Data Center Demands & Impacts on the Energy System: An Energy Horizons Special Report

OnLocation, Inc. Webinar

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[upbeat music]

(00:11)

[Francisco de la Chesnaye]

Good afternoon, everyone and welcome to OnLocation's Webinar on Data Center Demands and the impacts on the U.S. energy system. This is a follow on to our earlier released Energy Horizons report from last June. Just to quickly cover the disclaimer, which is effectively to communicate that this is an independent product from OnLocation. We are using a custom and enhanced version of the Energy Information Administration's National Energy Modeling System to produce this work.

(00:45)

But we just want to make sure this is clear that this is the work that we produce ourselves as an independent product. Today, we're going to cover a brief introduction, which I will provide, and then we're going to move to current market and important issues related to data centers and their demand, which should be covered by my colleague Samaneh Babaee.

(01:05)

Then after that, Hao Deng, who led the report and the analysis, will present new work we've completed with an enhanced version of the National Energy Modeling System. And then at the end, we will open it up for questions from the participants and include a broader set of OnLocation staff. A quick introduction to OnLocation. We are a small consulting firm that specializes in applying the latest energy, economics and energy system models to evaluate energy technologies, climate mitigation technologies, and energy and climate policies for a range of clients from the US government to think tanks, not for profits, and the private sector. OnLocation is also a subsidiary of KeyLogic corporation.

(01:58)

So why did we do this work? I think many of you know that the Energy Information Administration did not produce its Annual Energy Outlook, given that on location, our experts at the deployment and development of the NEMS model, we decided to provide an Energy Horizons report with a projection of the US energy system and CO_2 emissions up to

2050 and provide that as a benefit to the climate economic, energy, modeling and policy community.

(02:29)

In addition, we wanted to make sure to continue some of the development with the NEMS model demonstrate new modeling capabilities with technologies, and also in this case, evaluate some of the key driving forces in the US energy system. For example, on data centers, this webinar today is a summary of the fuller longer report that will be made available on OnLocation's webinar in the next couple of days.

(02:55)

As I mentioned, we have deployed a custom, an enhanced version of the National Energy Modeling System which we define as OL24-NEMS. The model is a very detailed representation of the full functioning of the U.S. energy system, and it has various modules that are interlocked, starting with primary energy across different energy sources to the conversion of those energies over to the rest of the system.

(03:27)

Finally, going to the demand modules which represent how end use consumers use and deploy energy as part of the U.S. economy. OnLocation regularly customizes and enhances the model, and in this particular analysis, we have enhanced the commercial buildings, part of the model and its demand for energy, particularly with a focus on projecting data center demand out to 2050.

(03:56)

There are many different drivers and key questions that you can see pretty much almost every single day with respect to the growth of artificial intelligence, cryptocurrencies, streaming services and many other energy consuming activities that are going to continue to drive more and more energy demand for data centers across the U.S. economy. So, we wanted to evaluate many of these drivers and questions, and I'm sure there's many more that participants can come up with.

(04:30)

But the way that we decided to evaluate this, to kind of basically put some voting on it, was to develop three scenarios. We start with a high growth scenario, which takes the reset, accelerated growth rate and uses that at a faster pace with a little bit of tapering off after 25, but continues out to 2050. At the other end, we have a low growth scenario which is effectively using some of the more recent growth and keeping that at a more lower level again out to 2050.

(05:03)

And then lastly, as a counterfactual case that we can more easily see, the difference with data center demands is one that effectively doesn't have any artificial intelligence growth is seen as more sort of a historical growth in commercial building space for energy consumption. So, the highlights of the report, just to give this to you upfront and then we'll dove into it in much more detail, is that we do see in the high growth scenario a substantial increase in electricity consumption for data centers up to 20% by 2050.

(06:06)

At the same time, while the U.S. is still projected to go in energy transition to cleaner energy in order to reduce CO_2 emissions. At the same time, in the clean energy expansion, we see the changes in the composition of electricity generation, mainly staying with natural gas, additionally with more renewable generation. And then we also see a potential for the increase of nuclear power, which again you can easily discern from some of the latest announcements made.

(06:09)

More recently, Microsoft's agreement with Constellation Energy to restart the Three Mile Island nuclear plant to meet its artificial intelligence energy demand. And we continue to see these pretty much every day. So, with this now, I'm going to turn over the current assessment to my colleague Samaneh Babaee. Samaneh.

(06:32)

[Samaneh Babaee]

Thank you, Francisco. This section is an overview of recent literature on U.S. data centers and a more complete version of this section will be available in our report. So more than a 4% of total U.S. electricity consumption today is from data centers and the two main driver for that are consumer preferences and Digital Transformation. Consumer preferences change over time, especially over the past five years after COVID. Consumers demanded more innovative products and digital services from data centers that consume a lot of energy to provide this kind of services.

(07:20)

For example, cloud computing, artificial intelligence models on applications, and other services such as crypto mining. As a result of these changes, a significant growth in electricity demand from data centers is projected to happen in the next ten years, with a potential growth of 9 to 12% per year by 2030 and 15 to 20% increase in total electricity demand by 2035.

(07:49)

And data centers have a large portion of that 20%. And as I mentioned, the rapid expansion of AI systems and also high-performance computation by the major tech companies and cloud service providers such as Amazon, Google and Microsoft are the main reason for this growth. So, as of August 2024 and according to cloud scene data, there are about 5400 data centers in the U.S. and their power consumption mainly depends on the size, design and specific use case of the facility, as well as the energy efficiency of I.T and non-I.T equipment.

(08:36)

The map on the left, it shows electricity consumption from data centers in 2023 by state. And as you see that data centers are distributed across the country with high concentration and in some of the states such as Virginia and Texas. In Virginia, specifically Northern Virginia, and also the state of Texas, they have more than 20 terawatt hours of electricity from their data centers.

(09:06)

And after these two states, other states such as Georgia, Arizona, West Coast, California, Washington, Oregon, and also Midwest, Illinois and Iowa as well as Pennsylvania, they are among the top highest data center electricity consumer. So, what are the main type of data centers? There's no official definition for the size and type of the data centers, but basically, they are either small scale or large scale. Small scale data centers have less than 10,000 square footages in space with the capacity of 500 kilowatt to five megawatts. Large scale data centers have the space larger than 10,000 square footages with more than 40 megawatts in IT capacity, and their average load is about 90% of total U.S. data center loads.

(10:07)

The small-scale data center, they include server rooms and edge data center. Edge center are this small, decentralized facilities that they provide their storage and computational services closer to where data is generated and consumed. So, they are closer to the end user and their major benefit is they are quick in delivery of their services with minimal latency and high-performance.

(10:37)

Small-scale data center, they provide their services for individual and local customer and small businesses in general. Large scale data center they provide their extensive operations such as cloud computing, processing, large data set AI models and training models, machine learning to bigger organizations, to government agencies, to multiple businesses at the same time, sometimes entire industry. There are three types for the large-scale data centers.

(11:11)

Enterprise co-location and hyperscale enterprise data center is owned and managed by a single company, and that company has a full control over hardware, software and security system of the data center. Co-location Data Center provides server hosting and hardware software services to multiple businesses, at the same time, in the same location. So basically, multiple businesses share one space and then hyperscale data centers, usually larger than 100,000 square footage.

(11:51)

Basically, they support major cloud providers and they can quickly expand to meet the computational and storage need of various organizations. It's important to note that the hyperscalers are the main reason for the data center expansion and growth in the next ten years. In terms of electricity consumption, a data center can be divided in three sections. I.T. Equipment, cooling system and auxiliary component.

(12:23)

I.T equipment includes servers, storage system and network infrastructure. Servers are the largest energy consumer of that data center because they handle the data and information. Storage system can be conventional hard disk drive or more efficient solid state drives for storing data. Network infrastructure includes such as routers and any component for transferring data and for connectivity.

(12:52)

And cooling systems are essential part of a data center and they provide optimal temperature for I.T and non I.T part of a data center. They can be a traditional HVAC system or more advanced technologies like liquid cooling and immersion cooling. An auxiliary component includes uninterruptible power supply, security system, and lighting. Uninterruptible power supply or UPS provides electricity in emergency situation when power is out. Security system has sensors, cameras and anything that protects a data center.

(13:35)

Lighting has a small portion of total electricity consumption on a data center. And as you see, the highest share of electricity consumption goes to I.T Equipment. But in general, these shares very much depend on the size of their data center and also over time, as we have more efficient technologies like cooling system, the range can change. It's important to note that even today with the 30 to 40% of total energy consumption going to cooling system, our literature review shows that the average annual load is fairly constant.

(14:15)

I think that will be covered more in our modeling section. So what are the limiting factors for data center expansion? The first one is site selection and land acquisition, which is highly impacted by how much power and internet connection is available. Also, how restrictive is permitting for building and construction and also, for example, zone approval. The other factor is how hard it is to comply with the state and local regulations and policies.

(14:52)

In addition to the federal regulation and policies and the community, resistance or acceptance is another factor. The second one is power, infrastructure and backup system. So before 2020, the average timeline for constructing a data center was around 1 to 3 years. Today is 2 to 6 years, and the main reason for that is lack of access to power.

(15:17)

So, for example, a data center larger than a 100 megawatt today can take up to seven years to connect to equity because there is a queue. The third reason is infrastructure and technological requirements, which can be impacted by supply chain issues. For example, anything related to the servers, chips, semiconductors or advanced billing system or even the security system.

(15:44)

And last but not the least, is a highly specialized and skilled workforce. But the surging demand for data center, it's very important and necessary to have trained workforce and also more automation. So, for example, if a data center is located in a remote area, the local workforce may not be familiar with installing, for example, advanced cooling system maintenance or the backup generator, the more advanced one, or the security system.

(16:17)

So, the shortage of skilled professionals can also be another barrier to data center growth. And the last slide in this section is about the primary and secondary source of power for data centers. So, with the growing importance of grid reliability, and also renewable energy integration, as well as climate change goals and extreme weather events and also the sustainability goal of a gigantic companies, it's important to have a robust and clean primary source of energy and also a reliable, low environmental impact for backup power.

(17:00)

So some of the examples of clean energy generation as the main source today are geothermal, small modular nuclear, hydropower, fossil with carbon capture and storage, and also solar and wind storage. And the examples are, for example, geothermal, Google and metal invested in geothermal for their centers, small modular nuclear, Amazon and recently Microsoft, which has invested in a retired nuclear power in Pennsylvania.

(17:36)

And the goal is to provide around 800 megawatt electricity for Microsoft by 2028, for the next 20 years from this retired power plant, nuclear power plant, which is called Three Mile Island. A hydropower or there's a company which is basically a data center provider called Iron Mountain. They invested in hydropower located in West Virginia and also Pennsylvania.

(18:06)

Fossil wood, carbon capture and storage, this is still under development, but Chevron and Microsoft in a joint effort, they are investing and working to develop old fossil with carbon capture storage for data centers. Solar and energy storage, it can be a primary or secondary source of power. And many companies have already invested on solar and wind storage. For the backup power, today, most of the data centers in the U.S. are using the diesel generators.

(18:40)

But for reliable and more environmental friendly backup power can be batteries, either lithium ion or solid state. So for example, Google already started to replace their diesel generators with batteries. Fuel cell, which is mainly hydrogen, Microsoft invested in hydrogen fuel cell. It can also be LPG and biogas as well. Solar and wind power with battery storage. I already talked about that.

(19:12)

Compressed air energy storage, this is still under development and a pilot project is going on. But the idea is to use the potential energy of compressed air and expand that stored air to discharge electricity when it's needed. And the last one is alternative fuel generators, and one of the biggest data center provider in the world called Equinix, invested in bio gas generator and basically using methane from organic waste to produce electricity for their data centers.

(19:51)

And with that, I'll turn it over to my colleague. Hao Deng to cover the energy system modeling results for data centers.

(20:02)

[Hao Deng]

We are now in the second half of the webinar, and I'd like to thank the summary for the insightful presentation so far I'll be thinking about here to dive into the analysis of how data center demand is shaping the U.S. power sector over the coming decades. Let's begin by discussing how data center demand is concentrated in specific regions and what that means for power systems.

(20:24)

From the power systems perspective, the key factors are where, when and by how much data center demand occurs. This map highlights the regional nature of that demand. What's crucial here is a significant variation in generation mix and availability of clean energy resources across different regions where data centers are located, where we directly influence capacity expansion, emissions and the grid reliability.

(20:52)

For this analysis, we've located data center electricity demand from the state level to 25, the electric reliability Region's PJM and the ERCOT country lead in data center demand. With these regions seeing the highest concentrations, this concentration will have major impact on their respective power system and well, I explore these regions in more detail later. In addition to location when your activity is consumed also matters to power systems.

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Unlike typical commercial buildings that peak, the state datacenters maintain a flat load throughout the day. And here, however, as technology evolves, this load pattern could shift depending on how they model and influence develops in the future. Now, with this understanding of where and when now, let's turn to the magnitude of data center demand growth. We modeled three scenarios high growth, low growth and no AI growth, a counterfactual case to explore what would happen without current AI research.

(22:00)

In the no AI scenario, it is important to know that demand still increases but at a much slower pace. Essentially the demand investment scenario follows historical growth patterns, with no additional surge in workloads like machine learning or AI train. This figure presents a selection of recent reports projecting datacenter demand.

(22:25)

What's particularly striking is the uncertainty reflected in their rate not just for the near future, but even for recent historical data. Drawing from this research, we get out of the two growth scenarios showing a surge in the short term, followed by its past current trajectory, commonly used to model the development of new technologies. And it's difficult to pinpoint exactly how those, but it is certain that data center demand has potential to significantly affect the electricity use.

(22:57)

Here we compare datacenter electricity demand with the electric vehicle demand, a key benchmark over the next 30 years. Data center demand could grow by over 600 kilowatt hours, accounting for nearly a third of commercial electricity use by 2050. This is equivalent to the output of roughly 130 gigawatts of new natural gas power generation. What's interesting is that in the near term, data center demand could surpass any emerging demand if not of replacing other loads, but adding to a already growing trend of electrification across the economy.

(23:38)

This puts additional stress on the power sector, especially in the short run, as that's to meet demand from both datacenters and electric vehicles. From late 2030 to 2050, the combined load could range from 30% to 35% of total electricity consumption. Next, we'll look at a total electricity demand across various sectors. This slide shows a stock bar chart illustrating demand by sector residential, commercial, industrial and transportation from 2020 to 2050, across different scenarios. Even without AI driven growth, national electricity demand is projected to rise by 48% by 2050, driven by a broader economy wide electrification under the post IRA policy landscape.

(24:32)

On top of that data center demand as an additional layer of pressure on this already growing trend. In the high growth scenario, with a large data center expansion, the electricity demand could increase by up to 69% by 2050, further intensifying the strain on the power grid. What this means is that while electrification alone posed significant challenges, data center demand could drastically accelerate the need for new capacity.

(25:00)

Now, this slide represents the core of our analysis. How different generation technologies compete and contribute to meeting the incremental demand while considering the geographic and temporal distribution of data center consumption. The model explores the main pathways the power sector uses to address that demand by building new capacity, delaying planned retirements or increasing the output of existing resources. Focusing on the differences between the No AI scenario and the high growth scenario.

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This figure shows how power sector response at a national level. In the near term, particularly by 2030 coal generation actually increases the rate of retirements of the existing coal plants. This temporary force house meet the surging demand from data centers. But I also underscore the challenge of balancing immediate demand with long term decolonization goals. As coal is expected to phase out due to the environmental regulation by 2040, natural gas will initially fill the gap.

(26:10)

By looking further into the future, renewables and nuclear would take a much larger role. By 2050, clen energy sources are projected to supply 92% of the incremental quality in the high growth scenario. This shift towards clean energy system funding costs and a supportive policy such as IRA and has significant implications on emissions in the long term. Now let's talk about the capacity needed to meet this growing demand.

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Initially, we see natural gas, solar and battery storage, driving capacity increases. Over time, wind and solar dominate new entities, while battery storage type an essential role in supporting grid reliability. Natural gas capacity, particularly from combustion turbines is also added to enhance grid reliability in the short term. What's interesting here is that by the long term nuclear capacity still grows due to both retention of existing facilities and a new construction of small modular reactors. This expansion highlights the evolving mix of technologies deployed to meet a data center demand with new renewables and storage is playing increasingly a central role.

(27:23)

Now, let’s zoom in PJM, the region most impacted by data center demand. In 2023, PJM accounted for 34% of national data center electricity demand. Most of this is concentrated in the Dominion subregion, but as the effects ripple across the entire PJM region into inter-regional trade and exchanges with neighboring areas. It was noteworthy at this shift in PJM generation mix over time. By 2050, solar and wind extend significantly, while nuclear generation increases after 2045 cost decline, and existing plants delay retirement.

(28:06)

This shift highlights how PJM generation landscape is adapting to the high concentration of data centers, transitioning towards a cleaner energy mix in the longer term. Staying with PJM, let's look at the capacity. The total electricity capacity in PJM is projected to more than triple by 2050. Solar, wind, and storage make up most of these new capacity additions.

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In the high growth scenario, clean generation plays an even larger role, making up roughly 54% of incremental capacity by 2030 and the rising to 100% by 2050. Coal plants, as shown in the dark blue at the bottom of the stack bar are expected to retire by 2040, driven by the new EPA greenhouse gas regulations. This transformation in PJM's capacity mix underscores the region's shift was clean energy, with photo and storage being critical to meeting the rising demand.

(29:05)

It also highlights the long term role that policy will play in shaping the power roles, especially at coal plants, plays out in favor of clean up technologies. Now let's move on to ERCOT in Texas. In 2023, ERCOT accounted for 14% of national electricity demand from data centers, making it another key region for analysis. Unlike PGA, ERCOT has limited ability to trade electricity with neighboring regions, which means that building new capacity is essential to meeting growing demand. Overtime, wind generation continuous to expanding growth while storage becomes a major part of the generation mix.

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In the high growth scenario, nuclear generation more than doubles after 2045, driven by declining construction costs and IRA clean electricity credits. This expansion of nuclear displaces some natural gas generation for this diversifying ERCOT energy mix and is supporting its capacity to meet increased electricity demand. In terms of capacity, ERCOT's total capacity is expected to more than triple by 2050.

(30:15)

And in the high growth scenario, ERCOT even quadruple solar, wind and storage dominate capacity additions along with new nuclear capacity, particularly in the high growth. One key difference in ERCOT is that construction costs for new nuclear and other generating capacity are projected to be lower than the national average, making it more cost effective to build out in this region. This positions ERCOT well to handle growing datacenter demand while keeping costs rather manageable.

(30:51)

By 2050, ERCOT'll have a much more diversified and resilient energy mix driven by the expansion of these technologies. Now that we've covered the regional results for ERCOT, let's shift the back to the national level and are focusing on CO_2 emissions across the country. Well, all scenarios, CO_2 emissions decline significantly over time as fossil generation replaced by cleaner sources.

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By 2050, emissions are similar across scenarios driven by long term clean energy growth. However, between 2025 and 2035, emissions rise by about 90 million metric tons per year in the high growth scenario due to increased fossil generation, but especially coal and natural gas to meet data center demand. This highlights the challenge of balancing rapid demand growth with innovation. In the long term, the shift to clean generation ensures emissions decline as supporting water decarbonization goals.

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Now to wrap up our analysis, let's review the key takeaways. First, data center demand is expected to grow significantly, accounting for up to 20% of total electricity demand by 2050. However, this growth will coincide with rapid transition to clean energy sources, which should help minimize long term emission impacts. In the near term, natural gas and existing fossil fuel capacity will still play a key role.

(32:23)

However, as we approach mid-century, we expect clean energy expansion to take over in the dominant new capacity. Meeting this demand will require contributions from multiple clean energy sources. Renewable generation, particularly solar and wind, will continue to account for the majority of new capacity in most regions. Battery storage will also be critical at the expense of availability of renewables and supports, grid reliability. Additionally nuclear power, particularly from small modular reactors will be play a prominent role in the later years, providing stable zero carbon energy to balance intermittent renewables.

(33:04)

These trends highlight both challenges and opportunities as a power sector adapt to a growing energy demand. With that, I'll hand it over to Francisco, who will discuss future directions and open floor for questions. Thank you.

(33:26)

[Francisco de la Chesnaye]

Thank you Hao and Samaneh for covering all of that. At this point I just want to thank the entire production team across OnLocation, as well as our colleagues at team people who helped us with the video production, so that we could produce a high quality product. So, now we want to move on to the question-and-answer session of the webinar.

(34:01)

Thank you to many of the participants who submitted questions beforehand and even some that have been coming in during the presentation. One of the few, one of the first ones we got actually is from very recent events. It has to do with the recent Talon and Amazon as well as the Microsoft Constellation Energy and Three Mile Island Restart.

(34:33)

Which is effectively, what are our thoughts on those actions with ones that we expect to continue and how does that relate to in climate analysis and policy? Is the question of additionality, in terms of greenhouse gas reductions and clean power. For that, I'm going to ask Frances Wood to address that, Frances.

(35:03)

[Frances Wood]

It is obviously a very important one, but hard to measure. In the modeling context, it's relatively easy. We could create a no air growth case and measure against it. In the real world, that's much more difficult. We are projecting the electricity sector to become less carbon intensive over time with a lot of renewables and other clean generation technologies coming online, regardless of the data center demand.

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So one question is they start making, building their data centers and contracting for new power supplies. There is always that question of what might have happened anyway and are they sort of contracting with the clean energy that would have been built? And then the other demands are just being met by everything else. But I think there is some evidence here in actions that the data centers have been taking, that they are trying for additionality.

(36:00)

In particular, the two that the question raised. One was the Talon, which is using an existing nuclear plant to satisfy demand from a data center which was uneconomic, in economic difficult times. So one could argue that perhaps that data demand is actually helping that nuclear plant survive. But it also was existing. So maybe that's whatever survived anyway. And it's harder to say that that's additional. On the Microsoft action of actually working with Constellation to bring back one of the Three Mile Island reactors does feel like additionality like that probably wouldn't have happened unless somebody had really gone forward with a big contract and made that possible.

(36:44)

So I think there is evidence that's one way to measure that additionality are things that we really didn't think would have happened in the absence. And to be clear, our modeling, we didn't consider that aspect. I mean, it's a very recent, fairly recent occurrence of this bringing back existing nuclear plants. So we don't really know how much that will happen.

(37:03)

I think the other sign of additionality is when the data centers are willing to pay premium. You don't really know yet where the tip of the iceberg. We don't yet know how much they're willing to pay. But if they're willing to pay to bring on new innovative technologies, then I think that does speak again to additionality probably are leading to reducing the emissions from their centers specifically above and beyond the carbon reductions that are occurring in the natural course of things.

(37:31)

[Francisco de la Chesnaye]

Thank you, Frances. Let's see, you've got another question here. This relates to, Hao was part of the presentation. And it essentially, you know, there's quite a lot of interest in the regional low growth numbers and evaluating particularly how low and no carbon technologies could supply a primary energy demand to meet a lot of the both regional state and, of course, national targets and with respect to, you know, different types of generation.

(38:10)

So I guess effectively, it's more of a question about the regional low growth, regional generation. And another question that was related to microgrids. But let me throw this over to Hao so he can talk a little bit more about the regional analysis that he that he did.

(38:33)

[Hao Deng]

Thanks for the question. When it comes to load growth, our current analysis assumes a uniform data center growth rate across regions, though there are certainly is significant uncertainty regarding the future locations of these data centers. And while data center is a major component of the electric load growth, I like to point out that they're are just one part of a broader trend driven by the ongoing economy wide electrification, including EVs and the industrial electrification and the residential electrification, etc..

(39:07)

In terms of how low end and low carbon technologies are meeting this demand, our report shows that renewable energies, particularly solar and wind, plays a pivotal role. Nationally, clean energy sources are expected to supply up to 92% of the incremental generation by 2050, brought by the data centers in the high growth scenario. This shift is underpinned by funding costs, advancements in technology and the policy supports, such as IRA.

(39:38)

And regionally, PJM are home to the largest concentration of data centers today. It is expected to see significant reliance on solar, wind and nuclear in the later years to meet future needs. Our full report also provides the results for the Northwest Power Pool. In comparison to PJM, the results there show relatively more yield out in wind, giving its resource endowment.

(40:05)

Here I'd like to note that our modeling results do cover all 25 electrical reliability regions and we are providing a detailed look at how regional differences affect our ability to meet a rising demand with clean technology. Yeah.

(40:24)

[Francisco de la Chesnaye]

Thank you, Hao. All right. Let's see. We're getting a lot of questions coming in. So, I'm sort of doing doing my best job here to referee this. This next question, I think goes to Samaneh as it relates to current policies and measures. So, that's let's see, what are the standard policies either under development or currently practice through just deployed in the model with regard to data centers that might restrict the types of backup systems that are employed?

(41:00)

And specifically, what are the percentage of this? What's percentage of the system now in the future that would have renewable energy in addition to battery storage, included in potential stated policies? That's a tough one. Samaneh, I'll part but I'll pass it over to you nonetheless. Go ahead.

(41:20)

[Samaneh Babaee]

Okay. Thank you. Actually, that's a good question. So today there is no single specific federal authority. That sees the type of backup power for data centers. However, there are some standards and politics at the state or federal that they either encourage or require more a clean option for the backup power. More energy efficient technology for backup power. So, for example, EPA under a Clean Air Act, they regulate emissions from stationery and diesel generator, and that will limit the data center to use a diesel generator.

(42:09)

Or they can install emission control technology to comply with the EPA rule. Another one is California Air Resources Board, which has stricter emission standards than EPA, especially for a diesel generator and during like non-emergency hours. And in general, California encourage data centers to explore other clean options for backup power, such as batteries, for example. And then at the federal level, the only thing that I found was US federal data center optimization initiative that will require the governmental data center to adopt more energy efficient technologies and practices in general for the data center and for the backup power.

(43:09)

And then, I think the second part of the question is asking about the role of renewable in the backup power for data center today and in future. So today, most of the data centers, they use diesel generators as their backup. And only recently Google started to replace their diesel generator with batteries. Also, Microsoft is investing and working on hydrogen fuel cell as their backup for data centers.

(43:44)

And you may know that these major tech companies, they have their own ambitious sustainability goal, for example, Google, Amazon, Microsoft and Metal, all of them, they have net zero emission target for their entire operation by 2030. Amazon, I think it's until 2040. And then in addition to these, we have state level prices in California and New York, we have a state policy of 100% clean electricity by 2040 and 45.

(44:26)

And then at the federal level, we have the administration goal of 100% clean electricity by 2035. So considering all of these goals and targets together, it's expected that renewable will grow significantly in future as the main source of power for data center or backup power with battery. But in addition to renewable. Our analysis shows that Google have also nuclear as an attractive, viable option for the main source of power and literature shows hydrogen fuel cell as well as the backup power.

(45:10)

[Francisco de la Chesnaye]

Thank you, Samaneh. Yeah, there's a lot to unpack there. Let's see a question here to Frances. This is about different primary energy, particularly natural gas. So let's see. The question is, I'd like to hear more about what impact data centers may have on natural gas demand, particularly by the different regions, Frances.

(45:41)

[Frances Wood]

Thanks. Yeah, we didn't speak much about the fuel markets, but clearly that's an aspect that we have given that we're running an integrated energy model, as we saw in some of these sample regions. We showed you that in the near term there is an increase in gas generation in some regions to meet this higher data center demand. And so total natural gas demand in the power sector goes up by somewhere between a half and a TCF, full TCF of and most of the you know, varies by year.

(46:16)

And most of that increase in demand is where you would expect it in the sense that it is in the regions like ERCOT, PJM and the Northwest that have high growing demands. I think that probably answers the question.

(46:34)

[Francisco de la Chesnaye]

Thank you, Frances. In next question here, I'll start and take from here, which is really related to some of what we're starting to see with these new announcements. But it has to do with clean power sources. So effectively with clean power sources, for example, wind, solar, nuclear, hydro, geothermal and, some would classify fossil with carbon capture, utilization and storage could be best suited to provide this new increase in demand for data centers of electricity.

(47:19)

I would put that in a context of the potential for microgrids. That would be the combination of renewable power with a large-scale energy storage. We're already seeing some clear movement with nuclear power. And if fossil generation, say, natural gas combined cycle plants with carbon capture and storage could be deployed, then that would give much greater flexibility, regionally for to meet this new power demand.

(47:59)

And in the work that we did here, we didn't get into too many specifics at the regional level for micro grids as I define them. But it is very much a next step of our analysis. Okay. So with this, I think I'm going to move back to the main slide deck just to sort of wrap everything up. But, sure we can get that back up on the screen.

(48:34)

All right. So I think from here. One second.

(48:52)

So what I want to do here sort of just effectively wrap things up. So what we provided today was a essentially a summary of the report that contains quite a bit more background information that was covered by Samaneh and was also compiled by Maria Lopez. And then much more details and longer section on the analysis that we did with, this enhanced version of of the NEMS model.

(49:25)

And effectively from here, there's a whole range of additional questions that were submitted to us, but also further research needs that. So we're going to be sort of digging into what we covered so that clean energy sources, in addition to that, there's going to be the regional question is going to be very important in the sense that there's many different, let's say, regional variations in terms of the power markets, electricity price, climate and environmental regulations, infrastructure, connectivity that we're going to start digging into to provide a better sense as to the regional competitiveness for data centers.

(50:19)

And then I think one of the last ones and one thing I want to make sure we reinforce is that in the analysis that we presented, our main scenario is one that includes all of the existing policies and measures in the United States. So that includes the recently enacted Inflation Reduction Act as well as if there is state and regional, environmental and climate mitigation targets.

(50:56)

We did not run a more stringent climate mitigation target. For example, a net zero greenhouse gas target to 2050, which is which is one that is is very much considered. In that forthcoming scenario, this additional load growth demand for data centers, which in our modeling could get up to about 30 to 35% of total electricity generation by 2050.

(51:32)

And again, if you just go back a couple of years, that load really wasn't included in most of the projections. So that increasing projected demand for electricity from data centers, combined with a more stringent climate mitigation target, is going to change the results that we showed. And that is another key party analysis from our perspective. So I think with that, I'm going to just thank the team here at OnLocation for the work that they've done and this analysis and presentation and also our colleagues, on Team People and encourage all of the participants in the webinar.

(52:19)

Sorry, we didn't have a chance to get to all of the questions, but please reach out to us and we'll get back to you as soon as we can. And remember, we will be sending out a note with the link to the final report once it is completed in a couple of days, so with that, I'm going to move to wrap this up, conclude the webinar and thanks everyone for attending.

(52:48)

[upbeat music]