that depend on generative AI, such as ChatGPT, that you might be using with more frequency. Researchers are pointing to the graphics processing units that are used in generative AI as being 10 to 15 times more electricity-intensive than traditional central processing unit processing.

Goldman Sachs research estimates that data center power demand will grow 160% by 2030.[25] So, we're not sure about the estimates, but one thing is pretty clear. The demand for electricity to fuel data centers is going to be greater in the future than it is today, and the growth is going to be differentiated across different localities.

For instance, there is the EIA's tracking of actual—not projected—commercial electricity demand by state over the past five years.[26] Electricity use is usually divided into three categories: residential use (think heating and cooling); industrial use (think manufacturing); and commercial use (think businesses and governments). Does U.S. commercial demand line up nicely with parts of the country that are trying to enhance renewables? Maybe yes, maybe no. Does it line up nicely with data center growth? Maybe yes, maybe no.

The data show that there are two outliers: Virginia and Texas—two states that are leading the way in data center development. Electricity demand has grown the most in Virginia, which added 14 billion kilowatt hours over this period, adding almost 100 new data centers. Texas is close behind, but then there are some interesting states next in line—South Carolina, Arizona, and North Dakota.

Maybe they're interesting because of the news that we're seeing. For example, Duke announced agreements with Big Tech for clean energy deployment in the Carolinas.[27] In North Dakota, EIA attributes the large computing facilities to that state's fastest relative growth.[28] Are these going to be the next data center hubs? We're not sure, but we can see that there are many factors that come into play in decisions about where to site and where electricity demand is occurring.

My fellow panelists are going to speak about some other reasons why data center developers are drawn to different areas, including tax incentives and local zoning regulations. But I'll throw in one additional constraint on these data center developers: their own carbon goals. Of course, the carbon footprint of each of these data centers

17. EIA, *Electricity: State Electricity Profiles*, https://www.eia.gov/electricity/state/ (last visited Feb. 25, 2025).
18. Arman Shehabi et al., Lawrence Berkeley National Laboratory, United States Data Center Usage Report (2016), https://eta-publications.lbl.gov/sites/default/files/lbnl-1005775_v2.pdf.
19. *Id.* at ES-1.
20. *Id.* at ES-3.
21. Press Release, Electric Power Research Institute (EPRI), EPRI Study: Data Centers Could Consume Up to 9% of U.S. Electricity Generation by 2030 (May 29, 2024), https://www.prnewswire.com/news-releases/epri-study-data-centers-could-consume-up-to-9-of-us-electricity-generation-by-2030-302157970.html.
22. John D. Wilson et al., Grid Strategies, Strategic Industries Surging: Driving US Power Demand (2024), https://gridstrategiesllc.com/wp-content/uploads/National-Load-Growth-Report-2024.pdf.
23. Dominion Energy, Virginia 2023 Integrated Resource Plan 58 (May 1, 2023), https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/global/company/2023-va-integrated-resource-plan.pdf?la=en&rev=6b14e6ccd15342b480c8c7cc0d4e6593.
24. International Energy Agency, *Executive Summary*, https://www.iea.org/reports/electricity-2024/executive-summary (last visited Mar. 13, 2025).
25. *AI Is Poised to Drive 160% Increase in Data Center Power Demand*, Goldman Sachs (May 14, 2024), https://www.goldmansachs.com/insights/articles/AI-poised-to-drive-160-increase-in-power-demand.
26. EIA, *Commercial Electricity Demand Grew Fastest in States With Rapid Computing Facility Growth* (June 28, 2024), https://www.eia.gov/todayinenergy/detail.php?id=62409.
27. Press Release, Duke Energy, Responding to Growing Demand, Duke Energy, Amazon, Google, Microsoft, and Nucor Execute Agreements to Accelerate Clean Energy Options (May 29, 2024), https://news.duke-energy.com/releases/responding-to-growing-demand-duke-energy-amazon-google-microsoft-and-nucor-execute-agreements-to-accelerate-clean-energy-options.
28. EIA, *supra* note 26.

will be dependent on the local electricity profile for the utility that serves them. In 2022, for example, Virginia's electricity supply relied on 54% natural gas, 31% nuclear, and 11% renewables.[29]

Big Tech is becoming a key player now in energy as well. By "Big Tech," I'm referring to Amazon, Microsoft, Alphabet/formerly Google, Meta/formerly Facebook, and Apple. Each of them publishes an annual sustainability report and each has made pledges. For example, Microsoft made a commitment to be carbon-negative by 2030.[30] Some say carbon-neutral, some say carbon-negative. There's a lot of discussion about these sorts of pledges.

Amazon says it's going to take until 2040, but it has also committed to a net-zero carbon emissions plan.[31] When you think about it, these goals are not that far away now. The 2030 pledges—there's just five years left to achieve them. So, what can we do?

We're starting to see a lot of news articles with titles like "Big Tech is the nuclear industry's new best friend: Amazon, Microsoft and Google rush to sign deals."[32] Many of them are looking to nuclear to solve their problems of needing a lot of electricity in a short period of time. It's a baseload source. But the last nuclear reactors built in the United States are in Georgia, the Vogtle Units 3 and 4, which went into operation in 2024. They took 15 years to build and cost more than $36 billion.[33] That was more than twice the projected timeline and cost, and that is going to be difficult to achieve in five years. That's part of why Pranava's suggestion about revitalizing existing infrastructure is so important.

Some of the research we need to do is identifying those sites that are already interconnected, because climate impacts also need to be considered when deciding where to site the next wave of data centers. The Lawrence Livermore National Lab released a report in 2023 on the drought and extreme heat impacts on data centers in northern California.[34] More of this work is needed to remind us of the importance of including climate projections in data center design and planning.

If Big Tech sticks to their carbon commitments, this means finding not only abundant and cheap electricity, but carbon-free electricity as well. DOE released a handy guide for future research.[35] It's good to remind us of areas to address or to think creatively about how we can meet these needs, to think about generation, transmission, energy efficiency, and the ways the data centers' efficiencies and flexibility could be used.

Servers can even improve their power-scaling abilities, reducing power draw during idle periods or when they're at low use. This is really important because very often we slip into thinking that we can only address electricity needs by building more power plants. Demand-side initiatives that shift times of use and enhance efficiencies can also help.

Building upon DOE's good work, I'll throw out a couple potential research areas. Even if all those projected demands are real, the real constraint may come from the supply side, because there's a question as to whether generation and transmission infrastructure will be able to keep pace with such demand at this speed.

There are some things to think about here. First, how do we achieve meaningful permanent reform to get electricity infrastructure completed? Second, how do we resolve the very long interconnection queues across the nation? We're starting to think about self-supply, as you may have followed with the Federal Energy Regulatory Commission (FERC) rejection of the Amazon-Talen co-location deal.[36]

I know that Tim is going to discuss equity concerns, but I want to be sure we think about equity across different service classes in electricity. What happens if electricity costs skyrocket? How do we make sure residential customers are not subsidizing data center customers? Thinking about regulatory needs to refine new nuclear construction for both traditional and small modular reactors, how will electric utilities behave in this transition? They stand to make a lot of money if data centers need all that extra electricity.

What should be the role of local and state regulators—public utility commissions (PUCs) and public service commissions—in the transition? What's the role for the regional transmission organizations and the independent system operators? How will those regions with competitive markets differ from those in traditionally regulated markets? How can we enhance the efficacy of policies related to local environmental, economic, and social impacts with so many varied stakeholders?

**Lauren Bridges:** The two previous speakers have outlined all of the core issues, especially around power. I'm going to jump off of those points and speak about water. Water and power are pretty entangled at this stage with data centers. That's because evaporative cooling is still the industry-standard way to cool servers. It's one of the cheapest and most convenient ways. This method uses a lot of water.

29. EIA, *Virginia: Profile Analysis*, https://www.eia.gov/state/analysis.php?sid=VA (last updated Feb. 20, 2025).
30. Brad Smith, *Microsoft Will Be Carbon Negative by 2030*, Off. Microsoft Blog (Jan. 16, 2020), https://blogs.microsoft.com/blog/2020/01/16/microsoft-will-be-carbon-negative-by-2030/.
31. Amazon, *Driving Climate Solutions*, https://sustainability.aboutamazon.com/climate-solutions (last visited Mar. 13, 2025).
32. David Meyer, *Big Tech Is the Nuclear Industry's New Best Friend: Amazon, Microsoft and Google Rush to Sign Deals*, Fortune (Nov. 21, 2024), https://fortune.com/2024/11/21/tech-nuclear-energy-google-microsoft-amazon-ai/.
33. Patty Durand et al., Plant Vogtle—The True Cost of Nuclear Power in the United States (2024), https://www.nonukesyall.org/pdfs/Truth%20about%20Vogtle%20report%20May%2030%20release.pdf.
34. Gemma J. Anderson, Lawrence Livermore National Laboratory, Drought and Extreme Heat Impacts to Data Centers in Northern California (2023), https://www.cisa.gov/sites/default/files/2024-01/data-centerreport_GJANDERSON_FINALRELEASE_508c_1.pdf.
35. DOE, *Clean Energy Resources to Meet Data Center Electricity Demand*, https://www.energy.gov/gdo/clean-energy-resources-meet-data-center-electricity-demand (last visited Mar. 13, 2025).
36. Ethan Howland, *FERC Rejects Interconnection Pact for Talen-Amazon Data Center Deal at Nuclear Plant*, Util. Dive (Nov. 4, 2024), https://www.utilitydive.com/news/ferc-interconnection-isa-talen-amazon-data-center-susquehanna-exelon/731841/.

Globally, data centers are forecasted to consume around 450 million gallons of water daily by 2030. This is up from 205 million in 2016.[37] Power and water consumption follow linear paths of growth across time, both increasing as demand for data centers increases. However, there's lots of variation around water usage. As Dr. Stein mentioned, not all data centers are built the same. The water usage will also depend on the location and the climate of that location.

The other major issue is that there are significant gaps in the data, so there's a lack of transparency. As researchers, we don't have access to the most recent and industry-standard consumption patterns. For example, in 2022, a survey by Uptime Institute found that only 39% of data center operators are actually measuring their water usage.[38] Most operators said that they weren't tracking water usage because they believed there was no business justification for doing so, which suggests that it's a low priority for management. Hopefully, that will change with some of the legislation that's coming down the pike and with increased community pressure. But at the moment, there is a lack of data and a lack of transparency.

All of this water usage has been increasing in intensity with the boom in AI. A study published in 2021 estimated that a single ChatGPT request consumes the equivalent of a 500-milliliter bottle of water.[39] But just a few weeks ago, the authors of this study warned that their original water calculation was based on the OpenAI figures from 2020.[40] Instead, they've already revised the paper to say that it will actually be four times as much for GPT-4. This is because the servers that are built for AI and the chips that are used for AI have much more power density and greater cooling demands. That's only going to increase as these models get more sophisticated over time.

It's also important to note that water usage in data centers is not distributed equally. It's concentrated in development hotspots. For example, in Northern Virginia, data center water usage has increased by almost two-thirds since 2019.[41] That's in the context of increased susceptibility in the region to droughts.

One of the important things I find, both as an educator and as someone who speaks on this topic frequently, is that we need to have common language to discuss these different impacts. There's language that's proposed and used by industry and it's important for us to understand what these terms are. There are different ways that water is consumed or used in data centers. We might think of this in terms of, for example, how the Greenhouse Gas Protocol uses the terms scope 1, 2, and 3 to talk about direct usage, indirect usage, and usage further in the tech supply chain.

Scope 1 refers to direct usage at the site. This includes water mostly used for cooling, but it also involves water used for other building purposes. According to Prof. Venkatesh Uddameri, director of the Water Resources Center at Texas Tech University, the typical data center uses anywhere between three million and five million gallons of water per day, or the equivalent of water that would be needed for a city of 30,000 to 50,000 people.[42]

While many data center operators are using gray water, the research shows that most of them are still relying on potable water, meaning our drinking water. This is particularly alarming because almost one-fifth of data center water is drawn from regions with moderate to high water stress.[43] This is creating strains on the communities where water is already scarce. There's a growing concern as more places are facing drought and high temperatures due to climate change.

We're also starting to see community pushback around water restrictions. For example, Chile recently halted a project with Google because of the drought conditions.[44] In a farming region in Spain's Talavera de la Reina, Meta is planning to build a $1.1-billion data center that is expected to consume 176 million gallons of water annually, despite concerns about water security.[45] In the United States, we've seen farmers and community members protesting data center water usage in New Mexico, Arizona, Texas, Colorado, and Virginia.[46]

Also, one of the main concerns here is that companies are now being found to be underestimating projected water consumption. For example, Microsoft's giant data center in northern Holland was projected to consume around 84 million liters of water during 2021, a year when heat caused severe water shortages. But the company and local authority initially estimated they would only need 12-20 million liters, four times lower than what was actually used.[47] These

37. Clara H. Lizarraga & Olivia Solon, *Thirsty Data Centers Are Making Hot Summers Even Scarier*, Bloomberg (July 26, 2023), https://www.bloomberg.com/news/articles/2023-07-26/extreme-heat-drought-drive-opposition-to-ai-data-centers.
38. *Id.*
39. Pengfei Li et al., *Making AI Less "Thirsty": Uncovering and Addressing the Secret Water Footprint of AI Models*, *available at* https://doi.org/10.48550/arXiv.2304.03271.
40. Mark Sellman & Adam Vaughan, *"Thirsty" ChatGPT Uses Four Times More Water Than Previously Thought*, Times (Oct. 4, 2024), https://www.thetimes.com/uk/technology-uk/article/thirsty-chatgpt-uses-four-times-more-water-than-previously-thought-bc0pqswdr.
41. Camilla Hodgson, *US Tech Groups' Water Consumption Soars in "Data Centre Alley,"* Fin. Times (Aug. 18, 2024), https://www.ft.com/content/1d468bd2-6712-4cdd-ac71-21e0ace2d048.
42. Edward M. Frederick, *Water Use Is a Significant Factor for Data Centers*, Frederick News-Post (Nov. 3, 2023), https://www.fredericknewspost.com/opinion/letter_to_editor/water-use-is-a-significant-factor-for-data-centers/article_07b17119-1d95-5bd0-9c8f-0242df861af0.html.
43. Md Abu B. Siddik et al., *The Environmental Footprint of Data Centers in the United States*, 16 Env't Rsch. Letters 064017 (2021), https://doi.org/10.1088/1748-9326/abfba1.
44. Omar Duwaji, *Chile Pulls Approval for Giant Google Data Center*, World (Feb. 28, 2024), https://theworld.org/segments/2024/04/04/chile-pulls-approval-for-giant-google-data-center.
45. Lizarraga & Solon, *supra* note 37.
46. Shannon Osaka, *A New Front in the Water Wars: Your Internet Use*, Wash. Post (Apr. 25, 2023), https://www.washingtonpost.com/climate-environment/2023/04/25/data-centers-drought-water-use/; Olivia Solon, *Drought-Stricken Communities Push Back Against Data Centers*, NBC News (June 19, 2021), https://www.nbcnews.com/tech/internet/drought-stricken-communities-push-back-against-data-centers-n1271344.
47. Peter Judge, *Drought-Stricken Holland Discovers Microsoft Data Center Slurped 84m Liters of Drinking Water Last Year*, Data Ctr. Dynamics (Aug. 16, 2022), https://www.datacenterdynamics.com/en/news/drought-stricken-holland-discovers-microsoft-data-center-slurped-84m-liters-of-drinking-water-last-year/.

are all issues around direct water usage, but indirect water usage is just as important, if not more important.

According to researchers at Virginia Tech, roughly three-quarters of water usage attributed to data centers actually happens indirectly at the site of electricity generation.[48] Sometimes, this power generation is happening in adjacent sites, states, or municipalities, which means that it's not only residents living next to data centers or in communities where data centers are located, but it is communities located in other geographies as well.

Again, this is like scope 2 water consumption. This doesn't get at the scope 3 impacts from water, which refer to other sections of the tech supply chain. For example, semiconductor foundries are known to use a lot of water as well. There's a lot of lack of transparency and a lack of actually tracking these metrics in industry, so we need more of that.

It's important to note that the concerns are not just about water usage and consumption. There are also growing concerns around impacts to water quality. For example, in Northern Virginia, the Occoquan Reservoir, which provides drinking water to three counties and more than two million residents, has seen an alarming increase in concentrations of sodium and other salt-related constituents. This has been found to be related to the increase in impervious surfaces from data center development. Thus, there are other concerns around how the development might also impact water sources and the longevity of the water quality of various sources.

Then, there are a couple of industry terms that are important to pay attention to, which are "water usage effectiveness" and "net water positive." These terms can often obscure a lot of information. Water usage effectiveness is actually a measure that tries to track the water efficiency of data centers by measuring the amount of water used per unit of energy consumed, but it obscures a lot. It doesn't account for the water source. It also doesn't differentiate between potable and recycled water. It focuses on a ratio of water usage related to energy. If you ended up having old equipment that meant you were using more energy as to water, it might obscure these facts. Similarly, net water positive doesn't pay attention to the water source.

**James McElfish:** I'm going to talk about local government regulation, which in the United States is where most land use issues are addressed. Local governments are governments of limited powers in the United States. Their powers are derived entirely from state law and state constitutions and, because of this, it's important to look at what states have reserved to themselves and what powers they have given to local governments.

For example, issues of air pollution are often reserved to the state environmental agency. Issues of water use, particularly water withdrawal from rivers, streams, or aquifers, often are within the competence of state governments, not local governments. So, bear in mind that local governments have limited powers but are also the primary actors in deciding on where land uses occur and under what conditions they occur. Again, there are a couple of ways that this applies to data centers.

The U.S. system largely is one in which local governments engage in comprehensive planning, looking at goals for future development, and typically comprehensive planning sets areas of residential or mixed use, of natural resource preservation, or industrial or the like. The comprehensive plan is a guide, but it is not itself regulatory. The regulatory measures are carried out in zoning ordinances typically defined by maps and zoning districts—the regulations that prescribe how many units you're allowed to have, or how dense development can be, or what sorts of uses are compatible with other uses.

When we get to data centers, obviously 10 or 15 years ago this was not an issue for local governments. Nevertheless, applications were occurring for these uses. The initial question is, what *kind* of land use is a data center? These are often fairly large buildings—100,000 square feet, or even several 100,000 square feet. What is a data center like and where does it fit? Is it a commercial use? Well, if it's a commercial use, is it one that we want in a zone where we have retail development or office development? It's not particularly compatible with some of those uses. With few employees, it has a very large footprint. Not something that would be conducive to a good streetscape or in trying to develop a mixed use area. Not great compatibility with transit, for example. So, maybe it's an industrial use.

Then, of course, we need to answer this question in our zoning ordinance, because what it is also affects *where* it can be sited. Can it be sited at all? Is it okay in an agricultural area? Many of these data centers are greenfield developments because they require large areas of land. They don't really necessarily want to be in a residential area, so we put it out in the agricultural zone. These are choices for local governments.

One other key thing is what *process* applies when an application for a data center is made within the zoning ordinance. If you zone an area for data centers and you define what it is, can it be approved by right? If so, it's approved by an administrative action of the zoning administrator. Or do we want to exercise greater control by designating data centers as a special exception? That requires more detail in the application and a legislative hearing by the county board or the township board or the like. Or is it approved only by rezoning that, in effect, like planned area development or planned unit development, each one is its own entity that requires legislative approval? That also provides greater control to the municipality.

There are many kinds of issues that arise with data centers that local governments are dealing with. Typically, the first one is, which zoning districts can these be in? Are we going to define a data center zoning district or are we going to confine them to heavy industrial? Are we going to confine them to the warehouse district, because they're a little bit like warehouse facilities where there is not a lot of pedestrian traffic and there are large buildings and the like?

48. Siddik et al., *supra* note 43.

Then, there's building size, form, and configuration. Is there a limit on how big they can be? Can they be single story? What form do they have? Is there a setback? Do cooling units have to be 300 to 500 feet from the property line? Then, there's parking. Since data centers rarely have on-site employees, we can't treat them like other commercial or industrial facilities for parking minimums.

Stormwater is particularly interesting. Very few municipalities have anything to say about, or any authority over, water usage. As long as the applicant has a source of water, that's usually nothing that the local municipality is able to get into. With stormwater, on the other hand, municipalities may have a great deal to say in terms of the configuration of facilities, parking lots, runoff, and the like.

Ancillary support facilities are extremely important. Many of these facilities require backup generators that often run on fossil fuels and often produce noise. Municipalities do have control over the siting and use of these. There are the typical issues of noise and lighting; and there are architectural requirements, too. Are these faceless warehouse-like buildings, or do we require something that makes them at least look like public or office buildings of some kind? I mention energy among the considerations largely because there's often not local government authority to deal with energy sources, but it's extremely important.

There are a number of examples of recent planning and zoning in Northern Virginia. Northern Virginia has more than 300 data centers and more in the pipeline. They've had to scramble to figure out where they're going to site them and have made a lot of ordinance changes.

Most recently, Fairfax County has revised its zoning ordinance.[49] It changed which districts data centers can be located in. It has instituted requirements for screening and enclosure of the venting and cooling systems. It has also limited the by-right development of future data centers. So, if you're a data center of 40,000 square feet or fewer in a commercial district or 80,000 square feet or fewer in an industrial zone, then you can go through the by-right permit process. Otherwise, you need to submit to a special exception that requires greater levels of review by the county governing body.

The interesting thing in the new zoning ordinance is that no more new data center applications will be approved for data centers within one mile from entrances to metro stations. Why is this important? You want your commercial and mixed use development to be concentrated near metro stations where people live, work, and are doing commercial things. If you're plopping down a data center that has few employees and no foot traffic and is not synergistic with other things, you don't want to waste your transit areas on that.

Prince William County instituted data center overlay districts in 2016.[50] It revised its ordinances several times, including most recently changing its county noise regulations to apply over a 24-hour period, not just at night, when applied to data centers.

Loudoun County has pending data center amendments to its comprehensive plan.[51] Loudoun County has more than 40 million square feet of existing data centers, with more than 40 million additional square feet of applications already in the pipeline. So, of 90 million square feet of data centers already known or pending in Loudoun, the plan amendment would change its approach to make all data centers a special exception review rather than by right in all districts where it's allowed. Loudoun has put in the comprehensive plan amendments, if adopted, a policy that it doesn't support new data centers in the urban *transit center* areas. Unfortunately, almost all the current data centers and pending applications are in urban transit centers, so Loudoun County is a little late in trying to control development of the data centers in areas that are important for mass transit.

Finally, I want to mention Chandler, Arizona. This is one of the areas with greenfield data centers and also water constraints. It revised its ordinance in December 2022 (effective in 2023) to limit data centers only to a specific planned unit development area.[52] It has adopted new requirements on noise, and prescribed backup generator testing limits.

One of the things that's happened since adoption of the ordinance is that, by requiring a legislative hearing for approval of all new data centers, Chandler has actually been able to affect water use. A new data center that was approved this summer agreed, as part of the approval process, to retrofit an existing data center already in Chandler to get off a water-cooling system and go to a more modern air-cooling system. So, Chandler essentially leveraged its land use approval process to change cooling approaches, something that it had not had the power to do directly.

There are some things to watch for or resources to use. The Virginia Legislative Audit Review Commission has a study that should be out this month examining impacts of data centers in Virginia.[53] The Piedmont Environmen-

49. Fairfax County, Proposed Zoning Ordinance Amendment—Staff Report: Data Centers (May 17, 2024), https://www.fairfaxcounty.gov/planning-development/sites/planning-development/files/Assets/Documents/PDF/data-centers-staff-report.pdf.

50. Prince William County, Comprehensive Plan Amendment #CPA2021-00004, PW Digital Gateway—Gainesville Magisterial District (Nov. 1, 2022), https://www.pwcva.gov/assets/2023-01/CPA2021-00004%20BoCS%20Res._No._22-508.pdf.

51. Loudoun County, *Data Center Standards & Locations*, https://www.loudoun.gov/5990/Data-Center-Standards-Locations (last visited Feb. 14, 2025).

52. Memorandum from Kevin Mayo, Planning Senior Manager, City of Chandler, Arizona, to Mayor and Council and Joshua H. Wright, City Manager, City of Chandler, Arizona, PLH22-0053 Data Centers Final Adoption of Ordinance No. 5033 (Dec. 8, 2022), https://www.chandleraz.gov/sites/default/files/departments/development-services/PLH22-0053-Council-Memo.pdf.

53. Joint Legislative Audit and Review Commission, Data Centers in Virginia (2024), https://jlarc.virginia.gov/pdfs/reports/Rpt598-2.pdf. The report finds, among other things, that unconstrained demand for power in Virginia will double in the next 10 years "with the data center industry being the main driver." This is inconsistent with the state's existing clean energy and climate goals.

tal Council, an environmental organization in Northern Virginia, has an interactive map on its website for data centers throughout the state.[54] The Virginia Department of Environmental Quality has rolled out a new website with all of the air emissions permits issued for data centers in Virginia.[55]

**Tim Cywinski:** I'm generally a climate activist and public advocate in state legislatures and communities. I'll do my best to keep up with the rest of the prestigious panelists here.

We talked about how Virginia is the data center capital of the world. My contribution to this discussion is talking about what all of this looks like in real time because, since we have the greatest data center burden, we can paint a picture of what the worst-case scenario looks like, and often what reckless data center development looks like. We've discussed this a bit already. There isn't uniformity in data centers. You can have a data center in Arizona that's going to look very different from a data center in Virginia.

Let's paint the landscape of why we're concerned and why Virginia is really the staging ground for how we should be able to develop policy that is responsible data center development, or data center pausing, or what it looks like if we don't do anything to create some safeguards, not just for our globe in terms of climate change, but also in terms of how we can protect people and people's livelihoods from this growth.

In Virginia, as we've mentioned, we already have more than 57 million square feet of constructed or operational data center growth and we have another nearly two million square feet proposed. The proposals, by the way, are not slowing down. Just in the past three weeks, we know of at least five new data center proposals. That's how large-scale this is. That's the equivalent of 1,000 Walmart Supercenters that are plaguing a lot of different communities who have to deal with the burdens that come with data center development.

The other side of this is energy. I won't exhaust this because it's been talked about, but 25% of Virginia's electricity is consumed by data centers right now.[56] That is the most of any state. The only place in the world that has more data centers than the state of Virginia is the country of China. That is a mind-boggling statistic when you think about it. If anyone knows what worst-case scenarios look like in terms of data center development, it is the commonwealth that I live in.

Why are they so bad in terms of the energy side? Well, they're being used as an excuse to build a fleet of new fossil fuel plants. Energy has to come from somewhere. The cheat code by the industry and utilities generally is to use natural gas. The United Nations says that the one thing we have to do is stop and mitigate methane usage.[57] Data centers are now being used as the example for continuing to keep natural gas and coal plants online as well as to create new infrastructure.

We mentioned IRPs. Dominion Energy, our largest utility, dropped its IRPs over the past month.[58] It has a new fleet of natural gas pipelines. It says it's pretty much exclusively to find power for data centers. That's doubling our electricity demand output. Doubling our demand means we have to supply the power from somewhere. The industry and utility say that it can't be done with clean energy. Now, whether or not that's true is another situation, but that's what they're proposing.

You cannot have data center development in its current stage and climate solutions at the same time. They cannot co-exist. Let's look at what that looks like for us just as the ratepayers or as people trying to live happy lives. Twenty-nine percent of Virginians in 2023 said that they had to forgo basic goods so they could afford their electric bill—to keep the heat on in the winter, they have to sacrifice buying as many groceries and getting gas in the car to go to work, buying medicine, and taking the kids to school.[59] That's the reality.

Dominion Energy says it's going to likely triple our bills in order to pay for the power development that we'll use to explicitly power data centers. That's what we're looking at. Now, that's one type of harm—the financial cost of data center development. The second side of it, of course, is the pollution that comes with it. Lauren did a great job of talking about the water. We can talk about how some of these things are taking from potable water sources or drinking sources.

In Northern Virginia alone, it's up by 250%,[60] which means some of the localities who are pretty much the sole purveyors of the proliferation of data centers might be put in a position where they have to choose between giving drinking water sources to a data center and their residents. In Caroline County, for example, Amazon has proposed an AI data center campus, and one part of that campus, which has been approved, will require 378,000 gallons of water per day to operate.[61]

Caroline County and surrounding counties are in the middle of a drought. What happens if that gets worse? Are

54. Piedmont Environmental Council, *Existing and Proposed Data Centers—A Web Map*, https://www.pecva.org/region/culpeper/existing-and-proposed-data-centers-a-web-map/ (last visited Jan. 29, 2025).
55. Virginia Department of Environmental Quality, *Issued Air Permits for Data Centers*, https://www.deq.virginia.gov/permits/air/issued-air-permits-for-data-centers (last updated Jan. 27, 2025).
56. EPRI, Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption (2024), https://www.epri.com/research/products/000000003002028905.
57. Press Release, United Nations Environment Programme, Global Assessment: Urgent Steps Must Be Taken to Reduce Methane Emissions This Decade (May 6, 2021), https://www.unep.org/news-and-stories/press-release/global-assessment-urgent-steps-must-be-taken-reduce-methane.
58. Dominion Energy, Virginia 2024 Integrated Resource Plan, fig. 4.2.1.1 (2024), https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/global/company/irp/2024-irp-w_o-appendices.pdf?rev=c03a36c512024003ae9606a6b6a239f3.
59. Press Release, U.S. Census Bureau, Household Pulse Survey Phase 4.2 Monthly Data Release (Oct. 3, 2024), https://www.census.gov/newsroom/press-releases/2024/household-pulse-phase-4-2-oct3.html.
60. *See* Piedmont Environmental Council, Data Center Usage—Reclaimed and Potable_FOIA Request (received Mar. 11, 2024).
61. Caroline County Virginia Government, *Caroline County Data Center Town Hall*, YouTube (Oct. 30, 2023), https://youtu.be/821DuF--3dY?si=SoZ4eCypkO5j_cxX.

they going to have to choose to be powering or making sure that a really big revenue source is able to operate or are they going to go to homes, businesses, and families? That's a precarious position that they find themselves in.

Another side of it is diesel generation. Take out the power plants for a second. Let's just talk about diesel generation. Every proposed data center in Virginia has diesel generation for emergency power. They say it's for emergency power, but these things have to operate throughout the week. In fact, there's a permit from the Department of Environmental Quality that says they get to operate from 9:00 to 5:00 every day except for the weekends. So, it's not just emergency power, it's maintenance costs. They run periodically.

There are toxic chemical releases from diesel generation with concentrations of 30, 40, 50 generators on-site, of arsenic, benzene, and nitrogen oxides ($NO_x$), which cause cancer and chronic respiratory illness.

In Northern Virginia, there are 4,000 diesel generators on-site around the data centers alone. If there is a blackout, those things are running at the same time. I can't even contemplate what that effect will be on the surrounding communities. We have no protections in a sense because, when they approve these data centers, there's no look at the cumulative impact of each site. It doesn't matter that there's 50 diesel generators over here. They're not going to include that in the analysis of whether these diesel generators should be put here. That's what the regulatory framework allows.

Some of these data centers can be located literally within 200 feet of a neighborhood. In Fairfax County, I went to a press conference about a new center where you could see where the site was going to be. It was a stone's throw from people's houses. So, on-site pollution and the energy demand increasing our ratepaying bills are issues that we're focusing on.

Last, like I said before, is the excuse to build new fossil fuel plants. Those are going to be located in environmental justice areas. Dominion Energy has now proposed a giant natural gas-fired power plant in Chesterfield County, which is a place that has already dealt with 80 years of pollution from a coal plant that was operating all the time. That area also has the 90th percentile for cancer, meaning that they have higher cancer rates than 90% of the country.

We're intensifying pollution in those areas. It's done, according to utilities, because of data center growth. There's mention of the Bring Your Own Power proposal. I love that idea because it lessens the burden on ratepayers. But I got off the phone with a Bloomberg reporter just yesterday, and Meta has proposed a $10-billion, four million-square-foot data center in Louisiana that will be powered by natural gas. That's going to hurt our climate and it's also going to hurt the communities around it.

I see this as something that is extremely reckless. It becomes a binary choice. We talked about research questions of how we're going to do this, of how we're going to power these things with clean energy, how we're going to answer the question of whether we can do data center development and solve our climate crisis. How, without even stopping to ask if we should. That's the stake on a global level.

By the way, $1.5 billion in tax incentives is given to the tech industry in Virginia.[62] This is the operational landscape. They come into a locality that's ill-equipped to look at the cumulative impacts. They buy land and they say they're going to build on it and there will be revenue. And don't worry about everything else over there, just look over here. You want money for your schools? Great. Here's the solution. They don't talk about how much water it's going to use, how much energy it's going to use, and how much pollution it's going to cause, because these are rich industries who are racing for AI and they don't care about how many people they have to trample to get there.

**Reid Lifset:** Thank you all for setting the stage. I'll start with a question. There have already been comments about the backup generation and the use of diesel fuel. Perhaps Professor Stein or Jim could talk about what regulatory apparatus is there to deal with the emissions from the backup generators?

**Amy Stein:** EPA and state definitions of "emergency" sources may differ, but each state issues air permits for these emergency generators. I would have to look specifically at each individual state, but I know that for most places it would probably count as emergency backup and not always be regulated under their current air emissions modeling. There's a different category for emergency backup types. They probably wouldn't be exempt from all emissions modeling, but their regulation would be specific to each jurisdiction's environmental agencies.

**James McElfish:** It's an area where state permitting should apply and where local governments have typically fairly limited power. Local governments often are limited to indicating where backup generators can be sited, or what the soundscape might be, or the enclosure. I think one of the Northern Virginia ordinances requires backup generation to be located behind or within the main building, the idea being to prevent the most immediate noise and air pollution impacts. But the direct controls are going to be primarily from the state air pollution agency.

**Amy Stein:** For example, in Wisconsin, the state Department of Natural Resources approved a 1.3-million-square-foot data center with 40 emergency electric generators with pollution controls. As backup power, they're expected to run only for testing and emergencies, and they're permitted to produce just under 100 tons of $NO_x$ emissions each year. So, they're regulated, but in different ways. You'd have to look specifically to your local regulations.

62. Joint Legislative Audit and Review Commission, Economic Development Incentives 2024 (2024), https://jlarc.virginia.gov/pdfs/reports/Rpt597.pdf.

**Lauren Bridges:** I can jump in about Northern Virginia. I believe that the backup diesel generators are allowed to run 500 hours a year. There was a proposal back in 2023 when Dominion was expected to reach capacity.[63] Tim, we've spoken about this previously. You were part of the community effort leading the pushback on this proposal, but DOE proposed relaxing the diesel emission regulations in Virginia. That issue got tabled at the time because of the great work of community organizing, but I expect it will come back around.

**Reid Lifset:** Is there any attention to cumulative emissions in the state air pollution regulations?

**Tim Cywinski:** No. The Department of Environmental Quality looks at things in an isolated sense. Everything is siloed out. This is true for fossil fuel pollution as well. If they want to have a proposal, they only look at that impact as if pollution just stays in one place. The same is true for diesel generation. They have to apply for a permit, but the permit does not include cumulative impacts in the surrounding areas.

**Reid Lifset:** Lauren, can you say more about specifically the local impacts, water impacts?

**Lauren Bridges:** The local impacts vary depending on the locality, the climate, and the type of data center. But essentially, as I outlined, there are various forms of impacts. There are impacts from water consumption at the site. There are also impacts to the water quality. There are impacts at the site of electricity generation. So, it really depends on what locality you're talking about within this tech supply chain, and at what moment in time, and in what season. But really there are deep, deep concerns about the lack of transparency and the lack of reporting.

One part I didn't get to was a proposal coming up in the 2025 legislative session by State Senator Kannan Srinivasan to create a statewide clearinghouse to make data center operators report on their water usage.[64] I have some concerns about what they will actually be reporting. If they'll be reporting, for example, the water usage effectiveness versus consumption, if they're going to be looking at the sources that they're drawing from. But yes, I think that we're going to see more of these kinds of proposals, these kinds of policies, as the development spreads out across the United States, and there needs to be more transparency.

**Tim Cywinski:** I want to add to that because I study industry talking points. We engage with stakeholders all the time. We want to have these conversations with them. Some industry actors decouple water usage from water cooling towers. Let's say the liquid cooling versus direct-source cooling, which I know Lauren can speak more to. But they will separate that out on the policy end because definitions are important when it comes to regulations. Definitions are important when it comes to legislation. So, there's liquid cooling towers, but they don't necessarily consider that it's direct-source water consumption. I think that's important to point out.

**Reid Lifset:** Can any of you say something about regulation that applies to water usage? Is it typically at the state level or is it also local? Is this yet another instance of "it varies"?

**James McElfish:** I would say it varies, but water usage is largely controlled by state law rather than left to municipalities. With municipalities, often if the applicant says, hey, we get our water from the public water supplier and the water supplier says, we're providing it, that's the end of the story. Unless there's a state law providing otherwise in terms of efficiency or usage. In areas of limited water supply, state laws can and do play a role. Particularly in the western United States, where there are water withdrawal provisions where you actually need water rights. They're tracked or monitored, but not necessarily limited.

**Lauren Bridges:** One area that could be interesting here is how municipalities and local governments could require reporting as a part of their application process. So, there might be other ways to intervene even though essentially the state will control the water regulation.

**Reid Lifset:** Are there questions or comments that any of you would like to pose to the other panelists?

**Pranava Raparla:** Yes, I was looking through the chat to see some of the questions that folks were talking about. A lot came up around building really close—setback requirements for where and how close you can build certain types of buildings and facilities like schools, residential areas, and communities.

I was wondering whether you all have thought about that. As I've engaged from DOE with various state and local community officials, where to actually site data centers is a big challenge. It's a different answer for each county and each community. I'm wondering, in your experiences doing this work? What's the right framework to think about this? Obviously, it's not one-size-fits-all.

**Lauren Bridges:** I'd be happy to talk about what happened in Prince William County. Jim, you mentioned the overlay district. I know that that was a community-led effort. It actually came out of a transmission line dispute over an Amazon data center, which began in 2015 and was eventually settled in 2018.[65] But after a long community dispute,

63. Peter Judge, *Dominion Energy Admits It Can't Meet Data Center Power Demands in Virginia*, Data Ctr. Dynamics (July 29, 2022), https://www.datacenterdynamics.com/en/news/dominion-energy-admits-it-cant-meet-data-center-power-demands-in-virginia/.

64. H.B. 2035, 2025 Leg. Sess. (Va. 2025), https://trackbill.com/bill/virginia-house-bill-2035-high-energy-facilities-water-and-energy-usage-info-reports-statewide-clearinghouse-established/2586772/.

65. Rich Miller, *Settlement Ends Dispute Over Haymarket Data Center Power Lines*, Data Ctr. Frontier (Apr. 2, 2018), https://www.datacenterfrontier.

community leaders, Dominion Energy, and policymakers sat down and asked, how do we avoid this happening again? Let's find an area where we think data centers should go in.

They outlined a 10,000-acre area in Prince William County and said it seemed like a good site. It's already zoned for industrial. It's got a brownfield and some greenfield sites. Essentially, since then so many of the applications have been outside the overlay district to the point that people in the community are wondering why they bothered going through the process of sitting down, developing, and outlining this particular space that's good for data center development when all of the applications are just coming in all over the place and being approved with a comprehensive plan amendment.

I think that's a pertinent question, but I also think the level of demand is making it more challenging for both policymakers and community members to find these spaces. It's often also cheaper for land outside of these industrial-zoned areas.

**James McElfish:** The tax advantages to municipalities are pretty great because typically these developments demand very few municipal services. For example, there aren't school children. Essentially, this is a use that can be a cash cow in the real estate markets. So, even if there is a planning or zoning ordinance, there's nothing to prevent someone from coming in and requesting an amendment. Lauren has laid out exactly how that can occur.

**Reid Lifset:** Let me switch gears a bit. We have received some questions about the Energy Permitting Reform Act of 2024[66] and what your views are on that. Any comments?

**Amy Stein:** It is a massive bipartisan proposal that covers things from accelerated judicial review of energy or mineral projects and transmission approvals to expedited National Environmental Policy Act review of geothermal and other resources. It has a lot of things that a lot of people are excited about. For example, the U.S. Department of the Interior (DOI) will hold lease sales for various energy resources on federal lands at different time intervals, and the Act requires DOI to set an increased goal for permitting renewable energy on federal land and expedites review of coal and oil leases.

But there's a lot of concern as well about having so many things in it that it has something basically for everyone to be upset and happy about. People are worried that there's a real conflict in trying to streamline our current permitting processes. We have stalled our transmission infrastructure development in large part because of that, because of the way transmission siting works in our country. Each state gets a decision about it. So, one state could block a multi-state transmission line. It's not a federal siting process for transmission lines, so people get very frustrated by that.

At the same time, people get very frustrated by eminent domain, which allows you to push through a pipeline somewhere people might not want it. This bill allows for more FERC involvement in permitting of interstate transmission projects. We as a nation really have to face these problems and decide how we're going to balance all these priorities. I mentioned the self-supply idea, because those of us who have solar panels on our roofs know about distributed generation. The idea is that if we generate on-site, maybe we can avoid a lot of the transmission costs, because they are expensive.

This is why this idea about co-locating, where a data center developer wants to connect to a resource "behind-the-meter," is very intriguing to me. Are they really taking advantage of the transmission line resources? Are they truly going to function as a microgrid? These are really big, deep questions that I'm not sure we have great answers to yet. We definitely need more thinking about this.

**Reid Lifset:** Let me follow up on that and say there's a difference between saying we need to know about some things and saying we specifically need research on things. If you had a large pot of money that you could dispense for research projects relating to local impacts of data centers, what would they be?

**Tim Cywinski:** I have to appreciate an analysis of the revenue of how much it would cost them to foot the bill for these things, because right now Virginia is footing the bill for the world's Internet access. The transmission lines that we're talking about in the context of the Energy Permitting Reform Act unfortunately make it easier also to fast-track fossil fuel projects.

Most of the transmission lines in our regional grid are being used for the specific purpose to power data centers. Now, I think in basic issues of fairness, that if you have the most money, you're also responsible for the demand, and you pay for it. I want something, I pay for it. That's how it works for normal people. That's how it works for families. Why do industries get the exception? Why do we have to pick up the tab for them?

How we format and build out these things in an equitable way is not just a qualitative question. It is a quantitative one because there has to be analysis of how to do a least-cost scenario for ratepayers. Right now, we don't really have that. All the projections and studies that do exist show across the United States a 25% to a 70% increase in our electric bills.[67] The data center industry in the United States is projected to make $100 billion in revenue every year.[68] So, when I hear we can't do things like clean energy projects or we don't want to pay for transmission lines, I

com/featured/article/11430265/settlement-ends-dispute-over-haymarket-data-center-power-lines.

66. S. 4753, 118th Cong. (2023-2024).

67. Zachary Skidmore, *Report Claims Data Centers Could Cause Virginia Energy Prices to Rise 75 Percent This Decade*, Data Ctr. Dynamics (Dec. 2, 2024), https://www.datacenterdynamics.com/en/news/data-centers-could-cause-virginia-energy-prices-to-rise-75-percent-this-decade-report/.

68. *Data Center Industry Assessment 2025-2037: A $900 Billion Opportunity With Hardware Markets Generating the Most Revenue*, Globe Newswire (Oct. 14, 2024), https://www.globenewswire.com/news-release/2024/10/14/2962613/28124/en/Data-Center-Industry-Assessment-2025-2037-A-

hear someone who just wants to save a buck who absolutely could afford it.

**Reid Lifset:** So, you want to know how much it would actually cost to meet some of these environmental goals. Are there other research projects that you would suggest?

**Amy Stein:** I would love to see better quantification trying to connect the dots between energy usage and specific types of use in the data centers. I have found it difficult to find such data. People seem to attack AI and think every data center is about AI; whereas a lot of data centers are about all of us keeping our pictures in the cloud and maintaining our digital world.

We all sort of use a data center behind the scenes. They are just now in increased proportions with the introduction of hyperscalers in AI, crypto, and the rest. I have found it hard to differentiate unless it's an AI-dedicated data center. I have found it hard to find out, say, how much of this data center is being used for specific purposes. That I think could get tied in, Tim, to what you're thinking about because we benefit from data centers too. I would love more data there.

**Pranava Raparla:** In a similar vein, I think understanding a little bit more about incentive structures we could use for flexible loads. Piggybacking off that comment around what's happening in the data center, specifically the two things that people are trying to balance in the industry are the speed to build the next generation of AI models and being first to market with how much it costs to potentially be flexible when it's better priced on the grid or with maybe a certain generation source that's not consistently 24/7.

There are a lot of opportunities if we can create an incentive structure to delay or to defer some of the work happening in data centers to a different time. We need to understand what the shape of that load looks like and what the shape of that work looks like. We need to also create financial incentive structures for some clients of data centers. Then, the data center developers themselves, when they make those contracts for how they sell power and compute in their data center, will keep it in mind where there's an incentive for the client to say that they'll pay a little bit less if you defer them to a better time for the grid.

**Tim Cywinski:** These are really interesting points that both of you brought up. One is the incentive structures. I'm a little skeptical of incentive structures working because already there's a bunch of incentives that exist. The Biden Administration earmarked $4 billion to invest in nuclear.[69] We've mentioned there's $1.5 billion in tax incentives for Virginia. I think they're already getting enough things. This is more of a stick and less of a carrot situation. You can't get these incentives if you don't uphold climate goals.

To put all this in perspective, data center development is being used alongside fossil fuel development. We can't solve the climate crisis without phasing out fossil fuels. Again, we're talking about research questions. How do we develop data centers, particularly AI data centers that are energy hogs, in a way that does not sacrifice climate goals and doesn't rely on energy that comes with the trade off of making people sick?

I think that should be the framework of the question. Because if policy is more about placating the industry and seeing how we can get them to play ball instead of saying you have to play by our rules—and that's what governments are for, to set the rules of how you can play—then we put ourselves in a position where we're set up to fail. In my 10+ years of working in legislative advocacy, it seems like taking something away that already exists is more effective than saying you could also get this.

**Reid Lifset:** In terms of a research framing, one thing to look at would be the relative efficacy of incentives versus mandates along these lines in this context.

**Tim Cywinski:** Yes, I think that's right. And what do regulations look like? By the way, regulations are alongside economic growth, not downfall. That's a misnomer. Every study confirms this. Regulations mean rules. You can't get something if you do this or that. And that's what we're missing—a policy framework or guidebook. Pranava, that's exactly what I'm looking at. I just think the foundation should be all-encompassing, as you mentioned, Reid. Not just one or the other.

**Lauren Bridges:** I want to highlight something that Tim brought up previously, which is that currently we're not looking at the cumulative impacts. We're looking at a site-by-site situation. Environmental impact reports are completed on a site-by-site basis. This is a huge flaw. It means it's really difficult for local policymakers to be making informed decisions on a case-by-case basis.

What I would love to see, if I had all of the money in the world to run research around this, is an account of all the proposals happening in all different locations, what all of the local resources are, what the spatial implications are, and what the related infrastructure implications are. It needs to be modeled out and it needs to be cumulative.

There's a lot of work to be done and I think it's an area that needs collaboration across different fields. This panel is a great example of how that could look. But I think we need to be paying attention to what is already currently being approved and in development to be able to understand what could be coming down the pike in the future.

**James McElfish:** I would say, too, that emphasis on state experiences and information that's relevant to state legislatures is going to be key because a lot of the sticks as well as the carrots lie in the hands of the state legislatures, in terms

900-Billion-Opportunity-with-Hardware-Markets-Generating-the-Most-Revenue.html.

69. Press Release, DOE, Biden-Harris Administration Announces $4 Billion in Tax Credits to Build Clean Energy Supply Chain, Drive Investments, and Lower Costs in Energy Communities (Mar. 29, 2024), https://www.energy.gov/articles/biden-harris-administration-announces-4-billion-tax-credits-build-clean-energy-supply.

of cumulative impacts, air permitting, siting powers, utility regulation in many instances, and greenhouse gas goals. So, something on the policy side that is not just federal and not just how do we incentivize our industry.

**Amy Stein:** I will add that I think you should all pay attention to what Pranava mentioned. He's got a focus on rate structures and the potential to use data centers as flexible load. I think there's a lot of creativity that can happen that can help. I don't know if any of you are following American Electric Power's recent settlement that it filed with the Indiana Utility Regulatory Commission.[70] It requires these new large-load customers to make long-term financial commitments to ensure that they're paying the cost.

This is something that everybody cares about, but I think that's a success story in some ways—hopefully—for Big Tech. They got together with the Citizens Action Coalition of Indiana and with the Office of the Utility Consumer Counselor. They reached this agreement and they're trying to find creative ways to get them to put their money where their mouth is, to put the money on the table. For example, if you want us to build for you, then you're in this for 10 years.

There was a long history in this country of stranded costs associated with building nuclear plants. We thought they were going to be too cheap to meter. Then, there was all this litigation over who's supposed to bear the burden when the projects aren't completed. So, in the law, we have principles like "prudent investment" and "used and useful" to allocate the risk of overbuilding between utilities and ratepayers. These things keep me up at night. In 10 years, are we all going to agree these were prudent investments when they were made today?

But that would be something to keep an eye on. For anyone who wants funds for the community, I think they got around half a million dollars annually to support low-income electricity customers in Indiana.[71] So, it's not going to be perfect, but it's an example of how maybe everybody has to work to try to create something that could be both feasible and legally binding for these companies.

**Pranava Raparla:** Also, an economic impact analysis, like focusing on redeveloping. Retiring coal assets is one example. There are a lot of opportunities in transitioning from coal to nuclear or coal to solar with storage. There's a lot of those opportunities. I think when we talk to data center developers and we talk to state and local officials, one of the challenges, or the big question, is how many jobs are actually coming to this particular community for this?

There's a general agreement that there's lots of construction jobs. But then, once the site is built, long-term, how many jobs are actually coming from that site? I think we're not all on the same page about what that economic impact actually looks like, so I'd love to see more research in that area too. And we're thinking about it as well.

**Reid Lifset:** There are lots of audience comments and questions about the use of nuclear energy to support data center activity. They are interested in hearing your take on that, especially keeping a focus on the local impacts.

**Tim Cywinski:** Most organizations, including us, have been concerned about the promise of small modular reactors being the silver bullet for data centers. That would be a minimized version of a nuclear plant. It has been proven in a lab, but has never gone to scale in the United States. There was an abandoned project in South Carolina in 2007.[72] They've been looking at expansions in nuclear through S/Mars, as they call them, for a while.

Again, from a utility structure perspective, they can build them. At least in Virginia, they can build them. And even if there isn't any power output, the cost recovery still falls to the ratepayer. That's very similar across the United States. It seems to me that it is experimental. In one way, I love American ingenuity and I want to reach for the stars, but I don't think the risk should be passed on to customers if it doesn't provide any power.

We're mentioning research questions. This would be an interesting thing. Even the power demand we are looking at, small modular reactors won't reach that, not alone. So, what is the viability of small modular reactors? I'm skeptical, but what I'm really perturbed by is that ratepayers might have to pay for a failed project.

Then, of course, from an environmental standpoint, there is waste with nuclear reactors. Where does that waste go? It goes into low-income communities. It goes into communities of color. In fairness, that's just not right.

**Reid Lifset:** I'll wrap up with one question, which is a very difficult one. What do you think is the most politically effective policy pathway for dealing with these problems? We can be policy analysts and talk about in theory what's the most effective policy. But obviously we live in a political world. Among the different ways of addressing some of the concerns that have been described here, what are the ones that are most politically viable?

**Amy Stein:** I think that we are going to see streamlining of permitting coming in the next few years. And Tim's right, it's streamlining for everybody. It's not going to be streamlining specific to certain types of energy. Politically and realistically, I don't think that's going to happen.

It goes back to the nuclear question. It's a very interesting one because nuclear has always caused divides within the environmental community. It's a carbon-free resource, but we still don't have anywhere to put our permanent

70. News Release, American Electric Power, I&M and Stakeholders File Large Load Settlement to Advance Grid Reliability and Support Economic Growth (Nov. 22, 2024), https://www.aep.com/news/stories/view/9883/IM-and-Stakeholders-File-Large-Load-Settlement-to-Advance-Grid-Reliability-and-Support-Economic-Growth-/.

71. *Id.*

72. Brad Plumer, *U.S. Nuclear Comeback Stalls as Two Reactors Are Abandoned*, N.Y. Times (July 31, 2017), https://www.nytimes.com/2017/07/31/climate/nuclear-power-project-canceled-in-south-carolina.html.

high-level nuclear waste—the failed Yucca Mountain is but one blip in the tortured history of nuclear energy in this country. Not to mention we still would have to mine for the uranium. Nuclear is not quite a renewable, but it counts as carbon-free so can help Big Tech achieve their carbon goals.

I think we're going to see some movement on nuclear. It might not just be in the small modular reactors that Tim and I were talking about. It's going to be in the creativity, like the Three Mile Island restart, like finding plants that already exist, but maybe were shut down for economic reasons and could now be restarted, so we could avoid the $36 billion construction costs. As long as they pass the Nuclear Regulatory Commission safety approval process, they can restart their licenses. That would be two realistic things that I could see happening.

**Pranava Raparla:** Adding on the policy question, plus-1 to permitting reform. In general, a big challenge we have is building more infrastructure more quickly. Even independent of data centers, we need that. We need that in this country, across many communities and across many regions. Part of that is permitting reform. Part of that is different tariff designs. Other innovative structures where we can incentivize certain types of build-outs that are not super possible in the current regulatory environment. We need a lot more thinking in those spaces.

Also, looking at the federal level, we need more coordination. This is not to say policy, but rather more coordination between all the parties, both regional and state parties, developers, utilities, PUCs, communities, and federal entities coming together to brainstorm all these options. There are many levers to pull to build well and with community in mind, but they're easier when you have a particular site in a particular region. It really requires bringing a lot of people to the table on that. I'd love to see more of that.